Westlake Epoxy

EUROPEAN PROCESS SAFETY CENTRE

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Quantification of Asset Integrity Program

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EPSC Process Safety Conference, Aachen

Ankit Agarwal

Process Safety Professional

- MSc in Safety Engg. (KU Leuven, BE)
- MSc in Aerospace Engg. (TU Delft, NL)
- B.Tech in Mech. Engg. (Indian Institute of Technology J, IN)

Current Position:	1 yr PSM focused Engineer, WL Pernis, NL 5yrs SAP plant mt. Global BPO Epoxy
Experience:	1 yr CFD engineer at Airbus Defence, Spain 5 yrs Mech engg. (rotating eqm.), Hexion, NL 5 yrs MI program Leader Global Epoxy, Hexion, NL
Hobby:	Gardening, Stock market trading

Agenda

- Asset Integrity Program (AIM) definition
- Components of AIM
- Why Quantify an AIM program?
- How to Quantify AIM?
- Benefits of Quantification

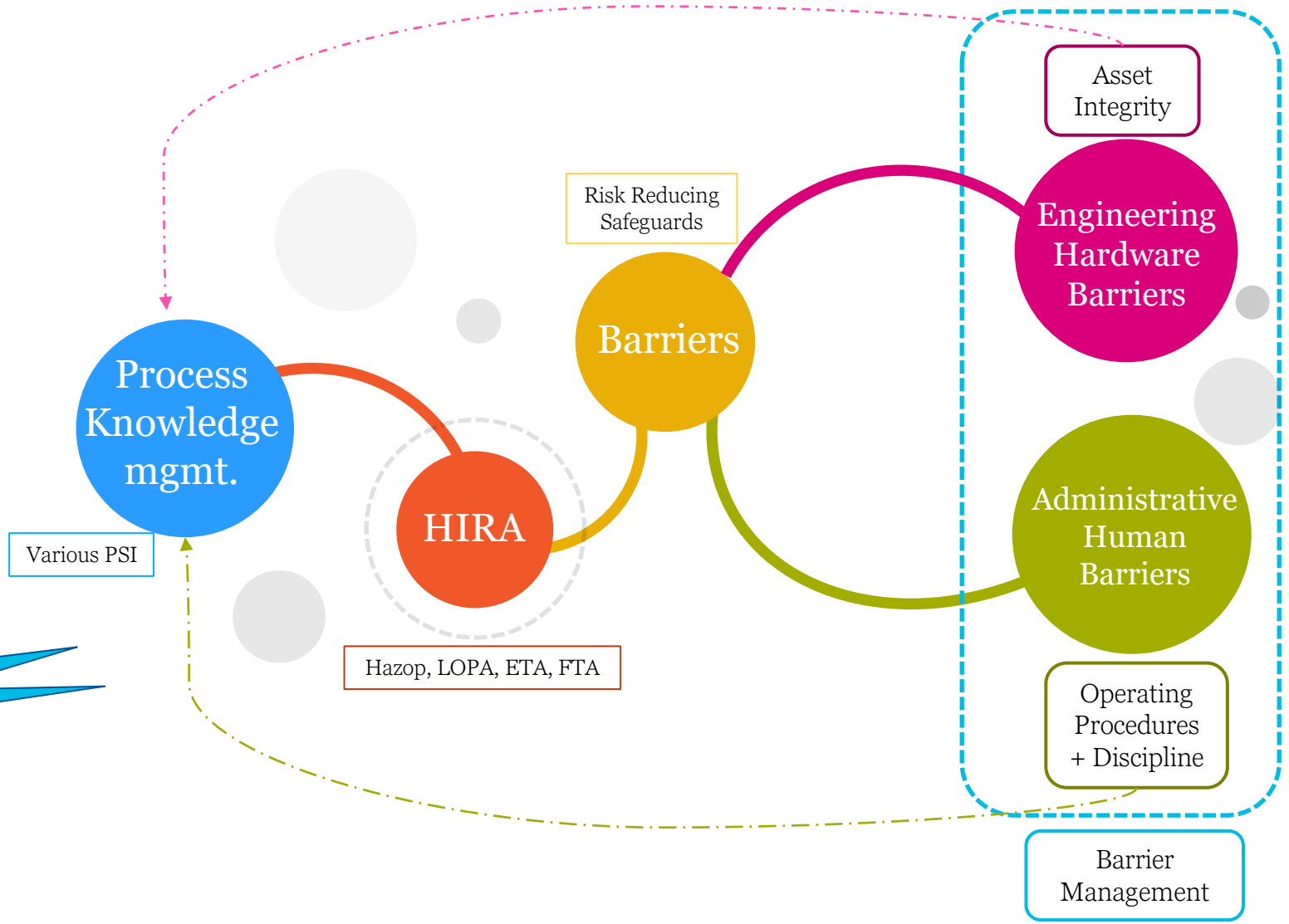
What is Asset Integrity Management?

Management of critical process equipment to ensure it is

1. designed,
2. installed,
3. operated &
4. maintained

to get desired performance in a safe manner.

