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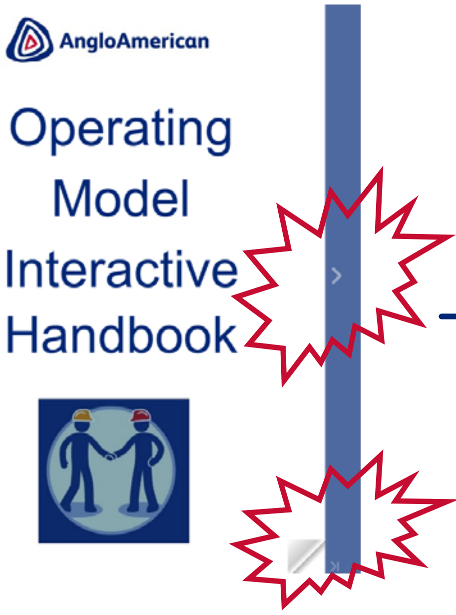
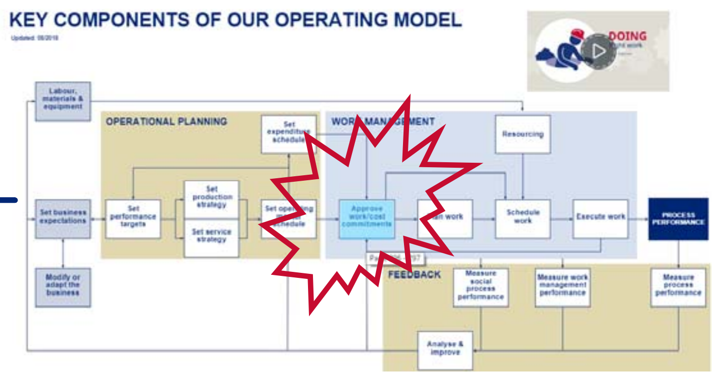
# Operating Model Interactive Handbook

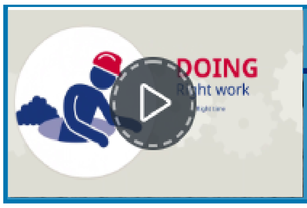
# How to use this manual




Flip page from bottom right or click on the arrow

Blue boxes highlight links to flowsheets or task




Videos

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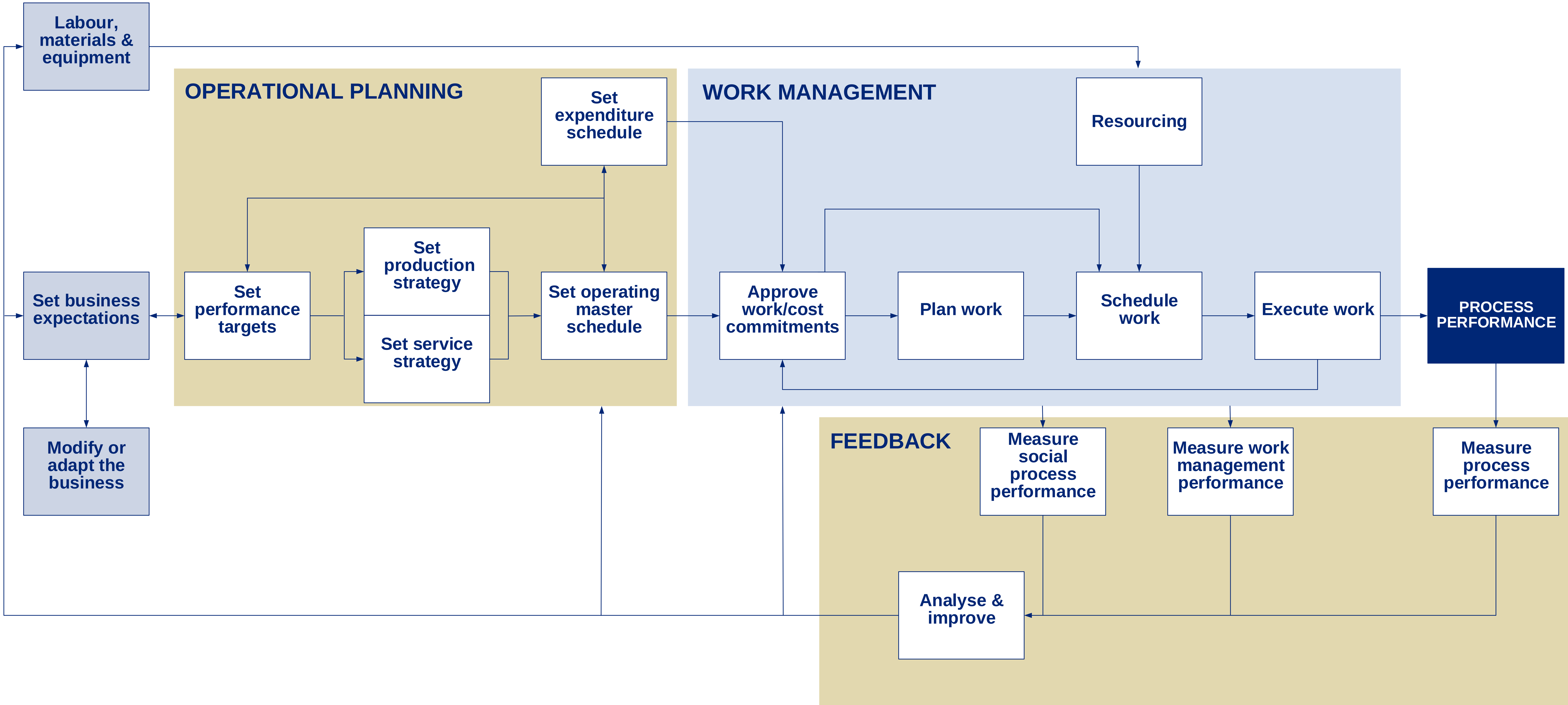
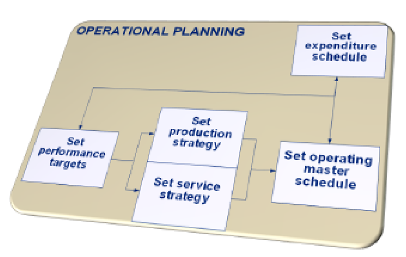
RIGHT WORK. RIGHT TIME. RIGHT WAY.

# KEY COMPONENTS OF OUR OPERATING MODEL

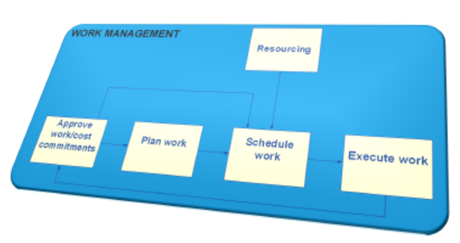
**Updated: 08/2018**



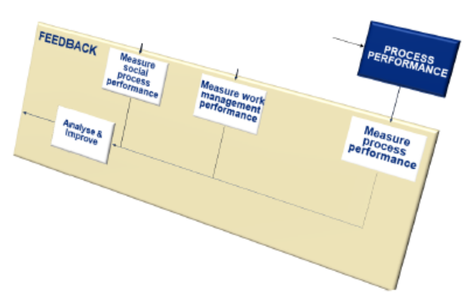

Operational Planning



Work Management



Feedback



Management Routines

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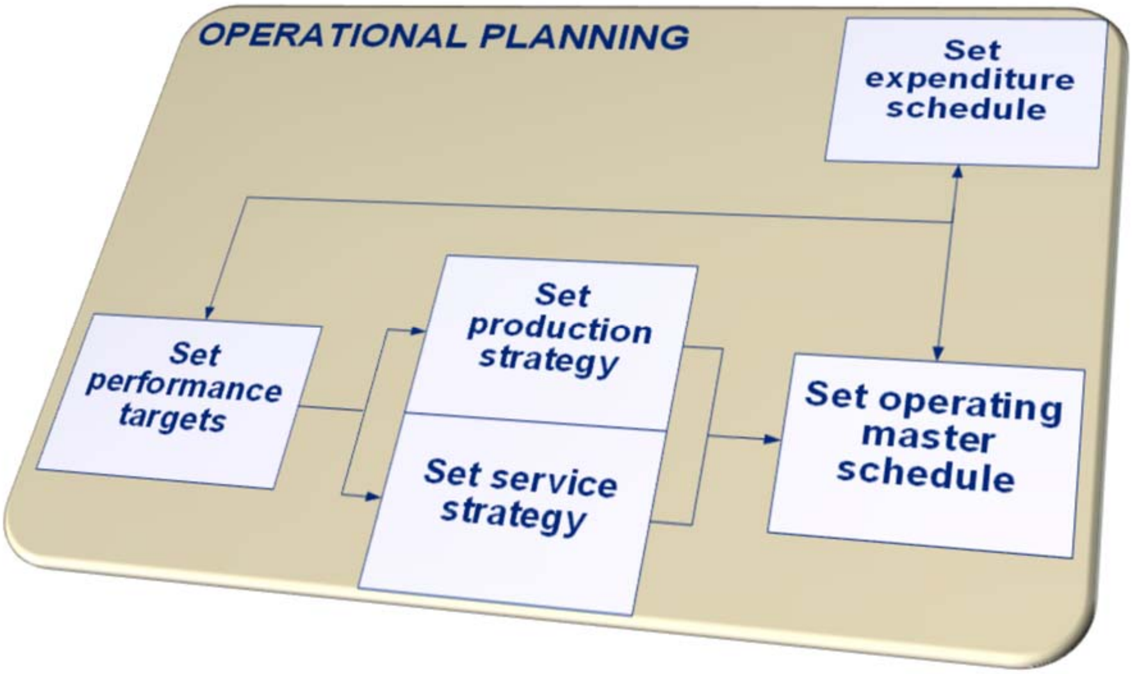
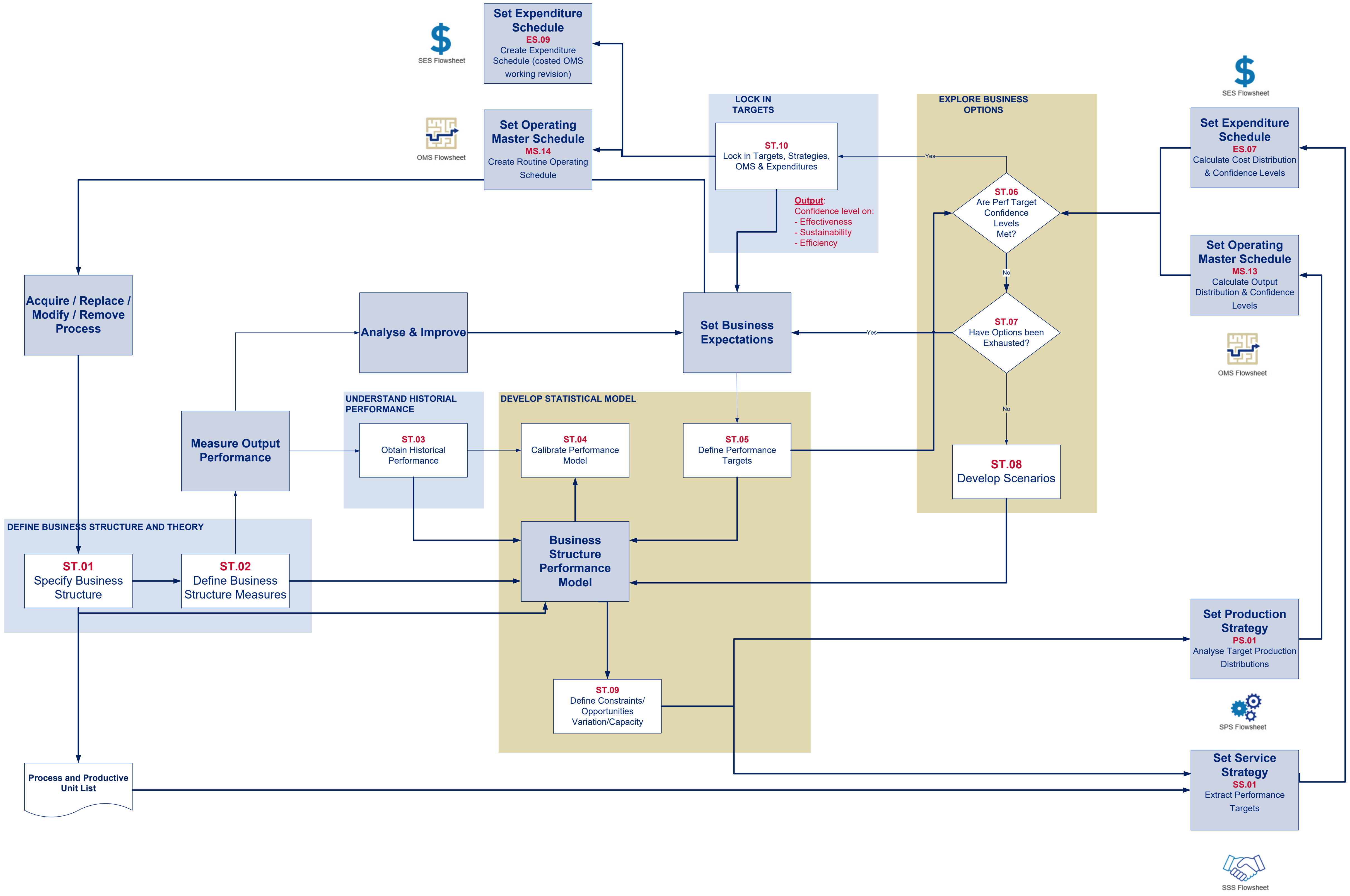
# AAOM Operational Planning



# SET PERFORMANCE TARGETS

Purpose: To specify the confidence of meeting Business Expectations.

**Updated: 05/2019**

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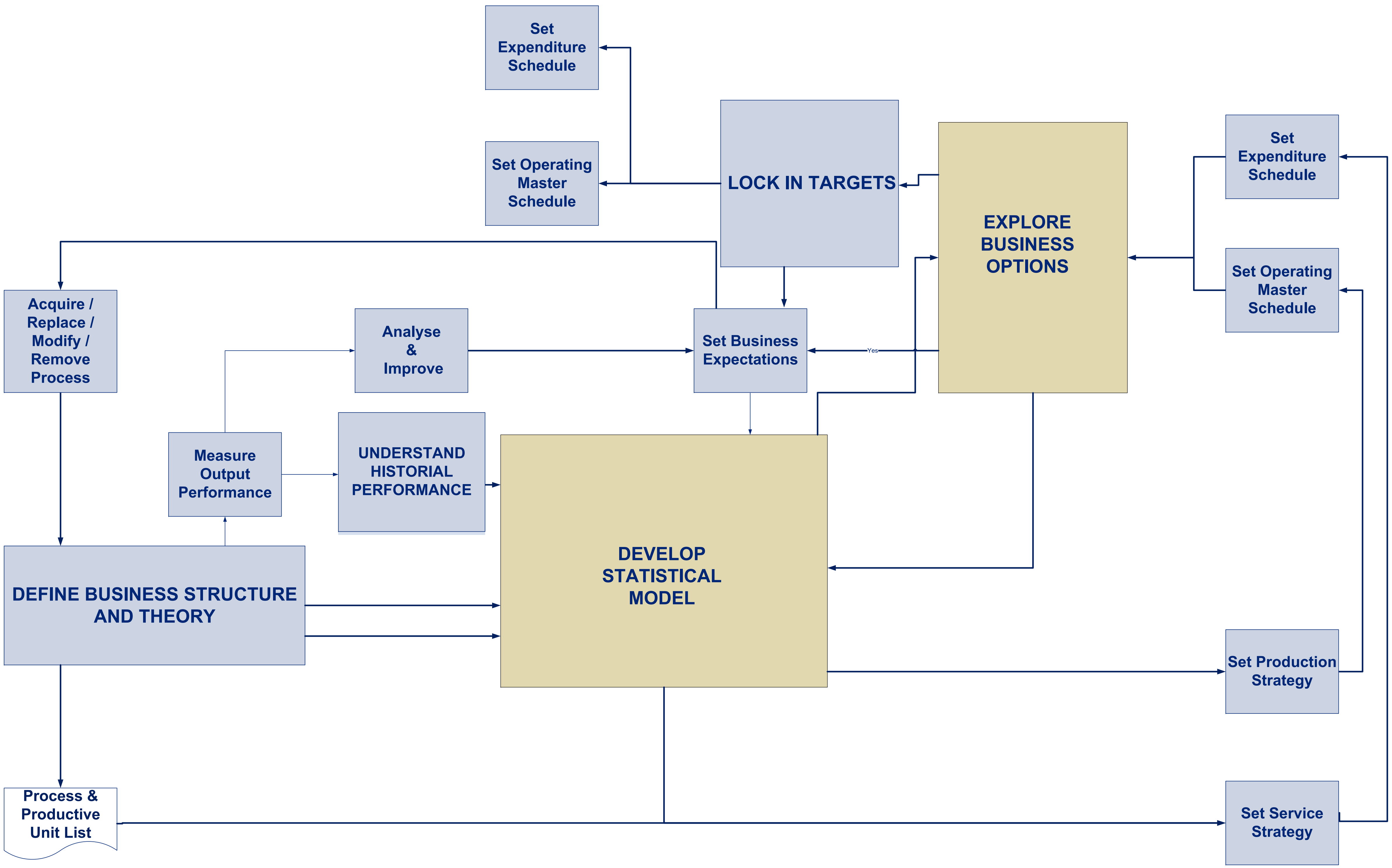
AAOM Flowsheet

# SET PERFORMANCE TARGETS- HIGH LEVEL

Purpose: To specify the confidence of meeting Business Expectations.

**Updated: 05/2019**



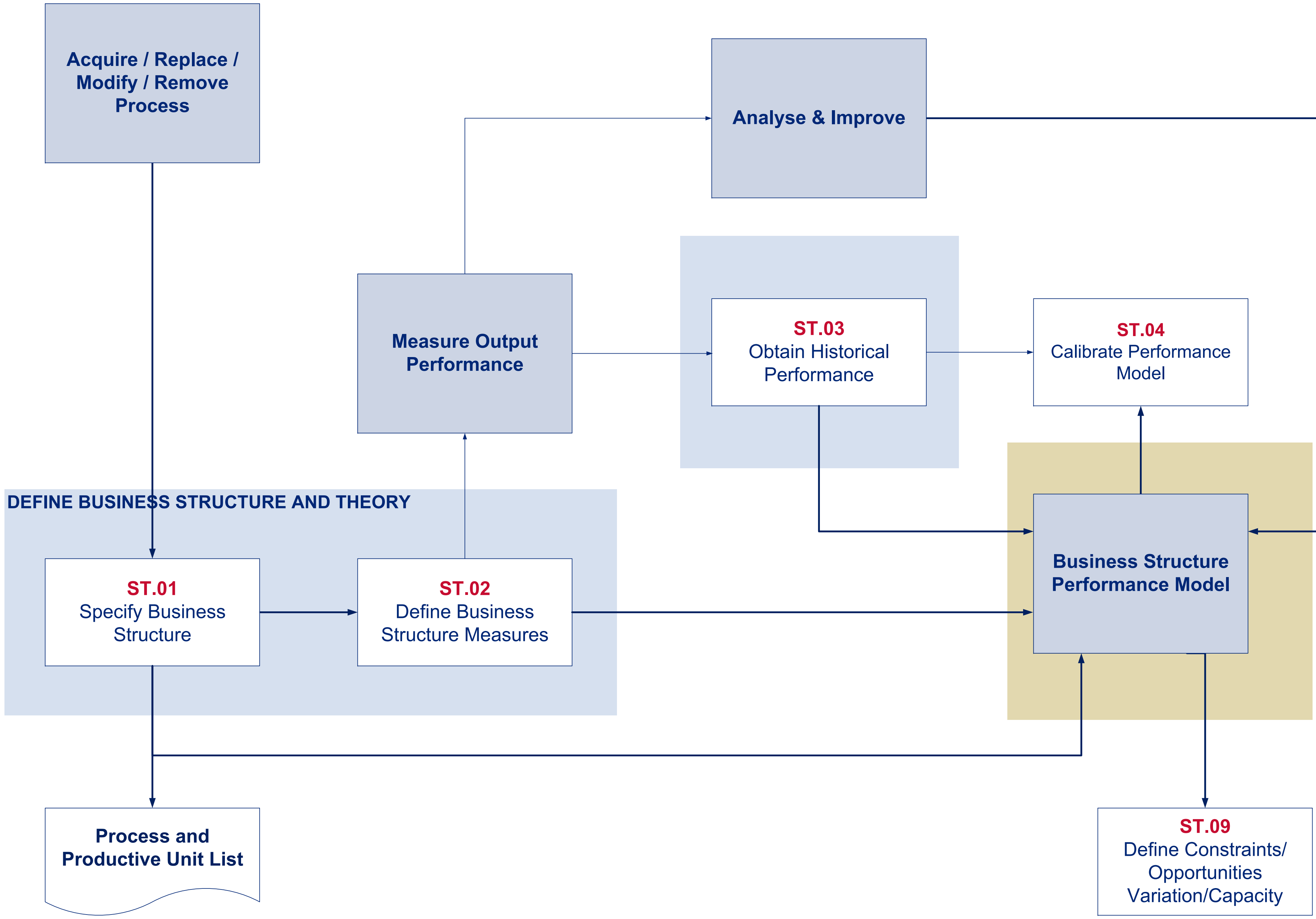

AAOM Flowsheet

SPT Flowsheet

# SET PERFORMANCE TARGETS- Business Theory & Model

Purpose: To specify the confidence of meeting Business Expectations.

**Updated: 05/2019**

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AAOM Flowsheet

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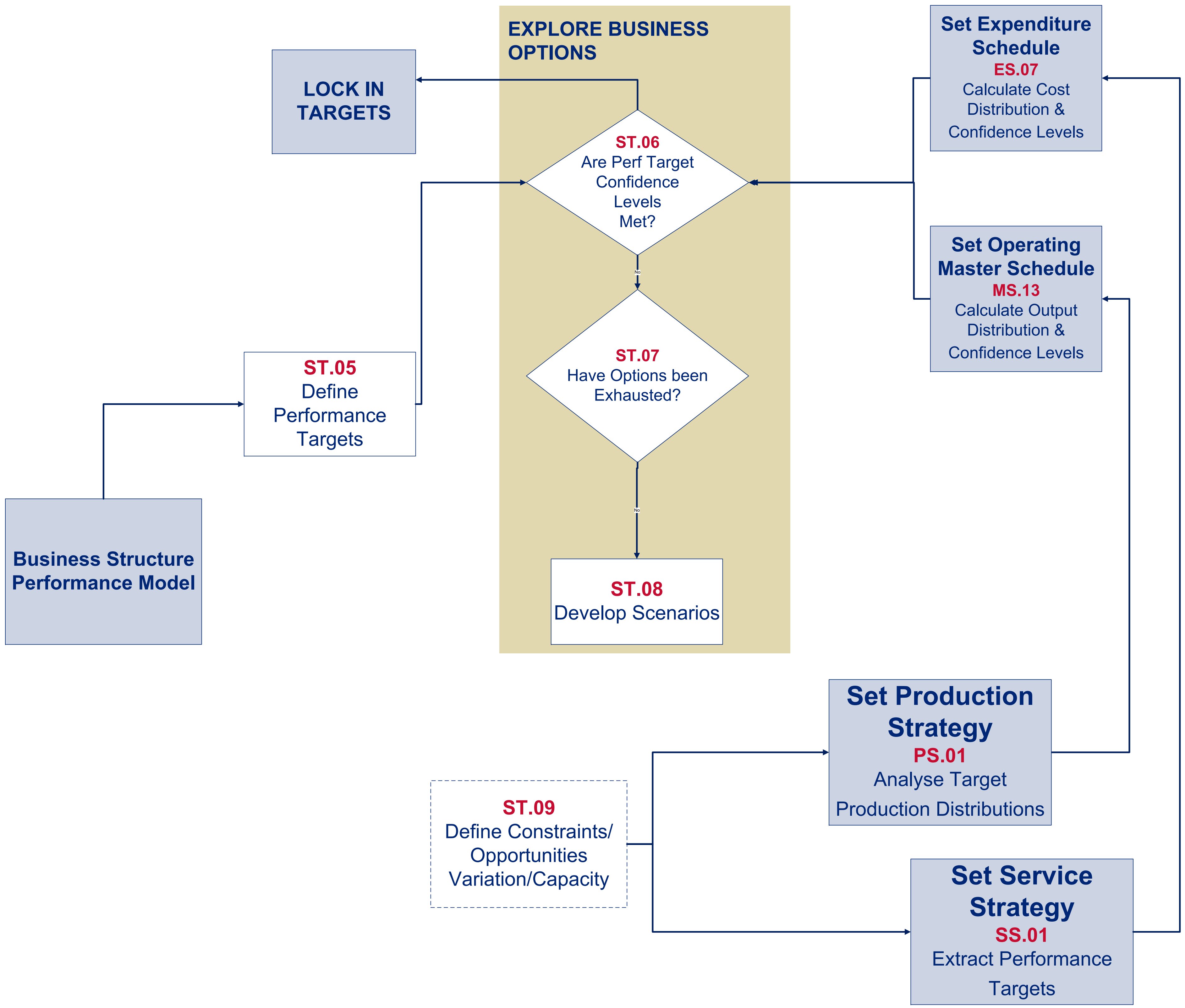
# SET PERFORMANCE TARGETS- Business Options

Purpose: To specify the confidence of meeting Business Expectations.

**Updated: 05/2019**

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AAOM Flowsheet

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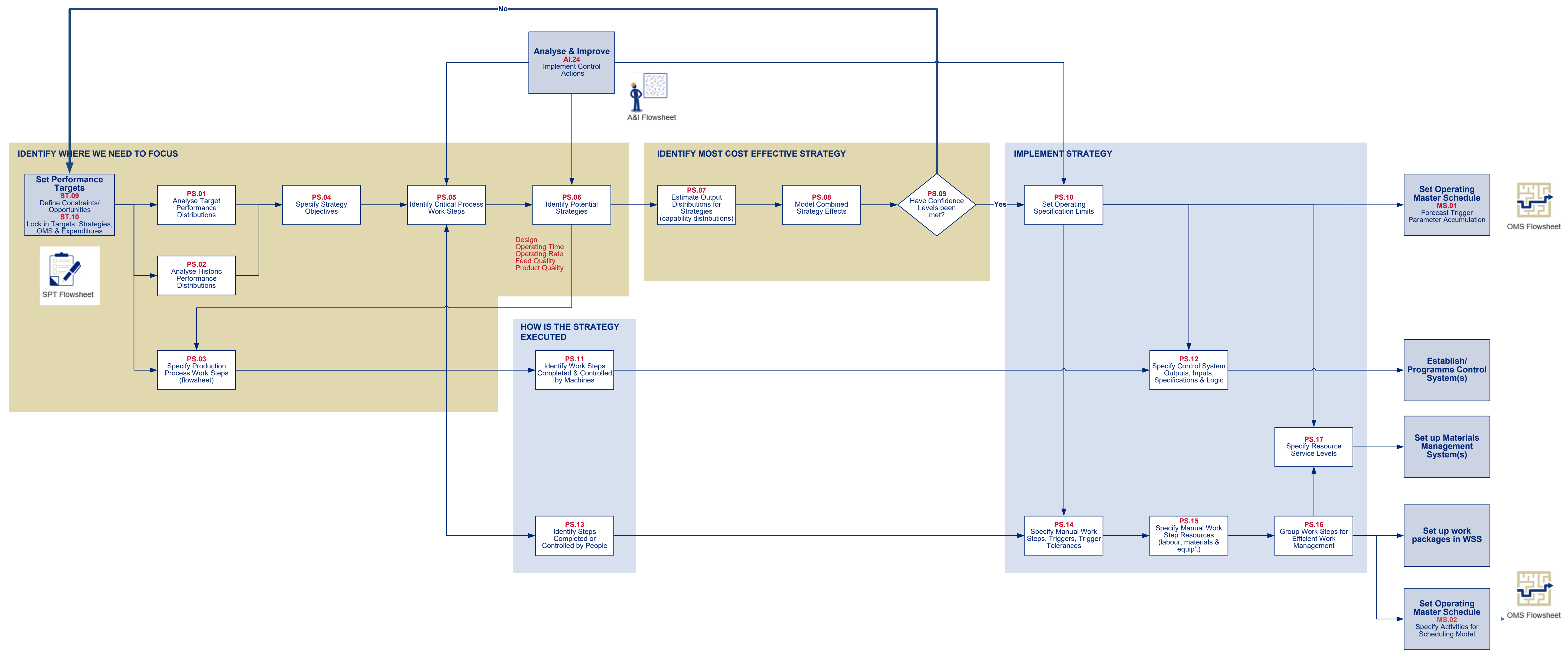
# SET PRODUCTION STRATEGY

## Purpose: To specify the most cost effective way to operate the process.

**Updated: 05/2019**

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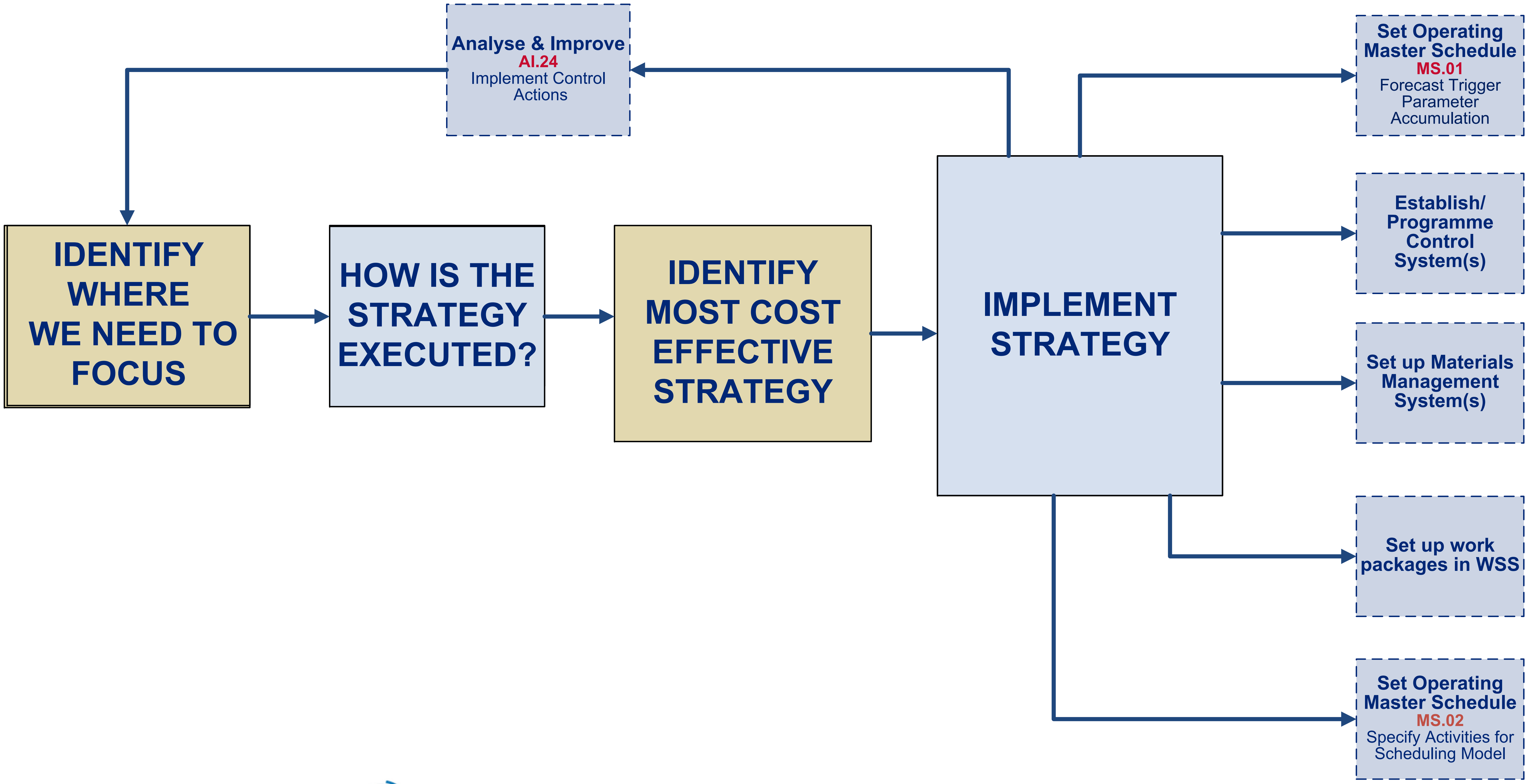
AAOM Flowsheet

# SET PRODUCTION STRATEGY- High Level

Purpose: To specify the most cost effective way to operate the process.

**Updated: 05/2019**

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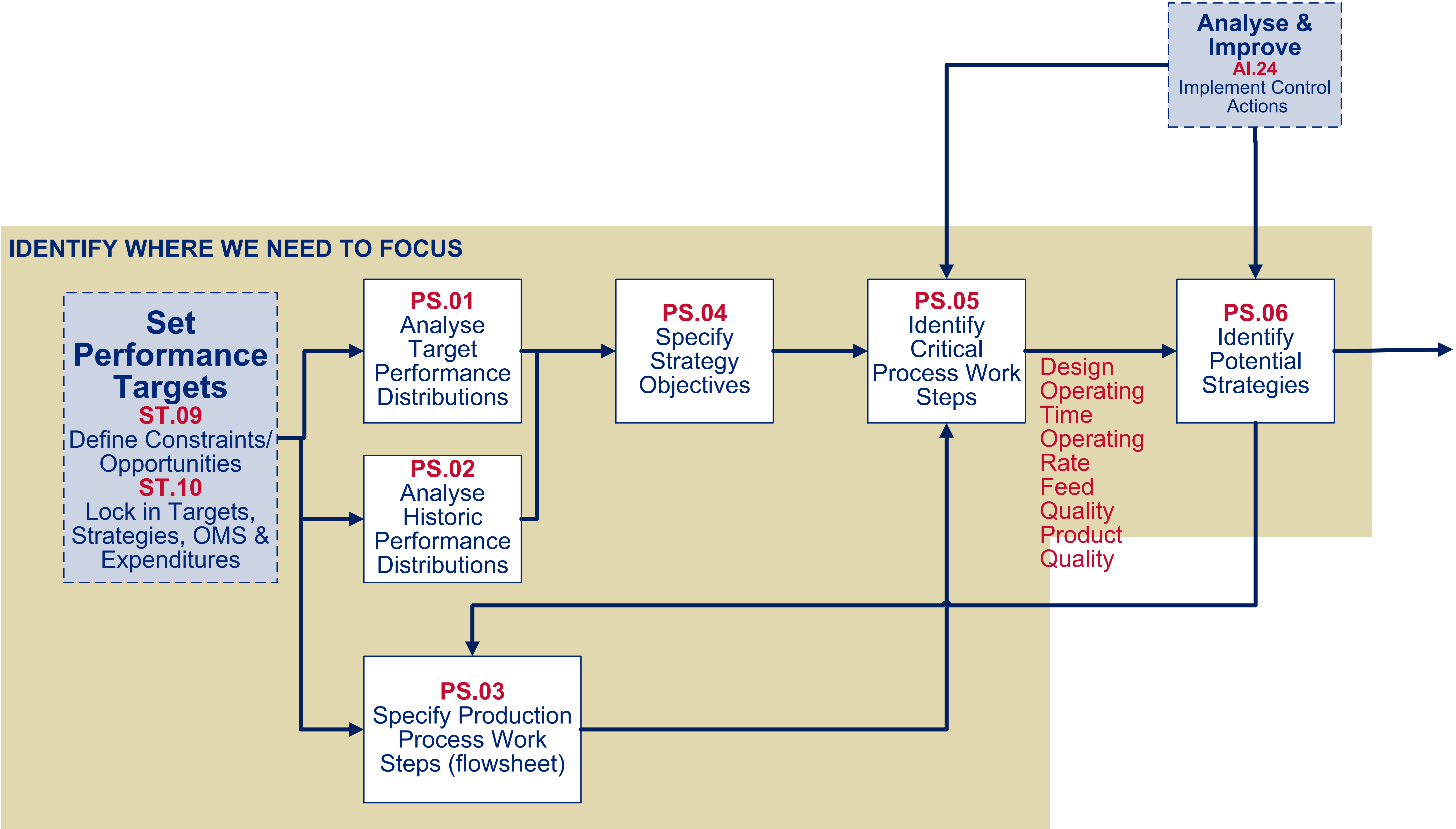
AAOM Flowsheet

SPS Flowsheet

# SET PRODUCTION STRATEGY- where to focus?

Purpose: To specify the most cost effective way to operate the process.

**Updated: 05/2019**

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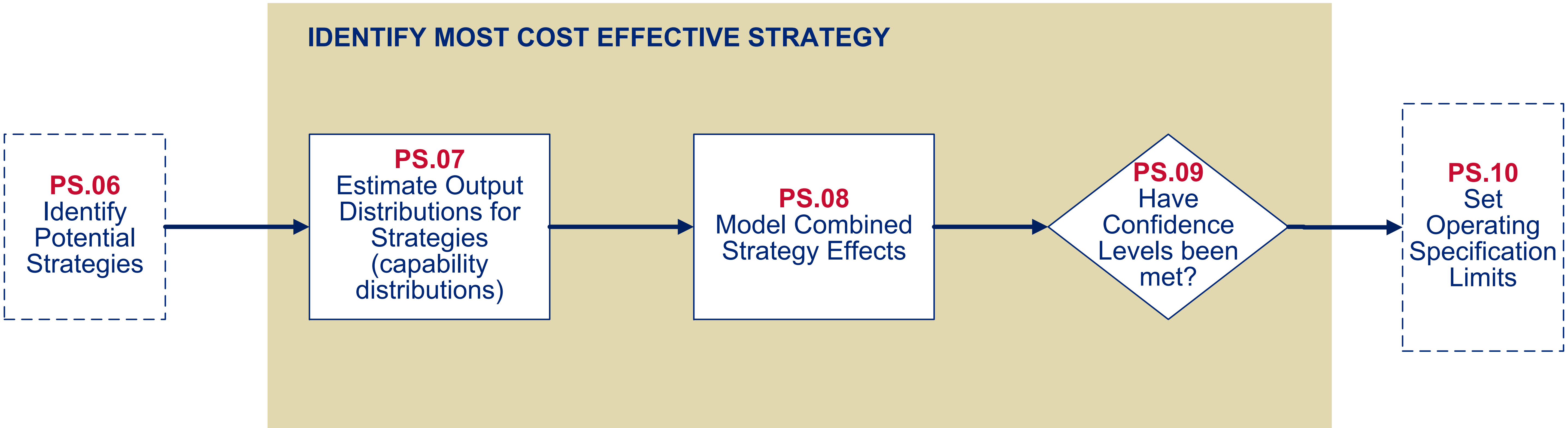
SPS Flowsheet

# SET PRODUCTION STRATEGY- Cost Effective?

Purpose: To specify the most cost effective way to operate the process.

**Updated: 05/2019**

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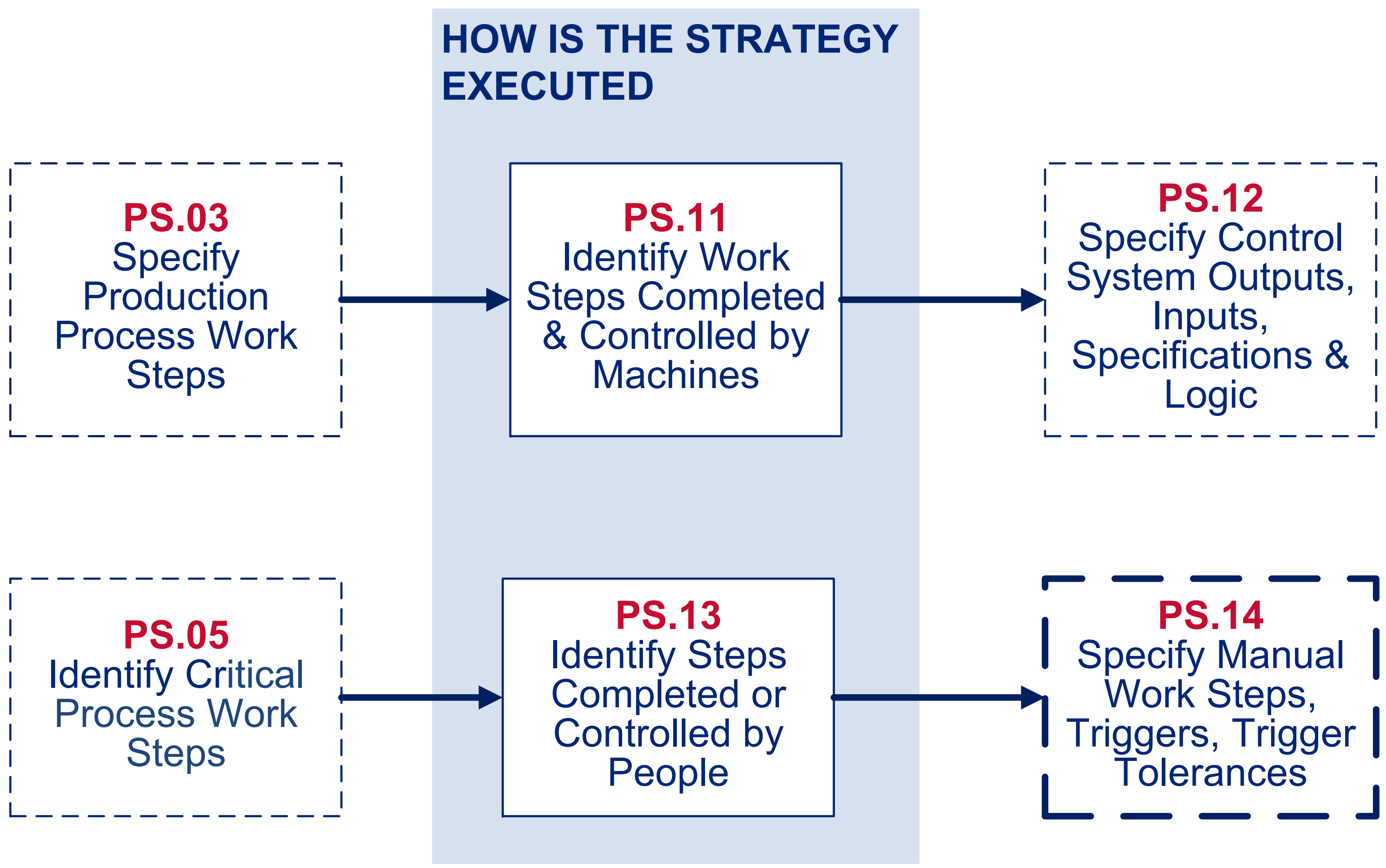
SPS Flowsheet

# SET PRODUCTION STRATEGY- How is strategy executed?

Purpose: To specify the most cost effective way to operate the process.

**Updated: 05/2019**

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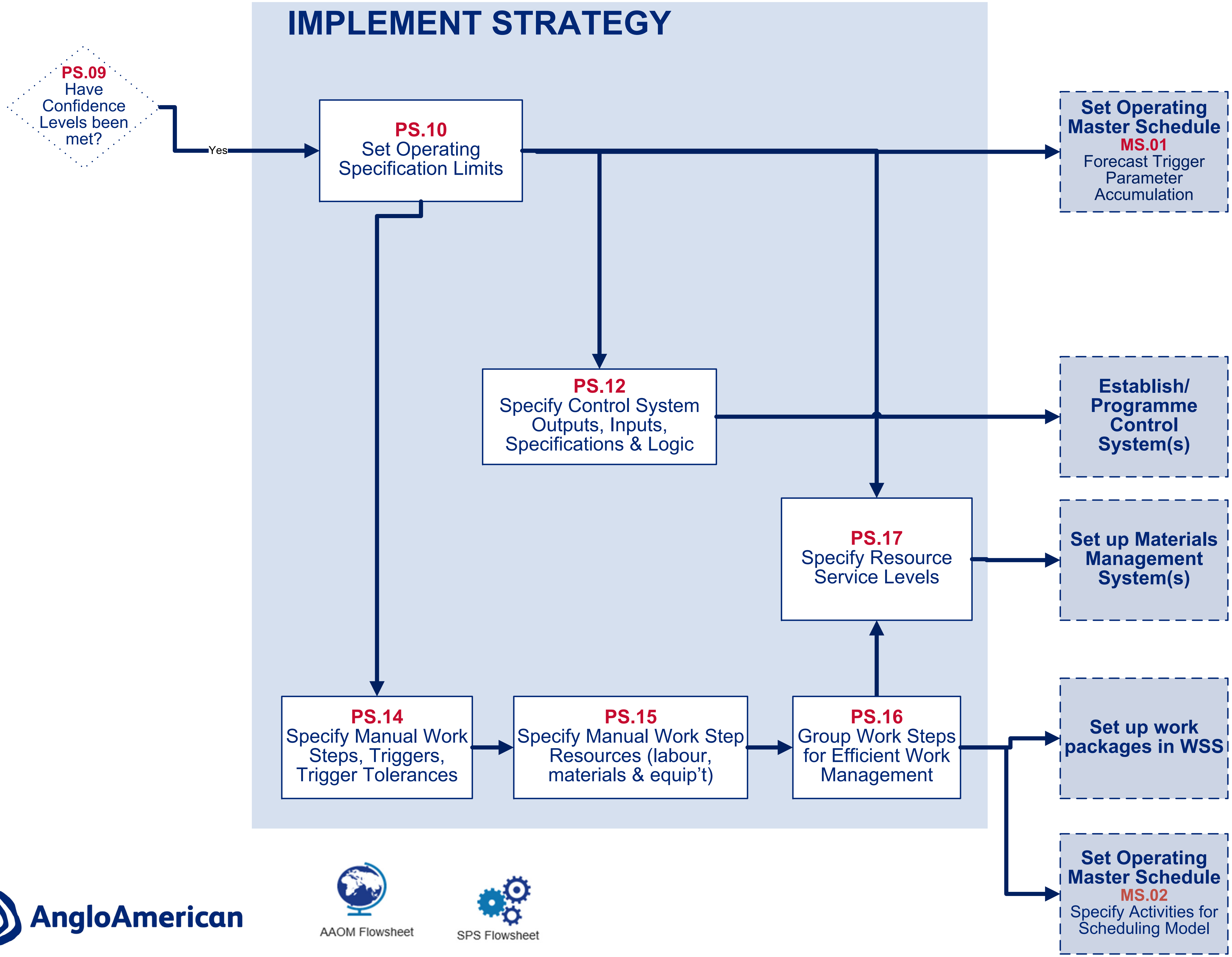
SPS Flowsheet

# SET PRODUCTION STRATEGY- Implement Strategy

Purpose: To specify the most cost effective way to operate the process.

**Updated: 05/2019**

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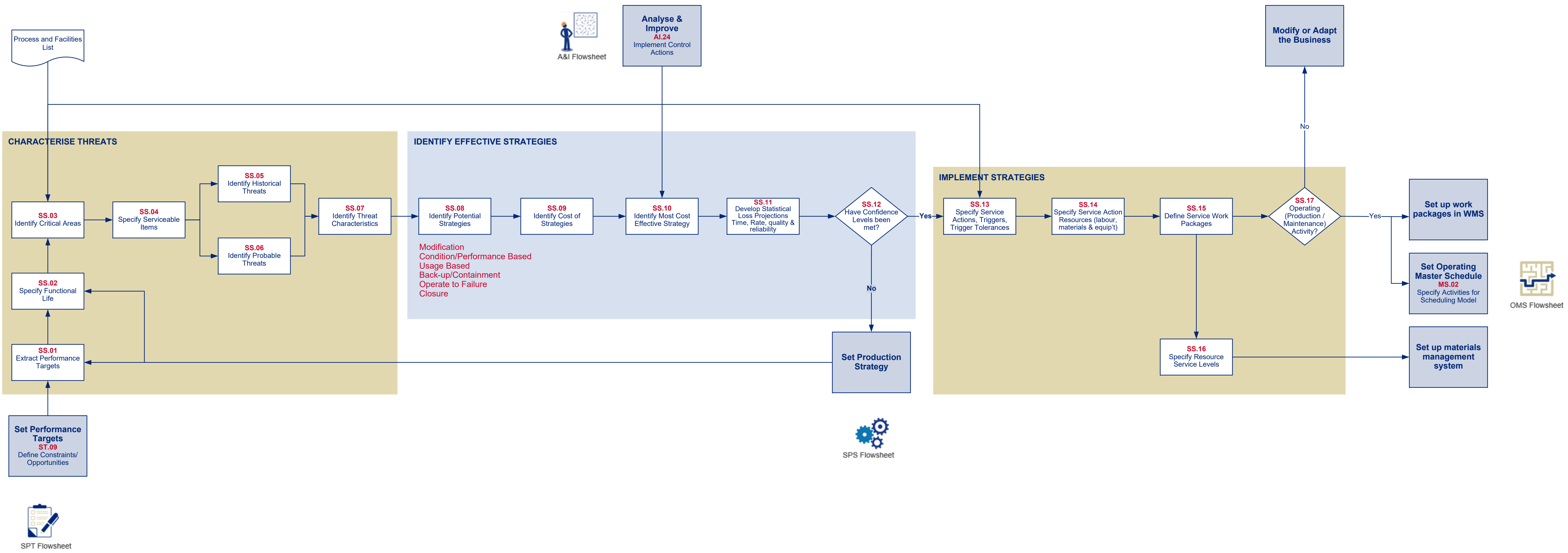
SPS Flowsheet

# SET SERVICE STRATEGY

Purpose: To specify the most cost effective way to manage threats related to the process.

**Updated: 04/2019**

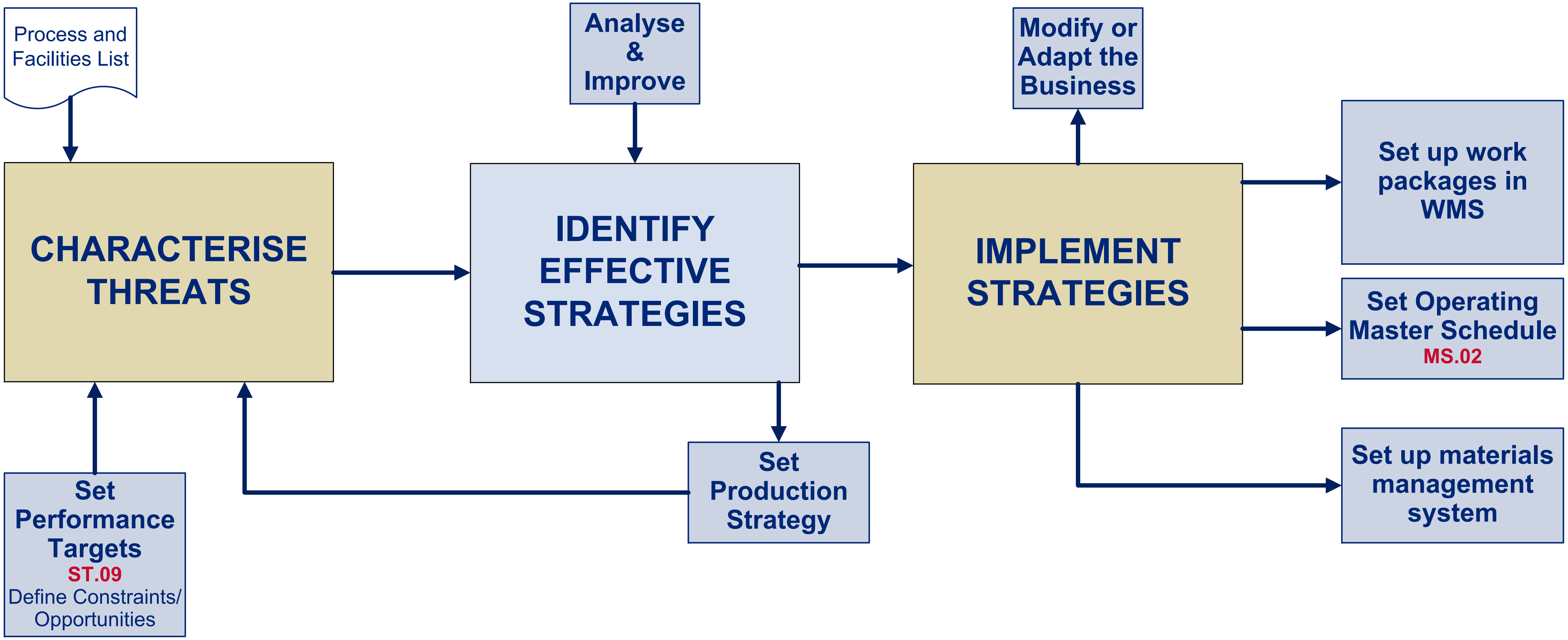



AAOM Flowsheet

# SET SERVICE STRATEGY- HIGH LEVEL

Purpose: To specify the most cost effective way to manage threats related to the process.

**Updated: 05/2019**

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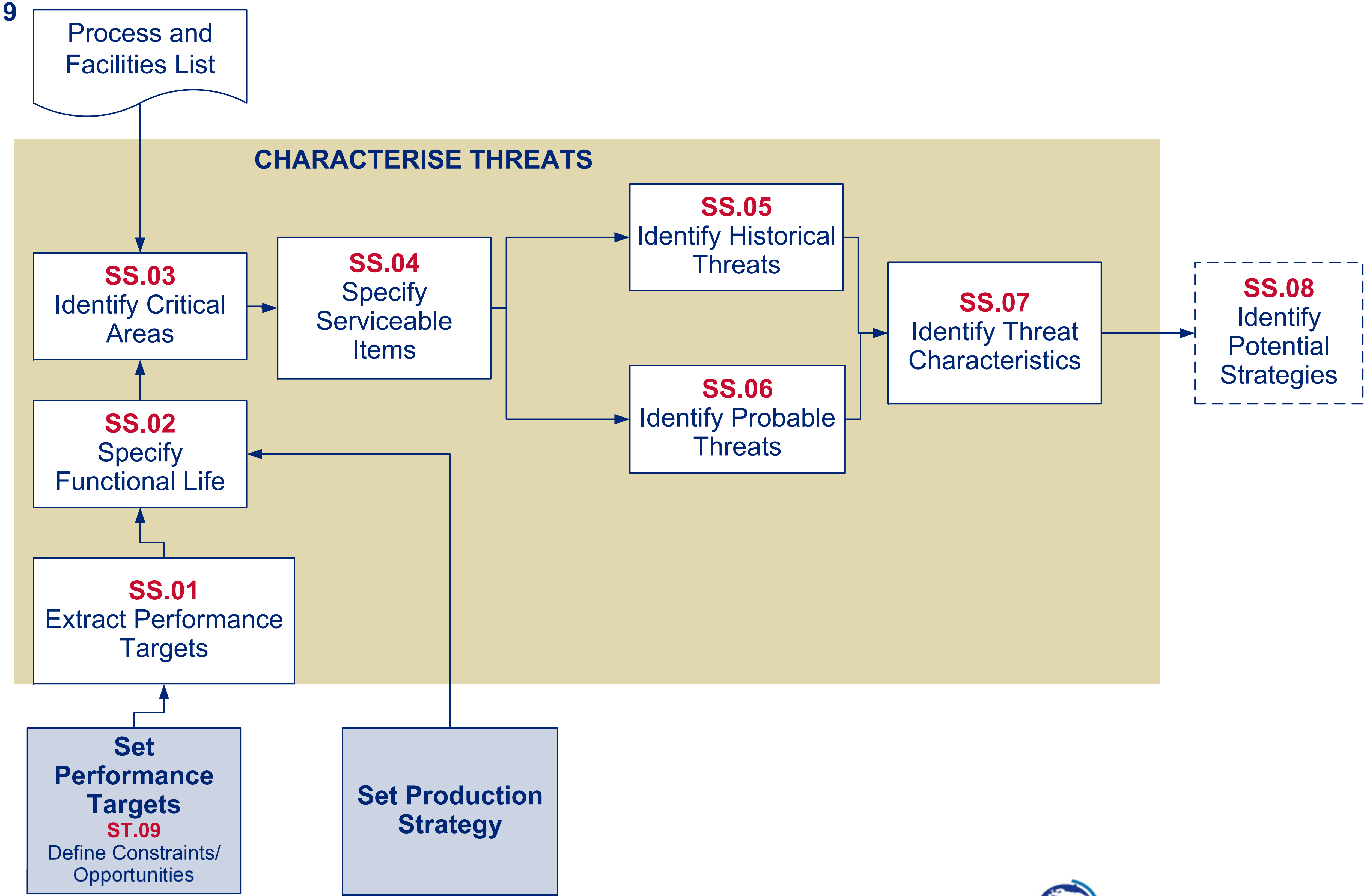
SSS Flowsheet

# SET SERVICE STRATEGY- CHARACTERISE THREATS

Purpose: To specify the most cost effective way to manage threats related to the process.

**Updated: 05/2019**

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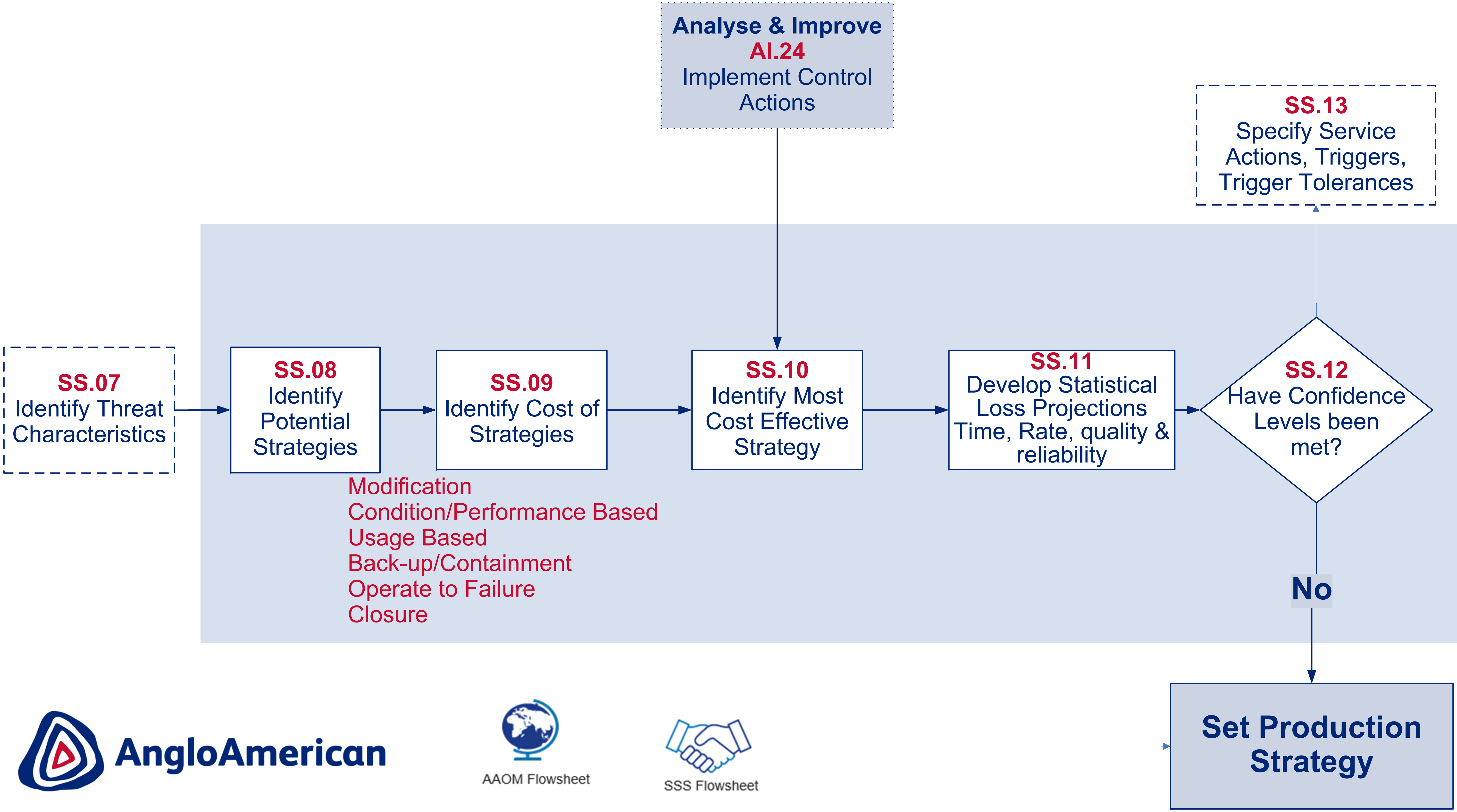
SSS Flowsheet

# SET SERVICE STRATEGY- IDENTIFY EFFECTIVE STRATEGIES

Purpose: To specify the most cost effective way to manage threats related to the process.

**Updated: 05/2019**

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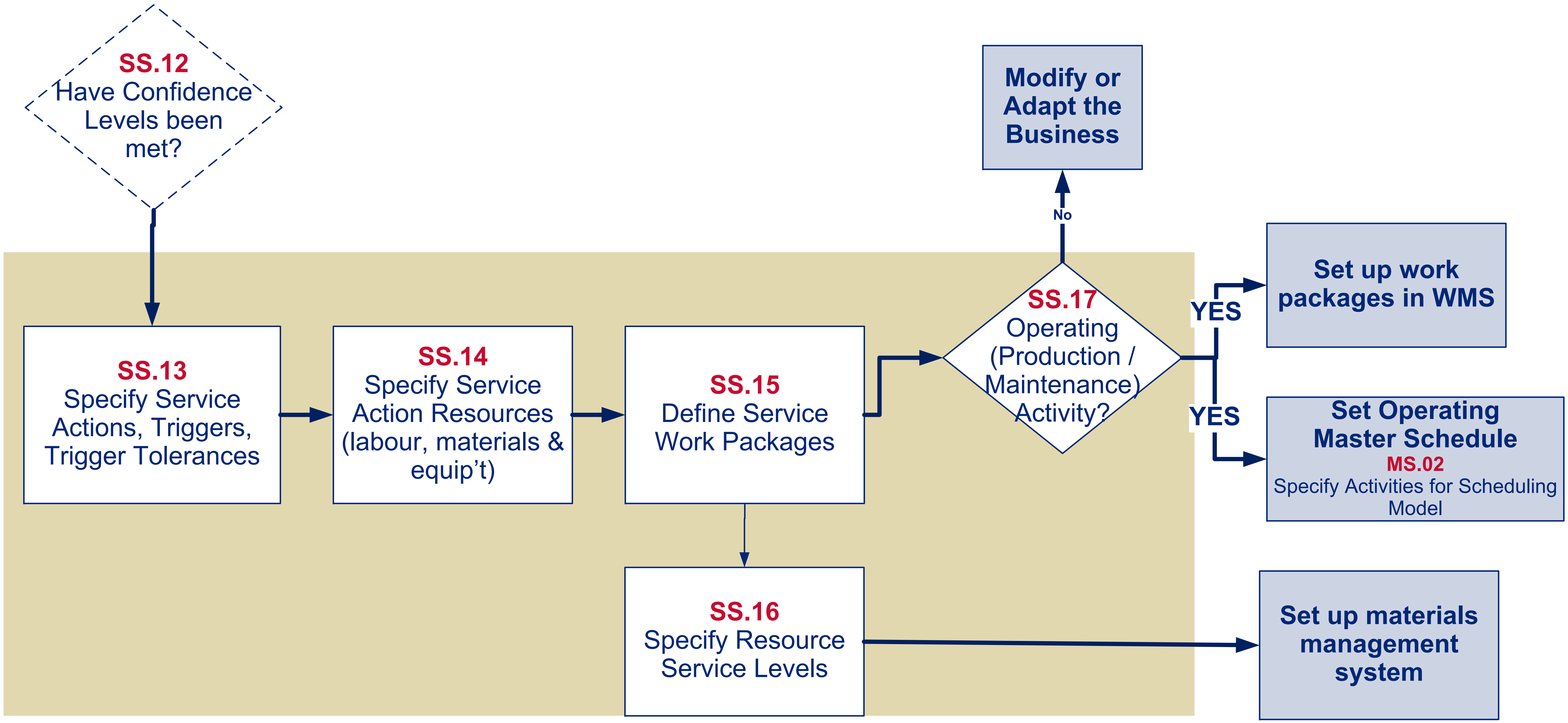
SSS Flowsheet

# SET SERVICE STRATEGY- IMPLEMENT STRATEGIES

Purpose: To specify the most cost effective way to manage threats related to the process.

