PWW

P (+61 8) 9457 6297 **E** info@plant-wellness-way.com

Overview the Plant Wellness Way EAM Methodology for a Simple and Successful Enterprise Asset Management System

Let a Plant Wellness Way EAM System-of-Reliability End Your Business Risks Forever

Abstract

Overview the Plant Wellness Way EAM Methodology for a simple and successful Enterprise Asset Management System. Learn how to apply the Plant and Equipment Wellness enterprise asset management methodology. Follow the steps to get the best performance from your plant and equipment. Learn what systems and processes produce the optimal plant and equipment reliability results. From creating low stress component environment for lasting equipment health through to establishing the simplest and most effective business system and processes for world class asset management performance, this overview guide to the Plant Wellness Way takes you step by step in creating the outstanding asset performance needed for world class operational excellence. As with human wellness, the Plant Wellness Way requires you to build a healthy life for your machines. Learn to control your plant's reliability by managing the stresses put on equipment parts and reducing the risk of failure so plant and equipment remains fit and healthy to produce its best performance. The Plant Wellness Way EAM methodology lets you find the ideal health conditions for your equipment and machines and makes you establish business processes and systems to achieve and maintain outstanding reliability performance.

Keywords: operational excellence, enterprise asset management, maintenance management, plant wellness

Plant Wellness Way EAM System-of-Reliability is a fully integrated life cycle asset management methodology. Its processes identify and install the optimal asset maintenance system and work quality practices into your company to minimise operational risk and gain operational excellence. Figure 1 is the Plant Wellness Triangle for asset management excellence, is shows you how to create and sustain highly reliable plant and equipment.

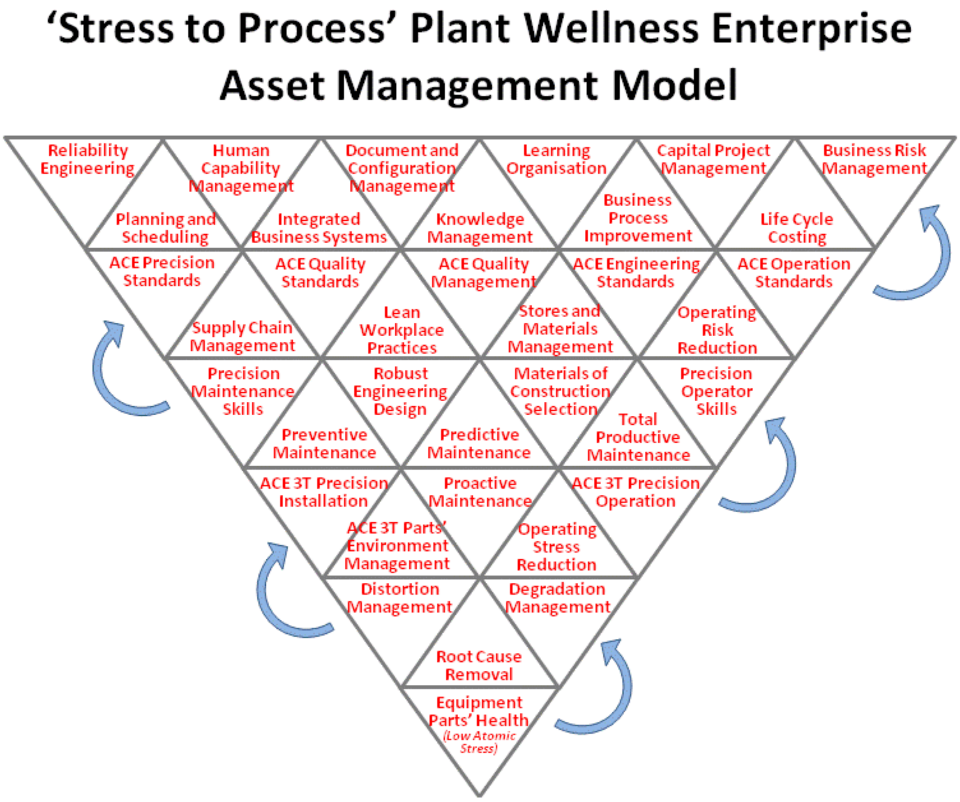


Figure 1 Contents and Processes of a Plant Wellness Way Asset Management and Maintenance System

Great operational asset performance is a vital component for operational excellence. An ideal asset management system is perfectly structured to produce world class asset management results. An optimal asset maintenance system uses the least resources to produce world class operational equipment reliability. The Plant Wellness Way encompasses the full life cycle requirements for least cost, long-lived, lasting physical asset health. Like human wellness, Plant Wellness focuses on living a life of maximum health and vitality, continuous fitness and wellbeing, and failure-free longevity.

Summary of the Plant Wellness Way EAM Methodology

Table 1 collects together the contents of the Plant Wellness Way EAM method. It shows you the steps to take to apply the methodology so that you can produce outstanding reliable equipment for operational excellence.

No	Strategy			Requirement	Description
1	OPERATIONAL RISK MANAGEMENT			Determine equipment criticality and resulting operational risk	A simple risk decision chart is used to categorise the impact on your operation of each item of equipment should it fail.
2				Determine assembly and parts' criticality and resulting operational risk	For each equipment item you use the same risk decision chart to identify critical assemblies and components so that you know what you need to focus on to ensure maximum equipment reliability.
3				Identify component failure categories	Using the Parts Drawing and Bill of Materials you categorise how each critical part can be failed during its life—by degradation, by deformation, by human error.
4				Identify and select component life cycle wellness requirements	For critical parts identify the life cycle engineering, manufacturing, operational and maintenance activities needed to create an environment that delivers maximum health and fitness to the part so that maximum equipment reliability results.
5				Categorise risk and failure prevention strategies	Based on component failure categories for each critical part you decide the failure prevention strategies to apply— life cycle degradation management, life cycle deformation management, life cycle defect/error elimination.
6				Identify and select component health and wellness standards	Specify the necessary ACE 3T quality standards for the required life cycle activities of each critical part that when met will ensure outstanding component reliability.
7		QUALITY MANAGEMENT		Identify engineering, operational and maintenance actions to apply	Decide how best, and who is best, to deliver the ideal environment to every critical component—your choices include operational, preventive, predictive, proactive and precision maintenance activities.
8				Identify spares and supply chain management strategies	Based on the component criticality, its likelihood of failure, and the availability of a replacement, you determine your spares holding and supply chain management requirements.
9			PERFORMANCE IMPROVEMENT	Confirm equipment risk reduction is below the risk boundary and industry ALARP	For each equipment item test on the risk matrix that once the wellness activities are done the operational risk for the equipment is below the business risk boundary. Adjust, add and refine activities until the operational risk is acceptable. *Note: the final risk may also need to meet ALARP levels.*
10				Cost the savings from reduced operational losses and higher uptime	Using the identified operational risk reduction determine the moneys annually saved by applying the Plant Wellness strategy.
11				Develop planned maintenance work orders to deliver and track activities	Equipment by equipment you write planned ACE 3T work orders that contain the exact requirements and the necessary standards to deliver lifelong health. The works is scheduled and the cost to provide plant wellness is identified.
12				Develop the business quality management system needed to support Plant Wellness	Apply ISO 9001 to identify and establish the necessary business systems and supporting processes to deliver and improve the Plant Wellness results—documentation and configuration management, capital project management, planning and scheduling, human capability management, reliability engineering, integrated business system, etc.
13				Continually improve the company's use of Plant Wellness strategy and activities	Apply those Lean Six Sigma methods that deliver greater efficiency and effectiveness to operational and maintenance processes—become a learning organisation, continually developing and integrating best practices.

Table 1 Summary of the Plant Wellness Way EAM Method

Plant Wellness Way is a scientifically based, business risk prevention technique used by shopfloor maintainers through to degree qualified manager. It is a universal asset management process that is simple in concept, correct in method, easy to apply, yet thorough and complete in its outputs. The methodology is based on sound business risk management strategy and successful reliability improvement science. It gets you and your people thinking correctly about failure prevention and shows you the right answers to adopt to create high equipment reliability and minimise life cycle operational costs.

This article explains how to use the Plant Wellness method. You follow a step-by-step process that starts with how big the breakdown and failure risks are in your operation, then determines the simplest and most effective ways to remove and prevent those risks and ends up with showing you how to create the optimal business processes to deliver a powerful wellness and health strategy for high equipment reliability.

1. Determine Equipment Criticality and Resulting Operational Risk

First an Equipment Criticality Analysis is done to identify the equipment where your operational risks are located to allow you to focus operational and maintenance efforts on where they pay-off the greatest for the business. Chart 1 is used with a company's risk matrix to determine each physical asset's criticality. Equipment by equipment, from the power supply into the operation through to each physical item of plant, gets rated for its criticality, i.e. the operating risk it brings to the business.