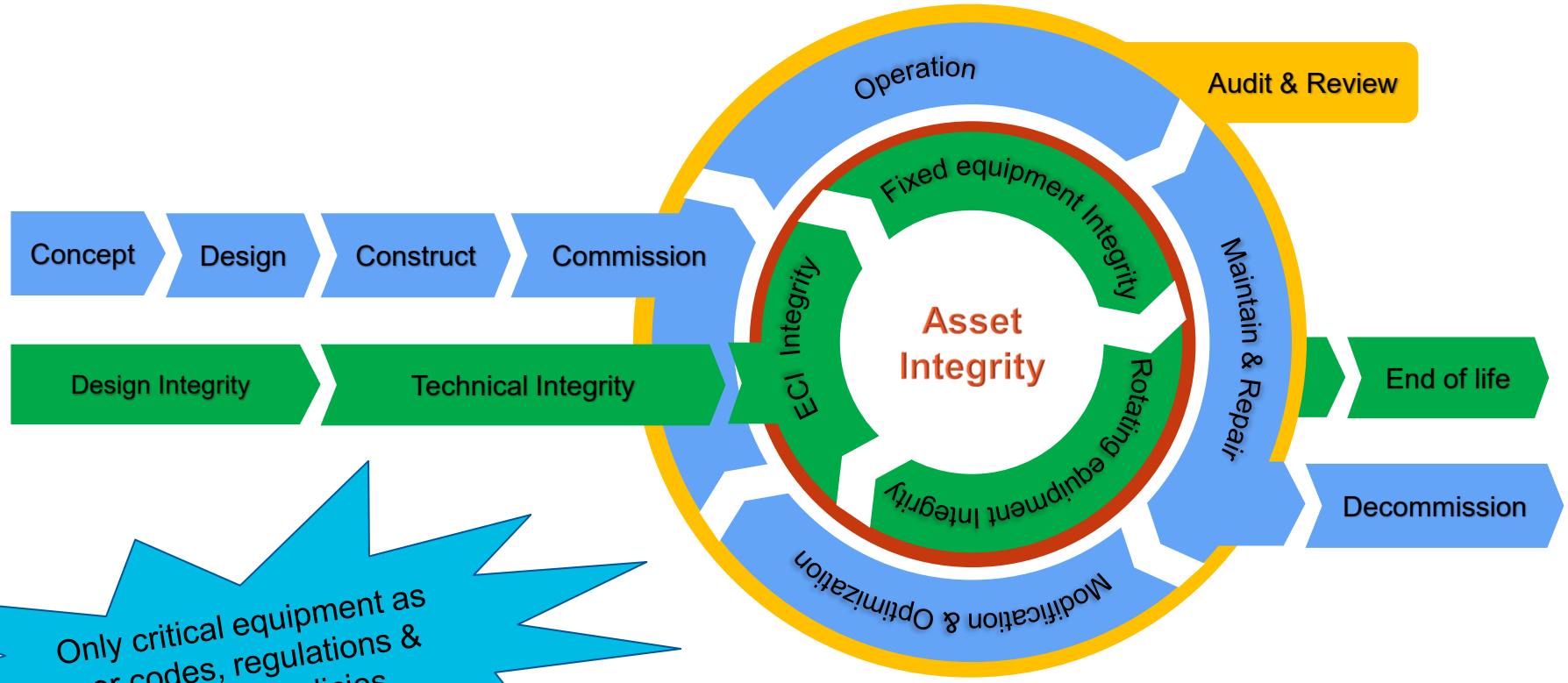
Where in PSM framework?

