

Introducing Enterprise Asset Management and Plant Wellness into Organizations

Enterprise asset management the Plant Wellness Way collects the key methods required for plant and equipment integrity and performance excellence into an optimizing life-cycle profit philosophy. The Plant Wellness Way provides enterprise asset management with the risk elimination and reliability improvement techniques and tools for the selection, use, and care of plant and equipment to achieve production and business goals year after year. The Plant Wellness Way gets physical assets performing at optimal operating profit by doing the following:

- Controlling the inherent variability in business, engineering, maintenance, and operating processes within the limits that produce excellence
- Reducing risk by eliminating the chance of adverse incidents and minimizing the consequences of any remaining risk
- Preventing equipment failure by setting and adhering to high-quality standards for parts health throughout their life, starting from capital equipment acquisition
- Creating a supply chain that delivers correct, reliable inputs for use in the organization
- Ensuring the accuracy and precision of human intervention and work activities
- Maximizing total life-cycle profits with proactive, fact-based financial modeling to justify eliminating failure, waste, and loss
- Bringing management, staff, and the workforce together to work cooperatively as a team of experts building a business that will secure their communal future

The Plant Wellness Way adds to enterprise asset management the specific methods to sustain equipment working parts in perfect health for a lifetime of reliability. It maximizes an organization's chance of reaching Operational Excellence. When you put a critical equipment part at risk of a bad outcome, you put the equipment at risk of failure. When your equipment is at risk, so is your operation and its future. All bad operating risks become production losses or harmful incidents when luck runs out.¹ Organizations that do not give priority to creating parts health and wellness in their equipment can never be world class—they will have too many failures and losses. Operational success needs healthy parts that do not fail, because when a part breaks, a machine dies, and then your business will instantly lose fortunes.

The introduction of change into organizations and the success of a change program require determined senior management commitment and leadership. The launch of a corporate-wide initiative as large as the Plant Wellness Way requires a solid appreciation by senior management of the principles and practices that must be applied if the business is to reap the maximum benefits most quickly. With a detailed understanding of the Plant Wellness Way, senior managers comprehend its effects on the organization and the benefits that result.

To prevent the Plant Wellness Way from becoming a “business fad” that is quickly dropped if improvements are not swiftly generated, companies introduce it through a pilot program. A representative portion of the business proves that the concepts and practices deliver improved operating performance and profits. Once the pilot program is successful, it is rolled it out progressively to the rest of the operation.

Asset Management and Plant Wellness Policy

An asset management and plant wellness policy is used to make sure that the right business decisions are made to support the well-being and long-term health of your plant and equipment. The policy drives the engineering, project, production, maintenance, and finance groups to improve equipment health and wellness. A successful business needs plant and equipment that makes on-time, least cost, quality product that its customers will buy willingly. Because an industrial operation's future depends on equipment working accurately and reliably, the finance, engineering, operations, and maintenance groups need to protect and improve the wellness of their machines' parts so their business has a highly reliable and trouble-free operating plant.

It is important to ensure that an asset wellness policy meets all the requirements that make it a useful and valuable document for guiding plans and practices. Within it are the organization's purpose and core goals, along with how its physical asset management efforts help goal achievement. A policy needs to be inspirational to the people it applies to. A limp policy does nothing for its readers or the company. The final published policy may need to be injected with energy by a writer who can bring it to life.

Table 1 lists the quality, risk, and asset management policy requirements of some internationally recognized standards. The comparison is intended to help you build into your asset management and wellness policy those things that are considered important to note in such documents. The checklist will help you get useful content into the policy so that it focuses on business benefits. This does not mean that an asset management policy must comply with every requirement in the table. The most important factors are the amount of "life" the policy breathes

into the people and the business, along with its ability to produce good decisions for equipment parts' health, and promote proactive actions that reduce life-cycle operational risk.

An example of an asset management policy for plant and equipment wellness is as follows:

We recognize that our plant and equipment are the foundation on which the livelihoods, plans, and dreams of us all depend (shareholders, staff, employees, suppliers, customers, and community). Without sure and certain competitively priced, quality products from our operation, we put our collective and individual futures at grave risk.

Because our business and individual success depends on the reliable and faithful production of 100% quality products that satisfy our customers' requirements, we will adopt and use those proactive asset management, engineering, project, operational, maintenance, and financial practices, methods, and business systems that minimize operating risks and prevent failure of our plant and equipment during its operating lifetime.