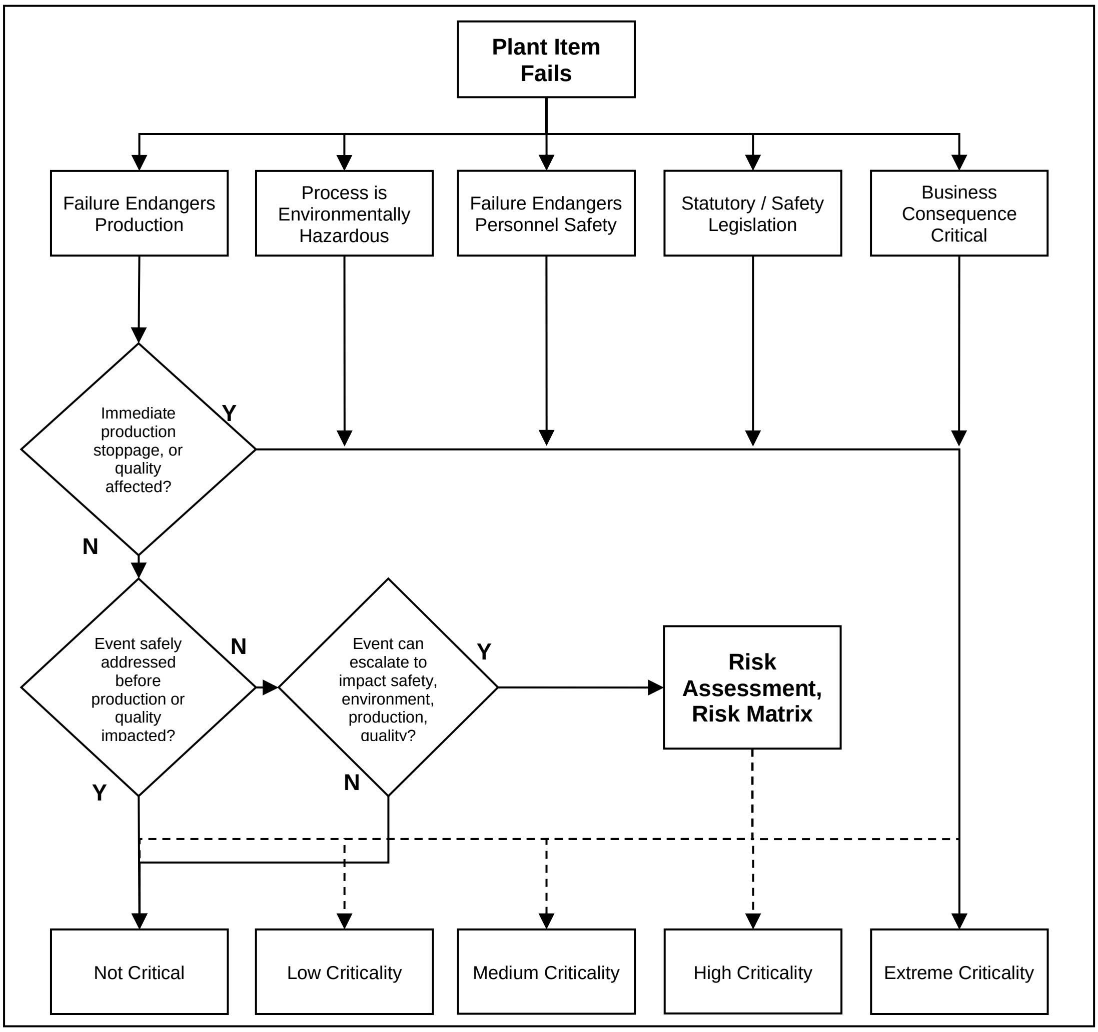


Chart 1 Assess Every Plant Item's Criticality

This assessment identifies how bad things can get in your operation if any of your operational equipment fails. The top of the chart is for situations where you never want a failure event to happen. Deaths, law breaking, environmental disasters, business destroying losses are failures you never want to face. The probability of such a failure event occurring is not a concern. These types of events must never happen because the consequences would be too severe and disastrous.

Where the effect of a failure event is a production impact, then the lower portion of the chart is used to apply probability of the event occurring through use of a risk matrix during the risk assessment. The risk analysis and risk prevention tools used in the Plant Wellness Way (PWW) will get you to select risk controls and mitigations that drive your operational risk to low and lesser levels. At the completion of Step 1 you have a list starting with the most critical plant and equipment and going down to the least critical

2. Determine Assembly and Parts' Criticality and Resulting Operational Risk

This step looks at the assemblies and parts in each item of equipment to identify which are the critical components that cause bad risk when they fail. An item of plant or equipment item only causes operational risk if critical components breakdown, stop working or lose integrity. The critical parts are now identified so appropriate risk management strategies, including operational and maintenance activities, can be selected.

The same risk assessment chart used to identify equipment criticality is used to identify component criticality. The one difference is that in Chart 2 we start with an assembly or component. In the review each part in a machine and every section of pipe, flange and valve is risk analysed. It was a failed pressure relief valve (PRV) on a section of pipe that caused the Three Mile Island nuclear power plant disaster, and a PRV was involved in the Piper Alpha off-shore platform fire, so you must look at every physical item in your operation and identify the worst case events that could happen should it fail.

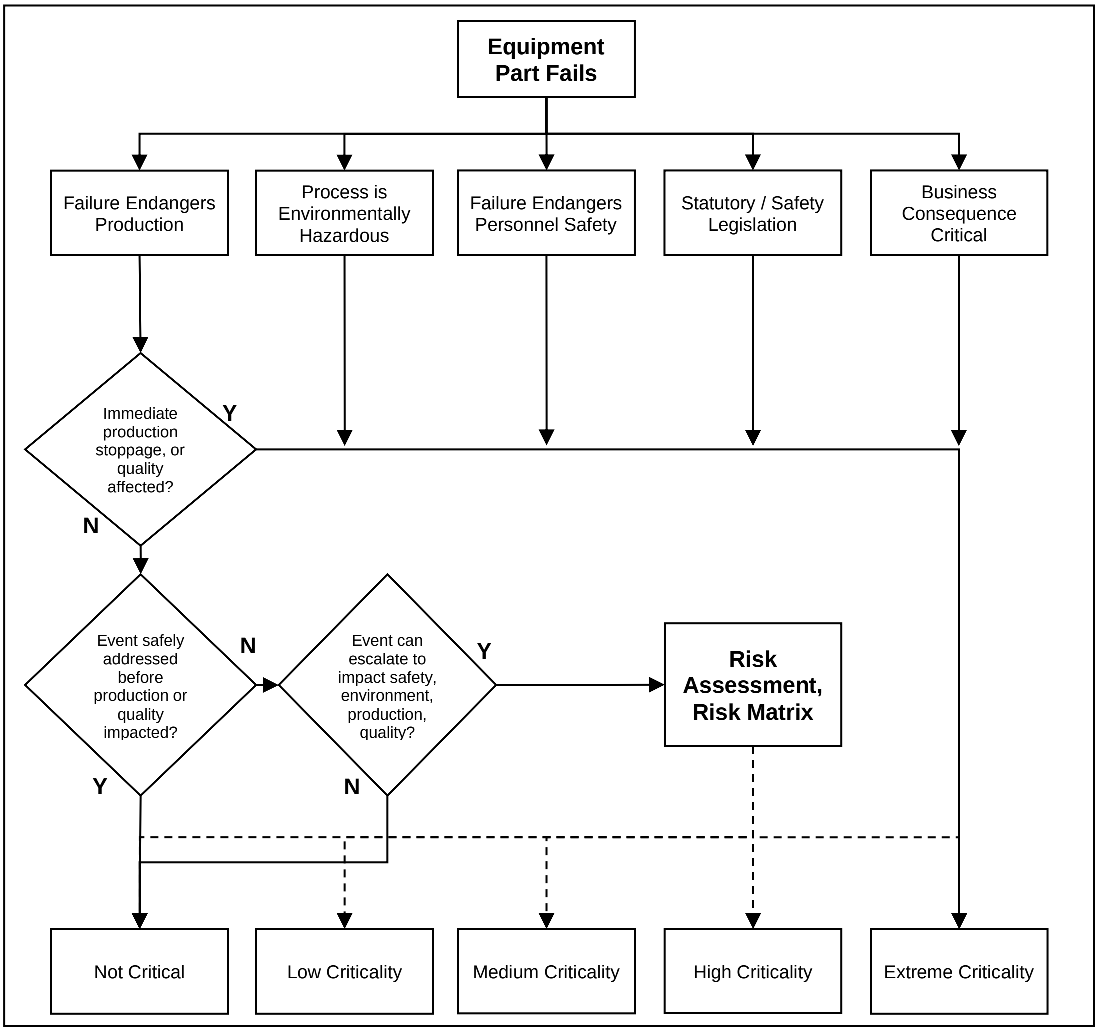


Chart 2 Assess Every Equipment Component's Criticality

3. Identify Component Failure Categories

Because parts fail before the equipment fails, the Plant Wellness Way requires you to prevent critical part's failure. From Step Two you know the critical parts in all your machines and items of plant. Now we need to understand how each critical part can fail—what situations can cause a part to fail and make the equipment breakdown, stop operating properly or lose integrity.

PWW focuses on using proactive failure prevention strategies instead of failure detection and repair. We are not interested in using the normal asset management practice of Reliability Centre Maintenance (RCM) where you identify the many failure causes and their resulting failure modes for each item of plant. Instead we want to understand the type of situations that will lead to equipment failures and control the situational causes so that no failures will arise that we then have to fix. By preventing failure causes starting Plant Wellness saves companies vast amounts of money.

For each equipment item its parts drawing, such as the one in Figure 2 for a V8 motor, and parts list, Figure 3 for the V8 Motor, is used to identify the critical assemblies and components. Using the parts list each part is categorised by the situations that can cause it to fail. Equipment components fail for one of two causes—they become degraded by use or they are over-stressed by deformation. Deformation is the result of a stress creating incident and human error. Degradation occurs through wear-and-tear and accumulating contamination. In Step 3 the parts that degrade from use and wear are identified, as are parts that fail from deformation through excess stress. Usually equipment parts fail multiple ways.