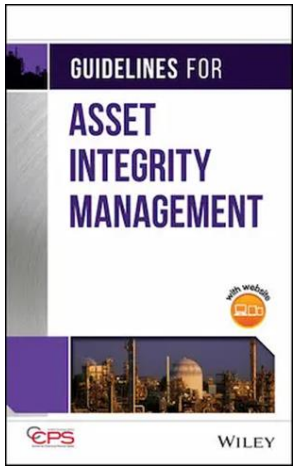


PSI: Process Safety Information
HIRA: Hazard Identification & Risk Assessment

Components of Asset Integrity Program

Lifecycle Approach

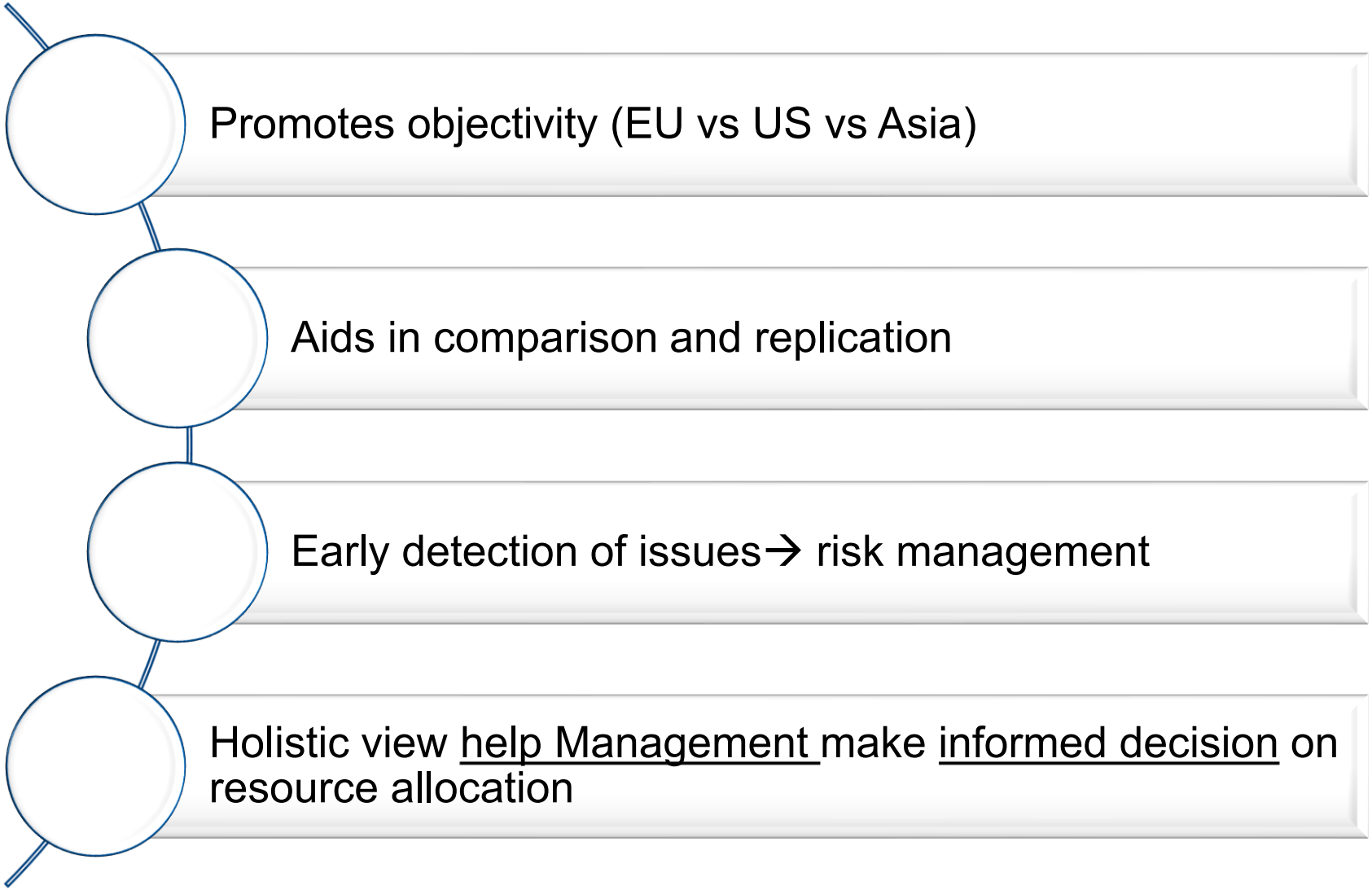




Only critical equipment as per codes, regulations & prevention policies

ECI: Electrical, Control and Instrumentation

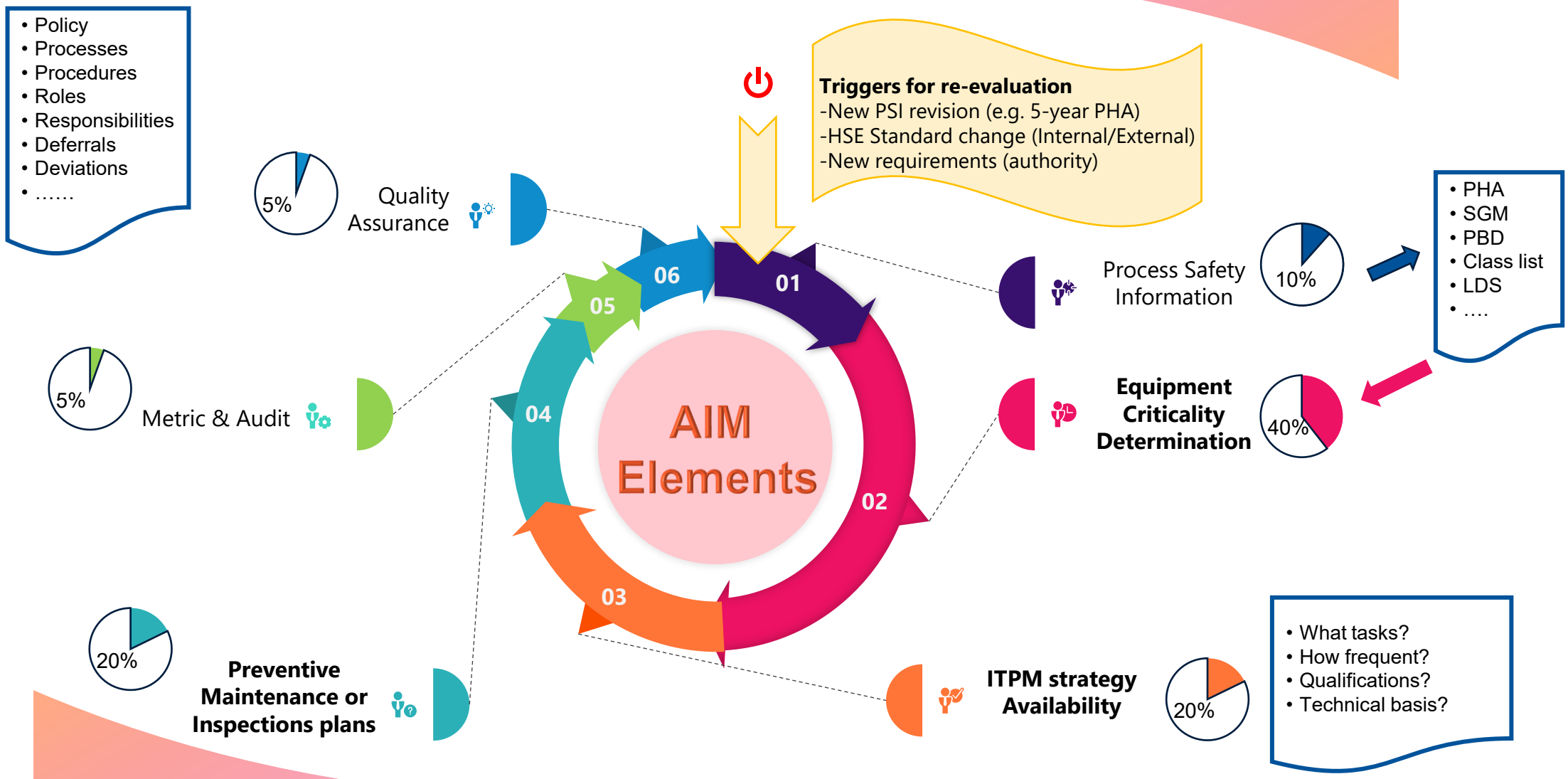
Why Quantify an AIM program?



Elements of AIM program

Quantification of Asset Integrity Management

6 Elements of AIM



ITPM: Inspection, Testing and Preventative Maintenance; SGM: Safe-Guarding Memo, PBD: Process Boundary, LDS: Line Designation sheet

Setting up the scorecard template

Listing various contributing factors per element

Template

Plant name Reference Date XX/XX/XXXX Version no. XX

N/A	Not included in scoring	Applicable	Included in scoring		
Work in progress	> 30% to < 60 %	Work in progress	> 60% to < 90%		
Implemented	>90%				

Overall	#DIV/0!	Implementation Score	####	####	####	####	#####	####
STAGE GATE		REQUIREMENTS	Process Safety Information	Equipment Criticality Determination	ITPM Verified / Available	Maintenance Plan (in SAP/RBI)	Measure & Audit	QA
		0	1	2	3	4	5	6
X.01		REGULATORY	A - Basic information	A - REGULATORY	Equipment Disciplines	Equipment types	Metrics	Maint.Management.Syst.
X.02		PIR (SEVESO)	PFD/ Simplified block diagrams	ATEX [electrical]	Fixed Equipment	Fixed Equipment	Audits (PSM - audit)	Document mgmt system
X.03		PED [Press Equip.]	P&ID set	ATEX [mechanical]	Instrumentation & Control	Instrumentation & Control	Audits (PS04 - self audit)	Roles & Responsibilities
X.04		ATEX	Process Boundary Determination systems	LDS	Piping	Piping		Training
X.05		Omgevings vergunning	Highly hazardous Chemicals list	Class list	Relief devices	Relief devices		MOC process
X.06		BRZO NL	Operating manual	VR-Insluitsystemen	Rotating	Rotating		Naming conv. Strategy
X.07		National electric code	Mass and heat balance	Process Boundary Determination				Managem. review process
X.08		WBDA NL	Insluitsystemen (containment systems)	Safe Guarding Memorandum				ITPM Inspection criteria
X.09		External Safety report		Emergency shutdown systems				ITPM Deviations
X.10		Company MANDATORY	B - Technical documents					Material verification
X.11		GMS-PSM	Safe Guarding Memorandum	C - Risk				Qualified personnel
X.12		GMS- PSI	Dust safety	Hazop				Continuous improvement
X.13		GMS-PHA	Expl. Safety Document	LOPA				Incident investigation
X.14		GMS-Mech.Integrity	Area classification dwg	SIL				PM planning process
X.15		GMS- Comb.Sol&Dusts	Equip. Class list [for covered equipment]	RBMI criticality				Equipment documentation
X.16		GMS- Phen.Handl.St.	Line Designation Sheet [for covered systems]					CUI inspection program
X.17		PFSS	Equip. documentation [for covered equipmen					
X.18		GMS-Open Ended Lines and	Pipeline Isometrics [for covered equipment]					
X.19		AgSS (Low conv)	Emergency shutdown systems					
X.20		GMS-ATM	Alarm management system					
X.21		others	C - Risk [determination]					
X.22		GMS- electrical safety	Hazop					
X.23		OTHER	LOPA (SIL determination)					
X.24		Risk Rubric score process an	SIL (3 SIL docs)					
X.25		Process Boundary Files	RBI criticality					
X.26		PSM Road map						
X.27		Lifecycle management SIL						

