

Safety Critical Equipment Management in Aging BSP Assets

BSP Team
Technical Safety Team



**Safety Case
Symposium 2019**
Singapore
Mar 26 - 27, 2019

Agenda

- ☐ Background and history
- ☐ Safety critical equipment – definition & identification
- ☐ Safety critical equipment determination
- ☐ Discipline-wise Ruleset for various SCE's (1)
- ☐ Discipline-wise Ruleset for various SCE's (2)
- ☐ Results of SCE's Rationalization
- ☐ Impact of SCE's Rationalization

Background and History

- ❑ BSP is operating aging assets, some more than 80 years
- ❑ Asset integrity programs are not effective as SCE's in BSP are more than 40-60% comparable to similar assets
- ❑ Maintenance backlog and SCE deviations are high
- ❑ Some systems do seem to qualify as SCE when compared to other locations
- ❑ As part of Asset HSSE case refresh it was decided to revisit SCE by relying more on quantitative risk assessments than merely qualitative studies and customizing a ruleset to identify SCE

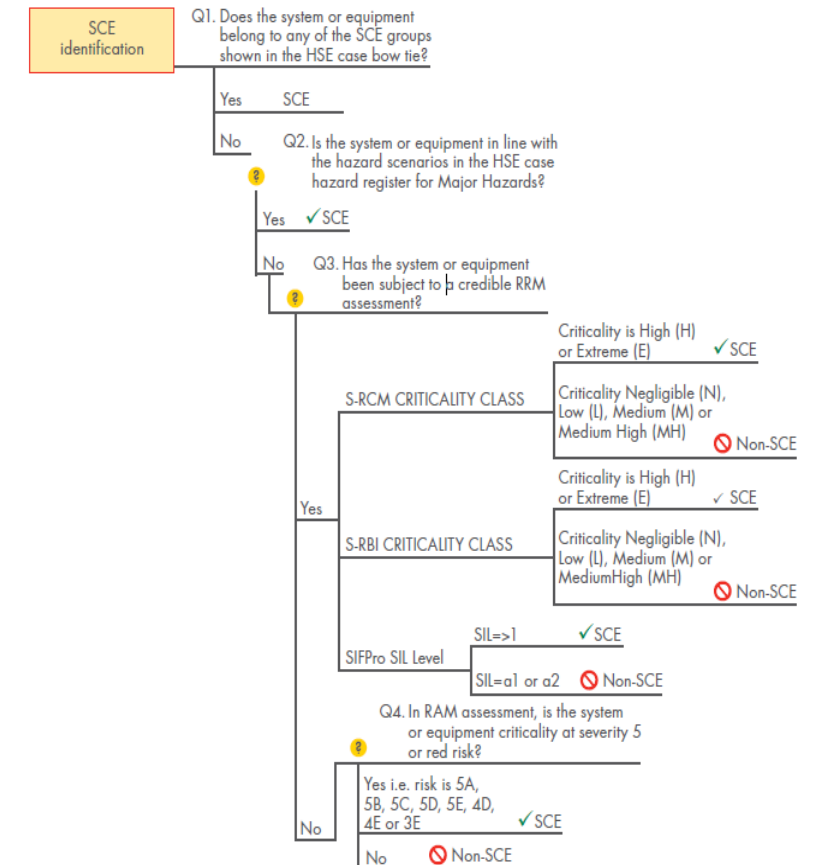
SCE = Safety Critical Equipment



Safety Critical Equipment – Definition & Identification