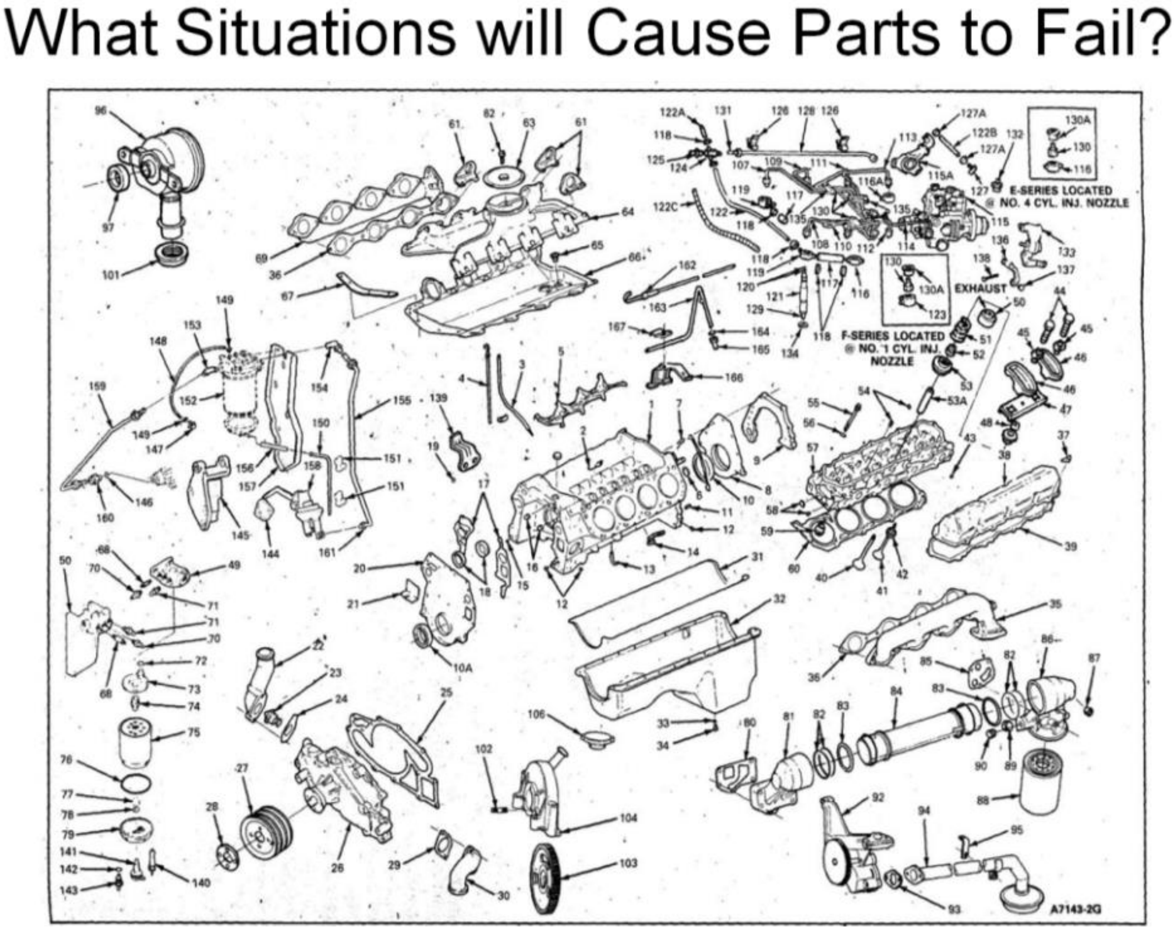


Figure 2 Equipment Parts Drawing

As shown on Chart 3, part by part is reviewed to see which situational causes lead to their failure. The explanation box in Figure 3 shows how they are categorised by those circumstances that produce degradation and those that produce deformation.

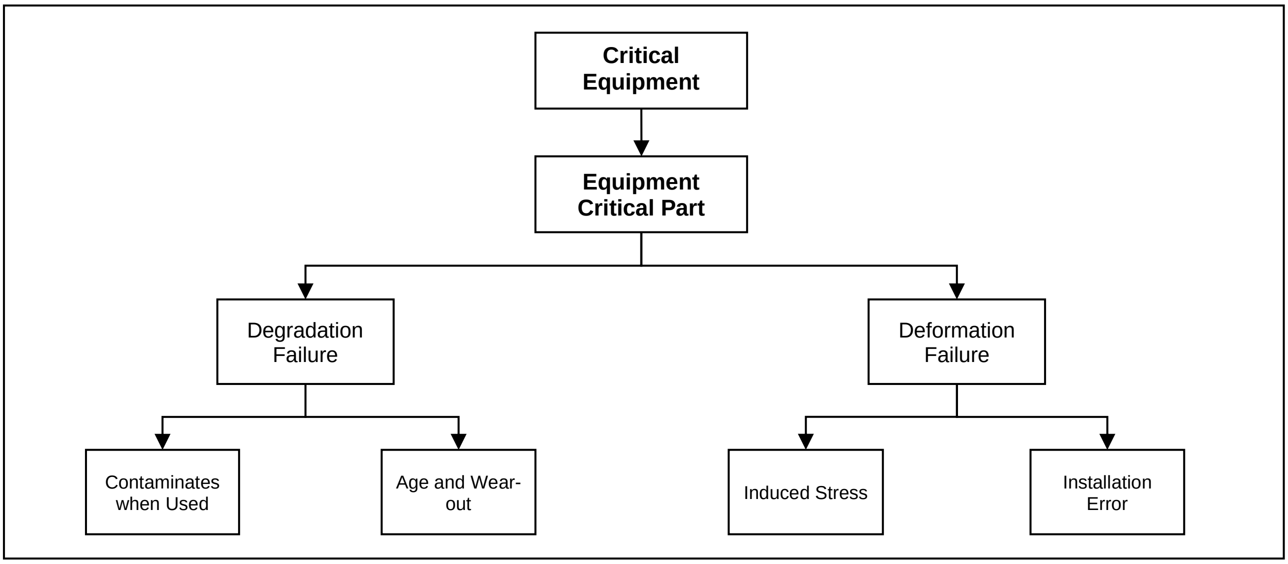
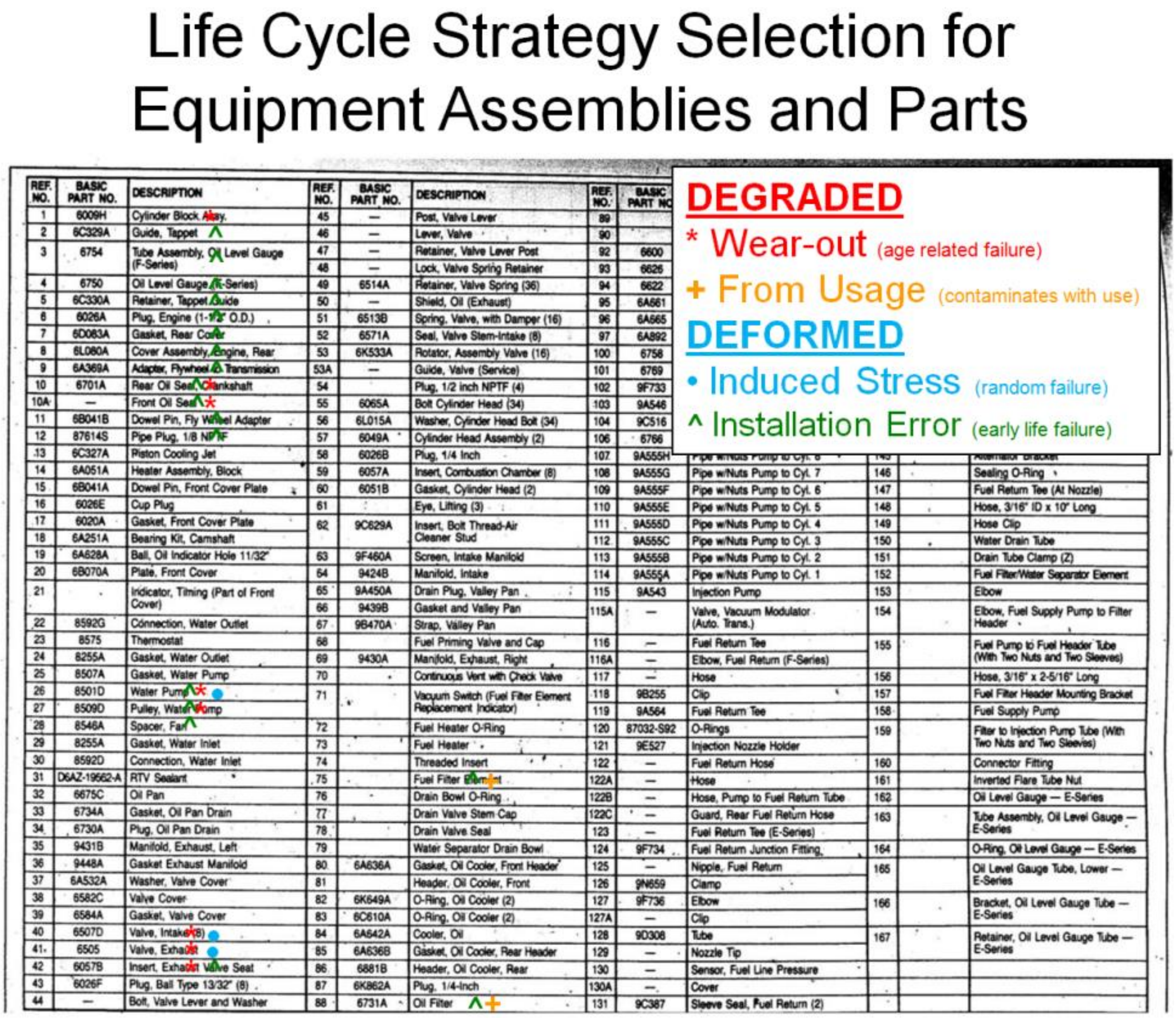