**Updated: 05/2019**

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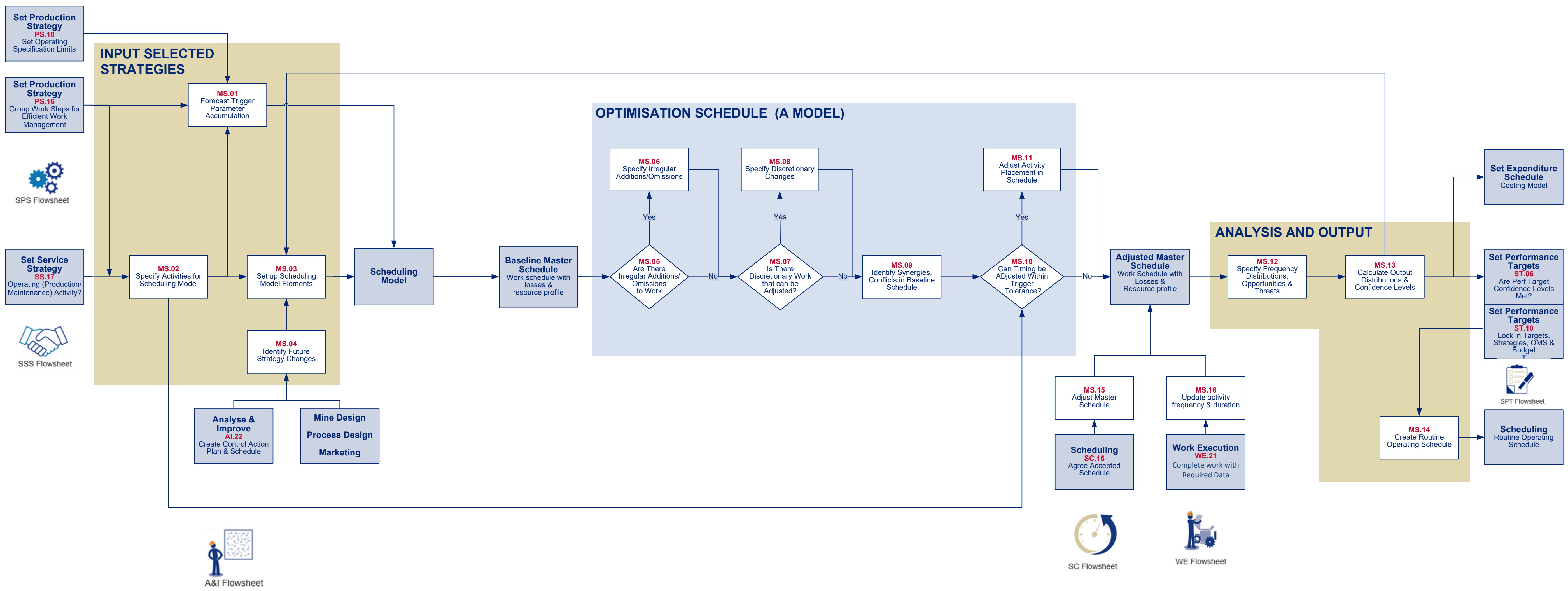
AAOM Flowsheet

SSS Flowsheet

# SET OPERATING MASTER SCHEDULE

## Purpose: To specify the optimum schedule for the selected strategies.

**Updated: 05/2019**

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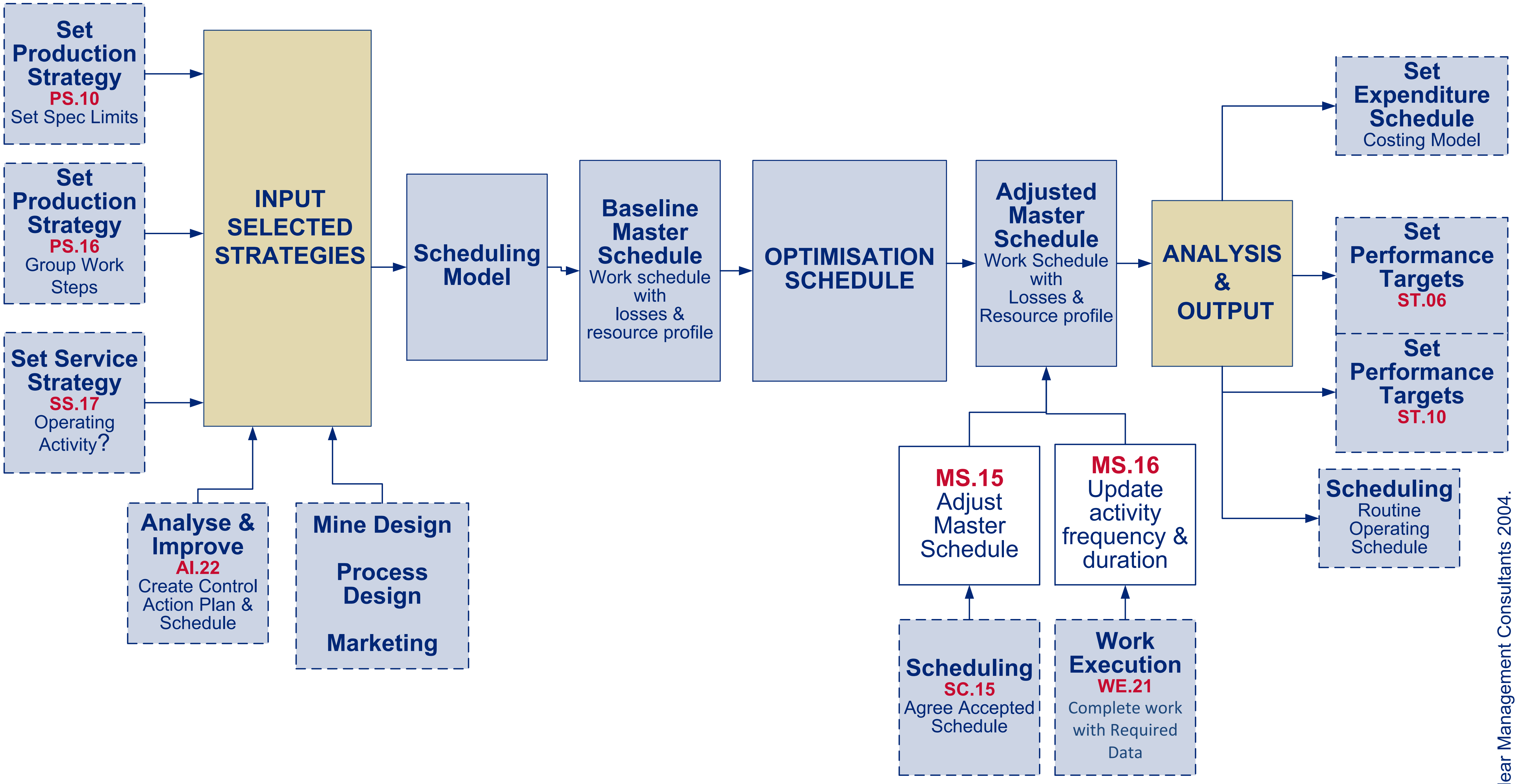
# SET OPERATING MASTER SCHEDULE- High Level

Purpose: To specify the optimum schedule for the selected strategies.

**Updated: 05/2019**

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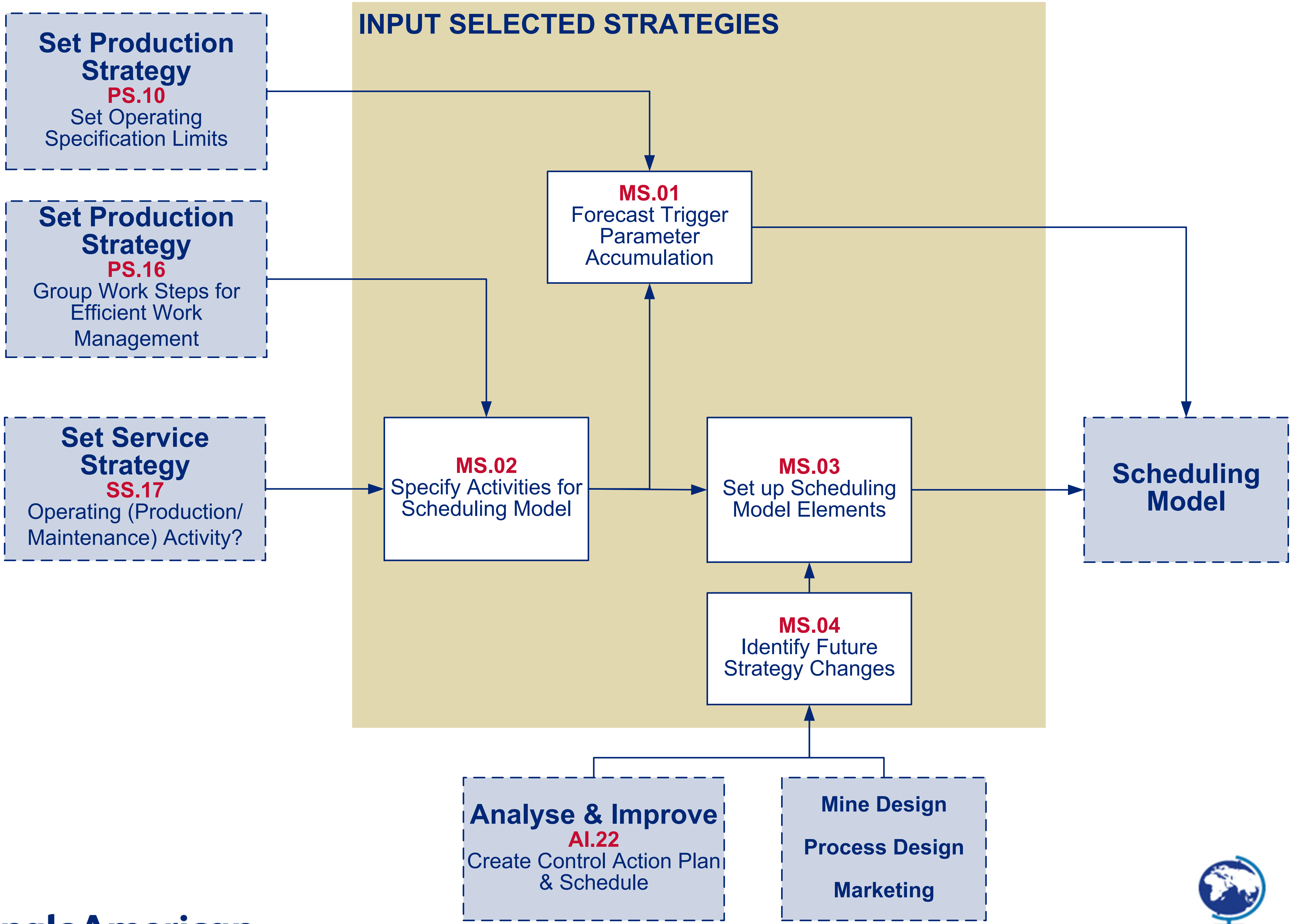
OMS Flowsheet

# SET OPERATING MASTER SCHEDULE- INPUT SELECTED STRATEGIES

Purpose: To specify the optimum schedule for the selected strategies.

**Updated: 05/2019**

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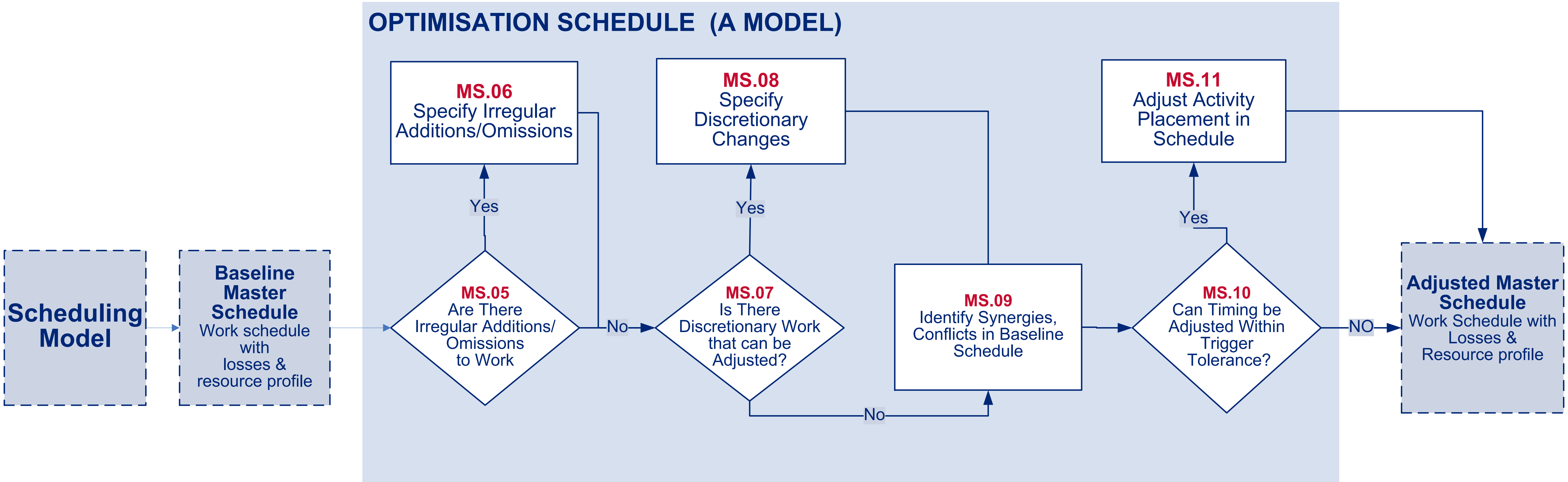
# SET OPERATING MASTER SCHEDULE- OPTIMISE SCHEDULE

Purpose: To specify the optimum schedule for the selected strategies.

**Updated: 05/2019**

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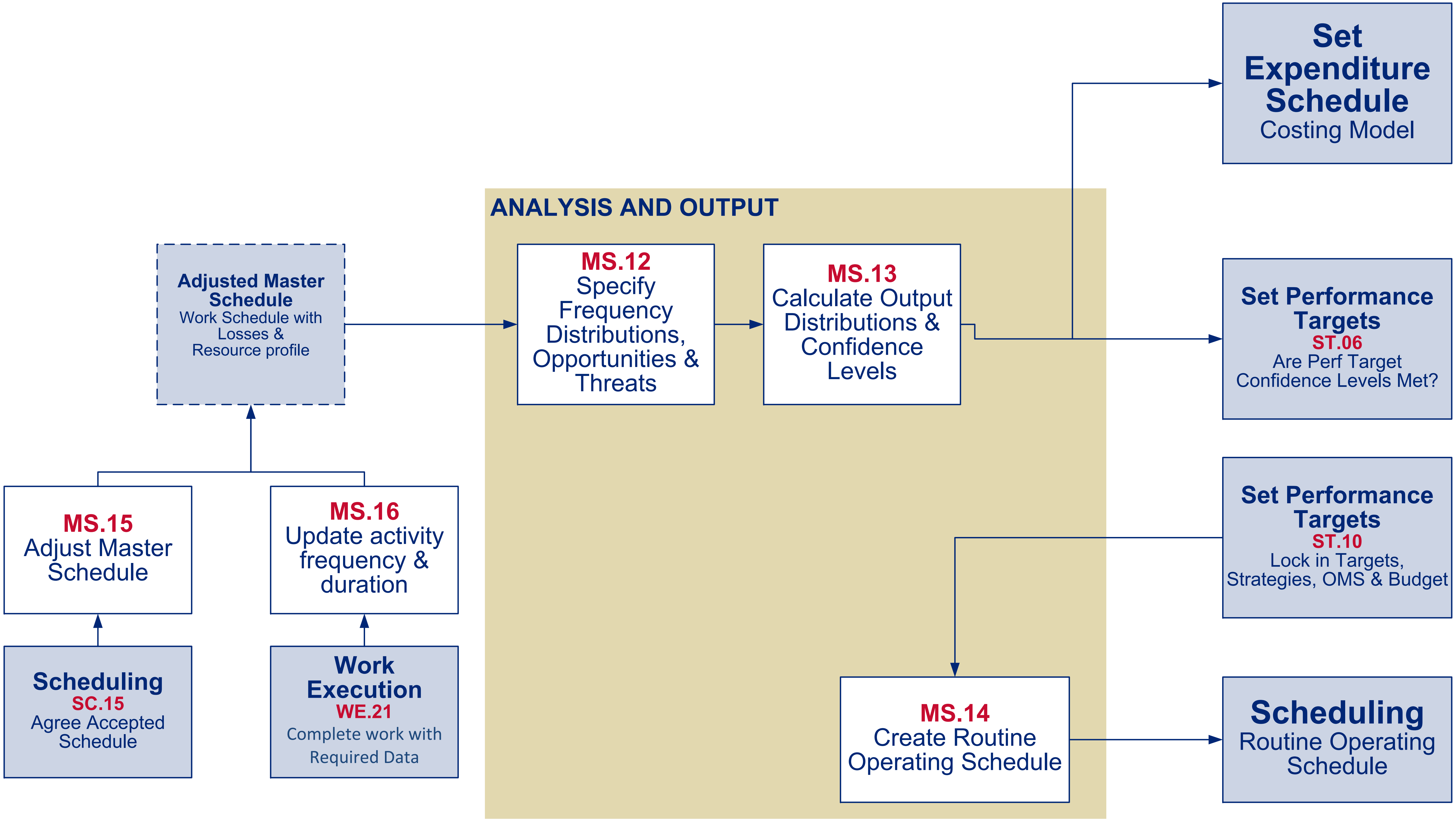
# SET OPERATING MASTER SCHEDULE- ANALYSIS AND OUTPUT

Purpose: To specify the optimum schedule for the selected strategies.

**Updated: 05/2019**

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AAOM Flowsheet

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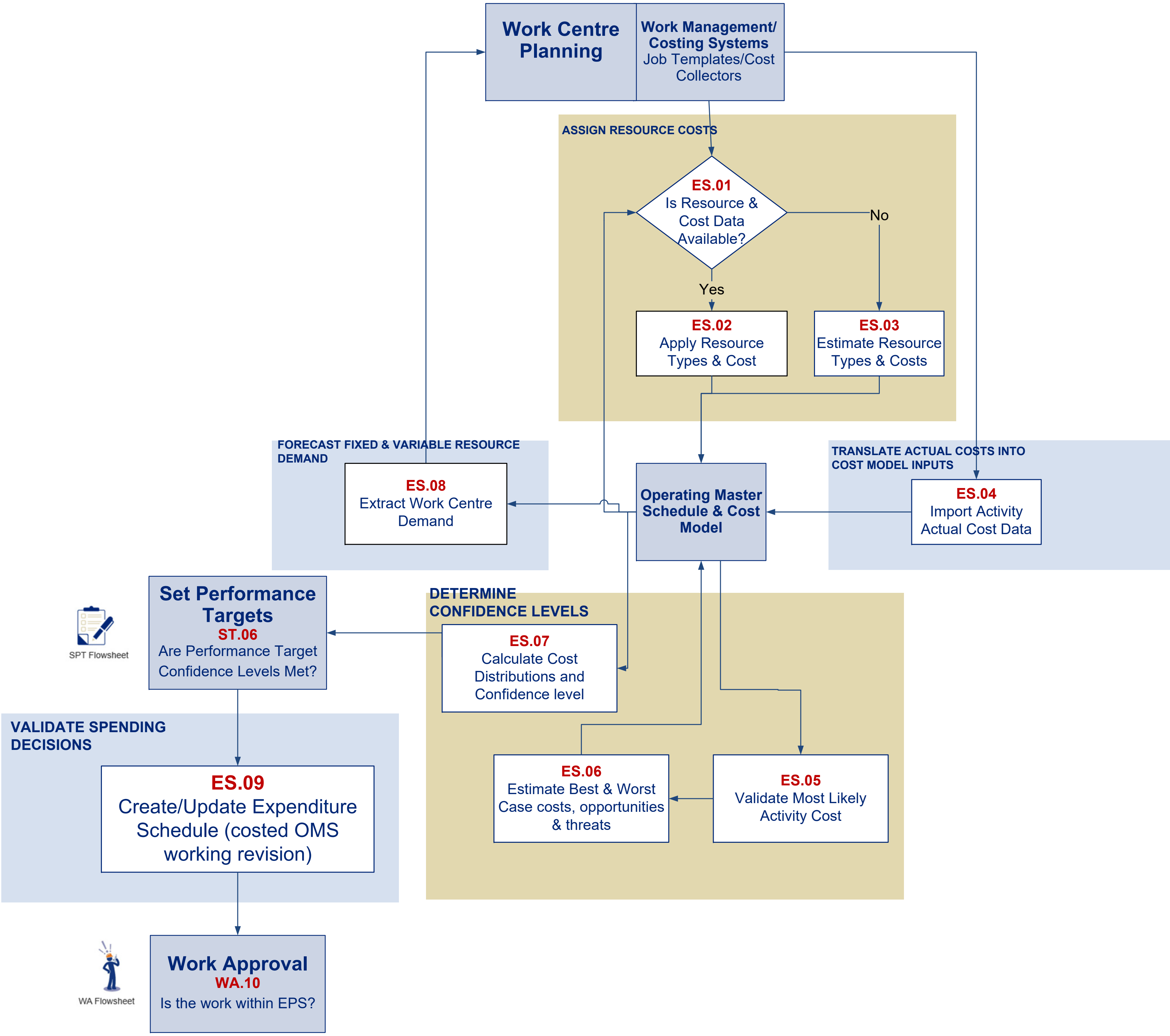
# SET EXPENDITURE SCHEDULE

Purpose: To specify the expenditures required for the Operating Master Schedule.

**Updated: 09/2019**

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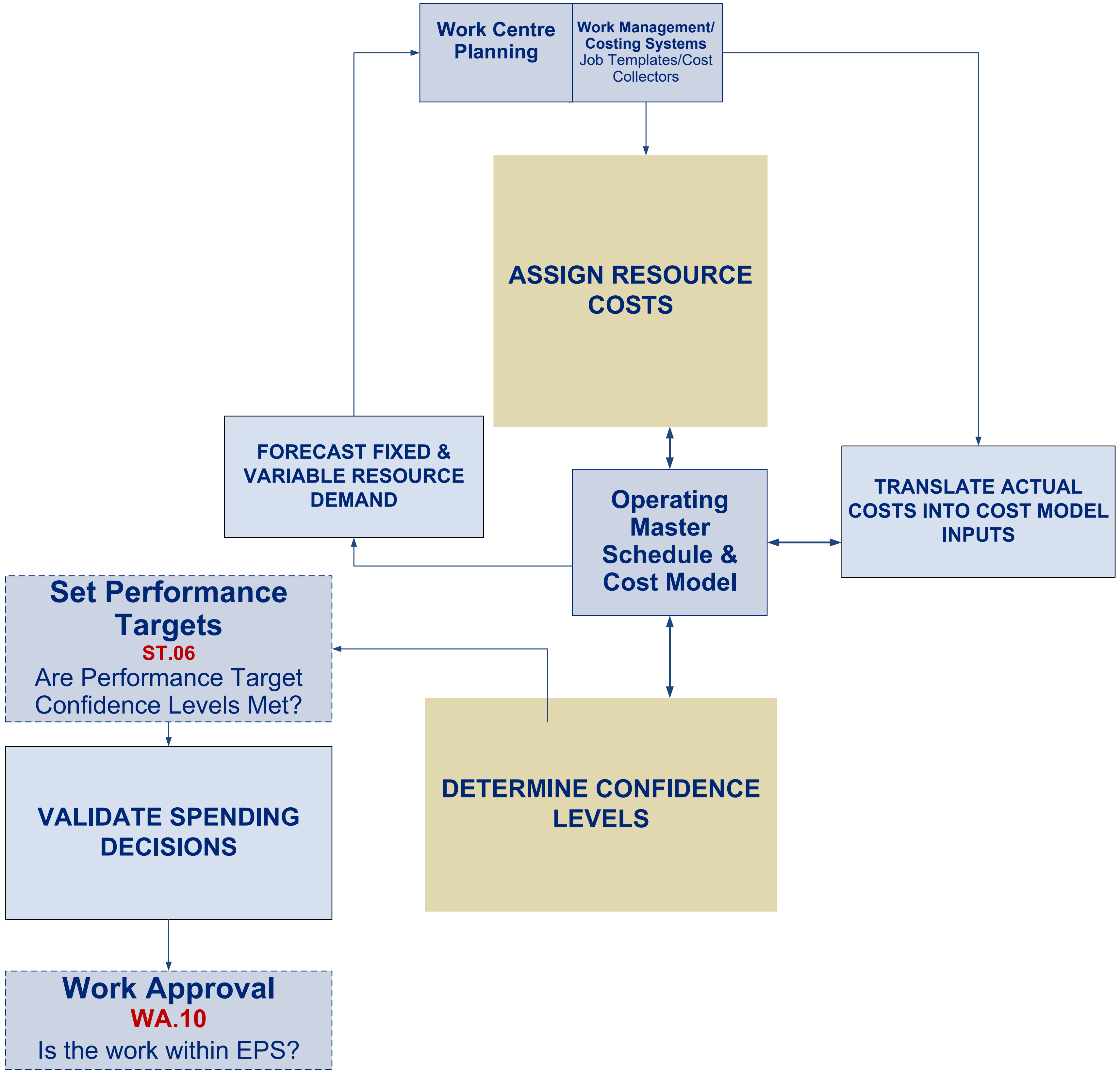
# SET EXPENDITURE SCHEDULE- HIGH LEVEL

Purpose: To specify the expenditures required for the Operating Master Schedule.

**Updated: 09/2019**

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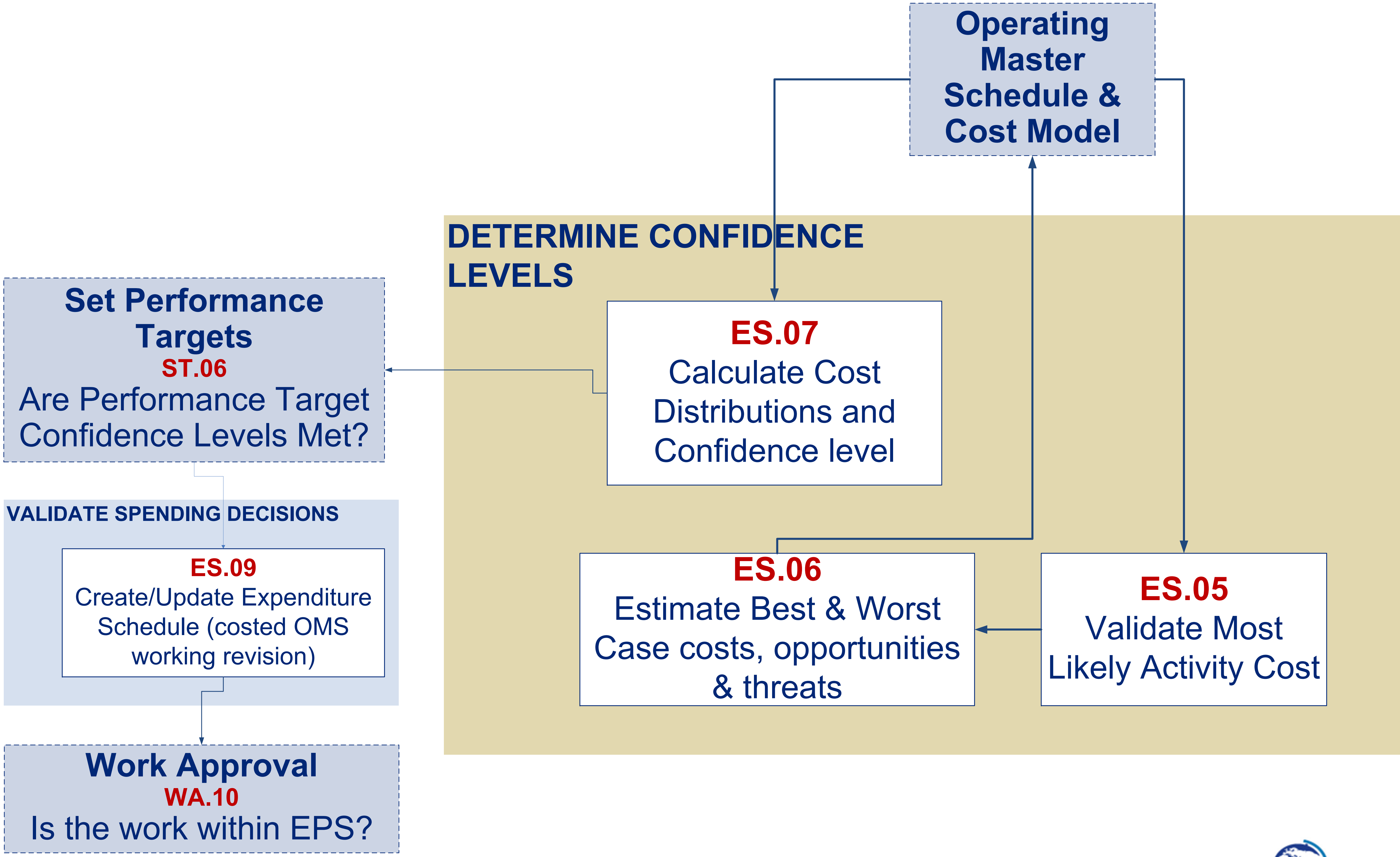
SES Flowsheet

# SET EXPENDITURE SCHEDULE- DETERMINE CONFIDENCE LEVELS, VALIDATE SPENDING

Purpose: To specify the expenditures required for the Operating Master Schedule.

**Updated: 09/2019**

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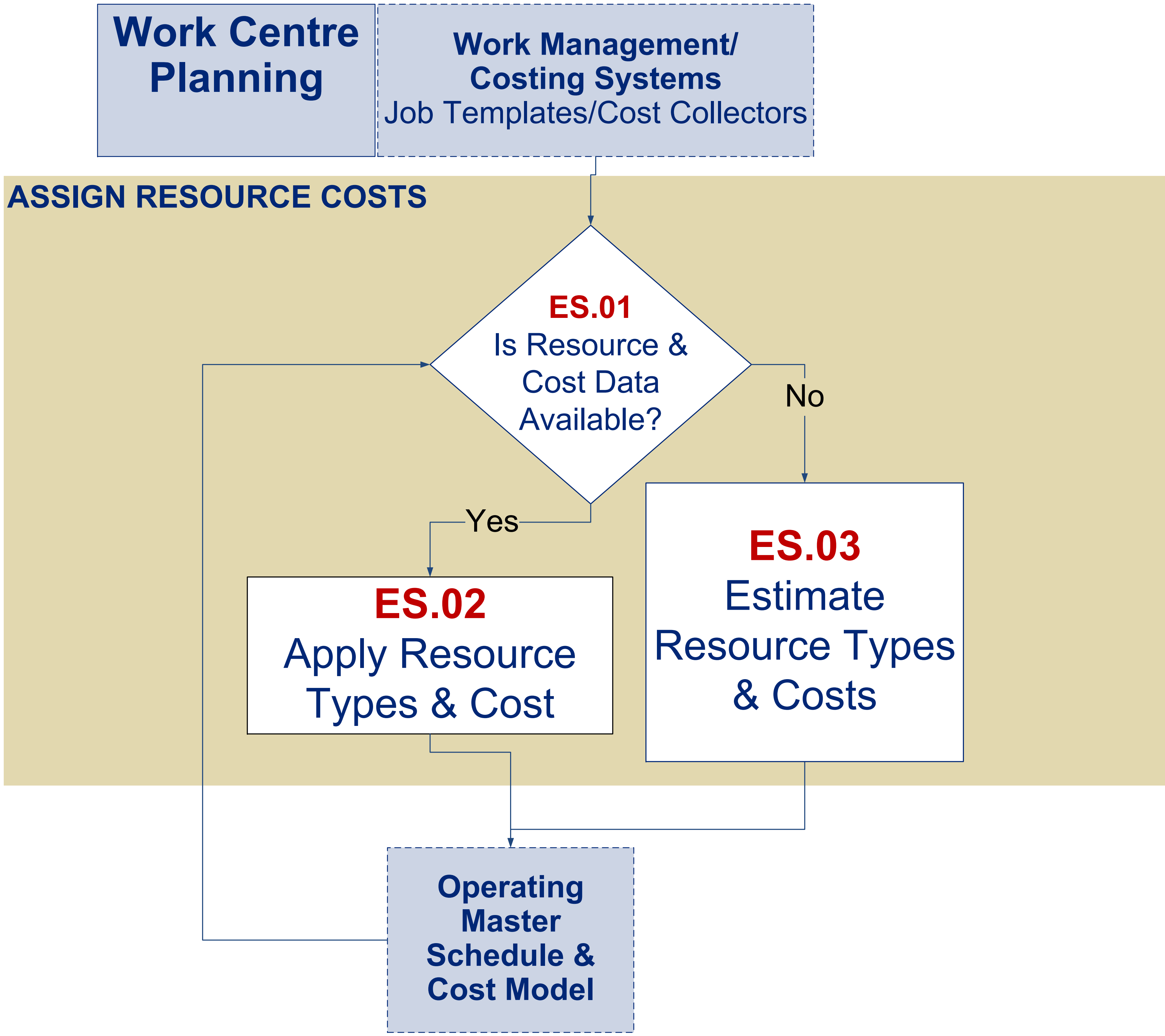
SES Flowsheet

# SET EXPENDITURE SCHEDULE- ASSIGN RESOURCE COSTS

Purpose: To specify the expenditures required for the Operating Master Schedule.

**Updated: 09/2019**

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SES Flowsheet



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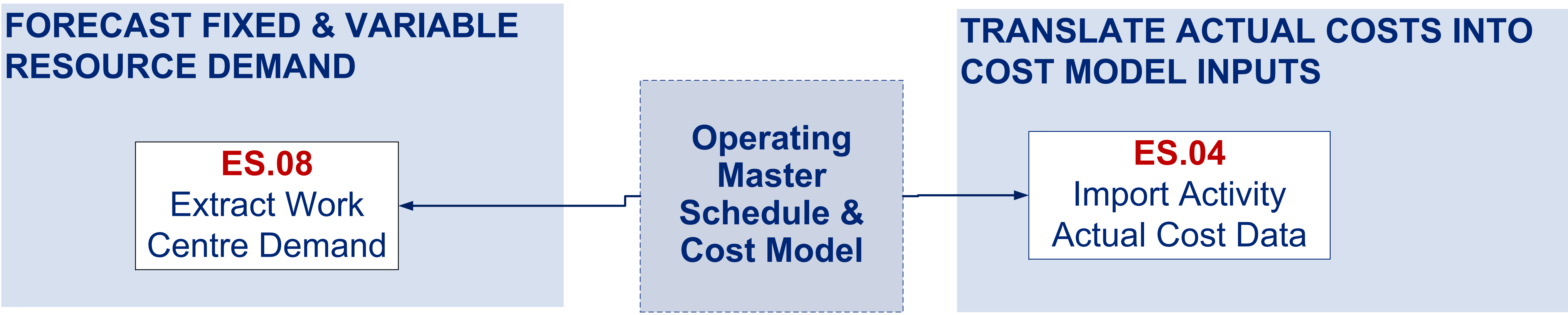
# SET EXPENDITURE SCHEDULE- FORECAST RESOURCE DEMAND, ACTUAL COST

Purpose: To specify the expenditures required for the Operating Master Schedule.

**Updated: 09/2019**




AAOM Flowsheet

SES Flowsheet



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INTERNAL

# ANGLO AMERICAN OPERATING MODEL: OPERATIONAL PLANNING
## SET PERFORMANCE TARGETS

**UPDATED: AUGUST 2018**

**CONTENTS**




AAOM Flowsheet


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# ST.00 Set Performance Targets

## Context

The stakeholders in a business (shareholders, employees, community and government) collectively define the expectations that the business must meet in order for them to continue to support its operation. These expectations, interpreted and defined by the board and senior management, typically encompass safety, environmental, social and economic dimensions. These overall business expectations define the success factors for the business, and set the context for the performance of every element of the business.

A business is typically comprised of a number of interconnected processes, each transforming, transferring or storing materials or information required to produce the outcomes expected of the business. Achieving the overall expectations will require the achievement of specific, and generally differing, expectations from each element of the business. It is therefore necessary to define how the overall Business Expectations break down to meaningful targets for the various processes that make up the business, and how the measured performance of these processes rolls up to a measure of the overall business performance.

Perhaps the first question to answer is what type of performance targets and measures are we talking about? The Operating Model considers three characteristics when defining outcome Performance Targets, and hence measures, for a process. These are;

- Effectiveness - the output delivered over time (which should include quantity, quality and time).
- Efficiency - a ratio between output delivered and resources consumed over time.
- Sustainability - the resources/condition(s) available to underpin the continued operation of the process.

See Appendix 1 for more discussion about the measuring these characteristics.

If we consider these characteristics at an overall business level then the targets may relate to;

- Effectiveness - the dividends and share price growth over time.
- Efficiency - return on capital invested.
- Sustainability - access to raw materials, markets, condition of fixed assets, and support from investors, regulators, communities, etc.

Such targets may be meaningful to external stakeholders and senior executives, and a business that did not satisfy the above expectations would not continue to operate for very long. Investors would abandon it, or regulators or communities would force its closure. However, these performance targets may not be very meaningful to the people working in the numerous processes that contribute to the overall function of the business. What do dividend and return on capital targets mean for an individual process within the business? It is not very obvious. Hence, overall business targets need to be dissected in a way that;

- provides meaningful targets for each process within the business, and
- will ensure that the collective targets optimise the overall business performance rather than individual processes.

In answer to the above question about what do dividend targets mean to an internal process, dividends are related to the free cash flow generated by the business, and cash flow is related to the revenue generated by the output of the process and the cost of producing that output. The manager of an internal process may not have direct control over sales and pricing but will have influence over the production level and operating expenditures. Hence, the appropriate performance targets for this process manager may be defined as;

- Effectiveness - quality product per unit of time.
- Efficiency - recovery or yield on feed stock, unit operating costs, stockpile working capital to throughput.
- Sustainability - feed stocks, safety and environmental performance, condition of fixed assets.

Where there are independent processes their output and cost results can be added to define the connections between their performance targets and the performance targets at the overall business level - it is straight arithmetic. An example of this type of situation is a large mining business where there are mining and processing operations independently producing a single final product in different countries. The output and costs of the operation in one country are not determined by the other. Even parameters such as margin, cash flow and return on capital can be derived through bringing output, price, costs and capital invested into the series of calculations - although now it involves multiplication, division and subtraction as well as addition. Whether we are looking at setting targets or measuring results the arithmetic of the relationships will, in the case of independent processes, work.

Unfortunately, real businesses and their processes are often not as simple as this. Complexity enters the picture where the processes that contribute to the outcome are not completely independent, i.e. the results of one process have an impact on the connected processes. This is very frequently the case. Take our mining example again, and consider a single operation within a country. In this case one that has several mines, from which ore is crushed and blended to a stockpile, and then fed into a single process plant. In this case we cannot just use arithmetic to determine the targets. We must also consider the logic that governs the flow of material (based on the capacities of mines, crushing facilities, stockpiles and the plant), as well as the quality and cost of the material being produced from each location.


AAOM Flowsheet

Regardless of which of the above situations we are dealing with, we need to construct a set of diagrams that accurately reflect the relationships and will support the development of a series of models that help us to understand how changing performance targets for one or more processes will change the performance targets for the business and vice versa. In the Operating Model this is done through the creation of a layered series of flow sheets that identify

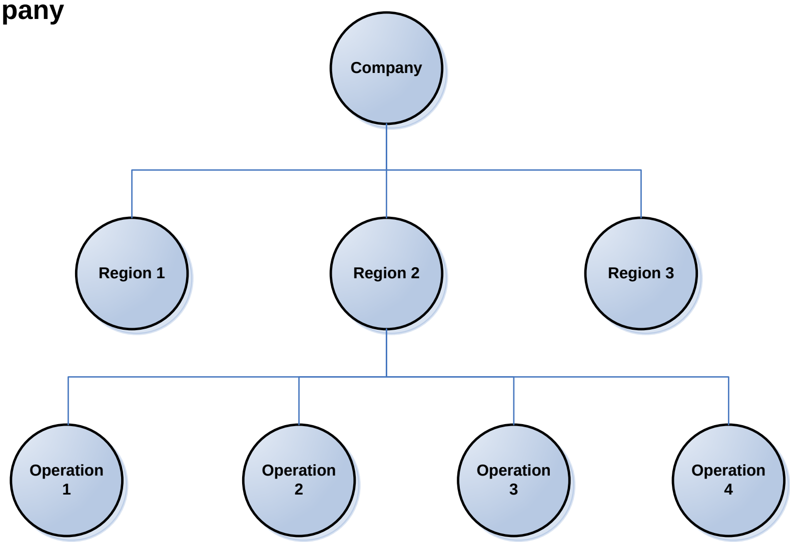

SPT Flowsheet

the key transform, transfer and store activities, and indicates the connections between these. For example:

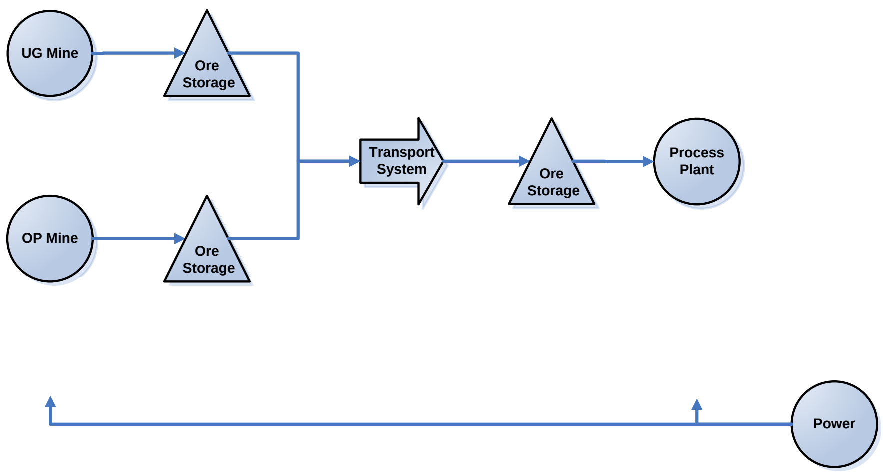
- At the layer of the Business Structure for the regional operations of a mining company the flow sheet may show several operating locations within the region, collectively contributing to the regional performance.
- At the next layer of the Business Structure, for a single operating location, the flowsheet may show several open pit and or underground mines, connected via stockpiles and transport networks to an ore common processing facility.
- At the next layer of the Business Structure for a mine or process plant the flowsheet will show processes for transforming, transferring and storing product or services (e.g. ore extraction locations, transport systems, crushing systems, stockpiles or bins, etc.).

Following are a few examples of what such flow sheets may look like. Note that the dependencies are relatively simple and vertical in the first chart, i.e. the results on one level depend on those below it, and the results across a level are independent. This type of flowsheet is commonly called a Value Driver Tree. However in the following two charts more complex dependencies can exist in the flow through the processes within a level, particularly the Operation level. These type of charts are commonly called Value Stream Maps. Some other example flow sheets are given in the Appendix 2.

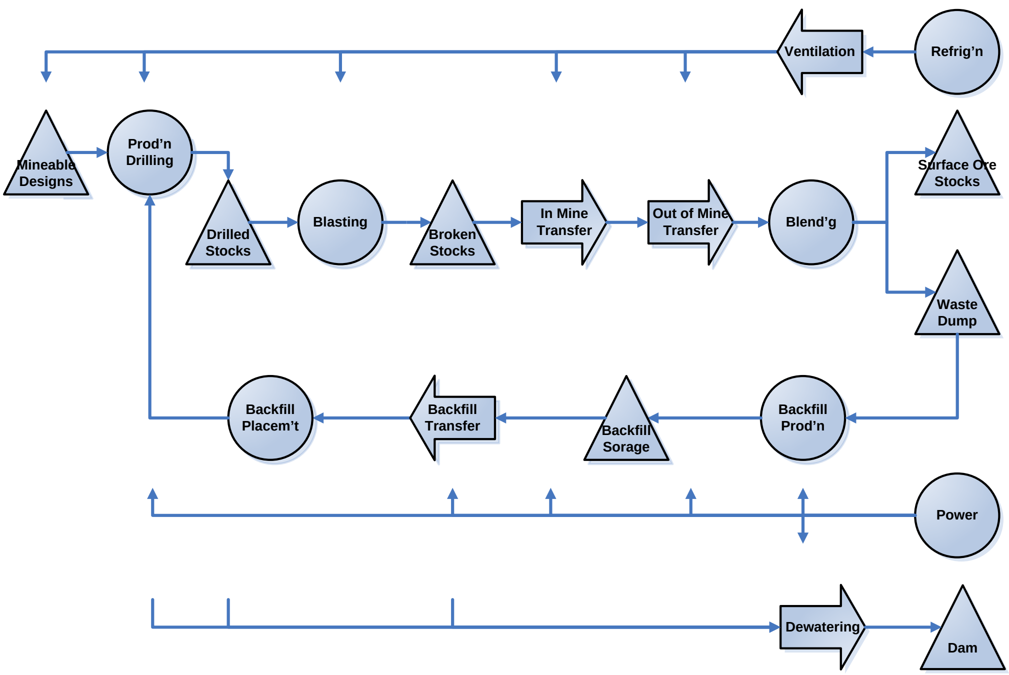
**Generic Company**



**Generic Operation**




**Generic UG Mine**




With this set of Value Driver Trees and Value Stream Maps we can understand what transform, transfer and store processes contribute to delivering an outcome, and **where** dependencies between them exist - both within and between levels. Within the Business Process Framework the relationships defined by these layered flow sheets are referred to as the Business Structure.

AAOM Flowsheet

The Business Structure will not on its own allow us to fully understand **how** dependent processes interact, and how these interactions affect the overall business performance. This is because understanding the interactions at a specific level of the Business Structure is complicated by the;

SPT Flowsheet

- logic that must be applied where alternative options for flow exist,

- random variation in the performance of each process that occurs over time, and
- effectiveness of buffering provided by stockpiles.

The only way to successfully predict the outcomes of this variation occurring within processes is with an appropriate statistical performance model. A statistical performance model uses Monte Carlo simulation to replicate the impact of **random** variation occurring within the system being modelled.

In setting up to use a statistical model we must realise that the variation seen in the measured performance of a system may not all be random. There are two types of non-random variation that may be present. Firstly, the total variation may be comprised of both independent variation (that arising from factors within a process) and dependent variation (that arising from the influence of a preceding or proceeding process) - note that the purpose of storage is actually to isolate variation in one process from affecting other connected processes. The dependent variation cannot be treated as random in the modelling process and hence needs to be removed (cleansed) from the data fed into the model. Secondly, the remaining variation may still have periods where it was not random, but had data that was linked to a specific, non-random cause – e.g. a process shut-down for maintenance. These events can be identified from a Control Chart of the cleansed data, where they should appear as 'special causes'. These non-random events will need to be treated as a separate input to the model.

The statistical performance model, if correctly designed and calibrated, and fed with the cleansed data, should make reliable predictions about the both the dependent variation that will occur, and the overall system performance (see examples in Appendix 1). This performance model can help to identify;

- what level of performance is required from each element of the Business Structure if overall Performance Expectations are to be met,
- what and where the constraints on performance are - either a capacity 'bottleneck' at a point in the process, excessive variation constraining performance across sections of the process, or ineffective buffering by stockpiles, and hence
- what and where the opportunities for performance improvement are.

The third area of performance for which targets may need to be set is Sustainability - a measure of the availability of key 'resources' required for a process to continue operating. There may be tree types of key resources:

- Physical materials such as ore reserves, in-process stocks, fuel supply, etc. that can be assessed via a measure of stocks divided by consumption rate. This yields a measure of 'time' such as years of reserves, or days of stocks or fuel.
- Physical assets such as steelwork, concrete and electrical systems for which the life can be depleted if appropriate sustaining (integrity) service strategies are not implemented. This situation will reduce the functional life of the assets and can be measured via an increase the threat of failure over time.

- Less tangible resources such as the support of local communities or governments, essential for sustaining a 'licence to operate'. This may include characteristics covering safety, environment, social expectations and return on investment, and may be assessed by measuring the delivery of outcomes against expectations.

Understanding and setting Performance Targets for Output Capacity and Unit Costs requires the ability to model the performance of each element in the Business Structure and the effect of interactions between the connected elements. Two different types of model are used for these functions in the Business Process Framework, a Value Driver Tree where performance is dependent between flow sheet levels but independent across a level and a Value Stream Map where performance is interdependent across a level.

Due to inherent variation in processes, the Performance Targets for each element of the Business Structure over a period of time is typically not a single value, but rather it is a range of values with differing frequencies and durations of occurrence (i.e. it is best represented in a Capability Histogram). The range and shape of the performance distribution(s) can be a function of;

- process design,
- Production and Service strategies
- the effectiveness of strategy implementation,
- the efficiency of strategy implementation,
- the cost effectiveness of the resources employed in implementing the strategies, and
- the relative position in the life cycles of the resources employed in executing the strategies (such as the changes in performance that occur as ore bodies and equipment are depleted or wear out, or the changes in performance that occur as new employees gain knowledge and experience).

If there are no significant changes to any of these fundamental performance drivers then the range and shape of the performance histogram should not change. However, if a shift in any of these drivers can be achieved then a change in the range or shape of the performance histogram can be predicted. A potential set of changes to these drivers represents a potential alternate operating scenario.

The starting point for the development of a scenario is the statistically stable historical performance. This performance can then be adjusted for each anticipated change to any of the fundamental performance drivers. These changes can affect either the range or shape of the performance histogram, or both. All of these anticipated changes for each element of a Business Structure can be fed into the appropriate performance model(s) and predict the range and shape of possible performance outcomes.

AAOM Flowsheet

The above modelling work allows us to predict what performance might be expected from any section of the Business Structure, given its historical performance and the anticipated set of changes defined in a scenario. We still need to determine if there are practical Production and Service strategies, and

SPT Flowsheet

an Operating Master Schedule and Expenditure Schedule that can deliver the scenario characteristics and meet the expectations set for the business. This is done through the Set Production Strategy, Set Service Strategy, Set Operating Master Schedule and Set Expenditure Schedule elements of the Business Process Framework. When the modelled predictions of output capacity and unit costs are developed, these need to be compared to the Business Expectations.

The specifications for a performance outcome can be either single or double sided. Examples of single sided specifications are; to produce at least 10,000 tonnes per week of prime concentrate, to fulfil a recruitment request within 12 weeks, end of month accounting processes will be completed within 5 days. Examples of double sided specifications are; prime concentrate will have a minimum of 15% and a maximum of 20% metal content, the successful recruitment candidate will accept a starting salary between $X and $Y, accounts due will be paid no earlier than 5 days before and no later than the due date. In some cases a further parameter, such as a target mean for the distribution, is defined in order to further tighten the specification. For example, while all prime concentrate must fall within the above upper and lower specification limits, the target for the mean metal value is set to 17%. This will probably be a much more difficult target to meet.

If the predicted (modelled) performance histogram overlaps the target specification then at least some of the performance will meet the target. The stakeholders in the business would probably like to know what percentage of the total performance will actually meet their expectations for a given period of time – called the confidence level on the performance expectation. Answering this seemingly simple question is complicated by the fact that, for a given process, the confidence level on meeting a specification varies with the time period that you are looking at, i.e. for a consistent process performance, the confidence level for meeting a specification is different for 1 day, 1 month, 1 quarter and 1 year. If a process can meet specification at all, then the longer the time interval the higher the confidence level. This is explained by the expectation that the more individual process outcomes you include in calculating the average for a period, the closer the average of those outcomes should be to the long term average for the process. The Central Limit Theorem, from statistics, allows us to calculate these results. To answer the question how much concentrate grade lies between the upper and lower specification limits, or how many accounts are paid within the time specification, given in the examples above, calculate the area of the performance histogram (constructed for data samples representing that time period) that overlaps the target specifications. This will highlight whether 100%, 80%, 40% or 0%, etc. of the performance will meet the specification.

If the above work indicates that the business expectations can be met then we can lock in the strategies, Operating Master Schedule and the Expenditure Schedule. Otherwise, we need to see if we can develop alternate scenarios for testing. If all potential scenarios have been exhausted then we may need to rethink the Business Expectations that can be delivered form the current process, and consider major changes to the processes (Modify or Change the Business).

## Purpose

To specify the confidence of meeting business expectations.

## Quantity

The deliverables from setting performance targets shall include;

- One set of flowcharts (a Business Structure) comprising Value Driver Trees and Value Stream Maps.
- One set of performance targets for each element of the Business Structure.
- One set of scenarios for delivery of performance targets.
- One set of identified constraints and opportunities for each scenario.
- One set of performance forecasts, based on evaluated scenarios.
- One confidence level for achievement of performance targets.
- One decision whether the Business Expectations can be met with the existing process and feasible scenarios for Production and Service strategy, Operating Master Schedule and Expenditure Schedule.

## Quality

The deliverables shall meet the following requirements;

- The Business Structure shall be based on processes within the business that perform a distinct transformation, transfer or storage function.
- A Value Driver Tree shall be used where performance relationships are dependent between levels but independent across a level.
- A Value Stream Map shall be used where performance relationships are independent between levels but interdependent across a level.
- A measured performance parameter shall be specified by a performance histogram. The target distribution characteristics shall be defined, or example, by specifying the minimum, maximum, mean, mode and shape factor of the distribution.
- Performance targets should include;
    - Effectiveness,
    - Efficiency,
    - Sustainability,
- A performance target may include the;
    - lower specification limit,
    - upper specification limit, and
    - target mean.
- Each target must include at least a lower or upper specification limit. If any of the other two specification values is significant in evaluating the performance of the process it shall also be specified in the target.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- **For all performance targets except Asset Integrity** – Performance forecasts made from the Operating Master Schedule (OMS) and Expenditure Schedule (EPS) modelling shall be developed

and presented as a histogram of the predicted performance distribution with the;
    - upper control limit,
    - lower control limit,
    - mean, and
    - target specifications,

  identified on the histogram.
- The confidence level for each performance target shall be calculated as the area of the predicted OMS and EPS performance histogram(s) that overlap with the area of the optimal target specification identified from the Business Structure Model. If a target mean value has been specified the ratio of the predicted performance mean and target mean shall also be given.

- **For Asset Integrity performance targets** –
  Performance forecasts shall be developed and presented as;
    - a histogram of the distribution of HSE threat rating values, and
    - a histogram of the distribution of Business threat rating values.
- The confidence level shall be calculated from the percentage of potential threats that have a forecast threat rating below the target upper specification limit.
- The confidence level for all performance targets shall be supported with;
  - a specification of the opportunities and threats that could significantly affect the outcome, and
  - the control actions that will be implemented to reduce threats and deliver opportunities.

The detailed activities of set plant performance targets shall conform to the specifications set out in the Set Asset Performance Target Flowchart and TAs ST.01 to ST.10.

## Appendix 1

Contributing to the overall Output Capacity and Unit Costs are several parameters that can vary independently of each other, and that are determined by the choices of Production and Service Strategy for delivering a single set of Performance Targets. For example;

Output Capacity (on-spec units per time period) =

Utilisation x Input Rate x Process Efficiency x Quality =

$$\frac{\text{Operating Time}}{\text{Time Period}} \times \frac{\text{Units Input}}{\text{Operating Time}} \times \frac{\text{Units Output}}{\text{Units Input}} \times \frac{\text{Units On-spec}}{\text{Units Output}}$$

The same Output Capacity can be achieved with different combinations of these characteristics.

Unit Cost (cost per on spec unit of output) =

Total Costs / Units on Spec =

(Fixed Costs + Variable Costs) / Units on Spec

The same Unit Cost can be achieved with different combinations of these characteristics.

The Service Work performed on a process has the purpose of ensuring that production can continue in the future, i.e. that it will not be interrupted by predictable/preventable issues. A measure of the Effectiveness of the Service Work is the time between unscheduled interruptions, or interventions, (the reliability of the process). This will often provide a leading indication of effects on process Effectiveness, Sustainability and Efficiency.

Hence, for a given set of Effectiveness and Efficiency targets there may be many possible sets of choices of strategy for;

- incremental adjustment of technical design parameters
- use of time,
- throughput rate,
- quality (product input/output specification), and
- service strategy.

These will in turn affect;

- reliability (frequency of disruption to the process),
- process efficiency (recovery),
- fixed costs,
- variable costs,

and that and all of these will ultimately impact on the Effectiveness, Sustainability and Efficiency targets. Variation also occurs in each of these strategy related parameters and hence requires a statistical model for analysis and forecasting. A relatively simple, standard, value driver tree model of how these characteristics combine to define the Output Capacity and Unit Costs can be built for any element of the Business Structure (see example in Appendix 2).

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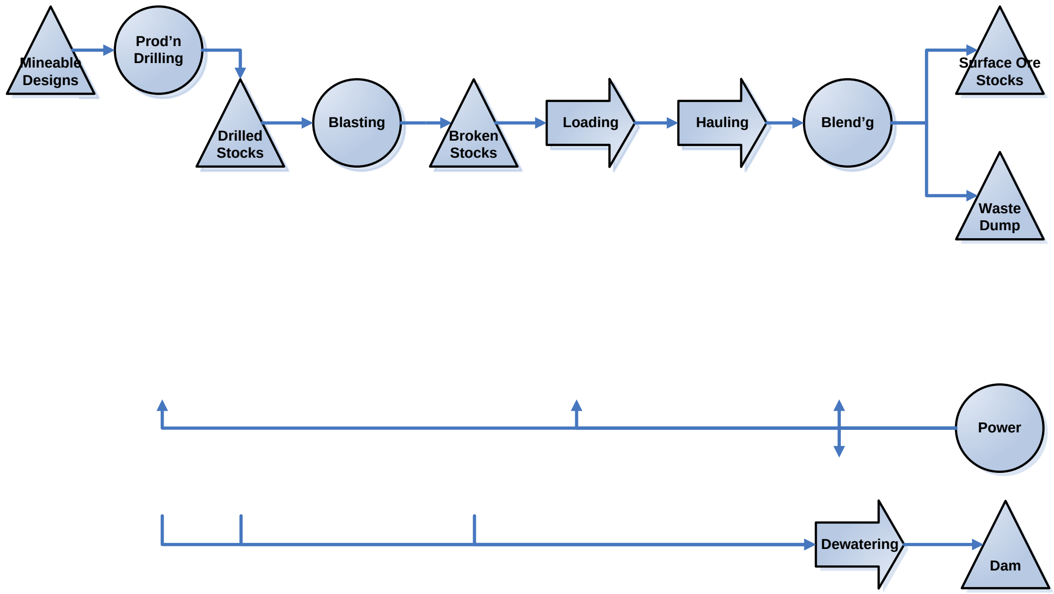
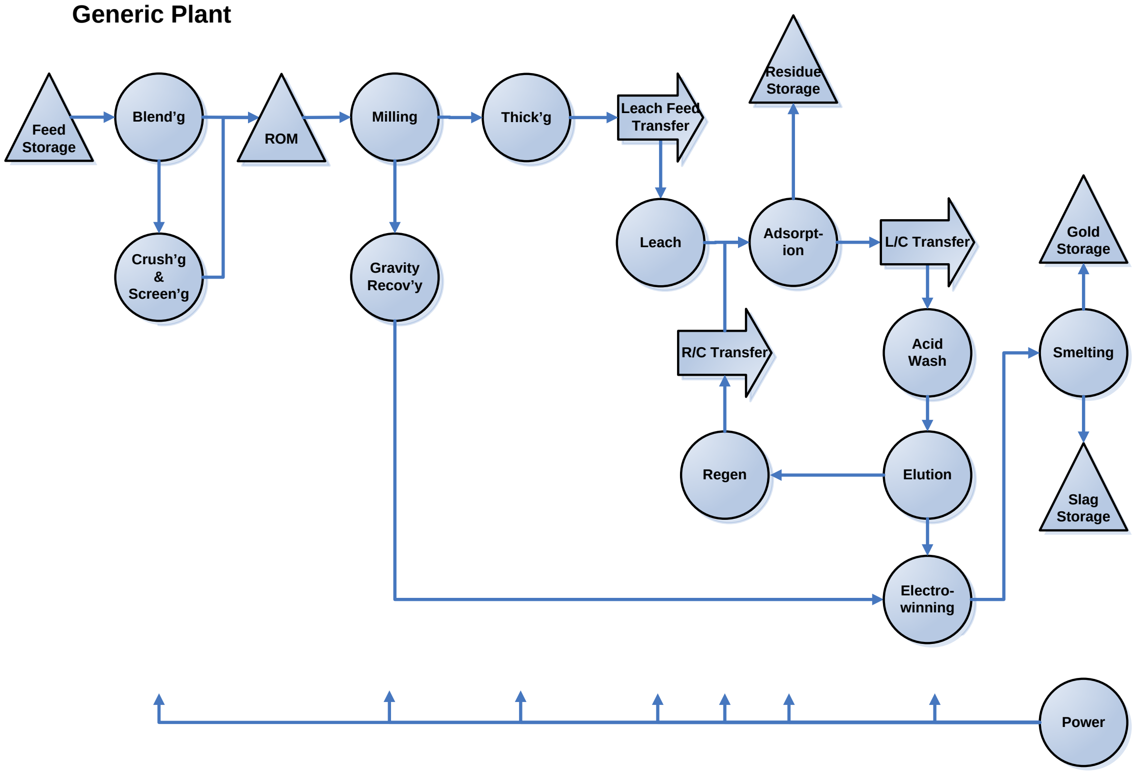
This type of model is used in conjunction with the Operating Model processes of Setting Production Strategy and Setting Service Strategy, to test whether a selected set of strategies is likely to deliver the required Output Capacity and Unit Cost performance targets.

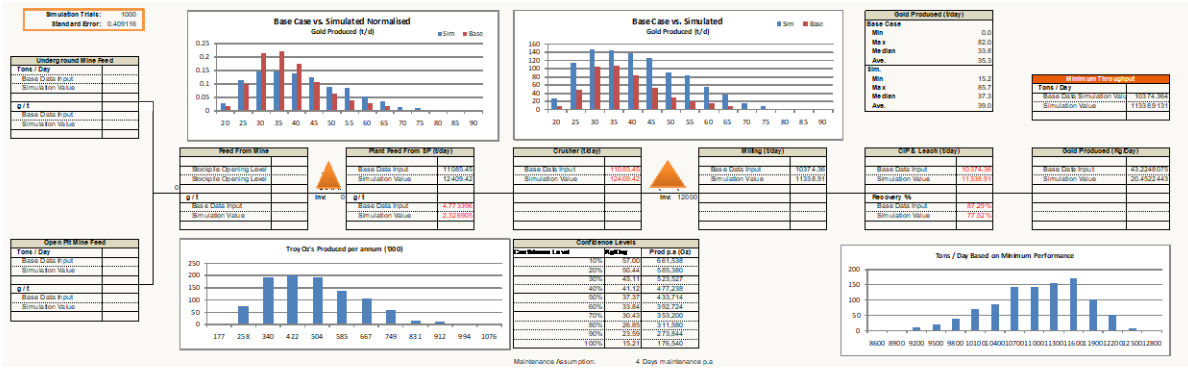
**Generic OP Mine**



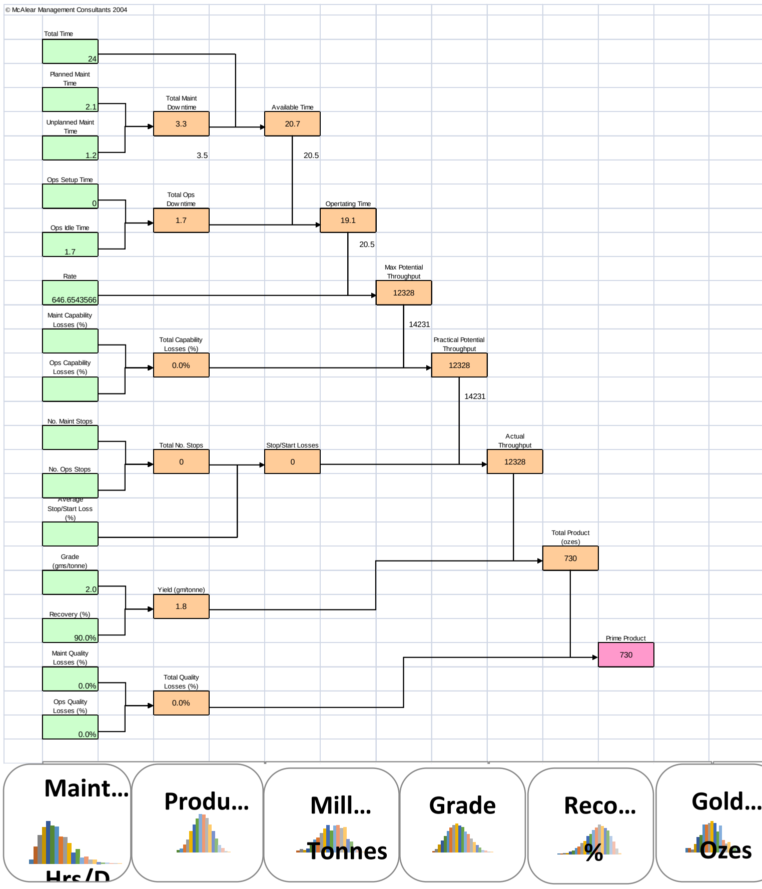

**Generic Plant**




## Appendix 2




## Appendix 3




| Mill Parameters | Min | Most Likely | Max | Weighting | Mean |
|---|---|---|---|---|---|
| Planned Maint Time | 0 | 0.5 | 12 | 40 | 0.8 |
| Unplanned Maint Time | 0 | 1.5 | 24 | 15 | 2.7 |
| Ops Setup Time | | | | | |
| Ops Idle Time | 0 | 2.5 | 5 | 15 | 2.5 |
| Rate | 0 | 750 | 950 | 8 | 694.6 |
| Maint Capability Losses (%) | | | | | |
| Ops Capability Losses (%) | | | | | |
| No. Maint Stops | | | | | |
| No. Ops Stops | | | | | |
| Average Stop/Start Loss (%) | | | | | |
| Grade | 1.3 | 2.1 | 3.5 | 10 | 2.2 |
| Recovery | 70.0% | 87.0% | 92.0% | 10 | 86% |
| Maint Quality Losses (%) | | | | | |
| Ops Quality Losses (%) | | | | | |

AAOM Flowsheet

SPT Flowsheet

# ST.01 Specify Business Structure

## Context

The stakeholders in a business (shareholders, employees, community and government) collectively define the expectations that the business must meet in order for them to continue to support its operation. These expectations, interpreted and defined by the board and senior management, typically encompass safety, environmental, social and economic dimensions. These overall business expectations define the success factors for the business, and set the context for the performance of every element of the business.

A business is typically comprised of a number of interconnected processes, each transforming, transferring or storing materials or information required to produce the outcomes expected of the business. Achieving the overall expectations will require the achievement of specific, and generally differing, expectations from each element of the business. It is therefore necessary to define how the overall Business Expectations break down to meaningful targets for the various processes that make up the business, and how the measured performance of these processes rolls up to a measure of the overall business performance. The first step to defining the performance targets is to break the performance targets into smaller elements.

Where there are independent processes their output and cost results can be added to define the connections between their performance targets and the performance targets at the overall business level - it is straight arithmetic. An example of this type of situation is a large mining business where there are mining and processing operations independently producing a single final product in different countries. The output and costs of the operation in one country are not determined by the other. Even parameters such as margin, cash flow and return on capital can be derived through bringing output, price, costs and capital invested into the series of calculations - although now it involves multiplication, division and subtraction as well as addition. Whether we are looking at setting targets or measuring results the arithmetic of the relationships will, in the case of independent processes, work.

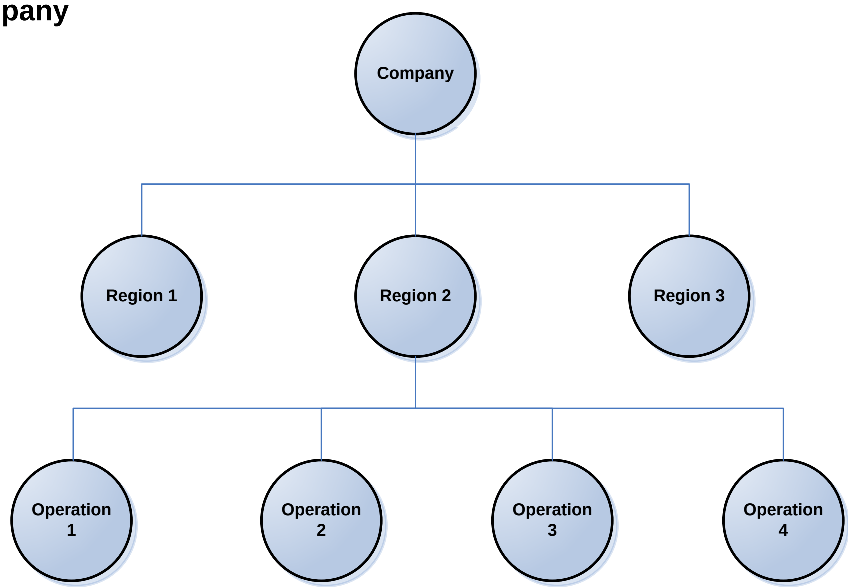
Unfortunately, real businesses and their processes are often not as simple as this. Complexity enters the picture where the processes that contribute to the outcome are not completely independent, i.e. the results of one process have an impact on the connected processes. This is very frequently the case. Take our mining example again, and consider a single operation within a country. In this case one that has several mines, from which ore is crushed and blended to a stockpile, and then fed into a single process plant. In this case we cannot just use arithmetic to determine the targets. We must also consider the logic that governs the flow of material (based on the capacities of mines, crushing facilities, stockpiles and the plant), as well as the quality and cost of the material being produced from each location.

Regardless of which of the above situations we are dealing with, we need to construct a set of diagrams that accurately reflect the relationships and will support the development of a series of models that help us to understand how changing performance targets for one or more processes will change the performance targets for the business and vice versa. In the Operating Model this is done through the creation of a layered series of flow sheets that identify the key transform, transfer and store activities, and indicates the connections between these. For example:

- At the layer of the Business Structure for the regional operations of a mining company the flow sheet may show several operating locations within the region, collectively contributing to the regional performance.
- At the next layer of the Business Structure, for a single operating location, the flowsheet may show several open pit and or underground mines, connected via stockpiles and transport networks to an ore common processing facility.
- At the next layer of the Business Structure for a mine or process plant the flowsheet will show processes for transforming, transferring and storing product or services (e.g. ore extraction locations, transport systems, crushing systems, stockpiles or bins, etc.).