Starting from the conception of a business idea through to the decommissioning of a plant, we will work together in cross-functional teams to seek ways that maximize the safety, productivity, and value added in every part of our operation while assisting our supply and distribution chains in doing the same. Included is the need to constantly minimize and eventually eliminate our business losses, waste, accidents, and incidents so that we do no harm to our planet, our people, and our community.

All our people continuously seek and learn better ways that improve their productivity and minimize the risks in every task. We encourage their learning with both formal methods and

by controlled experimentation. Through the ongoing drive of our people to seek excellence and mastery, we will become and remain a best-in-class asset management performer.

Maintenance Vision, Policy, and Strategy

With the importance of maintenance to production success firmly placed in a business context through the asset management and wellness policy, it is necessary to decide how to use maintenance to maximize operational productivity. This is the role of the maintenance policy. It contains what to achieve with maintenance, why it is necessary for the business, and how it will be done. It explains the maintenance vision and strategy to ensure the necessary production performance from your plant and equipment.

Table 2 is a maintenance capability hierarchy to help identify the maintenance vision and policy. Plot where your operation is in each column and then decide where you want to go over the next three to five years. Plotting on the table helps you develop a maintenance vision to guide the drafting of the policy. With the policy decided, work can start on the strategies and actions that will achieve the vision.

A sample maintenance management policy for plant and equipment wellness is as follows:

Maintenance is fundamental to successful production. The reliability of our plant and equipment assets are dependent on our production and maintenance people doing the maintenance function effectively in a timely manner.

Our maintenance activities support the asset management and plant wellness strategies in producing products that our customers want, with well-planned and well-executed delivery of the most economic maintenance strategy and best reliability practices that eliminate component risk so that we get the plant performance needed for on-time delivery of quality product at optimal operating profit.

We seek the most successful equipment performance through the cooperative teamwork and knowledge of maintenance, operations, engineering, and finance in relentlessly preventing operating risk by proactively introducing defect prevention and failure removal and by conducting responsible and controlled business process improvements.

Table 1—Asset Management Policy Content Comparison			
Policy Requirements	Quality Management System ISO 9001:2008	Physical Asset Management System ISO 55001:2014	Risk Management System ISO 31000:2009
Responsible for developing policy	Top management (board or chief executive officer)	Top management	Board or executive
Obligatory policy content inclusion	<ul style="list-style-type: none"> Commitment to comply with the requirements of the Quality Management System Commitment to continually improve the effectiveness of the Quality Management System 	<ul style="list-style-type: none"> Overall physical asset management objectives Physical asset management is directed at achieving the organization's strategic plan Commitment to continually improve the physical asset management process Commitment to comply with current applicable legislation, regulatory, and statutory requirements and with other requirements subscribed to by the organization 	
Recommended policy content inclusions			<ul style="list-style-type: none"> Objectives of risk management Commitment to risk management
Possible policy content inclusions			<ul style="list-style-type: none"> Objectives and rationale for managing risk Links between policy and strategic/corporate plans Guidance on extent and type of acceptable risks taken and ways to balance threats and opportunities Processes to be used to manage risk Accountabilities for managing particular risks Details of support and expertise available to assist those accountable for managing risk Level of documentation required Statement of how risk management performance will be measured Commitment to periodic review of risk management system Statement of commitment to the policy by directors and executives
Organizational context	<ul style="list-style-type: none"> Appropriate to the purpose of the organization Equal to and consistent with organization's overall policies and strategy Provides the framework for setting and reviewing measurable quality objectives 	<ul style="list-style-type: none"> Appropriate to nature and scale of the organization's physical assets and operations Derived from how the management of physical assets will help achieve the organization's strategic plan Consistent with other organizational policies Provides the framework for setting physical asset management strategy, objectives, targets, and plans Consistent with the organization's risk management framework 	<ul style="list-style-type: none"> Create linkages to other corporate strategies
Showing commitment to policy	<ul style="list-style-type: none"> Visibly endorsed by top management Communicated across the organization Understood by everyone within the organization Reviewed for continuing suitability 	<ul style="list-style-type: none"> Visibly endorsed by top management Documented in suitable media Implemented as standard practice Maintained in condition to meet purpose Communicate individual physical asset management obligations <ul style="list-style-type: none"> To relevant employees To relevant third parties Published to stakeholders where appropriate Reviewed periodically for relevance to and consistency with the organization's strategic plan 	<ul style="list-style-type: none"> Publish policy Communicate policy <ul style="list-style-type: none"> Establish management team to communicate and involve staff across the organization Raise awareness across the organization of the risk management process Risk management is in the organization's culture