Responsibilities

		Maintenance Manager	EHS Safety Engineer	MI Coordinator	Maintenance Engineer	Maintenance Supervisor	Technician and Operator	Project / Design Engineer
1	Training and awareness	responsible	none	supports	none	none	none	none
2	Equipment Criticality Determination	none	responsible	informed	supports	none	none	supports
3	Define and Maintain ITPM's in SAP	none	none	supports	responsible	none	none	none
4	Provide Technical Content for ITPM's	none	supports	none	supports	supports	responsible	supports
5	Maintain Equipment Records	none	none	none	responsible	supports	none	supports
6	Maintain MI controlled documents	none	none	responsible	supports	none	none	none
7	Plan & schedule MI tasks	none	none	none	responsible	supports	informed	none
8	Overseeing Contractors (in MI Roles)	none	none	none	none	responsible	supports	none
9	Registering ITPM results / test reports	none	none	none	informed	supports	responsible	none
10	Equipment Deficiency Management	informed	none	none	responsible	supports	none	none
11	Report / Review Metrics	informed	informed	responsible	supports	supports	informed	none
12	Establish Audit Schedule and Content	responsible	none	supports	none	none	none	none
13	Follow up on modifications	none	supports	supports	responsible	none	none	responsible
14	MI Process Development, roles and systems	responsible	supports	supports	none	none	none	none

List all contributing factors of each element

Process Safety Information
1
A - Basic information
PFD/ Simplified block diagrams
P&ID set
Process Boundary Determination systems
Highly hazardous Chemicals list
Operating manual
Mass and heat balance
Insluitsystemen (containment systems)
B - Technical documents
Safe Guarding Memorandum
Dust safety
Expl. Safety Document
Area classification dwg
Equip. Class list [for covered equipment]
Line Designation Sheet [for covered systems]
Equip. documentation [for covered equipmen
Pipeline Isometrics [for covered equipment]
Emergency shutdown systems
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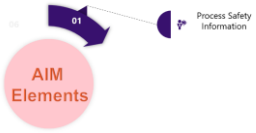
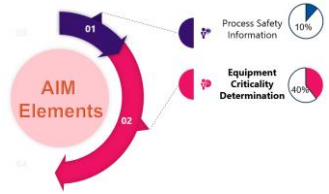
C - Risk [determination]
Hazop
LOPA (SIL determination)
SIL (3 SIL docs)
RBI criticality



"How to" process PSI to determine critical equipment

Equipment Criticality Determination
2
A - REGULATORY
ATEX [electrical]
ATEX [mechanical]
LDS
Class list
VR-Insluitsystemen
Process Boundary Determination
Safe Guarding Memorandum
Emergency shutdown systems
C - Risk
Hazop
LOPA
SIL
RBMI criticality

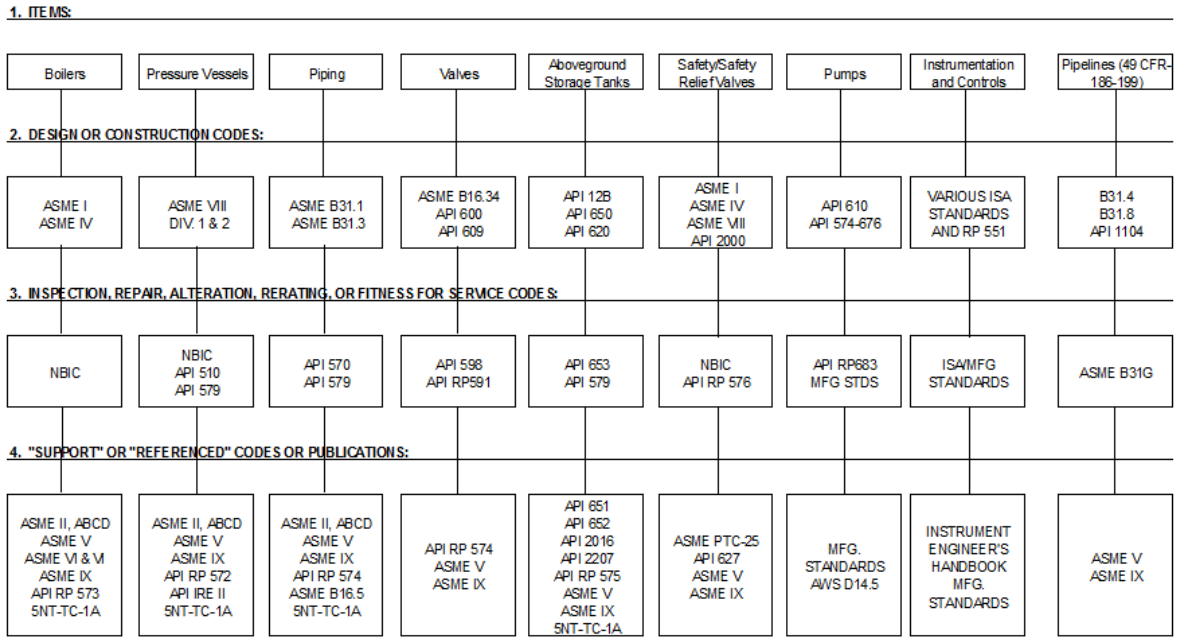


List all contributing factors of each element

ITPM Verified / Available
3
Equipment types
Fixed Equipment
Instrumentation & Control
Piping
Relief devices
Rotating

Based on engineering disciplines

Equipment Class/ Item	Equipment type	Equipment	Required Tasks	Task Interval	Technical Basis	Inspection Personnel Qualification Requirements	Procedure(s)	Comments
Section 1 – Pressure Vessels and Storage Tanks								
Pressure vessels (ASME-coded and noncoded)	**Reactor**	**Reactor**	Routine visual surveillance	Recommended daily; not to exceed 1 month	Industry practice	No specific certifications required; however, personnel knowledgeable in equipment operation are recommended		Normal operation is not documented; deficiencies are documented via an equipment deficiency report and/or work order
			External visual inspection and thickness measurement	Lesser of 5 years or calculated internal (or on-stream) inspection task interval	API 510 ANSI/NB-23	API 510 certification (inspector) NDE: ANST SNT-TC-1A Level I (or equivalent) to collect data ASNT SNT-TC-1A Level II (or equivalent) to collect and interpret data		N/A
			Internal visual inspection and thickness measurement	Lesser of 10 years or ½ of the remaining corrosion life	API 510 ANSI/NB-23	API 510 certification (inspector) NDE: ANST SNT-TC-1A Level I (or equivalent) to collect data ASNT SNT-TC-1A Level II (or equivalent) to collect and interpret data		Additional nondestructive testing to be performed as necessary