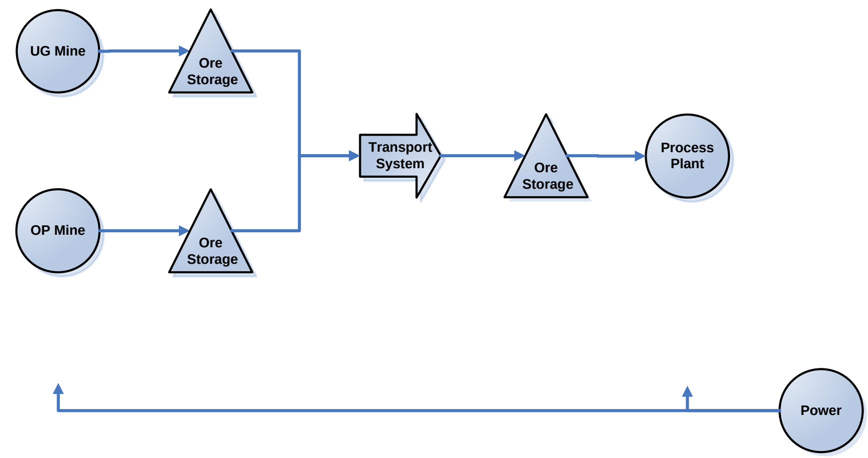
Following are a few examples of what such flow sheets may look like. Note that the dependencies are relatively simple and vertical in the first chart, i.e. the results on one level depend on those below it, and the results across a level are independent. This type of flowsheet is commonly called a Value Driver Tree. However in the following two charts more complex dependencies in the flow through the process. These type of charts are commonly called Value Stream Maps.

**Generic Company**

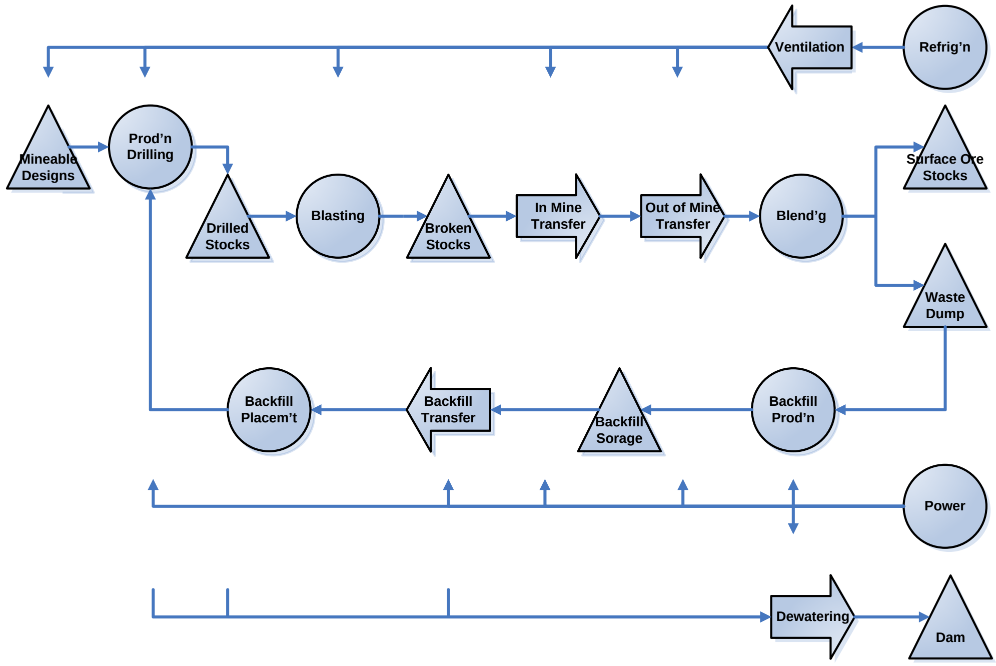




**Generic Operation**




**Generic UG Mine**




With this set of flow sheets we can understand what transform, transfer and store processes contribute to delivering an outcome, and **where** dependencies between them exist - both within and between levels. Within the Business Process Framework the relationships defined by these layered flow sheets are referred to as the Business Structure.

The Business Structure hierarchy is define by creating a series of layered Value Driver Tress and/or Value Stream diagrams that represent the flow of material or information that occurs between or within the levels of the Business Structure (e.g. ore, concentrate, steam, oxygen, purchase orders, costs, etc.).

A Value Driver Tree is constructed on the following principles;

- Start at the Outcome Node – the result.
- Each Branch is independent
- All Nodes in a branch must relate to the end Node of the branch
- A Driver that can be isolated to affecting a specific Node is placed under that Node.
- A driver that relates to several Nodes is placed at the same level as the highest related Node.
- A driver is not placed below the level at which it is controlled.

A Value Stream Map is constructed on the following principles;

- Start by identifying each significant storage point in the flow,
- Identify each significant branch of the flow,
- Insert each Transform or Transfer Process / Productive Unit between the Storage Points and Branches,
- Think carefully if you have a combination of Transform/Transfer processes without either a Storage point or a Branch between them. If either of the two does not exhibit independent variation combine them (e.g. a loader feeding onto a conveyor). If both exhibit independent variation it may be meaningful to separate them (e.g. a loader and a truck fleet).

In the Operating Model the typical elements of a Business Structure are;

- Value Driver Tree;
    - o Company,
    - o Business Unit,
    - o Operation.
- Value Stream Map;
    - o Process,
    - o Productive Unit.

The definitions are provided in the Quality section of this Task Assignment and examples are included in Appendix 1.

The relationships between elements of the Business Structure, and the flow of material or information through them, can be incorporated into a statistical model. Such a model allows the results of variation and interaction in the process to be visualised. With this information, the Performance Targets that each element of the flow sheet must deliver for the overall Business Expectations to be met can be determined. Similarly, reporting of performance can be rolled up as defined by the flow sheet relationships.

AAOM Flowsheet

It is typical for us, when defining a Business Structure, to think first of the major streams of material or information evident within a business. While this is probably a logical starting point the same approach can be adopted when breaking down or rolling up the performance of any function - for example potable water treatment systems and site surface water catchment/containment systems, supply chain functions, etc.

SPT Flowsheet

Most processes will over their lives undergo many changes, additions and/or contractions. The Business Structure and related measures must be updated whenever such changes are made.

**Purpose**

To specify the elements for which business Performance Targets will be set.

**Quantity**

- One Value Driver Tree (VDT) for performance relationships between the Company, Business Units and Operations.
- One set of Value Stream Maps (VSM) of the Processes and Productive Units within each Operation,
- One Purpose statement for each of the above elements of the Business Structure.
- One Theory statement for each of the Processes/Productive Units for each of the above elements of the Business Structure.

**Quality**

The Business Structure may comprise the following elements; Company, Business Units, Operations, Processes and Productive Units.

The **Company** is the highest level in the Business Structure. It is the level at which the Business Expectations are first defined in specific and measureable Performance Targets covering the characteristics of Effectiveness, Efficiency and Sustainability.

**Business Unit** shall be a grouping of Operations under a single manager accountable for the portfolio performance.

**Operations** shall be the separable elements of a Business Unit asset portfolio. That is, decisions about investment in, or divestment of, an Operation can be substantially independent of such decisions about other Operations within the Business Unit portfolio.

For example;

- Mines,
- Processing Plants
- Supply Chain shared services,
- Engineering shared services,
- Power Generation.

A **Process** is an element within an Operation that performs a distinct transformation, transfer or store function on a product or service. For example:

- Production Drilling
- Crushing
- Grinding
- Power Distribution.

**Productive Units** are elements within a Process that can make a separate contribution to the performance of the Process e.g. different loading/truck fleets within a mine, multiple crushing or grinding circuits within a mineral processing plant. They are the lowest level at which we set separate Performance Targets.

To arrive at the Value Driver Tree (VDT) of Company, Business Units and Operations, and construct a tree that identifies all of the elements at each of these levels.

As a guide to constructing a VDT;

- Start at the Outcome Node – the result.
- Each Branch is independent
- All Nodes in a branch must relate to the end Node of the branch
- A Driver that can be isolated to affecting a specific Node is placed under that Node.
- A driver that relates to several Nodes is placed at the same level as the highest related Node.
- A driver is not placed below the level at which it is controlled.

To arrive at the Value Stream Map (VSM) of Processes and Productive Units for an Operation, construct a flowsheet that identifies the transform, transfer and storage steps involved in the handling of products, services and waste streams within the Operation (e.g. ore, concentrate, reagents, steam, oxygen, tailings, fumes or effluent, etc.).

As a guide to constructing a VSM:

- Identify each significant storage point for product, services or waste,
- Insert the significant transform or transfer step between each storage point,
- Identify all branches from or to the significant transform, transfer or storage steps,
- Insert the transform or transfer steps within the branches, and
- Consider thoughtfully any area of the VSM where there are directly connected transform and/or transfer steps, i.e. no storage between these steps. If the connected transform/transfer steps;
  - do not exhibit significant independent variability in performance they should be combined into a single element. E.g. a loader feeding a conveyor belt – the conveyor does not exhibit independent variation in its throughput rate.
  - do exhibit significant independent variability in performance they should be kept as separate elements. E.g. a loader feeding a truck fleet – the loader and the truck fleet each exhibit independent variation in throughput rate.

AAOM Flowsheet

Where an ERP system is used to collect transactional data for activities and costs related to elements of the Business Structure, each element from the Business Structure shall be entered into the data hierarchies that need to reflect these relationships, e.g. Profit and Cost Centre structures, location and equipment structures.

SPT Flowsheet

In the ERP location/equipment structure the Operations, Processes and Productive Units providing materials or information to multiple elements of the Business Structure (e.g. power/water/air supply, mine dewatering system, etc.) should be included in a separate hierarchy to the point where they provide materials/information to multiple elements within a level of the location/equipment structure (i.e. product or service is shared across the elements). Thereafter, where they feed into only one element of the location/equipment structure, they should be incorporated within that element. For example; the main power supply to an Operation should be a separate element of the location/equipment structure to the level where a distribution board, switch and cable provides feeds to a Process within the Operation. The Distribution Board(s) within the Process, and all switches, cables and equipment that provide feed to the Productive Units within the process should be included in the hierarchy of the Process. Similarly the distribution boards, etc. within the Productive Unit should be included within its hierarchy.

If there are no significant sub divisions of a level in the Business Structure then the subordinate level may be skipped, or else the superior level may be replicated at the subordinate level.

**Time**

The Business Structure VDT and VSM shall be defined at the time of establishing a process.

Review and update of process VDT, VSM and Business Structure shall be completed each time a change to the process design is made.

**Resources**

Specification of Business Structure is the accountability of the role identified in the configured flowchart.

# ST.02 Define Business Structure Measures

## Context

The stakeholders in a business (shareholders, employees, community and government) collectively define the expectations that the business must meet in order for them to continue to support its operation. These expectations typically encompass safety, environmental, social and economic dimensions. At the overall business level, these expectations will be expressed in fairly broad terms that may not be easy to visualize as targets for specific areas within the business. However, in order to provide meaningful guidance for managers and transparent reporting of performance, the business expectations should be translated into specific performance targets for each area of the business.

Defining the Business Structure (ST.01), is a prerequisite for defining the detailed performance measures.

The number of possible measures that can be created for a process is limited only by the imagination of people. The more measures that we create the more difficult it becomes to differentiate between the important and the mundane. The Operating Model definition for the Key Performance Indicators for a process is the smallest set of measures that allow us to recognise that a process is not changing, and is not likely to change. These will be selected from set of Purpose and Theory measures for the process.

KPIs may include:

- Purpose (outputs) of the process Effectiveness, Efficiency and Sustainability.
- Theory behind the process - what makes reliable predictions about the output. These are typically;
    1. 'technical' theory for physical or chemical processes, etc.,
    2. strategy parameters such as utilisation, rate, quality, etc. and
    3. the inputs to the process.

Output KPIs indicate whether the process is delivering the Performance Targets required to meet the Business Expectations. Consequently, they (or a proxy for them) should be measured consistently. Output KPIs are a lagging measure, that is, we can only recognise that a change has occurred sometime after the event that caused the change. There are two situations where this can cause significant loss. Where there is a;

- long time lag between a change in process input or operation and the result becoming evident at the output e.g. the time lag between feed material going into a leach circuit and the gold output from the leach circuit, and
- a significant step in output in a very short time, e.g. in the blasting of ore.


AAOM Flowsheet


SPT Flowsheet

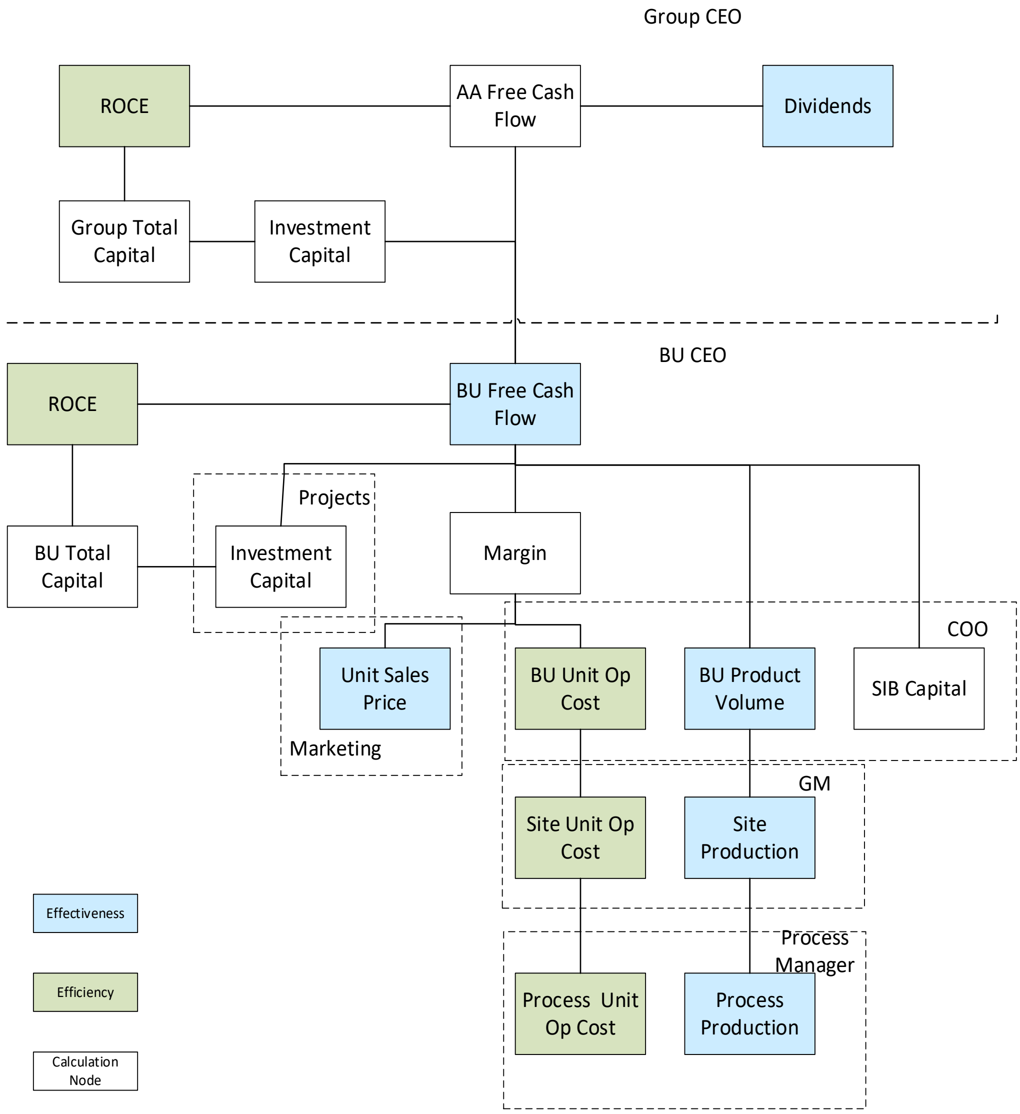
Obviously we would like to avoid or reduce these potential losses. This can be done by monitoring that the correct inputs, the technical theory of the process and the operating parameters (utilisation, rate, etc.) are being delivered. The technical theory is a recipe or formula that makes reliable predictions about the outcomes. For example;

- if we know that the feed, chemistry and residence time of the leach circuit are correct, then we can predict the gold that will be produced, and
- if we know that the drill pattern, charging and firing sequence of the blast are correct, then we can predict the blast outcomes.

In a process where there is a significant lag time, or a significant step in output, we should monitor the Theory and/or Input KPIs consistently.

The KPIs for a process should not be altered unless the Purpose and/or design (Theory) of the process are altered.

The KPIs will be different at different layers of the Business Structure, and hence the accountability for or ownership of the KPIs will depend on the level of the Business Structure – related to the level of work for a role. The Purpose KPIs of a lower level of the Business Structure will be inputs (Theory KPIs) to a higher level of the Business Structure.



The direct accountability of each role in an organisation is to monitor and respond correctly to the KPIs for that role, and to call to account those who are directly accountable for contributing measures. If a KPI indicates that a process is changing, or is likely to change, or a control action has been initiated to create a change in the KPI, then contributing measures from levels below in the Business Structure will be leading indicators of the change. When a role chooses to look at a contributing measure (lower level accountability) during the process of driving performance change, the measure is referred to in the Operating Model as a Control Measure. Once the required change is complete the monitoring of the measure by the higher level role should stop, and they should focus only on their direct KPIs and managing the direct reports accountable for their input measures.

A generic guideline to role accountabilities is:

1. Frontline Team Members (operators, tradesmen, etc.) are accountable for delivering the relevant Theory of the process. The Quantity, Quality and Time of tasks assigned to them.
2. Frontline Team Leaders are accountable for delivering the Schedule of work assigned to the team on time and to quality.
3. Programing Roles (Frontline Manager, Planner, Scheduler and Resource Coordinator) are accountable for setting up the approved Production and Service tactics for successful execution by the Frontline Team.
4. Department and Functional Heads are accountable for defining the Strategy Options and Tactics for implementing approved Strategies.
5. General Managers are accountable for optimising the Operation Value Stream performance, and approving Strategy choices that integrate across the value stream, in order to deliver the Business Expectations.

Having set Performance Targets and measures to a Productive Unit level, we can develop a Production Strategy and a Service Strategy for the Equipment/Workplaces within that Productive Unit.

Most processes will over their lives undergo many changes, additions and/or contractions. The Business Structure and related measures must be updated whenever such changes are made.

**Purpose**

To specify the Key Performance Indicators for a process.

AAOM Flowsheet

**Quantity**

- One purpose statement for each element of the Business Structure.
- One set of Purpose and Theory measures for each element of the Business Structure.
- For each measure:
    - One individual identified to be accountable (KPI Owner),
    - One set of specification limits, and
    - One specification for the expected shape of the distribution of performance.

SPT Flowsheet

## Quality

The KPIs for each level of the Business Structure, down to the Productive Unit level, shall be defined and measured in accordance with the following task assignments:

- TA WP.00 Measure Work Management Performance
- TA MP.00 Measure Process Performance
- TA SP.00 Measure Social Performance

In determining the KPI Owner for each measure, the following should be considered:

- What members of the workforce influence the measure most directly.
- The KPI Owner should be the manager of these workforce members.
- In the event the workforce members are in more than one accountability group, the cross-over manager of the groups should be the KPI Owner.

## Time

- The KPIs shall be defined at the time of establishing a process.
- Review and update of measures shall be made each time a change to the process design is made.
- The MSR shall be reset when the performance data, considered against the points in the Quality statement above, indicate that the 'Personal Best' of the process has changed.

## Resources

Specification of the Business Structure measures is the accountability of the role identified in the configured flow sheet.

Setting or resetting the MSR is the accountability of the KPI owners Manager Once Removed (MOR).

# ST.03 Obtain Historical Performance

## Context

The stakeholders in a business (shareholders, employees, community and government) collectively define the expectations that the business must meet in order for them to continue to support its operation. These expectations typically encompass safety, environmental, social and economic dimensions and translate into three distinct characteristic. These are;

- Effectiveness (units output per time period),
- Efficiency (a ratio between resources used and units of output)
- Sustainability (the material and social requirements for ongoing effectiveness).

The performance of a process over any period of time is not a single value, but rather it is a range of values with differing probabilities of occurrence (i.e. as can be represented in a capability histogram).

An essential input to the process of Setting Performance Targets is the historical performance of each element of the Business Structure. This historical performance can be used to calibrate a statistical model of the Business Structure performance. The calibration process will define the characteristics of the performance distributions for each element of the model, i.e. the range and shape of the performance histogram, as well establishing key input parameters for the model

There are four factors to be considered when gathering historical data for calibration of a performance model;

- Process stability - by definition, if a process is not stable then it is not performing in a consistent way. Consequently, modelling the performance of an unstable process generally produces unreliable results. Only stable periods of operation should be used to calibrate the model

- Operating level - the performance of a process will differ depending on the operating range within its performance/effort curve. Viz since process performance curves typically follow the law of diminishing returns, performance probability distributions tend to be different at the bottom and top of the performance curve - see figure 1 below. Hence the Business Structure Performance model should be calibrated using historical data appropriate to the targeted operating range.

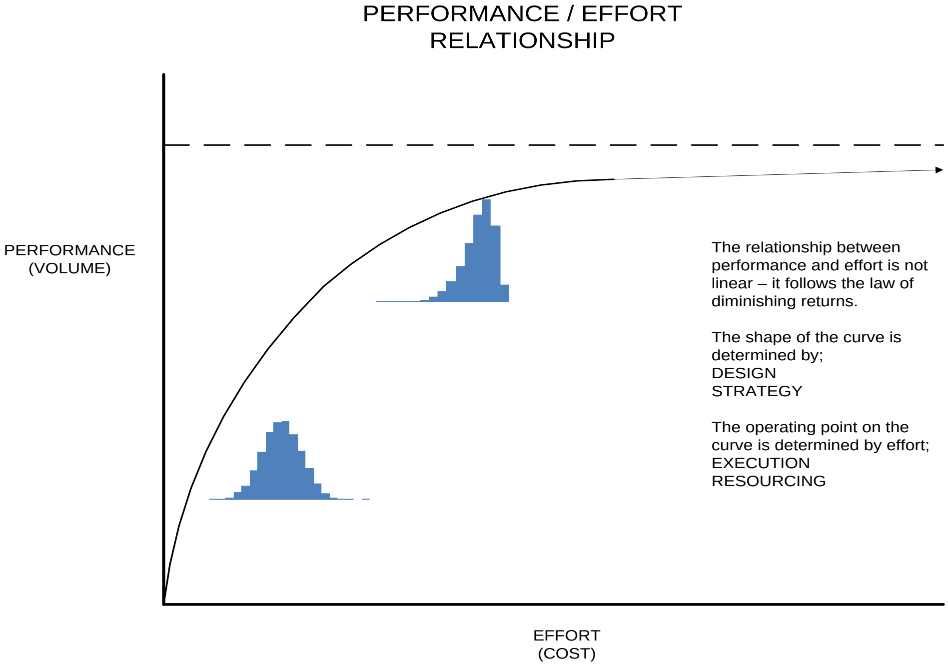

AAOM Flowsheet

- Sample size - the more data that is available to calibrate the model the better the calibration will be. Small data sets tend to under represent the range of variation that can be expected from the process, hence allowance will need to be made in the calibration process for the data set size.


SPT Flowsheet

- Data Independence - the data used for calibration of the model must include only the independent variation (i.e. arising wholly from causes within the element) of each element of the model. Raw measurements of the performance of an element in a connected series of elements will, unless there is significant storages that effectively isolate an element from its pre/proceeding elements, also contain dependent variation (i.e. arising from causes in the pre/proceeding elements). If the model is calibrated using data that contains dependent variation the model outputs will be unreliable. The Operating Model TA Quantify Common Causes of Variation provides a technique for isolating the dependent and independent components of variation.

Figure 1.






## Purpose

To obtain historical performance data that is representative of the performance of a Business Structure element.

## Quantity

- One set of historical data for stable, independent performance in a nominated operating range.

- One specification for the characteristics defining the distribution of historical, independent performance in a nominated operating range.

## Quality

The historical performance losses for which performance distributions are to be obtained may include;

- effectiveness (units output per time period),

- sustainability (the material and social requirements for continuing effectiveness),
- efficiency (the resources consumed per unit of output).

The historical data must, as far as possible;
- represent stable performance
- be conditioned to remove dependent variation. Note that when there is significant storage between elements of the business structure there may be little dependent variation in the data.

Historical performance distributions shall be defined for operating ranges across the performance/effort curve.

The size of the data set used to define the probability distribution shall be specified.

The probability distribution for a performance parameter shall, as a minimum, be defined by;
- the values of the minimum, maximum, mean and mode of the distribution,
- the 'shape factor' (i.e. spread of the distribution – e.g. standard deviation),

**Time**

The design performance shall be specified on the flowcharts at the time of establishing a process.

The historical performance distributions shall be updated whenever a significant process change is made.

**Resources**

Specification of Performance Targets is the accountability of the role identified in the configured flowchart.

AAOM Flowsheet

SPT Flowsheet

# ST.04 Calibrate Performance Model

## Context

The stakeholders in a business (shareholders, employees, community and government) collectively define the expectations that the business must meet in order for them to continue to support its operation. These expectations typically encompass safety, environmental, social and economic dimensions and translate into three distinct characteristic. These are;

- Effectiveness (units output per time period),
- Efficiency (a ratio between resources used and units of output)
- Sustainability (the material and social requirements for ongoing effectiveness).

The performance of a process over any period of time is not a single value, but rather it is a range of values with differing probabilities of occurrence (i.e. as can be represented in a capability histogram). In addition to the obvious constraints that exist when there are elements of the Business Structure that have capacity limitations, the variation that occurs in elements of the Business can interact to produce additional significant constraints to the throughput of the process. To effectively Set Performance Targets we need to be able to understand the constraints and opportunities within a process, and hence how the capacities and random variation within a process interact. This requires a statistical model of the process, i.e. the Business Structure.

A statistical model will only be helpful in understanding process performance and setting performance targets if it is calibrated so that it produces reliable forecasts of performance. This can be achieved by adjusting the model parameters so that when historical data is input to the model, the outputs of the model produce a match to the historical outputs.

The correct calibration of the model requires consideration of:

- The logic/mathematics of the model. This can change if the process design or operating (production and service) strategy is varied, and hence may require adjustment if either of these changes occur.
- The parameters that describe the probability distributions for the performance of each element of the model. The minimum, maximum, most likely and mean values, plus the shape factor of the distribution, may require adjustment to account for;
    - the degree of data randomness (independence),
    - a shift in process operating point on the performance/effort curve, and/or
    - the size of the historical data set.

- Non-statistical input parameters (e.g. maximum levels of stockpile or other physical parameters)

## Purpose

To calibrate the Business Structure Performance Model.

**Quantity**

- One set of model logic/mathematics.
- One specification of probability distribution characteristics for each model element.
- One set of input parameters to support process design

**Quality**

The characteristics that may require modelling of performance may include;

- effectiveness (units output per time period),
- sustainability (the material and social requirements for continuing effectiveness),
- efficiency (the resources consumed per unit of output).

The model logic/mathematics must correctly represent the process design and operating (production and service) strategy.

The historical data used for calibration must, as far as possible;

- represent stable performance i.e. random data,
- be conditioned to remove dependent variation between model elements. Note that when there is significant storage between elements of the Business Structure there may be little dependent variation in the data.

Different calibration parameters (performance distribution characteristics) may need to be defined for different operating ranges across the performance/effort curve.

Calibration of the model may require adjustment of the probability distribution parameters for elements of the model. The parameters most likely to require adjustment are;

- the values of the minimum and maximum of the distribution,
- the 'shape factor' (i.e. spread of the distribution).

**Time**

The calibration of a Business Structure Performance model shall be updated whenever a significant process change is made.

**Resources**

Specification of Performance Targets is the accountability of the role identified in the configured flowchart.

AAOM Flowsheet

SPT Flowsheet

# ST.05 Define Performance Targets

## Context

The stakeholders in a business (shareholders, employees, community and government) collectively define the expectations that the business must meet in order for them to continue to support its operation. These expectations typically encompass safety, environmental, social and economic dimensions and translate into three distinct characteristic. These are;

- Effectiveness (units output per time period),
- Efficiency (a ratio between resources used and units of output)
- Sustainability (the material and social requirements for ongoing effectiveness).

A business is typically comprised of a number of interconnected processes, each transforming, transferring or storing materials or information required to produce the outcomes expected of the business. Achieving the overall expectations will require the achievement of specific, and generally differing, expectations from each element of the business. The performance targets for a business therefore need to be broken down in a way that matches the way the business functions (its structure), and the spans and areas of management accountability. This can be achieved by defining the Effectiveness, Efficiency and Sustainability performance targets for each element of the Business Structure defined in TA ST.01.

The interaction of elements of the Business Structure, and the presence of independent and dependent variation, means that the performance must be represented as a distribution or specification. It also means that without using an appropriate statistical model we cannot confidently determine the targets (specifications and confidence level over a specified time horizon) for the elements of the business structure. In the Operating Model process of Setting Performance Targets we have defined the Business Structure, and developed a statistical model based on that structure. This model can be used to test and define the performance targets for each element of the Business Structure that will in combination deliver the Business expectations.

The Performance Targets for each element of the Business Structure are the set of specifications that, when entered into the Business Structure Performance Model, produce a forecast that matches the Business Expectations. The specification of Performance Targets should take into account the proven capability of each element of the Business Structure, and the reasonable expectations for adjustment of design, strategy, execution and resourcing that may be available.

To provide meaningful performance expectations a target value (specifications) and confidence level (the percentage of results that must meet the specifications) are required. The time period over which achievement of the target and confidence level are to be assessed must also be specified, as for a consistent set of specifications the confidence level may be different over different time intervals – e.g. the confidence level that the average of the values from rolling a dice will lie between 3 and 4 will increase with the number of rolls of the dice.

### Purpose

To define the performance targets that must be delivered by each Business Structure element, in order to meet the Business Expectations.

### Quantity

- One set of performance targets for each element of the Business Structure.

### Quality

- The objectives for overall business effectiveness, efficiency and sustainability expectations for any element of the Business Structure are defined by the requirements of the connected Business Structure elements.
- The performance targets for each element of the Business Structure, shall be the input specifications for the Business Process Performance Model that produce a forecast outcome that meets the Business Expectations.
- Performance targets may include;
  - Effectiveness (units output per time period),
  - Efficiency (a ratio between resources used and units of output)
  - Sustainability (the material and social requirements for ongoing effectiveness).
- A performance target may include a;
  - lower specification limit,
  - upper specification limit, and
  - target mean.
- Each performance target must include at least a lower or upper specification limit. If any of the other two specification values is significant in evaluating the performance of the process it shall also be defined in the target specification.
- The confidence level for each performance target shall be specified based on the area of the actual/forecast performance histogram (for the specified time interval) that is required to overlap with the area of the target specification. The confidence level indicates the probability that performance in a time period will meet specifications, and hence, definition of the confidence level will be guided by the expectations of the process 'customer', for example - if financial markets expect that company forecasts will meet guidance in 4 out 5 quarters, the confidence level required on targets will be 80%.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### Time

The Performance Targets shall be as required by the Analyse and Improve Process, and at each Business Planning Cycle.

### Resources

Specification of Performance Targets is the accountability of the role identified in the configured flowchart.

# ST.06 Are Performance Target Confidence Levels Met?

## Context

The overall purpose of the process of Setting Performance Targets is to define the confidence level of process meeting a set of business expectations. Achieving this requires that we compare the predicted performance of the process, under a specified set of conditions, with a set of performance targets derived from the Business Expectations. The predicted performance of a process is derived from the Operating Model processes of Setting Production and Service Strategies, Setting Operating Master Schedule, and Setting Expenditure Budget.

If the above Operating Model processes produce a set of strategies, schedule and expenditure budget that meet the Business Expectations then we have an approach that can be locked in for execution. If not, then we need to look for areas of the process performance where changes to strategy, schedule or resourcing/pricing may be able to allow Business Expectations to be met. That is, we need to identify the constraints in the current approach, and the opportunities that can move performance to match the Business Expectations.

A set of performance specifications can be either single or double sided. An example of a single sided specification is to produce at least 10,000 tonnes per week of prime concentrate. An example of a double sided specification is that prime concentrate will have a minimum of 15% and a maximum of 20% metal content. In some cases a further parameter, the target mean, is defined in order to further tighten the specification. For example, while all prime concentrate must fall within the above upper and lower specification limits, the target for the mean metal value is set to 17%. This will probably be a much more difficult target to meet.

If the performance histogram for a process, predicted by the Set Operating Master Schedule and Set Expenditure Budget elements of the Operating Model, overlaps the target specifications for a nominated time interval then at least some of the performance will meet the target. The owners, shareholders and stakeholders in the business would probably like to know what percentage of the total process outcomes will actually meet their expectations in that time period. A simple way to answer this question is to calculate the area of the performance histogram that overlaps the target specifications. This will highlight whether 100%, 80%, 40% or 0%, etc. of the performance will meet the specification. Where three parameter target specifications are given it may be necessary to use capability indices such as Cp and Cpk to indicate the degree to which the process performance can meet specifications.

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## Purpose

To decide whether the predicted performance meets the target and confidence level derived from the Business Expectations.

SPT Flowsheet

### Quantity

One decision whether the confidence level specified for a performance parameter is met by the predicted performance.

### Quality

- Performance target characteristics may include;
  - effectiveness (units output per time period),
  - sustainability (the material and social requirements for continuing effectiveness),
  - efficiency (the resources consumed per unit of output).
- A performance target may include the;
  - lower specification limit,
  - upper specification limit, and
  - target mean.
- Each target must include at least a lower or upper specification limit. If any of the other two specification values is significant in evaluating the performance of the asset it shall also be specified in the target.
- **For all performance targets except integrity** –
  Performance forecasts for an asset shall be developed and presented as a histogram of the predicted performance distribution with the;
  - upper control limit,
  - lower control limit,
  - mean, and
  - target specifications,

  identified on the histogram.
- The confidence level for each performance target shall be calculated as the area of the predicted performance histogram that overlaps with the area of the target specification. If a target mean value has been specified the ratio of the predicted performance mean and target mean shall also be given.
- **For integrity performance targets** –
  Performance forecasts shall be developed and presented as two histograms, one of the distribution of HSE threat rating values and the other of the distribution of Business threat rating values.
- The confidence level shall be calculated from the percentage of potential threats that have a forecast threat rating below the target upper specification limit.
- The confidence level for all performance targets shall be supported with;
  - a specification of the opportunities and threats that could significantly affect the outcome, and
  - the control actions that will be implemented to reduce threats and deliver opportunities.

### Time

The Performance Target confidence levels shall be determined at each Business Planning Cycle.

## Resources

Specification of Performance Targets is the accountability of the role identified in the configured flowchart.

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## ST.07 Have Options been Exhausted?

### Context

The overall purpose of the process of Setting Performance Targets is to define the confidence level of process meeting a set of business expectations. Achieving this requires that we compare the predicted performance of the process, under a specified set of conditions, with a set of performance targets derived from the Business Expectations. The predicted performance of a process is derived from the Operating Model processes of Setting Production and Service Strategies, Setting Operating Master Schedule, and Setting Expenditure Budget.

If the above Operating Model processes produce a set of strategies, schedule and expenditure budget that meet the Business Expectations then we have an approach that can be locked in for execution. If not, then we need to look for areas of the process performance where changes to strategy, schedule or resourcing/pricing may be able to allow Business Expectations to be met. That is, we need to identify the constraints in the current approach, and the opportunities that can move performance to match the Business Expectations.

During the process of Setting Performance Targets the historical performance and the estimated influence of projected changes to the Production and Service Strategies and Master Operating Schedule are fed into the appropriate performance model(s) to predict the range and shape of the predicted performance outcomes.

If the predicted performance does not meet the performance target confidence levels derived from the Business Expectations then we must decide whether;

- there are potential changes that can be made to the Production and Service Strategies, or
- there are potential adjustments that can be made to the Operating Master Schedule, or
- the performance targets must be reset, and/or
- changes to the basic process design must be considered if the performance targets are to be met.

The Production and Service Strategies underlying the modelling for predicted performance will include both historical strategies and changes proposed from application of the Analyse and Improve process to effectiveness, sustainability and efficiency outcomes. If this combination of Strategies does not produce the required performance then there are likely to be alternatives to the historical strategies that have been made practical by improved; technology, strategy specifications, or operating and maintenance practices since the historical Strategy was adopted. Alternately, there may be strategy options that can be implemented at a higher cost but still meet the performance targets.

The Operating Master Schedule is built around the Production and Service Strategies and the trigger parameters and tolerances defined for them. Options to optimise the Schedule around the trigger tolerance and synergies between work packages will have been reflected in the Schedule. There may be alternate schedule options that can meet the Strategy tolerances and also deliver better performance outcomes.

If the performance predicted for a set of Production and Service Strategies and a Master Operating Schedule do not meet the performance targets the first step is to identify whether all practical Production and Service Strategy and Schedule options have been tested.

Large numbers of changes to Production and Production and Service Strategies generally cannot be implemented quickly without high risk of unforeseen consequences. Therefore, in considering the options available to improve the confidence of achieving performance targets it is best to focus on a few, high potential areas. The Pareto principle suggests that 20% of the Strategy and Schedule elements will deliver 80% of the impact on performance.

**Purpose**

To decide whether there are other practical Production and Service Strategy and Master Operating Schedule options that may meet the performance targets.

**Quantity**

- One decision whether further practical Production and Service Strategy and Master Operating Schedule options are available.

**Quality**

In deciding if alternative Strategy or Schedule options are likely to be identified consider:

- The size of the gap between the required and predicted performance.
- The Pareto ranking of the performance losses resulting from the Production and Service Strategies.
- The Pareto ranking of the performance losses resulting from the Master Operating Schedule.
- The interval since there has been a rigorous review of Production and Service Strategies.
- The probability that technology, strategy specifications, or operating and maintenance practices have changed since the historical Strategy was adopted
- The number of iterations/options for the Master Operating Schedule that have been examined.

**Time**

Options shall be reviewed as required by the Analyse and Improve Process, and at each Business Planning Cycle.

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## Resources

Specification of Performance Targets is the accountability of the role identified in the configured flowchart.

# ST.08 Develop Scenarios

## Context

The overall purpose of the process of Setting Performance Targets is to define the confidence level of process meeting a set of business expectations. Achieving this requires that we compare the predicted performance of the process, under a specified set of conditions, with a set of performance targets derived from the Business Expectations. The predicted performance of a process is derived from the Operating Model processes of Setting Production and Service Strategies, Setting Operating Master Schedule, and Setting Expenditure Budget.

If the above Operating Model processes produce a set of strategies, schedule and expenditure budget that meet the Business Expectations then we have an approach that can be locked in for execution. If not, then we need to look for areas of the process performance where changes to strategy, schedule or resourcing/pricing may be able to allow Business Expectations to be met. That is, we need to identify the constraints in the current approach, and the opportunities that can move performance to match the Business Expectations.

Constraints and opportunities to process performance fall into two distinct categories. The first category is the one that is most commonly recognised, limits in the capacity of one or more of the Business Structure elements – i.e. bottlenecks. The second category of constraint is less commonly recognised, it is high variation in dependent processes, which just as effectively as a single bottleneck, restricts process performance. Every constraint represents a potential opportunity to deliver improved process performance. Constraints and opportunities can be identified by looking in detail into the performance model of a process.

The first types of constraint that should be identified and dealt with are those related to un-buffered high variation. Reducing the effects this variation typically yields several times the output benefit of trying to shift the process operating point without reducing the variation. When variation has been adequately dealt, with the capacity constraints in the process should be dealt with.

The potential process constraints can be identified by examining the probability distributions defined for each element of the calibrated Business Structure Performance Model. The width of the distribution will be an indication of where excessive variation may be a constraint. The skewness of a distribution, and the value of its end points, will be an indication of where capacity may be a constraint - a skewed distribution is typically associated with the increasing non-linearity that occurs towards the top of the performance/effort curve for a process.

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The actual process constraints can be defined by developing modelling scenarios where the potential constraints are systematically reduced – i.e. either the range of variation is reduced, storage is increased to buffer variation, or the distribution is shifted. The outcome of testing of these scenarios in the Business Structure Performance Model will allow constraints to be validated,

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and the opportunity to move the process performance towards the required targets quantified.

A scenario will be a set of altered, but realistic, operating parameters (either reductions in variation, shifts in operating points, or both) that reflect the potential process performance when a set of constraints have been relaxed. These scenarios can be tested via the Business Structure Performance model to determine if they are likely to move the process performance to the targets necessary to meet Business Expectations.

If testing of a scenario appears indicates that it is likely to be able to achieve the performance target confidence levels it needs to be further investigated through the Set production and Service Strategy, Set Operating Master Schedule and Set Expenditure Budget elements of the Operating Model.

**Purpose**

To specify operating scenarios that are likely to deliver the performance targets for a process.

**Quantity**

- One set of operating parameters to be tested via the Business Structure performance model.

**Quality**

- Scenarios dealing with excessive variation should typically be dealt with before scenarios related to capacity changes.
- Scenarios for reducing the impact of variation include reducing the variation itself and buffering the variation via storage.
- Scenarios may developed for changes to;
    - effectiveness (units output per time period),
    - sustainability (the material and social requirements for continuing effectiveness),
    - efficiency (the resources consumed per unit of output).
- The development and testing of scenarios to validate and quantify opportunities should be conducted in a systematic way. The objective should be to define the simplest of scenarios that can produce a significant shift towards the required performance targets.

**Time**

Scenarios shall be specified as required by the Analyse and Improve Process, and at each forecasting (budgeting) cycle.

**Resources**

Specification of Performance Targets is the accountability of the role identified in the configured flowchart.

# ST.09 Define Constraints and Opportunities

## Context

The overall purpose of the process of Setting Performance Targets is to define the confidence level of process meeting a set of business expectations. Achieving this requires that we compare the predicted performance of the process, under a specified set of conditions, with a set of performance targets derived from the Business Expectations. The predicted performance of a process is derived from the Operating Model processes of Setting Production and Service Strategies, Setting Operating Master Schedule, and Setting Expenditure Budget.

If the above Operating Model processes produce a set of strategies, schedule and expenditure budget that meet the Business Expectations then we have an approach that can be locked in for execution. If not, then we need to look for areas of the process performance where changes to strategy, schedule or resourcing/pricing may be able to allow Business Expectations to be met. That is, we need to identify the constraints in the current approach, and the opportunities that can move performance to match the Business Expectations.

Constraints and opportunities to process performance fall into two distinct categories. The first category is the one that is most commonly recognised, limits in the capacity of one or more of the Business Structure elements – i.e. bottlenecks. The second category of constraint is less commonly recognised, it is high variation in dependent processes, which just as effectively as a single bottleneck, restricts process performance. Every constraint represents a potential opportunity to deliver improved process performance. Constraints and opportunities can be identified by looking in detail into the performance model of a process.

The first types of constraint that should be identified and dealt with are those related to un-buffered high variation. Reducing the effects this variation typically yields several times the output benefit of trying to shift the process operating point without reducing the variation. When variation has been adequately dealt with, the capacity constraints in the process should be dealt with.

The potential process constraints can be identified by examining the probability distributions defined for each element of the calibrated Business Structure Performance Model. The width of the distribution will be an indication of where excessive variation may be a constraint. The skewness of a distribution, and the value of its end points, will be an indication of where capacity may be a constraint - a skewed distribution is typically associated with the increasing non-linearity that occurs towards the top of the performance/effort curve for a process.

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The actual process constraints can be defined by developing modelling scenarios where the potential constraints are systematically reduced – i.e. either the range of variation is reduced, storage is increased to buffer variation, or the distribution is shifted. The outcome of testing of these scenarios in the Business Structure Performance Model will allow constraints to be validated,

SPT Flowsheet

and the opportunity to move the process performance towards the required targets quantified.

The most promising opportunities coming out of this analysis can be examined to identify production or service strategy changes, operating master schedule changes, or resourcing changes that will deliver the opportunity.

**Purpose**

To define the opportunities most likely to shift a process towards its required performance targets.

**Quantity**

- One set of constraints and opportunities.

**Quality**

- Opportunities arising from excessive variation should typically be dealt with before opportunities related to capacity constraints.
- Opportunities to reduce the impact of variation include reducing the variation itself and buffering the variation via storage.
- Opportunities may relate to;
    - effectiveness (units output per time period),
    - sustainability (the material and social requirements for continuing effectiveness),
    - efficiency (the resources consumed per unit of output).
- The development and testing of scenarios to validate and quantify opportunities should be conducted in a systematic way. The objective should be to define the simplest of scenarios that can produce a significant shift towards the required performance targets.

**Time**

Constraints and opportunities shall be specified as required by the Analyse and Improve Process, and at each Business Planning Cycle.

**Resources**

Specification of Performance Targets is the accountability of the role identified in the configured flowchart.

# ST.10 Lock-In Targets, Strategies & Forecasting Schedules

### Context

When both the effectiveness, sustainability and efficiency outcomes predicted by the statistical models for an element of the Business Structure meet the Business Expectations, we have specified Production and Service Strategies, an Operating Master Schedule and Expenditure Schedule that can meet performance targets at an acceptable confidence level.

These should then be locked in for execution.

### Purpose

To define the approved operating regime for a process.

### Quantity

- One secure record of the approved Production and Service Strategies, Operating Master Schedule and Expenditure Schedule.

### Quality

The approved Production and Service Strategies, Operating Master Schedule and Expenditure Schedule shall be stored in a secure database and shall be protected against change.

### Time

The approved operating regime shall be locked in at each Business Planning Cycle.

### Resources

Specification of Performance Targets is the accountability of the role identified in the configured flowchart.

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AngloAmerican

Real Mining. Real People. Real Difference.

OPERATIONAL PLANNING:

# BUILDING A BUSINESS STRUCTURE PERFORMANCE (BSP) MODEL

## USER MANUAL

**Updated: June 2017**


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## CONTEXT

The Operating Model is our structured approach for how we set targets, plan, execute and improve our work. It is built around the theory that if the work is planned, scheduled and properly resourced ahead of execution, the desired outcome will be achieved more consistently and at a lower cost. The Operating Model consists of three main focus areas:

1) Operational Planning – ensures that we set out strategies and set targets to deliver the Business Expectations.
2) Work Management – enables us to plan, manage and execute work efficiently.
3) Feedback and Monitoring – to continually improve and sustain the business.

The basic principles of the Operating Model is to produce stability, reduce variation and provide clarity.

Business Improvement is responsible for the roll out of the Operating Model. Mark Cutifani introduced the Operating Model and has made it part of our strategy to allow us to reliably deliver on our Business Expectations. The Operating model has played an integral part and has contributed tremendously in the turnaround of Anglo American, in terms of decreasing our net debt and increasing our EBITDA, by getting the basics right and operating our assets to their full potential. The Operating model will continue to contribute to Anglo American the further we commence with the roll out and the more operations that have the Operating Model implemented.

Within the Anglo American Operating Model, the Operational Planning component is designed to determine the most cost effective way to operate the process. This is achieved by establishing a data-driven management tool to make the informed decisions and developing the Production and Service strategies required to execute them.

Two critical models are stipulated in the Operational Planning theory, which enable the management process to be implemented. The first is the Business Structure Performance (BSP) model and the second is the Operating Master Schedule (OMS) with and integrated expenditure schedule (EPS). The BSP model is the logical first step in the Operational Planning process and should be developed first.

While the BSP model alone, will not deliver the purpose of Operational Planning, it serves to identify constraints and opportunities in the system. As such, it is a tool that can evaluate the system benefit of proposed initiatives and highlight potential value opportunities. Trade-offs between throughput and cost can also be evaluated in such models.

This user manual is a detailed guide on how to develop a generic BSP model of Anglo American operations, how to use the model effectively and the benefits that the model provides.

## PURPOSE

To illustrate how to develop a generic calibrated Business Structure Performance model for an operation. How to effectively use it, as well as, the value that it adds.

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## ABBREVIATIONS

| | |
|---|---|
| BSP | Business Structure Performance |
| QPR | Quarterly Performance Review |
| GM | General Manager |
| MTP | Medium Term Planning |
| UCL | Upper Control Limit |
| LCL | Lower Control Limit |
| EPS | Expenditure Schedule |
| OMS | Operating Master Schedule |
| BU | Business Unit |
| LOM | Life of Mine |
| RDP | Regional Development Plan |
| OMS | Operating Master Schedule |
| EPS | Expenditure Schedule |

# 1 INTRODUCTION

It is important to first have a comprehensive understanding of the BSP model, i.e. how it works and how it is developed, and what value it adds to the operation before looking at building the model. Being able to construct an effective model can create for a powerful cost saving and productivity boosting platform.

The BSP model is capable of testing and validating A&I initiatives – an extremely powerful capability to have at one’s disposal. Before implementing any initiatives, both expensive and inexpensive initiatives, the BSP model can be used to identify whether or not it is a good idea to implement a recommended initiative, in terms of both productivity enhancement and cost of implementing initiative. The BSP model can provide comprehensive evidence and proof that an initiative will be beneficial, and that further investigation into the initiative should be done, or that the initiative will add no benefit, and no additional time or effort should be focused further on this initiative.

The BSP model serves as a tool to identify constraints and opportunities in the system. Constraints and opportunities to process performance fall into two distinct categories. The first category is the one that is most commonly recognised, limits in the capacity of one or more of the Business Structure elements - i.e. bottlenecks. The second category of constraint is less commonly recognised, it is high variation in dependent processes, which just as effectively as a single bottleneck, restricts process performance. Every constraint represents a potential opportunity to deliver improved process performance. Constraints and opportunities can be identified by looking in detail into the performance model of a process.

The first types of constraints that should be identified and dealt with are those related to insufficiently buffered high variation. Reducing the effects of this variation typically yields several times the output benefit of trying to shift the process operating point without reducing the variation. When variation has been adequately dealt with, the capacity constraints in the process should be dealt with.

The potential process constraints can be identified by examining the probability distributions defined for each element of the calibrated Business Structure Performance Model. The width of the distribution will be an indication of where excessive variation may be a constraint. The skewness of a distribution, and the value of its end points, will be an indication of where capacity may be a constraint - a skewed distribution is typically associated with the increasing non-linearity that occurs towards the top of the performance/effort curve for a process.

The actual process constraints can be defined by developing modelling scenarios where the potential constraints are systematically reduced - i.e. either the range of variation is reduced, storage is increased to buffer variation, or the distribution is shifted. The outcome of testing of these scenarios in the Business Structure Performance Model will allow constraints to be validated, and the opportunity to move the process performance towards the required targets quantified.

A scenario will be a set of altered, but realistic operating parameters (either reductions in variation, shifts in operating points, or both) that reflect the potential process performance when a set of constraints have been relaxed. These scenarios can be tested via the Business

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Structure Performance model to determine if they are likely to move the process performance to the targets necessary to meet Business Expectations.

If testing of a scenario indicates that it is likely to be able to achieve the performance target confidence Levels it needs to be further investigated.

## 2 VALUE OF BSP MODELLING

The BSP model has great capability and can add great value to an operation. The benefits and value attributing factors of the BSP model are discussed in detail below:

### 2.1 Analyse and Improve

The BSP model allows the user to quickly and effectively identify the constraints within the entire value chain of the operation. By overlapping all the processes, normalised to a common unit, contained in the value chain with each other, the user is able to identify the constraining process in the system, as the process that is positioned furthest to the left on the overlapping Histogram graph has the least capability of all the processes, and is constraining all other processes from reaching their full performance potential, as depicted in Figure 1 below. The constraining process is referred to as the bottleneck and becomes the focus area.

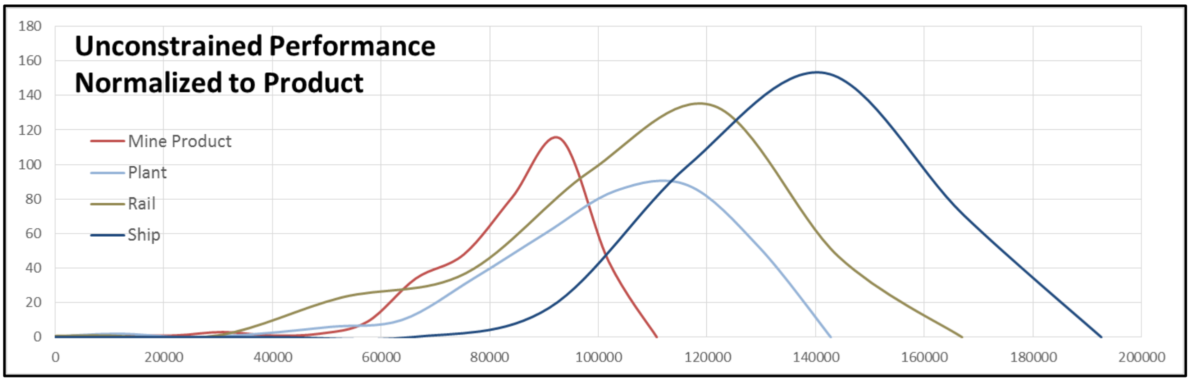


**Figure 1 - Normalised Unconstrained Overlaying Histogram (Mine is the constraint)**

Once the bottleneck has been identified and analysed, it is time to shift and improve the bottleneck. This will increase the production capability of the operation. The user must now test initiatives and scenarios through the model that he/she believes will shift the constraint. An initiative that the user wants to test through the model is known as the ‘TO-BE’ state, and the original state is known as the ‘AS-IS’ state. Once the user has tested the initiative through the model, he/she can the overlap the ‘AS-IS’ state with the ‘TO-BE’ state and determine the impact that the initiative has had, as depicted in Figure 2 on the following page. The user can then re-look at the overlapping Histogram graph, depicted in Figure 1 above, and take note of how the constraining process has shifted in terms of capability. It may still be the same process that is the constraining process or it may now be another process, never the less, the Analyse and Improve process is repeated again and again to ensure continuous improvement.

Once an initiative has been tested through the model, the user needs to make the decision and investigate further whether or not to implement the initiative. A tradeoff between productivity benefit and cost to implement initiative needs to be done by the user.

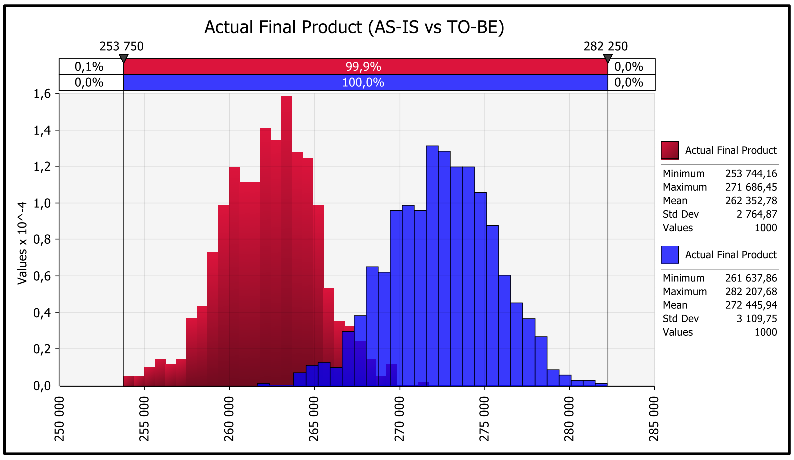


**Figure 2 - AS IS vs TO BE output (impact of initiative)**

## 2.2 Provides a platform for decision making

The BSP model can be used to evaluate the whole-system for critical decision making. The BSP model considers both upstream and downstream processes in the value chain allowing monitoring of not only the process outcomes but “final product” as well. It allows to view and understand up-stream and downstream consequences of strategies

The BSP models performance of systems and processes with dependant variation and buffering. Variability is inherent to any process, and taking into consideration the variability within processes and how it can impact immediate processes and inventories is essential to understand final outputs in the value chain.

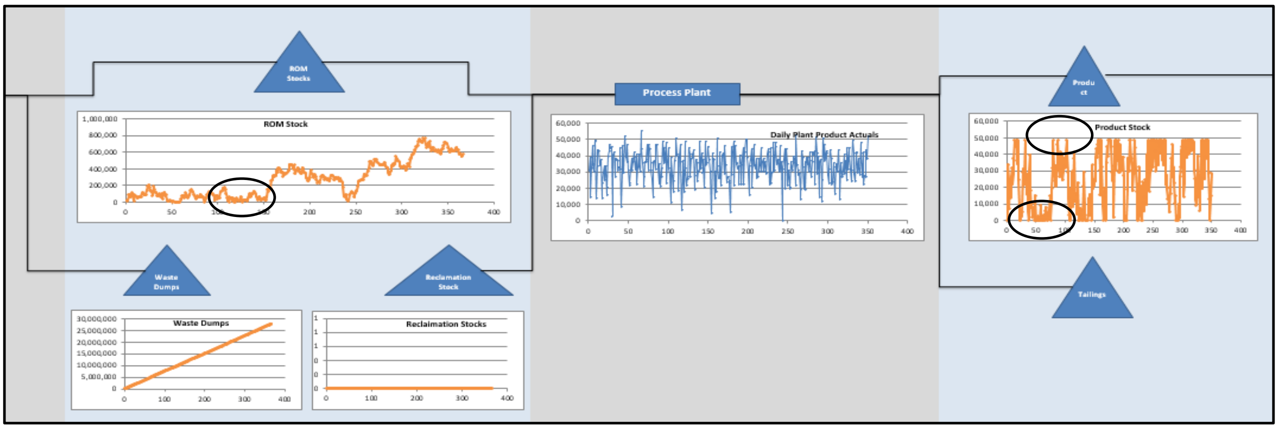


**Figure 3 - Variability within processes**

The BSP model is a dynamic model using probabilistic distributions for input variables. The stochastic (working with distributions) BSP model, rather than deterministic (working with averages), provides a better representation of real processes. It allows for a better understanding of outputs which are also represented by probabilistic output distributions. Using a dynamic model allows for easy consideration of input distribution as well as the correlation between variables and/or events.

The BSP model takes into consideration the interdependencies and variability differences among each process in the value stream to produce the overall probabilistic output curve of

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tonnes of product. See Figure 2. The BSP model has the capability of running many iterations allowing for a more realistic and accurate representation of what the operation is capable of doing, hence, allowing the operation to determine the most likely outcome of all its processes and final outputs. The BSP model can thus be used as a tool to aid in setting realistic targets and budgets at the start of the production year.

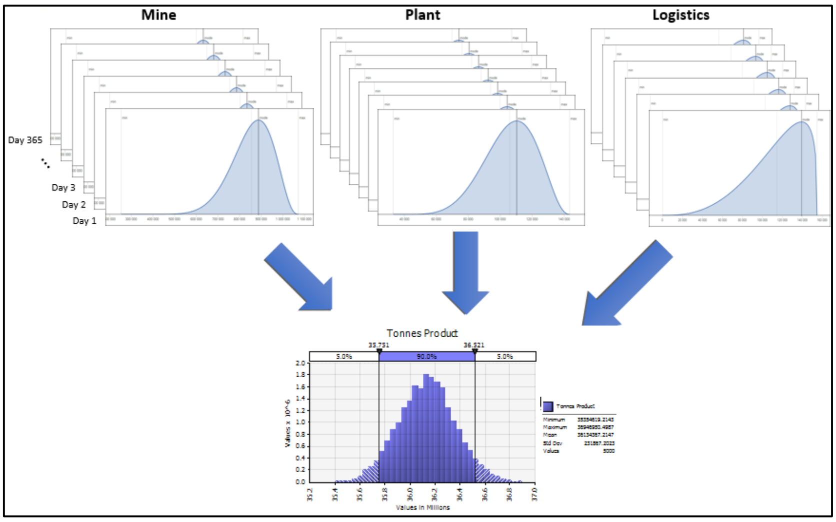


**Figure 4 - Example of Probabilistic Curve Output**

## 2.3 Allows for reviewing and defining confidence of meeting targets

The BSP model reinforces Quarterly Performance Review (QPR) forecasts. The model can be integrated with reporting to understand confidence of meeting targets, i.e. the model can be used to measure performance against targets.

The model separates variation and risk elements of performance (common and special causes). Understanding and modelling different classes of risk events and the variability within these allow for better estimate of confidence intervals and hypothesis tests in regards to forecast outputs. In other words, it will allow us to calculate confidence levels and set optimal, but realistic targets.

The model allows the user to foresee future constraints and opportunities. The BSP model allows us to focus on the “predominant” bottleneck and understand the impact of solving these. Understand how far apart the constraining processes are.

The BSP model allows the user to identify and investigate instable and constraining processes, and to define strategies to mitigate the instability and constraint through inventory management and priority allocation etc.

## 2.4 Allows for quick and efficient scenario evaluation

The BSP model provides consistent statistical evaluation of operating strategies. The model is a sound, user-friendly tool that utilises proven statistical concepts. The BSP model is Microsoft Excel based and available to a wide range of final users.

The BSP model can be used to evaluate production and cost scenarios for multiple operating environments. The BSP model can assist in understanding trade-offs between strategies targeting volumes and/or cost by providing clear visibility of “premiums”. Evaluating potential gains on an unconstrained process does not necessarily materialise on final system output. Furthermore, the BSP model can be used to identify opportunities not yet identified.

The BSP model supports budget process by leveraging special cause analysis. The model allows for a concise understanding of special cause impact on individual processes and on final system output. Depending on buffer/inventory levels, the impact of special causes on a particular process can have different levels of impact on final outcome, for example, one zero day of material movement, due to rain, could possibly have no impact on crusher feed (depending on ROM pad inventory level). Similarly, seven consecutive zero days due to rain, could have a totally different outcome. The BSP models allows the user to model for specific special cause events.

## 2.5 Prioritisation of initiatives

The BSP model provides a consistent set of tools for evaluating production and service strategy scenarios.

It supports the prioritisation of technical (business improvements) initiatives (constraints and opportunities).

- Trade-off throughput, cost, recovery and product quality
- Review current and future constraints and opportunities

It supports the prioritisation of resources.

- Allocate scarce resources on the constrained process

It supports the identification of operating processes to be targeted for cost reduction.

- Identify areas with surplus capacity
- Configure master and servant processes

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## 3 OBTAINING HISTORICAL PERFORMANCE DATA

An essential input to the process targets is the historical performance of each element of the Business Structure. This historical performance is used to create realistic statistical distributions to be inputted into the BSP model. The historical performance data is a key aspect used to calibrate a statistical BSP model. It is, therefore, essential to obtain at least the previous year's historical data, however, preferably, the previous three year's historical data. The more historical data available to work with the more representative the distribution parameters will be of how the operation really operates. Without authentic and reliable historical data, the less reliable and realistic the model outputs will be. It is, therefore, of utmost importance to ensure the historical data collection process is done soundly and correctly. The historical data needs to be obtained from the operation/asset itself for which the BSP model is being built. It is advised the person responsible for building the BSP model and the person supplying the historical data work closely together and develop this aspect of the model as a collected effort.

The historical data that is required to build a BSP model depends on the site and the processes contained in the value chain of the operation. For each operation the historical data required to develop a BSP model of the operation may be different.

Examples of usual historical data that should be looked at are as follows:

**Table 1 - Examples of historical data that may be required**

| | |
|---|---|
| Strip Ratio | Mass splits (total movement - % waste to % ore) |
| Splits in parallel streams (capacity – 2 crusher vs 1) | Grade & Concentrate |
| Working hours (calendar hours, availability, utilisation) | Working hours (calendar hours, availability, utilisation) |
| Stockpile capacities (starting levels and maximum capacities | Fleet capability (drilling, load & haul) |
| Composition of fleet (waste only fleet vs ore only fleet vs single fleet for multiple products) | Crusher Output |
| Waste mined (tonnes/day) | Total tonnes moved (tonnes/day) |
| Ore mined (tonnes/day) | Crusher (tonnes/day or hours) |
| Plant data | Direct Operating Hours (DOH) |
| DOH allocation per month | Hours allocated to waste moved per month |
| Distance to move waste per month | Hours allocated to ore moved per month |
| Distance to move ore per month per pit | |

# 4 SOFTWARE USED TO BUILD BSP

## 4.1 Microsoft Excel

Microsoft Excel is software used to calculate financial, statistical and engineering information that people are most familiar with. It is an extremely user friendly program, and together with @Risk it can be used to perform all necessary calculations and tasks to successfully build the required BSP models. Excel is one of the most popularly used electronic spreadsheet programs worldwide, thus, making it the ideal software to use when dealing with developing Anglo American BSP models for operations situated all over the world.

## 4.2 @Risk

@RISK (pronounced “at risk”) performs risk analysis using Monte Carlo simulation to show you many possible outcomes in your spreadsheet model—and tells you how likely they are to occur. It mathematically and objectively computes and tracks many different possible future scenarios, then tells you the probabilities and risks associated with each different one. This means you can judge which risks to take and which ones to avoid, allowing for the best decision making under uncertainty. @Risk is an ad in of Microsoft Excel and is very easy to use, as it maintains the excel format.

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# 5 MODELLING AND STATISTICAL TECHNIQUES

Monte Carlo simulation is a computerised mathematical technique that allows people to account for risk in quantitative analysis and decision making. Monte Carlo simulation furnishes the decision-maker with a range of possible outcomes and the probabilities that they will occur for any choice of action. It shows the extreme possibilities—the outcomes of going for broke and for the most conservative decision—along with all possible consequences for middle-of-the-road decisions.

Monte Carlo simulation performs risk analysis by building models of possible results by substituting a range of values—a probability distribution—for any factor that has inherent uncertainty. It then calculates results over and over, each time using a different set of random values from the probability functions.

The @Risk software allows the user to build a Monte Carlo simulation model in Excel.

By using probability distributions, variables can have different probabilities of different outcomes occurring. Probability distributions are a much more realistic way of describing uncertainty in variables of a risk analysis. @Risk has the capability of determining which distribution, as well as, the associated parameters should be used or best suited according to the historical data that requires a distribution to be fitted over it. There are a range of distributions in @Risk – the user must either fit a distribution, using @Risk, over the historical data that the user is looking at (most accurate), or the user must use his/her discretion in selecting an appropriate distribution according to the historical data (could be slightly inaccurate or non-representative), or if the user still needs to become familiar with distribution selections then the recommended distribution to use in the meantime is a PERT distribution.

- PERT- The user defines the minimum, most likely, and maximum values, just like the triangular distribution. Values around the most likely are more likely to occur. However values between the most likely and extremes are more likely to occur than the triangular; that is, the extremes are not as emphasised. An example of the use of a PERT distribution is to describe the duration of a task in a project management model.

During a Monte Carlo simulation, values are sampled at random from the input probability distributions. Each set of samples is called an iteration, and the resulting outcome from that sample is recorded. Monte Carlo simulation does this hundreds or thousands of times, and the result is a probability distribution of possible outcomes. In this way, Monte Carlo simulation provides a much more comprehensive view of what may happen. It tells you not only what could happen, but how likely it is to happen.

# 6 DEVELOPING THE BSP MODEL

There are several steps that are essential in developing an effective, efficient and reliable BSP model for any operation. It is recommend to follow the order of steps chronologically to develop the BSP model contained in this section. The reason for this is for convenience purposes and to ensure that all necessary steps and aspects are contained in the BSP model. After having built several BSP models for different operations the conclusion is that the most successful BSP models have been those that were developed in the order depicted in this section, however, this is only a recommendation and if the developer feels more comfortable doing it at his/her own discretion this is also acceptable, as long as, all the steps are built into the BSP model.

## 6.1 Developing the Business Structure

In order to develop the model through which to evaluate constraints and opportunities across the Group and for it to provide the value that it's capable of, it is essential to first create an appropriate Business Structure of the operation. The Business Structure represents the basis and the starting point of the BSP model. Preferably the Business Structure should be developed together with a person on site to ensure that the most up to date and most accurate Business Structure is developed. Otherwise, if this is not possible, the developer should at least get the operation to sign off the Business Structure to ensure that the site complies with the Business Structure that the developer is going to model.

The Business Structure should contain all the processes of the operation, however, it is up to the developer to decide on how much detail he/she wants to include in the BSP model. Often the BSP model's purpose can be achieved by not including all the finer details, which can save the developer a lot of time. The developer must use his/her discretion, together with the operation, to decide the level of detail of the BSP model. The developer must consider the trade-off between:

The more detail that is included in the Business Structure, the more accurate your BSP model's outputs will be, however, the more complicated and time consuming the development of the BSP model will become, and it may not be necessary to go into such detail. The developer needs to decide what processes are required to achieve the purpose of the BSP model, while maintaining it as simple as possible.