Chart 3 Identify Situations that Cause Critical Parts Fail



REF. NO.	BASIC PART NO.	DESCRIPTION
1	6009H	Cylinder Block Assy. *
2	6C329A	Guide, Tappet ^
3	6754	Tube Assembly, Oil Level Gauge (F-Series) ^
4	6750	Oil Level Gauge (F-Series) ^
5	6C330A	Retainer, Tappet Guide ^
6	6026A	Plug, Engine (1-1/2" O.D.) ^
7	6D083A	Gasket, Rear Cover ^
8	6L080A	Cover Assembly, Engine, Rear ^
9	6A369A	Adapter, Flywheel to Transmission ^
10	6701A	Rear Oil Seal, Crankshaft ^ *
10A	—	Front Oil Seal ^ *
11	6B041B	Dowel Pin, Fly Wheel Adapter ^
12	87614S	Pipe Plug, 1/8 NPTF ^
13	6C327A	Piston Cooling Jet
14	6A051A	Heater Assembly, Block
15	6B041A	Dowel Pin, Front Cover Plate
16	6026E	Cup Plug
17	6020A	Gasket, Front Cover Plate
18	6A251A	Bearing Kit, Camshaft
19	6A628A	Ball, Oil Indicator Hole 11/32"
20	6B070A	Plate, Front Cover
21		Indicator, Timing (Part of Front Cover)
22	8592G	Connection, Water Outlet
23	8575	Thermostat
24	8255A	Gasket, Water Outlet
25	8507A	Gasket, Water Pump
26	8501D	Water Pump ^ * •
27	8509D	Pulley, Water Pump ^ *
28	8546A	Spacer, Fan ^
29	8255A	Gasket, Water Inlet
30	8592D	Connection, Water Inlet
31	D6AZ-19562-A	RTV Sealant
32	6675C	Oil Pan
33	6734A	Gasket, Oil Pan Drain
34	6730A	Plug, Oil Pan Drain
35	9431B	Manifold, Exhaust, Left
36	9448A	Gasket Exhaust Manifold
37	6A532A	Washer, Valve Cover
38	6582C	Valve Cover
39	6584A	Gasket, Valve Cover
40	6507D	Valve, Intake (8) * •
41	6505	Valve, Exhaust * •
42	6057B	Insert, Exhaust Valve Seat * ^
43	6026F	Plug, Ball Type 13/32" (8)
44	—	Bolt, Valve Lever and Washer

REF. NO.	BASIC PART NO.	DESCRIPTION
45	—	Post, Valve Lever
46	—	Lever, Valve
47	—	Retainer, Valve Lever Post
48	—	Lock, Valve Spring Retainer
49	6514A	Retainer, Valve Spring (36)
50	—	Shield, Oil (Exhaust)
51	6513B	Spring, Valve, with Damper (16)
52	6571A	Seal, Valve Stem-Intake (8)
53	6K533A	Rotator, Assembly Valve (16)
53A	—	Guide, Valve (Service)
54		Plug, 1/2 inch NPTF (4)
55	6065A	Bolt Cylinder Head (34)
56	6L015A	Washer, Cylinder Head Bolt (34)
57	6049A	Cylinder Head Assembly (2)
58	6026B	Plug, 1/4 Inch
59	6057A	Insert, Combustion Chamber (8)
60	6051B	Gasket, Cylinder Head (2)
61		Eye, Lifting (3)
62	9C629A	Insert, Bolt Thread-Air Cleaner Stud
63	9F460A	Screen, Intake Manifold
64	9424B	Manifold, Intake
65	9A450A	Drain Plug, Valley Pan
66	9439B	Gasket and Valley Pan
67	9B470A	Strap, Valley Pan
68		Fuel Priming Valve and Cap
69	9430A	Manifold, Exhaust, Right
70		Continuous Vent with Check Valve
71		Vacuum Switch (Fuel Filter Element Replacement Indicator)
72		Fuel Heater O-Ring
73		Fuel Heater
74		Threaded Insert
75		Fuel Filter Element ^ +
76		Drain Bowl O-Ring
77		Drain Valve Stem Cap
78		Drain Valve Seal
79		Water Separator Drain Bowl
80	6A636A	Gasket, Oil Cooler, Front Header
81		Header, Oil Cooler, Front
82	6K649A	O-Ring, Oil Cooler (2)
83	6C610A	O-Ring, Oil Cooler (2)
84	6A642A	Cooler, Oil
85	6A636B	Gasket, Oil Cooler, Rear Header
86	6881B	Header, Oil Cooler, Rear
87	6K862A	Plug, 1/4-Inch
88	6731A	Oil Filter ^ +

REF. NO.	BASIC PART NO.	DESCRIPTION
89		
90		
92	6600	
93	6626	
94	6622	
95	6A661	
96	6A665	
97	6A892	
100	6758	
101	6769	
102	9F733	
103	9A546	
104	9C516	
106	6766	
107	9A555H	[illegible]
108	9A555G	Pipe w/Nuts Pump to Cyl. 7
109	9A555F	Pipe w/Nuts Pump to Cyl. 6
110	9A555E	Pipe w/Nuts Pump to Cyl. 5
111	9A555D	Pipe w/Nuts Pump to Cyl. 4
112	9A555C	Pipe w/Nuts Pump to Cyl. 3
113	9A555B	Pipe w/Nuts Pump to Cyl. 2
114	9A555A	Pipe w/Nuts Pump to Cyl. 1
115	9A543	Injection Pump
115A	—	Valve, Vacuum Modulator (Auto. Trans.)
116	—	Fuel Return Tee
116A	—	Elbow, Fuel Return (F-Series)
117	—	Hose
118	9B255	Clip
119	9A564	Fuel Return Tee
120	87032-S92	O-Rings
121	9E527	Injection Nozzle Holder
122	—	Fuel Return Hose
122A	—	Hose
122B	—	Hose, Pump to Fuel Return Tube
122C	—	Guard, Rear Fuel Return Hose
123	—	Fuel Return Tee (E-Series)
124	9F734	Fuel Return Junction Fitting
125	—	Nipple, Fuel Return
126	9N659	Clamp
127	9F736	Elbow
127A	—	Clip
128	9D308	Tube
129	—	Nozzle Tip
130	—	Sensor, Fuel Line Pressure
130A	—	Cover
131	9C387	Sleeve Seal, Fuel Return (2)

REF. NO.	BASIC PART NO.	DESCRIPTION
145		Alternator Bracket
146		Sealing O-Ring
147		Fuel Return Tee (At Nozzle)
148		Hose, 3/16" ID x 10" Long
149		Hose Clip
150		Water Drain Tube
151		Drain Tube Clamp (Z)
152		Fuel Filter/Water Separator Element
153		Elbow
154		Elbow, Fuel Supply Pump to Filter Header
155		Fuel Pump to Fuel Header Tube (With Two Nuts and Two Sleeves)
156		Hose, 3/16" x 2-5/16" Long
157		Fuel Filter Header Mounting Bracket
158		Fuel Supply Pump
159		Filter to Injection Pump Tube (With Two Nuts and Two Sleeves)
160		Connector Fitting
161		Inverted Flare Tube Nut
162		Oil Level Gauge — E-Series
163		Tube Assembly, Oil Level Gauge — E-Series
164		O-Ring, Oil Level Gauge — E-Series
165		Oil Level Gauge Tube, Lower — E-Series
166		Bracket, Oil Level Gauge Tube — E-Series
167		Retainer, Oil Level Gauge Tube — E-Series

Figure 3 Equipment Parts List Showing Parts Situational Failure Causes

At the end of Step 3 the critical parts are identified and the situational causes of their failure are known.

4. Identify and Select Component Life Cycle Wellness Requirements

Plant Wellness is a life cycle asset management philosophy that proactively prevents the causes of failure starting. It requires that you put into place in your business the strategies, methods and practices which create highly reliable plant and machinery. Prevent and control the situations that can cause bad risks and problems to parts and you stop operational failures.

To maximise operational profits we must prevent operational risks occurring. You need to find and implement the specific actions that produce the required health outcomes which prevent critical parts failing. Loss can only happen if first a bad risk is present that can lead to the failure of an equipment's critical parts. If you prevent the start of a bad risk you kill the failure cause and effect tree by removing the root causes of failure. Stop opportunity for a failure to start you get reliability.

The PWW gets you to choose risk removal and mitigation activities for each phase of a critical component's life cycle to greatly reduce the opportunity of error and defects arising during its lifetime. By preventing operational risks at every stage of a component's life you stop the defects and errors that will later become operational equipment failures.

Chart 4 helps you to target the sort of practical techniques and deeds that create machinery and equipment health and plant-wide wellness in your operation. When you stop critical parts failing your equipment becomes outstandingly reliable. Chart 4 is used to select the types of life cycle activities on which to focus that will prevent equipment failure.