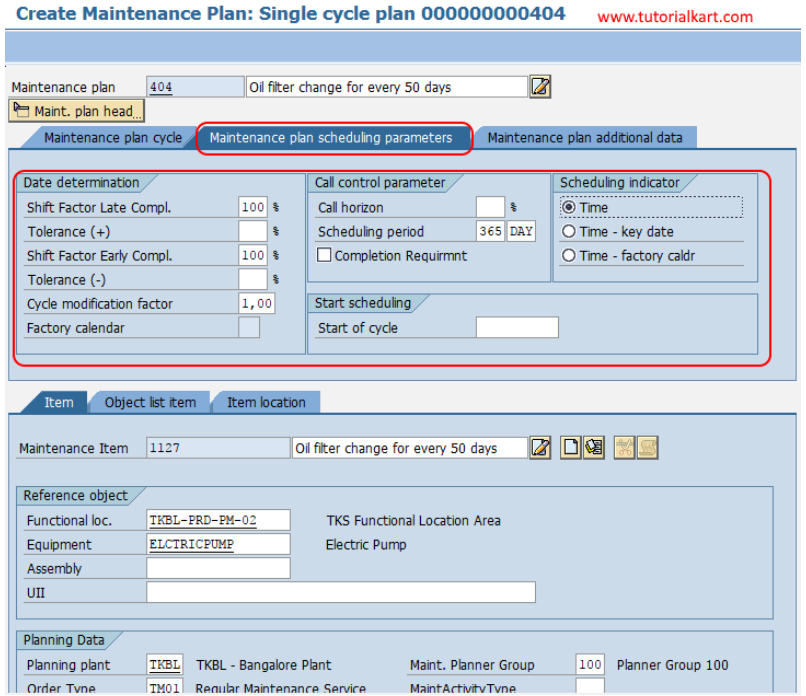
Common RAGAGEPs

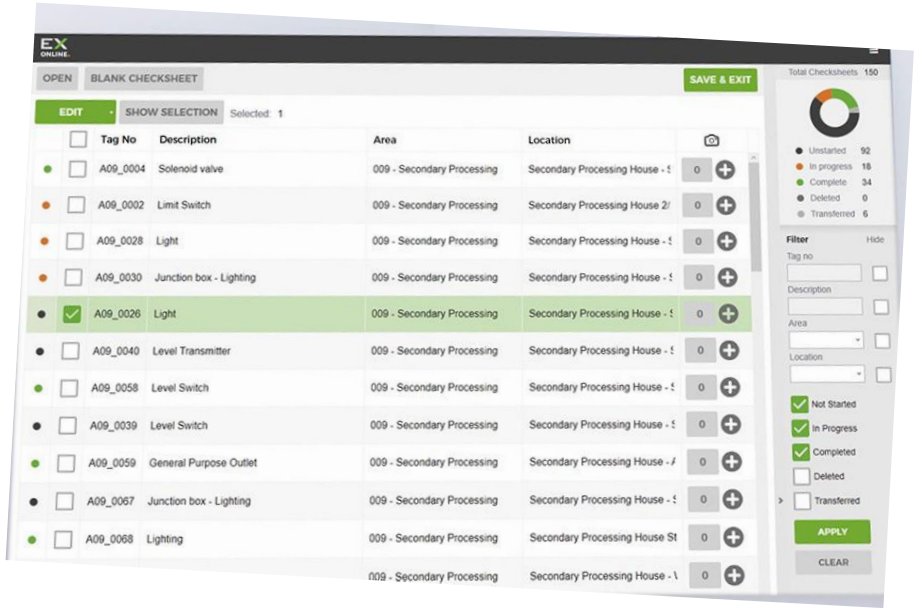
Equipment Class/ Item	Equipment type	Equipment	Required Tasks	Task Interval	Technical Basis
Section 1 – Pressure Vessels and Storage Tanks					
Section 2 – Piping					
Section 3 – Relief and Vent Systems					
Section 4 – Safety and Emergency Systems					
Section 5 – Instrumentation, Controls, and Electrical					
Section 6 – Pumps and other Rotating Equipment					
Section 7 – Infrastructure					

List all contributing factors of each element

Maintenance Plan (in SAP/RBI)
4
Equipment Disciplines
Fixed Equipment
Instrumentation & Control
Piping
Relief devices
Rotating

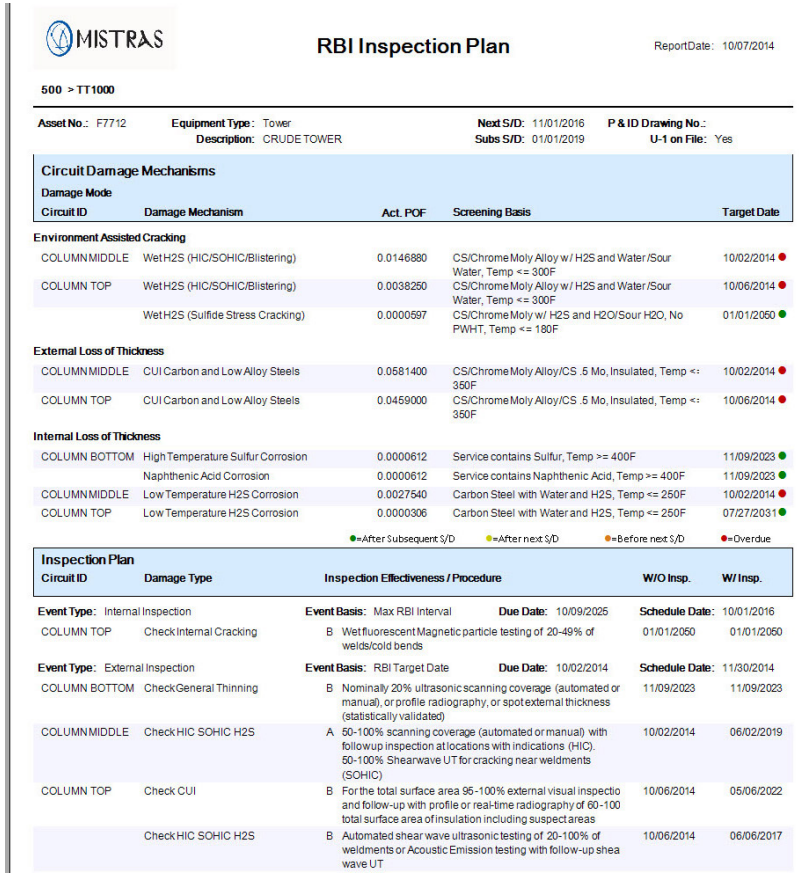
SAP PM plan





ATEX inspection plan

RBI inspection plan

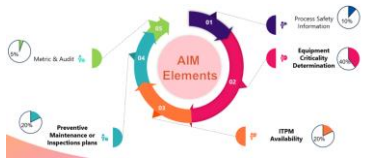


List all contributing factors of each element

Measure & Audit
5
Metrics
Audits (PSM - audit)
Audits (PS04 - self audit)