A process is defined as any step within the value chain of the operation where the material is either transformed, transferred or stored. Hence, it is recommended to use the objects depicted in Figure 5 below to develop the Business Structure.

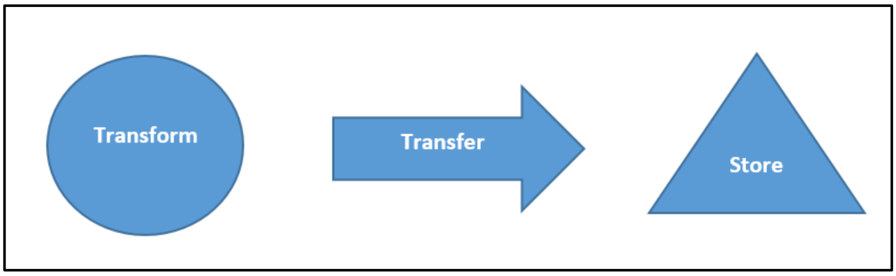


**Figure 5 – Recommended objects to use to develop the Business Structure**

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The function of the objects depicted in Figure 5 are as follows:

- **Transform process** - to change the specification/composition of the product. It is represented by a circular object. 'Break rock', 'break ore' and 'crush ROM' are all examples of Transform processes.
- **Transfer process** - to change the location of a product, i.e. move the product to a different location. It is represented by an arrow. 'Move Ore', 'Move Waste', 'Pipeline' are all examples of transfer processes.
- **Store process** – to create a buffer between 'transform' processes. It is represented by a triangular object. 'ROM stockpile', 'Crushed ROM stockpile', 'Final Product stockpile' are all examples of store processes.

Once the appropriate Business Structure of the operation has been established and has been approved/signed off by site, the developer can then move onto the modelling phase of the Business Structure.

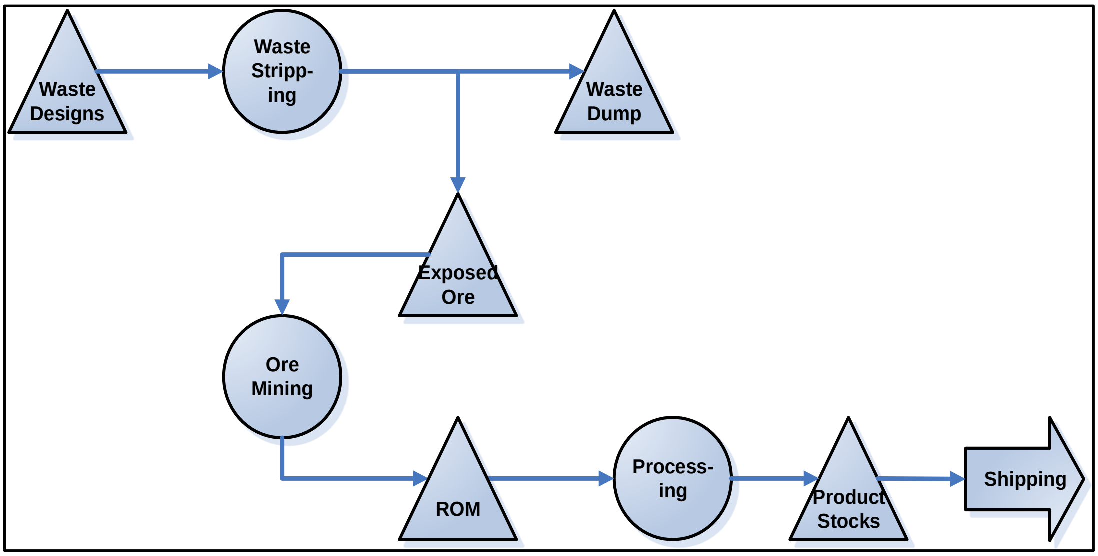


**Figure 6 - Example of what a simple Business Structure looks like**

## 6.2 Process Input Data Tab

Each of the processes contained in the Business Structure will have inputs associated with it. The developer will look at historical data of all Transform and Transfer processes to determine the distribution that should be used for the specific process and its associated parameters. The parameters of the distribution will be displayed as inputs in the BSP model, so that they can be changed and updated, either for when the user is testing initiatives or for when the operating level of the process changes. The distribution with its associated parameters will be used to generate 365 days' worth of random values that lie within the distribution. This will be further discussed in the 'Business Structure modelling tab'. Transform and Transfer processes use distributions to generate random values and will always have the associated parameters available as inputs, whereas, Store processes will only have the start capacity of the stockpile and the max capacity of the stockpile available as inputs.

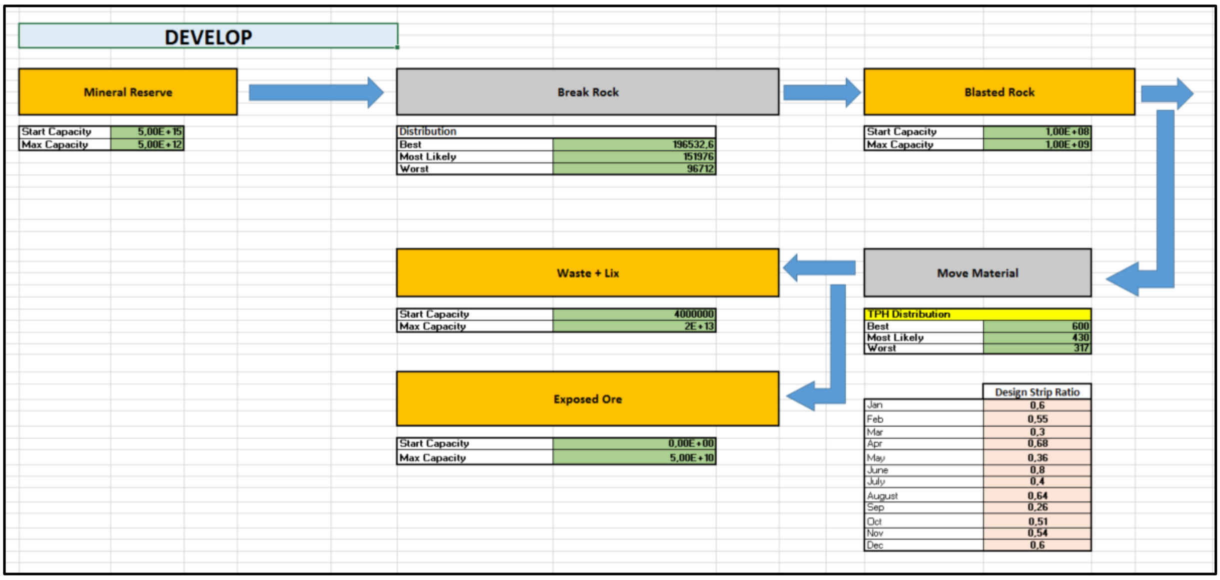


**Figure 7 - Example illustrating all the inputs associated with the Transform, Transfer & Store processes of the high level Develop process**

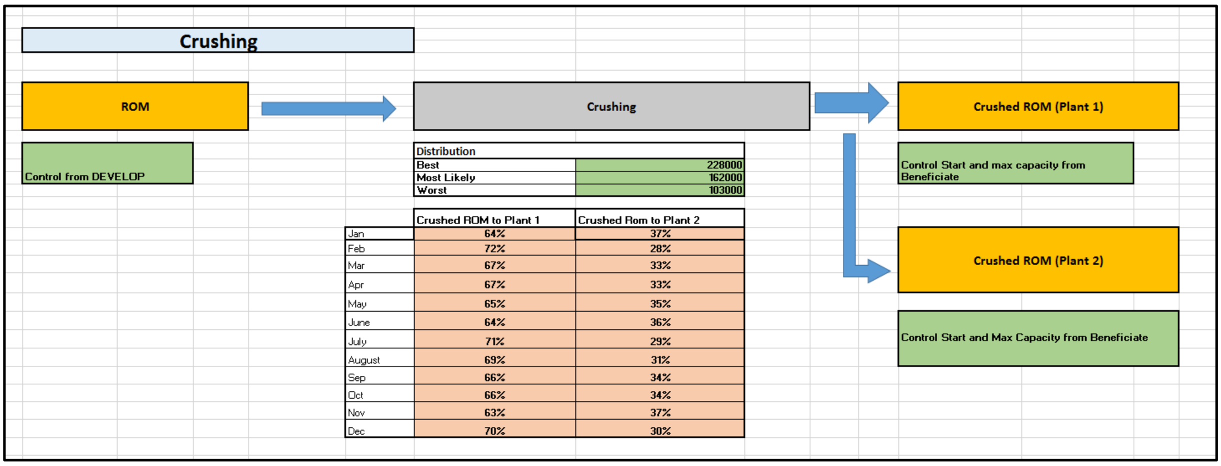


**Figure 8 - Examples of all the inputs associated with the Crushing Transform process**

Figure 7 and Figure 8 above indicate inputs associated with the high level Develop and Crushing processes in terms of Transform, Transfer and Store functions taken from a BSP model built for one of Anglo American's operations. There are many more processes that will be contained in the operations Business Structure of which each will require the necessary inputs similar to the ones depicted in Figure 7 and Figure 8 above. The Transform and Transfer processes are colour coded in grey and the Store processes are colour coded in gold. All Transform and Transfer inputs associated to a distribution, hence, the parameters to the distribution, are colour coded in green, and any other inputs that may be required for the specific process, such as design strip ratio per month or crushed ROM plant split percentage per month, are colour coded in light orange.

It is good practice to keep all BSP model inputs for all the processes on a single sheet, where the user can quickly and easily control all inputs from.

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| Crushing | |
|---|---|
| Distribution | |
| Best | 228000 |
| Most Likely | 162000 |
| Worst | 103000 |

**Figure 9 - Distribution parameter inputs for the Transform Crushing process**

Figure 9 above indicates the distribution parameter inputs that the user would need to input in the Process Input Data Tab. These inputs are applicable to both Transform and Transfer processes. The user is inputting the best amount of tonnes that the crusher is capable of crushing on given day, the most likely tonnes and the worst amount of tonnes that the crusher would process on a bad day. These parameters would be associated with a PERT distribution, which would then be referenced into the Business Structure Modelling tab where 365 days of random crushing values would be generated according to the distribution selected and the parameters inputted. This is discussed in greater detail in the Modelling of the Business Structure section of this document.

| ROM | |
|---|---|
| Start Capacity | 1000000 |
| Max Capacity | 2E+12 |

**Figure 10 - Inputs required for the ROM Store process**

Figure 10 above indicated the inputs required to be inputted by the user for the ROM stockpile. The start capacity indicates the tonnes of ROM material available on day one of 365. The maximum capacity indicates that the stockpile of ROM can never be greater than this value. If more ROM is being processed than what the stockpile can handle it will have a constraining effect on the upstream processes. The user is required to input the start capacity and max capacity of all Store processes contained in the Business Structure.

The inputs contained may vary from operation to operation. It is up to the developer to ensure that all necessary inputs are available, and that they can be easily changed and controlled by the user of the BSP model.

## 6.3 Modelling the Business Structure

Once our Business Structure has been developed and approved, and all our Business Structure inputs are in order and have been made available to the user, then the Business Structure can be modelled and calculated in terms of a statistical Monte Carlo simulation to perform risk analysis using a stochastic simulation of interdependent processes. The BSP model uses statistical distributions to compute and track daily outputs.

Let's use the high level Business Structure depicted in Figure 11 to illustrate how to model all processes of an operation.

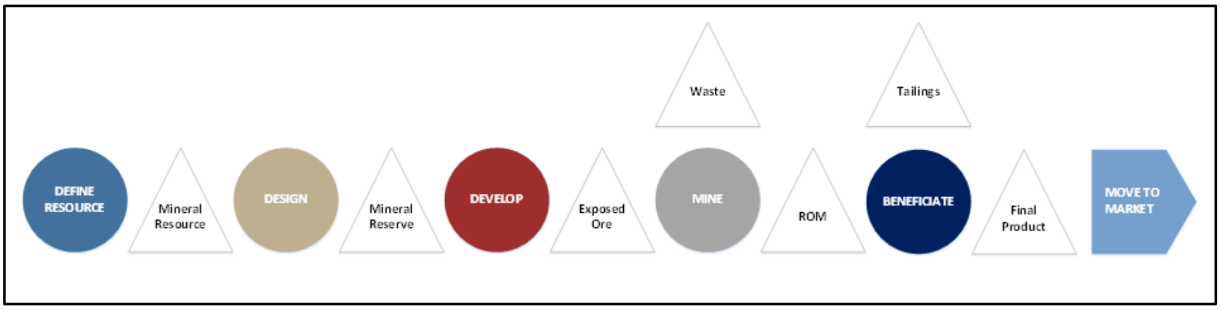
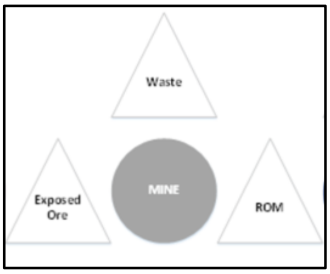



**Figure 11 - High Level Business Structure to illustrate how to model a BSP model**

Take the Mine process of the Business Structure depicted in Figure 11 for example:




- Mine is a transform process and requires the parameters of the distribution to be available as inputs in the inputs tab, which are then referenced into the model calculations tab. The distribution is used to calculate the Unconstrained Mining Total (t/d) column depicted in Figure 12.
- Mine is an intermediate process, meaning that there is a process before and after the Mine process. This is important as it determines which flowchart to use to develop the equation to calculate the actual column depicted in Figure 12. The intermediate flowchart to use to setup the equation is depicted in Figure 17.

Transform and Transfer process modelling:

| | MINING | | |
|---|---|---|---|
| Period (days) | Unconstrained Mining Total (t/d) | Actual Ore (t/d) | Normalized Unconstrained Mining Total to Product (t/d) |
| 1 | | | |
| 2 | | | |
| 3 | | | |
| 4 | | | |
| 5 | | | |
| 6 | | | |
| 7 | | | |
| 8 | | | |
| 9 | | | |
| 10 | | | |

**Figure 12 - Columns that need to be modelled for the Mining process**

It is important to note that all Transform and Transfer processes are modelled in the same manner as is about to be explained.

| Mine | |
|---|---|
| **Distribution** | |
| Best | 196532 |
| Most Likely | 151976 |
| Worst | 96712 |

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**Figure 13 - Distribution inputs available in the inputs data tab for the Mine process**

Let's now model each of the empty columns of the Mine process depicted in Figure 12:

**STEP 1: Modelling the 'Unconstrained Mining Total (t/d)' column:**

The Unconstrained column is the column that indicates the processes optimal performance, as there are no other factors that could possibly constrain this column. The distribution and its associated parameters are of the unconstrained column are obtained from historical data of the specific process, where the historical data is unconstrained and stable. The developer will need to develop a control chart of the historical data to be able to determine an unconstrained and stable period that can be used. The unconstrained total output represents the production of the process generated statistically to represent performance of an unconstrained independent variation only.

- The developer will need to type in the equation as depicted in Figure 14 into the first empty cell next to the period 1.

| fx | =RiskPert('Process Input Data'!$AO$18;'Process Input Data'!$AO$17;'Process Input Data'!$AO$16) |
|---|---|

**Figure 14 - Pert distribution used to calculate the unconstrained column**

- The formula depicted in Figure 14 references the inputs depicted in Figure 13 from the Process Input Data tab. The format of the PERT equation is RiskPert(worst, most likely, best), where cell AO18, AO17, AO16 in Figure 14 represents worst, most likely, best respectively – which are depicted in Figure 13.
- The RiskPert function is a @Risk function and the user will require the @Risk software at this stage to be able to the see the value that the RiskPert function has generated for the first empty cell next to Period 1.
- The developer/user then drags this formula down all the way to period 365. @Risk will then automatically generate the random values for 365 day's according to the distribution chosen and the parameters entered as inputs.

| | MINING | | |
|---|---|---|---|
| Period (days) | Unconstrained Mining Total (t/d) | Actual Ore (t/d) | Normalized Unconstrained Mining Total to Product (t/d) |
| 1 | 140895,3462 | | |
| 2 | 125609,8628 | | |
| 3 | 161517,5483 | | |
| 4 | 145736,9068 | | |
| 5 | 141872,4409 | | |
| 6 | 128919,5821 | | |
| 7 | 174889,1816 | | |
| 8 | 127419,9169 | | |
| 9 | 105371,6157 | | |
| 10 | 161148,5582 | | |

**Figure 15 - Progress of the Mine Process modelling phase**

**STEP 2: Modelling the 'Actual Ore (t/d)' column:**

The actual column is the actual production process volume of ore for a determined time period. There is a well-established and accurate flow diagram that has been developed to calculate the actual production process volumes. Depending on whether the process is a first production process in the model, an intermediate production process or a final production process in the model a separate flow diagram has been developed for each of the three production stages.

- The actual column takes into consideration the feed rate of the upstream processes, the capability of the downstream processes, the level of the stockpile upstream, the level of the stockpile downstream and the system constraint.
- If none of those aspects are constraining the Mine process then the actual column will equal the unconstrained column, however, if one of the aspects is in fact performing at a lower capability that the capability of the Mine process, then the actual capability of the Mine process will not be its maximum capability, but it will rather perform at the capability of the process or aspect that is constraining it.
- Mine is an intermediate process, and, hence, the intermediate production process flowchart depicted in Figure 17 is used to calculate the actual column of the Mine Transform process.
- Figure 17 depicts flowchart to develop the equation, see Figure 16, to calculate the actual column for an intermediate production process, such as the Mining Process that is being looked at.

```
fx  =IF(AJ31>AH31+Z31;IF(AJ31>(AR$13-AR31);(AR$13-AR31);(AH31+Z31));IF(AJ31>$B31;IF(AJ31>($B31+(AR$13-AR31));($B31+(AR$13-AR31));AJ31);$B31))
```

**Figure 16 - The equation to calculate the actual column of the intermediate Mining process**

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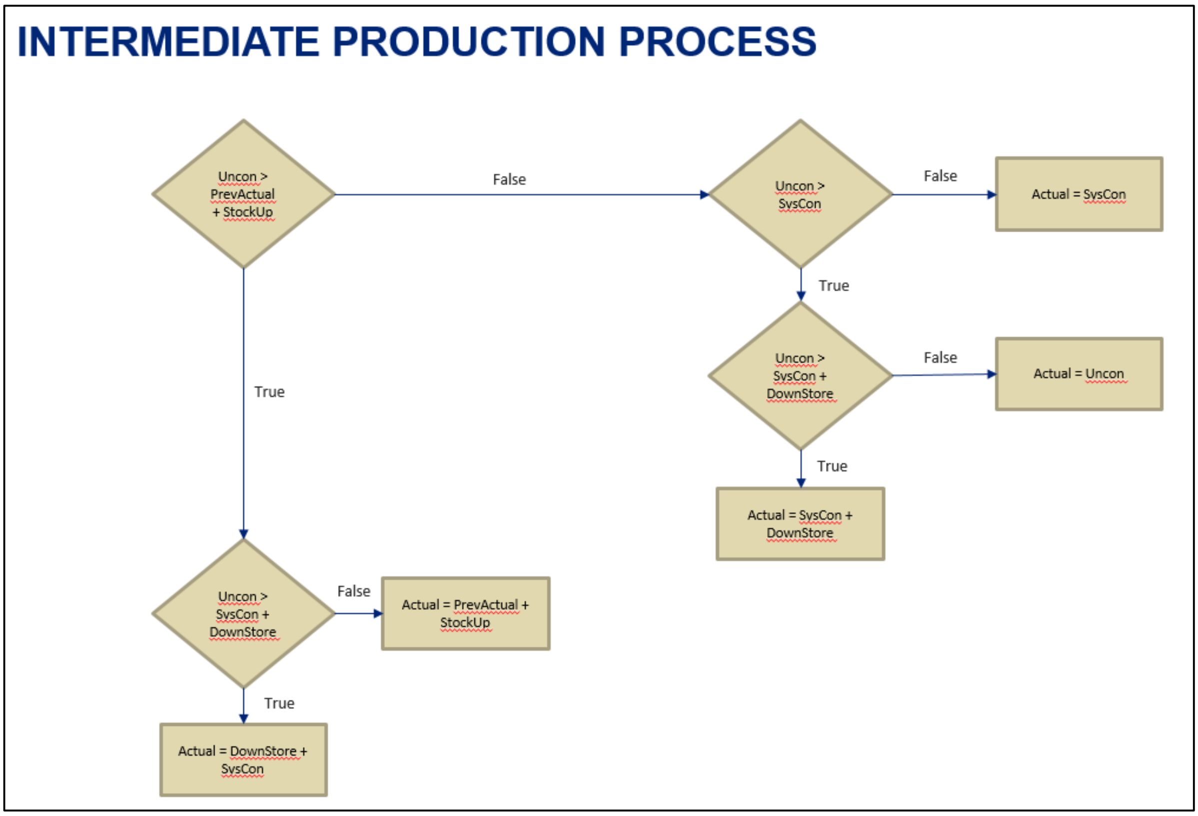


**Figure 17 - Flowchart to develop the equation to calculate the actual column for an intermediate production process**

The flow diagram in Figure 17 takes all variables into consideration to allow for an accurate calculation of the actual production process volumes. The variables that the flow diagram takes into consideration when calculating actual volumes are:

- **Unconstrained** - Unconstrained rate, i.e. the production rate of a process generated statistically to represent maximum performance of an independent process with independent variation. This would refer to the unconstrained column depicted in Figure 12.
- **System Constraint -** System Constraint, i.e. the minimum actual production rate of all the productive units or processes in the Business Structure. It is recommended that the developer creates an additional column for the System Constraint where it returns the minimum of all the actuals for each period of all processes in the Business Structure, which can then be referenced when creating the actual formula, and where the System Constraint needs to be looked at.
- **Previous Actual**: The actual production rate of the preceding production process. The formula looks at the actual column of the previous process to determine if there is enough feed from the upstream process for the current process, or if the current processes capability can handle the feed coming in from the upstream process.
- **Stock Up**: The available stock of the immediately preceding stockpile at the start of the determined time period. With regards to the Mine processes that is being dealt with, the immediate preceding stockpile or Store process is exposed ore, and the start capacity of exposed ore for each period would need to be looked at to develop the formula to determine the actual column.

- **Down Store**: The available storage capacity of the immediately succeeding stockpile at the start of the determined time period. It is calculated as the max capacity of the stockpile minus the start capacity of the specific period. With regards to the Mine process that is being looked at, the formula would look at the ROM stockpile and the Waste stockpile.
- **Actual** – This is the output of the true case that the flowchart determines. The actual production rate of a production process for a determined time period.

It is important to ensure that all the variable listed in the formula, and detailed above, are in the same unit in order, to ensure that like is being compared with like. This will guarantee accuracy for the actual output and allow for reliable comparisons within the flow diagram.

| | MINING | | |
|---|---|---|---|
| Period (days) | Unconstrained Mining Total (t/d) | Actual Ore (t/d) | Normalized Unconstrained Mining Total to Product (t/d) |
| 1 | 159280,8027 | 104493,9645 | |
| 2 | 114830,904 | 108063,9653 | |
| 3 | 154363,416 | 162577,7237 | |
| 4 | 166974,549 | 99712,36749 | |
| 5 | 149425,8717 | 165690,8518 | |
| 6 | 128825,8975 | 128744,5896 | |
| 7 | 184735,666 | 112752,4451 | |
| 8 | 158322,6725 | 142232,294 | |
| 9 | 167344,6326 | 114586,4148 | |
| 10 | 157087,6613 | 146432,6528 | |

**Figure 18 - Progress of the Mine process modelling phase**

If the Mine process was a first production process in the Business Structure the flowchart depicted in Figure 19 would be used to calculate the actual and the formula would look as follows:

```
fx  =IF(C65>A$65; IF(C65>(A$65 +  O65); (A$65 + O65);C65);A$65)
```

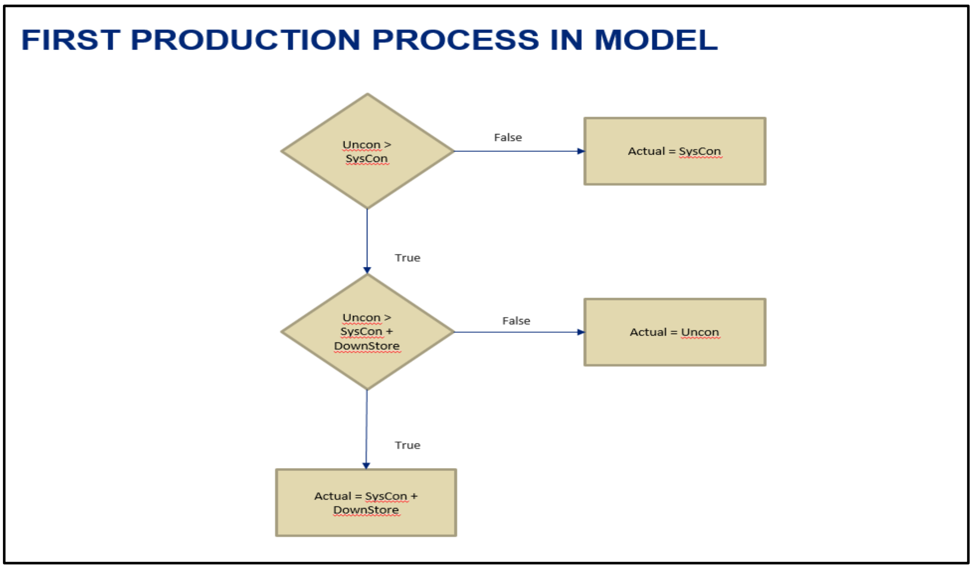


**Figure 19 – First production flowchart to be used to develop the actual calculation**

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If the Mine process was a final production process in the Business Structure the flowchart depicted in Figure 20 would be used to calculate the actual and the formula would look as follows:

```
fx  =IF(DY65>CZ65+DK65; CZ65+DK65; IF(DY65>W65;DY65;W65))
```

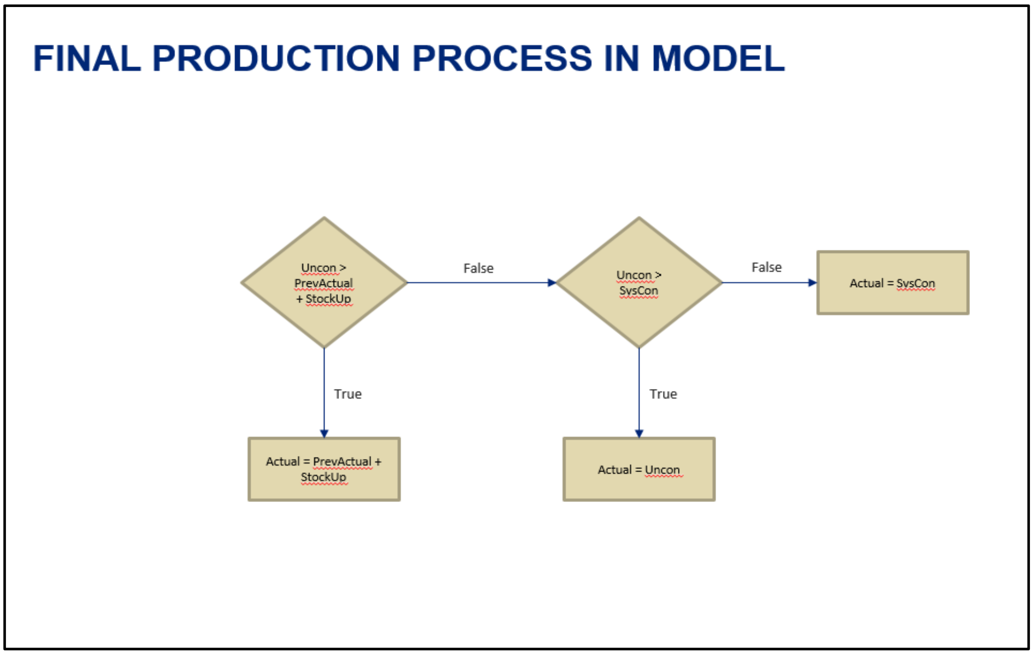


**Figure 20 - Final production flowchart to be used to develop the actual calculation**

Note that the variables to calculate the actuals of a first and final production processes illustrated in Figure 19 and Figure 20 are the same as the variables to calculate the actuals of an intermediate production process as depicted in Figure 17. The explanation of the variables is given in this section of the document.

**STEP 3: Modelling the 'Normalised Unconstrained Mining Total to Product (t/d)':**

The Normalised Unconstrained Output column exhibits the Unconstrained Total Output converted to a common meaningful measure at that specific stage in the process, such as valuable mineral for example. Each 'transform' and 'transfer' process modelled has a Normalised Unconstrained Output. All Normalised Unconstrained Outputs have the same unit, and can thus be used as the common measure to compare all 'transform' and 'transfer' processes against one another, allowing for the identification of the system constraint. The Normalised Unconstrained column of each process is used to create a histogram of each process. All these histograms are then overlapped with each other on a single graph. As depicted in Figure 1 of this document. This graph can then be used to identify our constraining process and our focus areas within the Business Structure.

If the product is in terms of tons it's referring to a product such as copper or coal, as their output is measured in tons. If it were platinum it would be ounces, and diamonds would be carats etc. It would be specific to the operation.

With regards to the Mine process that we looking at the valuable mineral is Ore. The question that needs to be asked is: “What needs to be done to convert Ore into copper product?”

- The unconstrained column needs to be multiplied by the recovery, multiplied by the grade and divide by the percentage of product in concentrate. By performing this calculation it is possible to determine the capability of the Mine process in terms of product.

Let’s for example sake say the grade is 65%, the recovery is 85% and the percentage of product in concentrate is 30%, then we can calculate the Normalised unconstrained product column:

| Normalized Unconstrained Mining Total to Product (t/d) | = | Unconstrained Mining Total (t/d) | X | Recovery | | X | Grade | | / | Product in Concentrate | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Percentage | 85% | | Percentage | 0,65% | | Percentage | 30% |

**Figure 21 - Normalising the Unconstrained Mine column into product**

Note that the grade, recovery and concentrate are all inputs that the user could update or change as necessary, either for testing or because the operating level has changed.

- Depending on which process that is being looked at determines the necessary steps that need to be taken to normalise the specific process’ unconstrained column into product.
- Once all the processes within the Business Structure have been normalised to product, all the normalised histograms of all the processes can be overlapped with one another, see Figure 1, and the constraining process can be identified.

| | MINING | | |
|---|---|---|---|
| Period (days) | Unconstrained Mining Total (t/d) | Actual Ore (t/d) | Normalized Unconstrained Mining Total to Product (t/d) |
| 1 | 144573,7868 | 132310,6521 | 2436,721176 |
| 2 | 123234,7385 | 125140,3534 | 2304,668175 |
| 3 | 177692,2299 | 147701,3613 | 2720,166736 |
| 4 | 146483,3376 | 83627,07827 | 1540,132025 |
| 5 | 171804,4334 | 133256,9471 | 2454,148775 |
| 6 | 111929,0646 | 113126,4929 | 2083,412911 |
| 7 | 148561,8438 | 150470,8267 | 2771,171058 |
| 8 | 140484,817 | 129939,8513 | 2393,058928 |
| 9 | 153973,2569 | 134001,7816 | 2467,866144 |
| 10 | 150579,4358 | 99342,71203 | 1829,561613 |

**Figure 22 - Progress of the Mine process modelling phase**

Store process modelling:

| Ore Stockpile | |
|---|---|
| Start Capacity | End Capacity |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |

**Figure 23 - Columns that need to be modelled for the ROM stockpile**

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- The first empty cell under start capacity is equal to the start capacity input available in the inputs page, see Figure 10 of this document.
- The end capacity column in Figure 23 is calculated as the start capacity + the feed of the previous process – the feed that goes out to the next process. Figure 24 illustrates this graphically.

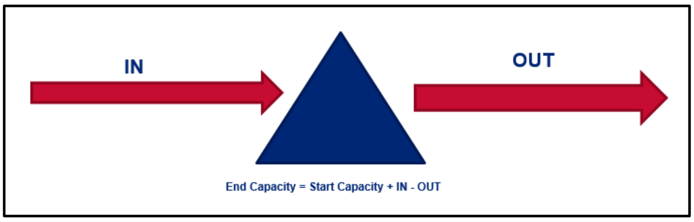


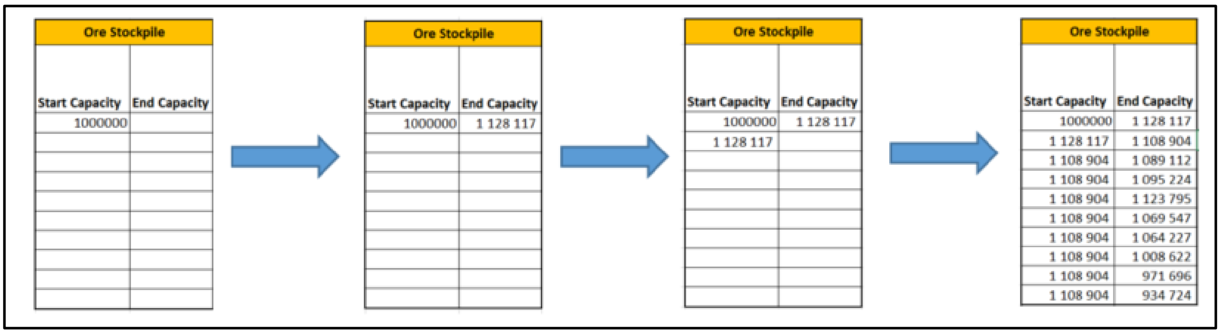

**Figure 24 - Graphical presentation to calculate the end capacity**

The formula to calculate the end capacity looks as follows:

```
=IF((P51+J51-X51)<0;0;IF((P51+J51-Y51)>'Process Input Data'!$AP$16;'Process Input Data'!$AP$16;(P51+J51-X51)))
```

- P51 = start capacity; J51 = feed coming in; X51 = feed coming out
- AP16 = maximum capacity of the stockpile, and is referenced from the inputs page.
- The stockpile can never be less than 0.

The start capacity of period 1 is equal to the input start capacity in the inputs page, thereafter, it is important to note that the end capacity of period 1 is equal to the start capacity of period 2.



| Ore Stockpile | |
|---|---|
| Start Capacity | End Capacity |
| 1000000 | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |

| Ore Stockpile | |
|---|---|
| Start Capacity | End Capacity |
| 1000000 | 1 128 117 |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |

| Ore Stockpile | |
|---|---|
| Start Capacity | End Capacity |
| 1000000 | 1 128 117 |
| 1 128 117 | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |

| Ore Stockpile | |
|---|---|
| Start Capacity | End Capacity |
| 1000000 | 1 128 117 |
| 1 128 117 | 1 108 904 |
| 1 108 904 | 1 089 112 |
| 1 108 904 | 1 095 224 |
| 1 108 904 | 1 123 795 |
| 1 108 904 | 1 069 547 |
| 1 108 904 | 1 064 227 |
| 1 108 904 | 1 008 622 |
| 1 108 904 | 971 696 |
| 1 108 904 | 934 724 |

**Figure 25 - Progress of the ROM Store process modelling phase**

This section shows how to model a Transform, Transfer and Store process. All process can be modelled using this method. The developer may need to make small adaptions to his/her modelling, however, the principle remains the same. The developer needs to use his/her discretion to determine when slight adaptions or necessary changes are required for the BSP model that the developer is developing.

If the developer wanted to model the high level Business Structure depicted in Figure 11 in greater detail he/she could transform the high level processes into something similar of that depicted in Figure 26. The method used to model each of the in detail processes stays the same as described in this section above.

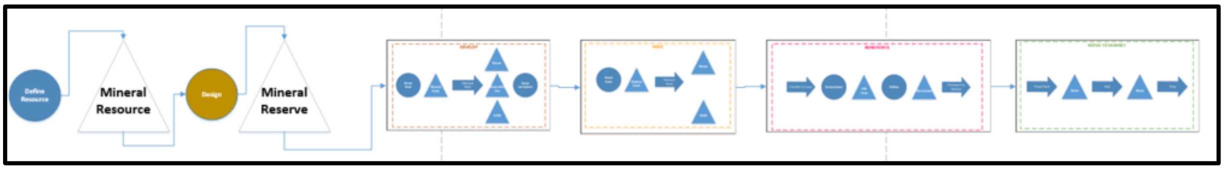



**Figure 26 - More in detail Business Structure that can be modelled in the same way**

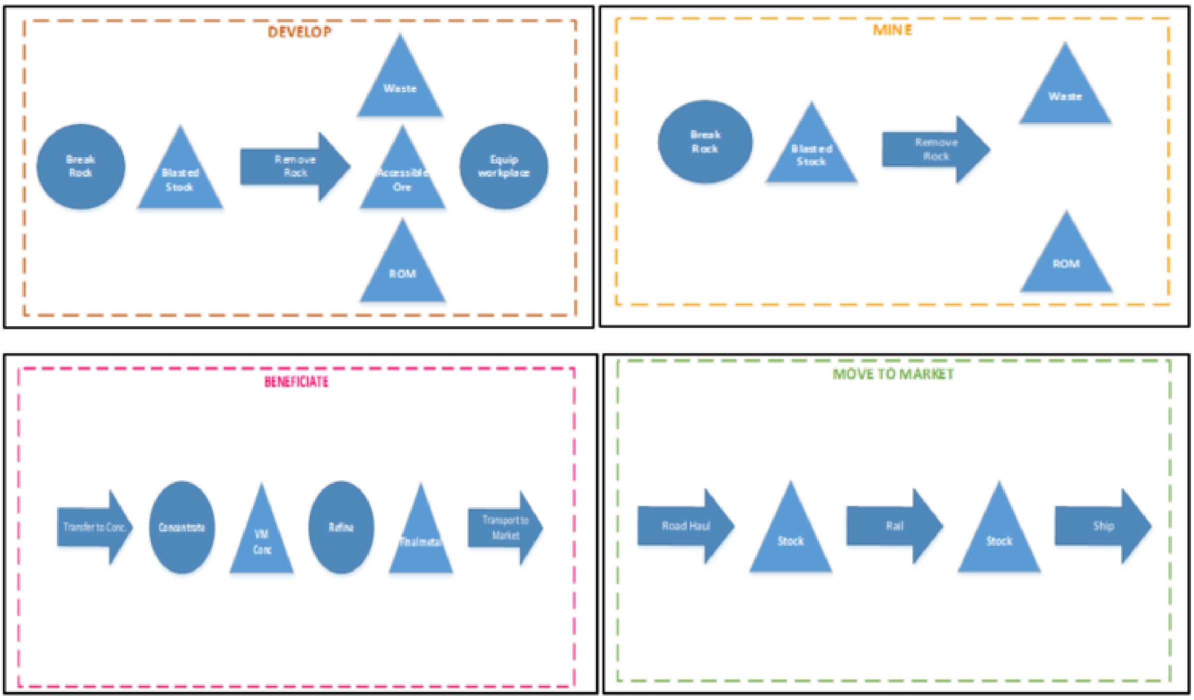



**Figure 27 - The more in detail processes contained within the high level processes depicted in Figure 11**

## 6.4 Outputs

It is recommended that the developer creates two tabs/pages for the outputs. One for the Process Outputs and one for the System Outputs, however, the developer must use his/her discretion to decide whether to have two tabs or only a single tab for the outputs.

### 6.4.1 Process Outputs Tab

The Process Outputs tab consists of graphs of all ‘Transform’, ‘Transfer’ and ‘Store’ activities modelled in the Business Structure. For ‘Transform’ and ‘Transfer’ activities actual production levels modelled per day (independent variable, y-axis) are plotted against the period of 365 days (dependent variable, x-axis). For ‘Store’ activities the end capacities modelled of the stockpile is plotted on the y-axis against the period of 365 days on the x-axis. Figure 51 and Figure 52 depicts an example of a ‘Transform’ and ‘Transfer’ process graph created in the Process Outputs tab as well as a ‘Store’ process graph respectively.

AAOM Flowsheet

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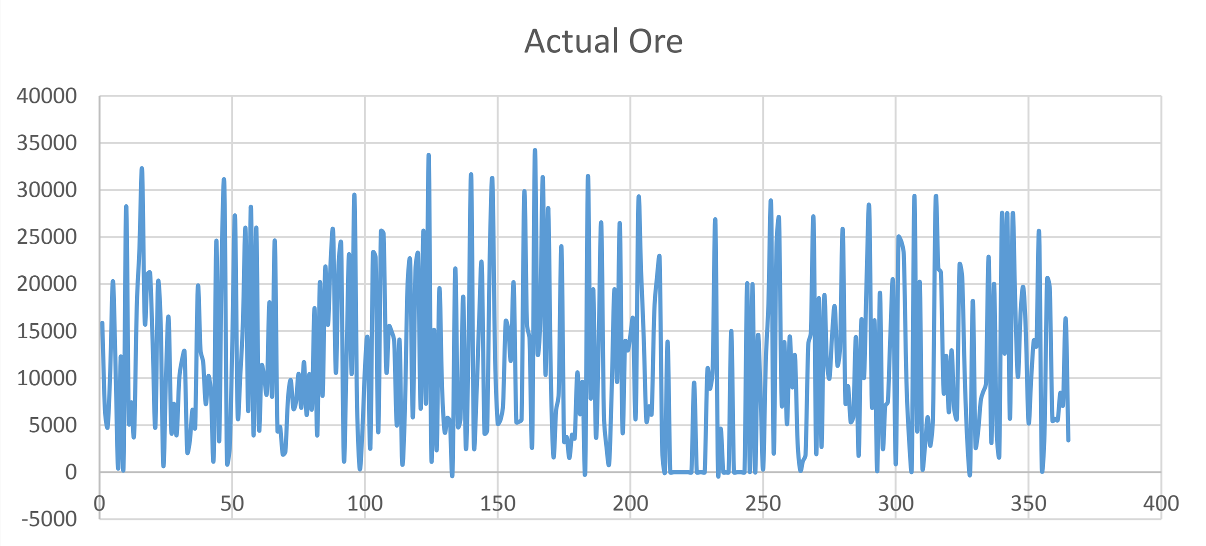


**Figure 28 - Example of a daily throughput tracking chart contained in the Process Outputs page**

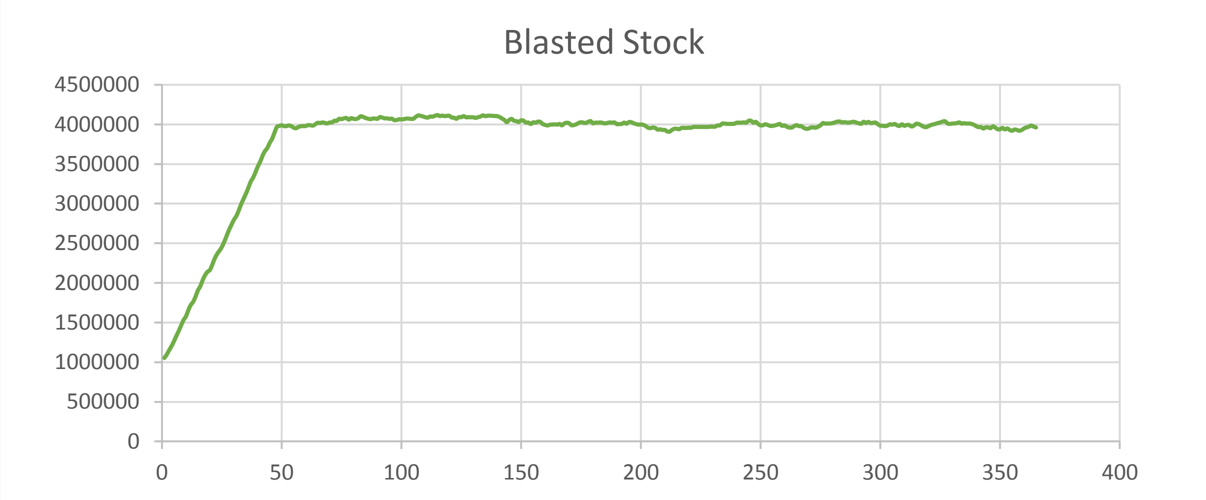


**Figure 29 - Example of Store (stockpile) level tracking graph contained in the Process Outputs Page**

The graphs in the Process Outputs tab allows the user to work through the operation graphically. Having visual images of production and stockpile levels, as seen in Figure 28 and Figure 29, and how they move and interact over a period of a year is very beneficial to the user, as the user can identify when a process is instable, when a process is not performing well and when a stockpile level is depleted. Graphing the production of the operation allows for many benefits, such as quick identification of where there are discrepancies and constraints in the operation, which the user can then further investigate as to why these occurrences are appearing, and investigate on how to eradicate them. This greatly aids in the user in making the right decisions.

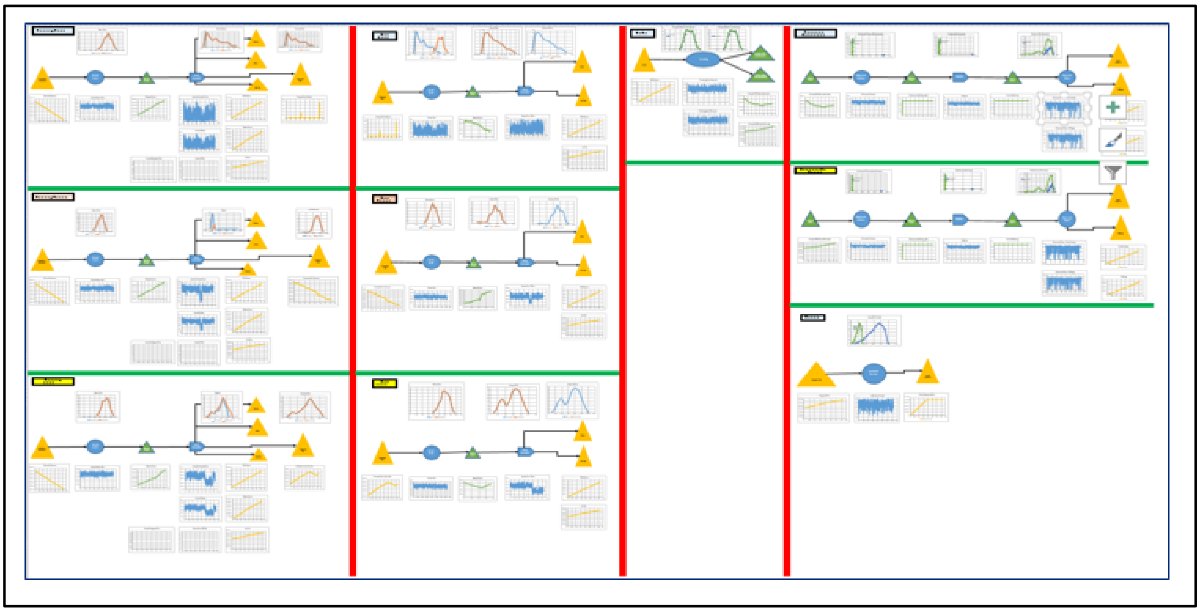

**Figure 30 - An Example of a Process Outputs tab/page (depicts all the graphs of the Business Structure to allow user daily monitoring and tracking)**

The Process Outputs tab also depicts overlapping Histograms of all ‘Transform’ and ‘Transfer’ activities. These Histograms overlap the actual (constrained) performance of the process with the unconstrained performance of the process. Here the user can identify whether or not the process is performing at its optimal. If the actual Histogram overlaps perfectly with the unconstrained Histogram it indicates that the ‘Transform’ or ‘Transfer’ activity is performing at its maximum. If the unconstrained and constrained performance do not overlap on top of each other perfectly, i.e. the unconstrained is greater than the constrained, it indicates that the performance of that specific process is being constrained, and not performing at its maximum capability and the user needs to investigate why this is the case. If the constrained is greater than the unconstrained there is something wrong with the model logic, as this is not possible, and needs to be rectified. The ideal process performance would be to have all the processes actual histograms overlap perfectly (one on top of the other) with the unconstrained histogram as it would mean that all processes are performing at their optimal and the system is perfect, this is almost impossible to achieve, there will always be a process constraining the system. Please see Figure 31 for an actual Histogram being overlapped with an unconstrained histogram of the Break Rock Transform process.

AAOM Flowsheet

SPT Flowsheet

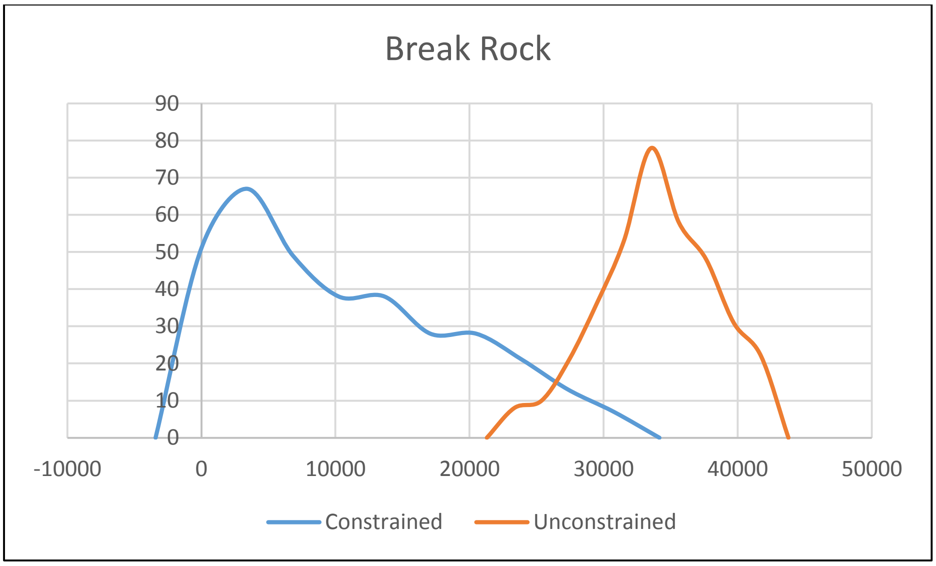


**Figure 31- The actual performance capability being achieved by this process is less than the unconstrained capability, meaning this specific system is not performing at its optimal**

### 6.4.2 Systems Output Tab

The Systems Outputs Tab simulates the the outputs of the entire operation using @Risk. Examples of Annual Outputs that are simulated using the @Risk function; 'RiskOutput', are:

- Tonnes Product
- Total Tonnes Moved
- Expit Ore
- Waste
- Cost

The user can add up to as many outputs as he/she feels fit. The annual outputs to be displayed can vary according to different operations. It is up to the user to decide what the critical model outputs to be displayed should be, whatever provides value to the user.

The Systems Outputs tab is the most important tab/page to analyse the systems performance, as it provides the measures and visuals that trigger the user to make decisions and take action. All the value attributing factors covered in Section 2 of this document come into realisation from the Systems Outputs page.

These outputs listed above indicate to the user how well the operation is performing. The outputs of the model can be compared to the budgeted targets and the user can determine whether the operation is reaching its targets, exceeding targets or failing to reach targets. The model outputs can also be compared to actuals, and indicate to the user whether or not the operation was performing as well as what the model inidicates it can perform at. If nothing changes on the operation and the model has been developed as an accurate represntation of the operation, then the operation should be performing very close to what the model indicates.

| Annual Output | Sim Cells | Formula |
|---|---|---|
| Tonnes Product | 51 102 562 | =RiskOutput("Tonnes Product")+SUM(Model!DY65:DY404) |
| Expit Ore | 46 880 927 | =RiskOutput("Expit Ore")+SUM(Model!BR65:BR404) |
| Waste | 46880927 | =RiskOutput("Waste Expit")+SUM(BS65:BS404) |
| Cost | $1 416 748 913 | =RiskOutput("Total Cost")+SUM(Model!EE65:EE404) |

**Figure 32 – Examples of @Risk Outputs displayed in the System Outputs tab**

By using the @Risk function ‘RiskOuput’ for the annual outputs depicted in Figure 32 the user can simulate the outputs as many times as the user would like and @Risk will automatically create Histograms of all outputs that contain the RiskOutput function. The user has the option to run the simulation once or to run a 100000 iterations of the simulation. The number of iterations chosen to simulate, the longer the simulation will take, however, the more accurate and realistic the outputs will be. On average 1000 iterations takes anything between 5 and 10 minutes to simulate. Each time @RISK runs a model iteration, the output is logged onto the Histogram. The purpose of @RISK is that it brings in the variation aspect, which deterministic models do not consider. Hence, the @RISK BSP model outputs a much more realistic and accurate output in terms of a Histogram. For example the Histogram depicted in Figure of this document illustrates the Histogram output that @RISK generated of “Actual Final Product” with 1 000 model iterations (the model is run 1 000 times, generating an output with each iteration).

The Histogram can then be used to study statistical measures such as the mean, the confidence levels of reaching or exceeding targets (C20 and C80). It’s a graph with great capability and the output of the model histogram is looked at in three different dimensions:

1) Reduce variation of process – eliminating large spread of Histogram. It’s known that reducing variation of a process helps to optimise performance output.
2) Setting and delivering targets - the confidence levels of reaching or exceeding targets (C20 and C80).
3) Implementing initiatives to shift the constraining process’ mean to the right, hence, shifting process’ performance. It is important to note that if the process’ mean is shifted to the right the capability of the process is improved.

AAOM Flowsheet

SPT Flowsheet

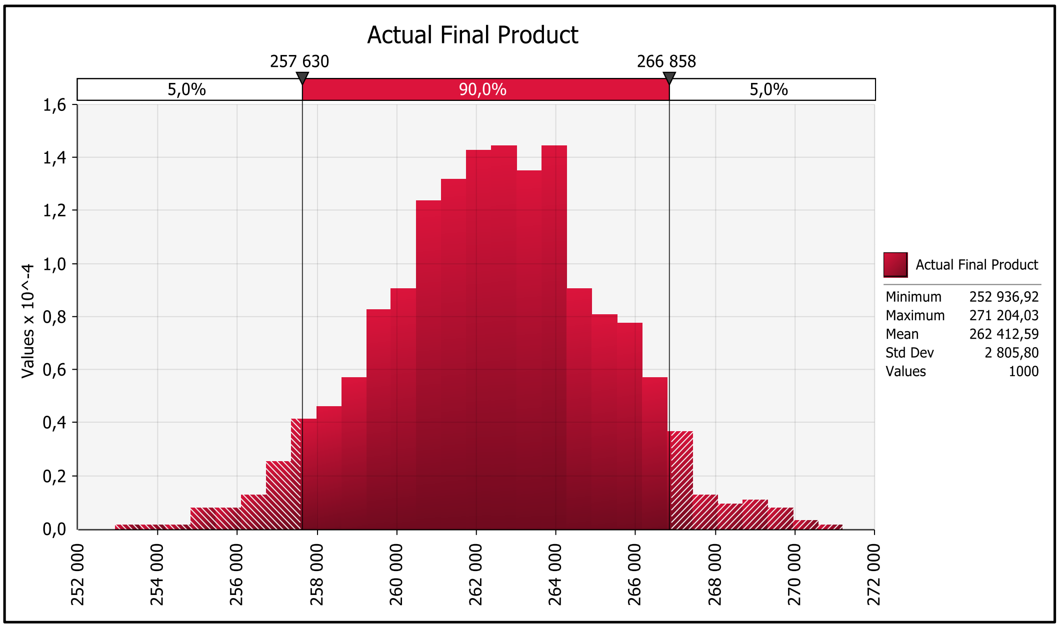


**Figure 33 - Histogram generated by @Risk of the @Risk product output for 1000 iterations**

Once the Histogram has been studied, and it is noted for example that budget is not being achieved, the user can further us the model to identify as to why this is the case.

The System Outputs tab also displays the Unconstrained Performance graph Normalised to Product. The Unconstrained Performance graph displays the Histograms of all ‘Transform’ and ‘Transfer’ activities normalised to product, as discussed earlier, on a single graph. An example of what the Unconstrained Performance, normalised to product, graph looks like, and how it is used to improve performance is depiced in Figure 34. Section 2 of this document explains in detail how the user must use this graph for it to add value.

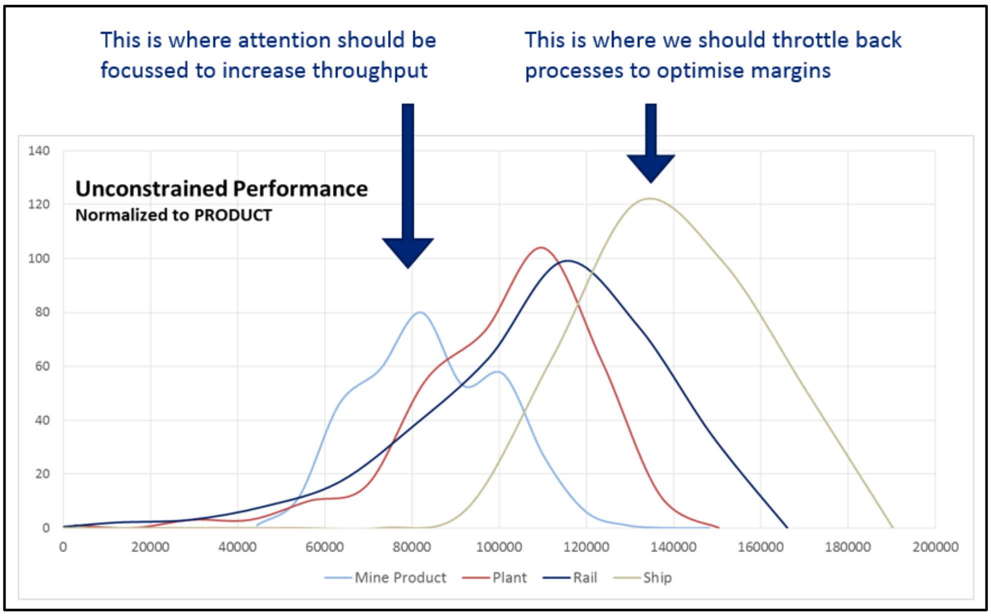


**Figure 34 - Unconstrained Performance Graph of overall operation**

Depending on the level of detail that the developer built the Business Structure to, determines the level to which the user can identify the process constraint to. For example let's call the process Histogram depicted in Figure 34 a Level 1 (high level) process Histogram. It is representative of a Level 1 Business Structure, see Figure 11, and let's call the Business Structure depicted in Figure 26 a level 2 Business Structure.

The user will study the overlapping Histograms on a Level 1 and Level 2 basis to determine as to why the operation is underperforming and where attention should be focused to increase throughput.

Level 1 overlaying Histogram depicted in Figure 34 of this document allows the user to identify the high level process (Mine, Plant, Rail, Ship) constraint within the operation.

The process histogram that is furthest to the left on the overlaying Histogram graph is identified as our constraint, as it is the process with the least capability, hence, our focus process.

Analysing Figure 34 allows the user will notice that 'Mine' is our Level 1 constraint and should be focused on to better performance and increase confidence of reaching targets. If the user has built in the capability of a level 2 into the model, the user can dive one step deeper and identify the constraint of all the processes contained within mining. This provides the user with a more in detail and more focused area to start improving performance. However, if the user has only built in Level 1 capability, the user will identify that the Mine process in this example is the constraint and the user will have to further investigate to figure out what is causing the Mine to be the constraint.

Once the Level 1 constraint has been identified the user moves into Level 2 of the Level 1 constraining process. For example, the processes that the Mine Transform process contains is Break Rock and Move Rock, see Figure 27. These two processes histograms are overlapped with one another, as depicted in Figure 35. From Figure 35 the user can determine that the 'Move Rock' process within the Mine Transform process, which is the Level 1 constraint, is the Level 2 constraint, as it has less capability than the 'Break Rock' process. Now that the user has determined that Break Rock process within the high level Mine process is the constraint and the focus area to improve performance, the user can come up with a potential initiatives to improve performance and shift the current constraint.

AAOM Flowsheet

SPT Flowsheet

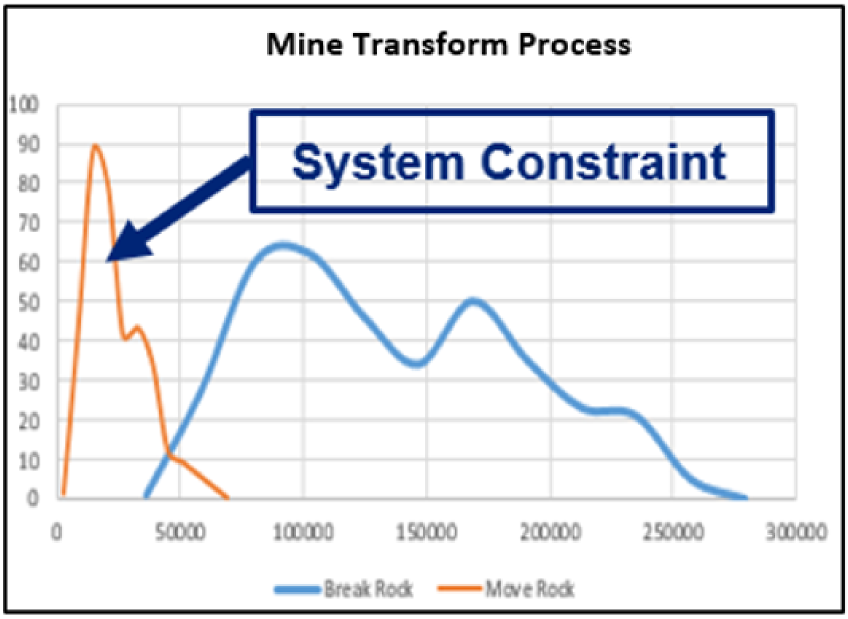


**Figure 35 - Level 2 overlapping Historams to determine Level 2 constriant of the Level 1 constraint**

## 6.5 Developing a Histogram

The user should be capable of developing a Histogram, however, the contents to follow is to refresh the users/developers memory if required.

Histograms are plotted using frequency (y-axis) against the bin (x-axis), for each different process. The way that the Histograms in this document and in the BSP model are created for each of the different process that have been plotted are as follows:

Take ‘Mine’ for example:

In the Unconstrained Performance graph, Figure 34. The Mine Histogram was created by generating bins (tonnes of material) and frequencies of the Mine process values generated by the BSP model. The bins and frequencies calcualted of the Mine process are depicted in Figure 36. The frequency values calculated are plotted on the y-axis and the bin calculations are plotted on the x-axis. By doing so the Histogram of the Mine process depicted in Figure 34 is created.

| Mine Ore | Constrained | | Unconstrained | |
|---|---|---|---|---|
| Bin Interval | 10 | | 10 | |
| Single Interval | 19546,86 | | 19546,86 | |
| Rounded Interval | 19547 | | 19547 | |
| Start Value | 7057,00 | | 7057 | |
| | | | | |
| Tonnes | | | | |
| **Constrained** | | | **Unconstrained** | |
| Bin | Frequenc | Bin | Frequency | |
| 7057,00 | 0 | 7057 | 0 | |
| 26604 | 3 | 26604 | 3 | |
| 46151 | 10 | 46151 | 10 | |
| 65698 | 13 | 65698 | 13 | |
| 85245 | 26 | 85245 | 26 | |
| 104792 | 44 | 104792 | 44 | |
| 124339 | 59 | 124339 | 59 | |
| 143886 | 52 | 143886 | 52 | |
| 163433 | 57 | 163433 | 57 | |
| 182980 | 42 | 182980 | 42 | |
| 202527 | 13 | 202527 | 13 | |
| 222074 | 0 | 222074 | 0 | |

**Figure 36 – How the frequencies and bins are created in order to plot the Mine Transform Histogram**

The way that the bin values and the frequency values are calculated is as follows:

- Bin Interval = 10 = cell CH40, chosen arbitrarily
- Single Interval = *fx* =((MAX(BW43:BW407) - MIN(BW43:BW407))/CH40)
  Where, BW43:BW407 is the Ore column obtained from move material in the Mine process, or whatever the values that the user wants to create a Histogram for. This column will either be the actual Ore column or the unconstrained Ore column, depending on whether constrained or unconstrained is being worked with. CH40 refers to the bin interval cell.
- Rounded Interval – The single interval rounded up using the following formula:
  *fx* =ROUND(FC8;0)
- Start value = *fx* =(ROUND(MIN(BW43:BW407);0))-CJ42
  Where, CJ42 refers to the rounded interval cell.
- The first bin is equal to the start value. The rest of the bins are created through the incrimination of the rounded value to the start value.
- The frequency is generated through the following formula:
  *fx* =COUNTIFS(BW43:BW407; ">" & CI48; BW43:BW407; "<" & CI49)
  The COUNTIFS formula counts all the values in column BW43:BW407 that fall between the values in cell CI48 and cell CI49, which look at the bin values that have been generated, see figure 59 below:

| | Unconstrained |
|---|---|
| Bin | Frequency |
| 5180 | =COUNTI |
| 24545 | 5 |

**Figure 37 - Depicts the values that the COUNTIFS formula looks at**

AAOM Flowsheet

SPT Flowsheet

The value highlighted in red represents the value in cell CI48 and the value highlighted in purple represents the value CI49. This is repeated for all bins to generate all frequency values.

This step is repeated for all 'Transform' and 'Transfer' activities for which the user wants to develop Histograms for, with only the column being looked at changing, to generate the Unconstrained Performance Histogram graph, see Figure 34.

## 6.6 Special Causes

Some, nearly all, operations may experience special causes. Something that is out of the norm is considered a special cause or anything that happens seldom, or something that happens yearly, but can't be controlled due to external factors, however, it affects output is considered a special cause.

For example the Los Bronces operation in Chile faces a harsh winter each year due to the location (high altitude in the Andes), which affects their performance tremendously. The BSP model has to take this into consideration, as the operating level in winter is different to that in summer, i.e. different distributions are used for winter than what are used for summer. If summer distributions were used for the entire year the BSP model would not be representative of the operation and the outputs would be unreliable and false.

Each operation has its own specific special causes that the operation is faced with. The developer must use his/her discretion to know when something is considered a special and whether or not it must be factored into the model, depending on the frequency and impact of the special cause.

The contents to follow illustrates an example of how a special cause can be dealt with and how it can be integrated into the model. This can be adapted and applied to the specific special cause that an operation is faced with.

Upon studying the data using control charts (all developers should be familiar with control charts), one might notice that there are several data points within the data set that fall above the UCL or below the LCL, and there may even be several 0 days. These data points are considered as special causes and need to be incorporated into the BSP model. They cannot be ignored. Their impact needs to be integrated into the model, as they will affect performance and throughput. The way that the impact of the special causes are incorporated into the model is as follows:

Step 1: Count the number of special causes and separate them into their respective special cause classification, see Table 2 below:

**Table 2 - Special Cause Classification**

| | # Days | Total Days | Impact |
|---|---|---|---|
| Days Below LCL | 47 | 365 | Pert(30,50,65%) |
| Zero days | 10 | 365 | 100% |

In this case there are only special causes as a result of data points being below the LCL and data points being equal to zero, there are no special causes due to data points being above the UCL. There are 47 special causes due to data points being below the LCL and 10 special causes due to data points being equivalent to zero, and there are 365 (one year) data points in total. This is how the table above was developed, and the data set that was analysed to obtain the values displayed in Table 2, were transformed into a control chart, see Figure 38 below, which was then analysed to obtain the values depicted in Table 2.