Table 2—The Climb to Reliability and Maintenance Mastery

	Leadership and Capability					Systems and Processes				
	Maintenance Vision & Strategy	Performance Measures	Organization Structure	Human Resources	Knowledge Base	Maintenance Strategy	Materials Management	Planning & Scheduling	Contractor Management	Reliability Engineering
Mastery	Quality system managed, Accuracy-Controlled Enterprise in which everyone in every department works to 3T (target, tolerance, test) error prevention procedures; effectiveness philosophies improve processes	Business strategy focus; maximizing life-cycle profit; TDAF cost database. Process step contribution monitoring across all processes	Integrated cross-functional teams incorporating financial, engineering, operations, and maintenance	Empowered, flexible, cross-functional teams of experts working to scientific discipline	Continuously learning, pushing the boundaries of human knowledge and understanding; Six Sigma discipline is normal	Precision domain drives all engineering, installation, operations and maintenance work; risk analysis and management normal	Materials problems designed-out, OEM monitors real-time information on critical parts' condition and carries necessary spares	Maintenance reduced as continual improvements extend time between outages; continually reducing time to repair with lean philosophies	Small teams of experts servicing entire local industry delivering precision maintenance and design-out maintenance with profit sharing	Design and Operations Cost Totally Optimized Risk (DOCTOR) is used to minimize all operating risks throughout the facility's life; reliability growth pervades thinking
Excellence	Personnel action plans; appraisals are clearly tied to the maintenance strategy	Ongoing benchmarking of metrics and processes; full cost database	Total productive maintenance in which operators drive reliability, fault-find, and maintain equipment; root cause failure analysis by operators and maintainers	Empowered, flexible, world-class workers; self-managed teams	Expert systems used; fully integrated CMMS common database	Preventive and predictive plans continuously optimized; the "right" maintenance tactic is applied based on analysis	Stores system integrated to CMMS and accounting system; bar coding or radio frequency tags of all stores items; World-class Stores Management	More than 90% of all maintenance is planned and more than 95% first-time schedule compliance; rolling schedule fixed for the week ahead	Small numbers of contractors on long-term sharing partnership agreements with high innovativeness	Risk and unplanned failure reduced to best in industry by analysis and modeling
Competence	Reliability-focused maintenance improvement action plan is linked to the maintenance management strategy	Statistical process control applied to maintenance process measures; equipment-specific maintenance costs available	Established teams for achieving key objectives in the maintenance management strategy	Multiskilled trades with process capability analysis and basic operating skills	Easy access to knowledge bases for all employees at all times	Preventive and predictive plans exist for all maintainable items; emphasis on PdM; all tactics understood	Single-source supplier partnerships established and effective; area stores with visual controls; reliability of spares maintained; suppliers provide technical expertise	Long-term asset planning established; critical path analysis used for all rebuilds and shutdowns	Contractors are established based on principle of risk sharing; contractors provide technical expertise	Effective root cause analysis applied to equipment problems to extend life

Understanding	A clear maintenance vision and strategy is documented and communicated to all employees	Input/output process measures reviewed and displayed; downtime by cause; segregated maintenance costs reviewed	Decentralized with central support; clearly written mandates/roles for each maintenance function and group	Trades have problem identification and solving; team dynamics and training skills	Document control system established; CMMS installed and used to manage knowledge bases	Preventive and predictive plans exist for key equipment; compliance with scheduled plan is more than 95%	Spares classified with separate strategies; spares linked to bills of materials/equipment drawings; standardization policies exist; A-B-C spares priority management with vital "A" spares protected	All but unexpected failures planned; all planned jobs specify safety, labor, materials, tools, technical details	All contractors repairing rotables are capable of original equipment manufacturer's testing	Basic equipment conditions established; good failure databases; all major failures investigated; PM modified based on site experience
Awareness	No clearly documented role of maintenance; no maintenance vision or strategy	Some downtime records; maintenance costs regularly available but not segregated into area/line	Centralized maintenance group with alignment to production; team approach to technical problems	Trades have operational health and safety and maintenance support (inspection, reporting) skills	Plant register established and useful data collected; central technical library; all drawings and equipment information identified	System to identify all maintainable items exists; emphasis on time-based overhauls and inspections	Stores catalog established; Inventory accuracy is greater than 95%; goods receiving practices in place	Work request/work order system established; major rebuilds, shutdowns fully planned and programmed	Contractors used for peak loads and noncore maintenance work	Collect the failure data; equipment histories occasionally reviewed for failure analysis
Innocence	The main role is to fix it when it breaks/fails	Incomplete or no maintenance downtime records; maintenance costs not readily available	Centralized maintenance group with no alignment to production; command and control approach	Trades have their basic trade skills, but little or no technical knowledge or support and training is given	Ad hoc records kept for purchasing; no plant register or control of drawings	"If it isn't broke, don't fix it"; annual shutdown and inspections only	Ad hoc stores; no costing or control of spares	No planning function; planning done on the run; short-term focus	All maintenance carried out by in-house team, which may include individual contractors	No failure records