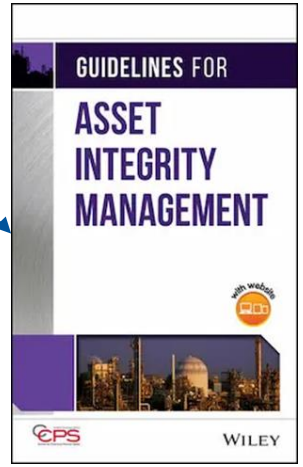
E.g. PSM work overdue, Deficiency corrective actions, Deviation / Deferrals

Detailed Internal PSM audit every 3yrs



QA
6
Maint.Management.Syst.
Document mgmt system
Roles & Responsibilities
Training
MOC process
Naming conv. Strategy
Managem. review process
ITPM Inspection criteria
ITPM Deviations
Material verification
Qualified personnel
Continuous improvement
Incident investigation
PM planning process
Equipment documnetation
CUI inspection program

A “how to” on each as part of site Quality Management System



Template with various contributing factors per element

Plant name | Reference Date XX/XX/XXXX | Version no. XX

N/A	Not included in scoring	Applicable	Included in scoring
Work in progress	> 30% to < 60 %	Work in progress	> 60% to < 90%
Implemented	>90%		

Overall #DIV/0! — Implementation Score: #### | #### | #### | #### | ##### | ####

STAGE GATE	REQUIREMENTS 0	Process Safety Information 1	Equipment Criticality Determination 2	ITPM Verified / Available 3	Maintenance Plan (in SAP/RBI) 4	Measure & Audit 5	QA 6
X.01	REGULATORY	A - Basic information	A - REGULATORY	Equipment Disciplines	Equipment types	Metrics	Maint.Management.Syst.
X.02	PIR (SEVESO)	PFD/ Simplified block diagrams	ATEX [electrical]	Fixed Equipment	Fixed Equipment	Audits (PSM - audit)	Document mgmt system
X.03	PED [Press Equip.]	P&ID set	ATEX [mechanical]	Instrumentation & Control	Instrumentation & Control	Audits (PS04 - self audit)	Roles & Responsibilities
X.04	ATEX	Process Boundary Determination systems	LDS	Piping	Piping		Training
X.05	Omgevings vergunning	Highly hazardous Chemicals list	Class list	Relief devices	Relief devices		MOC process
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X.12	GMS- PSI	Dust safety	Hazop				Continuous improvement
X.13	GMS-PHA	Expl. Safety Document	LOPA				Incident investigation
X.14	GMS-Mech.Integrity	Area classification dwg	SIL				PM planning process
X.15	GMS- Comb.Sol&Dusts	Equip. Class list [for covered equipment]	RBMI criticality				Equipment documnetation
X.16	GMS- Phen.Handl.St.	Line Designation Sheet [for covered systems]					CUI inspection program
X.17	PFSS	Equip. documentation [for covered equipmen					
X.18	GMS-Open Ended Lines and	Pipeline Isometrics [for covered equipment]					
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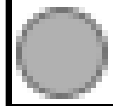
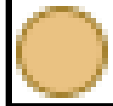
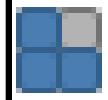
X.21	others	C - Risk [determination]					
X.22	GMS- electrical safety	Hazop					
X.23	OTHER	LOPA (SIL determination)					
X.24	Risk Rubric score process an	SIL (3 SIL docs)					
X.25	Process Boundary Files	RBI criticality					
X.26	PSM Road map						
X.27	Lifecycle management SIL						

How to do the scoring?

Scorecard Legend

Symbol	Text	Description	Contribution
	N/A	Not included in scoring	-
	Applicable	Included in scoring	0
	Work in progress	> 30% to < 60 %	0.5
	Work in progress	> 60% to < 90%	0.75
	Implemented	>90%	1

Scoring Each Element

E.g. Element 1: PSI

87%

Process Safety Information	
1	
	A - Basic information
	PFD/ Simplified block diagrams
	P&ID set
	Process Boundary Determination systems
	Highly hazardous Chemicals list
	Operating manual
	Mass and heat balance
	Insluitsystemen (containment systems)
	B - Technical documents
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	Equip. documentation [for covered equipmen
	Pipeline Isometrics [for covered equipment]
	ESD / Interl. Definition
	C - Risk [determination]
	Hazop
	LOPA (SIL determination)
	SIL (3 SIL docs)
	RBMI criticality

- Equal wt. to each contributing row
- E.g. Dust Safety is not applicable
- Clear visibility on gaps (highlighted yellow)
- Notes to capture comments

					See cell comment for additional guidelines!	Actionlog reference and / or final state reference
1	PSI		**A - Basic information**			
2		1.02	PFD/ Simplified block diagrams	*PFD available but not up-to-date*	-	*GMS-PS02* *5.5.1.1 A Block Flow Diagram or Simplified Process Flow Diagram.* *[for non complicated processes where a PFD will not add value (like process flow easy to understand from limited number of P&ID's) PFD not required under the MI program]*	*Available* *Block diagram helps in scaling up/down; but not a showstopper if not available* *Data available is sufficient for MI*
3		1.03	P&ID set	*PID set available for majority of the processes but not up-to-date*	*PID set available for all processes.* *PID set not older than 3 years and likely up-to-date with respect to critical modifications.* *No process in place to secure PID's are kept up-to-date.*	*GMS-PS02* *5.6.1 At a minimum, Equipment Process Safety Information must include:* *5.6.1.2 Piping and Instrumentation Diagrams (P&IDs)* *GMS-PS04* *5.4.2 Equipment Criticality:* *5.4.2.3 The Following is a list of items recommended for use in establishing equipment criticality.* *• P&ID's*	*Available* *Data available is sufficient for MI*