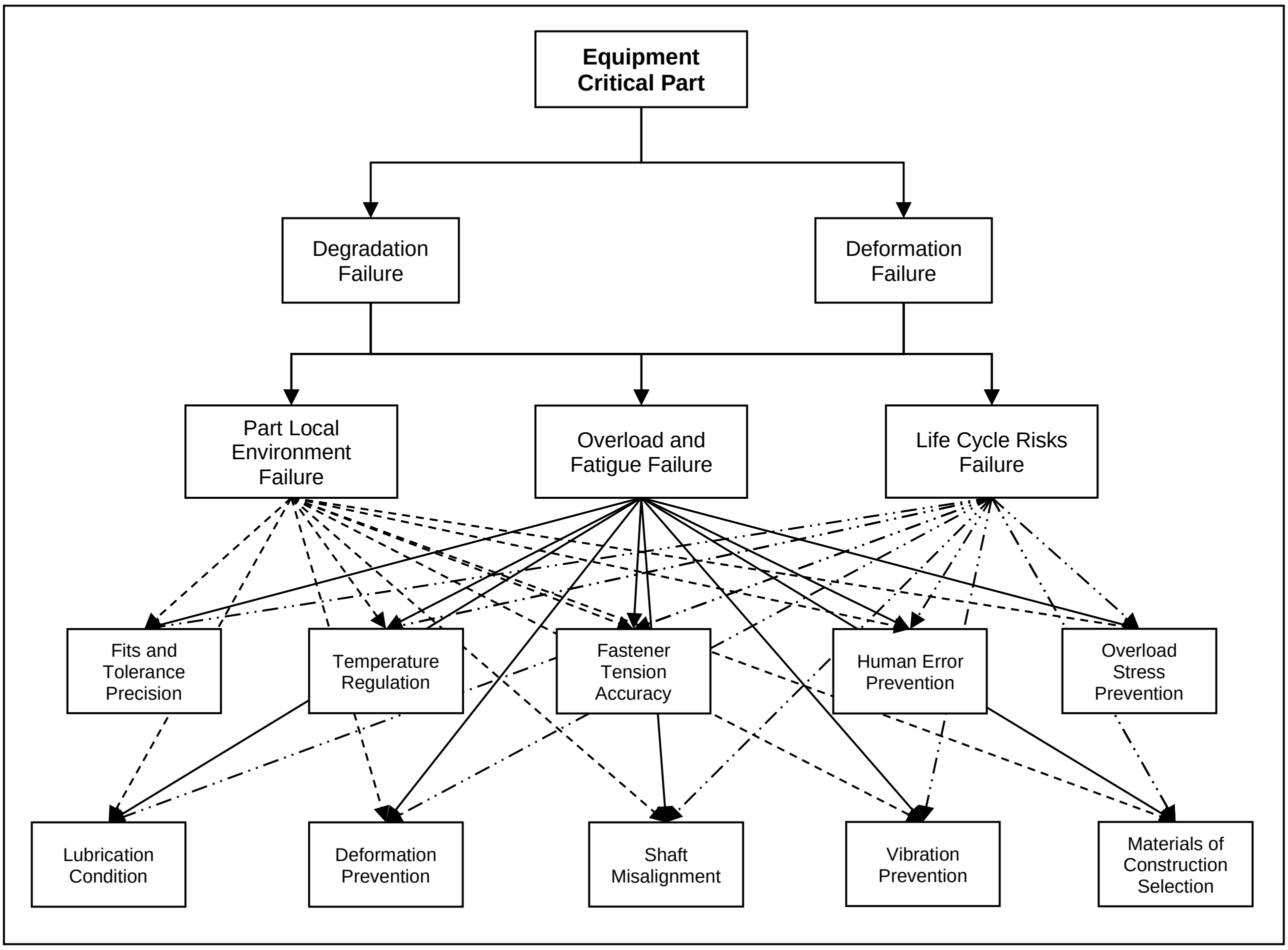


Chart 4 Selecting Part's Failure Prevention Life Cycle Strategies

For each critical part, the trigger risks listed at the bottom of Chart 4 are used to review the part and identify if it can be failed from any of the risk factors. Activities are then identified to address the part's local environment, operational stresses and life cycle risks to remove or at least greatly reduce the risk factor. The power of Plant Wellness is its recognition that there are only a few fundamental causes of failure and by controlling them you can get any level of plant and equipment reliability that you want. Unlike other asset management methodologies that look for evidence of failure and then fix the failure, PWW instead gets you to recognise the situations that produce outstanding reliability and create them in your business.

5. Categorise Risk and Failure Prevention Strategies

PWW requires you to put the risk mitigation actions into appropriate engineering, operational and maintenance processes to ensure that they happen correctly. Knowing how the critical parts will be protected from failure allows you to identify guiding project engineering, operational and maintenance strategies to prevent their failure. Chart 5 is used to categorise the life cycle failure prevention activities into the applicable strategies that prevent and control the situational circumstances that lead to a critical part's failure.

Parts that fail from induced stress require strategies that remove and prevent over-stress circumstances developing. Parts that fail from installation error need their installation process to be carefully controlled. Parts that fail from contamination require strategies to prevent or remove contamination. Those parts that degrade by wear need strategies to reduce degradation and ensure that they are replaced before they fail.

Notice that we have started at the bottom of the Plant Wellness Triangle—with the parts. By delivering the right strategies for your parts you get outstanding equipment reliability. Once the right pre-emptive risk activities are selected the PWW methodology will take you up the 'stress to business process' triangle and show you the business processes to build in order to surely deliver the right life cycle asset management strategies to your equipment and machinery for lifetime reliability.

6. Identify and Select Component Health and Wellness Standards

We have so far selected engineering, operational and maintenance risk management strategies and activities to prevent defects and errors during each critical components' life cycle phases. Next you need to set the performance standards for each activity that, when the standard is achieved, will deliver long, highly reliable component life. With long, failure-free component life comes long, trouble-free equipment life and you get the high plant availability that you want.

These standards are the precision workmanship and quality control standards that need to be met throughout the life cycle by your consultants, vendors, suppliers, contractors and your own engineering, operations and maintenance people. In setting and providing quality standards you place minimum acceptance criteria on equipment performance and work quality outcomes so that a known degree of reliability is achieved. When a higher level of reliability is wanted we make the quality standards more demanding and develop the methods to achieve them with certainty.

Some of the suggested precision machinery health standards are noted in Table 2.

7. Identify Engineering, Operational and Maintenance Actions to Apply

You next identify ownership for each risk mitigation activity and action. You make clear where the responsibility and accountability lays for the performance of each activity. Chart 5 identifies the applicable business and risk management processes that an activity will belong to. The selected strategies, methods, activities and standards are written into the applicable company processes by including them in the relevant business process documentation. Policies, procedures, work instructions and training are updated to include the activities that need to be performed and the standards that need to be achieved.

You start by documenting the correct way equipment reliability is achieved and then you train your people to do the right activities rightly. We first educate people in the right practices and then teach them to correctly use the right practices. The Plant Wellness Way is written into your processes and inculcated into the operation, and thereby it is forevermore made part your organisation's cultural DNA.

P (+61 8) 9457 6297 **E** info@plant-wellness-way.com

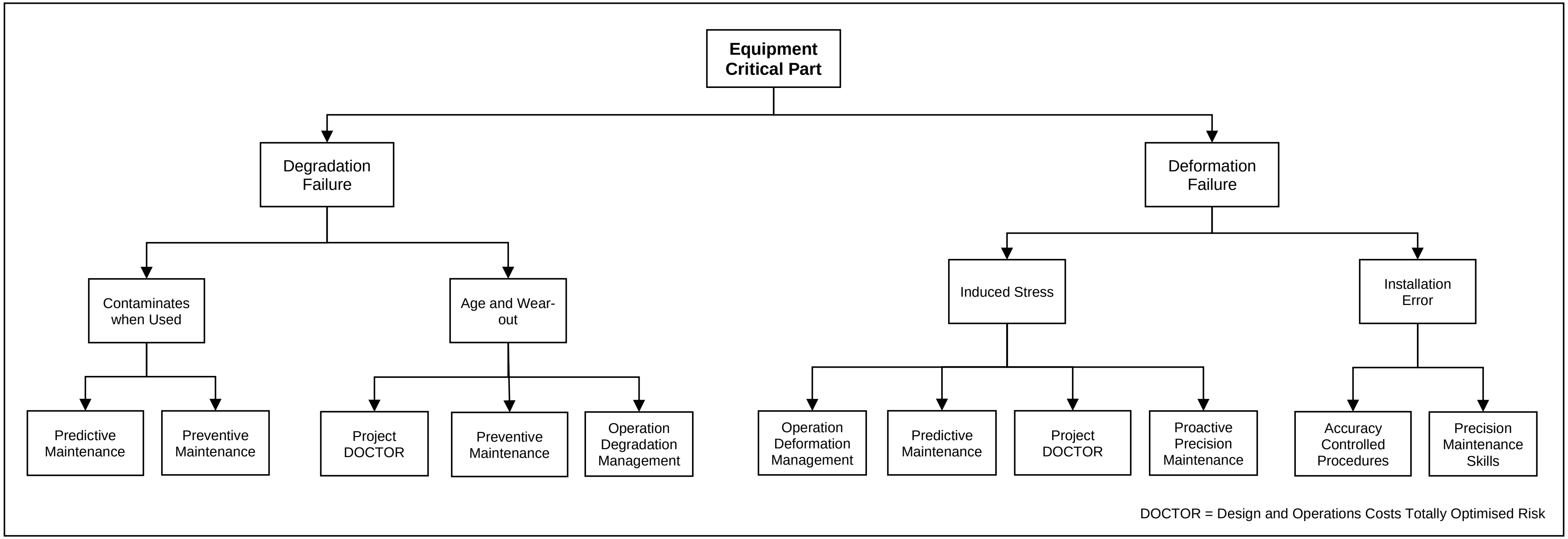
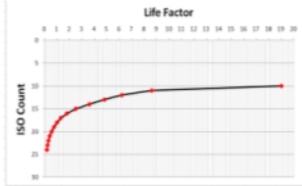
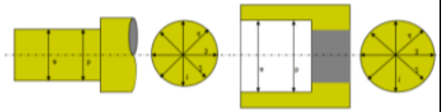
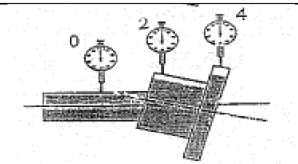
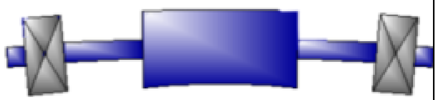
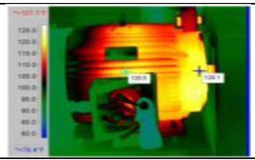
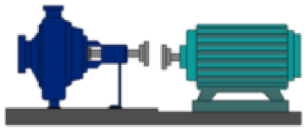
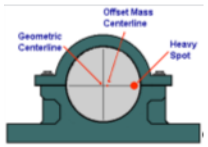
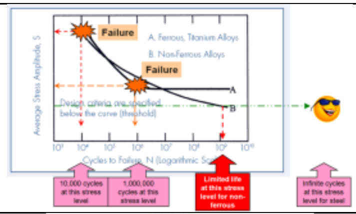
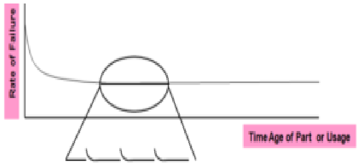
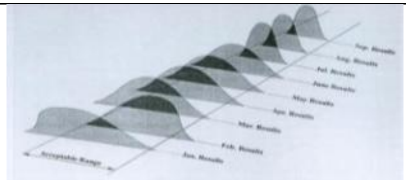