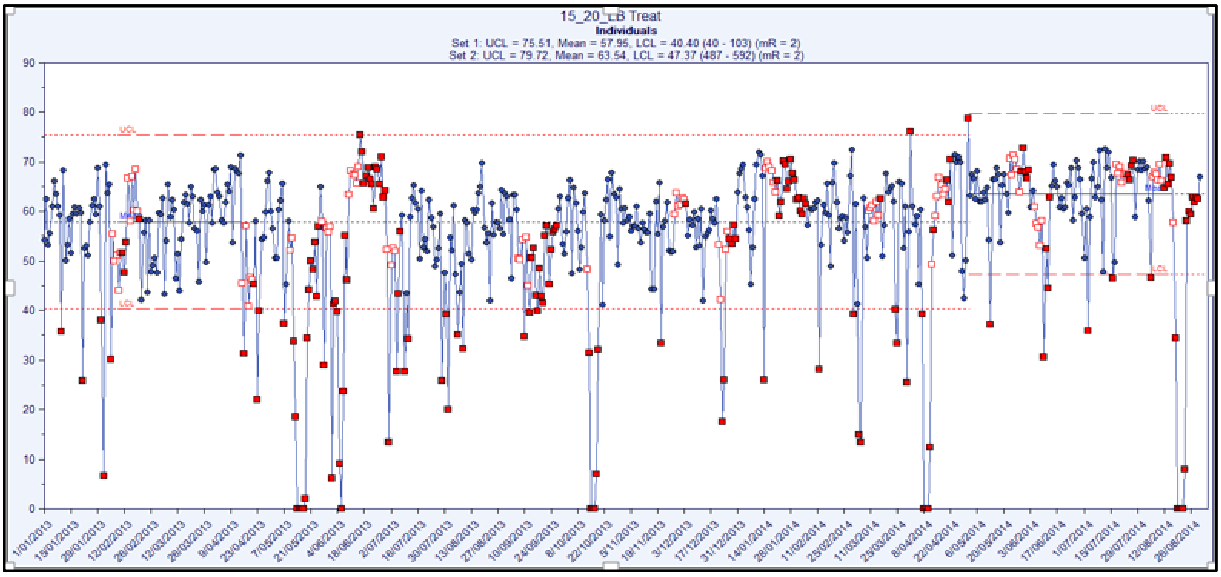


**Figure 38 - Data set transformed into a control chart to analyse for special causes, as well as, unconstrained data ranges**

It is a control chart such as the one depicted in Figure 38 that is also used to determine determine the parameters of the statistical distributions used to model the 'transform' and 'transfer' activities.

Step 2: It is advised to set up table or use a similar method of that depicted in Figure 45 below. This table is used to determine the probability of a special cause occurring and the impact the special cause will have if it does occur.

| | Days Below LCL | | Zero days | | Total |
|---|---|---|---|---|---|
| **Date** | **Probability** | **% Impact** | **Probability** | **% Impact** | **PxI** |
| 2015-01-01 | 0 | 49% | 0 | 100% | 100% |
| 2015-01-02 | 1 | 53% | 0 | 100% | 47% |
| 2015-01-03 | 1 | 47% | 0 | 100% | 53% |
| 2015-01-04 | 0 | 44% | 0 | 100% | 100% |

**Figure 39 - Incorporation of special causes into stable data distributions**

The probability column of Days below LCL was calculated using a Binomial distribution (a 1 or a 0) with a probability of:

$Binomial\ probability\ parameter = \frac{total\ days\ below\ LCL}{total\ number\ of\ days}$ = 47/365, the function looks as follows:

AAOM Flowsheet

SPT Flowsheet

`=RiskBinomial(1;$I$4/$J$4)`

The percentage impact column is calculated by fitting a PERT distribution with the parameters being in terms of percentages. The distribution will generate random statistical percentages according to the impact parameters used, i.e. biggest impact percentage of a special cause, least impact percentage of a special cause and the average impact that a special cause has. The parameters are described as follows:

> PERT(X, Y, Z)
> X – The special cause that has the least impact in terms of percentage.
> Y – The most likely impact that the special cause has in terms of percentage.
> Z – The special cause that has the highest impact in terms of percentage.

The probability column of zero days was calculated using a Binomial distribution (a 1 or a 0) with a probability of number of zero days divided by total number of days. This distribution is used over the period of 365 days.

`=RiskBinomial(1;$I$5/$J$5)`

The percentage impact column for zero days is 100% throughout, as any zero day will have a 100% impact on the performance and throughput of the operation. To work out the total percentage impact that the special cause has the function in Figure 40 below is used, and the total column in Figure 39 above is produced, which needs to be multiplied through by the unconstrained total output of the Mine 'transform' activity of the Business Structure in the model calculations tab. This will ensure that the special causes are integrated into the model. For any special cause that affects the performance of the operation, it can be integrated in a similar manner

`=MAX(1-(I10*J10+K10*L10);0)`

**Figure 40 - Overall impact percentage function**

Where,

> I10 = the probability that the specific day (2015-01-01) will be below the LCL. This value is obtained from the values in Figure 39.
> J10 = the percentage impact obtained from the PERT distribution that the special cause will have on the stable distribution from the values depicted in Figure 39.
> K10 = the probability that the specific day (2015-01-01) will be equal to 0, which is obtained from the values in Figure 39.
> L10 = the percentage impact that a 0 day (always 100% impact) has on the stable distribution, which is obtained from the values in Figure 39.

It is also important to observe from the control whether or not the data over the summer period is significantly different to the data over the winter period. If this is the case a summer distribution needs to be created over the summer period and a different winter distribution needs to be used over the winter period. If this is the case the user should be able to input separate parameters for both the summer distribution and as well as the winter distribution in the ‘Process Input Data’ tab as depicted in Figure 42 below:

| SUMMER Distribution | | | WINTER Distribution | |
|---|---|---|---|---|
| Best | 300000 | | Best | 200000 |
| Most Likely | 225000 | | Most Likely | 130000 |
| Worst | 130000 | | Worst | 0 |

**Figure 41 -The parameters that need to be inputted for the different distributions**

## 7 CLOSING COMMENTS

This document provides examples of how the logic of a BSP model can be built. It serves to provide insight to the user on how previous BSP models were developed, and what thought process was integrated into the model. This document is intended to provide a starting point for the BSP model developer and to assist the developer through the process of building a BSP model.

Every operation is different and may need to be modelled slightly different to how this document describes the modelling process. The developer should be able to use the knowledge obtained from this document to adapt and alter the developing steps of this document to build a representable and authentic BSP model for the operation that the developer is building the model for.

The developer needs to apply his/her expertise of the operation in concern to the methods described in this document. The developer needs to use his/her discretion as necessary to develop an efficient and beneficial BSP model.

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SPT Flowsheet

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INTERNAL

# ANGLO AMERICAN OPERATING MODEL: OPERATIONAL PLANNING
## SET PRODUCTION STRATEGY

**UPDATED: AUGUST 2018**

**CONTENTS**




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# PS.00 Set Production Strategy

## Context

Within the Operating Model three terms[1] are used to classify different types of activity that can be applied to a process. These are;

1. *Production Work* – activities directly involving transferring, transforming or storing materials or information within a process. For example:
   a) in a mining/mineral processing environment; blasting, hoisting, stockpiling, grinding, smelting.
   b) in a power generation environment; transferring fuel, transforming energy (e.g. oil to heat, rotation of alternator to electricity), transforming voltage & current levels and transmitting power over lines.
   c) in a procurement and supply environment, placing orders, receiving, warehousing and issuing goods.

   **Note:** The world is full of interconnected processes, and the output of one process may produce and/or deliver an output (materials or information) that is an input (ingredient, reagent or consumable) in another process. In such cases the process that is delivering the input may sometimes be described as providing a 'service' to the primary process, and hence it may be tempting to classify all work taking place in the source process as ‘service’ work. This approach does not fit with the definition of Production and Service work adopted within the Operating Model, since the 'service' process is also transferring, transforming or storing materials or information. Hence, in the Operating Model, all activities involved in transforming, transferring or storing materials or information, in any process, are defined as the Production work of that process.

2. *Service Work* – activities involved in identifying and managing threats (to both the process and its environment) associated with a Process. For example:
   a. in a mining/mineral processing environment; monitoring and maintenance of environmental controls, monitoring and maintenance of ground support or pit walls, monitoring and maintenance of roads, monitoring and maintenance of equipment.
   b. in a power generation environment; monitoring and maintenance of environmental controls, monitoring and maintenance of equipment.
   c. in a procurement and supply environment; stocktaking, contract compliance assessment and turning of bearings on warehoused spare equipment.

   From this definition of Service work it should be obvious that setting a Service strategy is a process of risk management. It follows then that in

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[1] These terms are adapted from the work of Macdonald Associates.

order to effectively set a Service Strategy it is first necessary to understand the threats that may exist or arise in or around a process.

3. *Support Work* – activities that predominantly serve the purpose of improving the effectiveness or efficiency of a Process. That is, Production and Service work can proceed without effective Support work, but the outcomes and or cost may not be optimal. Many of the elements of the Operating Model define activities that Support the improvement of the effectiveness of a task, function or operation that we are applying the Operating Model principles to. These include Setting Performance Targets, Setting Production and Service Strategies, Setting an Operating Master Schedule, Setting an Expenditure Schedule, Approving Work, Planning Work, Scheduling Work, Measuring results and applying Analyse and Improve.

The concepts of Production, Service and Support work can be applied to any process - spanning a single task undertaken by a person, through to the running of a function, department or operation. In every case the effective, efficient sustainable delivery of the outcome should involve;

- **activities** to turn inputs into outputs,
- **activities** to identify and manage potential threats, and
- **activities** for planning, organising and problem solving to optimise performance.

Therefore, in the Operating Model the terms Production, Service and Support are applied to activities and not to roles, functions, departments, etc. While it is helpful to consider these different activities independently during the process of identifying options for delivering the activity purpose, there will almost always be interaction and/or interdependence in the delivery of the activities.

Through the rest of the Operational Planning Process the Operating Model documentation will refer to the detailed elements of Production and Service work activities as work steps.

Some, but not all, Production work is undertaken by people. For example, in mining people are directly involved in the set-up and operation of equipment that transforms or transports ore. In mineral processing almost all of the transformation and transfer of material is undertaken by hardware, and the 'operators' of the plant almost exclusively inspect, monitor, adjust and replace items in order to protect and sustain performance. In accounting or human resources processes Production work is typically shared between people and hardware. In the Operating Model element of Set Production Strategy we will consider all Production work, whether performed by people or hardware, since we wish to optimise the overall Production Strategy. The differentiation between work steps performed by people or hardware comes in implementation.
Setting the Production Strategy considers the Production Strategy options for running the process (i.e. our approach to running the process) and, for the selected strategies, the operating specifications required to implement them. Those Production work steps that will be undertaken by people should then be translated into Work Packages that will be managed via the Operating Model.

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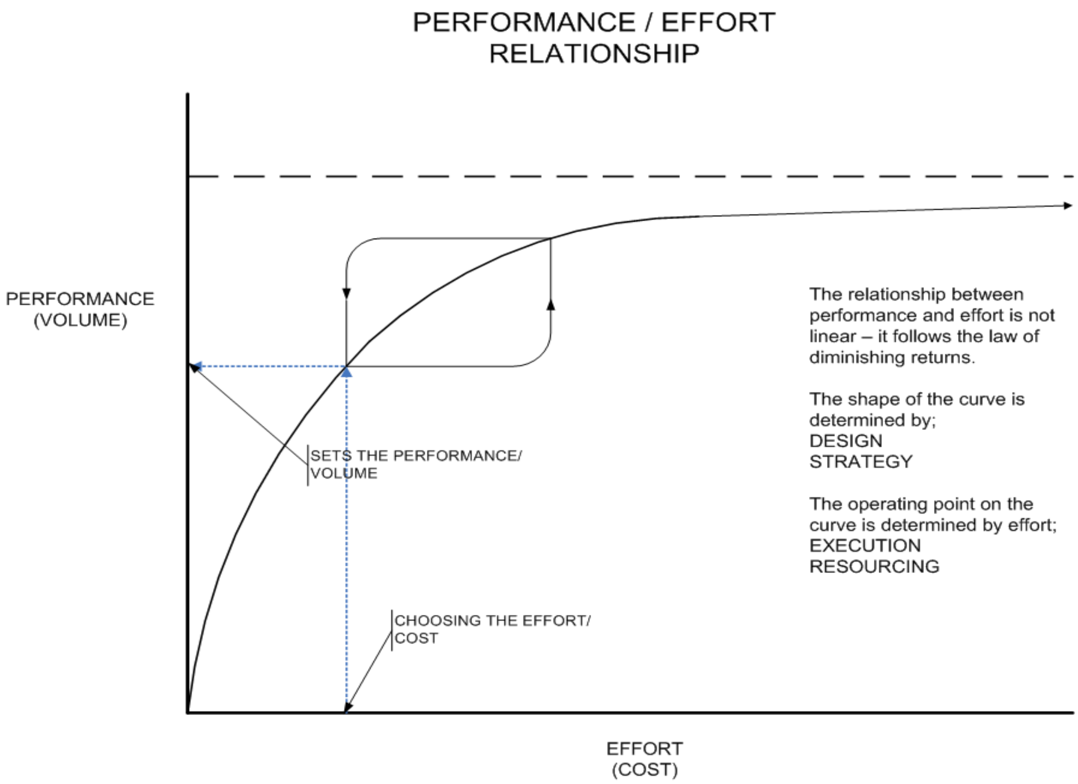
Those Production work steps that will be implemented through process automation and computer systems must obviously be translated into the hardware and software design of those systems.

The underlying theory for the Operating Model design is that process output performance will be delivered if the Right Work is completed at the Right time and in the Right way – and that this output performance will be achieved more consistently, and at lower cost, if the work is planned, scheduled and resourced in advance of its execution. This theory applies equally to the Production, Service and Support work of a process.

It follows then that a complete system to implement the Operating Model theory must contain elements to establish what is the right Production work, the right time to execute that work (specified as the sequence and trigger event for the work), and the right way to complete the work. This component of the Operating Model is termed setting the Production strategy.
The effect of Production Strategy can be placed in context via the following diagram.






The design and strategy selected for the process define the shape of the performance/effort curve. The asymptote to the initial slope of the curve is defined by the limiting efficiency of the process, and the asymptote to the maximum output is defined by the limiting capability of the process. The execution and resourcing of the strategy will determine the operating point on the curve, i.e. variation in the execution of the strategy, and/or from the input specifications (resourcing), will produce variation in the process output as determined by the shape of the curve.

When a change in the quality of execution or resourcing occurs there is typically a time lag between this change and the evidence in the output. This occurs for both reductions and increases in effort and is indicated by the loop drawn around the curve (known as a hysteresis loop). This suggests the type of see-sawing performance, and associated losses, that occurs when the Right Work is not consistently done at the Right Time and in the Right Way.

The transform, transfer and store work steps in a production process are determined in the design Theory of the process. This is guided by the Purpose of the process, the inputs available to it and the underlying theory (which may include physics, chemistry and technology, etc.) applied to deliver the Purpose. The production process work steps do not change unless the underlying design Theory changes. However, if the process or its Theory is complex, the transform, transfer and store work steps may perhaps be organised in a number of alternate ways (series/parallel arrangement of the steps), with different impacts on the effectiveness or efficiency of the process. The process Theory may also allow choices around operating set points for parameters such as speed/flow, temperature, recipe, chemistry, etc. that can alter the rate of process throughput, and therefore the effective efficiency and capability asymptotes, to a value below the design limiting values. Finally, the performance/effort curve of a process can also be shifted by changing the input or output specifications. Optimising Production strategy for a given performance target therefore involves a range of choices that can be made around organisation of the process work steps determined by the process design, and how the process is operated; i.e. running time, rate set points, and what quality of inputs and outputs are specified.

The optimum Production and Service Strategy choices will be the balance of choices that best meet the Effectiveness, Efficiency and Sustainability targets of the process. These choices will define the Right Work, Right Time and Right Way for transform, transfer and store work steps.

### *Right Work*

The Right Work for a production process is defined through;

- identification of each distinct work step required for the transformation, transfer or storage of the material, service or information, and
- identification of the arrangement, sequencing and dependencies for each work step.

The Right Work can be defined with a flowchart or animation of the work steps in the Production process. Note. This is what the Operating Model design flowcharts do, and is also what a process plant flow-sheet does.

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### *Right Time*

The fact that there is sequencing and dependency of Production work steps indicates that there is a Right Time for each action. The Right Time will be a trigger event and trigger tolerance that will be determined by the flow-sheet of the process and/or the specification for the Production steps. Trigger events may take a variety of forms;

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- the occurrence of another event – e.g. the completion of a precedent action. In drill and blast charging comes after drilling. In mineral processing size screening comes after crushing. In a supply chain process goods storage comes after receiving. These sequence of these actions is defined in the process flowsheet.
- the passing of a specified time period – e.g. in gold smelting stripping the mould from the ingot comes after a specified cooling time. The values for these time periods will be set out in automatic control systems or standard operating procedures.
- the achievement of a specified value or condition, e.g. the achievement of load specification limits in filling a truck will release the truck from the loading point. The achievement of a temperature specification in gold smelting will initiate the casting process. The values for these specifications will be set out in automatic control systems or standard operating procedures.

### *Right Way*

Each Production work step will have a specification. This may include the actions, outcomes, standards/tolerances, method of execution, conditions and constraints and resource requirements.

In most processes there will be a large number of actions required to implement all of the Production work steps, hence, for efficiency of managing those actions executed by people we will often wish to group the production actions with synergies into a smaller number of Work Packages that are more efficient to schedule, resource and execute. The workplace, conditions and constraints, resource requirements and trigger characteristics for actions are used to identify synergies for creating Production Work Packages.

Forecasts for the expected quantities, frequency and demand lead time for the resources (labour, materials and equipment) necessary for the execution of the Production Work Packages can be derived from the detailed specifications of the Work Packages, in combination with the process operating forecasts and the triggers for the Work Packages. This data can be used to define the service levels and supply/logistics strategies for the resources required to implement the Production strategy(s).

### *Operating Parameters*

The inputs that may be necessary for setting appropriate operating parameters for a process are;

- the output performance targets (including Effectiveness, Efficiency and Sustainability),
- the proven capability of the process (defined by the measured capability histogram),
- a detailed understanding of the process operation and technical specifications,
- a detailed understanding of the impact of operating parameters on process Service strategies.

There are five of these potential changes, and they can be adjusted separately or concurrently. They are:

- *Design change* - incremental change to the design of the production process work steps and/or their sequencing, or to change the process technology. In work step or flow changes unproductive work steps may be removed, serial work steps may be performed in parallel. A technology change in a mining process may be to change to lighter truck tray bodies in order to increase payload on each cycle. In a mineral processing plant this may be to change instrumentation or control loop design to reduce variation or shift operating levels. In a supply chain process it may be to introduce bar coding and scanners to reduce the processing time for materials movements.
- *Operating time (utilisation) change* - modify the operating times or patterns for the process. In a mining process this could be a change to 'hot seat' changeover on equipment in order to increase productive equipment time. In a mineral processing plant this could be extend the intervals between planned maintenance stoppages in order to increase operating time and stability. In an accounting function it could be to introduce variable working hours to deal with variable workloads through the monthly accounting cycle.
- *Operating Rate change* - modify the speed/flow, temperature, recipe, chemistry, cycle times or volumes for the process. In a mining process this could be to vary the payload, on haulage trucks in order to change the ore volume moved each cycle. In a mineral processing plant this could be to vary the speed of a conveyor in order to change material movement each hour. In a supply chain process this could be to change storage locations to change the picking times for items.
- *Feed (input) quality change* - modify the specification limits for the goods or services used/consumed by the process. In a mining process this could be to alter the cut-off grade to optimise value recovery from the ore-body. In a mineral processing plant this could be to change to an alternate feed or reagent specification in order to improve output volumes or cost. In a supply chain process it could be changing to electronic rather than paper documentation.
- *Product (output) quality change* - modify the specification limits for the goods or services produced by the process. In a mining process this could be to modify the size distribution achieved by blasting in order to service an alternate customer. In a mineral processing plant this could be to modify the chemistry or grade of a product in order to service an alternate customer. In a supply chain process this could be to change the purchase specifications for a material to increase available sources or improve pricing.

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Production and Service Strategy choices will frequently be highly interactive, and this is deliberately reflected in the way these two elements are represented in the Operating Mode – i.e. they are abutted to each other. Changes in Production Strategy may place different stresses on the process and therefore affect either the Service requirements, process sustainability, or both. Changes in Service Strategy may alter the available operating time or rate for the process, or both. Therefore, changes to Operating Parameters should not be

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considered independently. Any Production Strategy parameter may have interdependencies or interactions with other parameters. Changes to operating parameters may also change process efficiencies and/or require changes in Service Strategies. Operating Parameter changes can also modify the operational life of the process, i.e. there can be a trade-off between short term gain and longer operational life. In a mining process this could be to high-grade the ore body in order to improve short term cash flow at the cost of a reduced mining life. In a mineral processing plant this could be to increase operating loads in order to increase short term cash flow at the expense of reduced plant life or earlier re-investment in a new plant. In a supply chain process this could be a reduction in the supplier base leading to increased risk of exposure to supplier failure.

Production and Service activity outcomes and durations, and operating specification values, are never constant. They exhibit the inevitable variation that all real processes have. Additionally, there can be dependencies between some of these parameters, e.g. in a gold plant there is typically an inverse correlation between feed grade and recovery (i.e. as feed grade goes up recovery in the process goes down). Predicting the outcome that will be delivered from a choice of Production and Service Strategies means that we may have to deal with the independent and dependent variation that occurs in each of the potential strategy parameters. This will be dependent on the Target specification limits, required confidence level, and time period/sample size over which the target performance is assessed. To deal with variation successfully we must use a statistical model.

**Purpose**

To specify the most cost effective way to operate the process.

**Quantity**

The deliverables from setting a Production strategy shall include;

- One flowsheet of the Production process work steps.
- One list of Production Strategy critical issues/opportunities.
- One set of data quantifying alternate scenarios for feasible combinations of Production strategies (this may include the statistical modelling of the feasible combinations).
- One set of Production strategies, selected to be the most cost effective.
- One set of operating specifications for each step of the production process flowsheet.
- One list of Production process work steps executed by machines.
- One set of specifications for automatic control systems.
- One list of Production process work steps executed by people.
- One set of implementation action specifications (tasks) for each Production process work step executed by people.
- One set of Work Packages for implementation of Production work steps (tasks) executed by people.
- One set of service level specifications for resources required for Production work.

## Quality

The deliverables shall meet the following requirements;

- The flowsheet for the operating process shall define each transform, transfer and store work step comprising the Production process. In determining the level of detail in the flowsheet, proceed to the level that ensures each person operating or monitoring the process has a clear and unambiguous understanding of all of the work steps that are material to the delivery on the process outcomes, plus their sequencing and dependencies.
- The Production Strategy critical issues shall be those value driver parameters that will have the dominant impact on closing the gap between the current and required Capability Histogram(s) of the performance measures of the process.
- The feasible Production strategies for each Productive Unit shall include the following;
  - Design
  - Operating Time,
  - Operating Rate,
  - Feed Quality,
  - Output Quality.
- The feasible and selected Production strategies shall be substantiated by statistical modelling indicating the potential range of performance outcomes for a combination of Production strategies for each Productive Unit. The range of potential outcomes shall be in the form of capability histograms for the output of the Productive Unit, and for each of the independent characteristics that contribute to output (time, rate, quality, efficiency, etc.) that are used as an input to the model.
- Operating specifications shall be provided for every step in the process flowsheet, and for the actions necessary to deliver the step. In determining the level detail in the specifications proceed to the level that ensures will be a clear and unambiguous understanding of all operating parameters that are material to the safe and successful completion of the production step/actions, and the process as a whole. Note – machine executed steps will typically require a much more detailed flow-sheet and specification than those executed by people, because people typically have knowledge, experience, skill judgement that they will use in conjunction with the flow sheet and specification.
- The Production work steps/actions executed and controlled by machines shall be those where both the physical effort and its control is undertaken by machinery (i.e. fully automated).
- The specifications for control systems shall include the inputs, outputs, process control logic and operating specification limits.
- The Production work steps/actions executed or controlled by people are those where people either directly provide physical effort to complete the step (e.g. pushing a wheelbarrow), or where they manually control equipment that provides the physical effort to execute the work step (e.g. driving a truck).
- The specifications for a Production action to be completed by a person shall include work outcomes and specifications, trigger parameter for

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the action, allowable tolerance for completion of the action around the trigger parameter, constraints or conditions necessary for completing the action, resources required for the action, and estimated cost of the action.

- Work Packaging shall consolidate Production actions into efficiently manageable Work Package (typically those actions that have the same workplace and trigger parameters, use the same resources, and share the same condition and constraints).
- The service level specifications for resources shall include the quality, quantity and demand lead time (the interval between when the need for the resources can be identified and the need must be fulfilled) for each resource.

All data fields that form part of the Production strategy analysis and specification process, and that are also required for implementation of the strategy in a Work Scheduling System (a WSS - provides automatic triggering of work packages based on specified trigger parameters), shall use the standard codes and definitions from the appropriate WSS.

A database shall be used to record the Production strategy analysis outcomes and rationale. The database shall include;

- the Production process flowsheet,
- the proven performance (Time, Rate, Quality, Efficiency, etc. capability distributions) for the steps of the process,
- feasible Production strategies,
- selected Production strategies (most cost effective),
- action(s) required for Production steps implemented by people,
- Trigger Parameter and Completion Tolerance for each Production action implemented by people,
- Constraints or Conditions for each Production action implemented by people,
- resource requirements for each Production action implemented by people,
- Work Scheduling system (WSS) Standard Job reference for the Work Package in which the Production action is implemented, and
- service level specification for Production resources.

The detailed activities of setting a Production strategy shall conform to the specifications set out in the Set Production Strategy Flowchart and TAs PS.01 to PS.17.

# PS.01 Analyse Target Production Distributions

## Context

Within the Operating Model the term Production work is used to describe the **activities** directly involving transferring, transforming or storing materials, services or information within a process. For example:

a) in a mining/mineral processing environment; blasting, hoisting, stockpiling, grinding, smelting.
b) in a power generation environment; transferring fuel, transforming energy (e.g. oil to heat, rotation of alternator to electricity), transforming voltage & current levels and transmitting power over lines.
c) in a procurement and supply environment, placing orders, receiving, warehousing and issuing goods.

The Operating Model considers three characteristics when defining process outcome Performance Targets, and hence measures of Production work success. These are;

- Effectiveness - the output delivered over time (which should include quantity, quality and time).
- Efficiency - the ratio between output delivered and resources consumed over time.
- Sustainability - the resources/condition(s) available to underpin the continued operation of the process (e.g. buffer stocks).

See Set Performance Targets for more discussion about measuring these characteristics.

The process of Setting Performance Targets undertakes the analysis and modelling needed to define the performance that each Process and Productive Unit of the Business Structure must deliver, in order for the overall Business Expectations to be met. Since all real world process show variation in their performance over time, performance targets are stated in the form of target specification, a confidence level of achieving that specification over a given time period and a margin of error (an indication of the spread of the performance distribution). These outputs from Set Performance Targets are the Process and Productive Unit Capability histograms (performance distributions) that, when modelled, produced a performance forecast that could meet the Business Expectations. The process of Setting Production Strategy will look for the most cost effective operating regime that can deliver the target performance specification for a Process or Productive Unit.

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The Effectiveness, Efficiency and Sustainability outcomes of a Process or Productive Unit are a function of several parameters that are directly influenced by Production and Service Strategy choices and implementation. These parameters include process; Design, Operating Time, Throughput Rate, Reliability, Quality performance, Work Management and Resourcing, Efficiency/Recovery, and Fixed and Variable Costs. The parameters for the target performance distributions of the Process or Productive Unit can provide insights into the options for adjusting these parameters.

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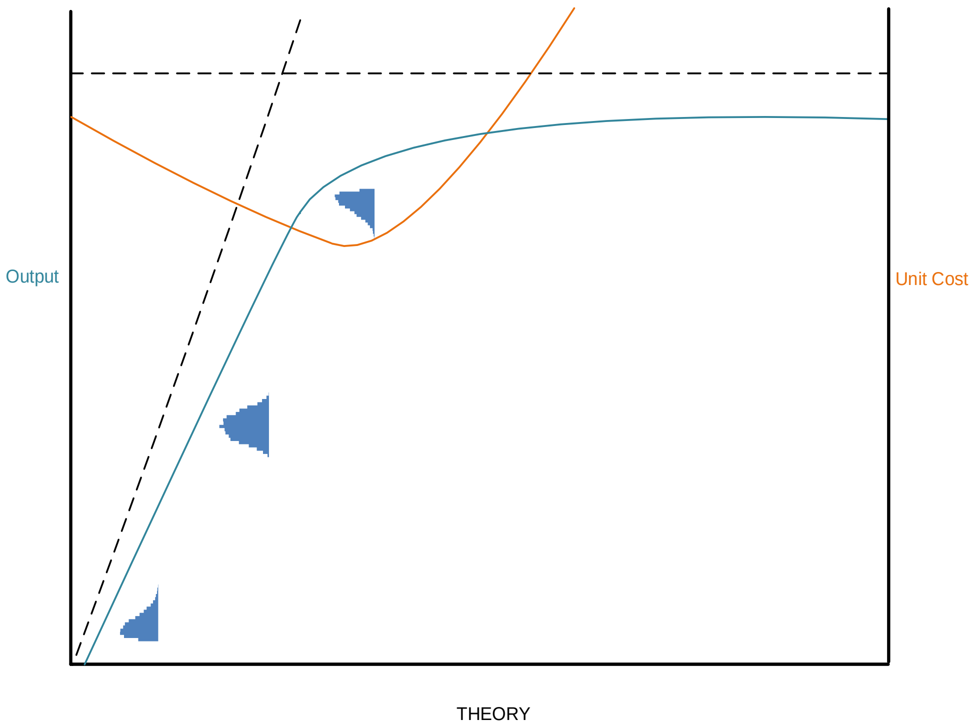
A requirement for a normal performance distribution suggests that the Process or Productive Unit is not the chosen dominant constraint in the value chain, and hence flexibility and responsiveness is the prime requirement. These can be achieved by either flexible resourcing or sacrificing some resource productivity. In this scenario Utilisation (both equipment and labour) and Throughput Rate are likely to be less than the maximum possible, but should be balanced on the basis of the impact these have on fixed and variable costs. Good process management (control systems and work management), and flexible resourcing strategies, will produce a tighter performance distribution, with adjustability to match the demand of the intended value chain constraint. This will result in higher Efficiency.

A requirement for a strongly left skewed distribution suggests that the Process or Productive Unit is an intended constraint in the value chain, and hence maximised productivity is required. In this case Utilisation and Throughput Rates should be maximised within the bounds of acceptable Efficiency and Sustainability – noting that Efficiency and Sustainability decline rapidly when a process is pushed beyond the inflexion point of the performance effort curve. Here as well, good process management (control systems and work management) will produce a tighter performance distribution, resulting in higher process Effectiveness and Efficiency. Resourcing flexibility is not likely to be possible or appropriate in this scenario – since the logical location for a designed value stream constraint is where capacity is the most expensive or difficult to add.




In order to effectively evaluate potential Production strategies, and then to select the most cost effective combination, it is necessary to understand both the Performance Target distribution characteristics and the historical performance of the process. This will assist in identifying the type of strategy outcomes required and the most appropriate options to focus on.

A comprehensive estimate of the performance results of any set of strategies cannot be finalised until the Set Operating Master Schedule and Set Expenditure Schedule processes have also been completed, however, during the Set Production Strategy process some approximations can be made in order to identify the strategy options that are likely to be the most cost effective.

**Purpose**

To identify the Production Strategy characteristics that will be most significant to delivering the required Process or Productive Unit performance targets.

**Quantity**

- One set of Production Strategy characteristics relevant to achieving the target performance distribution for a Process/Productive Unit.

**Quality**

In defining the Production Strategy characteristics consider the following.

- The maximum of the target distribution. This will influence choices of the;
  - maximum Throughput Rate,
  - maximum Utilisation,
  - maximum feed quality,
  - minimum output quality, and/or
  - maximum quantity of processing resources.
- The minimum of the target distribution. This will influence choices of the;
  - minimum Throughput Rate,
  - minimum Utilisation,
  - minimum feed quality,
  - maximum output quality, and/or
  - minimum quantity of resources.
- The spread of the target distribution. This is an indication of the flexibility in performance required by the Value Stream. This will influence choices of whether performance variability may be best delivered through varying;
  - Throughput Rate,
  - Utilisation,
  - Feed quality,
  - Output quality, and/or
  - resource quantities.
- The choice of which parameters to make variable should be based on consideration of;
  - Practicality (with regard to process technical and product quality specification limits),
  - impact on yield/recovery,
  - impact on fixed costs,
  - impact on variable costs, and/or
  - process sustainability.

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The output of this task should be an analysis of the above choices recording the:

- Key data and assumptions used.
- Production Strategy characteristics concluded to be most significant to achieving the target performance distribution.
- Reasons for the conclusions made.

**Time**

The Production Strategy shall be specified during establishment of a process.

Review and validation of Production Strategy shall be based on either a change of targets driven by changing business expectations or the benefit ranking of improvement opportunities identified through analysis of performance.

**Resources**

Specification of Production Strategy is the accountability of the role identified in the configured flowchart.

# PS.02 Analyse Historic Production Distributions

## Context

Within the Operating Model the term Production work is used to describe the actions directly associated with transferring, transforming or storing materials, services or information within a process. For example:

a) in a mining/mineral processing environment; blasting, hoisting, stockpiling, grinding, smelting.
b) in a power generation environment; transferring fuel, transforming energy (e.g. oil to heat, rotation of alternator to electricity), transforming voltage & current levels and transmitting power over lines.
c) in a procurement and supply environment, placing orders, receiving, warehousing and issuing goods..

The Operating Model considers three characteristics when defining process outcome Performance Targets, and hence measures of Production work success. These are;

- Effectiveness - the output delivered over time (which should include quantity, quality and time).
- Efficiency - the ratio between output delivered and resources consumed over time.
- Sustainability - the resources/condition(s) available to underpin the continued operation of the process (e.g. buffer stocks).

See Set Performance Targets for more discussion about the measuring these characteristics.

The process of Setting Performance Targets undertakes the analysis and modelling needed to define the performance that each Process and Productive Unit of the Business Structure must deliver, in order for the overall Business Expectations to be met. Since all real world process show variation in their performance over time, performance targets are stated in the form of target specification, a confidence level of achieving that specification over a given time period and a margin of error (an indication of the spread of the performance distribution). These outputs from Set Performance Targets are the Process and Productive Unit Capability histograms (performance distributions) that, when modelled, produced a performance forecast that could meet the Business Expectations. The process of Setting Production Strategy will look for the most cost effective operating regime that can deliver the target performance specification for a Process or Productive Unit.

The Effectiveness, Efficiency and Sustainability outcomes of a Process or Productive Unit are a function of several parameters that are directly influenced by Production and Service Strategy choices and implementation. These parameters include process; Design, Operating Time, Throughput Rate, Reliability, Quality performance, Work Management and Resourcing, Efficiency/Recovery, and Fixed and Variable Costs. The parameters for the historic performance distributions of the Process or Productive Unit can provide

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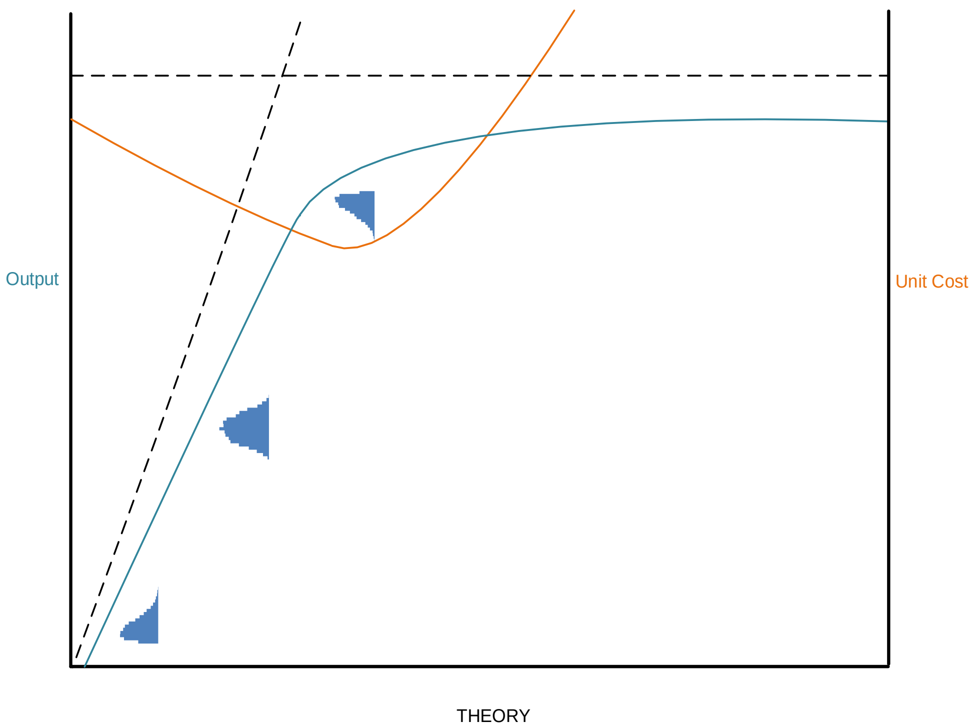
insights into the options for adjusting scope for adjustment of these parameters, and into the interactions that occur between them.

A normal performance distribution suggests that the Process or Productive Unit is not operating with a single dominant constraint, but performance is determined by multiple independent variables. It is possible that the technical capacity limit of this process is not being reached and may not even be known with confidence. The capability of the process can be restricted by low or variable Utilisation, Throughput Rate and/or through poor process management (control systems and work management). A change to process design is not a good choice of Production strategy in this scenario.

A strongly skewed distribution suggests that the Process or Productive Unit is operating with a single dominant constraint. For a left skewed distribution this will be caused by either Utilisation and/or Throughput Rate approaching a current technical limit. For a right skewed distribution this will be caused by either very low Utilisation and/or a lack of effective resources. A change to process design is not a good choice of Production strategy in this scenario.
If a distribution has a wide spread then it suggests that either the flexibility demanded of the process is high, or that the execution or resourcing of the process is variable. Here, good Service strategy and process management (control systems and work management) will produce a tighter performance distribution, resulting in higher process Effectiveness and Efficiency.

**Figure 1.**




In order to effectively evaluate potential Production strategies, and then to select the most cost effective combination, it is necessary to understand both the Performance Target distribution characteristics and the historical performance of the process. This will assist in identifying the type of strategy outcomes required and the most appropriate options to focus on.

In the Operating Model, the processes of Measure Process Performance and Measure Work Management performance will provide the data for the historical Purpose and Theory (including Production Strategy Theory) performance of the process. This data will allow the effects and interactions of Utilisation, Throughput Rate, Quality, Schedule Effectiveness, Schedule Completion, etc. on Process performance to be analysed.

Since all real world processes show variation in their performance over time, performance measures are provided in the form of Control Charts and Capability Histograms (performance distributions).

There are four factors to be considered when gathering historical data analysis of Production strategy;

- *Process stability* - by definition, if a process is not stable then it is not performing in a consistent way – instability occurs when the process either deviates from normal operation or suffers a failure. Consequently, data from stable and unstable periods should be separated and data from unstable periods only used for production strategy analysis when the reason for the instability is a understood deviation.

- *Operating level* - the performance of a process will differ depending on the operating range within its performance/effort curve. *viz* since process performance curves typically follow the law of diminishing returns, performance distributions tend to be different at the bottom and top of the performance curve - see figure 1 above. Hence we need to understand where data sits in the process performance effort curve and why the process was at that operating level.

- *Sample size* - the more data that is available the representative it will be. Small data sets tend to under represent the range of variation that can be expected from the process, hence allowance will need to be made in the analysis for the data set size.

- *Data Independence* - the data we collect may include independent and dependent elements. This is particularly true for the Purpose measures of a process in a connected series of Value Chain elements, unless there are significant storage points that effectively isolate the process from its pre/proceeding elements. Since the distribution output from the Set Performance Targets process is for the forecast independent performance distribution we must also look at the historical independent measurement data. The Theory measures for a process are generally likely to have a high degree of independence but the issue should be considered when looking at the data.

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**Purpose**

To identify the Production Strategy capability of a Process or Productive Unit from the historic performance measures

**Quantity**

- One set of historical Purpose and Theory measure data for the Process or Productive Unit.

- One set of characteristics defining the constraints and opportunities for adjustment of Production strategy parameters.

**Quality**

The historical data must, as far as possible;
- represent stable, or fully understood, performance,
- be conditioned, where necessary, to remove dependent variation. Note that when there is significant storage between elements of the business structure there may be little dependent variation in the data,
- represent performance for operating ranges across the performance/effort curve (so that the curve can be interpreted from the data sets),
- constitute a representative sample of the process performance, or be extrapolated to account for a limited data set.

In defining the Production Strategy constraints and opportunities consider the following.
- The maximum of the measured historical distributions. This will be influenced by the;
    - maximum Throughput Rate,
    - maximum Utilisation,
    - maximum feed quality,
    - minimum output quality, and/or
    - maximum quantity of processing resources.
- The minimum of the measured historical distributions. This will be influenced by the;
    - minimum Throughput Rate,
    - minimum Utilisation,
    - minimum feed quality,
    - maximum output quality, and/or
    - minimum quantity of resources.
- The spread of the measured historical distributions. This is an indication of the variability in performance displayed by the process. This will be influenced by the;
    - controlled flexibility of processing resources,
    - feed quality variation,
    - output quality variation,
    - uncontrolled resource quantity or quality variation, and/or
    - process management (control systems and work management).

**Time**

The Production Strategy shall be specified during establishment of a process.

Review and validation of Production Strategy shall be based on either a change of targets driven by changing business expectations or the benefit ranking of improvement opportunities identified through analysis of performance.

**Resources**

Specification of Production Strategy is the accountability of the role identified in the configured flowchart.

AAOM Flowsheet

SPS Flowsheet

# PS.03 Specify Production Process Work Steps

## Context

Within the Operating Model the term Production work is used to describe the actions directly associated with transferring, transforming or storing the goods or services that will form the output of the process. For example:

a) in a mining/mineral processing environment; blasting, hoisting, stockpiling, grinding, smelting.
b) in a recruitment services environment, advertising, screening applications, interviewing, reference checking, offer preparation.
c) in a procurement and supply environment, placing orders, receiving, warehousing and issuing goods..

The basic transform, transfer and store steps, and the sequence for their execution, in a Production process are determined in the design of the process. This is guided by the Purpose of the process, the inputs available to it and the underlying theory (which includes physics, chemistry and technology) applied to deliver the Purpose. Hence, the basic Production process steps, and there sequence, do not change unless one of these three change. For example, in a mining process the choice of blasting as the theory to fragment ore defines the basic drill, blast, load and haul steps and sequence for the process. While the location, timing and scale of these will vary over time, in accordance with the Life of Mine plan and schedule (which drives the Operating Master schedule and its content), the basic Work Packages and sequence is defined by the strategy choice. In mineral processing the choice of theory will similarly define the work steps and sequencing, however the location will be fixed and the timing and scale will be determined by choices around utilisation and operating rate.

Setting a Production Strategy therefore requires a correct understanding of the nature, sequence and relationships of the distinct transform, transfer and store steps of the Production process. A flowchart is an effective way of communicating this information.

## Purpose

To specify the flow of steps that make up the Production process.

## Quantity

- One flowchart of the Production process for each Productive Unit.

## Quality

The flowchart shall identify each distinct transform, transfer and store step that is be performed on a product or service within the Productive Unit.

For this purpose of constructing the flowchart, a step shall be considered distinct when it can be successfully performed at a separate time from other steps. For example, in blast hole drilling positioning of the drill and the boring of the hole are transfer and transformation steps that are performed as distinct steps, separate in time. The boring of the hole involves both fragmentation (transformation) of the rock and movement (transfer) of the broken rock out of the hole, however these two steps cannot practically be separated in time and therefore are not distinct. A flowchart would show both positioning, and boring as distinct steps.

The flowchart shall indicate the sequence of steps and the dependencies between steps.

**Time**

The Production Strategy shall be specified during establishment of a process.

Review and validation of Production Strategy shall be based on either a change of targets driven by changing business expectations or the benefit ranking of improvement opportunities identified through analysis of performance.

**Resources**

Specification of Production Strategy is the accountability of the role identified in the configured flowchart.

AAOM Flowsheet

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# PS.04 Specify Strategy Objectives

## Context

The outcome of TA PS.03, Analyse Target Production Distributions, was an analysis of the process performance required to deliver the Business Expectations and identification of the production strategy characteristics that are most significant to the achievement of the type of distribution required. The outcome of TA PS.02, Analyse Historic Production Distributions, was an analysis of historic process performance to identify the demonstrated limitations and capabilities in process performance. In order to progress the development of a cost effective Production strategy we need to compare the outputs of these two TAs and define:

- what type of change from current process performance is required to meet the target (variability, operating level or both),
- what change of specification from current process performance is required to meet the target (max, mode, mean, minimum),
- whether the process has a demonstrated capability that is consistent with the target requirements,
- what type of changes to the process production strategy specification or implementation are most relevant to achieving the change from current to target performance.

Once the Production strategy objectives have been defined we can look at the work steps within the process, understand the type and level of impact they have on the gap between current and target performance, and consequently identify the critical issues for closing the performance gap.

## Purpose

To specify the Production strategy objectives for the process.

## Quantity

- One statement of the type of gap that needs to be closed.
- One specification of the change in the Productive unit Capability Histogram that needs to be effected.
- One comparison of demonstrated and required capability.
- One list of changes to strategy specifications or implementation with probable relevance to the objective.

## Quality

The gap analysis shall be based on analysis undertaken in accordance with TAs PS.01, Analyse Target Production Distributions, and PS.02, Analyse Historic Production Distributions.

The objective statement shall specify:

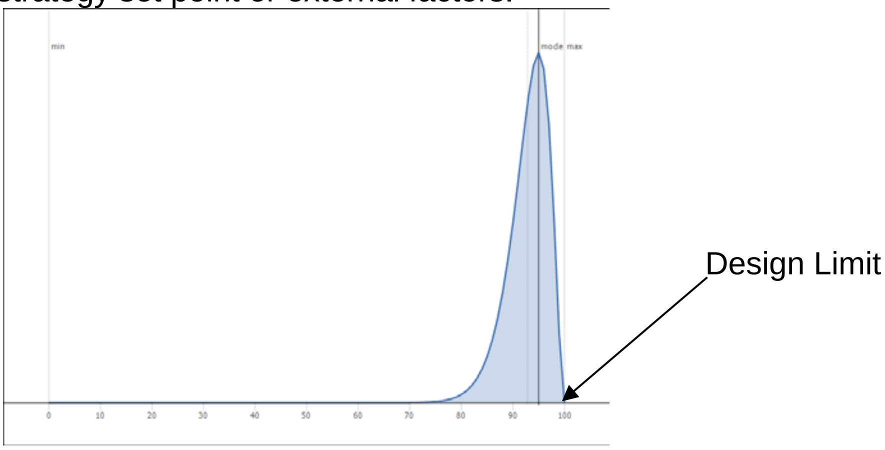
- If the required outcome is to;

    - reduce, for improved efficiency, or increase, for improved flexibility, process output variability over time,
    - shift the operating range, mode or mean of the process, or
    - both.

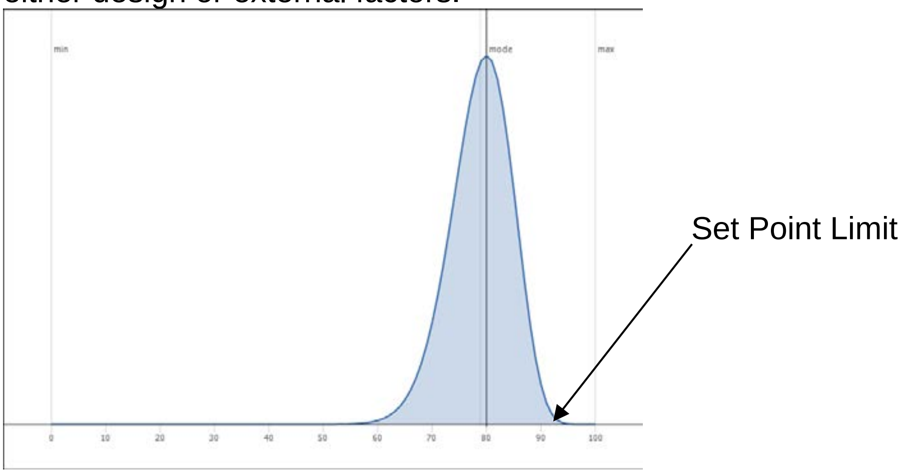
- The changes required to one or more of the Capability Histogram parameters;
    - the values of the minimum, maximum, mean or mode of the distribution, and
    - the 'weighting factor' (spread of the distribution).

- The demonstrated performance parameters;
    - the values of the minimum, maximum, mean or mode of the distribution, and
    - the 'weighting factor' (spread of the distribution).

- The most probable changes to be further investigated, consider;
    - Process design where the historic performance demonstrates a skewed distribution that is not limited by either operating production strategy set point or external factors.




    - Production strategy set point where the historic performance demonstrates a normal or skewed distribution that is not limited by either design or external factors.

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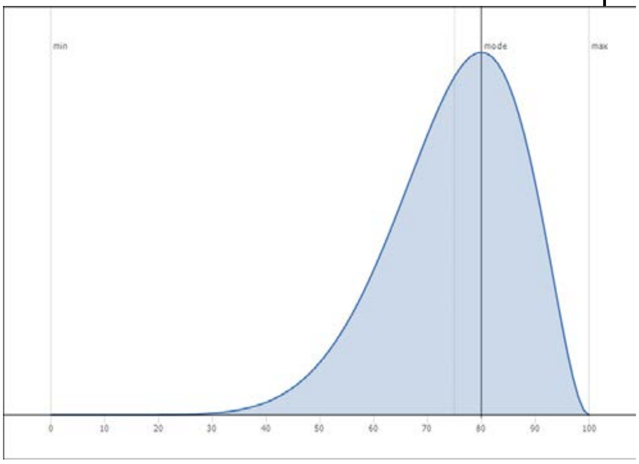
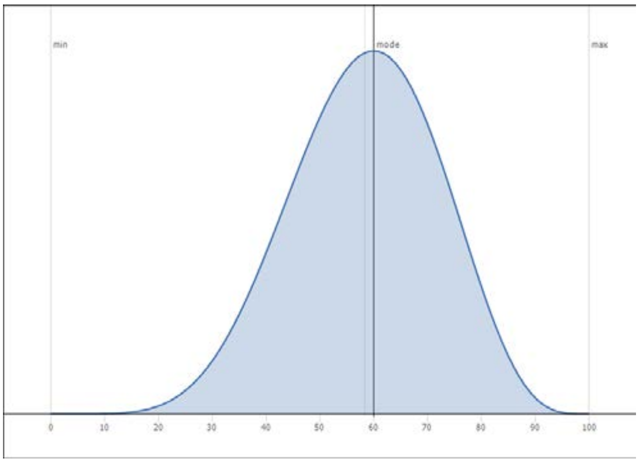
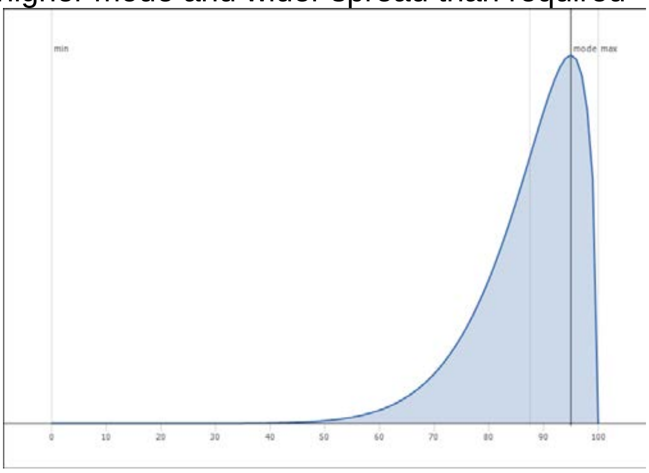
- Production strategy implementation quality (control system or work management optimisation) or resourcing quality improvements when the historic performance demonstrates a normal or skewed distribution with lower mode and/or wider spread than required.




- More flexible resourcing levels where a wider distribution spread is required to avoid restricting a design constraint elsewhere in the Value Stream.




- Service strategy specification or implementation quality (work management) or resourcing quality improvements when the historic performance demonstrates a normal or skewed distribution with higher mode and wider spread than required



## Time

The Production Strategy shall be specified during establishment of a process.

Review and validation of Production Strategy shall be based on either a change of targets driven by changing business expectations or the benefit ranking of improvement opportunities identified through analysis of performance.

## Resources

Specification of Production Strategy is the accountability of the role identified in the configured flowchart.

AAOM Flowsheet

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# PS.05 Identify Critical Process Work Steps

## Context

Within the Operating Model the term Production work is used to describe the **activities** directly involving transferring, transforming or storing materials, services or information within a process. For example:

a) in a mining/mineral processing environment; blasting, hoisting, stockpiling, grinding, smelting.
b) in a power generation environment; transferring fuel, transforming energy (e.g. oil to heat, rotation of alternator to electricity), transforming voltage & current levels and transmitting power over lines.
c) in a procurement and supply environment, placing orders, receiving, warehousing and issuing goods.

The transform, transfer and store elements of the various value streams within an Operation, comprising Processes and Productive Units, were defined in the Operating Model in the step of Defining the Business Structure in the process of Setting Performance Targets. Within a transform or transfer Process or Productive Unit is also likely that there may be multiple work steps that also involve the transforming, transferring or storing of material or information. These work steps were defined in TA PS.03, Specify Process work Steps.

The transform, transfer and store work steps in a production process are determined by the design of the process. This is guided by the Purpose of the process, the inputs available to it and the underlying technical theory (which may include physics, chemistry and technology, etc.) applied to deliver the Purpose. The production process steps do not change unless the underlying technical Theory changes. However, if the process or its Theory is complex, the transform, transfer and store steps may perhaps be organised in a number of alternate ways (designs - series/parallel arrangement of the steps), with different impacts on the effectiveness or efficiency of the process.

Once we have identified the objective of the Production Strategy review we need to look at the work steps within the Process or Productive unit (there will be at least one and maybe more) to identify which will have the greatest impact on delivering the objective that has been specified for the Production strategy.

The complexity of the work involved in doing this may vary, dependent on;

- the number of work steps - the more to choose from the complex the choice may become,
- the relative contribution of each work step to the Process or Productive Unit performance - if there is only one or a few very dominant work steps then they will have the greatest impact and be easy to identify,
- the number of series or parallel work steps – the more unbuffered series work steps the greater the possibility that interdependent variation between work steps drives performance rather than a single work step, and
- the availability of data on the work step performance.

Identifying the critical process work steps should always be based on data, and may involve;

- analysing potential work step contribution to the objective performance gap,
- accessing or creating data, and
- validate hypotheses, including testing or modelling (in some cases Value Steam Monte Carlo simulation).

**Purpose**

To identify the work steps within a Process/Productive Unit that are most critical to the Production strategy objective.

**Quantity**

- One completed 'Issue Investigation' (using the Operating Model A&I process) including;
    - One list of probable significant contributors,
    - One set of validation specifications,
    - One set of data to support validation.
    - One set of tests or modelling validating the critical process work steps.
- One quantified (Pareto style) ranking of the work step contribution to the Production strategy objective.

**Quality**

The identification of the critical process work steps shall be undertaken in accordance with the Operating Model Analyse and Improve process Issue Investigation.

**Time**

The Production Strategy shall be specified during establishment of a process.

Review and validation of Production Strategy shall be based on either a change of targets driven by changing business expectations or the benefit ranking of improvement opportunities identified through analysis of performance.

**Resources**

Specification of Production Strategy is the accountability of the role identified in the configured flowchart.

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# PS.06 Identify Potential Strategies

## Context

Once the gap between historical and target performance has been determined, and the critical Production steps identified, we must determine what Production strategies are potentially available to close the performance gap.

There are five basic strategy options that may be applicable. These are;

1. Design change - incremental change to the design of the Production process. This may include changes to the process; flow sheet, technology (hardware, reagents, etc.) or technical operating points (chemistry, temperature, pressure, etc.).
2. Operating time (utilisation) change - modify the operating times or patterns for the process..
3. Operating Rate change - modify the cycle times or volumes for the process.
4. Feed (input) quality change - modify the specification limits for the goods or services used/consumed by the process.
5. Product (output) quality change - modify the specification limits for the goods or services produced by the process.

The strategies that are appropriate for a particular situation, and for a Production step, will depend upon a few basic factors;

- The technology employed in, or available to, the process.
- The current operating point(s) within the proven safe operating range of the process technology.
- The technical feasibility of each of the strategy options.
- Interdependence/interaction between production strategy options.
- The impact on process efficiency.
- The impact on equipment service life and service strategy.
- The impact on probable operational life.
- The potential risks that may be associated with implementing the strategy.
- The total cost of adopting the strategy (total production and service costs).

Any change in Production Strategy has the potential to impact a range of other areas, and these potential impacts must be evaluated as part of the strategy selection. For example; a design change may require that the process flowsheet be redrafted, an operating time, rate or quality change may result in efficiency changes and require changes to Service Strategies and or operating life forecasts.

## Purpose

To specify the Production Strategy options that are technically feasible for closing a gap between historic and target process performance.

### Quantity

- One list of potential (technically feasible) Production Strategies.

### Quality

The following criteria shall be used to compile the list of potential Service Strategies;

- If there is an incremental process design or technology, with proven or probable suitable operating characteristics, then consider the option to modify process design.
- If the Capability Histogram of operating time has either wide distribution, or a gap between the distribution location and the theoretical range of locations, then consider the option to change operating times.
- If the Capability Histogram of operating rate has either wide distribution, or a gap between the distribution location and the theoretical range of location(s), then consider the option to change operating rates.
- If the Capability Histogram of input quality has either wide distribution, or a gap between the distribution location and the theoretical range of location(s), then consider the option to change input quality.
- If the Capability Histogram of output quality has either wide distribution, or a gap between the distribution location and the theoretical range of location(s), then consider the option to change output quality.

### Time

The Production Strategy shall be specified during establishment of a process.

Review and validation of Production Strategy shall be based on either a change of targets driven by changing business expectations or the benefit ranking of improvement opportunities identified through analysis of performance.

### Resources

Specification of Production Strategy is the accountability of the role identified in the configured flowchart.

AAOM Flowsheet

SPS Flowsheet

# PS.07 Estimate Output Distributions for Strategies

## Context

The objective of a Production Strategy for a process is to deliver the required process output at the lowest practical cost.

The task assignments completed to up to this point in the process of setting the Production Strategy have identified the performance gap to be addressed, and the feasible Production Strategy options for closing the performance gap.

Due to the inherent variability in the independent process output characteristics (time, rate, quality, etc.) that Production strategies act on, the interactions that occur between these characteristics, and the random nature of much of the variation, we can only estimate the probable result of any combination of Production strategy choices, in a specific time interval, by using a statistical model employing Monte Carlo simulation. In order to run such a model we need estimates of the distributions in process independent output characteristics that will result from strategy choices.

The Service Strategy selected for a process will also impact on the overall performance of the process - since it will typically affect operating times through service intervals and durations, and may also affect operating rates and efficiencies through changing equipment condition. These impacts on process characteristics need to be drawn from the Set Service Strategy process when evaluating Production Strategy options.

## Purpose

To specify the Capability Histogram of independent process output characteristics associated with Production Strategy options.

## Quantity

- One set of Capability Histograms for each combination of Production Strategies.

## Quality

Changes in process design (flowsheet, technology or technical operating points) are likely to have an impact on several process characteristics, including cycle times, production rates per cycle, efficiency/costs, and service work requirements. Estimating the potential impact of these may be complex, and hence may require either mathematical modelling, laboratory testing, or full scale process testing of the change in order to produce estimates of the change impact on the independent process output characteristics (time, rate, quality, reliability, efficiency/cost and sustainability). Changes to operating time, rate, input quality, etc., resulting from changes to service intervals/ durations, equipment speed or load, ore grade, etc. will typically be much easier to estimate.

Regardless of the simplicity or complexity, effective evaluation of strategy options will require the production of a set of capability histograms for estimated independent process output characteristics for modelling the overall output of the process.

The set of Capability Histograms required for the process modelling may include;

- scheduled service time,
- unscheduled service time,
- operating time,
- operating rate,
- scheduled interruption frequency,
- unscheduled interruption frequency,
- ramp-down time,
- ramp-up time,
- input quality,
- process efficiency,
- fixed production costs
- variable production costs,
- fixed service costs
- variable service costs

The Capability Histogram shall be the performance distribution that will result from the Production Strategy choice, for each affected output characteristic for the Productive Unit. The following data relating to the histogram shall be provided;

- the values of the minimum, maximum, mean and mode of the distribution,
- the 'shape factor' (spread of the distribution – e.g. standard deviation).

**Time**

The Production Strategy shall be specified during establishment of a process.

Review and validation of Production Strategy shall be based on either a change of targets driven by changing business expectations or the benefit ranking of improvement opportunities identified through analysis of performance.

**Resources**

Specification of Production Strategy is the accountability of the role identified in the configured flowchart.

AAOM Flowsheet

SPS Flowsheet

# PS.08 Model Combined Strategy Effects

## Context

The objective of a Production Strategy for a process is to deliver the required process output at the lowest practical cost.

The task assignments completed to up to this point in the process of setting the Production Strategy have identified the performance gap to be addressed, the feasible Production Strategy options for closing the performance gap, and the estimated effects of those strategy choices on independent process output characteristics.

Due to the inherent variability in the output characteristics that Production strategies act on, the interactions that occur between parameters, and the random nature of much of the variation, we can only estimate the probable result of any combination of strategy choices by using a statistical model employing Monte Carlo simulation.

## Purpose

To produce a forecast of the production output/costs resulting from the choice of a set of Production Strategies.

## Quantity

- One set of Capability Histograms of production output and costs for each combination of Production Strategies.

## Quality

The model for estimating performance confidence levels shall;

- be based on the mathematical relationships that exist between process time, rate, quality, reliability and efficiency/cost characteristics and the production and cost outputs of the processes, and
- incorporate Monte Carlo simulation of the outputs based on the estimated performance distributions for the process characteristics.

The performance distribution estimates used for the model shall be those determined in TA PS.07 – Estimate Output Distributions for Strategies.

The output and cost Capability Histograms shall be those predicted by the statistical model, based on the estimated distributions for independent output parameters for the Production Strategy choice. The following data relating to the histogram shall be provided;

- a graph of the probability distribution,
- the values of the minimum, maximum, mean and mode of the distribution,
- the 'shape factor' (i.e. spread of the distribution – e.g. standard deviation), and

- a table of the percentage of results within each quantisation band of the histogram.

**Time**

The Production Strategy shall be specified during establishment of a process.

Review and validation of Production Strategy shall be based on either a change of targets driven by changing business expectations or the benefit ranking of improvement opportunities identified through analysis of performance.

**Resources**

Specification of Production Strategy is the accountability of the role identified in the configured flowchart.

AAOM Flowsheet

SPS Flowsheet

# PS.09 Have Confidence Levels Been Met?

## Context

The objective of a Production Strategy for a process is to deliver the required process output at the lowest practical cost.

The task assignments completed to up to this point in the process of setting the Production Strategy have identified the performance gap to be addressed, the feasible Production Strategy options for closing the performance gap, and the estimated effects of those strategy choices on output and costs.

If the modelled performance for the proposed strategies produce a match to the confidence level set for the performance targets then the strategies will be effective and can be further developed for implementation.

If the modelled performance for the proposed strategies produce a confidence level that exceeds that set for the target then the responsible manager may wish to reset the performance targets.

If the modelled performance for the proposed strategies produce a confidence level below that set for the target then a new package of strategies will need to be proposed, or new targets set, or the lower confidence level accepted by the responsible manager.

## Purpose

To determine if the performance forecast for the proposed Production Strategies meets the confidence level set for the performance targets.

## Quantity

- One decision whether the performance target confidence level for the selected Production Strategies meets the confidence level target set for the process.

## Quality

If the estimated confidence levels on performance targets is between +0 and +5% of the target set for the process the confidence levels shall be considered to meet the target and the selected Production Strategies shall be implemented. If the estimated confidence levels fall outside of this range then the process of Setting Performance Targets must be revisited to decide whether to;

- try a new package of strategies, or
- set new targets, or
- lower the confidence level that will be accepted.

## Time

The Production Strategy shall be specified during establishment of a process.

Review and validation of Production Strategy shall be based on either a change of targets driven by changing business expectations or the benefit ranking of improvement opportunities identified through analysis of performance.

### Resources

Specification of Production Strategy is the accountability of the role identified in the configured flowchart.

AAOM Flowsheet

SPS Flowsheet

# PS.10 Set Operating Specification Limits

## Context

The Task Assignments completed up to this point have defined a set of Production strategies that are likely to deliver the target performance and confidence level for the process. This set of Production strategies comprises the Production steps that must be completed to deliver the required output from the process and the operating approach for these steps. These production steps may be executed by either people or machines, but in every case there will be a set of specification limits that should be adhered to in completing the step if the process is to consistently meet its target confidence levels.

The Capability Histograms for independent output characteristics that produced the modelling result that met the confidence levels for the process performance define the specification limits for these characteristics. The distributions for other technical parameters associated with these Production strategy choices (chemistry, temperature, pressure, etc.) define the operating specification limits for these parameters.

A set of specification limits may include;
- a lower specification limit,
- an upper specification limit, and
- a target operating point.

## Purpose

To define the operating specification limits for Production steps.

## Quantity

- One set of specification limits for each Production step.

## Quality

A set of specification limits may include;
- a lower specification limit,
- an upper specification limit, and
- a target operating point.

Each significant operating parameter for each Production step must have at least one of the above specification values. In many processes the range of output performance has a significant impact on connected processes, and hence it should be common that at least an upper and lower specification limit be set. If any of the other two specification values is significant in evaluating the performance of the asset it shall also be specified in the target.

## Time

The Production Strategy shall be specified during establishment of a process.

Review and validation of Production Strategy shall be based on either a change of targets driven by changing business expectations or the benefit ranking of improvement opportunities identified through analysis of performance.

## Resources

Specification of Production Strategy is the accountability of the role identified in the configured flowchart.

AAOM Flowsheet

SPS Flowsheet

## PS.11 Identify Work Steps Completed & Controlled by Machines

### Context

Within the Operating Model the term Production work is used to describe the actions directly associated with transferring, transforming or storing the goods or services that will form the output of the process. For example:

a) in a mining/mineral processing environment; blasting, hoisting, stockpiling, grinding, smelting.
b) in a recruitment services environment, advertising, screening applications, interviewing, reference checking, offer preparation.
c) in a procurement and supply environment, placing orders, receiving, warehousing and issuing goods.

A Production Strategy defines our approach to the execution of this Production work. Hence, in determining a Production Strategy we need to define the transform, transfer and store (production) steps that must be completed to deliver the required output from a Production process. Production steps may be executed and/or controlled by either people or machines. In a manual process, such as hand picking items from a store's inventory, the physical energy and the control of the movement is performed by a person. In a mechanised process that is manually controlled, such as picking items from a store with a forklift, the physical energy to move the material is provided by a machine but the control of the movement is performance by a person. In the case of a fully automated system, such as an automated stores inventory picking system, both the physical energy to move the items and the control of the movement is controlled by machinery.

In every case there will be a sequence, logic and set of specification limits that should be adhered to if the process is to consistently meet its target performance confidence levels.

In the case of those steps completed and controlled by machines, the process step sequence, inputs, outputs, logic and specifications must be implemented through an appropriate control system. In the case of those steps completed or controlled by people, the process step sequence, inputs, outputs, logic and specifications must be incorporated into the training, operating procedures and work management process applied to their work.