An example of AIM quantification

Plant name | Reference Date XX/XX/XXXX | Version no. XX

N/A	Not included in scoring	Applicable	Included in scoring
Work in progress	> 30% to < 60 %	Work in progress	> 60% to < 90%
Implemented	>90%		

Overall	74%	Implementation Score	87%	75%	70%	65%	100%	72%
STAGE GATE		REQUIREMENTS	Process Safety Information	Equipment Criticality Determination	Maintenance Plan (in SAP/RBMI)	ITPM Verified / Available	Measure & Audit	QA
		0	1	2	3	4	5	6
X.01		REGULATORY	A - Basic information	A - REGULATORY	Equipment types	Equipment types	Metrics	Maint.Management.Syst.
X.02	✓	PIR (SEVESO)	PFD/ Simplified block diagrams	ATEX [electrical]	Fixed Equipment	Fixed Equipment	Audits (PSM - audit)	DMS
X.03	✓	PED [Press Equip.]	P&ID set	ATEX [mechanical]	Instrumentation & Control	Instrumentation & Control	Audits (PS04 - self audit)	Responsibilities
X.04	✓	ATEX	Process Boundary Determination systems	LDS	Piping	Piping		Training
X.05	✓	Omgevings vergunning	Highly hazardous Chemicals list	Class list	Relief devices	Relief devices		MOC process
X.06	✓	BRZO NL	Operating manual	VR-Insluitsystemen	Rotating	Rotating		Naming conv. Strategy
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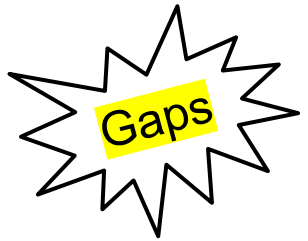
X.13	✓	GMS-PS03 PHA	Expl. Safety Document					Incident investigation
X.14	✓	GMS-PS04 Mech.Integrity	Area classification dwg					PM planning process
X.15	✓	GMS-PS07 Comb.Sol&Dusts	Equip. Class list [for covered equipment]					Equipment documnetation
X.16	✓	GMS-PS-T08 Phen.Handl.St.	Line Designation Sheet [for covered systems]					CUI inspection program
X.17	!	PFSS	Equip. documentation [for covered equipmen					
X.18	!	GMS-PS06 Open Ended Line	Pipeline Isometrics [for covered equipment]					
X.19		AgSS (Low conv)	ESD / Interl. Definition					
X.20	✓	GMS-S15 ATM						
X.21		others	C - Risk [determination]	C - Risk				
X.22	!	GMS-S02 electrical safety	Hazop	Hazop				
X.23		OTHER	LOPA (SIL determination)	LOPA				
X.24	✓	Risk Rubric score process ar	SIL (3 SIL docs)	SIL				
X.25	✓	Process Boundary Files	RBMI criticality	RBMI criticality				
X.26	✓	PSM Road map						
X.27	✓	Lifecycle management SIL						



Calculating overall score for AIM program per site/unit

AIM overall score = (10% PSI) + (40% ECD) + (20% ITPM availability) + (20% PM planning) + (5% Measure & Audit) + (5% QA)

Let's assume score per element:

1. PSI = 90
2. ECD = 50
3. ITPM availability = 90
4. PM planning = 60
5. Measure & Audit = 100
6. QA = 90

Equal wt. AIM overall score
= (90+50+90+60+100+90)/6
= 80

AIM overall score based on proposed wt.
= (0.1*90 + 0.4*50 + 0.2*90 + 0.2*60 + 0.05*100 + 0.05*90)
= 68.5

What to do after scoring?

Make Long term AIM program

MASTER PLAN AIM program						
STRATEGY AND OBJECTIVE	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**
Improve PSM	PSM Audit Hazop U1000 PSI Update	PSM Audit recommendations Hazop U1000 Bulk RM Hazop PSI Update (SGM) Combustible dust hazard analysis	Hazop U2000 complete Start Hazop Utilities PSI Update (SGM)	PSM Audit Contractor MGT Hazop Utilities complete PSI Update (SGM)	Hazop U3000 complete	Hazop U1000 (revalidation)
Mechanical Integrity as standard	Define plan start to implement	Equipment criticality - U1000 PED-PSV (all units)	Equipment criticality - U2000 Validate U1000 APQ (all units) Validate ATEX	Equipment criticality - Utilities Validate U2000 Rotating equipment Piping	Equipment criticality - U3000 Validate PN Validate Utilities Safeguards (interlocks)	Full MI Implementation (meeting the standard)
Preventive Maintenance as standard	Set-up org Define roles & work processes	Implement plan autonomous mtto	Building plans & schedules for preventive maint. - U1000	Buildings plans and schedules for preventive maint. - U2000	Buildings plans and schedules for preventive maint. - Utilities	Others

Whether it's engineering schedules or Sunday dinner: some processes can't be rushed.

Prioritization Matrix

Revisit once per year

Time Reference: January 20XX
e.g. Current AIM score is 58%

Moving activities (+12%; AIM score 58% → 70%)

a. NOBO approval of pressure eqm re-classification study
b. Migrate to HSE software
c. MI criticality study
d. Conclude PM optimization for SIL proof testing
e. Program of SafeGuarding Memorundum ongoing as planned
f. Finalize SIL study
g. Development of ATEX compliance plan