Chart 5 Selecting Applicable Business Processes for the Failure Prevention Strategies

No	BUSINESS PROCESS FAILURE	VISUAL OBSERVATION	EFFECT ON MACHINE	LIFE PRECISION REQUIREMENT	PARAMETERS	TARGET VALUE	TOLERANCE
1	**Poor lubrication condition**	 		Chemically correct, contaminant-free lubricant	VISCOSITY, ADDITIVES, DISSOLVED WATER, WEAR PARTICLE COUNT	**Right viscosity at operating temperature; Correct proportion of additives; <100ppm water; ISO 4406 12/9 cleanliness**	ISO 4406 14/11 cleanliness
2	**Wrong fits and tolerance**			Accurate fits and tolerance at operating temperature	INTERFERENCE FIT, OPERATING TEMPERATURE	**Form IT5, Operating temperature at design conditions**	IT7
3	**Running off-centre**			Shafts, bearings and couplings running true to centre	CENTRE OF ROTATION, RUN-OUT, TOLERANCE & FORM ACCURACY	**IT5**	IT7
4	**Deformed, bent, buckled parts**			Distortion-free equipment for its entire lifetime	SOFTFOOT, STRUCTURAL DISTORTION	**IT5**	IT7
5	**Excessive loads and forces**			Forces and loads into rigid mounts and supports	DESIGN LOAD, FORCES INTO SOLID LOCATIONS, FOUNDATION RIGIDITY	**No Looseness; Safely absorb/dampen forces**	
6	**Misaligned shafts**			Accurate alignment of shafts at operating temperature	SHAFT ALIGNMENT, STRAIGHTNESS, DEFLECTION	**Coupling/Feet offset 10µm/20µm**	20µm/40µm
7	**Unbalanced rotors**			High quality balanced rotating parts	ROTOR BALANCE, CENTRE OF MASS	**G1**	G2.5

8	**Induced and forced vibration**			Total machine vibration low	MACHINE VIBRATION, MACHINE DISTORTION, STRUCTURAL RIGIDITY	**1.5mm/s rms**	4mm/s rms
9	**Incorrectly tightened fasteners**			Correct torques and tensions in all components	SHANK TENSION, LOOSENESS, FASTENER GRADE	**± 5% of correct tension**	± 10%
10	**Poor condition tools and measures**			Correct tools in precise condition to do task to proper standards	GOOD-AS-NEW CONDITION, RELIABLY CALIBRATED	**As new condition/correctly calibrated**	
11	**Inappropriate materials of construction**			Only in-specification parts	MATERIAL OF CONSTRUCTION, DIMENSIONAL SPECIFICATION	**OEM approved material and design specs**	
12	**Root cause not removed**			Failure cause removal during maintenance	CREATIVE DISASSEMBLY, DEFECT ELIMINATION	**Use Creative Disassembly and Precision Assembly**	
13	**Assembly quality below standard**			Proof test for precision assembly quality	INSPECTION TEST ACCURACY, PRECISION STANDARD	**Ensure every activity is proven correct (apply the Carpenter's Creed)**	Milestone Tasks Tested
14	**Process out-of-control and/or not capable**			A quality assurance system to make all the above happen	QUALITY CONTROL STANDARDS, PROCESS IN STATISTICAL CONTROL	**ACE 3T Procedures**	ITP (Inspection & Test Plan)

NOTE: *These parameters are indicative and may not apply to a particular machine. Confirm actual requirements with the manufacturer.*

Table 2 Indicative Target Values for Creating High Machine Reliability

8. Identify Spares and Supply Chain Management Strategies

Some of the actions and activities in the various risk management strategies used will require that parts and material be available to minimise business and operational risks. The supply chain management, purchasing and materials management practices that make those items available at the appropriate times need to be identified and put into place. Which parts and materials are needed on-hand or which can be brought are identified with the help of Chart 6, which is Chart 1 modified to consider spare parts criticality.

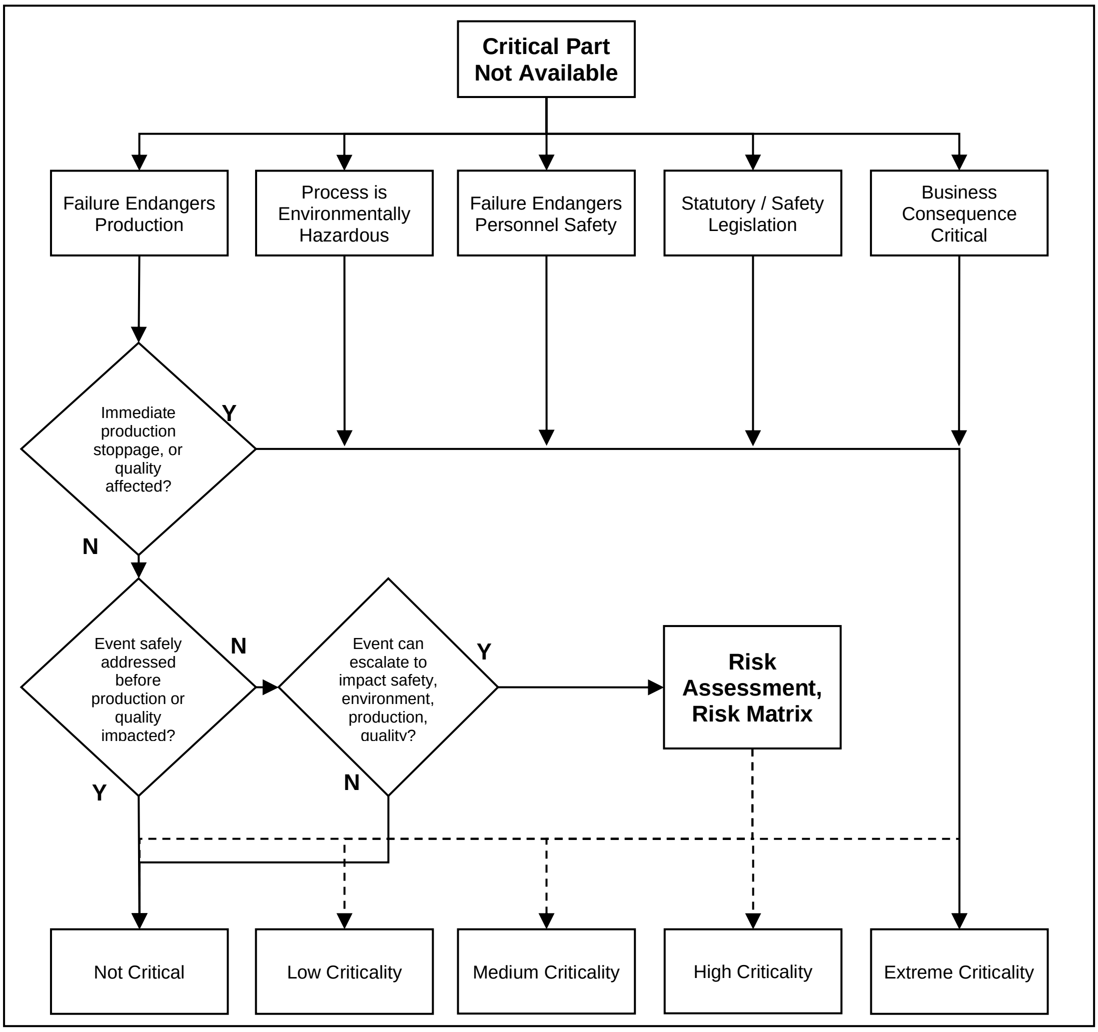


Chart 6 Assess Spare Part Criticality

Like any risk based decision, which parts to carry, which parts to purchase-on-demand and the integrity of the business processes that support the supply chain and materials management practices are dependent on the risk a company is willing to carry.

9. Confirm Equipment Risk Reduction is Below the Risk Boundary and Industry ALARP

The PWW methodology requires that the risk mitigations selected must drive the operational risk for an asset to below the Corporate Low risk level, and if necessary down to the industry's As Low As Reasonably Practicable (ALARP) level.

It is easy to select risk management activities and create a lot of work for operators and maintainers. Just because a mitigation can be imagined and performed it does not mean that operational risk is reduced by doing the activity. When risk mitigations are chosen they must surely, without question, reduce risk—either by reducing the loss from the failure event and/or by reducing the frequency of the failure event. Plant Wellness requires indisputable evidence that the failure rate of a critical part is substantially reduced by doing the mitigation activity. Consequence reduction alone is not enough; there must be clear frequency reduction visible on the risk matrix. Only frequency reduction means real reliability improvement.