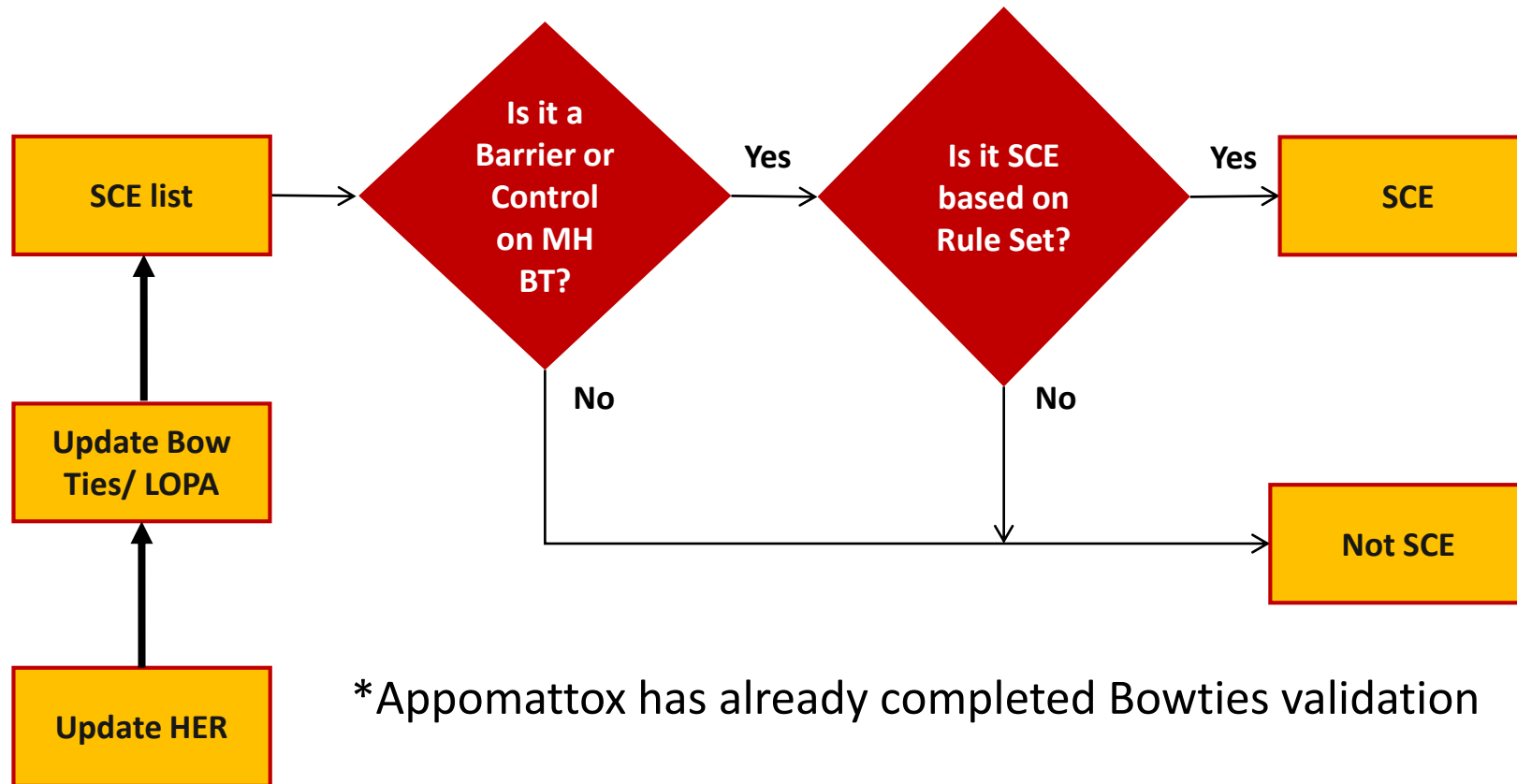
Shell's Definition

- An item of equipment or structure, or a system (including software logic), that acts as a barrier to prevent the uncontrolled release of a Hazardous Substance or release of energy leading to worst case credible scenario with RAM red, yellow 5A or yellow 5B Risk, or acts as a barrier to control or mitigate the effects of such a release. HSSE critical equipment is also known as Safety Critical Equipment or SCE.
- Barrier validity tests to ensure barriers are:
 - ✓ **Capable / Effective** – Big enough, Strong enough, Fast enough
 - ✓ **Independent** of other barriers and the threat
 - ✓ **Auditable** – Verification the barrier is functioning



Safety Critical Equipment (SCE) Determination

Process to determine if a system or equipment is a SCE



*Appomattox has already completed Bowties validation

Discipline-wise Ruleset for Various SCE (1)

Ruleset was developed to determine SCE for static and rotating equipment containing HC or hazardous substances, for control systems, civil and electrical equipment mainly on left hand side of bow tie and for the recovery barriers.