### Purpose

To define the production steps for which an automatic control system must be implemented.

### Quantity

- One list of production steps where both the execution and the control of the work is completed by machines.

**Quality**

The criteria to be used are that:

- If the Production step is both completed and controlled by machinery then all requirements for doing so must be incorporated in an automatic control system.
- If the mechanical effort for the process step is supplied by machinery but people are required to direct and or control the machinery, then the Production step involves a Work Package that is executed by people. The Work Package must be specified, and controlled through a work management system.
- If the mechanical effort for the Production step, and the control of that effort, is provided by people, then the Production step is a Work Package that is executed by people. The Work Package must be specified, and controlled through a work management system.
- If the Production step appears to have elements of control by both machinery and people then the step can be split in two, one step controlled by machine and one step controlled by people.

**Time**

The Production Strategy shall be specified during establishment of a process.

Review and validation of Production Strategy shall be based on either a change of targets driven by changing business expectations or the benefit ranking of improvement opportunities identified through analysis of performance.

**Resources**

Specification of Production Strategy is the accountability of the role identified in the configured flowchart.

AAOM Flowsheet

SPS Flowsheet

# PS.12 Specify Control System Outputs, Inputs, Specifications and Logic

## Context

Within the Operating Model the term Production work is used to describe the actions directly associated with transferring, transforming or storing the goods or services that will form the output of the process. For example:

a) in a mining/mineral processing environment; blasting, hoisting, stockpiling, grinding, smelting.
b) in a recruitment services environment, advertising, screening applications, interviewing, reference checking, offer preparation.
c) in a procurement and supply environment, placing orders, receiving, warehousing and issuing goods.

A Production Strategy defines our approach to the execution of this Production work. Hence, in determining a Production Strategy we need to define the transform, transfer and store (Production) steps that must be completed to deliver the required output from a Production process. Production steps may be executed and/or controlled by either people or machines. In a manual process, such as hand picking items from a store's inventory, the physical energy and the control of the movement is performed by a person. In a mechanised process that is manually controlled, such as picking items from a store with a forklift, the physical energy to move the material is provided by a machine but the control of the movement is performance by a person. In the case of a fully automated system, such as an automated stores inventory picking system, both the physical energy to move the items and the control of the movement is controlled by machinery.

In every case there will be a sequence, logic and set of specification limits that should be adhered to if the process is to consistently meet its target performance confidence levels.

In the case of those steps completed and controlled by machines, the process step sequence, inputs, outputs, logic and specifications must be incorporated into an appropriate control system. In the case of those steps completed or controlled by people, the process step sequence, inputs, outputs, logic and specifications must be incorporated into the training, operating procedures and work management process applied to their work.

## Purpose

To define the information required to implement an automatic control system for production steps.

## Quantity

- One set of specifications necessary to implement the control of Production steps in an automatic control system.

### Quality

The specifications shall include;

- the sequencing/dependencies of Production steps,
- the outputs to be provided by the control system to the controlled machinery,
- the specification of the characteristics required by the connected equipment for each output,
- the inputs needed by the control system in order to execute the control logic that will determine outputs,
- the specification of the characteristics of the signals from connected equipment for each input,
- the logic (including calculations, conditions, limits, etc.) used to define output states based on the inputs.

### Time

The Production Strategy shall be specified during establishment of a process.

Review and validation of Production Strategy shall be based on either a change of targets driven by changing business expectations or the benefit ranking of improvement opportunities identified through analysis of performance.

### Resources

Specification of Production Strategy is the accountability of the role identified in the configured flowchart.

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# PS.13 Identify Steps Completed or Controlled by People

## Context

Within the Operating Model the term Production work is used to describe the actions directly associated with transferring, transforming or storing the goods or services that will form the output of the process. For example:

a) in a mining/mineral processing environment; blasting, hoisting, stockpiling, grinding, smelting.
b) in a recruitment services environment, advertising, screening applications, interviewing, reference checking, offer preparation.
c) in a procurement and supply environment, placing orders, receiving, warehousing and issuing goods.

A Production Strategy defines our approach to the execution of this Production work. Hence, in determining a Production Strategy we need to define the transform, transfer and store (Production) steps that must be completed to deliver the required output from a Production process. Production steps may be executed and/or controlled by either people or machines. In a manual process, such as hand picking items from a store's inventory, the physical energy and the control of the movement is performed by a person. In a mechanised process that is manually controlled, such as picking items from a store with a forklift, the physical energy to move the material is provided by a machine but the control of the movement is performance by a person. In the case of a fully automated system, such as an automated stores inventory picking system, both the physical energy to move the items and the control of the movement is controlled by machinery.

In every case there will be a sequence, logic and set of specification limits that should be adhered to if the process is to consistently meet its target performance confidence levels.

In the case of those steps completed and controlled by machines, the process step sequence, logic and specifications must be incorporated into the appropriate control system. In the case of those steps completed or controlled by people, the process step sequence, logic and specifications must be incorporated into the training, operating procedures and work management process applied to their work.

## Purpose

To define the production steps for which Tasks must be specified for a work management system.

## Quantity

- One list of Production steps where either the execution or the control of the work is completed by people.

## Quality

The criteria to be used are that:

- If the Production step is both completed and controlled by machinery then all requirements for doing so must be incorporated into an automatic control system.
- If the mechanical effort for the Production step is supplied by machinery but people are required to direct and or control the machinery, then the Production involves a Work Package that is executed by people. The Work Package must be specified, and controlled through a work management system.
- If the mechanical effort for the Production step, and the control of that effort, is provided by people, then the Production step is a Work Package that is executed by people. The Work Package must be specified, and controlled through a work management system.
- If the Production step appears to have elements of control by both machinery and people then the step can be split in two, one step controlled by machine and one step controlled by people.

## Time

The Production Strategy shall be specified during establishment of a process.

Review and validation of Production Strategy shall be based on either a change of targets driven by changing business expectations or the benefit ranking of improvement opportunities identified through analysis of performance.

## Resources

Specification of Production Strategy is the accountability of the role identified in the configured flowchart.

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# PS.14 Specify Manual Work Steps, Triggers and Trigger Tolerances

## Context

Within the Operating Model the term Production work is used to describe the actions directly associated with transferring, transforming or storing the goods or services that will form the output of the process. For example:

a) in a mining/mineral processing environment; blasting, hoisting, stockpiling, grinding, smelting.
b) in a recruitment services environment, advertising, screening applications, interviewing, reference checking, offer preparation.
c) in a procurement and supply environment, placing orders, receiving, warehousing and issuing goods.

A Production Strategy defines our approach to the execution of this Production work. Hence, in determining a Production Strategy we need to define the transform, transfer and store (Production) steps that must be completed to deliver the required output from a Production process. There will be a sequence, logic and set of specification limits for these production steps that should be adhered to if the process is to consistently meet its target performance confidence levels.

In the case of those Production steps completed or controlled by people, the process step sequence, logic and specifications must be incorporated into the training, operating procedures and work management process applied to their work. To do this we must define the actions that people must take to execute the step, what trigger will initiate the action (this may be an event, calendar time, a measured value such as operating time, tonnes, etc.), and the allowable tolerance around the trigger event for completing the action.

## Purpose

To specify the actions required for people to implement a set of Production strategies.

## Quantity

- One set of outcomes, specifications and scheduling specifications for each separate action for implementing a Production Strategy.

## Quality

The outcome for each action shall be specified in the form of an action and an object (e.g. drill hole in ore face, move material from X to Y).

Specifications may include operating times, operating rates, input quality, chemistry, temperature, pressure, etc.

The trigger (scheduling) parameters for each action shall comprise;

- The type of trigger parameter (e.g. prior event, calendar time, operating time, condition/performance parameter),
- The trigger value (e.g. following blasting, start of shift, 4 hrs, level less than X tonnes),
- The trigger tolerance (e.g. ±1 hr, ±Y tonnes), and

The specification of service actions shall comply with the requirements of TA PL.00 Planning and its subordinate task assignments.

**Time**

The Production Strategy shall be specified during establishment of a process.

Review and validation of Production Strategy shall be based on either a change of targets driven by changing business expectations or the benefit ranking of improvement opportunities identified through analysis of performance.

**Resources**

Specification of Production Strategy is the accountability of the role identified in the configured flowchart.

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# PS.15 Specify Manual Work Step Resources

## Context

Within the Operating Model the term Production work is used to describe the actions directly associated with transferring, transforming or storing the goods or services that will form the output of the process. For example:

a) in a mining/mineral processing environment; blasting, hoisting, stockpiling, grinding, smelting.
b) in a recruitment services environment, advertising, screening applications, interviewing, reference checking, offer preparation.
c) in a procurement and supply environment, placing orders, receiving, warehousing and issuing goods.

A Production Strategy defines our approach to the execution of this Production work. Hence, in determining a Production Strategy we need to define the transform, transfer and store (Production) steps that must be completed to deliver the required output from a Production process. There will be a sequence, logic and set of specification limits for these production steps that should be adhered to if the process is to consistently meet its target performance confidence levels.

In the case of those Production steps completed or controlled by people, the process step sequence, logic and specifications must be incorporated into the training, operating procedures and work management process applied to their work. To do this we must define the actions that people must take to execute the step, and the resources required for completing each action.

## Purpose

To specify the resources required for each action people must complete to implement a set of Production strategies.

## Quantity

- One resource specification for each separate Production action.

## Quality

The **minimum requirement** for the specification of the resources for implementation of a Production action is the type (quality), number and duration of:

- Each labour skill,
- Each material,
- Each specialised tool or item of equipment.

Where components of a Production action will occur at different times, or require different types, numbers or duration of resources, these should be specified as separate tasks comprising the action, and the resources for each task shall be separately specified.

The specification of Production actions shall comply with the requirements of TA PL.00 Planning and its subordinate task assignments.

**Time**

The Production Strategy shall be specified during establishment of a process.

Review and validation of Production Strategy shall be based on either a change of targets driven by changing business expectations or the benefit ranking of improvement opportunities identified through analysis of performance.

**Resources**

Specification of Production Strategy is the accountability of the role identified in the configured flowchart.

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# PS.16 Group Work Steps for Efficient Work Management

## Context

Within the Operating Model the term Production work is used to describe the actions directly associated with transferring, transforming or storing the goods or services that will form the output of the process. For example:

a) in a mining/mineral processing environment; blasting, hoisting, stockpiling, grinding, smelting.
b) in a recruitment services environment, advertising, screening applications, interviewing, reference checking, offer preparation.
c) in a procurement and supply environment, placing orders, receiving, warehousing and issuing goods.

A Production Strategy defines our approach to the execution of this Production work. Hence, in determining a Production Strategy we need to define the transform, transfer and store (Production) steps that must be completed to deliver the required output from a Production process. There will be a sequence, logic and set of specification limits for these production steps that should be adhered to if the process is to consistently meet its target performance confidence levels.

In the case of those Production steps completed or controlled by people, the process step sequence, logic and specifications must be incorporated into the training, operating procedures and work management process applied to their work. To do this we must define the actions that people must take to execute the step, and the resources required for completing each action.

The actions that people must complete may occur at different times, and under different conditions, and may require different labour materials and equipment for their implementation.

It is also possible that synergies exist between the actions required to implement different Production steps that make it advantageous to combine some of these actions into a single Work Package. For example, if the actions for two or more Production steps are sequential, occur in the same workplace, and require the same resources, there will probably be advantages to incorporating these actions into a single Work Package.

## Purpose

To construct Production Work Packages that take advantage of usable synergies between Production actions.

## Quantity

- One set of Work Packages that optimise the synergies between Production actions.

### Quality

Synergies between service actions typically occur around;

- Workplace,
- Sequencing of actions,
- Trigger events and tolerances,
- Resource requirements (labour, tools and equipment).

### Time

The Production Strategy shall be specified during establishment of a process.

Review and validation of Production Strategy shall be based on either a change of targets driven by changing business expectations or the benefit ranking of improvement opportunities identified through analysis of performance.

### Resources

Specification of Production Strategy is the accountability of the role identified in the configured flowchart.

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# PS.17 Specify Resource Service Levels

## Context

The timely, efficient and correct execution of a Production Work Packages requires that all the specified resources be available, at the appropriate location, when needed.

Putting in place the most reliable and efficient resourcing strategy to achieve this requires a specification of;

- the type of resource(s) required (including all important quality parameters) ,
- how many resources are required,
- how often resources will be required,
- how much lead time there will be between recognising the need and the required fulfilment of the need, and
- for re-useable resources (such as labour and equipment) the duration of the need.

Most of the above information has been defined in the previous task assignments for Setting the Production Strategy:

- The type and number of resources were specified in TA PS.15 Specify Production Action Resources (labour, materials and equipment).
- How often the resources will be required is determined by the time, rate and efficiency operating parameters for the process or by the scheduling parameters for actions.
- The fulfilment lead time for resources is defined by the time horizon of the Production work Execution Schedule.
- The duration of the need (for re-useable resources) was specified in TA PS.15 Specify Production Action Resources (labour, materials and equipment).

The above data can be used to define the Service Levels required for Production work resources.

A resource may potentially be utilised in more than one Production Work Package, and these separate Work Packages may have different service level requirements. An accurate specification of the above data for the differing service level requirements allows a resourcing strategy that can meet all requirements to be defined.

## Purpose

To specify the resource service levels required for implementation of a Production Strategy.

## Quantity

- One set of service level specifications for each resource.

**Quality**

A resource service level specification shall include;

- the type of resource(s) required (including all important quality parameters) ,
- how many resources are required,
- how often resources will be required,
- how much lead time there will be between recognising the need and the required fulfilment of the need, and
- for re-useable resources (such as labour and equipment) the duration of the need.

Where the data for a resource service level parameter is developed for a task assignment in the process of Setting the Production Strategy, that data shall be used in the service level specification.

Where resources are used in service work packages that have different service level requirements, each set of specifications shall be recorded.

**Time**

The Production Strategy shall be specified during establishment of a process.

Review and validation of Production Strategy shall be based on either a change of targets driven by changing business expectations or the benefit ranking of improvement opportunities identified through analysis of performance.

**Resources**

Specification of Production Strategy is the accountability of the role identified in the configured flowchart.

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AngloAmerican

INTERNAL

# ANGLO AMERICAN OPERATING MODEL: OPERATIONAL PLANNING
# SET SERVICE STRATEGY

**UPDATED: AUGUST 2018**

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# SS.00 Set Service Strategy

## Context

Within the Operating Model three terms[1] are used to classify different types of activity that can be applied to a process. These are;

1. *Production Work* – activities directly involving transferring, transforming or storing goods or services within a process. For example:
    a. in a mining/mineral processing environment; blasting, hoisting, stockpiling, grinding, smelting.
    b. in a power generation environment; transferring fuel, transforming energy (e.g. oil to heat, rotation of alternator to electricity), transforming voltage & current levels and transmitting power over lines.
    c. in a procurement and supply environment, placing orders, receiving, warehousing and issuing goods.

    **Note:** The world is full of interconnected processes, and the output of one process may produce and/or deliver a product or service that is an ingredient, reagent or consumable in another process. In such cases the process that is delivering the ingredient, reagent or consumable may be viewed as providing a 'service' to the primary process, and hence it may be tempting to classify all work taking place in the 'service' process as service work. This approach does not fit with the definition of Production and Service work adopted within the Operating Model, since the 'service' process is also transferring, transforming or storing goods or services. Hence, in the Operating Model, all activities involved in transforming, transferring or storing goods or services, in any process, are defined as the Production work of that process.

2. *Service Work* – activities involved in identifying and managing threats related to a process (i.e. to both the process and its environment). For example:
    a. in a mining/mineral processing environment; monitoring and maintenance of environmental controls, monitoring and maintenance of ground support or pit walls, monitoring and maintenance of roads, monitoring and maintenance of equipment.
    b. in a power generation environment; monitoring and maintenance of environmental controls, monitoring and maintenance of equipment.

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[1] These terms are adapted from the work of Macdonald Associates.

c. in a procurement and supply environment; stocktaking, contract compliance assessment and turning of bearings on warehoused spare equipment.

From this definition of Service work it should be obvious that setting a Service strategy is a process of risk management. It follows then that in order to effectively set a Service Strategy it is first necessary to understand the threats that may exist or arise in or around a process.

3. *Support Work* – activities that predominantly serve the purpose of improving the effectiveness or efficiency of a Process. That is, Production and Service work can proceed without effective Support work, but the outcomes and or cost may not be optimal. Many of the elements of the Operating Model are Support work. These include Setting Performance Targets, Setting Production and Service Strategies, Setting an Operating Master Schedule, Setting an Expenditure Schedule, Approving Work, Planning Work, Scheduling Work, Measuring results and applying Analyse and Improve. All of the above, except Measurement and Analyse and Improve, are preparative activities, completed in order to set up the Resourcing and Execution of the Production and Service work of the process for success. We could still continue to mine, process, maintain and supply without effectively implementing these activities of the Operating Model, and in fact, highly reactive operations do. However, the performance of the process will be far from optimal. Measurement and Analyse and Improve are also Support activities, but of a feedback nature, since they provide the data and approach to improve the process design, strategy, execution or resourcing. The Support activities of the Operating Model can be applied equally effectively to a diversity of processes, e.g. mining, mineral processing, maintaining or procurement and supply processes.

By definition, a threat has potential to cause harm, either to communities, employees, the environment or the process performance. It is not possible to produce a zero risk situation, hence, setting a Service strategy must start with defining the level of risk that the stakeholders in any situation consider acceptable. The acceptable level of risk is shaped by many factors, and it is not equal for all people in every situation, and will change over time. For example, one survey in a western society revealed that on average this group felt that a 1 in 10,000 risk of being killed in a car accident, a 1 in 100,000 risk of being killed at work, and a 1 in 1,000,000 risk of being killed at home were acceptable.

A Service strategy may be applied to any activity, workplace, equipment or material that is utilised in a process, and to the commercial, natural and social environments related to the process. Materials science has defined a set of mechanisms by which material failures can be categorised. When looked at from a boarder context it can be observed that, with some adaptation, these can provide a set of threat types that could be useful in considering probable threats across many types of processes:

- ***Stress*** - materials science subdivides this into catastrophic overstress that produces sudden failures (e.g. fracture), prolonged high stress that produces creep deformation and prolonged cyclic stress that produces

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fatigue failure. Similar types of results can be produced in people. Some examples of potential forms of stress are; physical/mechanical, thermal, voltage, radiation, mental, etc.

- ***Chemical*** - in materials science terms this would be due to the (re)action of chemicals such as oxygen, acids, alkalis, but in a broader context could also include drugs, alcohol etc.
- ***Wear*** - materials science subdivides wear into different mechanisms for the removal of material, e.g. abrasion, erosion, fretting, etc.
- ***Fouling*** - accumulation of material, e.g. silting, scaling, contamination, etc.
- ***Obsolescence*** - this is not a category used in materials science but reflects a type of threat that arises from the loss of support for either the products or services of a process, e.g. due to innovation or competition, the imposition of constrictions to the process, e.g. imposition of new standards/laws, or the loss of essential resources for the continued operation of the process, loss of people, skills or knowledge, loss of parts sources etc.

The above threat mechanisms may act either alone or in combination, and when acting in combination may produce a threat that does not occur with either of the mechanisms absent, e.g. stress corrosion cracking, the result of a combination of highly alkaline environment and high physical stress levels.

The initiating mechanisms to consider when trying to identify the types of threats that may arise in or around a process are:

- ***Design*** - fatigue, chemical action, wear and fouling are all, to some extent, 'designed in' to a process based on the purpose of the process and the choice of technologies for its implementation.
- ***Operation*** - wear, stress and fouling can be influenced by the age of process elements, operating rates, operating conditions, feed materials, maintenance and process shutdown/start-up cycles etc.
- ***People*** - the errors, omissions or deliberate actions of people, resulting in changes to operating procedures/limits or material/equipment specifications, can lead to stress, chemical action or wear.
- ***Environment;***
    - *Commercial* - innovation and competition may lead to obsolescence of product, services or technology.
    - *Natural* – e.g. flood, tornado, hurricane, volcanic eruption, earthquake, or landslide can lead to stress, erosion, or silting.
    - *Social* – e.g. social unrest or sovereign risk may lead to damage or changes to expectations, standards, laws etc.

The underlying theory for the Operating Model design is that future performance will be delivered if the right work is completed at the right time and in the right way – and that this performance will be achieved more consistently, and at lower cost, if the work is planned, scheduled and resourced in advance of its execution. This theory applies equally to the Production, Service and Support work of a process.

A complete system to implement the Operating Model theory must therefore contain elements to establish what is the right Service work, the right time to execute that work (identified as the trigger event for the work), and the right way to complete the work. This component of the Operating Model is termed Set Service Strategy.

***Right Work***

The optimum Service strategy for any process is dependent on the design and application of the process, the level of output performance required from it, and the cost that can be accepted in order to achieve the desired output performance.

Therefore, the inputs that may be necessary for setting an appropriate Service strategy for a process are;

- the performance required from the process (from which an assessment of the level of stress or wear rates, etc. can be made),
- the process design and technical specifications (from which the potential effects of stress and wear rates, etc. can be made),
- the commercial, social and regulatory environment (from which both the level of acceptable risk and potential external threats can be determined),
- the historical threats, determined either from the actual process or from similar processes,
- the potential consequences of threats, and
- the potential exposure to the consequences if a threat materialises.

In identifying potential threats we must consider both the threats created by the operation of the process, and potential external threats to the process. A practical Service strategy will identify all the threats that are probable and meaningful, not all the ones that are possible.

The starting point for considering what is the right Service work is to identify where a proactive Service strategy is necessary. The most effective way of doing this may be through the elimination of those areas where a proactive service strategy is not necessary, i.e. by identifying all the elements of a process (hardware, people, environment) where any probable threats would not cause an unacceptable risk. A detailed analysis can then be conducted on the remaining process elements, starting with the identification of the probable threats and the estimation of the relative risk ranking for each of these.

When considering what threats are probable the base assumption must be 'what would be probable if there is not a service strategy in place'. To explain further, since the purpose of a Service strategy is to reduce the consequence, probability or exposure of a threat, in deciding whether we need a Service strategy we must approach the decision from the viewpoint that a Service strategy is not, or will not be in place. Where there is any relevant incident history, either from the specific process or from a similar process, and there has been no change to the design, operation or environment of the process that would significantly change the characteristics of a threat, this threat should be considered probable. Where there is no relevant incident history the probable

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threats must be identified based on a detailed understanding and analysis of the relevant threat mechanisms and initiators.

There are six basic options (Service Strategies) for managing threats. These options can be arranged in a hierarchy of desirability where the highest option in the hierarchy that is both feasible and has lower cost (both direct implementation costs and the lost opportunity cost that arises from implementation of the strategy) is the preferred choice for the process. The options in this hierarchy are:

- *Modification of the process* – implement design changes in order to reduce the threat consequence, probability or exposure. This type of strategy may be applicable where there are alternative designs, materials or methods. Implementation of this strategy requires a single change action, and will typically also either remove or reduce the need for further Service work. However, where any probability of the threat remains, one of the remaining Service Strategies will be required to deal with the residual threat. In an underground mining process this strategy could be the use of 'shot-crete' ground support in lieu of rock-bolts, hence reducing the risk of injury from falling material and removing the need to scale the walls and ceilings of workplaces. In a mineral processing plant this could be to change the design of a material feed chute to remove or reduce the occurrence of blockages and the need to clear them. In a safety context this might be the application of mechanical lifting aides to remove/reduce the risk of physical injury caused by lifting heavy items.
- *Monitor process condition and/or performance to identify the development of a threat, and hence determine the best timing and type of Service action to deal with the developing threat.* This type of strategy may be appropriate where there is considerable variability in either the onset of threat development or in the rate at which a threat escalates, and there is a detectable indication of the developing threat condition that provides sufficient warning for an effective control action to be taken. Implementation of this strategy requires a primary action to regularly monitor the threat indication, and when the indication exceeds an acceptable level (defined by measureable condition or performance parameters), a secondary action to manage the threat. In an underground mining process this could be the monitoring of erosion in an ore pass in order to determine if reconditioning is required. In a mineral processing plant this could be to monitor pressure drop across a filter in order to determine when the filter is blocking and hence when to clean or change the filter media. In a safety context this might be the use of task observations to determine when re-training of personnel in safe work methods is required, or the use of a hazard assessment process prior to the commencement of a task.
- *Initiate Service actions based on a pre-defined interval or life - usage based.* This type of strategy may be appropriate where the probability of a threat is initially very low, but shows a rapid increase after a relatively consistent time or service interval. Implementation of this strategy relies on measuring a proxy for the probability of threat development (typically

parameters such as calendar or operating time, or process throughput), and when the predefined interval or life is reached a corrective action is taken in order to deal with the threat. In a mining process this could be a regularly scheduled oil changes for mobile equipment based on either operating time for the equipment or calendar time. In a mineral processing plant this could be a regularly scheduled task to change screen/filter media based on expired time or the amount of material processed. In a safety context this might be a regularly scheduled task to conduct a fire drill, at a time interval that keeps the required response fresh in the memory of personnel.

- *Install back-up or containment systems to circumvent or mitigate the consequences of the failure of an element of the process.* This type of strategy may be appropriate where none of the above options is feasible or cost effective but the consequences of an uncontained threat are not acceptable. In an underground mining process this could be a back-up dewatering pump. In a mineral processing plant this could be a duty/standby process pump. In a safety context this might be the implementation of personal protective equipment or a barrier/guarding system.
- *Operate the process to the point of failure.* This is the default option, i.e. if you put no other Service Strategy in place then this is what will happen. This option is perfectly acceptable for the many potential threats that have very low consequence, probability and exposure. Once the failure has occurred, a corrective action is required in order to deal with the results of the threat.
- *Closure of the process.* If it is considered that there is no viable and/or cost effective strategy, that will reduce the risk profile of a probable threat to an acceptable level, then the only remaining option is to shut down the process and establish a safe and secure condition. This strategy option is evident in the actions of the German government in 2011 when, following the Fukushima nuclear power plant disaster in Japan, they announced the accelerated closure of all nuclear power plants within Germany. Note that after closure of the process the most significant threats may be removed, but there may be an ongoing need to maintain the safety and security of the process against residual, but lesser, threats. In such cases appropriate Service Strategies will be required until such time as there is no longer any unacceptable threat.

***Right Time***

Each Service strategy selected for a process will require some action(s) for its implementation. Each of these actions will have a trigger event and a trigger tolerance that will be determined by both the characteristics of the threat to be addressed and the selected Service strategy.

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Trigger events may take a variety of forms;

- the occurrence of another event – e.g. the completion of a precedent action. In mining a ventilation door inspection may be scheduled to occur after a major blast. In a mineral processing plant the refurbishment of a filter media may be triggered after the exchange of the filter system.

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The occurrence of the precedent event for these actions will be set up as a trigger in the Work Scheduling System (WSS).

- the passing of a specified calendar time period - In underground mining a hoist or shaft inspection will typically be required at specified calendar intervals. In a mineral processing plant, switchboard servicing will typically be required at specified calendar intervals. In a supply environment stock counts and contract compliance audits will typically be scheduled at defined calendar intervals. The values for these calendar intervals will be set up as triggers in the WSS.
- the accumulation of a specified value for a counted parameter, which could be; operating hours, tonnes, litres, cycles etc. In mining the servicing of mobile equipment is usually triggered by a counter of operating hours. In a mineral processing plant inspection or replacement of wear items is usually triggered by a counter of material throughput.
- the achievement of a specified condition, which could be thickness, flow reduction, pressure drop or increase etc. In mining brake linings/pads are typically replaced on reaching a minimum thickness. In mineral processing a pump may be scheduled for repair or replacement based on performance deteriorating to a set of lower specification limits for flow and pressure. The values for these measurement points will be set up as triggers in the WSS.

These trigger events are used in both the production of an Operating Master Schedule (via the OMS software), and in driving the routine generation of Work Packages into the Work Management process (via the Work Scheduling System - a system that provides automatic triggering of work packages based on specified trigger parameters).

***Right Way***

Each Service action will include a scope of work and specification. These may include the outcomes, specifications/tolerances, method of execution, conditions and constraints and resource requirements. In most operating processes there will be a large number of Service actions, hence, for efficiency of management we will often wish to group service actions with synergies into a smaller number of Work Packages that are more efficient to schedule, resource and execute. The workplace, conditions and constraints, resource requirements and trigger characteristics for service actions are used to identify the synergies for creating Service Work Packages.

Forecasts for the expected quantities, frequencies and demand lead times for the resources (labour, materials and equipment) necessary for the execution of the Service Work Packages can be derived from the detailed specifications of the Work Packages, in combination with the process operating forecasts and the triggers for the Work Packages. This data can be used to define the service levels and supply/logistics strategies for the resources required to implement the Service strategy.

**Purpose**

To specify the most cost effective way to manage threats related to the process.

**Quantity**

The deliverables from setting a Service strategy shall include;

- One list of Serviceable Items.
- A risk rating for each Serviceable Item.
- One list of probable threats for each Serviceable Item.
- One set of data quantifying the characteristics and consequences for the probable threats for each Serviceable Item.
- One set of feasible Service strategies for each probable threat.
- One set of Service strategies selected to be the most cost effective.
- One set of data substantiating the selection of Service strategies.
- One set of implementation actions for each Service strategy.
- One set of Work Packages for implementation of Service actions.
- One set of service level specifications for resources required for Service Work Packages.

**Quality**

A specification for what is considered an 'acceptable' risk level must be defined. Different risk levels may be defined for different potential consequences, e.g. for the safety of people and the environment and for business impact.

The deliverables of Set Service Strategy shall meet the following requirements;

- Serviceable Items shall be the elements of a process or its environment (equipment, structures, containments, barriers, discharge points, transport routes, energy services, etc.) for which an Operate to Failure Service strategy will not produce an acceptable risk outcome.
- The risk ratings shall provide a consistent and objective ranking of the threats for Serviceable Items based on the;
  - potential consequences of a loss of function (worst case),
  - probability of an event causing the loss of function, and
  - probability that people, the environment or business outcomes will be exposed to the potential consequences (this will be affected by factors such as location, working patterns, recovery capacity and recovery times).
- The consequence of each threat shall be specified based on a consistent and objective rating of the probable safety, environment, revenue, costs, reputational, regulatory and social impacts.
- The Service Strategies shall be one or more of the following options;
  - modification of the process,
  - condition or performance monitoring,
  - fixed interval servicing,
  - installed redundancy/containment,
  - operate to failure, or
  - closure of the process.
- The minimum specifications for a Service action shall include work outcomes and specifications, trigger parameter for the action, allowable tolerance for completion of the action around the trigger

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parameter, constraints or conditions necessary for completing the action, resources required for the action, and estimated cost of the action.

- Work Packaging shall consolidate Service actions into efficiently manageable Work Package (typically those actions that have the same workplace and trigger parameters, use the same resources, and share the same condition and constraints).
- The service level specifications for resources shall include the quality, quantity and demand lead time (the interval between when the need for the resources can be identified and the need must be fulfilled) for each resource.

All data fields that form part of the Service strategy analysis and specification process, and that are also required for implementation of the strategy in a Work Scheduling System shall use the standard codes and definitions from the appropriate WSS.

A database shall be used to record the Service strategy analysis outcomes and rationale. The database shall include;

- Identification of the objects on which Service actions will be scheduled (consistent with the WSS identification),
- proven performance for the Serviceable Item,
- consequence of lost performance for the Serviceable Item,
- probable threats for the Serviceable Item,
- feasible Service strategies for each threat
- selected Service strategies (most cost effective) for each threat,
- primary and secondary action(s) (e.g. assess condition/performance/ hazard and then stabilise/refurbish/replace) for each threat,
- Trigger Parameter and Completion Tolerance for each Service action,
- constraints or conditions for each Service action,
- resource requirements for each Service action,
- WSS Standard Job reference for the Work Package in which the Service action is implemented, and
- service level specification for resources for each Service action.

The detailed activities of setting a Service strategy shall conform to the specifications set out in the Set Service Strategy Flowchart and TAs SS.01 to SS.17.

# SS.01 Extract Performance Targets

## Context

The purpose of a Service Strategy is to identify the most cost effective way to manage threats related to a Process. The objective is to deliver the safe, cost effective life required from Processes that the Business is accountable for, or relies upon. Achieving this entails;

- protecting people from harm,
- protecting the environment from harm,
- maintaining stakeholder support (investors, communities and regulators),
- preserving the Effectiveness of the Process,
- preserving the Efficiency of the Process, and
- preserving the operational life of the Process.

By definition, a threat has potential to cause harm, either to communities, employees, the environment or the process performance. It is not possible to produce a zero risk situation, hence, setting a Service strategy must start with defining the level of risk that the stakeholders in any situation consider acceptable. The acceptable level of risk is shaped by many factors, and it is not equal for all people in every situation, and will change over time. For example, one survey in a western society revealed that on average this group felt that a 1 in 10,000 risk of being killed in a car accident, a 1 in 100,000 risk of being killed at work, and a 1 in 1,000,000 risk of being killed at home were acceptable.

In the Operating Model three types of Process performance parameters are defined;

- Effectiveness - does the Process deliver the output that is required in a period or by a time (quality product in/by time),
- Efficiency - what is the output delivered compared to the resources used in producing it (e.g. recovery of product, unit cost of output, return on investment, etc.), and
- Sustainability - is the Process positioned to continue delivering the output into the future (does it have the resources, asset condition and licence to operate – i.e. regulatory and community support).

The consequences of any threat related to a Process can be expressed in terms of one or more of these parameters, or the characteristics that make them up.

The Effectiveness of a Process is a function of;

- time usage (including availability and utilisation),
- operating rate,
- quality performance(on-specification product), and
- reliability,

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The Efficiency of a Process is a function of;

- yield/recovery,
- Effectiveness (units output per time period), and
- fixed and variable costs.

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The sustainability of a Process is a function of;

- resources/reserves,
- asset integrity (a threat rating),
- safety performance,
- environmental performance, and
- reputation with;
    - investors,
    - regulators, and
    - communities.

Setting Performance Targets takes the expectations established for the Business as a whole and breaks these down into specific Effectiveness, Efficiency and Sustainability targets for Processes within layers of a Business Structure (down to Productive Unit level).

Setting Production Strategy takes Effectiveness targets and breaks these down into availability, utilisation, rate, quality, reliability, and recovery targets. In order to set a Service Strategy the relevant performance target characteristics for the individual Processes must be extracted from the outcomes of the Set Performance Targets and Set Production Strategy processes.

**Purpose**

To specify the Service Strategy performance targets.

**Quantity**

- One set of performance targets for each Process.

**Quality**

The performance targets and data required to Set the Service Strategy may include;

- time (including availability and utilisation),
- rate,
- quality yield (% on-specification product),
- recovery (units out to units in),
- reliability (frequency of process interruption),
- maximum Health Safety and Environment (HSE) consequence rating,
- maximum HSE Integrity Threat Rating,
- maximum Business Integrity Threat Rating, and
- asset Functional Life (the period of time for which an asset will be required to produce a product or service.).

The values for each of these parameters that is relevant to the Process shall be extracted from the output of the processes of Setting Performance Targets and Setting Production Strategy.

### Time

Performance targets shall be specified during establishment of a Process.

Review and validation of performance targets shall be based on either a change of targets driven by changing business expectations or the benefit ranking of improvement opportunities identified through analysis of performance.

### Resources

Definition of performance targets is the accountability of the role identified in the configured flowchart.

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# SS.02 Specify Functional Life

## Context

The purpose of a Service Strategy is to identify the most cost effective way to manage threats related to a process. The objective is to deliver the safe, cost effective life required from processes that the Business is accountable for, or relies upon. Achieving this entails;

- protecting people from harm,
- protecting the environment from harm,
- maintaining stakeholder support (investors, communities and regulators),
- preserving the Effectiveness of the process,
- preserving the Efficiency of the process, and
- preserving the operational life of the process.

A process that is owned and operated by the Business should obviously be included in the consideration of threats. Perhaps it is not always as obvious that processes that are owned and/or operated by other parties can be significant to the performance or sustainability of the Business, and these should also be included in the consideration of probable threats. Third party owned and/or operated processes may include services such as power, water, roads, transport, contracted activities etc.

If our objective is to deliver the safe, cost effective process life required by the Business then we must define what the required Functional Life of each process is, i.e. for what period is the function/service provided by the process required. The Functional Life can be longer than the viable life of the physical assets currently in service i, a condition that will highlight that asset life extension or replacement will be required during the Functional Life. Some processes may be required to provide a Functional Life beyond the production life of an operation. For example, tailings dams may need to provide secure containment for years after production of tailings at an operation has ceased.

## Purpose

To specify the Functional Life required of a process.

## Quantity

- One Functional Life for each process that the Business is either accountable for or relies upon.

## Quality

The Functional Life is defined by the latest year that the functions/services of a process must be provided.

A functional Life shall be specified for each process, i.e. an element within the Business Structure (down to Productive Unit level) and for each third party provided process identified as an input or exit to the flowcharts from which the Business Structure is developed.

### Time

The Functional Life shall be defined at the establishment of the process.

Review and update of Functional Lives shall be undertaken on a regular basis, typically no less than every 2 years.

### Resources

Specification of the Functional Life is the accountability of the role identified in the configured flowchart.

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SSS Flowsheet

# SS.03 Identify Critical Areas

## Context

The purpose of a Service Strategy is to identify the most cost effective way to manage risks related to a process. The objective is to deliver the safe, cost effective Functional Life required from processes that the Business is accountable for, or relies upon. Achieving this entails;

- protecting people from harm,
- protecting the environment from harm,
- maintaining stakeholder support (investors, communities and regulators),
- preserving the Effectiveness of the process,
- preserving the Efficiency of the process, and
- preserving the operational life of the process.

It is not possible to produce a zero risk situation, hence, setting a Service Strategy must start with defining the level of risk that the stakeholders in any situation consider acceptable. The acceptable level of risk is shaped by many factors, and it is not equal for all people in every situation, and will change over time.

Since it is not practical to eliminate all hazards, and produce a zero risk situation, it is sensible to be proactive in managing the most probable, and high consequence risks. Ranking processes, based on the likelihood, consequences and exposure of risks, will allow the set of critical processes (those where the risk posed is not acceptable) to be identified. This will allow service work to be focused on those areas where it will produce the greatest return.

## Purpose

To rank the criticality of processes and operational risk for which a proactive Service Strategy should be applied.

## Quantity

- One list of the critical processes.
- One set of data used to evaluate the Criticality Rating for each process.
- One number representing the Criticality Rating for each process.
- A list of significant operational risks and related priority unwanted events in terms of the Operational Risk Management (ORM) Baseline Risk Management process.

## Quality

Two Pareto diagrams shall be produced showing the ranking of the Criticality Rating (described below) for all processes entries in the Business Structure flow sheet (down to Productive Unit level). The two Pareto diagrams shall rank the processes based on

HSE Criticality,

Business Criticality.

The processes and risks that have Criticality Ratings beyond the acceptable threshold shall be identified.

The criticality rating (CR) shall be calculated based on the formula;

CR = Sum of Consequences × Probability of Threat During Functional Life × Probability of Exposure

NB: For threats where the probable time to occurrence is short compared to the Functional Life the Probability of Failure during the Functional Life will be 100% and the formula becomes;

CR = Sum of Consequences × Probability of Exposure

The consequence matrix contained in Appendix 1 shall be used as a guide in calculating the Criticality Rating while the ORM Risk Matrix shall be applied to risks within the scope of the ORM Baseline Risk Management Process. The consequences used in determining the criticality rating shall be based on the worst probable scenario (that with the highest value for consequence rating × probability of occurrence × probability of exposure) for any of the identified risks.

The likelihood of process risk indicates the probability that the failure event will occur at least once during the Functional Life, on the basis that no control action is in place to prevent it – i.e. the probability if we do nothing. For example, for a plant with a 10 year Functional Life the Probability of Failure for; a v-belt on a continuously operated pump drive is likely to be 100%, and for the concrete base on which the pump set is mounted it is likely to be 0%.

The Probability of Exposure indicates the percentage of risk events from which the full consequences are likely to arise. For example the probability of exposure to environmental damage in the event of a mine fuel storage tank leak is; almost 100% if there is no secondary containment structure around the tank and, is almost 0% if there is a secondary containment structure.

When evaluating the Criticality Rating of a process consider;

- the common causes of unwanted events.
- Safety margins employed during design.
- Construction materials, techniques and practices.
- The environment in which the process is located.
- Operating practices.
- Modification of design, use or operation.
- The probable frequency of an unwanted event.
- The health, safety or environmental consequences of the unwanted event.

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- Performance Targets.
- Containment or mitigation related to the unwanted event.
- The ability to re-process or divert product or services to alternate uses.
- Alternate means of achieving the function of the process in the event of an unwanted event.
- Surplus capacity available to ‘catch up’ losses.
- The probable exposure to HSE, production and cost consequences of each unwanted event occurrence.

The deliverables shall meet the following requirements for each Process and operational risk;

- The decision criteria values and rationale used in evaluating the criticality of each shall be recorded in a database.
- The data base entry for each must clearly identify a reference to the criticality evaluation criteria and rationale.
- The data base entry for each Process must clearly identify the criticality rating assigned.

**Time**

The first assessment for criticality shall be completed during establishment of a process.

Validation of criticality shall be completed whenever a change to the process is made, or each two years, whichever comes first.

The first ORM Baseline Risk Management process shall be completed during the establishment of the process and reviewed annually or when significant change to the process is made or when the characteristics of a risk change significantly.

**Resources**

Identification of critical processes is the accountability of the role identified in the configured flowchart.

Execution of ORM Baseline Risk Management is the accountability of the General Manager.

# Appendix 1 – Process Consequence Rating Matrix

| Rating Matrix | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Safety | | Environment | | Revenue | | Cost | | Reputation | | Regulatory | | Social | | Threat Level |
| Value | Description | Value | Description | Value | Description | Value | Description | Value | Description | Value | Description | Value | Description | |
| 40 | Multiple fatalities | 40 | Release above permit >1 week | 20 | >US$25M revenue loss | 20 | >US$10M direct cost | 20 | International news | 20 | Court prosecution by external regulator | 20 | Permanent displacement or loss of livelihood for people, class legal action | Major |
| 28 | Single fatality, multiple disablement, multiple occupational disease cases | 28 | Release above permit >2 days | 14 | >US$5M revenue loss | 14 | >US$2M direct cost | 14 | National news | 14 | Fine from external regulator | 14 | Long term displacement or loss of livelihood for people, individual legal action | |
| 18 | Multiple lost time injuries, single occupational disease case | 18 | Release above permit >1 day | 9 | >US$1M revenue loss | 9 | >US$400k direct cost | 9 | Provincial news | 9 | Corrective orders from external regulator | 9 | Short term displacement or loss of livelihood for people, repeated complaints | Significant |
| 10 | Single lost time injury | 10 | Release above permit <1 day | 5 | >US$200k revenue loss | 5 | >US$100k direct cost | 5 | Local news | 5 | Investigation by external regulator | 5 | Decreased opportunity or livelihood for people, multiple complaints | |
| 4 | Injury or ill health | 4 | Release significantly exceeding normal levels but < permit | 2 | <US$200k revenue loss | 2 | <US$100k direct cost | 2 | Word of mouth | 2 | Report to external regulator | 2 | Discomfort or complaint | Minor |
| 0 | No affect | 0 | No release | 0 | No loss | 0 | No cost | 0 | No publicity | 0 | No action | 0 | No action | |

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SSS Flowsheet

# SS.04 Specify Serviceable Items

## Context

The purpose of a Service Strategy is to identify the most cost effective way to manage risks related to a process. The objective is to deliver the safe, cost effective life required from processes that the Business is accountable for, or relies upon. Achieving this entails;

- protecting people from harm,
- protecting the environment from harm,
- maintaining stakeholder support (investors, communities and regulators),
- preserving the Effectiveness of the process,
- preserving the Efficiency of the process, and
- preserving the operational life of the process.

It is not possible to produce a zero risk situation, hence, setting a Service strategy must start with defining the level of risk that the stakeholders in any situation consider acceptable. The acceptable level of risk is shaped by many factors, and it is not equal for all people in every situation, and will change over time. For example, one survey in a western society revealed that on average this group felt that a 1 in 10,000 risk of being killed in a car accident, a 1 in 100,000 risk of being killed at work, and a 1 in 1,000,000 risk of being killed at home were acceptable.

Since it is not practical to eliminate all hazards, and produce a zero risk situation, it is sensible to be proactive in managing the most probable and high consequential risks. Ranking processes, based on the likelihood, consequences and exposure to risks, will allow the set of critical processes (those where the risk posed is not acceptable) to be identified. This will allow service work to be focused on those areas where it will produce the greatest return.

A critical area is likely to comprise; human activities, workplaces, equipment/components, materials and the environment of the process. Ultimately a risk arises due to an unacceptable change in the performance or use of one of these. Therefore, a Service Strategy to prevent, detect, mitigate or correct the conditions that may lead to an unacceptable change will involve distinct actions to, for example;

- monitor performance of activities or tasks undertaken by people, or monitor the condition or performance of equipment or the environment,
- coach people or adjust equipment to counter drift in performance,
- refresh the training of people or repair equipment to reset performance to required standards,
- relieve people who are fatigued by duty or replace equipment that is worn out.

The items (human activities, workplaces, equipment, materials and areas of the environment) that these monitoring and corrective actions are performed on are termed Serviceable Items in the Operating Model.

The actions taken to implement a Service Strategy must be packaged so that it is efficient to manage (i.e. plan, schedule, resource and execute), and so that the history of the work associated with the strategy is meaningful for future scheduling and analysis of Service work. Consequently we need to uniquely identify within the work management (often an ERP) Location/ Equipment structure and work management system each Serviceable Item. This identification is in effect an extension of the Business Structure elements.

The approach for setting up the highest levels of the Business Structure (Company, Business Unit, Operation, Process and Productive Unit) was set out in Task Assignment ST.01, Specify Business Structure. The purpose of this activity is to define the elements for which distinct business targets are set.

The purpose of defining the Serviceable Items, (Activity/Workplace/ Equipment and Task/Location/Component) is to define the items for which Service Strategies are proactively set (i.e. the Service Strategy is chosen on the basis of a considered decision). By default, if no other strategy is selected, the Service Strategy will be Operate to Failure, i.e. respond only after an incident has occurred.

As with the identification of critical areas, correctly identifying the Serviceable Items where a risk is likely to produce an unwanted event, Service Strategy effort should to be focused on those items where it will produce the greatest return. These are the items where there is;

- a probability (if we do not manage effectively) of a unwanted event occurring during the required Functional Life,
- it is probable that people, the environment, community or business will be exposed to a hazard by the occurrence of the unwanted event, and
- where there are likely to be significant consequences arising from the unwanted event.

Most operations will over their lives undergo many changes, additions and/or contractions that should be incorporated into the work management database. It is not uncommon that the updating of the database does not keep pace with changes. In order to maintain a current and accurate catalogue of Serviceable Items, a regular process must be in place to physically identify/validate Serviceable Items, and to confirm that they are accurately recorded.

**Purpose**

To specify the items for which a proactive Service Strategy will be created.

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**Quantity**

- One entry in the Work Management Location/Equipment Structure for each Serviceable Item.

**Quality**

The following guidelines should be considered when structuring the database for Serviceable Items.

1. The items that;
   - on their own, transform, transfer or store the product or service of a Process/Productive Unit (e.g. interviewing of job applicants; each draw point within a mining stope; each truck within a fleet; the feed chute, crusher and discharge feeder within a crushing system), or
   - perform a distinct function within the Facilities of an Operation, Process/Productive Unit (e.g. the foundation, structural steel, cladding, bunding, etc.)
     - where all elements of a Facility have a similar failure consequence, probability and exposure do not create separate Components for them e.g. if beams, columns, and bracing of a steel structure have essentially the same failure characteristics make them one Equipment – 'Structural Steel',
     - where elements of a Facility have a different hazard types, consequence, probability and exposure, identify elements with like characteristics as components of the Serviceable Item e.g. beams, columns, and bracing comprising the 'Structural Steel', and
   - for which Service Work packages are likely to be independent of those for other Serviceable Items,
   - that identify the likely Pareto set (the 20% of Serviceable Items that include 80% of the work) for Service Strategy actions in that Process,

   should be created as Activities/Workplaces/Equipment in the work management system database.

2. The elements of an Activity/Workplace/Equipment that;
   - do not, on their own, transform, transfer or store the product or service of the Process/Productive Unit, but
     - perform a distinct function within the Activity/Workplace/ Equipment (preparing interview documentation, the box front on a draw point, the chassis, drive system and tray of the truck; the structure, drive system and belting of the conveyor, etc.), and
     - will have Service Work completed as an independent unit,

     or
   - form part of a function within a Facility item but have significantly different failure consequence, probability or exposure,
     - groups of Facility elements within an Equipment that have a similar failure characteristics can be grouped as a single Component (e.g. beams, columns, and bracing ),

     and

- for which Service Work packages are likely to be independent of the Service Work packages for other elements of the Activity/Workplace/Equipment, and
- that identify the likely Pareto set (the 20% of items that include 80% of the work) for Service Strategy actions on that Activity/Workplace/ Equipment,

should be created as Tasks/Locations/Components of the Activity/ Workplace/Equipment.

3. Each parts assembly where the most common Service Strategy will be replacement of the assembly on the functional failure of one of its elements (the simplest may be a single item) should be created as a Part.

4. Serviceable Items associated with providing services (power/water/air supply, mine dewatering, etc.) should be included as a separate leg of the work management Location/Equipment structure where they provide services to multiple items in other legs of the structure, and then merged where they service only one item. For example, a power or water distribution system for a multi-storey building should be a separate leg of the structure from the point of supply through to the branch off to individual floors of the building. From the switch or valve that isolates each floor the serviceable items should be included in the structure for that floor. As a guide to the structure for Serviceable Items having an Asset Integrity target only, an assembly of like components that have a similar consequences in the event of an unwanted event should be identified as a Serviceable Item. For example a building may comprise; structural steel, concrete foundations/footings, roofing and cladding, each of which could be classified as Serviceable items. The components (such as columns, beams, etc.) that will likely be affected by a specified risk will be identified as objects in the risk description, e.g. corrosion of column bases.

When identifying Serviceable Items, consider;

- Process Flowcharts, P&IDs, General Layouts, equipment lists, etc. to identify potential Serviceable Items,
- potential Integrity critical items matching any entry in the attached checklist – Appendix 1,
- potential hazards from the checklist in Appendix 2,
- potential hazard release mechanisms in Appendix 3,
- Risk ranking from the table in Appendix 4,
- safety margins, operational controls, checks and mitigation techniques in place,
- the probability distribution of the occurrence of an unwanted event, and
- the probability of exposure to an unwanted event once the hazard is released.

A database entry shall be created for each Serviceable Item.

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**Time**

Serviceable Items shall be specified during establishment of a process

Review and validation of Serviceable Items shall be completed whenever a change to the process is made, or not less than every 2 years, whichever comes first.

**Resources**

Identification of Serviceable Items is the accountability of the role identified in the configured flowchart.

## Appendix 1 – Integrity Critical Item Checklist

**Structural**
Piles
Footings/Foundations
Slabs (floor, wall & roof)
Columns/Beams/Braces/Connection Plates
Platforms/Walkways
Stairs/Ladders
Rafters/Purlins
Sheeting/Cladding (roofs & walls)
Brickwork
Services ducts (buried)
Pipe & cable racks
Bridges

**Storage/Containment**
Tanks/ Bins/Hoppers/ Vessels (including thickeners, washers, clarifiers, float cells, etc.)
Dams (water, tailings, etc.)/Ponds
Dykes/Bunds
Sumps
Berms/Containment barriers

**Electrical**
Distribution transformers
Transmission lines/ Cables/ Poles
Lightning Protection
Filters (including harmonic)
Ground systems
Switchboards/Switchgear/Circuit Breakers
UPS/Control/Alarm Systems (including process & fire)
Rectifiers/Drive systems
Motors/Generators
Communications systems

**Materials Transfer**
Piping/Troughs//Chutes/Conveyors (bucket, chain, belt, plate, etc.)
Spillways/Sluice gates/Channels (including creeks)
Drains/Sewers/Siphons
Ducting/Flues/Chimneys/Vents
Locomotives/Rails/Rail Beds
Roads/Bridges/Cuttings/Tunnels

**Mining**
Ramps/Drives/Rises/Ore Passes/Service Bays
Shafts/Hoists/ Headframes/Ropes/ Cages
Shovels

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**Process Equipment**
Crushers/Mills
Analysers
Digesters/Claves/Reactors/Roasters
Ladles (including slag cars)
Furnaces/Converters/Boilers/Cold boxes
Turbines/ Compressors/Blowers
Cranes

## Appendix 2 - Hazard Types

- ***Stress*** - materials science subdivides this into catastrophic overstress that produces sudden failures (e.g. fracture), prolonged high stress that produces creep deformation and prolonged cyclic stress that produces fatigue failure. Similar types of results can be produced in people. Some examples of potential forms of stress are; physical/mechanical, thermal, voltage, radiation, mental, etc.

- ***Chemical*** - in materials science terms this would be due to the (re)action of chemicals such as oxygen, acids, alkalis, but in a broader context could also include drugs, alcohol etc.

- ***Wear*** - materials science subdivides wear into different mechanisms for the removal of material e.g. abrasion, erosion, fretting etc.

- ***Fouling*** - accumulation of material e.g. silting, scaling, contamination, etc.

- ***Obsolescence*** - this is not a category used in materials science but reflects a type of hazard that arises from the loss of support for either the products or services of a process, e.g. due to innovation or competition, the imposition of constrictions to the process, e.g. imposition of new standards/laws, or the loss of essential resources for the continued operation of the process, loss of people, skills or knowledge, loss of parts sources etc.

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**Appendix 3 – Hazard Release Mechanisms**

- ***Design*** - fatigue, chemical action, wear and fouling are all, to some extent, 'designed in' to a process based on the purpose of the process and the choice of technologies for its implementation.

- ***Operation*** - wear, stress and fouling can be influenced by the age of process elements, operating rates, operating conditions, feed materials, maintenance and process shutdown/start-up cycles etc.

- ***People*** - the errors, omissions or deliberate actions of people, resulting in changes to operating procedures/limits or material/equipment specifications, can lead to stress, chemical action or wear.

- ***Environment;***
    - ***Commercial*** - innovation and competition may lead to obsolescence of product, services or technology.
    - ***Natural*** – e.g. flood, tornado, hurricane, volcanic eruption, earthquake, or landslide can lead to stress, erosion, or silting.
    - ***Social*** – e.g. social unrest or sovereign risk may lead to damage or changes to expectations, standards, laws etc.

# Appendix 4 - Process Consequences Rating Matrix

| Rating Matrix | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Safety | | Environment | | Revenue | | Cost | | Reputation | | Regulatory | | Social | | Threat Level |
| Value | Description | Value | Description | Value | Description | Value | Description | Value | Description | Value | Description | Value | Description | |
| 40 | Multiple fatalities | 40 | Release above permit >1 week | 20 | >US$25M revenue loss | 20 | >US$10M direct cost | 20 | International news | 20 | Court prosecution by external regulator | 20 | Permanent displacement or loss of livelihood for people, class legal action | Major |
| 28 | Single fatality, multiple disablement, multiple occupational disease cases | 28 | Release above permit >2 days | 14 | >US$5M revenue loss | 14 | >US$2M direct cost | 14 | National news | 14 | Fine from external regulator | 14 | Long term displacement or loss of livelihood for people, individual legal action | |
| 18 | Multiple lost time injuries, single occupational disease case | 18 | Release above permit >1 day | 9 | >US$1M revenue loss | 9 | >US$400k direct cost | 9 | Provincial news | 9 | Corrective orders from external regulator | 9 | Short term displacement or loss of livelihood for people, repeated complaints | Significant |
| 10 | Single lost time injury | 10 | Release above permit <1 day | 5 | >US$200k revenue loss | 5 | >US$100k direct cost | 5 | Local news | 5 | Investigation by external regulator | 5 | Decreased opportunity or livelihood for people, multiple complaints | |
| 4 | Injury or ill health | 4 | Release significantly exceeding normal levels but < permit | 2 | <US$200k revenue loss | 2 | <US$100k direct cost | 2 | Word of mouth | 2 | Report to external regulator | 2 | Discomfort or complaint | Minor |
| 0 | No affect | 0 | No release | 0 | No loss | 0 | No cost | 0 | No publicity | 0 | No action | 0 | No action | |

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# SS.05 Identify Historical Threats

## Context

The purpose of a Service Strategy is to identify the most cost effective way to manage risks related to a process, hence delivering the safe, cost effective life required from the process.

To define the Service actions for a process it is first necessary to identify the probable and priority risks, and then to identify the most appropriate Service Strategy for dealing with each risk. Finally, the selected Strategy can be turned into a set of actions (the right work) that can be executed at the right time and in the right way.

Materials science has defined a set of mechanisms by which material failures can be categorised. When looked at from a boarder context it can be observed that, with some adaptation, these can provide a set of hazard types that could be useful in considering probable risks across many types of processes:

- ***Stress*** - materials science subdivides this into catastrophic overstress that produces sudden failures (e.g. fracture), prolonged high stress that produces creep deformation and prolonged cyclic stress that produces fatigue failure. Similar types of results can be produced in people. Some examples of potential forms of stress are; physical/mechanical, thermal, voltage, radiation, mental, etc.
- ***Chemical*** - in materials science terms this would be due to the (re)action of chemicals such as oxygen, acids, alkalis, but in a broader context could also include drugs, alcohol etc.
- ***Wear*** - materials science subdivides wear into different mechanisms for the removal of material e.g. abrasion, erosion, fretting etc.
- ***Fouling*** - accumulation of material e.g. silting, scaling, contamination etc.
- ***Obsolescence*** - this is not a category used in materials science but reflects a type of hazard that arises from the loss of support for either the products or services of a process, e.g. due to innovation or competition, the imposition of constrictions to the process, e.g. imposition of new standards/laws, or the loss of essential resources for the continued operation of the process, loss of people, skills or knowledge, loss of parts sources etc.

The above hazard mechanisms may act either alone or in combination, and when acting in combination may produce an unwanted event that does not occur with either of the mechanisms absent e.g. stress corrosion cracking, the result of a combination of highly alkaline environment and high physical stress levels.

A failure mechanism classification of 'Random' is sometimes applied to electronic components. However, this is a situation where the consequences related to an unwanted event are visible (the failure), but the underlying mechanism is usually not readily identifiable, rather than the result of a different hazard release mechanism. Analysis of electronic failures most commonly reveals evidence of overstress, fatigue or chemical reaction. However, the evidence for the hazards release mechanism is usually masked by either the small scale of the issue, or by the packaging of the component, or by the damage caused by the failure. Overstress usually results in random catastrophic failure of electronic components. Fatigue is typically thermal or mechanical in origin, and hence evident in the operating environment (heat or vibration), and exhibits a wear out pattern. Chemical action is also typically evident in the operating environment and also exhibits a wear out pattern. Hence, a reasonable estimate can be made of the likely hazard release mechanisms applying to electronic components.

The risk source sources to consider when trying to identify the types of hazards and unwanted events that may arise in or around a process are:

- ***Design*** - fatigue, chemical action, wear and fouling are all, to some extent, 'designed in' to a process based on the purpose of the process and the choice of technologies for its implementation.
- ***Operation*** - wear, stress and fouling can be influenced by the age of process elements, operating rates, operating conditions, feed materials, maintenance and process shutdown/start-up cycles etc.
- ***People*** - the errors, omissions or deliberate actions of people, resulting in changes to operating procedures/limits or material/equipment specifications, can lead to stress, chemical action or wear.
- ***Environment;***
  - ***Commercial*** - innovation and competition may lead to obsolescence of product, services or technology.
  - ***Natural*** – e.g. flood, tornado, hurricane, volcanic eruption, earthquake, or landslide can lead to stress, erosion, or silting.
  - ***Social*** – e.g. social unrest or sovereign risk may lead to damage or changes to expectations, standards, laws etc.

Whether or not one of these release mechanisms might arise depends on;

- capability of people for their role,
- behaviours, symbols and systems in the social environment,
- induction and training,
- physical environment,
- design of processes, work, plant and equipment,
- choice of materials, operating limits, techniques and practices,
- operating stability and rates,
- control of modification of design, use or operation,
- maintenance/care of people, hardware and software,
- the required Functional Life of the process.

There are many possible risks, but far fewer that are probable. In setting a Service Strategy we should focus on the risks;

- that are probable given the specific combination of the above factors that operate, and
- which are likely to result in a significant consequences and exposure.

Some risks emerge early in the life of a process and some may not appear for many years or decades. In order to ensure that a complete record of probable

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hazards is compiled, all of the available sources of information regarding historical threats should be consulted. This may include the;

- experience of personnel,
- internal records of past risks, including sources such as process, maintenance, accident, incident and complaints records, plus
- external sources such as news articles.

This information may also be extrapolated to provide guidance on the risk that may yet develop with other processes.

In the case of an existing process with a relatively short time intervals between unwanted event recurrences, the history of the process should provide most of the required information on the probable risk and their characteristics. While it might be hoped that the complete, relevant risk history for a process will be available in the records, this is often not the case. Hence, assembling a record of the historical risks will generally involve drawing on both the records and the knowledge of experienced personnel.

A comprehensive record of all identified probable risks for a process may be used to;

- reduce the incidence of detrimental modification of standard Service Work Packages, by allowing easy identification of the reasons that Service Strategies and actions were implemented.
- use results of the process performance and actual unwanted event occurrences to validate or improve the Service Strategy design.

**Purpose**

To specify the historical risks for which a Service Strategy will be created.

**Quantity**

- One list of historical risks.
- A list of historical risks and related priority unwanted events in terms of the Operational Risk Management (ORM) Baseline Risk Management process.

**Quality**

To identify the historical risks and characteristics;

- Review design and engineering documents, assessments and reports for relevant information.
- Research the process operating, maintenance, accident, incident and complaints records, plus external sources such as news articles, for the historical risks evident in the records.
- Describe each probable risk, as the Serviceable Item, the risk type (reputational, operational, etc.), and the risk source. For example;
    - employee stress from extended working hours,
    - slurry pump wear from abrasive fluids,
    - engine wear from contamination of oil,
    - structural steel corrosion from paint failure.

- Group records that indicate a probable recurring risk, i.e. the same Serviceable Item, hazards release mechanism.
- Have a review team with both technical knowledge and experience of the history of the process consider the records and;
    - Validate/correct any risks defined for the records,
    - Validate/correct any prior grouping of records,
    - Identify other unrecorded events related to potential risk,
    - Group other events related to recurring risks,
    - Specify the most probable risks - those for which a pro-active Service strategy should be developed.

In identifying the probable risks associated with a process consider at least the following possible hazard types:

- ***Stress*** - materials science subdivides this into catastrophic overstress that produces sudden failures (e.g. fracture), prolonged high stress that produces creep deformation and prolonged cyclic stress that produces fatigue failure. Similar types of results can be produced in people. Some examples of potential forms of stress are; physical/mechanical, thermal, voltage, radiation, mental, etc.
- ***Chemical*** - in materials science terms this would be due to the (re)action of chemicals such as oxygen, acids, alkalis, but in a broader context could also include drugs, alcohol etc.
- ***Wear*** - materials science subdivides wear into different mechanisms for the removal of material e.g. abrasion, erosion, fretting etc.
- ***Fouling*** - accumulation of material e.g. silting, scaling, contamination etc.
- ***Obsolescence*** - this is not a category used in materials science but reflects a type of hazard that arises from the loss of support for either the products or services of a process, e.g. due to innovation or competition, the imposition of constrictions to the process, e.g. imposition of new standards/laws, or the loss of essential resources for the continued operation of the process, loss of people, skills or knowledge, loss of parts sources etc.

In identifying the probable risks associated with a process consider at least the following possible hazard release mechanisms:

- ***Design*** - fatigue, chemical action, wear and fouling are all, to some extent, 'designed in' to a process based on the purpose of the process and the choice of technologies for its implementation.
- ***Operation*** - the life, operating rates, operating conditions, feed materials etc.
- ***People*** - the errors, omissions or deliberate actions of people, resulting in changes to operating procedures/limits or material/equipment specifications, can lead to stress, chemical action or wear.
- ***Environment;***
    - ***Commercial*** - innovation and competition may lead to obsolescence of product, services or technology.
    - ***Natural*** – e.g. flood, tornado, hurricane, volcanic eruption, earthquake, or landslide can lead to stress, erosion, or silting.

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- ***Social*** – e.g. social unrest or sovereign risk may lead to damage or changes to expectations, laws etc.

A database shall be used to record the historical risk events and hazards for a process.

**Time**

The historical risks associated with a process shall be specified and reviewed during operation of the process, based on the benefit ranking of improvement opportunities identified through analysis of performance and costs and through consideration of the priority of unwanted events captured in the ORM baseline.

**Resources**

The identification of historical risks is the accountability of the role identified in the configured flowchart.

## Appendix 1: Example Hazard Type

| ENERGY | EXAMPLE OF HAZARD | UNWANTED EVENT | POSSIBLE BARRIERS/ CONTROLS | TYPE OF CONTROL (HIERARCHY OF CONTROL) |
|---|---|---|---|---|
| **Biological** | Bacteria, viruses, diseases, natural poisons | Fungal infections, Legionnaire's disease HIV infection, Malaria | Maintenance of air-conditioning systems, education, condoms, Malaria tablets | Engineering, Administrative, PPE |
| **Chemical** | Gases, fuels, lubes, degreasers, solvents, acids, alkalis, cyanide | Occupational asthma, dermatitis, asphyxiation, poisoning, unconsciousness, corrosion | Enclosure of processes, substitution for less corrosive chemical, ventilation, safe work procedures, PPE | Elimination, Substitution, Engineering, Administrative, PPE |
| **Electrical** | High voltage, low voltage, live parts, frayed cords, overload | Accidental contact, arcing | Isolation and lockout, training, PPE | Engineering, Administrative, PPE |
| **Gravitational (Objects)** | Unsupported coal, rock, tools, components, structures | Object falls on Worker Tool falls on miner | Stope support, SOPs, mining design, PPE | Engineering, Administrative, PPE |
| **Gravitational (People)** | Unsupported/ unbalanced person/s (who could fall from heights) | Miner falls while working at heights | Barricading, fall arrest equipment, safe work procedure | Engineering, Administrative, PPE |
| **Mechanical** | Rotating elements, nip points, sharp edges etc | Arm gets caught in moving parts | Machine guards, machine design, SOPs | Engineering, Administrative |
| **Kinetic** | Haulage trucks, LHDs, service vehicles, gen sets, speeding | Light/Heavy Vehicle collision with another vehicle, a person or an object | Construct separate roadways for light and heavy vehicles, transport plan | Eliminate, Administrative |
| **Magnetic** | Strong magnetic fields (near metal objects/tools, sensitive equipment) | Ferromagnetic object interferes with sensitive equipment, pacemaker malfunctions | Awareness, Operator competency/ education, isolation and lockout, SOPs | Administrative |
| **Noise** | Gas leaking at high speed, exhaust system, pump cavitation, etc. | Hearing impairment, distractions | Fit mufflers to reduce noise, quieter equipment, maintenance of equipment, PPE, rotation of workers | Engineering, Substitution, Administrative, PPE |
| **Pressure & Potential Energy** | Pressurised cylinders, tyres, springs, coils, etc. | Explosion, flying objects | Awareness, training, safe work procedures, work inside tyre cage, regular maintenance of tyres and pressure equipment | Engineering, Administrative |
| **People** | Human error (unintentional or intentional) | Slip or trip due to lack of awareness of surroundings or objects left around due | Training and SOPs | Administrative |
| **Thermal** | Objects or material at high/low temperature, radiation etc. | Burn due to contact, heat stress, heat stroke | Barriers, separation from heat, shields, cooling systems, ventilation, training and acclimatisation, Work Permit System, SOPs, PPE | Engineering, Administrative, PPE |
| **Vibration** | From vehicles, equipment, tools, worn parts etc. | Fatigue, backache, poor concentration, increased chance of accidents | Road maintenance, purchase suitable equipment and vehicles, maintenance PPE, rotation of workers | Engineering, Substitution, Administrative, PPE |

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# SS.06 Identify Probable Threats

## Context

The purpose of a Service Strategy is to identify the most cost effective way to manage risks related to a process, hence delivering the safe, cost effective life required from the process.