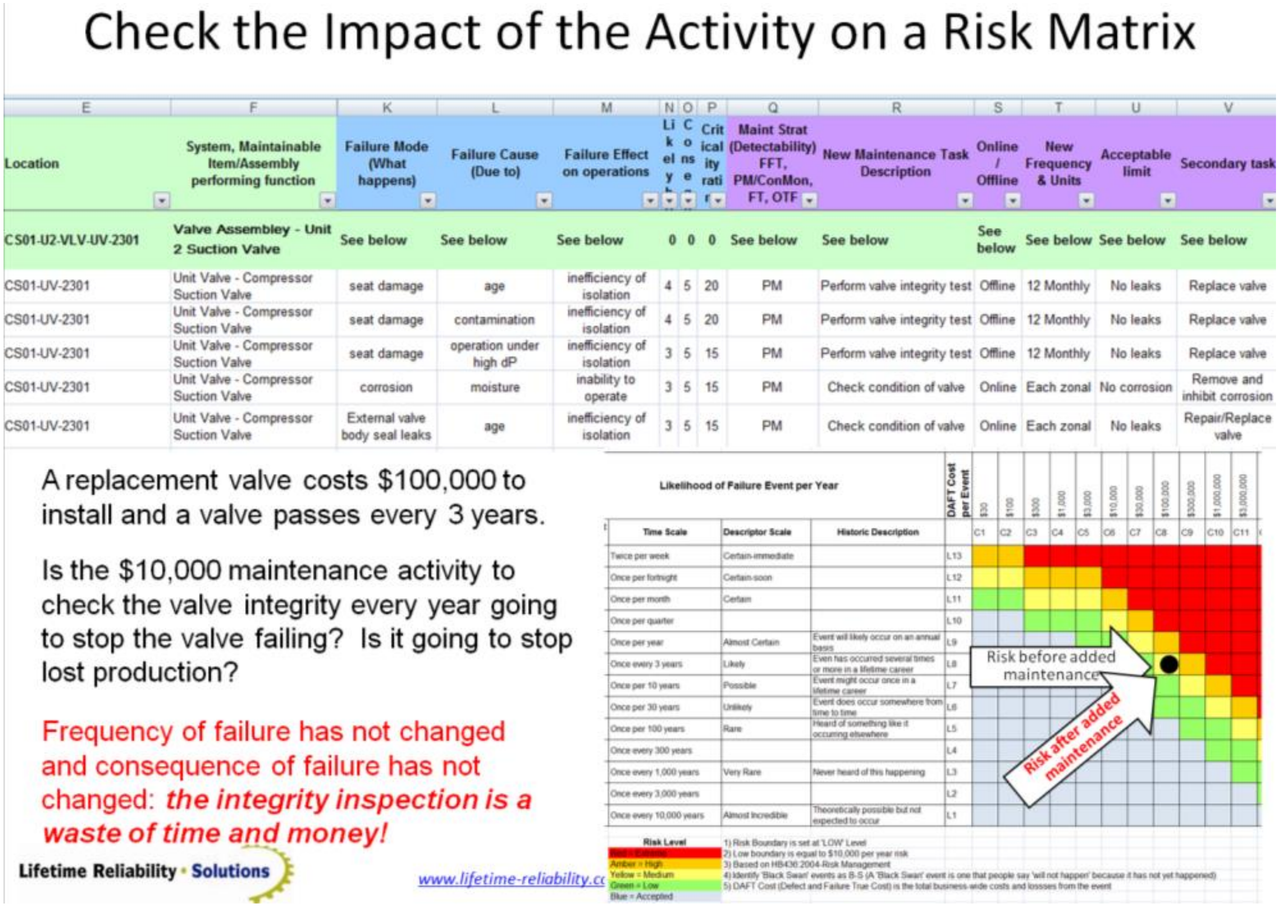


Figure 5 Not All Maintenance Work Actually Reduces Risk

Figure 5 shows how easy it is to develop maintenance activities that have no risk reduction value. When the valve passes there is a loss of $100,000 operational cost to rectify the problem and in lost opportunity to sell product. A valve on average lasts three years before it passes. The inspection will either find a valve in working condition or in a unusable condition. The maintenance task to inspect the valve integrity every year does not stop the failure or reduce the chance of failure. The annual $10,000 task is a waste of time and money because risk is not changed by doing the maintenance. The maintenance activity to integrity test the valve will do nothing to actually stop the valve failing. It would be better to replace the valve with a properly renewed valve every three years at $25,000 a time and do naught else. By replacing the valve with a fully refurbished valve on a three-yearly cycle, half the valves would not have failed and the $100,000 each would cost repairing them during operation would be saved.

To do justice to the business the failure-prone control valves should undergo a full and proper root cause analysis of the failures to develop better answers that address the real causes of control valves passing.

10. Cost the Savings from Reduced Operational Losses and Higher Uptime

Because Plant Wellness requires a clear, observable reduction in failure event frequency to be identified on the risk matrix we can also measure the expected financial benefits from every risk mitigation activity.

Figure 6 shows how money saved is identified on a risk matrix from doing an effective mitigation. A consequence reduction will produce obvious savings and an event frequency reduction will lead to fewer failures over a period of time. Both consequence reduction and frequency reduction bring measurable financial gain that can be estimated for each risk mitigation undertaken before committing to it being done.

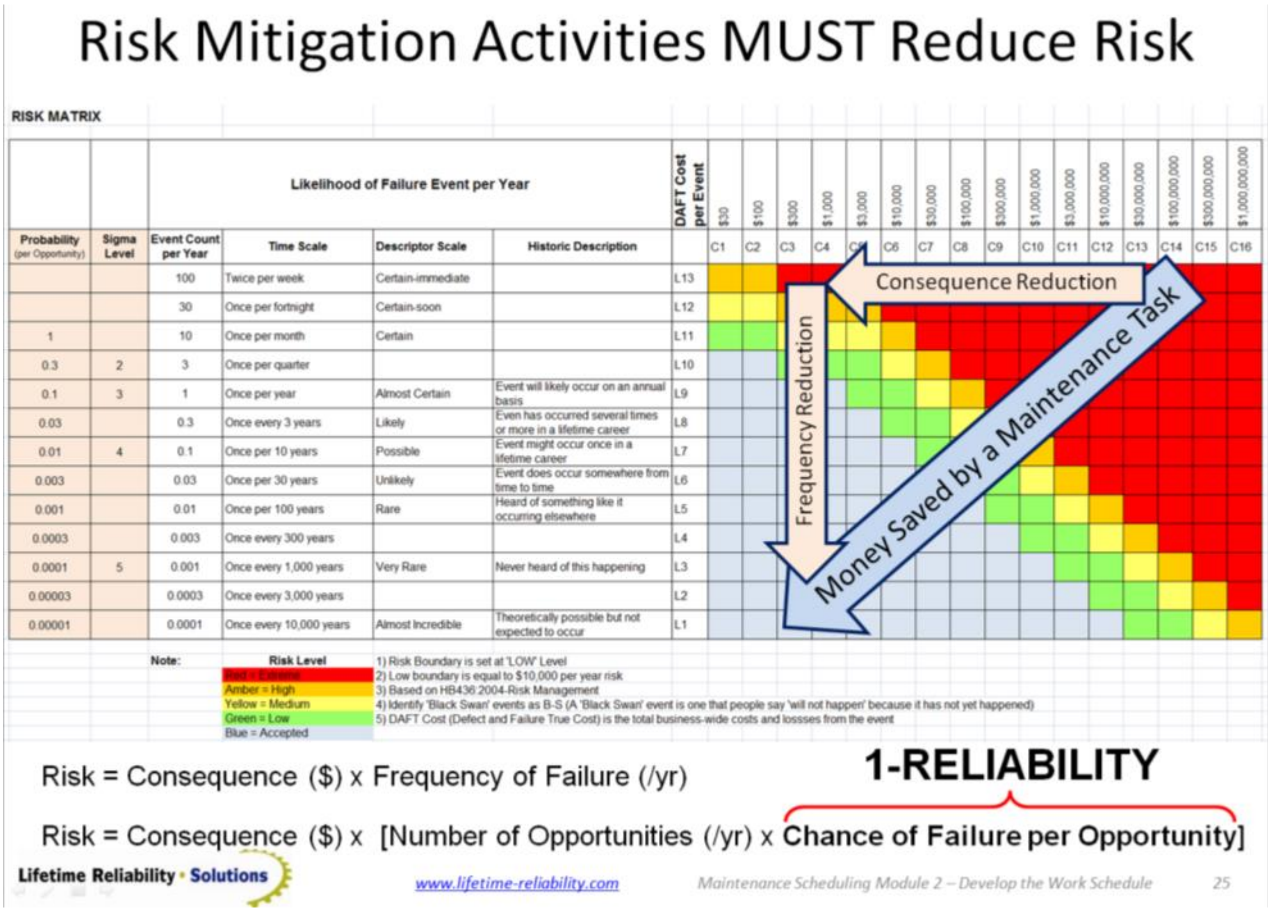


Figure 6 Check the Money Saved by Doing an Activity

The quantum of moneys saved is determined by using a spreadsheet in which each mitigation's consequence reduction and frequency reduction financial benefits are tabulated and tallied.

11. Develop Planned Maintenance Work Orders to Deliver and Track Activities

The selected risk mitigations must be done to prevent opportunity of a bad event to arise and develop, and to limit the consequence of a bad event. It is only by doing the mitigations that risk is contained. It is necessary to ensure that all mitigations are done, traceable and their proper actioning is recorded. The risk management activities selected to be done by Operations and Maintenance are put into the Computerised Maintenance Management System. Each activity is planned thoroughly and in detail so that a work pack with all necessary information, parts, materials and actions to be taken and recorded is available for each job when it is done.