RULESET FOR HC CONTAINING EQUIPMENT

FOR GAS / MIXED PHASE

Pressure (Psig)	Release Equivalent Hole Size				
	Small 3mm	Medium 10mm	Large 25mm	Very Large 50mm	Full Bore (Riser only) 100mm
<100	3	3	3	4	5
100-250	3	3	4	5	5
250-725	3	4	4	5	5
725-1850	3	4	5	5	5
>1850	3	4	5	5	5

FOR LIQUID PHASE

Pressure (Psig)	Release Equivalent Hole Size				
	Small 3mm	Medium 10mm	Large 25mm	Very Large 50mm	Full Bore (Riser only) 100mm
<50	2	2	2	3	4
50-100	2	2	3	4	4
100-300	2	2	3	4	4
>300	2	3	4	4	4

RULESET FOR HC-CONTAINING EQUIPMENT

- IPS for RAM Red or 5A/B, boundaries – entire loop using calibrated HER for LOPA
- F&G Detection – entire loop
- Safety Shutdown System – entire loop
- Communication with Shore
- Marine Instrumentation and Collision avoidance as a System

RULESET FOR CIVIL / STRUCTURES

Item is SCE if:

- Major Structure
- Mooring System
- Ballast Pumps
- Mechanical handling equipment/ Crane

Discipline-wise Ruleset for Various SCE (2)

RULESET FOR CIVIL / STRUCTURES

Item is SCE if:

- Navigation aids as a System
- UPS and Emergency Power – SCE functionality is to provide emergency lighting and communication
- PA/GA as a System
- Emergency Lighting as a System
- Certified Electrical Equipment as per HAC
- Earthing / Grounding and Bonding