To define the Service actions for a process it is first necessary to identify the probable and priority risks, and then to identify the most appropriate Service Strategy for dealing with each risk. Finally, the selected Strategy can be turned into a set of actions (the right work) that can be executed at the right time and in the right way.

Materials science has defined a set of mechanisms by which material failures can be categorised. When looked at from a boarder context it can be observed that, with some adaptation, these can provide a set of hazard types that could be useful in considering probable risks across many types of processes

- ***Stress*** - materials science subdivides this into catastrophic overstress that produces sudden failures (e.g. fracture), prolonged high stress that produces creep deformation and prolonged cyclic stress that produces fatigue failure. Similar types of results can be produced in people. Some examples of potential forms of stress are; physical/mechanical, thermal, voltage, radiation, mental, etc.
- ***Chemical*** - in materials science terms this would be due to the (re)action of chemicals such as oxygen, acids, alkalis, but in a broader context could also include drugs, alcohol etc.
- ***Wear*** - materials science subdivides wear into different mechanisms for the removal of material e.g. abrasion, erosion, fretting etc.
- ***Fouling*** - accumulation of material e.g. silting, scaling, contamination etc.
- ***Obsolescence*** - this is not a category used in materials science but reflects a type of hazard that arises from the loss of support for either the products or services of a process, e.g. due to innovation or competition, the imposition of constrictions to the process, e.g. imposition of new standards/laws, or the loss of essential resources for the continued operation of the process, loss of people, skills or knowledge, loss of parts sources etc.

The above hazard release mechanisms may act either alone or in combination, and when acting in combination may produce an unwanted event that does not occur with either of the mechanisms absent, e.g. stress corrosion cracking, the result of a combination of highly alkaline environment and high physical stress levels.

A failure mechanism classification of 'Random' is sometimes applied to electronic components. However, this is a situation where the consequences related to an unwanted event are visible (the failure), but the underlying mechanism is usually not readily identifiable, rather than the result of a different hazard release mechanism. Analysis of electronic failures most commonly reveals evidence of overstress, fatigue or chemical reaction. However, the evidence for the hazard release mechanism is usually masked by either the small scale of the issue, or by the packaging of the component, or by the damage caused by the failure. Overstress usually results in random catastrophic failure of electronic components. Fatigue is typically thermal or mechanical in origin, and hence evident in the operating environment (heat or vibration), and exhibits a wear out pattern. Chemical action is also typically evident in the operating environment and also exhibits a wear out pattern. Hence, a reasonable estimate can be made of the likely hazard release mechanisms applying to electronic components.

The risk sources to consider when trying to identify the types of hazard and unwanted events that may arise in or around a process are:

- ***Design*** - fatigue, chemical action, wear and fouling are all, to some extent, 'designed in' to a process based on the purpose of the process and the choice of technologies for its implementation.
- ***Operation*** - wear, stress and fouling can be influenced by the age of process elements, operating rates, operating conditions, feed materials, maintenance and process shutdown/start-up cycles etc.
- ***People*** - the errors, omissions or deliberate actions of people, resulting in changes to operating procedures/limits or material/equipment specifications, can lead to stress, chemical action or wear.
- ***Environment;***
  - ***Commercial*** - innovation and competition may lead to obsolescence of product, services or technology.
  - ***Natural*** – e.g. flood, tornado, hurricane, volcanic eruption, earthquake, or landslide can lead to stress, erosion, or silting.
  - ***Social*** – e.g. social unrest or sovereign risk may lead to damage or changes to expectations, standards, laws etc.

Whether or not one of these release mechanisms might arise depends on;

- capability of people for their role,
- behaviours, symbols and systems in the social environment,
- induction and training,
- physical environment,
- design of processes, work, plant and equipment,
- choice of materials, operating limits, techniques and practices,
- operating stability and rates,
- control of modification of design, use or operation,
- maintenance/care of people, hardware and software,
- the required Functional Life of the process.

There are many possible risks, but far fewer that are probable and materially consequential. In setting a Service Strategy we should focus on the risks;

- that are probable given the specific combination of the above factors, and
- which are likely to result in a significant consequences and exposure.

Many Serviceable Items in a Process will have some history of application that will provide useful guidance on the types of risk that may be expected to arise. In the case of a new process, or one established is a significantly different

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environment, the history from other similar processes, applications and environments can often be extrapolated to provide guidance on the hazards that might be experienced. However, there are some probable hazards that may not begin to emerge until later in the life of a process. In these cases there will be no prior history, or record of evidence of the hazard or actions taken to manage it. Identifying the probable hazards that are yet to emerge requires an explorative assessment be made of the potential hazard types, the hazard release mechanism that could lead to an unwanted event developing, and the factors that may mitigate against these.

In order to ensure that a complete record of probable hazards is compiled, the experience of personnel, designer's/manufacturer's data, and the results of hazard identification for like situations should be reviewed.

A comprehensive record of all identified unwanted events for a process may be used to;

- reduce the incidence of detrimental modification of standard Service Work Packages, by allowing easy identification of the reasons that Service Strategies and actions were implemented.
- use results of the process performance actual unwanted events occurrences to validate or improve the Service Strategy design.

**Purpose**

To specify the risk events for which a Service Strategy will be created.

**Quantity**

- One list of probable risks.
- A list of probable risks and related priority unwanted events in terms of the Operational Risk Management (ORM) Baseline Risk Management process

**Quality**

To identify the probable risks and characteristics;

- Review design and engineering documents, assessments and reports for relevant information.
- Produce a list of the Serviceable Items for which probable risks are to be assessed. The checklist of likely Integrity Serviceable Items in Appendix 1 may be of assistance.
- Where applicable, identify the relevant design characteristics for the Serviceable Items, e.g.;
  - output,
  - skills,
  - capacity,
  - construction,
  - material(s) etc.
- Identify the relevant characteristics for the application of the Serviceable Items, e.g.;

    - Environment, e.g. temperature, moisture, dust, etc.,
    - loading,
    - duty.
- Identify any Serviceable Items that are similar in design and application for which risk data is available. Data may be available from;
    - other similar processes,
    - other companies,
    - manufacturers.
- Have a review team with both technical knowledge and experience of the of the Serviceable Item types and application consider the data and;
    - Review potentially relevant data from similar items and applications.
    - Specify the most probable risks for each Serviceable Item.
- Describe each probable risk, as the Serviceable Item, the hazard type, and the hazard source. For example;
    - employee stress from extended working hours,
    - slurry pump wear from abrasive fluids,
    - engine wear from contamination of oil,
    - structural steel corrosion from paint failure..

In identifying the probable risks associated with a process consider at least the following possible hazard types:

- ***Stress*** - materials science subdivides this into catastrophic overstress that produces sudden failures (e.g. fracture), prolonged high stress that produces creep deformation and prolonged cyclic stress that produces fatigue failure. Similar types of results can be produced in people. Some examples of potential forms of stress are; physical/mechanical, thermal, voltage, radiation, mental, etc.
- ***Chemical*** - in materials science terms this would be due to the (re)action of chemicals such as oxygen, acids, alkalis, but in a broader context could also include drugs, alcohol etc.
- ***Wear*** - materials science subdivides wear into different mechanisms for the removal of material e.g. abrasion, erosion, fretting etc.
- ***Fouling*** - accumulation of material e.g. silting, scaling, contamination etc.
- ***Obsolescence*** - this is not a category used in materials science but reflects a type of hazard that arises from the loss of support for either the products or services of a process, e.g. due to innovation or competition, the imposition of constrictions to the process, e.g. imposition of new standards/laws, or the loss of essential resources for the continued operation of the process, loss of people, skills or knowledge, loss of parts sources etc.

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In identifying the probable risks associated with a process consider at least the following possible hazard release mechanism:

- ***Design*** - fatigue, chemical action, wear and fouling are all, to some extent, 'designed in' to a process based on the purpose of the process and the choice of technologies for its implementation.
- ***Operation*** - the life, operating rates, operating conditions, feed materials etc.

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- ***People*** - the errors, omissions or deliberate actions of people, resulting in changes to operating procedures/limits or material/equipment specifications, can lead to stress, chemical action or wear.
- ***Environment;***
  - ***Commercial*** - innovation and competition may lead to obsolescence of product, services or technology.
  - ***Natural*** – e.g. flood, tornado, hurricane, volcanic eruption, earthquake, or landslide can lead to stress, erosion, or silting.
  - ***Social*** – e.g. social unrest or sovereign risk may lead to damage or changes to expectations, laws, etc.

A database shall be used to record the probable risk events and hazards for a process.

- ORM Layer 1 Hazard Inventory and Baseline WRAC detailing unwanted events and related consequences.

**Time**

The probable risk events and related hazards for Serviceable Items shall be specified during design and implementation/construction of a process.

Review and validation of risk events and related hazards shall be based on the benefit ranking of improvement opportunities identified through analysis of performance and costs.

**Resources**

The identification of probable risk event and related hazards is the accountability of the role identified in the configured flowchart.

## Appendix 1 – Integrity Serviceable Item Checklist

**Structural**
Piles
Footings/Foundations
Slabs (floor, wall & roof)
Columns/Beams/Braces/Connection Plates
Platforms/Walkways
Stairs/Ladders
Rafters/Purlins
Sheeting/Cladding (roofs & walls)
Brickwork
Services ducts (buried)
Pipe & cable racks
Bridges

**Storage/Containment**
Tanks/ Bins/Hoppers/ Vessels (including thickeners, washers, clarifiers, float cells, etc.)
Dams (water, tailings, etc.)/Ponds
Dykes/Bunds
Sumps
Berms/Containment barriers

**Electrical**
Distribution transformers
Transmission lines/ Cables/ Poles
Lightning Protection
Filters (including harmonic)
Ground systems
Switchboards/Switchgear/Circuit Breakers
UPS/Control/Alarm Systems (including process & fire)
Rectifiers/Drive systems
Motors/Generators
Communications systems

**Materials Transfer**
Piping/Troughs//Chutes/Conveyors (bucket, chain, belt, plate, etc.)
Spillways/Sluice gates/Channels (including creeks)
Drains/Sewers/Siphons
Ducting/Flues/Chimneys/Vents
Locomotives/Rails/Rail Beds
Roads/Bridges/Cuttings/Tunnels

**Mining**
Ramps/Drives/Rises/Ore Passes/Service Bays
Shafts/Hoists/ Headframes/Ropes/ Cages
Shovels

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**Process Equipment**
Crushers/Mills
Analysers
Digesters/Claves/Reactors/Roasters
Ladles (including slag cars)
Furnaces/Converters/Boilers/Cold boxes
Turbines/ Compressors/Blowers
Cranes

## Appendix 2: Example Hazard Type

| ENERGY | EXAMPLE OF HAZARD | UNWANTED EVENT | POSSIBLE BARRIERS/ CONTROLS | TYPE OF CONTROL (HIERARCHY OF CONTROL) |
|---|---|---|---|---|
| **Biological** | Bacteria, viruses, diseases, natural poisons | Fungal infections, Legionnaire's disease HIV infection, Malaria | Maintenance of air-conditioning systems, education, condoms, Malaria tablets | Engineering, Administrative, PPE |
| **Chemical** | Gases, fuels, lubes, degreasers, solvents, acids, alkalis, cyanide | Occupational asthma, dermatitis, asphyxiation, poisoning, unconsciousness, corrosion | Enclosure of processes, substitution for less corrosive chemical, ventilation, safe work procedures, PPE | Elimination, Substitution, Engineering, Administrative, PPE |
| **Electrical** | High voltage, low voltage, live parts, frayed cords, overload | Accidental contact, arcing | Isolation and lockout, training, PPE | Engineering, Administrative, PPE |
| **Gravitational (Objects)** | Unsupported coal, rock, tools, components, structures | Object falls on Worker Tool falls on miner | Stope support, SOPs, mining design, PPE | Engineering, Administrative, PPE |
| **Gravitational (People)** | Unsupported/ unbalanced person/s (who could fall from heights) | Miner falls while working at heights | Barricading, fall arrest equipment, safe work procedure | Engineering, Administrative, PPE |
| **Mechanical** | Rotating elements, nip points, sharp edges etc | Arm gets caught in moving parts | Machine guards, machine design, SOPs | Engineering, Administrative |
| **Kinetic** | Haulage trucks, LHDs, service vehicles, gen sets, speeding | Light/Heavy Vehicle collision with another vehicle, a person or an object | Construct separate roadways for light and heavy vehicles, transport plan | Eliminate, Administrative |
| **Magnetic** | Strong magnetic fields (near metal objects/tools, sensitive equipment) | Ferromagnetic object interferes with sensitive equipment, pacemaker malfunctions | Awareness, Operator competency/ education, isolation and lockout, SOPs | Administrative |
| **Noise** | Gas leaking at high speed, exhaust system, pump cavitation, etc. | Hearing impairment, distractions | Fit mufflers to reduce noise, quieter equipment, maintenance of equipment, PPE, rotation of workers | Engineering, Substitution, Administrative, PPE |
| **Pressure & Potential Energy** | Pressurised cylinders, tyres, springs, coils, etc. | Explosion, flying objects | Awareness, training, safe work procedures, work inside tyre cage, regular maintenance of tyres and pressure equipment | Engineering, Administrative |
| **People** | Human error (unintentional or intentional) | Slip or trip due to lack of awareness of surroundings or objects left around due | Training and SOPs | Administrative |
| **Thermal** | Objects or material at high/low temperature, radiation etc. | Burn due to contact, heat stress, heat stroke | Barriers, separation from heat, shields, cooling systems, ventilation, training and acclimatisation, Work Permit System, SOPs, PPE | Engineering, Administrative, PPE |
| **Vibration** | From vehicles, equipment, tools, worn parts etc. | Fatigue, backache, poor concentration, increased chance of accidents | Road maintenance, purchase suitable equipment and vehicles, maintenance PPE, rotation of workers | Engineering, Substitution, Administrative, PPE |

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# SS.07 Identify Threat Characteristics

## Context

The purpose of a Service Strategy is to identify and manage potential risks related to a process. Some of the common hazard types related to historic and probable risks are;

- ***Stress*** - materials science subdivides this into catastrophic overstress that produces sudden failures (e.g. fracture), prolonged high stress that produces creep deformation and prolonged cyclic stress that produces fatigue failure. Similar types of results can be produced in people. Some examples of potential forms of stress are; physical/mechanical, thermal, voltage, radiation, mental, etc.
- ***Chemical*** - in materials science terms this would be due to the (re)action of chemicals such as oxygen, acids, alkalis, but in a broader context could also include drugs, alcohol etc.
- ***Wear*** - materials science subdivides wear into different mechanisms for the removal of material, e.g. abrasion, erosion, fretting etc.
- ***Fouling*** - accumulation of material, e.g. silting, scaling, contamination etc.
- ***Obsolescence*** - this is not a category used in materials science but reflects a type of hazard that arises from the loss of support for either the products or services of a process, e.g. due to innovation or competition, the imposition of constrictions to the process, e.g. imposition of new standards/laws, or the loss of essential resources for the continued operation of the process, loss of people, skills or knowledge, loss of parts sources etc.

The above hazards may act either alone or in combination, and when acting in combination may produce an unwanted event that does not occur with either of the mechanisms absent, e.g. stress corrosion cracking, the result of a combination of highly alkaline environment and high physical stress levels.

- A failure mechanism classification of 'Random' is sometimes applied to electronic components. However, this is a situation where the unwanted event is visible (the failure), but the underlying mechanism is usually not readily identifiable. Analysis of electronic failures most commonly reveals evidence of overstress, fatigue or chemical reaction. However, the evidence for the hazard release mechanism is usually masked by either the small scale of the issue, or by the packaging of the component, or by the damage caused by the failure. Overstress usually results in random catastrophic failure of electronic components. Fatigue is typically thermal or mechanical in origin, and hence evident in the operating environment (heat or vibration), and exhibits a wear out pattern. Chemical action is also typically evident in the operating environment and also exhibits a wear out pattern. Hence, a reasonable estimate can be made of the likely hazard release mechanisms applying to electronic components.

Some aspects to consider when trying to identify the types of hazards that may arise in or around a Process are:

- ***Design*** - fatigue, chemical action, wear and fouling are all, to some extent, 'designed in' to a process based on the purpose of the process and the choice of technologies for its implementation.
- ***Operation*** - wear, stress and fouling can be influenced by the age of process elements, operating rates, operating conditions, feed materials, maintenance and process shutdown/start-up cycles etc.
- ***People*** - the errors, omissions or deliberate actions of people, resulting in changes to operating procedures/limits or material/equipment specifications, can lead to stress, chemical action or wear.
- ***Environment;***
  - ***Commercial*** - innovation and competition may lead to obsolescence of product, services or technology.
  - ***Natural*** – e.g. flood, tornado, hurricane, volcanic eruption, earthquake, or landslide can lead to stress, erosion, or silting.
  - ***Social*** – e.g. social unrest or sovereign risk may lead to damage or changes to expectations, standards, laws, etc.

The probability of risks can differ significantly, and can also differ significantly over the life of a process. Some hazards and release mechanisms occur frequently, and consequently personal and organisational experience helps us to recognise the potential for them, to understand them and where they are likely to occur, and to identify Service Strategies that can be applied to them. However, some hazard and release mechanisms (for example fatigue, corrosion, fouling, and obsolescence) can develop very slowly, perhaps over decades, and sometimes out of easy view, with the result that;

- few of us ever experience such events and hence do not expect them or understand what causes them,
- the mechanisms may remain ‘hidden’ from direct observation,
- when the mechanisms are visible we tend to become conditioned to slow changes and hence do not recognise the extent of change, and
- even when changes are recognised there is a tendency to think that because the process is still functional repairs can be deferred in favour of the frequent, pressing issues that we must deal with.

It is therefore important that we understand the probability distribution over time for each probable unwanted event.

There are many possible probability distribution shapes for unwanted event, but the following are the most common:

- High early risk probability decreasing (either linearly or exponentially) over time or operation to a more constant level (this distribution is referred to as infant mortality). This type of risks probability distribution is typically associated with the period immediately after a change to a process, e.g. a new employee, modification, maintenance, shutdown, start-up. The most common causes of infant mortality relate to design, construction/installation or operating errors that produce overstress or rapid corrosion or fatigue. The best preventive strategy for these threats is to ensure that the Work Management processes for new employees, modification, maintenance, shutdown or start-up delivers the right work, at the right time and in the right way. Any of the Service strategies except

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Fixed Interval replacement may be appropriate during the high risk period.

- Constant risk probability over time or operation (random). This type of distribution is typical of steady state process operation where there are many independent potential initiators of an unwanted event. This type of distribution is also typical of situations where human behaviour plays a significant role in the hazard release mechanism, (e.g. stress caused by incorrect use or operation of the process or equipment).
- Increasing risk probability (either linearly or exponentially) over time or operation (wear out). This type of distribution is typical of the situation where an element of the process is subject to fatigue, corrosion, wear or fouling, and the design allowance for these actions is consumed.

The characteristics that are most significant in the consideration of potential Service Strategies are:

- The Functional Life of the process (related to the time period for which risks related to the process may persist - which may extend beyond the operating life of the process. For example, a tailings dam must contain waste long after disposal into the dam has ended),
- The probable unwanted event (a combination of the Serviceable Items, risk types and hazards)
- The potential consequences of the unwanted event (safety, environment, health, revenue, costs, reputational, regulatory and social impacts),
- The level of exposure that is probable if the unwanted event occurs. The level of exposure will be affected by issues such as; the capacity to mitigate the consequences by using stockpiles or extra capacity, the capacity of containment systems, or the number of people in a potential area of exposure and the proportion of time they are there.
- The shape of the probability distribution of the unwanted event over time or operation.
- Whether (and how) the development of the unwanted event is detectable.
- The current situation and consequent risk level (this is particularly relevant when evaluating Service Strategy options for unwanted events with a very long and predictable development period – e.g. corrosion, obsolescence).
- The Warning Interval (or probability distribution of intervals) between the indication of a developing unwanted event or consequence and the ultimate occurrence of unwanted event or consequence.

Risks can be found around every process. Whether or not a risk is realised might depend on any of the following elements of context for the process;

- capability of people for their role,
- behaviours, symbols and systems in the social environment,
- induction and training,
- physical environment,
- design of processes, work, plant and equipment,
- choice of materials, operating limits, techniques and practices,

- operating stability and rates,
- control of modification of design, use or operation,
- maintenance people, hardware and software,
- the required Functional Life of the process.

The characteristics for each probable threat for a process, as shaped by the context for the process, must be defined in order to evaluate the merit of the Service strategy options.

**Purpose**

To specify the characteristics for each risk.

**Quantity**

- One specification for the characteristics for each probable risk.
- ORM Layer 1 Hazard Inventory and Baseline WRAC detailing risk characteristics through hazard characterisation and unwanted event and related consequences descriptions. The detail may be defined in ORM Layer 2 Issue Based Risk Management processes where detailed analysis is undertaken if uncertainty is identified in the ORM Baseline Risk Management information.

**Quality**

The specification for risk characteristics shall include;

- The Serviceable Item (this will typically be an activity, workplace, equipment used in the Work Management process).
- The probable unwanted events identified. Each distinct combination of hazard types (stress, chemical, wear, fouling, obsolescence) and the trigger (arising from either design, operation, people or environment) will have different characteristics and hence must be treated as a separate threat.
- Date of risk characterisation.
- Personnel and organisations performing the characterisation.
- The data sources on which the characterisation was based.
- The potential consequences of the identified unwanted events (this may include; safety, environment, health, revenue, costs, reputational, regulatory and social impacts).
- The probable exposure to each of the consequences if the unwanted event occurs (ideally each consequence should be treated separately but in some cases it may be reasonable to group some consequences (e.g. safety and environment, business risks) and estimate the exposure for the highest consequence/exposure combination for each grouping.
- The shape of the risk probability distribution. This may be expressed as a function of either calendar time or an operating parameter such as hours, tonnes, etc., whichever is the most appropriate. The minimum requirements should be to specify;
  - o The dominant development pattern(s), i.e. infant mortality, random and/or wear out characteristics. Note that with the

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Operating Model definition of risk (comprising the three elements of a Serviceable Item, risk type and risk source), the probability distribution for each risk will typically be simple. It will either be a single one of the three distribution types, or it may be a combination of a period of constant risk followed by a wear out period. In specifying the distribution type remember that we are dealing with statistical estimates and we should not overcomplicate things. For example, if less than 10% of the cumulative probability for a risk follows a random pattern and 90%+ follows a wear out pattern, treating it as a straight wear out failure will probably result in an effective Service strategy selection.

    - The boundary and inflexion points in the distribution curve, i.e. where does application of the curve start in the life or operation, where does it change shape (e.g. from decreasing probability to constant/increasing, or from constant probability to increasing), and where does it terminate (failure is close to certain).
    - The shape and value(s) of the probability curve for each failure pattern region. There are potentially many mathematically functions available to describe the possible shapes (e.g. binomial, exponential, linear, logarithmic, step, weibull, etc.). Again, since we are dealing with statistical estimates we should not overcomplicate things. If a simple function such as linear provides a 90%+ fit, then using it will probably result in an effective Service strategy selection.
- Whether the commencement of the unwanted event can be reliably detected, and if so how.
- The unwanted event Warning Interval, either the minimum interval between possible detection of the developing unwanted event and the ultimate occurrence of the unwanted event, or preferably, the probability distribution of the warning time.
- A calculated Criticality Rating - indicating the current risk level in relation to the Criticality Rating. Note that for unwanted events that have an early failure or wear out pattern the Criticality Rating varies with time (decreasing and increasing respectively). The records should also specify how the Criticality Rating is calculated.

A database shall be used to record the risk characteristics.

**Time**

The risk characteristics shall be specified during establishment of a process.

Review and validation of risk characteristics shall be based on either a change of performance targets driven by changing business expectations or the benefit ranking of improvement opportunities identified through analysis of performance.

**Resources**

Definition of risk characteristics is the accountability of the role identified in the configured flowchart. For ORM Layer 2 Issue Based Risk Management accountability will reside with appointed risk owners to characterise significant risk.

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# SS.08 Identify Potential Service Strategies

## Context

After the probable risks and related unwanted events for Serviceable Items have been identified we must determine what strategies are available to predict, prevent, correct and/or mitigate these risks.

There are six basic options (Service strategies) for managing risks. These are:

- *Modification of the process* – implement design changes in order to reduce the probability or frequency of the unwanted event. This type of strategy may be applicable where there is an alternative design, approach or material that inherently has either a lower impact, probability or exposure associated with an unwanted event. Implementation of this strategy requires a single change action, and will typically also either remove or reduce the need for further Service work. However, where any probability of the unwanted event occurring remains, one of the remaining Service Strategies will be required to deal with the residual risk. In an underground mining process this strategy could be the use of 'shot-crete' ground support in lieu of rock-bolts, hence reducing the risk of injury from falling material and removing the need to scale the walls and ceilings of workplaces. In a mineral processing plant this could be to change the design of a material feed chute to remove or reduce the occurrence of blockages and the need to clear them. In a safety context this might be the application of mechanical lifting aides to remove/reduce the risk of physical injury caused by lifting heavy items.
- *Monitor process condition and/or performance to identify the development of an unwanted event, and hence determine the best timing and type of Service action to deal with the escalating risk*. This type of strategy may be appropriate where there is considerable variability in either the onset exposure to the hazards or in the rate at which a risk escalates, and there is a detectable indication of the developing condition that provides sufficient warning for an effective control action to be taken. Implementation of this strategy typically requires a primary action to regularly monitor the hazard, and when the indication exceeds an acceptable level (defined by measureable condition or performance parameters), a secondary action to manage the risk. In an underground mining process this could be the monitoring of erosion in an ore pass in order to determine if reconditioning is required. In a mineral processing plant this could be to monitor pressure drop across a filter in order to determine when the filter is blocking and hence when to clean or change the filter media. In a safety context this might be the use of task observations to determine when re-training of personnel in work methods is required, or the use of a hazard assessment process prior to the commencement of a task.
- *Initiate Service actions based on a pre-defined interval or life.* This type of strategy may be appropriate where the probability of a risk is initially very low, but shows a rapid increase after a relatively consistent time or service interval. Implementation of this strategy relies on measuring a proxy for the probability of unwanted event development (typically

parameters such as calendar or operating time, or process throughput), and when the predefined interval or life is reached a corrective action is taken in order to deal with the risk. In a mining process this could be a regularly scheduled oil changes for mobile equipment based on either operating time for the equipment or calendar time. In a mineral processing plant this could be a regularly scheduled task to change screen/filter media based on expired time or the amount of material processed. In a safety context this might be a regularly scheduled task to conduct a fire drill, at a time interval that keeps the required response fresh in the memory of personnel.

- *Utilise back-up or containment systems to circumvent or mitigate the consequences of a risk.* This type of strategy may be appropriate where none of the above options is feasible or cost effective but the consequences of the risk are not acceptable. In an underground mining process this could be a back-up dewatering pump. In a mineral processing plant this could be a duty/standby process pump. In a safety context this might be the implementation of personal protective equipment or a barrier/guarding system.
- *Operate the process to the point of failure*. This is the default option, i.e. if you put no other Service Strategy in place then this is what will happen. This option is perfectly acceptable for the many potential risks that have very low consequences, probability and exposure. Once the failure has occurred, a corrective (recovery) action is required in order to deal with the consequences.
- *Closure of the process.* If it is considered that there is no viable and/or cost effective strategy that will reduce the risk profile of a probable unwanted event to an acceptable level then the only remaining option is to shut down the process and establish a safe and secure condition. This strategy option is evident in the actions of the German government in 2011 when, following the Fukushima nuclear power plant disaster in Japan, they announced the accelerated closure of all nuclear power plants within Germany. Note that after closure of the process the most significant risks may be removed, but there may be an ongoing need to maintain the safety and security of the process against residual, but lesser, risks. In such cases appropriate Service Strategies will be required until such time as there is no longer any unacceptable risk.

Where a Service Strategy requires a corrective action (i.e. monitor condition or performance, defined interval and operate to failure), the possible corrective actions are:

- *Stabilisation* - actions taken to slow or defer the development of an unwanted event, without restoring any degraded condition. This is economical when applied early in the development of an unwanted event, where only limited degradation of condition has occurred, and the stabilised item will still meet acceptable risk standards. For example; resting employees working in harsh conditions, blasting and painting corroded metal in order to either slow or defer the corrosion process, changing lubricating oils in combustion engines in order to slow the rate of engine wear or corrosion caused by oil contaminants. Neither of these

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actions will 'undo' the corrosion or wear that has already occurred, but each will slow the rate at which further corrosion or wear occurs.

- *Reconditioning* – actions taken to reduce a likelihood of an unwanted event occurring by restoring the degraded condition of only a component, or limited area, of a Serviceable item. This is typically economical where there are a number of independent risks, each with a different rate of development, and which can be economically controlled individually. For example; retraining employees on critical activities, replacing bolts in a steel structure (bolts typically have a higher rate of corrosion than the primary steelwork), replacing worn valves and valve seats in an engine (that may typically degrade at a much faster rate than the bulk of the cylinder head or engine).
- *Replacement* – actions taken to reduce a risk by replacing the whole, or a substantial part of a Serviceable Item. This is typically economical where there are a number of probable risks that develop at the same time (which is often the 'designed life' of an item) and where it is more economical to replace the whole item than it is to restore or replace individual elements. For example, truck engines are replaced at an economic tipping point in their life, as is the whole truck.

The Service strategies that are appropriate for a particular risk will depend upon a few basic factors;

- The technical feasibility of each of the strategy options.
- Whether the unwanted event has a detectable onset.
- The warning time for detectable onset unwanted events.
- Whether the unwanted event has an 'age' related characteristic with a sharply rising probability.
- The consistency of the interval to rising probability for 'age' related unwanted event.
- The consequence of the risk (the HSE risk characteristics, the direct repair cost and the lost opportunity cost of production).
- The level of exposure to potential consequences when a risk is realised (unwanted event occurs), i.e. to what extent the potential consequences are probable.
- The cost to implement the strategy option.

As explained above, some strategies will require both a primary and secondary service action for their implementation. Specifying the potential Service Strategies for a process includes specifying the primary and secondary actions associated with that strategy.

**Purpose**

To specify the Service Strategy options that are technically feasible for each significant risk.

**Quantity**

- One list of potential (technically feasible) Service Strategies for each identified significant risk.

- Operational Risk Management Layer 2 Bowtie control profiles for the identified significant risks (priority unwanted events).

**Quality**

The following criteria shall be used to compile the list of potential Service Strategies;

- If there is an alternate design with proven or probable lower risk consequence, probability or exposure, and/ or lower Service work requirements, then include the option to modify the process.
- If the development of an unwanted event is detectable through condition or performance indicators then include the option to monitor process condition or performance.
- If the risk development exhibits a consistent and well defined interval to failure then include the option to service at a defined interval.
- Include the option to install redundancy in all cases.
- Include the option to operate to failure in all cases.

A database shall be used to record the potential Service Strategy options.

**Time**

The potential strategies for the serviceable items shall be specified during establishment of a process.

Review and validation of Service Strategies shall be based on the benefit ranking of improvement opportunities identified through analysis of performance.

**Resources**

The identification of potential strategy options is the accountability of the role specified in the configured flow chart.

Operational Risk Management Layer 2 Issue Based Risk Management Bowties control strategies are the accountability of the appointed risk owners.

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# SS.09 Identify Cost of Strategies

### Context

There are six basic strategy options that may be applicable to manage a risk. These are;

1. Modification of the process – remove or reduce the risk and the need for service work.
2. Monitor process condition and/or performance to identify the best time and type of service action.
3. Initiate service actions based on a pre-defined interval or life.
4. Install back-up or containment systems to circumvent or mitigate the consequences of the threat.
5. Operate the process to the point of failure.
6. Closure of the process.

The strategies that are appropriate for a particular failure mode will depend upon a few basic factors;

- The technical feasibility of each of the strategy options.
- Whether the early development of the threat is detectable.
- The warning time for detectable threats.
- Whether the threat has an Age Related characteristic.
- The interval to occurrence for Age Related threats.
- The consequence of the threat (the HSE threat, the direct cost of dealing with the consequences of the threat, and the lost opportunity cost arising from the threat).
- The direct and lost opportunity cost to implement the strategy option.

Every strategy option will require at least one action to implement it. A condition/performance monitoring strategy will require at least two actions for implementation. For example: The vibration level for a gearbox bearing may be monitored on a regular basis in order to predict the failure of the bearing – this action may occur hundreds of times over the life of the gearbox. When the vibration indicates an imminent failure of the bearing the bearing will be changed – this action may occur several times over the life of the gearbox. These actions are generally referred to as the primary and secondary actions of the strategy.

In evaluating the cost to implement a strategy the direct and opportunity cost of all actions associated with the strategy must be included.

The most cost effective strategy can only be determined after all the relevant consequences and costs to implement each of the viable strategy options have been estimated.

### Purpose

To estimate the cost for implementation of each potential Service Strategy option for a threat.

**Quantity**

- One estimate of the cost to implement each potential Service Strategy for each threat.
- One Net Present Value (NPV) for the implementation cost of each potential Service Strategy.

**Quality**

Each estimate shall consider;

- all of the labour, materials and contract costs necessary to implement the Service Strategy, including operating and capital expenditure, and
- the opportunity cost (i.e. the cost of lost revenue) of implementing the Service Strategy.

Estimate values should be to the same confidence level expected for 5 year expenditure forecasts.

The Net Present Value of (NPV) implementing each viable Service Strategy option shall be calculated. The NPV calculation shall;

- be based on total direct expenditure on the strategy option,
- include the cost of all actions required to implement the strategy.
- be evaluated over the period of the longest service life provided by one of the potential strategy options,
- use an interval between service actions equal to the most likely interval to failure for Age Related failure modes and the historical or estimated mean time to failure for non-Age Related failure modes,
- use the discount rate applied to capital project evaluation, and
- shall conform to the standards used for capital project evaluation.

A database shall be used to record the cost estimates and NPV calculations for potential Service Strategy options.

**Time**

The cost of potential Service Strategies shall be specified during establishment of a process.

Review and validation of Service Strategies shall be based on the benefit ranking of improvement opportunities identified through analysis of performance.

**Resources**

The identification of potential strategy options is the accountability of the role specified in the configured flow chart.

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# SS.10 Identify Most Cost Effective Strategy

### Context

There are six basic strategy options that may be applicable to manage a threat. These are;

1. Modification of the process – remove or reduce the threat and the need for service work.
2. Monitor process condition and/or performance to identify the best time and type of service action.
3. Initiate service actions based on a pre-defined interval or life.
4. Install back-up or containment systems to circumvent or mitigate the consequences of the threat.
5. Operate the process to the point of failure.
6. Closure of the process.

The strategies that are appropriate for a particular failure mode will depend upon a few basic factors;

- The technical feasibility of each of the strategy options.
- Whether the early development of the threat is detectable.
- The warning time for detectable threats.
- Whether the threat has an Age Related characteristic.
- The interval to occurrence for Age Related threats.
- The consequence of the threat (the HSE threat, the direct cost of dealing with the consequences of the threat, and the lost opportunity cost arising from the threat).
- The direct and lost opportunity cost to implement the strategy option.

The previous task assignments in this process for setting a Service Strategy have provided us with the above data for each of the probable threats related to a process. With this information we can now select the most likely cost effective Service Strategy.

For each threat, the Service Strategy that can deliver an HSE consequence rating below the required performance target, and that provides the best NPV for the direct and opportunity cost of adoption, would normally be proposed to evaluate whether it has the potential to meet the required Performance Targets.

Identifying the most likely cost effective strategy option can be an iterative process. If the first selected strategy cannot meet the performance targets, a higher cost option may need to be evaluated.

### Purpose

To specify the most likely cost effective Service Strategy for each threat.

### Quantity

- One Service Strategy, which meets the HSE performance target and has the lowest NPV for implementation, selected for each threat.

### Quality

A Service Strategy shall be selected from the potential strategy options identified in task assignment TA SS.08 Identify Potential Strategies.

Any strategy option that cannot deliver an HSE performance target better than the Business Expectations shall be rejected. Of the remaining strategy options, the one that has the lowest total NPV shall be selected to evaluate whether it can deliver the other required performance targets. The NPV of the implementation cost for each of the strategy options was calculated in TA SS.09 Identify Cost of Strategies.

Any strategy option that has been evaluated and cannot meet the performance targets required to deliver Business Expectations shall be rejected, unless all options have been evaluated and failed, in which case the most cost effective option available should be selected.

A database shall be used to record the evaluation data and outcomes for selection of the most cost effective Service Strategy.

### Time

The most cost effective Service Strategies for a process shall be specified during establishment of the process.

Review and validation of Service Strategies shall be based on the benefit ranking of improvement opportunities identified through analysis of performance.

### Resources

The identification of potential strategy options is the accountability of the role specified in the configured flow chart.

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# SS.11 Develop Statistical Business Loss Projections

## Context

The objective of a Service Strategy for a process is to manage threats so that the process can sustainably deliver the required outcomes, at the lowest practical cost.

The task assignments completed to up to this point in the process of setting the Service Strategy have identified the probable threats related to the process, and the most likely cost effective Service Strategy available to manage those threats.

The most likely cost effective Service Strategy was selected on the basis that it could meet the HSE performance targets and produced the lowest NPV for implementation. However, this does not guarantee that it will meet the performance targets required to deliver the Business Expectations.

Each service strategy also has the potential to impose its own restrictions on the performance of the Process on which the strategy is implemented. Some examples of these restrictions could be:

- Downtime needed to execute work required by the strategy.
- Reductions in process operating rate before, during or after the execution of work required by the strategy.
- Production of non-prime output before, during or after the execution of work required by the strategy.

To determine if the proposed Service strategies have the potential deliver the performance target we must estimate the performance losses that will be created by the implementation of the Service strategies. The impact of these potential loss distributions will be modelled in a Production and Service strategy value driver tree, to determine the likely performance of a set of Production and Service strategies. If the modelling does indicate that the Performance Targets are likely to be met, then other potential Production and Service strategies will need to be evaluated, until the best option is identified.

If the Service Strategies for Equipment and Workplaces have not changed then the impact of those strategies on performance losses will not change. Where a change in Service Strategy has occurred, or is planned to occur, the expected impact on performance losses must be estimated and modelled.

The probable performance loss from a Service Strategy over any period of time is not a single value, but rather it is a range of values with differing probabilities of occurrence (i.e. the performance is best represented in a capability histogram). This is consistent with the way we have defined and modelled the performance for a process during the Set Performance Targets.

Where a change in Service Strategy occurs, the projected performance losses can be estimated by taking the historical performance losses and adjusting them for the estimated changes to the losses produced by the historical and planned strategies.

**Purpose**

To estimate the performance losses that will be created by the implementation of the Service Strategies proposed for a Process.

**Quantity**

- One estimate for the characteristics defining the distribution of probable losses arising from the implementation of a set of Service Strategies.

**Quality**

Projections for performance losses shall include each of the following parameters:

- The downtime duration required to implement the strategy,
- Reductions in process operating rate before, during or after the execution of work required by the strategy.
- The number of Service Strategy events that will restrict process operating rate.
- Production of non-prime output before, during or after the execution of work required by the strategy.
- The number of Service Strategy events that will affect output quality.

Where no change in the Service Strategy is forecast to occur, the projected losses should be unchanged from the historical losses.

Where a change in the Service Strategy is forecast to occur, the specification of performance losses shall include:

- The performance losses forecast prior to the strategy change.
- The forecast date for implementation of the strategy change.
- The performance losses forecast after to the strategy change.

Changes to the performance losses projected for a change in Service Strategy shall be estimated from the expected changes to;

- the downtime duration required to implement the strategy,
- reductions in process operating rate before, during or after the execution of work required by the strategy.
- the number of Service Strategy events that will restrict process operating rate.
- production of non-prime output before, during or after the execution of work required by the strategy.
- the number of Service Strategy events that will affect output quality,

produced by the change in strategy.

The probability distribution for the performance loss parameter shall be defined in the form of a PERT value function with four parameters; the best case value, most likely case value, worst case value and the weighting factor.

A database shall be used to record the performance loss projections.

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**Time**

After any change to the Service Strategies is proposed.

The Service Strategies shall be specified during establishment of a process.

Review and validation of Service Strategies shall be based on the benefit ranking of improvement opportunities identified through analysis of performance.

**Resources**

The identification of potential strategy options is the accountability of the role specified in the configured flow chart.

# SS.12 Have Confidence Levels on Performance Targets Been Met?

## Context

The objective of a Service Strategy for a process is to manage threats so that the process can sustainably deliver the required outcomes, at the lowest practical cost.

The task assignments completed to up to this point in the process of setting the Service Strategy have identified the probable threats related to a process, identified the most likely cost effective Service Strategy available to those threats, and estimated the performance losses that will arise from the implementation of the strategy.

The most likely cost effective Service Strategy was selected on the basis that it could meet the HSE performance targets and produced the lowest NPV for implementation. However, this does not guarantee that it will meet the performance targets required to deliver the Business Expectations.

To determine if the proposed Service Strategies will deliver the performance targets we must determine whether the estimated performance impacts of the strategy will produce any significant impact on the confidence levels for the process performance targets. The performance target confidence levels for a change in Service Strategy can be estimated using a statistical value driver tree model of the Production and Service Strategy characteristics (time, rate, quality, reliability, process efficiency, etc.). The model must be fed with the projected loss distributions estimated for the selected strategies.

If the estimated performance and confidence level for the proposed Production and Service strategies produce a match to the confidence level required for the performance targets then the strategies will likely be effective and can be further developed for implementation.

If the estimated performance for the proposed strategies produce a confidence level that exceeds the target then the responsible manager may wish to reset the performance targets.

If the estimated performance for the proposed strategies produce a confidence level below the target then a new package of strategies will need to be proposed, or new targets set, or the lower confidence level accepted by the responsible manager.

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## Purpose

To determine if the performance forecast for the proposed Service Strategies meets the confidence level set for the process performance targets.

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**Quantity**

- One decision whether the performance target confidence level for the selected Service Strategies meets the confidence level set for the process performance targets.

**Quality**

The statistical model for estimating performance confidence levels shall be the standard Operating Model value driver tree model for strategy characteristics.

The performance loss estimates used for the model shall be those determined in TA SS.11 – Develop Statistical Loss Projections.

If the estimated confidence levels on performance targets is between +0 and +5% of the target set for the asset the confidence levels shall be considered to be meet the target and the selected Service Strategies shall be incorporated into the Operating Master Schedule. If the estimated confidence levels fall outside of this range then the process of Setting Performance Targets must be revisited to decide whether to;

- try a new package of strategies, or
- set new performance targets, or
- lower the confidence level that will be accepted.

**Time**

After any change to the Service Strategies is proposed.

The Service Strategies shall be specified during establishment of a process.

Review and validation of Service Strategies shall be based on the benefit ranking of improvement opportunities identified through analysis of performance.

**Resources**

The identification of potential strategy options is the accountability of the role specified in the configured flow chart.

# SS.13 Specify Actions, Triggers and Trigger Tolerances

## Context

A Service Strategy is a high level description of the types of action required to prevent, predict, mitigate and or correct a threat that is likely to occur.

There are six basic strategy options that may be applicable to manage a threat. These are;

1. Modification of the process – remove or reduce the threat and the need for service work.
2. Monitor process condition and/or performance to identify the best time and type of service action.
3. Initiate service actions based on a pre-defined interval or life.
4. Install back-up or containment systems to circumvent or mitigate the consequences of the threat.
5. Operate the process to the point of failure.
6. Closure of the process.

Every strategy option will require at least one action to implement it. A condition monitoring strategy will require at least two actions for implementation. For example: The vibration level for a gearbox bearing may be monitored on a regular basis in order to predict the failure of the bearing – this action may occur many times over the life of the gearbox. When the vibration indicates an imminent failure of the bearing the bearing will be changed – this action may occur several times over the life of the gearbox. These actions are generally referred to as the primary and secondary actions of the Service Strategy.

Once a set of Service Strategies have been selected for a process, the specific actions (e.g. measure vibration at point X), and triggers for these actions, need to be specified.

## Purpose

To specify the actions and scheduling detail to implement the Service Strategy for a process.

## Quantity

- One set of actions and scheduling specifications for each Service Strategy.

## Quality

Each service action shall be described in the form of an action and an object (e.g. remove process spillage from under conveyor Z, replace engine oil, replace brake pads).

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The scheduling parameters for each Service Strategy action shall comprise;

- The type of trigger parameter (e.g. calendar time, operating time, condition/performance parameter),
- The trigger value (e.g. 30 days, 250 hrs, thickness less than X mm),
- The trigger tolerance (e.g. ± 5 days, ± 25 hrs, ± Y mm), and

The specification of service actions shall comply with the requirements of TA PL.00 Planning and its subordinate task assignments.

**Time**

After a change to the Service Strategies is accepted.

Review and validation of Service Strategies shall be based on the benefit ranking of improvement opportunities identified through analysis of plant performance.

**Resources**

The identification of potential strategy options is the accountability of the role specified in the configured flow chart.

# SS.14 Specify Service Action Resources (Labour Materials & Equipment)

### Context

A Service Strategy is a high level description of the types of action required to prevent, predict, mitigate and or correct a threat that is likely to occur.

There are six basic strategy options that may be applicable to manage a threat. These are;

1. Modification of the process – remove or reduce the threat and the need for service work.
2. Monitor process condition and/or performance to identify the best time and type of service action.
3. Initiate service actions based on a pre-defined interval or life.
4. Install back-up or containment systems to circumvent or mitigate the consequences of the threat.
5. Operate the process to the point of failure.
6. Closure of the process.

Every strategy option will require at least one action to implement it. A condition monitoring strategy will require at least two actions for implementation. For example: The vibration level for a gearbox bearing may be monitored on a regular basis in order to predict the failure of the bearing – this action may occur many times over the life of the gearbox. When the vibration indicates an imminent failure of the bearing the bearing will be changed – this action may occur several times over the life of the gearbox. These actions are generally referred to as the primary and secondary actions of the strategy.

Once the service actions have been defined the details of the resources required to complete those actions can be specified.

### Purpose

To specify the resource requirements for each service action.

### Quantity

- One resource specification for each separate service action.

### Quality

The **minimum requirement** for the specification of the resources for implementation of a service action is the type (quality), number and duration of:

- Each labour skill,
- Each material or spare part,
- Each specialised tool or item of equipment.

Where components of a service action will occur at different times, or require different types, numbers or duration of resources, these should be specified as

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separate tasks comprising the action, and the resources for each task shall be separately specified.

The specification of service actions shall comply with the requirements of TA PL.00 Planning and its subordinate task assignments.

**Time**

After the actions and tasks to implement a Service Strategy for have been fully specified.

The Service Strategies shall be specified during establishment of a process.

Review and validation of Service Strategies shall be based on the benefit ranking of improvement opportunities identified through analysis of performance.

**Resources**

The identification of potential strategy options is the accountability of the role specified in the configured flow chart.

# SS.15 Define Service work Packages

## Context

A Service Strategy is a high level description of the types of action required to prevent, predict, mitigate and or correct a threat that is likely to occur.

There are six basic strategy options that may be applicable to manage a threat. These are;

1. Modification of the process – remove or reduce the threat and the need for service work.
2. Monitor process condition and/or performance to identify the best time and type of service action.
3. Initiate service actions based on a pre-defined interval or life.
4. Install back-up or containment systems to circumvent or mitigate the consequences of the threat.
5. Operate the process to the point of failure.
6. Closure of the process.

Implementation of any Service Strategy option will require more detailed specifications than are contained in a description of the option.

The detailed specifications may involve several actions that must occur at different times, and under different conditions, and that may require different labour materials and equipment for their implementation.

It is also possible that synergies exist between the actions required to implement different Service Strategies which make it advantageous to combine some of these actions into a single work package. For example, if the Service Strategy for a number of separate bearings in several items of process equipment require quarterly vibration measurements by a specialist, there may be advantages to incorporating this work into a single work package.

## Purpose

To construct service work packages that take advantage of usable synergies between service actions.

## Quantity

- One set of work packages that optimise the synergies between service actions.

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## Quality

Synergies between service actions typically occur around;

- Trigger events and tolerances,
- Resource requirements (labour, tools and equipment),
- Process condition (operating or shutdown, opened up for access, etc.).

SSS Flowsheet

**Time**

After the specifications for Service Strategy actions and resources have been completed.

The Service Strategies shall be specified during establishment of a Process.

Review and validation of Service Strategies shall be based on the benefit ranking of improvement opportunities identified through analysis of plant performance.

**Resources**

The identification of potential strategy options is the accountability of the role specified in the configured flow chart.

# SS.16 Specify Resource Service Levels

## Context

The timely, efficient and correct execution of a Service Work packages requires that all the necessary resources be available, at the appropriate location, when needed.

Putting in place the most reliable and efficient resourcing strategy to achieve this requires a specification of;

- the type of resource(s) required (including all important quality parameters) ,
- how many resources are required for each service action,
- how often resources will be required,
- how much lead time there will be between recognising the need and the required fulfilment of the need, and
- for re-useable resources (such as labour and equipment) the duration of the need.

Most of the above information has been defined in the previous task assignments for Setting the Service Strategy:

- The type and number of resources were specified in TA SS.14 Specify Service Action Resources (labour, materials and equipment).
- How often the resources will be required was estimated in task assignments TA SS.09 Identify Cost of Strategies.
- The fulfilment lead time for resources is defined by the warning time for detectable on-set failure modes (identified in TA SS.05 Identify Historical Threats and TA SS.06 Identify Threat Characteristics.
- The duration of the need (for re-useable resources) was specified in TA SS.14 Specify Service Action Resources (labour, materials and equipment).

The only remaining item of data that requires specification is the fulfilment lead time for non-detectable on-set threats.

The above data can be used to define the Service Levels required for resources.

A resource may potentially be utilised in more than one service work package, and these separate work packages may have different service level requirements. An accurate specification of the above data, for the differing service level requirements, allows a resourcing strategy that can meet all requirements to be defined.

## Purpose

To specify the resource service levels required for implementation of Service Work.

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**Quantity**

One set of service level specifications for each resource.

**Quality**

A resource service level specification shall include;

- the type of resource(s) required (including all important quality parameters) ,
- how many resources are required for each work package,
- how often resources will be required,
- how much lead time there will be between recognising the need and the required fulfilment of the need (Fulfilment Lead Time), and
- for re-useable resources (such as labour and equipment) the duration of the need.

Where the data for a resource service level parameter is developed for a task assignment in the process of Setting the Service Strategy, that data shall be used in the service level specification.

Where the fulfilment lead time for a service work package has not been defined in a previous task assignment the lead time shall be estimated based on the most likely interval between the work package initiation and the Required Date for completion of the work package, also taking into account the estimated duration of the work and when in the work execution the resource will be required.

Where resources are used in service work packages that have different service level requirements, each set of specifications shall be recorded.

**Time**

After the work packages to implement the Service Strategies have been fully specified.

The service levels for service work resources shall be specified during establishment of a process.

Review and validation of service levels for service work shall be based on the benefit ranking of improvement opportunities identified through analysis of performance.

**Resources**

The identification of potential strategy options is the accountability of the role specified in the configured flow chart.

# SS.17 Operating (Production or Maintenance) Activity?

## Context

Having defined a set of Service Strategies, actions and work packages for the Process, a decision must be made whether the resulting Service Work will be classified and managed as either an operating or capital activity.

This decision must be made in accordance with the standards and guidelines established for the classification of expenditures and activities.

## Purpose

To decide if Service Work will be managed as an operating or capital activity.

## Quantity

- One decision whether Service Work Package will be classified and managed as either operating or capital.

## Quality

This decision shall be made in accordance with Standard WA.AP Expenditure Classification.

Once work packages are classified they shall be registered (entered) in the appropriate management system.

## Time

The decision on classification and treatment of work packages is made after each work package is specified.

## Resources

The identification of potential strategy options is the accountability of the role specified in the configured flow chart.

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INTERNAL

# ANGLO AMERICAN OPERATING MODEL: OPERATIONAL PLANNING
# SET OPERATING MASTER SCHEDULE

**UPDATED: AUGUST 2018**

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# MS.00 Set Operating Master Schedule

## Context

The underlying theory for the Operating Model design is that future process performance will be delivered if the right Production and Service work is completed at the right time and in the right way – and that this will be achieved more consistently, and at lower cost, if the work is planned, scheduled and resourced in advance of its execution. Through the process of developing the Production and Service Strategies for a process we specified what the right work is and what is the appropriate trigger event that will initiate that work.

Each of the Work Packages derived from the selection of Production and Service Strategies is necessary to deliver the performance targets for a process, but the target performance cannot be achieved unless all of these Work Packages are executed at the right time and in the right way. The trigger parameters defined for each work package specify how the right time for the execution of each Work Package is determined. Some of the most common trigger events are;

- a specified date,
- a calendar time interval (e.g. days or weeks),
- an operating parameter (e.g. utilisation or operating rate),
- a condition parameter (e.g. a wear, contamination level), or
- completion of another Work Package (e.g. when replacement of a worn component triggers an overhaul of the replaced item).

By entering the Work Package details, their trigger parameters, a forecast of process operating parameters (utilisation & operating rate), and the dependencies between Work Packages into an appropriate scheduling tool, a forecast of the schedule of Work Packages that should occur over any specified time period can be produced.

Some events appear to occur randomly (e.g. extreme weather events, activities based on an operate to failure (OTF) service strategy) and can only be forecast on the basis of the probable time between events. Where several such events are highly likely to occur within a Business Structure element and within a schedule period over which confidence levels must be met (reporting interval)l they can be incorporated in the Operating Master Schedule for that level of the Business Structure. Where it is improbable that an event will occur within a Business Structure element in a reporting interval, reliable predictions can only be made for similarly characterised events over a larger sample population. For example, if the average life of electric motors in a process is 5 years, and the service strategy for these is OTF, it is not possible to predict the failure of an individual motor in a reporting interval with an acceptable degree of confidence. However, it is possible to predict that within a population of 10 motors in the process 2 failures are likely in any reporting interval, with a best case of perhaps 1 and a worst case of 3. Similarly, while it may not be possible to predict that an extreme weather event will affect an individual operation within a business, it may be possible to predict that such an event is probable in at least one of a group of geographically distributed operations.

Specified date and calendar interval trigger parameters will have no, or low, variability in their timing in the schedule. However, there may be significant variability in the rate of progress towards the other operating and condition parameters, and hence in the potential forecast of events in the schedule that are based on these. This variability will be reflected in the output and expenditure forecasts derived from the schedule, and hence could have significant impact on the confidence of reaching performance targets for a specified reporting interval. However, even if there is variation in the timing or output of individual Work Packages for an activity, the more times that an activity is repeated in a time period the closer the resulting event count moves to the total time divided by the average time between events, and the closer the total output and total cost moves to the sum of the averages of the individual events (in statistics this is characteristic referred to as the Central Limit Theorem). Hence, for any activity with a high repetition rate within a reporting interval, and moderate variability in outcomes or costs, we can use the average trigger interval, activity output and activity cost. Where activities have a low repetition rate, and/or very high variability in the individual event output or cost within a reporting interval, we must use a probability distribution of the potential variables, and Monte Carlo simulation, in order to determine the confidence level of the schedule meeting the Performance Targets.

A manageable schedule needs to provide sufficient detail to enable confirmation of progress to schedule without providing so much detail that it becomes difficult and slow to track progress. The Pareto principle suggests that 20% of the activities in the schedule will contribute 80% towards reaching the performance targets. These are the activities that should stand out in the Operating Master Schedule, while the minor activities should be easily identified (in summary form) without confusing the overall picture. Appropriate grouping of these minor activities will result in high repetition rate within a reporting interval and hence will allow us to use average values in forecasting intervals, output and costs. As the Work Packages related to a schedule activity are initiated they can be checked against the Operating Master Schedule to identify that the outcome, method and timing of the work is consistent with the strategies and schedule. If it is, then the output and cost results should meet expectations. If not, then some corrective action must be taken.

Over time the Production and Service Strategies for a process can be altered by changes to;

- regulatory requirements,
- output required from the process,
- cost targets,
- design of elements of the process,
- other production strategies and practices,
- other service strategies and practices, and
- relative location in the process life cycle.

Consequently the Operating Master Schedule is a document that requires regular revision.

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An Operating Master Schedule constructed using the above principles will comprise;

- the relatively few elements, representing activities that have a major impact on process performance and costs, and
- a number of elements that characterise and summarise the remaining activities.

The process of forecasting the occurrence of activities in the schedule, with the exception of dependency based triggers, treats each activity independently. Hence, the resulting (baseline) schedule may not align all of the schedule elements to maximise the synergies and minimise the potential conflicts between packages. However, an experienced person reviewing the baseline schedule can often readily identify such synergies and conflicts. In this case it is possible to adjust the scheduling of elements, within the range of tolerance allowed by the Production and Service strategy, in order to optimise output and/or resourcing for the schedule.

The Work Package specifications developed when setting the Production Strategies include the identification of the operating parameters (utilisation, operating rate, quality, etc.) and major resources (labour, equipment, materials) required for the Production work. The work package specifications developed when setting the Service Strategy, and for unpredicted events, include the identification of the impact on operating parameters (availability, operating rate, quality, etc.) and major resources (labour, equipment, materials) associated with the activity. If the operating parameters and major execution resources are assigned as 'resources' to the activities in the Operating Master Schedule, a forecast of the quantity and timing of outputs produced, and resources required, can be produced. A basic principle of the Operating Model is that Service Work cannot be displaced by Production work, since by definition Service work is necessary for future Production work to occur. Service work can be adjusted in the schedule, to minimise its impact on Production work, but not displaced. Hence, in instances where a Service Work Package in the schedule would prevent or constrain Production work (by requiring downtime or a lowered operating rate, quality or efficiency) the Operating Master Schedule must recognise this constraint in the modelling of the process output.

Due to the impact of variation in activity parameters forecasts of output and resourcing may be in the form of a run chart over time and probability distribution for a reporting interval. These probability distributions can be used to validate that the Production Strategy, Service Strategy and the Operating Master Schedule can deliver the output Performance Targets at the required level of confidence, and to help define and manage resourcing strategies.

The Operating Master Schedule defines the roadmap to the achievement of the Performance Targets. We can use the Operating Master Schedule to help us identify where we stand in relation to completion of the intended Production and Service Strategies, and what further work needs to be completed in order to deliver the target performance.

## Purpose

To specify an optimised schedule for delivering Performance Targets.

## Quantity

The deliverables from setting an Operating Master Schedule shall include;

- One set of schedule activities for the major (significant impact on outputs and costs) work packages of the Production and Service Strategies and random events.
- One set of schedule activities that characterise, describe and summarise the minor (low impact on outputs and costs) work packages of the Production and Service Strategies and random events.
- One baseline and one optimised schedule of the frequency and timing of occurrence of the above activities for the specified forecasting period.
- One baseline and one optimised forecast of the quantity and timing (probability distribution) of the output produced by the schedule.
- One baseline and one optimised forecast of the quantity and timing (probability distribution) of the major resources (labour, materials or equipment) required for the schedule.
- One confidence level for the optimised schedule delivering the output Performance Targets.

## Quality

The deliverables shall meet the following requirements;

- the time horizon of the Operating Master Schedule shall be long enough to cover the lead time for preparation and completion of any event that will impact the delivery of Performance Targets, and in any case not less than 3 years,
- the forecast of the frequency and timing of occurrence for the activities shall be in the form of a Gantt chart,
- the detail of activity breakdown in each interval of the schedule time horizon shall be sufficient to deliver the confidence level required for the forecasts for the period (typically higher confidence close to the present and less confidence further in the future),
- as a guideline, the Gantt chart view of the schedule would typically have a minimum time scale unit of one week for the first year, 1 quarter for the subsequent 2 years, and 1 year thereafter
- the major schedule activities shall comprise the 20% of items that are likely to deliver 80% of the impact on process output and costs,
- the minor schedule activities shall summarise the 80% of the items that are likely to deliver 20% of the impact on process output and costs,
- a baseline Operating Master Schedule shall be developed around the trigger parameters and durations for Work Packages derived from the Production and Service Strategies for major schedule activities and the average grouped Work Package interval and duration for the minor schedule activities,
- forecasts for unpredicted events shall be included at the Business Structure level for which confident predictions can be made, i.e. the

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probability of an event is greater than the confidence level required from the schedule,

- the probability distributions for the triggers, outputs and durations where variability can have significant impact on confidence levels for reporting interval must be specified,
- Monte Carlo simulation shall be used to produce the schedule forecasts
- the forecast of the quantity and timing of the performance parameters shall be in the form of a probability distribution for each reporting interval (typically quarters and years),
- the forecast of the quantity and timing of the major resource demands shall be in the form of a probability distribution for each reporting interval (typically quarters and years),
- an Operating Master Schedule, optimised for output and/or resources, shall be produced by adjusting the schedule events within the trigger tolerance range specified within the Production and Service Strategies,
- The probability distributions of the schedule forecasts, and the Performance Target specifications shall be used to generate the confidence level for the optimised schedule.

The Operating Master Schedule shall include data to allow the schedule to be filtered by;

- accountability for the work, and
- the Business Structure (down to Productive Unit level).

The detailed activities of set Operating Master Schedule shall conform to the specifications set out in Set Operating Master Schedule flowchart and TAs MS.01 to MS.14.

# MS.01 Forecast Trigger Parameter Accumulation

## Context

Each of the Work Packages derived from the selection of Production and Service Strategies is necessary to deliver the performance targets for a process, but the target performance cannot be achieved unless all of these Work Packages are executed at the right time and in the right way. The trigger parameters defined for each work package specify how the right time for the execution of each Work Package is determined. Some of the most common trigger events are;

- a specified date,
- a calendar time interval (e.g. days or weeks),
- an operating parameter (e.g. utilisation or operating rate),
- a condition parameter (e.g. a wear, contamination level), or
- completion of another Work Package (e.g. when replacement of a worn component triggers an overhaul of the replaced item).

Forecasting the schedule for Production and Service Work that is triggered on an operating parameter requires a forecast of the rates at which these parameters will accumulate over time. The process of Setting Production Strategy defined the estimates of the operating parameters (utilisation/operating time and throughput rates) for each Productive Unit. From these estimates we can, where they are used directly as the scheduling trigger, derive the triggering parameter estimates for Production and Service work for the Equipment/Workplaces and components. For example, the operating hours on a truck will be derived from the forecast utilisation of the haulage process and the allocation of work to the trucks within the fleet. For condition triggered, and unpredicted, activities we can in most cases define a proxy scheduling trigger based on an operating parameter. For example material volumes may be used a proxy for wear, operating hours as a proxy for contamination and for operator damage, etc.

Therefore, in order to produce the Operating Master Schedule, the values of operating parameters over time, and the consequent rate of accumulation of the related Activity trigger parameters must be forecast.

## Purpose

To specify the accumulation rate(s) for Operating Parameter related Activity triggers within the Operating Master Schedule.

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## Quantity

One forecast for each;

- Operating Rate related trigger parameter specified for an Activity in the Operating Master Schedule, and
- for each time scale unit of the Operating Master Schedule.

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### Quality

The Activities for which usage triggers shall be forecast is defined in TA MS.02, Specify Activities for Scheduling Model.

Forecasts shall specify accumulation rates derived from the Operating Parameters specified in the Production Strategy.

### Time

Whenever Operating Parameters are changed.

### Resources

This task is the accountability of the role identified in the configured flowchart.

# MS.02 Specify Activities for Scheduling Model

## Context

The underlying theory for the Operating Model design is that future process performance will be delivered if the right Production and Service work is completed at the right time and in the right way – and that this will be achieved more consistently, and at lower cost, if the work is planned, scheduled and resourced in advance of its execution. Through the process of developing the Production and Service Strategies for a process we specified what the right work is and what is the appropriate trigger event that will initiate that work.

The Operating Master Schedule lays out the sequence and timing of the Production and Service Activities that must be executed in order to deliver the process performance targets. Performance targets are broken down into a structure reflecting both the elements of the process that significantly define the performance outcomes and the management accountabilities for these. Consequently, the Operating Master Schedule should be broken down in a parallel structure.

The full list of Production and Service Work packages for a process could comprise hundreds or thousands of items. Trying to construct an Operating Master Schedule that includes each of these individually would generally be impractical. A manageable Schedule needs to provide sufficient detail to enable confirmation of progress to schedule, without providing so much detail that it becomes difficult and slow to track progress.

The 20% of the Production and Service work packages that will have the greatest impact on process output and costs should each be individually identified as an Activity in the Operating Master Schedule. Note - Activities may be classified in the top 20% because of a single high impact work package, or because of the frequent recurrence of a work package that produces a high cumulative impact.

The remaining 80% of the Production and Service work packages must also be included in the Operating Master Schedule. However, the objective is to group this component of the work into a smaller number of Activities based on characteristics shared by many work packages. This will make the overall number of Activities in the Schedule easy to manage, but provide sufficient detail to allow significant variation between the forecast and actual frequency or timing of Activities to be easily identified.

A practical number of activities to represent the grouping of minor Production and Service Work would result when each of these activities has an annual total output impact or cost of the same order as the lowest ranked of the top 20% of activities.

The characteristics that may be used to summarise this minor Production and Service Work include;

- the accountability for the work (typically a First Line Manager),

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- the Equipment/Workplace type (e.g. pumps, valves, ore pass, drains), and
- the work type (production or service)
- the strategy type (e.g. preventive, predictive, predicted repair, breakdown repair, etc.) and
- the type of trigger parameter (tonnes, kilometres, calendar hours, operating hours) that best predicts the occurrence of the work.

Many activities within the Operating Master Schedule will relate to individual Equipment or Workplaces. However there are some instances where activities can only be built into the Schedule at a higher level of the Business Structure. These will include some predictive and preventive Service Work that is incorporated into work packages that span across Equipment or Workplaces (e.g. vibration monitoring for rolling element bearings may include all electric motors in a Productive Unit or a Process), and some work packages arising from apparently random events (e.g. extreme weather events and those based on an operate to failure (OTF) service strategy) where it is improbable that an event will occur within a Business Structure element in a reporting interval. In the latter case, reliable predictions can only be made for similarly characterised events over a larger sample population. For example, if the average life of electric motors in a process is 5 years, and the service strategy for these is OTF, it is not possible to predict the failure of an individual motor in a reporting interval with an acceptable degree of confidence. However, it is possible to predict that within a population of 10 motors in the process 2 failures are likely in any reporting interval, with a best case of perhaps 1 and a worst case of 3. Similarly, while it may not be possible to predict that an extreme weather event will affect an individual operation within a business, it may be possible to predict that such an event is probable in at least one of a group of geographically distributed operations.

The set of Activities that meet the above criteria, extracted from the Production and Service Work packages will allow the construction of a practical and meaningful Operating Master Schedule.

### Purpose

To identify the Activities that will be used to construct the Operating Master Schedule.

### Quantity

- One Operating Master Schedule Activity for each of the few Production and Service Work packages that have the highest total estimated impact on performance and costs.
- One Operating Master Schedule Activity for each grouping of Production and Service Work packages that summarises the numerous low impact work packages.
- One Operating Master Schedule Activity for each significant random event that will impact on process output and/or costs.