Contents of an Asset Maintenance Strategy and Plan Document

A document recording all of the outcomes and recommendations from your life-cycle reliability strategy will be required so that all stakeholders can review your strategic asset management plans. Typical issues in a life-cycle reliability strategy document are listed below. If there are other specific needs required in your operation, add them into the Physics of Failure Reliability Strategy Analysis. The development of strategic asset management plans is a large undertaking. But without them, maintenance and operations fly by the seat of their pants, everything becomes guesswork, and the business is run too much by luck rather than good management. Without a sure strategy and plans to achieve your asset management and maintenance policies, vast amounts of production time and money will be wasted. With a Physics of Failure Reliability Strategy, you have the best chance of becoming a top performing operation. Turning your company into a world-class leader is a job worth doing well.

Contained in each of the following sections is an overview of the range of issues and plans that your life-cycle asset management and maintenance strategy document should address.

Asset Management and Maintenance Visions

Explain why you do asset management or maintenance and how they help the business.

Asset Management and Maintenance Policies

Outline what your business aims to achieve with asset management and maintenance, how it is to be done, who will do it, what is expected of the organization in the long run.

Production Performance Envelope

What daily plant availability is needed to meet production output? What is the average and the peak production rate to sustain the required output and not compromise production asset reliability? What is the minimum daily quality rate required to meet production plans? What is the uptime needed for each piece of plant to deliver the required total plant availability? How much can you afford to spend on maintenance and repairs? Typical headings under which these questions are answered in your strategy and plan document include those noted below.

- Production performance required
- Production costs required
- Process reliability analysis (chart your production process to identify its reliability weaknesses and likely performance problems)

Risk Assessment of Operational Assets

What can go wrong with your equipment, what will it cost, how often does it happen? Risk analysis is done using the Operating Criticality spreadsheet with the TDAF costs as the consequence value.

- Equipment used, description, and service duty (i.e., each asset used and its duty)
- Financial and throughput impact on production of failures in each equipment item

- Operating criticality (prioritize the importance of the equipment to sustaining production)
- Assembly level criticality (e.g., foundations, base frame, pump, coupling, motor, power supply)
- Physics of Failure Factors Analysis at the part level to identify the ways in which equipment parts can fail

Production Risk Management Plan

Explain how maintenance is used at the parts and assembly levels to reduce production risk at the equipment level. The related decision making is part of completing a Physics of Failure Reliability Strategy Analysis.

Precision Maintenance Standards

Specify the engineering values of world-class maintenance quality and accuracy needed to deliver outstanding plant and equipment reliability (mechanical, electrical, instrumentation, structural, civil, etc.)

Precision Operation Standards

Specify the quality and accuracy needed to run plant and equipment to meet operational performance at least degradation and least maintenance costs (mechanical, electrical, instrumentation, structural, civil, safety, environmental, etc.)

List Equipment on Preventive Maintenance

List the equipment and parts to adjust and those requiring replacement of wearing parts.

- List of equipment and their assemblies done as shutdown, as opportunity-based preventive maintenance, or as time/use scheduled preventive maintenance
- Precision standards when performing preventive maintenance

List Equipment on Predictive Maintenance

List the equipment and parts monitored to detect impending failure and restore before failure.

- What condition monitoring will be used?
- Where will the condition monitoring be done?
- How will it be decided when it is time to maintain or replace?
- Who will competently do the condition monitoring? (i.e., subcontract, in-house maintainer, in-house operator)
- Who is the competent person responsible for receiving the report, understanding its information, and acting on it?
- What will be done when the condition has deteriorated too far?

List Equipment to Rebuild

List the equipment, assemblies, and parts that are to be repaired.

- Criteria to justify repair instead of replacement
- How many times to rebuild before replacing with new?
- Precision standards to meet on each rebuild
- Precision standards to meet on installation

List Equipment to Replace

Identify the equipment and assembly parts that should always be replaced and not repaired. The TDAF cost of a breakdown often justifies installing new equipment rather than taking the chance of keeping and reusing old, tired equipment that will cause an unplanned production stoppage.