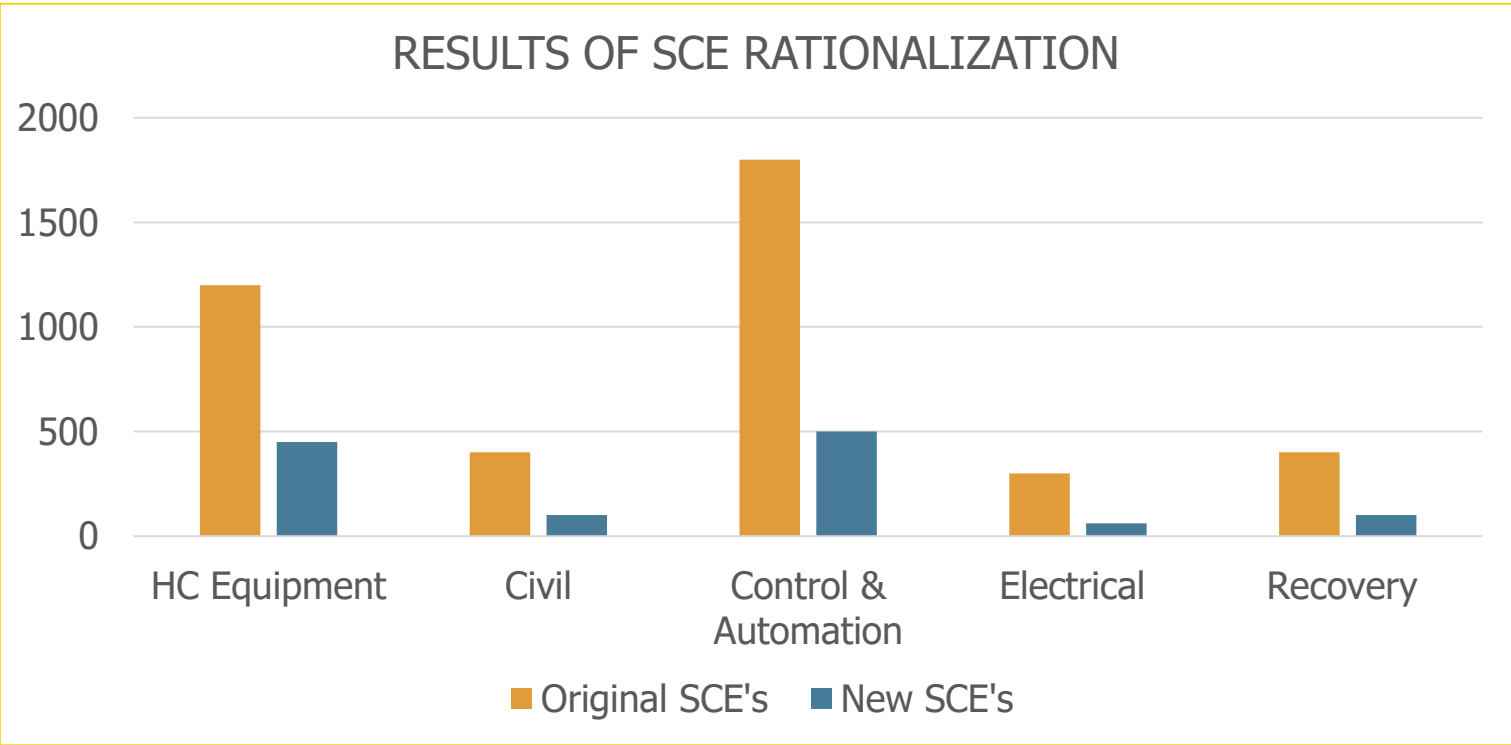
RULESET FOR RECOVERY MEANS

Item is SCE if:

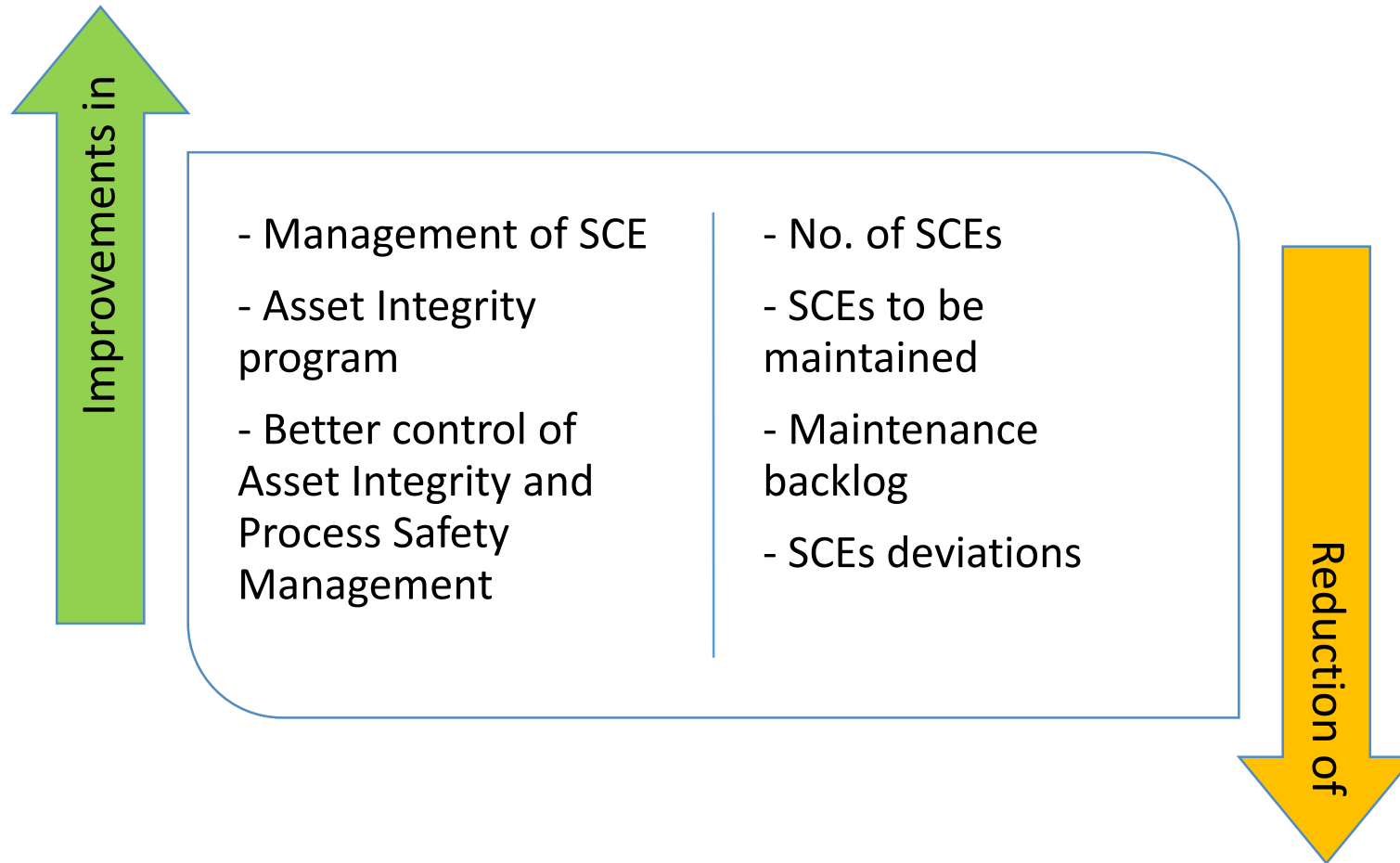
- Lifeboats, life rafts, davit for FRC (?)
- Structural integrity of TR, AICC, Muster / Embarkation Areas, Escape Routes
- HVAC dampers
- Drainage as a system
- Fire protection as a system including all accessories