Those operational risk mitigations that belong to Capital Projects, Engineering and other departments are written into the applicable process documents. Where mitigations are time based in those departments the mitigations are initiated through an automatic system so they are not forgotten. For situational based mitigations applicable procedures will generate needed actions and management activities will track them.

An annual audit reviewing risk management and mitigation is undertaken to ensure the necessary risk control activities and actions are being performed by all parties. As part of weekly, monthly and annual reporting the performance and success of risk mitigations are measured and reported to senior management.

12. Develop the Business Quality Management System Needed to Support Plant Wellness

We are now at the top of the Plant Wellness Way Triangle in the region related to the business systems and processes needed to sustain the equipment health that delivers Plant Wellness at the corporate level.

The previous steps in the PWW methodology produce the risk control activities and risk mitigation actions that greatly reduce operational risks. Across the life cycle of every asset we identify what to do to get outstanding equipment reliability. It is now necessary to ensure that all these risk reduction activities and lifetime reliability deeds are done, and always will be done, by the organisation.

Chart 7 shows a business quality management system and the Plant Wellness processes needed to reduce operational risk and reach high equipment reliability. The processes shown are used to produce the asset management performance required to get operational excellence. The top row of processes are the 'working' processes—those whose outputs deliver lifetime reliability. The bottom row of processes are those that sustain Plant Wellness. The aim is to have small the smallest business processes while ensuring each process achieves, nourishes and maintains everlasting Plant and Equipment Wellness in your company.

13. Continually Improve the Company's Use of Plant Wellness Strategy and Activities

Figure 7 shows the self-improvement model used by learning organisations to push themselves to the forefront of performance. It is a powerful tactic for improving equipment reliability and getting Plant Wellness asset management success. It asks you to test new ideas and approaches purposefully seeking improvement and to adopt changes that bring you benefits. Introducing Lean principles and practices into your organisation and using them properly fits the model and provides you with pacesetter rewards.

The success of a company depends on the usefulness of its products and services and its ability to deliver better products for less cost using fewer resources. This requires new cost reduction practices and innovations that generate an advantage. The simplest way to become a learning organisation that continually improves itself is to adopt the practices and methodologies of LEAN throughout the business. From Boardroom to shopfloor introduce and master the Lean processes and practices that create efficiency to reduce costs and those that drive creativity and change to improve the business.

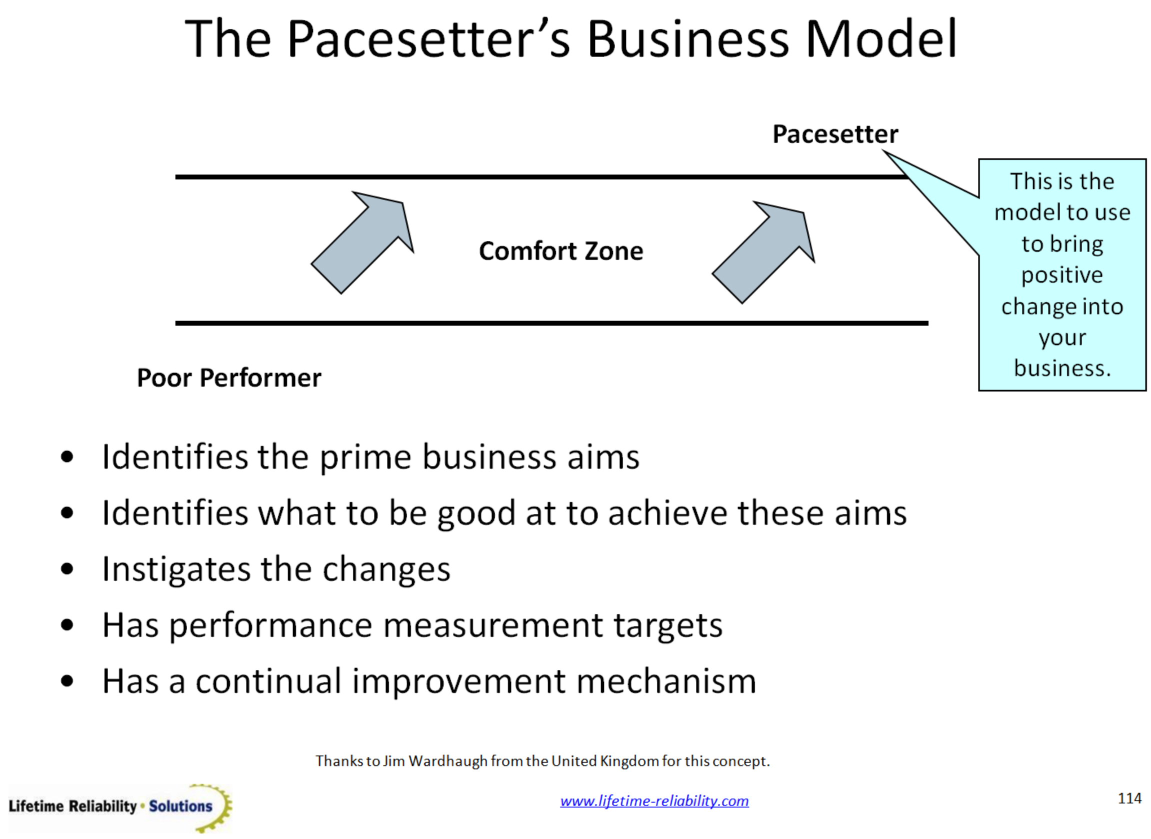


Figure 7 Becoming a Learning Organisation

For more information and details on using the Plant Wellness Way EAM methodology please contact us at info@plant-wellness-way.com.

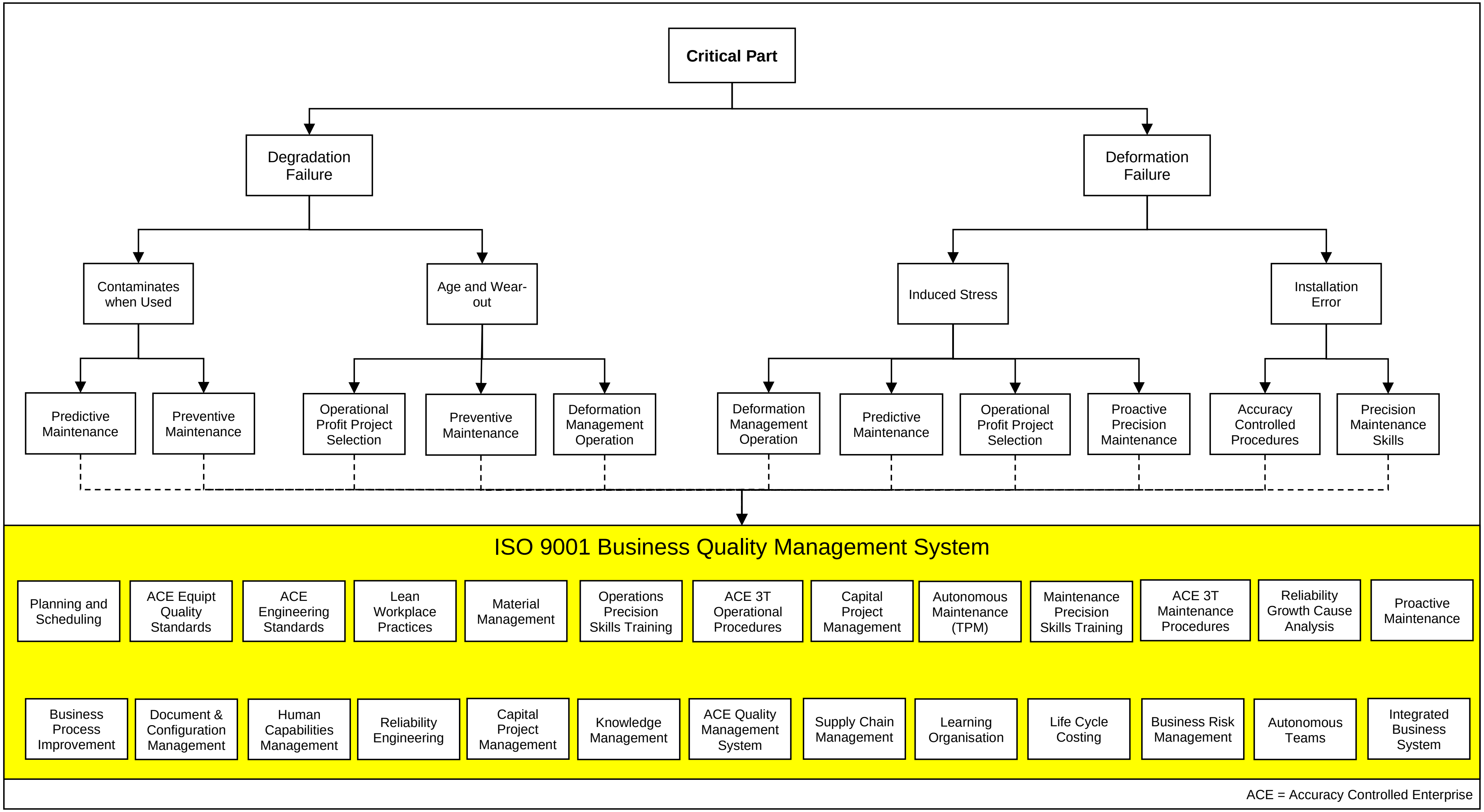


Chart 7 The Supporting Business Management System and Its Processes Needed to Reach and Sustain Plant and Equipment Wellness