- Assemble and part numbers replaced new and the criteria when replacement occurs
- Routable spares and the number of times used before disposal and replacement with new
- Precision standards new equipment must meet
- Precision standards to meet on installation

Critical Spares List

List the vital equipment, assemblies, and parts you must always have available on site.

- Equipment or parts to be carried on site
- Equipment or parts to be carried by a local supplier

- Stores management standards to protect the integrity of each type of spare

Records Management

Indicate all of the engineering, operating, maintenance, and procurement documents needed.

Specify the necessary documented maintenance history to be kept of equipment and parts use in order to identify future reliability improvement opportunities.

- The engineering, operational, and maintenance documents to keep
- How documents are to be kept current and safe
- What records are to be made and kept during each equipment life
- What analysis of records will be required and the information to be provided by the analysis
- How records and documents will be controlled and their content kept correct and current

Maintenance Performance Monitoring

Identify the monitoring and measuring to be undertaken to ensure that maintenance is delivering the reliability, availability, quality, and cost that the production plan requires. These measures often become Key Performance Indicators (KPIs) in business reports.

- Definition, formula, and data sources for each measure
- Plant-level KPIs (e.g., availability, unit cost of production, quality rate, maintenance cost proportion of production cost)
- Equipment-level KPIs (e.g., uptime, quality rate, production rate, maintenance cost)
- Personnel KPIs (e.g., hours spent developing skills, employee satisfaction)
- Maintenance process performance KPIs (e.g., daily work order complete per trade type, backlog of work, percentage planned work, percentage scheduled achievement)
- Maintenance improvement KPIs (e.g., number of procedures written to ACE 3T standard, number of design-out projects started, number of design-out projects completed)
- Reliability prediction KPIs (e.g., number of work orders spent improving reliability, reliability improvement graphs such as Crow-AMSAA plots)
- Plant wellness index audit (annually measure the capability of the organization to create and sustain high-reliability plant)
- Specify the run charts to be kept and the frequency distribution curves to be plotted

Maintenance Resources Required

Identify all manning, infrastructure, equipment, and support services needed to resource the production risk management activities known as maintenance.

- Necessary maintenance equipment and technologies
- Necessary stores capacity and stores internal operating methodologies
- Necessary engineering and maintenance knowledge
- Necessary trade skills and competence
- Necessary numbers of people by trade type/service
- Location of people for most efficient operation of maintenance activities
- Necessary computerized maintenance management system capabilities

Cost–Benefit Analysis

Prove and confirm that the cost of doing maintenance will return value to the business.

- Annual maintenance cost versus the cost of failures prevented (the risk analysis will provide the TDAF costs that will be incurred by the business if equipment fails)
- Annual maintenance cost versus the cost of lost production output if plant availability does not meet production targets (production and equipment history is used to determine the numbers of production slowdowns and stoppages in an average year that did not need to happen)
- Maintenance costs as a proportion of operating costs

Rolling Five-Year Maintenance Program

To provide focus and drive reliability improvement, indicate exactly when and what is to be done during the next five years for each item of plant to deliver maximum production productivity.

- Work orders by type performed on each equipment item and the benefits provided
- Schedule of work orders for each equipment
- Reliability improvement projects planned for each equipment item

Rolling Two-Year Maintenance Budget

Develop a believable budget that will deliver the risk control that production needs. Using a rolling two-year forecast allows inclusion of the savings from future improvement initiatives.

Two years is a believable period for anticipating changes and planning reliability improvements.

Beyond two years, forecasting becomes unrealistic because one cannot anticipate the impacts of a continually changing world.

- Maintenance cost by equipment
- Maintenance cost by plant
- Maintenance cost by type
- Maintenance cost per time period
- Costs estimates to do equipment improvement plans

The strategic asset maintenance plan content listed here is reasonably comprehensive but may need to be tailored to suit the situation and requirements of your operation and its management. Once the time and effort are put into developing such a detailed strategy, there will be confidence it can achieve its intention. A reliability creation strategy is the result of many peoples' efforts and input. A team consisting of production, engineering, maintenance, and finance working together is the best way to develop it. It can take three to six months to fully do the job. A simpler document can be compiled within a couple of months and later refined as resources become available.

References

1. Andrew Hopkins, *Safety, Culture and Risk: The Organisational Causes of Disasters* (North Ryde: CCH Australia, 2005).