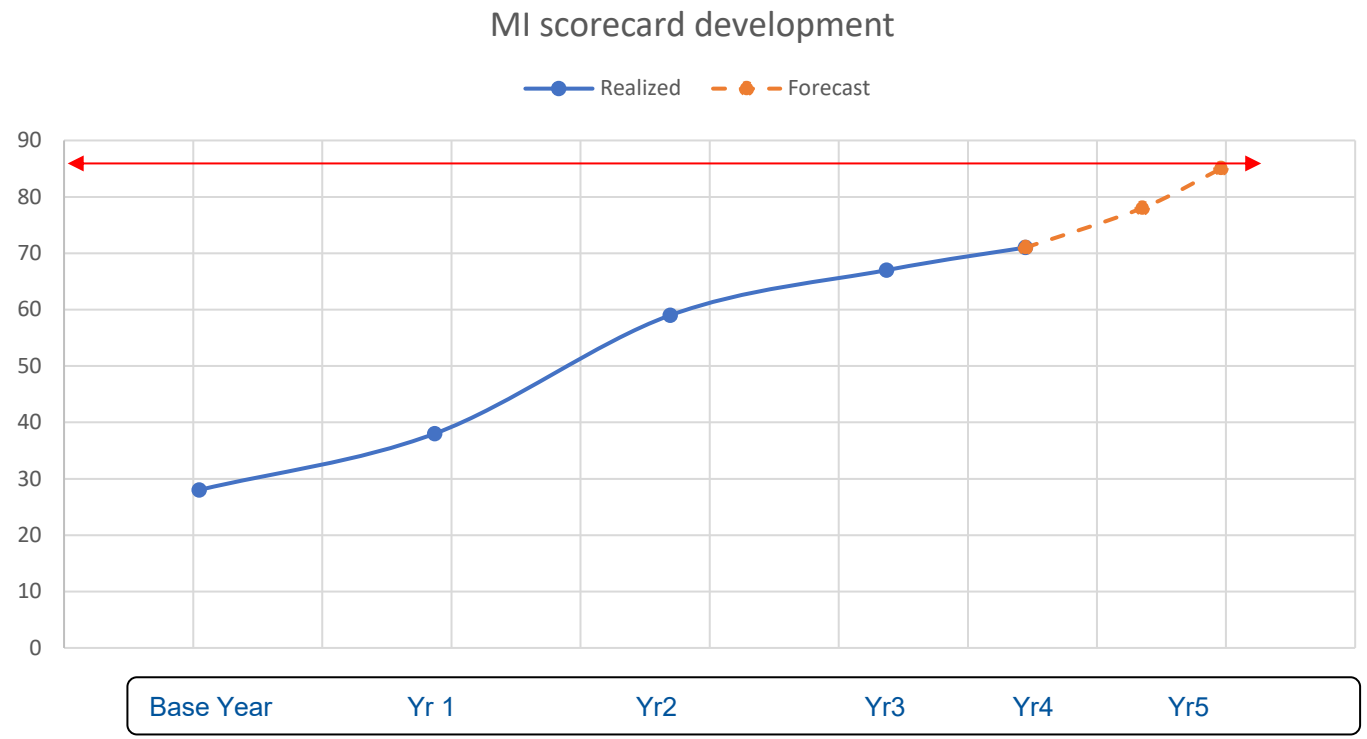
Activities in pipeline (+8%; AIM score → 78%)

h. Create missing RBMI piping Inspection plans
i. SAP master data & RBI inspection plans for relief devices
j. Hazop revalidation
k. Remaining MI criticality study

To be planned (+10%; AIM score → 88%))

l. Verify existing PM plans of MI eqm
m. Start MI self auditing
n. Migrate from Exsilentia 3 to 4
o. Revise Process Boundary Definition along with system limiter project
p. Update Area classification
q. Development of PM inspection strategy for ATEX eqm

AIM Program Realization

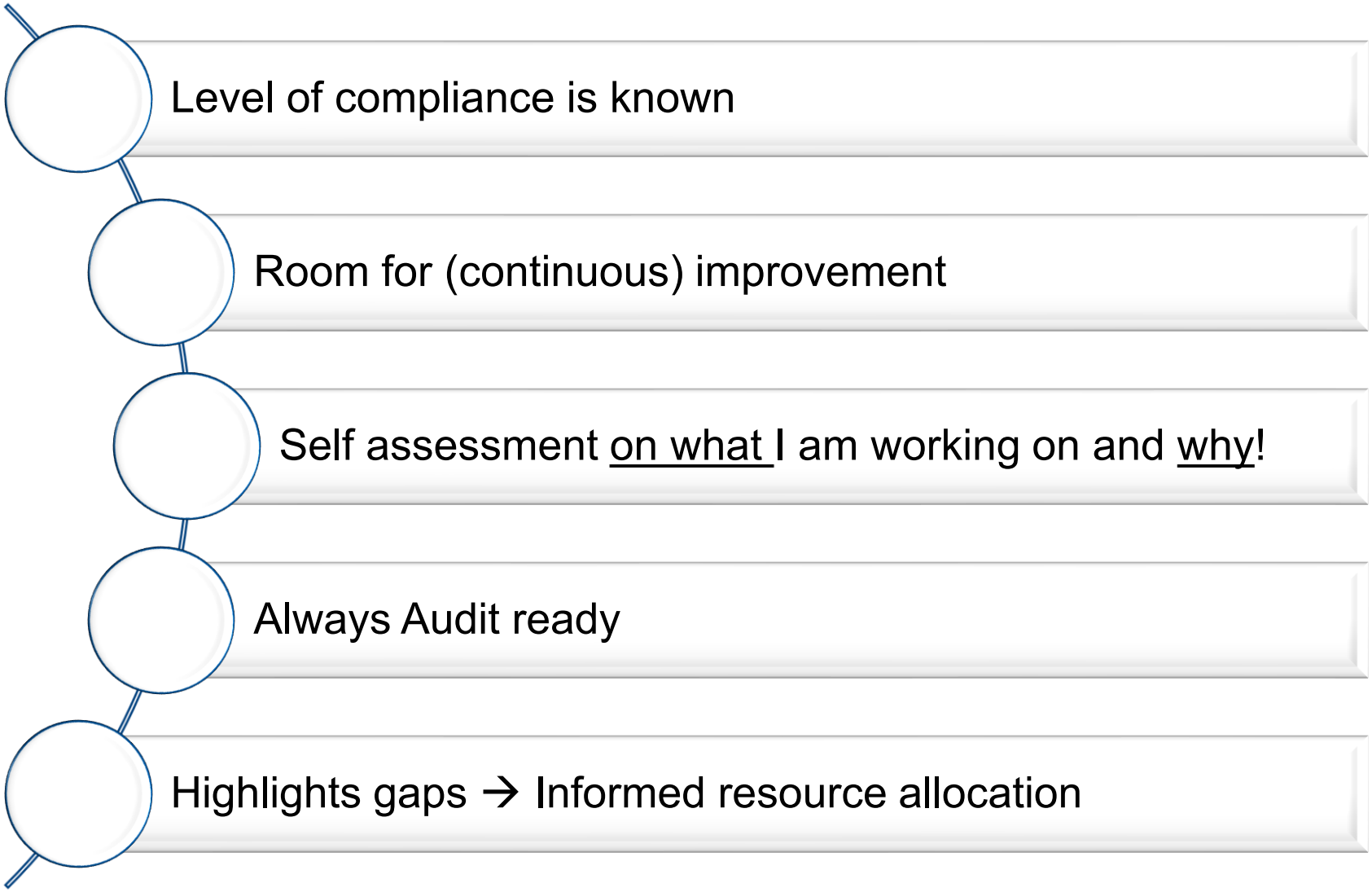


Base Year: AIM score → 28%

Year 1: AIM score → 38%
Year 2: AIM score → 59%
Year 3: AIM score → 67%
Year 4: AIM score → 71%

Conclusion: Benefits of scoring

Key Benefits of scoring



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Now you know a tool to measure the Unseen !!

Let's Connect

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