Results of SCE Rationalization

- Ruleset is used in various Shell assets and was applied to one of the onshore facilities and results are as below:



Impact of SCE Rationalization





FRED MODELLING

*Also used for Appomattox Topsides Main HAZOP where ranking was needed

RAM People Consequence for Gas / Two Phase Release Leading to Jet Fire or Explosion

Pressure (Psig)	Release Equivalent Hole Size				
	Small	Medium	Large	Very Large	Full Bore (Riser only)
	3mm	10mm	25mm	50mm	100mm
<100	3	3	3	4	5
100-250	3	3	4	5	5
250-725	3	4	4	5	5
725-1850	3	4	5	5	5
>1850	3	4	5	5	5

RAM People Consequence for Liquid Release Leading to Pool Fire

Pressure (Psig)	Release Equivalent Hole Size				
	Small	Medium	Large	Very Large	Full Bore (Riser only)
	3mm	10mm	25mm	50mm	100mm
<50	2	2	2	3	4
50-100	2	2	3	4	4
100-300	2	2	3	4	4
>300	2	3	4	4	4

Rulesets developed with inputs from TA-1s (Process, HSE, and MMI) in VTO-300-MX-7180-0000001-000

50mm holes used as largest credible design case for SCE determination, in line with previous UA / PTP TSE TA-1 recommendations for design scenarios (e.g. PFP)

Ruleset to be applied based on equipment connection sizing, not directly accounting for vessel ruptures (reasonably limit potential consequence for small equipment)

10% mole flash fraction is the assumed cut-off for liquid vs. two phase based on UKOOA ignition model guidelines

Major Hazard and SCE Definitions

- Major Hazard- RAM 5 or Red, People (P), Asset (A), Environment (E), Community (C)
 - Not a Major Hazard: If 5A/B or Red Risks for Asset or business loss only

SEVERITY	CONSEQUENCES				INCREASING LIKELIHOOD				
	People	Assets	Community	Environment	A	B	C	D	E
					Never heard of in the Industry	Heard of in the 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 effect					
1	Slight injury or health effect	Slight damage	Slight effect	Slight effect					
2	Minor injury or health effect	Minor damage	Minor effect	Minor effect					
3	Major injury or health effect	Moderate damage	Moderate effect	Moderate effect					
4	PTD or up to 3 fatalities	Major damage	Major effect	Major effect					
5	More than 3 fatalities	Massive damage	Massive effect	Massive effect					

■ Major Risk Area

- “A **Safety Critical Equipment (SCE)** is an item of equipment or structure whose failure could lead to a **Major Hazard** or whose purpose is to prevent or limit the consequences of a major incident, excluding business loss”.

Safety Critical Equipment Management in Aging BSP Assets

Thank you!

BSP Team
Technical Safety Team



**Safety Case
Symposium 2019**
Singapore
Mar 26 - 27, 2019
www.SafetyCaseSymposium.com