**Quality**

An operating Master Schedule Activity may be defined by;

- a Production or Service work package that individually has a process output or cost impact that is in the top 20% of a Pareto analysis of Work Packages over a period, or
- a Production or Service work package that is executed many times over a period and the sum of the repeated process output or cost impacts is in the top 20% of a Pareto analysis of Work Packages over the period, or
- a random event that has a high probability of occurring within a time period, and that individually has a process output or cost impact that is in the top 20% of a Pareto analysis of Work Packages over the period. or
- a group of Production or Service work packages that share a common grouping characteristic that is used to summarise the numerous Work Packages that have a low cumulative impact over a time period.

High impact activities shall be identified by Pareto analysis of;

- The cumulative process output contribution over a time period - based on the most likely value estimate of a Production work package.
- The cumulative process output losses over a time period - based on the most likely value estimate of a Service work package or random disruptive event.
- The cumulative costs over a time period - based on the most likely value estimate estimates of a Service work package or random disruptive event.

The top 20% of these groupings shall be individually identified as a Activities in the Operating Master Schedule.

The remaining Production and Service Work, and random disruptive events, shall be filtered and sorted into groupings (preferably based on work type, trigger parameter type, equipment type and strategy type) where the total process performance or cost impacts is of the same order as the lowest ranked of the top 20% of Activities

The following data shall be specified for each Activity to be defined within the Operating Master Schedule;

- The Standard Job number for the Activity,
- the Business Structure element to which the Activity is attached,
- the role accountable for the Activity,
- a description of the Activity based on the defining characteristics, e.g. for a truck these may include; 250 hour PM services, 10,000 hour engine replacement, hydraulic breakdown repairs etc.
- the trigger parameter and value that initiates the Activity,
- the trigger parameter tolerance,
- constraints on scheduling (e.g. requires plant downtime, or plant operating, etc.),

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- the estimated operating parameters (utilisation, operating rate and quality) for the Production Activities - in the form of a probability distribution where activities have a low repetition rate, and/or very high variability in the individual event output or cost within a reporting interval,
- the estimated impact on operating parameters (availability, operating rate and quality) arising from the execution of the Service Activities - in the form of a probability distribution where activities have a low repetition rate, and/or very high variability in the individual event output or cost within a reporting interval,
- the estimated quantities for the major resources (labour, materials or quality equipment) required for the Activity (most likely case only).

### Time

At each forecasting cycle.

### Resources

This task is the accountability of the role identified in the configured flowchart.

# MS.03 Set Up Scheduling Model Elements

## Context

Each of the Work Packages derived from the selection of Production and Service Strategies is necessary to deliver the performance targets for a process, but the target performance cannot be achieved unless all of these Work Packages are executed at the right time and in the right way. The trigger parameters defined for each work package specify how the right time for the execution of each Work Package is determined. Some of the most common trigger events are;

- a specified date,
- a calendar time interval (e.g. days or weeks),
- an operating parameter (e.g. utilisation or operating rate),
- a condition parameter (e.g. a wear, contamination level), or
- completion of another Work Package (e.g. when replacement of a worn component triggers an overhaul of the replaced item).

TA MS.02, Specify Activities for Scheduling Model, defined the set of Activities (based in the Production and Service Strategy work) that will determine both how the process will operate, and what performance it is likely to deliver. A Scheduling Model must be able to take the information on these Activities, combine it with the Operating Parameters from the Production Strategy, and produce reliable forecasts of the frequency and timing of the Production and Service Work Packages that will be generated for a process. The Scheduling Model must also be able to take operating parameter and resourcing data and apply it to the Work Package forecasts to produce reliable forecasts for process output and resource demands.

A basic principle of the Operating Model is that Service Work cannot be displaced by Production work, since by definition Service work is risk management. Service work can be adjusted in the schedule, to minimise its impact on Production work, but not displaced. Hence, in instances where a Service Work Package in the schedule would prevent or constrain Production work (by requiring downtime or a lowered operating rate, quality or efficiency) the Scheduling Model must apply this constraint to the scheduling of the Production work and to the modelling of the process output.

Hence, to build and run the Scheduling Model, the Activities, their trigger parameters, a forecast of process operating parameters (utilisation, availability, operating rate, quality rate, efficiency), the key labour and equipment (Resource Types), and the dependencies and interactions between Work Packages must be entered into an appropriate model.

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## Purpose

To set up the Operating Master Schedule Activities within the Scheduling Model.

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**Quantity**

- All scheduling information for each Activity entered into the Scheduling Model.

**Quality**

A Scheduling Model Element shall be set up for each of the Activity defined in TA MS.02 Specify Activities for Scheduling Model.

Each Scheduling Model Activity shall record the following identifying data;

- the Business Structure identifier for the Activity (the identifier shall allow filtering of activities at any level of the structure),
- the role accountable for the Activity,
- the Activity description, and
- the Work Management System Job Template identity for the Activity.

Each Scheduling Model Activity shall record the following scheduling data, where appropriate;

- trigger parameter,
- trigger parameter start value (to identify where in the life cycle of an activity the forecast commences),
- trigger value (the point at which the activity is scheduled),
- trigger tolerance (earliest and latest schedule points around the trigger value),
- constraints on scheduling (e.g. operating, down, full, empty, access),
- scheduling commencement date (for activities that will only commence active scheduling at some time after the forecast commences), and
- scheduling termination date (for activities that will only cease active scheduling at some time after the forecast commences).

Each Scheduling Model Activity shall record the following performance data, where appropriate;

- Work Package duration,
- utilisation,
- availability,
- operating rate,
- quality rate,
- efficiency.

To cater for the situations where variability in a parameter will be significant in determining the confidence of meeting performance targets for a process, the model must allow a probability distribution to be entered for the parameter. The probability distribution for a performance parameter shall, as a minimum, be defined by;

- the values of the minimum, maximum, mean and mode of the distribution,
- the 'shape factor' (i.e. spread of the distribution - e.g. standard deviation),

In cases where the variability in the parameter will not be significant in determining the confidence of meeting performance targets the model shall use a mean value only.

Each Scheduling Model Activity shall specify the following resource data;

- labour Resource Types, and
- equipment Resource Types.

Resource Types are the categories of labour and equipment used in executing Production and/or Service work for either one or many processes. A specific Resource Type should be defined for each of the 20% of labour types and equipment types/capability that make up 80% (the Pareto set) of the capacity required for Production or Service work in the OMS. Each of these high impact Resource Types should represent resources that are equivalent/ interchangeable, e.g. mechanical fitters, electricians, mill operators, jumbo drills, 50t dump trucks, etc. The remaining resources can be grouped into one or a few Resource Types, based on the significant common characteristics of the resources, e.g. civil trades, light trucks etc. That is, we approach the modelling of resources, using Resource Types, in the same way as we approached the modelling of Work Packages via Activities in the OMS. Note that determining the Pareto set of Resource Types may require a few iterations, using feedback from the forecast Resource Type demand profiles output from the OMS. To cater for the situations where variability in Resource Type demands will be significant, the model must allow a probability distribution to be entered for these values. The probability distribution for a Resource Type demand shall, as a minimum, be defined by;

- the values of the minimum, maximum, mean and mode of the distribution,
- the 'shape factor' (i.e. spread of the distribution – e.g. standard deviation),

In cases where the variability in resourcing will not be significant in determining the confidence of meeting performance targets the model shall use a mean value only.

Each Activity triggered by a specific date (or date range) shall be connected to a calendar so as to forecast the Activity when the date is reached.

Each Activity triggered by calendar time accumulation shall be connected to a calendar time accumulator so as to forecast the Activity each time the accumulator reaches a whole increment of the trigger value.

Each operating (usage) parameter triggered Activity shall be connected to the appropriate accumulator so as to forecast the Activity each time the accumulator reaches a whole increment of the trigger value.

Each Activity that is triggered by the scheduling of another Activity shall be connected so as to forecast the Activity when the trigger event is scheduled.

The dependencies between Service and Production work Activities shall be set up so that constraints imposed by Service work are reflected in the Production work schedule and output forecasts.

When the Scheduling Model is run;

- evaluation of trigger points shall commence from the trigger start value,

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- evaluation of trigger points shall not occur until after the scheduling commencement date (i.e. Activities will not be scheduled before this date),
- the triggering of each calendar and usage based Activity shall recognise the trigger parameter start value when determining the first occurrence of the Activity in the schedule,
- evaluation of trigger points shall not occur after the scheduling termination date (i.e. Activities will not be scheduled after this date),
- a Gantt chart view of the work packages forecast shall be produced,
- a run chart forecast mean output of the process for each minimum time scale unit shall be produced,
- a capability histogram of the forecast process output for each reporting interval shall be produced,
- a run chart forecast of the mean demand for Resource Types for each minimum time scale unit shall be produced,
- a capability histogram of the forecast demand for Resource Types for each reporting interval shall be produced.

### Time

At each forecasting cycle.

### Resources

This task is the accountability of the role identified in the configured flowchart.

# MS.04 Identify Future Strategy Changes

## Context

The Operating Master Schedule lays out the sequence and timing of the Production and Service Work that must be executed in order to deliver the process Performance targets.

The starting point for forecasting the Operating Master Schedule must be the;

- current Production work and operating parameters defined in setting the Production strategy,
- current Service work defined in setting the Service Strategy.

The expectations, design and operation of processes are not however guaranteed to be unchanging over time. These parameters may be changing due to customer expectations and demands, modification or adaptation of the process, changes in the resources available to the process. Since forecasts are by nature developed well ahead of the events that they are predicting, they must have the current strategies as there starting point but must reflect the expected timing and effects of future changes in strategy that have been identified for the process. Such changes will likely result in the commencement and/or termination of schedule Activities, or changes to the nature of some Activities. Where such changes may have a significant effect on the frequency, timing, impact or resourcing of any Activity within the Operating Master Schedule, these changes must be reflected in the Schedule.

## Purpose

To specify the Scheduling Model elements/characteristics that must be set up for future Production and Service Strategy changes.

## Quantity

- One Operating Master Schedule Activity for each new Production or Service Work activity that will fall within the top 20% estimated impact on performance and costs.
- One Operating Master Schedule Activity for each modified individual or group of Production or Service Work packages.

## Quality

Forecast changes to Production and Service Work shall be reflected in the Operating Master Schedule by retaining the existing Activity and creating a new Activity for the changes resulting from the Strategy changes.

A scheduling termination date shall be specified for each Operating Master Schedule Activity that will be superseded as the result of a change in Production or Service Strategy.

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A scheduling commencement date shall be specified for each Operating Master Schedule Activity that will be activated as the result of a change in Production or Service Strategy.

Each Scheduling Model Activity shall record the following identifying data;

- the Business Structure identifier for the Activity (the identifier shall allow filtering of activities at any level of the structure),
- the role accountable for the Activity,
- the Activity description, and
- the Work Management System Standard Job number for the Activity.

Each Scheduling Model Activity shall record the following scheduling data, where appropriate;

- trigger parameter,
- trigger parameter start value (to identify where in the life cycle of an activity the forecast commences),
- trigger value (the point at which the activity is scheduled),
- trigger tolerance (earliest and latest schedule points around the trigger value),
- constraints on scheduling (e.g. operating, down, full, empty, access),
- scheduling commencement date (for activities that will only commence active scheduling at some time after the forecast commences), and
- scheduling termination date (for activities that will only cease active scheduling at some time after the forecast commences).

Each Scheduling Model Activity shall record the following performance data, where appropriate;

- Work Package duration,
- utilisation,
- availability,
- operating rate,
- quality rate,
- efficiency.

To cater for the situations where variability in a parameter will be significant in determining the confidence of meeting performance targets for a process, the model must allow a probability distribution to be entered for the parameter. The probability distribution for a performance parameter shall, as a minimum, be defined by;

- the values of the minimum, maximum, mean and mode of the distribution,
- the 'shape factor' (i.e. spread of the distribution – e.g. standard deviation),

In cases where the variability in the parameter will not be significant in determining the confidence of meeting performance targets the model shall use a mean value only.

Each Scheduling Model Activity shall specify the following resource data;

- labour,
- materials, and

- equipment.

To cater for the situations where variability in resourcing will be significant in determining the confidence of meeting performance targets for a process, the model must allow a probability distribution to be entered for the parameter. The probability distribution for a performance parameter shall, as a minimum, be defined by;

- the values of the minimum, maximum, mean and mode of the distribution,
- the 'shape factor' (i.e. spread of the distribution – e.g. standard deviation),
- In cases where the variability in resourcing will not be significant in determining the confidence of meeting performance targets the model shall use a mean value only.

### Time

At each forecasting cycle.

### Resources

This task is the accountability of the role identified in the configured flowchart.

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# MS.05 Are there Irregular Additions or Omissions to the Schedule?

## Context

The Production and Service strategies for an process are developed to deliver the required performance targets, and a good Production and Service strategies will identify most of the work that will regularly be required in the Operating Master Schedule. Hence, the process of Setting the Master Operating Schedule has to this point focused on building the schedule around the Production and Service Strategies.

One predictable characteristic of real processes, operated in the real world, is that there will be variation, and the Operating Master Schedule is not immune from this.

In any forecasting period there is certain to be some work that does not regularly occur, and there is certain to be some work that is normally required that will not be necessary during a particular period.

Any irregular additions or omissions to the Operating Master Schedule need to be identified if the Schedule is to be complete and accurate.

## Purpose

To identify any irregular additions or omissions to the Operating Master Schedule.

## Quantity

- One list of activities that are to be included as a 'once off' in the Operating Master Schedule.
- One list of activities that must have one or more occurrences 'suppressed' in the Operating Master Schedule.

## Quality

A draft Operating Master Schedule, reviewed in detail and in light of the known context for a forecasting period, can provide a prompt to stimulate people to recognise irregular changes required to the schedule. The draft Operating Master Schedule should be issued to the group of personnel who will be required to provide input. The appropriate personnel should record their individual suggestions for irregular changes to the schedule. These should be 'brainstormed with the group to confirm the list of changes that are required.

A list of the agreed 'once off' changes to the schedule shall be compiled.

## Time

At each forecasting cycle.

## Resources

This task is the accountability of the role identified in the configured flowchart.

AAOM Flowsheet

OMS Flowsheet

# MS.06 Specify Irregular Additions & Omissions

## Context

The Production and Service strategies for an process are developed to deliver the required performance targets, and a good Production and Service strategies will identify most of the Work Packages that will regularly be required in the Operating Master Schedule. Hence, the process of Setting the Master Operating Schedule has to this point focused on building the schedule around the Work Packages for Production and Service Strategies that are regular and recurring.

The optimised Operating Master Schedule is used to estimate the confidence of delivering the Performance Targets for the process. Hence, it is essential that the schedule include all work that will impact on the operation of the process and the performance levels delivered. This may include work that is outside of the scope of the regular, recurring Production and Service strategies, for example;

- mine development, equipping and ore depletion work in accordance with the life of mine plan and schedule,
- Production or Service strategy items for which the frequency or scale will be altered by unusual circumstances,
- irregular Asset Integrity Work,
- other capital work that will affect process operating times, rates, quality etc.

Any of these potential irregular additions or omissions to the Operating Master Schedule need to be specified for update of the Schedule.

## Purpose

To specify any irregular additions or omissions to the Operating Master Schedule.

## Quantity

- One set of specifications for each Activity that is to be included as a ‘once off’ in the Operating Master Schedule.
- One set of specifications for Activities that must have one or more occurrences ‘suppressed’ in the Operating Master Schedule.

## Quality

In identifying irregular additions or omissions from the Operating Master Schedule consider the following;

- the detailed work required by the Life of Mine plan and schedule,
- circumstances that will reduce or increase the frequency or scale of Production and Service strategy activities,
- Asset Integrity work that occurs irregularly,

- capital work that will affect process operating characteristics (time, rate, quality, etc.).

The following data shall be specified for each irregular Activity to be included to the Operating Master Schedule;

- the Business Structure identifier for the Activity (the identifier shall allow filtering of activities at any level of the structure),
- the role accountable for the Activity,
- the Activity description, and
- the Work Management System Standard Job number for the Activity.

where appropriate the;

- trigger parameter,
- trigger parameter start value (to identify where in the life cycle of an activity the forecast commences),
- trigger value (the point at which the activity is scheduled),
- trigger tolerance (earliest and latest schedule points around the trigger value),
- constraints on scheduling (e.g. operating, down, full, empty, access),
- scheduling commencement date (for activities that will only commence active scheduling at some time after the forecast commences), and
- scheduling termination date (for activities that will only cease active scheduling at some time after the forecast commences).

where appropriate the;

- Work Package duration,
- utilisation,
- availability,
- operating rate,
- quality rate,
- efficiency.

To cater for the situations where variability in a parameter will be significant in determining the confidence of meeting performance targets for a process, the model must allow a probability distribution to be entered for the parameter. The probability distribution for a performance parameter shall, as a minimum, be defined by;

- the values of the minimum, maximum, mean and mode of the distribution,
- the 'shape factor' (i.e. spread of the distribution – e.g. standard deviation),

In cases where the variability in the parameter will not be significant in determining the confidence of meeting performance targets the model shall use a mean value only.

the;

- labour,
- materials, and
- equipment.

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To cater for the situations where variability in resourcing will be significant in determining the confidence of meeting performance targets for a process, the model must allow a probability distribution to be entered for the parameter. The probability distribution for a performance parameter shall, as a minimum, be defined by;

- the values of the minimum, maximum, mean and mode of the distribution,
- the 'shape factor' (i.e. spread of the distribution – e.g. standard deviation),
- In cases where the variability in resourcing will not be significant in determining the confidence of meeting performance targets the model shall use a mean value only.

The following data shall be specified for each irregular omission of an Activity from the Operating Master Schedule;

- the Business Structure identifier for the Activity (the identifier shall allow filtering of activities at any level of the structure),
- the role accountable for the Activity, and
- the occurrences of the Activity that are to be suppressed.

**Time**

At each forecasting cycle.

**Resources**

This task is the accountability of the role identified in the configured flowchart.

## MS.07 Is there Discretionary Work that can be adjusted?

### Context

The Production and Service strategies for an process are developed to deliver the required performance targets, and a good Production and Service strategies will identify most of the work that will regularly be required in the Operating Master Schedule. Hence, the process of Setting the Master Operating Schedule has to this point focused on building the schedule around the Production and Service Strategies.

Since the work arising from the Production and Service strategies is based on data, and a tangible link between the work and some aspect of the process performance, there is not a great deal of choice about doing much of it, except as allowed by the trigger tolerance and some variation to the scope of individual work packages.

In addition to the work from the Production and Service Strategies there may be work arising from the need to meet expectations other than the immediate operating performance targets of the process. This can include work to; create a buffer in a critical part of the process or schedule, optimise or enhance the process capability, improve the aesthetics or amenity of the process or its environment for both the workforce and community.

With this type of work there is far more discretion over the scope and timing of what can be included in any forecasting period.

In preparing the Operating Master Schedule there is certain to be some discretionary work that can be added to or removed from the schedule as part of its optimisation.

The span of the Operating Master Schedule typically covers at least several years, thus providing an opportunity to rebalance at each new forecast period the non-discretionary and discretionary work over the life of the schedule. In periods where the resource or expenditure demands of the Production and Service strategy work are low, more discretionary work may be included. In periods where the resource or expenditure demands of the Production and Service strategy work are high, more discretionary work may be omitted.

### Purpose

To identify discretionary work that can added to, or omitted from, the Operating Master Schedule.

AAOM Flowsheet

### Quantity

- One list of discretionary Activities that are to be added to the Operating Master Schedule.
- One list of forecast discretionary Activities that are to be removed from or moved in the Operating Master Schedule.

OMS Flowsheet

## Quality

In identifying discretionary work changes to the Operating Master Schedule consider the following;

- creation of buffer capacity in the process
- creation of 'float' in the OMS
- process optimisation,
- process capability enhancement,
- environment,
- amenities
- community projects, etc.

A broad range of personnel may be stakeholders in this discretionary work and hence, should be consulted for input and advised of outcomes.

## Time

At each forecasting cycle.

## Resources

This task is the accountability of the role identified in the configured flowchart.

# MS.08 Specify Discretionary Changes

## Context

The Production and Service strategies for an process are developed to deliver the required performance targets, and a good Production and Service strategies will identify most of the work that will regularly be required in the Operating Master Schedule. Hence, the process of Setting the Master Operating Schedule has to this point focused on building the schedule around the Production and Service Strategies.

Since the work arising from the Production and Service strategies is based on data, and a tangible link between the work and some aspect of the process performance, there is not a great deal of choice about doing much of it, except as allowed by the trigger tolerance and some variation to the scope of individual work packages.

In addition to the work from the Production Plan and Service Strategy there may be work arising from the need to meet expectations other than the performance of the process. This can include work to improve the aesthetics or amenity of the process or its environment for both the workforce and community. For example items such as gardening programs to enhance the image of the operation within the community, reconditioning of meal rooms, change rooms, workshops, offices, and aesthetic painting of buildings etc.

With this type of work there is far more discretion over the scope and timing of what can be included in any forecasting period.

In preparing the Operating Master Schedule there is certain to be some discretionary work that can be added to or removed from the schedule as part of its optimisation.

The span of the Operating Master Schedule typically covers at least several years, thus providing an opportunity to rebalance at each new forecast period the non-discretionary and discretionary work over the life of the schedule. In periods where the resource or expenditure demands of the Production and Service strategy work are low, more discretionary work may be included. In periods where the resource or expenditure demands of the Production and Service strategy work are high, more discretionary work may be omitted.

Any discretionary work changes to the Operating Master Schedule need to be specified.

## Purpose

To specify any discretionary work additions or omissions to the Operating Master Schedule.

AAOM Flowsheet

OMS Flowsheet

**Quantity**

- One set of specifications for each discretionary Activity that is to be included in the Operating Master Schedule.
- One set of specifications for discretionary Activities that must be removed from or moved in the Operating Master Schedule.

**Quality**

The following data shall be specified for each discretionary Activity to be included to the Operating Master Schedule;

- the Business Structure identifier for the Activity (the identifier shall allow filtering of activities at any level of the structure),
- the role accountable for the Activity,
- the Activity description, and
- the Work Management System Standard Job number for the Activity.

where appropriate the;

- trigger parameter,
- trigger parameter start value (to identify where in the life cycle of an activity the forecast commences),
- trigger value (the point at which the activity is scheduled),
- trigger tolerance (earliest and latest schedule points around the trigger value),
- constraints on scheduling (e.g. operating, down, full, empty, access),
- scheduling commencement date (for activities that will only commence active scheduling at some time after the forecast commences), and
- scheduling termination date (for activities that will only cease active scheduling at some time after the forecast commences).

where appropriate the;

- Work Package duration,
- utilisation,
- availability,
- operating rate,
- quality rate,
- efficiency.

To cater for the situations where variability in a parameter will be significant in determining the confidence of meeting performance targets for a process, the model must allow a probability distribution to be entered for the parameter. The probability distribution for a performance parameter shall, as a minimum, be defined by;

- the values of the minimum, maximum, mean and mode of the distribution,
- the 'shape factor' (i.e. spread of the distribution – e.g. standard deviation),

In cases where the variability in the parameter will not be significant in determining the confidence of meeting performance targets the model shall use a mean value only.

the;

- labour,
- materials, and
- equipment.

To cater for the situations where variability in resourcing will be significant in determining the confidence of meeting performance targets for a process, the model must allow a probability distribution to be entered for the parameter. The probability distribution for a performance parameter shall, as a minimum, be defined by;

- the values of the minimum, maximum, mean and mode of the distribution,
- the 'shape factor' (i.e. spread of the distribution – e.g. standard deviation),
- In cases where the variability in resourcing will not be significant in determining the confidence of meeting performance targets the model shall use a mean value only.

The following data shall be specified for each discretionary Activity to be removed from or moved within the Operating Master Schedule;

- the Business Structure identifier for the Activity (the identifier shall allow filtering of activities at any level of the structure),
- the role accountable for the Activity, and
- the occurrences of the Activity that are to be removed or moved.

**Time**

At each forecasting cycle.

**Resources**

This task is the accountability of the role identified in the configured flowchart.

AAOM Flowsheet

OMS Flowsheet

# MS.09 Identify Synergies & Conflicts in Baseline Schedule

## Context

The baseline forecast produced by the Scheduling Model will place Activities within the Schedule based strictly on the scheduling parameters, and Production work to Service work dependencies, that were specified when the Activities were set up in the model. These included a nominal trigger value for each Activity and a range of tolerance (variation) permitted on that trigger value. Within the Scheduling Model it is the nominal trigger value that will determine the placement of an Activity within the Baseline Schedule output.

The Baseline Schedule may not align all of the forecast Work Packages to maximise the synergies and minimise the potential conflicts between packages. For example, the Baseline Schedule may show two Service work packages that restrict process output as occurring separately when scheduling tolerances would allow them to be aligned. However, an experienced person reviewing the Baseline Schedule can often readily identify such synergies and conflicts. In this case it is possible to adjust the scheduling of forecast Work Packages, within the range of tolerance allowed by the Production and Service strategies, in order to optimise process output and/or the resourcing for the Schedule.

## Purpose

To identify potential synergies and conflicts between Activities within the Baseline Operating Master Schedule.

## Quantity

- One list of Schedule Activities that may be able to be moved to optimise the Schedule.

## Quality

The following criteria should be considered when assessing the schedule for possible opportunities to optimise synergies;

- Activities that have similar scheduling constraints (e.g. plant condition) and that are relatively closely placed in the schedule,
- Activities that have the same specialised resource requirements (e.g. specialised equipment or skills) and that are relatively closely placed in the Schedule, and
- Activities that have relatively wide trigger tolerances and that may be readily moved to align with other Activities.

The following criteria should be considered when assessing the schedule for possible conflicts to resolve;

- Activities that occur together in the schedule and that have conflicting scheduling conditions (e.g. full, empty, access), and

- Activities that require a constrained resource (e.g. a workplace, specialised equipment or specialised skills) and that occur together in the schedule.

The criteria for potential synergies and conflicts may be applied as filters to the Operating Master Schedule to produce a report listing all of the potential opportunities for optimisation.

Where Activities based on an Operate to Failure (OTF) strategy are identified as potential synergies and conflicts you cannot move them in the schedule as they will happen when they happen. The potential variability in their ultimate impact is better dealt with in specifying the probability distribution for the impact, i.e. depending on what else is happening when the event occurs its impact may be distributed between zero and the maximum possible.

### Time

At each forecasting cycle.

### Resources

This task is the accountability of the role identified in the configured flowchart.

AAOM Flowsheet

OMS Flowsheet

# MS.10 Can Timing be Adjusted Within Trigger Tolerance

## Context

The baseline forecast produced by the Scheduling Model will place Activities within the Schedule based strictly on the scheduling parameters, and Production work to Service work dependencies, that were specified when the Activities were set up in the model. These included a nominal trigger value for each Activity and a range of tolerance (variation) permitted on that trigger value. Within the Scheduling Model it is the nominal trigger value that will determine the placement of an Activity within the Baseline Schedule output.

The Baseline Schedule may not align all of the forecast Work Packages to maximise the synergies and minimise the potential conflicts between packages. For example, the Baseline Schedule may show two Service work packages that restrict process output as occurring separately when scheduling tolerances would allow them to be aligned. However, an experienced person reviewing the Baseline Schedule can often readily identify such synergies and conflicts. In this case it is possible to adjust the scheduling of forecast Work Packages, within the range of tolerance allowed by the Production and Service strategies, in order to optimise process output and/or the resourcing for the Schedule.

## Purpose

To identify Activities that can be moved from their nominal placement in the Operating Master Schedule, in order to optimise synergies and resolve conflicts, without breaching the trigger tolerance on the Activity.

## Quantity

- One set of decisions on which Activities can be moved in the Schedule to optimise synergies and resolve conflicts, without breaching the trigger tolerance on any Activity.

## Quality

In making these decisions consider the following criteria;

- Activities based on an Operate to Failure (OTF) strategy should not be moved in the schedule (they will happen when they happen),
- select the simplest changes that can optimise the schedule,
- confine potential schedule movements to a point that is within the trigger tolerance for the Activity, and
- check for potential new conflicts created if an Activity is moved.

## Time

At each forecasting cycle.

## Resources

This task is the accountability of the role identified in the configured flowchart.

AAOM Flowsheet

OMS Flowsheet

# MS.11 Adjust Activity Placement in Schedule

## Context

The baseline forecast produced by the Scheduling Model will place Activities within the Schedule based strictly on the scheduling parameters, and Production work to Service work dependencies, that were specified when the Activities were set up in the model. These included a nominal trigger value for each Activity and a range of tolerance (variation) permitted on that trigger value. Within the Scheduling Model it is the nominal trigger value that will determine the placement of an Activity within the Baseline Schedule output.

The Baseline Schedule may not align all of the forecast Work Packages to maximise the synergies and minimise the potential conflicts between packages. For example, the Baseline Schedule may show two Service work packages that restrict process output as occurring separately when scheduling tolerances would allow them to be aligned. However, an experienced person reviewing the Baseline Schedule can often readily identify such synergies and conflicts. In this case it is possible to adjust the scheduling of forecast Work Packages, within the range of tolerance allowed by the Production and Service strategies, in order to optimise process output and/or the resourcing for the Schedule.

Once a set of decisions have been made on what schedule adjustments can be made to optimise synergies and remove conflicts between Activities these changes must be manually ‘forced’, to temporarily override the normal scheduling of the Activity.

## Purpose

To temporarily override the nominal scheduling criteria for specified Activities.

## Quantity

One temporary override of the nominal scheduling parameters for each specified Activity.

## Quality

Any ‘forced’ override of the scheduling of an Activity must be temporary and shall not alter any of the nominal scheduling parameters.

All activities with a ‘forced’ schedule must be readily identifiable.

Some options available for ‘forcing’ an Activity in the schedule include;

- Setting the scheduled time to a specific calendar time,
- Setting the Activity to be dependent on the Activity you want it tied to,
- Setting the Activity with a dependency on and an offset to another Activity you wish to link with, or avoid.

**Time**

At each forecasting cycle.

**Resources**

Adjustment of Activity placement is the accountability of the role identified in the configured flowchart.

AAOM Flowsheet

OMS Flowsheet

# MS.12 Specify Frequency Distributions, Threats & Opportunities

## Context

Each activity that was included in the Scheduling Model had a trigger parameter and trigger tolerance specified for it. The nominal trigger value was used to produce the Baseline Schedule. The trigger tolerance information was used in making adjustments to the scheduling of Activities in order to optimise the Schedule.

This optimised Schedule represents only one of many possible outcomes for the actual frequency and timing of the Activities in the schedule. In practice there is a range of potential times at which each Activity could occur, with each time having a different probability of occurring (i.e. the likely timing of an Activity is best represented by a probability histogram).

In order to determine the process performance confidence level that can be delivered by the schedule the probability distribution for the Schedule outcomes must be estimated. The range of potential Activity frequencies is one parameter that may influence the process output performance distribution. Where the potential range of frequencies can produce a significant influence on output and resource forecasts these need to be included in the modelling.

The most likely case frequency has already been defined in the Baseline Schedule. The probability distribution of possible frequencies around this need to be specified. These estimates do not need to be precise, and the historical records for the Activities, the experience of appropriate personnel and a knowledge intended changes to the either the process, Production strategies or Service strategies can allow these estimates to be made with adequate accuracy.

In making the estimates it is necessary to consider what can go well, that will help the best case to be achieved, and what can go badly, to make the worst case occur. If these opportunities and threats are recorded then it is possible to implement some control actions that might increase the probability of a better outcome.

## Purpose

To specify the probability distribution for the frequency of the Activities of the Operating Master Schedule.

**Quantity**

For each Activity in the Operating Master Schedule where the variability in the frequency of occurrence can be significant The probability distribution for a performance parameter shall, as a minimum, be defined by;

- the values of the minimum, maximum, mean and mode of the distribution,
- the 'shape factor' (i.e. spread of the distribution – e.g. standard deviation),;

In addition, for each such activity specify;

- the actions that are possible to increase the probability of a best case outcome,
- the issues that will increase the probability of a worst case outcome, and
- the actions that are possible to decrease the probability of a worst case outcome.

**Quality**

The characteristics of the probability distribution for each Activity shall be recorded in the Scheduling Model so that the Schedule impact on Asset performance and the confidence level for the achievement of performance targets can be forecast.

The control actions identified to increase the probability of a better outcome shall be recorded in a system where the implementation of the actions can be managed.

**Time**

At each forecasting cycle.

**Resources**

Specification of frequency distributions is the accountability of the role identified in the configured flowchart.

AAOM Flowsheet

OMS Flowsheet

## MS.13 Calculate Ouput Distributions and Confidence Levels

### Context

The objective of the Production and Service strategies, and Operating Master Schedule, for a process is to define how to deliver the performance targets at the confidence level required.

To determine if the proposed Production and Service Strategies, and Operating Master Schedule, will deliver the required performance we must determine the probability distribution for the output delivered by the optimised Operating Master Schedule.

The specification for each Activity in the Operating Master Schedule includes the probability distribution for performance parameters (availability, utilisation, operating rate, quality and efficiency) affected by the Activity. The probability distributions for the process performance that will result from the schedule can be obtained by statistically modelling (e.g. using Monte Carlo simulation) the performance parameter distribution for the process over a period of the schedule. This prediction is consistent with the way we have defined and modelled process performance in Setting Performance Targets from business expectations.

Performance predictions for processes can be rolled up in the Business Structure from Productive Unit, Process, Process Stream and Asset performance using the same models that were used in Setting Performance Targets.

### Purpose

To estimate the output performance that will result from implementation of the Operating Master Schedule.

### Quantity

- one run chart containing the forecast 10th percentile, mean and 90th percentile output of the process for each minimum time scale unit,
- one capability histogram of the forecast process output for each reporting interval,
- one run chart containing the forecast 10th percentile, mean and 90th percentile demand for each Resource Type for each minimum time scale unit,
- one capability histogram of the forecast Resource Type demand for each reporting interval,

### Quality

Output forecasts shall be produced for each element and level of the Business Structure identified in the Operating Master Schedule. Forecasts for Productive Unit, Process, Operation and Region shall be produced by combining the distributions produced from the schedule using the plant performance models from Set Performance Targets.

A database shall be used to record the performance forecasts.

**Time**

At each forecasting cycle.

After any change to the Production or Service strategies for a process is proposed.

**Resources**

Specification of frequency distributions is the accountability of the role identified in the configured flowchart.

AAOM Flowsheet

OMS Flowsheet

# MS.14 Create Routine Operating Schedule

## Context

The objective of the Production and Service strategies, and Operating Master Schedule, for a process is to define how to deliver the performance targets at the confidence level required. It is the Operating Master Schedule that specifies when the Production and Service strategies will be implemented. It is in effect the route map of work content, sequencing and timing, that is most likely to deliver the required performance.

As with any route map prepared before a journey, the closer the actual journey follows the content, sequencing and timing of the route, the more likely that the destination will be achieved on time and within cost expectations. Success in delivering the process performance forecast by the Operating Master schedule will therefore depend on the actual Execution Schedule (the schedule developed and executed in Work Management) following as closely as possible the intent set out within the approved Operating Master Schedule.

The Operating Master Schedule is a forecasting tool and not an execution tool. It therefore does not contain all of the Work Packages and all of the planning detail required for execution. It does however set out the key Activities, the sequencing and timing of these, the operating and down times for the process, and the process resource demands over time. This information can be used as a framework (referred to as the Routine Operating Schedule) for building an Execution Schedule that will deliver the intent of the Operating Master Schedule.

If all of the work that is identified as necessary, appropriate and funded in the Work Management process, can be organised within the framework of sequencing, timing, operating/down times, and process resource demands defined by the Routine Operating Schedule, then the performance forecasts of the Operating Master Schedule are likely to be delivered.

The Routine Operating Schedule is produced from the Operating Master Schedule by extracting;

- the sequencing and timing of activities with critical dependencies (this is equivalent to the summary tasks within a typical project schedule),
- for single line processes (i.e. those with a single entry and exit point, such as a typical crushing circuit), the occurrence of operating and downtime, and
- for multi-line processes (i.e. those with a multiple independent entry and exit points, such as a typical haulage fleet), the number of operating and down lines (e.g. trucks) at each point in time.

## Purpose

To define the significant parameters for constructing an Execution Schedule that will deliver the performance forecast by the Operating Master Schedule.

**Quantity**

- One Routine Operating Schedule for each Productive Unit defined within a Business Structure.

**Quality**

The Routine Operating Schedule shall be drawn from the parameters of the Operating Master Schedule. It shall specify, as appropriate to the type of process;

- the sequencing and timing of activities with critical dependencies
- for single line processes (i.e. those with a single entry and exit point, such as a typical crushing circuit), the occurrence of operating and downtime,
- for multi-line processes (i.e. those with a multiple independent entry and exit points, such as a typical haulage fleet), the number of operating and down units (e.g. trucks), and
- the key operating parameters that must be targeted in the development of the Execution Schedule (availability/uptime hours, utilisation/operating hours, rate).

The critical dependencies in a Routine Operating Schedule shall be presented in the form of a Gantt chart - refer to example in Appendix 1.

Operating/down times and/or number of operating units, and key operating parameters shall be presented in the form of a table - refer to example in Appendix 1.

**Time**

At each forecasting cycle.

After any change to the Production or Service strategies for a process is made.

**Resources**

Specification of frequency distributions is the accountability of the role identified in the configured flowchart.

AAOM Flowsheet

OMS Flowsheet

# Appendix 1

## FIGURE 1: THE PLANT

**Operating State and Downtime Hou**

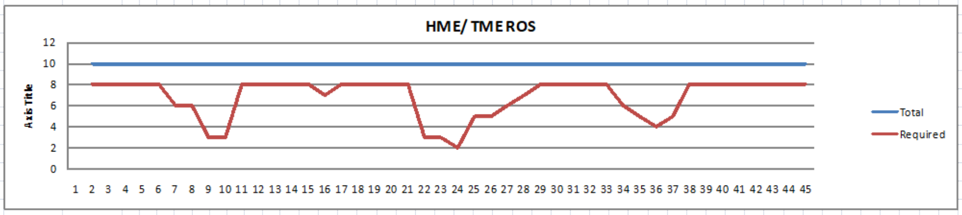
**Mill 1**

**Productive Unit**

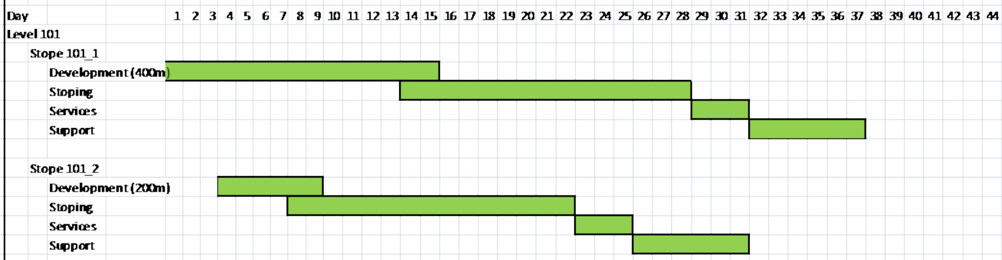
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Mill 1 Reef Silo** | Operating State | O | O | O | M | S | O | O | O | O | O | O | M | O | O | O | O | O | O | O | M | O | O | O | O | O | O | O | M | O | O | O | O |
| | Downtime Hours | 0 | 0 | 0 | 24 | s | 0 | 0 | 0 | 0 | 0 | 0 | 24 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 24 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 24 | 0 | 0 | 0 | 0 |
| **Mill 1 Feed Conveyor** | Operating State | O | O | O | M | S | O | O | O | O | O | O | M | O | O | O | O | O | O | O | M | O | O | O | O | O | O | O | M | O | O | O | O |
| | Downtime Hours | 0 | 0 | 0 | 24 | s | 0 | 0 | 0 | 0 | 0 | 0 | 24 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 24 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 24 | 0 | 0 | 0 | 0 |
| **ROM Mill 1** | Operating State | O | O | O | M | S | O | O | O | O | O | O | M | O | O | O | O | O | O | O | M | O | O | O | O | O | O | O | M | O | O | O | O |
| | Downtime Hours | 0 | 0 | 0 | 24 | s | 0 | 0 | 0 | 0 | 0 | 0 | 24 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 24 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 24 | 0 | 0 | 0 | 0 |

## FIGURE 2: HME/ TME

| Day | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Haulage** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| CAT 777C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Total** | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| **Required** | 8 | 8 | 8 | 8 | 8 | 6 | 6 | 3 | 3 | 8 | 8 | 8 | 8 | 8 | 7 | 8 | 8 | 8 | 8 | 8 | 3 | 3 | 2 | 5 | 5 | 6 | 7 | 8 | 8 | 8 | 8 | 8 | 6 | 5 | 4 | 5 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 |




## FIGURE 3: MINING



# MS.15 Adjust Master Schedule

## Context

The Operating Master Schedule (OMS) provides a roadmap of the work activities appropriate to delivery of the business expectations, and the distribution of the duration for each activity. The OMS is the approved specification of the Right Work, Right Time and Right Way

As with any map an OMS can only be used effectively if we are able to accurately identify and track our current position against the expected position and desired end point. To achieve this we need an appropriate level of forecast detail and must provide regular, timely and accurate feedback of actual versus expected progress at this same level of detail.

A usable rolling forecast will be made up of the;

- actual frequency and duration of the events linked to each OMS Activity, for each reporting interval to date, plus
- projected distributions of frequency and duration for the remainder of the OMS time horizon.

It is possible that some of the more significant decisions taken in the Execution Scheduling process, in order to manage critical issues, may result in material changes to the forecast for future OMS reporting intervals. When this situation arises it is necessary to reflect the impact of these decisions in the OMS forecast.

## Purpose

To maintain a reliable OMS forecast.

## Quantity

In the event of a significant execution Scheduling decision, with material impact on the OMS forecast for future reporting intervals (but not the current reporting interval), the following information should be updated to the OMS.

For each low sample rate Service Activity in the OMS;

- The change in the measurement period in which the event is forecast, and/or
- The duration of the event.

For each high sample rate Service Activity in the OMS;

- The change in the total number of occurrences of events linked to the Activity in the measurement periods, and
- The average duration of the events.

For each high sample Production Activity in the OMS;

- The change in the output  distribution for the measurement period,

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## Quality

Only make changes that will have a material impact on the OMS forecast, that is, changes that would be likely to create a special cause in the control chart of the process performance.

Only make forecast changes for future OMS reporting intervals (i.e. typically the next month and beyond). Changes made on shorter notice will be reflected in the reporting of actual timing/frequency and duration from the work management system to the OMS.

## Time

Within the Execution Schedule period.

## Resources

Completion of this task is the accountability of the role nominated on the configured Operating Master Schedule flowchart.

# MS.16 Update Activity Actual Frequency and Duration

## Context

The Operating Master Schedule (OMS) provides a roadmap of the work activities appropriate to delivery of the business expectations, and the distribution of the duration for each activity. The OMS is the approved specification of the Right Work, Right Time and Right Way

As with any map an OMS can only be used effectively if we are able to accurately identify and track our current position against the expected position and desired end point. To achieve this we need an appropriate level of forecast detail and must provide regular, timely and accurate feedback of actual versus expected progress at this same level of detail.

A usable rolling forecast will be made up of the;

- actual frequency and duration of the events linked to each OMS Activity, for each reporting interval, to date, plus
- projected distributions of frequency and duration for the remainder of the OMS time horizon.

For low sample rate Activities the actual values recorded in the OMS for a reporting interval will represent the outcomes for a single event. For high sample rate Activities the actual values recorded in the OMS for a reporting interval will represent the total count and the average duration for multiple events.

The timing/frequency of the events linked to each Activity should be extracted from the appropriate systems of record and recorded in the OMS to match the reporting interval (typically monthly).

## Purpose

To track actual results against the OMS forecast.

## Quantity

The following information should be imported to the OMS.

For each low sample rate Service Activity in the OMS;

- The occurrence of an event linked to the Activity in the measurement period, and
- The duration of the event.

For each high sample rate Service Activity in the OMS;

- The total number of occurrences of events linked to the Activity in the measurement period, and
- The average duration of the events.

For each high sample Production Activity in the OMS;

- The total output for the measurement period,

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### Quality

In the case of discrete event (e.g. work order) Activities, the frequency of Activity occurrence should be the number of work packages executed in the measurement interval. This information should be derived from the work management system of record.

In the case of 'continuous' Production Activities (e.g. crushing, grinding), the output should be the number of units of product processed in the measurement period. This information should be derived from the production system of record.

### Time

At least once each reporting interval (typically monthly), but daily if practical.

### Resources

Completion of this task is the accountability of the role nominated on the configured Operating Master Schedule flowchart.

INTERNAL

# ANGLO AMERICAN OPERATING MODEL: OPERATIONAL PLANNING
# SET EXPENDITURE SCHEDULE

**UPDATED: AUGUST 2018**

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# ES.00 Set Expenditure Schedule

## Context

The underlying theory for the Operating Model states that process performance targets will be delivered if the Right Work is completed at the Right Time and in the Right Way. The recipe for the Right Work and Right Way is defined in the Operating Model processes for setting the Production Strategy (viz the optimum work for operating the process to achieve the Performance Targets), and Service Strategy (viz the optimum work for managing threats related to the process). Using the trigger parameters and dependencies specified as part of the Production and Service strategies, these two types of work are integrated in the Operating Master Schedule (OMS), optimising the synergies and removing potential conflicts in order to define the most effective schedule for delivering all of the work. The OMS also allows us to produce a forecast of the probable outcomes and resource demands for the process. The final step in the Operational Planning process is to define the ExPenditure Schedule (EPS) required to deliver the work in accordance with the OMS.

The EPS is a costed version of the OMS. That is, the forecast cost for the Resource Types (labour, equipment, materials/spares and utilities, etc.) that will be required to implement the OMS is combined with a quantity estimate on each OMS Activity, and the frequency/timing of the Activities, to forecast the expenditure profile over time.

An effective EPS will provide expenditure forecasts and records that will help drive appropriate management decisions on forecasting and committing the work and resources necessary to deliver the process Performance Targets. It is therefore important that expenditure forecasts and cost records provide an accurate, though not necessarily precise, picture of the Production and Service Work. That is, figures that are 90% to 95% accurate will probably lead to management decisions that are as effective as figures that are 99.9% precise. Consequently development of an EPS should focus on the identification and estimation of the resources and costs that are **significant** to the overall cost of each activity, and that are **directly involved** in that activity. Other resource costs could reasonably be incorporated into overhead expense categories.

The preferred source for data is directly from the costing system(s) of record (usually an Enterprise Resource Planning system - ERP), as this provides data based on actual expenditure records. Whilst this data is obviously historical, if used appropriately it can still provide a sound guide to estimates of future costs. The significant sources of volatility (special cause events) in cost forecasts over time are;

- variability in the workload over time (e.g. mining volumes or maintenance over the life cycle of an asset), and
- volatility in resource pricing (wide swings over relatively short time periods), where that resource pricing has a very dominant place in the cost of an activity (e.g. diesel fuel in mining).

Note that the cost of most resources is not the major source of volatility in cost forecasts, because of either small and gradual price changes or because they do not have a dominant position in the cost of the activity. The major source of volatility is more often the variability in the workload - hence the importance of a credible OMS to the delivery of a credible expenditure forecast.

Ideally, each Activity on the OMS should have either a Job Template or a Cost collector, or both, in the Enterprise Resource Planning system (ERP). These records should identify both the Resource Types that are utilised in the work and the consumption and cost of these resources. Where available, this information should be used to populate the Resource Types and their cost estimates for the EPS. If this information is not available from the ERP (e.g. when a new OMS Activity is created) then the Resource Types and costs will need to be estimated from first principles.

Where the OMS should be used as a roadmap to the achievement of the process output targets, the EPS should be used as a guide to the responsible commitment of costs. In order to achieve this the progress of actual work and cost commitments against the forecast of the OMS/EPS must be tracked. This requires that each work package created in the ERP be recorded as an event and cost against the appropriate Activity in the OMS/EPS. These records support the tracking of the actual frequency, timing and cost of work compared to the forecast of the OMS/EPS. This comparison can be used to validate the accuracy of estimates and, to identify the degree of variability over time, or to identify where detailed analysis may be necessary in order to update the estimates of resource usage and costs. It is not necessary to record the cost of every occurrence of an Activity in the EPS (the detail will reside in the ERP). What is necessary to record in the EPS is the number of occurrences of each Activity within a forecasting/measurement period and the total cost of all of the occurrence during that period. If there is a significant difference between the forecast and actual frequencies and costs for a period then the detailed analysis can be made in the ERP.

When Activities have both significant cost per occurrence, and a low frequency of occurrence in a forecasting/measurement period (for cost information the shortest interval is usually monthly), the impact of this variability on the forecast for that period may be substantial. When Activities have a high frequency of occurrence in a forecasting/measurement period the total cost will converge on the product of the frequency and the average cost. Hence low frequency Activities will require an estimate of the distribution of likely cost outcomes while high frequency Activities can use an estimate of the average cost. Because of the inevitable presence of variation in both frequency and cost of Activities, the cost forecasts from the EPS cannot be a single value, they must be probability distribution of outcomes. The EPS must therefore provide a statistical model that deals with these variables and forecasts the probability distribution of outcomes. The confidence level of the cost performance target can be determined from this distribution.

Resources such as materials and utilities that are consumed in the course of completing work, are managed through a supply system, and are charged to the appropriate work order/cost receiver as used. The pricing of these

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resources will be visible through the supply system of the ERP and the historical costs of these resources will be visible through either work order or cost collector records in the ERP. Resources such as labour and equipment are continually reassigned to new work in a schedule and an ERP utilises the concept of a Work Centre to manage these. A Work Centre resource simply represents the capacity of a particular resource that can be assigned to a schedule (e.g. a mechanics for B hrs, C 100t trucks for D hrs). Where Work Centre costs are required to be quantified and/or charged to specific work activities an ERP cost collector will be created, for the Work Centre, in the ERP. The cost centre can be used identify the cost and pricing of the Work Centre resource, and where charge out rates are applied to a Work Centre resource the work order records can be used to identify historical Work Centre resource quantities and costs for the work.

The significant set of Resource Types used within an EPS (those that make up >90% of the total costs) should be individually and accurately estimated for the appropriate Activities. The remaining resource costs cannot be ignored in the EPS, and should be estimated against the appropriate Activities, but can be grouped into a general cost classification rather than individually identified. The estimates for Work Centre Resource Type quantities can be used in the EPS model to forecast the distribution of Work Centre demand over time. The parameters of this distribution can be used to set the fixed capacity for a work Centre as well as guiding the selection of an appropriate strategy for dealing with the variable element of demand (e.g. overtime, over-resourcing, contracting, etc).

The ExPenditure Schedule will be based on the fully costed OMS for the process.

**Purpose**

To specify the expenditures required for the Operating Master Schedule.

**Quantity**

The deliverables from setting ExPenditure Schedules shall include;

- specification of the Resources Types required to cost the OMS,
- the cost estimate for each non Work Centre Resource Type for each OMS/EPS Activity,
- the quantity and cost estimate for each Work Centre Resource Type for each OMS/EPS Activity,
- an estimate for the Minimum, Most Likely and Maximum total cost estimates for occurrences of an Activity,
- one estimate of the probability distribution for the expenditure outcomes for each Expenditure Schedule.
- one confidence level for the 'most likely' Expenditure Schedule total.
- one estimate of the 'contingency' value necessary to achieve the confidence levels specified for the process expenditure target,
- the forecast of distribution of demand for each Work Centre Resource Type over time,

- one comparison of forecast and actual frequency, and cost for each Activity for each forecasting/measurement period (minimum period typically 1 month).

**Quality**

The deliverables shall meet the following requirements;

- The Resource Types should be those that are **significant** to the overall cost of the Activities in the EPS, and that are **directly involved** in those Activities (consider labour, equipment, utilities and materials/spares, etc).
- The Resource Type cost estimates should be informed by ERP data records wherever possible.
- The options for filtering and presentation of the EPS shall match those specified for the Operating Master Schedule.
- Each infrequent (less than 10 occurrence per month) Activity shall have a three point estimate of cost – the worst case, most likely and best case estimates. An average cost may be used for high frequency Activities.
- The Activity cost estimates shall be combined in a Monte Carlo simulation with the OMS estimates for the frequency of the Activity to estimate the probability distribution for costs.
- A confidence level for the Expenditure Schedule shall be the cumulative probability of the most likely budget value within the probability distribution as defined above.
- The value of the expenditure contingency estimate shall be the sum that must be added to the 'most likely' value for the Expenditure Schedule in order to reach a budget value equal to the target confidence level.
- The EPS shall typically include 3 to 5 years, commencing with the current year.
- The EPS shall be extended on a regular basis, typically no more than 3 monthly.
- The Expenditure Schedule shall provide monthly forecast expenditure values for the next 12 months, and annual values f subsequently.
- The profile of Work Centre resource demand shall be in the form of a histogram of the units of resource required, per week, to deliver the OMS. The histogram should show the weekly total demand for the next 12 months of the OMS, and the monthly demand thereafter.

The detailed activities of Set Expenditure Schedule shall conform to the specifications set out in the Set Budget Flowchart and TAs ES.01 to ES.09.

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# ES.01 Is Resource and Cost Data Available?

## Context

As a business, most of the expenditure we incur is related to completing some work necessary to produce an outcome (or at least should be). Therefore, the key to effective forecasting and management of costs is the understanding and forecasting of the work and the resources required to complete it, and the management of cost commitments against that forecast. These key outcomes are achieved in an Operating Model implementation using the Operating Master Schedule (OMS) - define the work, the Expenditure Schedule (EPS) - define the resources and cost, and the Work Approval process - understand and approve cost commitments.

To be an effective guide to expenditure an EPS requires resource cost data that is realistic. The preferred source for this data is directly from the costing system(s) of record, as this provides data based on actual expenditure records. Whilst this data is obviously historical, if used appropriately it can still provide a sound guide to estimates of future costs. The significant sources of volatility (special cause events) in cost forecasts over time are;

- variability in the workload over time (e.g. mining volumes or maintenance over the life cycle of an asset), and
- volatility in resource pricing (wide swings over relatively short time periods), where that resource pricing has a very dominant place in the cost of an activity (e.g. diesel fuel in mining).

Note that the cost of most resources is not the major source of volatility in cost forecasts, because of either small and gradual price changes or because they do not have a dominant position in the cost of the activity. The major source of volatility is more often the variability in the workload - hence the importance of a credible OMS to the delivery of a credible expenditure forecast.

Ideally the data from the financial system is recorded and presented in a way that matches the way we identify and control the work that delivers the outcomes and incurs the expenditure. This typically entails the location of the work (mine/bench, or plant/equipment, etc.), the outcome of the work (e.g. drill/blast/load, refurbish/replace component, etc.) and the accountability for the Activities in the OMS/EPS. In an Enterprise Resource Planning (ERP) system this information can typically be located in either costing system records and/or work management systems records (work orders).

The work management system records are the most likely to provide useful cost estimates and actual values for Activities that are managed as a series of distinct events dispersed over time. This would typically cover Service work Activities such as maintenance of plant and equipment, but may also include the elements of the mining Production work cycle (drilling, blasting, loading, hauling, etc.) if these are managed through a work management system. Provided that the work management system and OMS/EPS each adequately specify the location (mine bench/block or equipment), plus the work description/type and accountable position, it should be possible to produce a report from the work management system that will allow the Resource Types, quantities and costs to be identified for the OMS/EPS. In the case of high impact, low frequency events the information from the work management system should be extracted to provide a clear picture of the range of values that might be expected for any discrete event. This is necessary due to the low sample rate of these events within a forecasting period (typically monthly). Where an OMS/EPS Activity represents a group of many low impact high frequency events the information from the work management system can be extracted to provide the total count of events, and the total Resource Type, quantities and costs for the forecasting periods, since for large population samples values tend sharply towards the mean.

Where discrete event records are not created for OMS/EPS Activities, and this would often be the case for 'continuous' activities such as crushing, grinding, etc., and the mining Production cycle where it is not managed through a work management system, the costing system records are likely to contain a cost collector (e.g. Cost Centre) for each such 'continuous' activity. Cost information within a cost collector is typically further divided into expense classifications (labour, materials, utilities, etc.) that should be able to provide Resource Types, consumption rates and cost records for the Activity over time. Whether conscious or not, classification of these activities as 'continuous' is recognition that they can be viewed as a very high repetition of a unit of work – e.g. loading, crushing or grinding a tonne of material. With inherently high sample sizes in any forecasting period, and provided that the distribution of key characteristics is random (i.e. there is no shift or drift in the control chart of such characteristics), then the average values that can be extracted from the costing system will be adequate for the EPS forecasts.

Where an ERP system contains realistic forecasts of the Resource Types, consumption rates and costs for OMS/EPS Activities this data should be utilised in the EPS.

**Purpose**

To identify if there is validated costing information relevant to the EPS.

**Quantity**

One decision whether reliable costing data can be obtained from the work management/costing systems.

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### Quality

The decision criteria to be used are;

- there is a data source that is appropriate to the OMS/EPS Activity, and
- the data can be filtered and sorted to align with the characteristics required for the EPS, which may include;
    - Accountability,
    - Business Structure element,
    - Work Type,
    - Work Description,
    - Resource Type,
    - Resource Quantity/consumption,
    - Resource Pricing.

### Time

At each forecasting cycle.

### Resources

Completion of this task is the accountability of the role nominated on the configured Expenditure Schedule flowchart.

# ES.02 Apply Resource Type and Cost

## Context

The ExPenditure Schedule (EPS) is a costed version of the Operating Master Schedule (OMS). That is, the forecast cost for the labour, materials, equipment and utilities, etc. that will be required to implement the OMS is combined with a quantity estimate on each OMS Activity, and the frequency/timing of the Activities, to forecast the expenditure profile over time. The preferred source for the cost data is directly from the costing system(s) of record.

Work management system records are the most likely to provide useful cost estimates and actual values for Activities that occur as a series of distinct events dispersed over time. This would typically cover Service work Activities such as maintenance of plant and equipment, but may also include the elements of the mining Production work cycle (drilling, blasting, loading, hauling, etc.) if these are managed through a work management system. Provided that the work management system and OMS/EPS each adequately specify the location (mine bench/block or equipment), plus the work description/type and accountable position, it should be possible to produce a report from the work management system that will allow the resources, quantities and costs to be identified for the OMS/EPS. In the case of high impact, low frequency events the information from the work management system should be extracted to provide a clear picture of the range of values that might be expected for any discrete event. This is necessary since the low sample rate of these events within a forecasting period (typically monthly) means that the variation is likely to have a large impact on the period. Where an OMS/EPS Activity represents a group of many low impact high frequency events the information from the work management system can be extracted to provide the total count of events, and the total resources, quantities and costs for the forecasting periods, since for large population samples values tend sharply towards the mean.

Where discrete event records are not created in the costing systems of record for OMS/EPS Activities, and this would often be the case for 'continuous' activities such as crushing, grinding, etc., and the mining Production cycle where it is not managed through a work management system, the costing system records are likely to contain a cost collector (e.g. Cost Centre) for each such 'continuous' activity. Cost information within a cost collector is typically further divided into expense classifications (labour, materials, utilities, etc.) that should be able to provide resources, consumption rates and cost records for the Activity over time. Whether conscious or not, classification of these activities as 'continuous' is recognition that they can be viewed as a very high repetition of a unit of work – e.g. loading, crushing or grinding a tonne of material. With inherently high sample sizes in any forecasting period, and provided that the distribution of key characteristics is random (i.e. there is no shift or drift in the control chart of such characteristics), then the average values that can be extracted from the costing system will be adequate for the EPS forecasts.

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Resources such as materials and utilities (e.g. power) are consumed in the course of completing work, are managed through a supply system, and are charged to the appropriate work order/cost receiver as used. The pricing of these resources will be visible through the supply element of the ERP and the historical costs of these resources will be visible through either work order or cost collector records in the ERP. Resources such as labour and equipment are continually reassigned to new work in a schedule and an ERP utilises the concept of a Work Centre to manage these. A Work Centre resource simply represents the capacity of a particular resource that can be assigned to a schedule (e.g. A mechanics for B hrs, C 100t trucks for D hrs). Where Work Centre costs are required to be quantified and/or charged to specific work activities an ERP cost collector will be created for the Work Centre, in the ERP. The cost centre can be used identify the cost and pricing of the Work Centre resource, and where charge out rates are applied to a Work Centre resource the work order records can be used to identify historical Work Centre resource quantities and costs for the work.

The significant set of Resource Types used within an EPS (those that make up >90% of the total costs) should be identified from analysis of the above data and individually and accurately estimated for the appropriate Activities. The remaining resource costs cannot be ignored in the EPS, and should be estimated against the appropriate Activities, but can be grouped into a general cost classification rather than individually identified. The estimates for Work Centre Resource Type quantities are used in the EPS model to forecast the distribution of Work Centre demand over time. The parameters of this distribution can be used to set the fixed capacity for a work Centre as well as guiding the selection of an appropriate strategy for dealing with the variable element of demand (e.g. overtime, over-resourcing, contracting, etc.). The set of Resource Types that are most appropriate will differ from one EPS to another.

While there are potentially a multitude of different types of resources and expenses used with the Work Management and costing systems, these can be summarised into a much smaller number of EPS Resource Types to meet the above purposes. The following categories may be used as a guideline;

- Equipment,
- Labour,
- Materials,
- Spares,
- Contract Services &
- Utilities.

These categories may be subdivided further, but only where doing so provides a material improvement to the forecasting of cost or demand for critical resources. For example, in a mechanised mining EPS the Equipment Resource Types may be subdivided into to be the different capacity drills, loaders, and trucks since equipment of different capacity is not usually interchangeable in a schedule. Note that since this equipment is scheduled with an operator the operator demand will be linked to the equipment demand and the operator costs can be included in the equipment costs. In a Heavy Mining Equipment maintenance EPS the Labour Resource Types are likely to be the specialised skills such as mechanic, auto electrician, boilermaker etc. In process plant operations the listed categories may suffice for the EPS. The final selection of Resource Types for an EPS must be consistent with the purpose of providing accurate, but not precise, forecasts for costs and Work Centre capacity demand.

There will be variability in the cost of each occurrence for an Activity, in addition to the probable variability in their frequency and timing. When Activities have both significant cost per occurrence, and a low frequency of occurrence in a forecasting/measurement period, the impact of this variability on the forecast for that period may be substantial. When Activities have a high frequency of occurrence in a forecasting/measurement period the total cost will converge on the product of the frequency and the average cost. Hence low frequency Activities will require an estimate of the distribution of likely cost outcomes while high frequency Activities can use an estimate of the average cost.

As actual data becomes available, through feedback to the EPS from the costing information system, the estimates of Resource Types, pricing and costs should be refined.

**Purpose**

To apply validated cost estimating data to the OMS activities.

**Quantity**

- One set of Resource Types for each EPS.
- One cost estimate for each of the Resource Types for each of the Activities of the OMS/EPS.

**Quality**

In identifying the Resource Types for an EPS consider;

- The data available from the costing system(s) of record.
- The following generic resource types;
    - Equipment,
    - Labour,
    - Materials,
    - Spares,
    - Contract Services &
    - Utilities.
- The minimum number of Resource Types that can support a reliable forecast for Activity costs and Work Centre demand for each EPS. Note that different Resource Types may be appropriate for different EPS'.

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In estimating the price/cost of Activity Resource Types consider;

- Information available from work management, supply and costing systems.

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- The frequency of Activity occurrence in the time intervals for which cost forecasts are required (typically monthly).
- The average Resource Type consumption and cost for Activities with a high frequency of occurrence.
- The Distribution of Resource Type consumption and cost for Activities with a high cost and low frequency of occurrence (distributions should be specified in the form of a PERT value function - minimum, most likely, maximum and weighting).

### Time

At each forecasting cycle.

### Resources

Completion of this task is the accountability of the role nominated on the configured Expenditure Schedule flowchart.

# ES.03 Estimate Resource Types and Cost

## Context

The ExPenditure Schedule (EPS) is a costed version of the Operating Master Schedule (OMS). That is, the forecast cost for the labour, materials, equipment and utilities, etc. that will be required to implement the OMS is combined with a quantity estimate on each OMS Activity, and the frequency/timing of the Activities, to forecast the expenditure profile over time. The preferred source for the cost data is directly from the costing system(s) of record, however this may not always be possible, particularly where there are new or significantly modified Activities added to the OMS/EPS. In such cases it will be necessary to construct a resource and cost estimate from the best available sources.

In most instances the Resource Types that are required for a new or modified Activity within an EPS are likely to be from the same set required for other Activities within that EPS. If the new or changed Activity results in significant new Resource Types, (that is, those that make up >90% of the total costs) then these would need to be specified and incorporated in the EPS. In the case of creating a new EPS the Resource Types will need to be defined from scratch. If it is a new EPS within a current operation then the existing Work Management and costing systems should be consulted in order to assist in defining the most appropriate set of Resource Types. In the case of a new operation then the Resource Types will need to be defined from a first principles analysis of the Activities in the EPS. While there are potentially a multitude of different types of resources used, these can be summarised into a much smaller number of EPS Resource Types to meet the above purposes. The following categories may be used as a guideline;

- Equipment,
- Labour,
- Materials,
- Spares,
- Contract Services &
- Utilities.

These categories may be subdivided further, but only where doing so provides a material improvement to the forecasting of cost or demand for critical resources. For example, in a mechanised mining EPS the Equipment Resource Types may be subdivided into to be the different capacity drills, loaders, and trucks since equipment of different capacity is not usually interchangeable in a schedule. Note that since this equipment is scheduled with an operator the operator demand will be linked to the equipment demand and the operator costs can be included in the equipment costs. In a Heavy Mining Equipment maintenance EPS the Labour Resource Types are likely to be the specialised skills such as mechanic, auto electrician, boilermaker etc.  In process plant operations the listed categories may suffice for the EPS. The final selection of Resource Types for an EPS must be consistent with the purpose of providing accurate, but not precise, forecasts for costs and Work Centre capacity demand.

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The quantity and pricing estimates for new or significantly changed Activities should, where possible, be based on the most credible reference Activities, pricing information, historical cost data, and/or a first principles estimate.

There will be variability in the cost of each occurrence for an Activity, in addition to the probable variability in their frequency and timing. When Activities have both significant cost per occurrence, and a low frequency of occurrence in a forecasting/measurement period, the impact of this variability on the forecast for that period may be substantial. When Activities have a high frequency of occurrence in a forecasting/measurement period the total cost will converge on the product of the frequency and the average cost. Hence low frequency Activities will require an estimate of the distribution of likely cost outcomes while high frequency Activities can use an estimate of the average cost.

As actual data becomes available, through feedback to the EPS from the costing information system, the initial estimates of Resource Types, pricing and costs can be refined.

**Purpose**

To estimate the cost of new/modified OMS Activities.

**Quantity**

- One set of Resource Types for each new/modified Activity.
- One cost estimate for each of the Resource Types for each of the new/modified Activities.

**Quality**

In identifying the Resource Types for an EPS consider;

- The data available from the costing system(s) of record.
- The following generic resource types;
    - Equipment,
    - Labour,
    - Materials,
    - Spares,
    - Contract Services &
    - Utilities.
- The minimum number of Resource Types that can support a reliable forecast for Activity costs and Work Centre demand for each EPS. Note that different Resource Types may be appropriate for different EPS'.

In estimating the price/cost of Activity Resource Types consider;

- Information available from work management, supply and costing systems.

- The frequency of Activity occurrence in the time intervals for which cost forecasts are required (typically monthly).
- The average Resource Type consumption and cost for Activities with a high frequency of occurrence.
- The Distribution of Resource Type consumption and cost for Activities with a high cost and low frequency of occurrence (distributions should be specified in the form of a PERT value function - minimum, most likely, maximum and weighting).

**Time**

At each forecasting cycle.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Expenditure Schedule flowchart.

AAOM Flowsheet

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## ES.04 Import Activity Actual Cost Data

### Context

The Expenditure Schedule (EPS) is a guide to the appropriate commitment of expenditure over time. The EPS is a costed version of the Operating Master Schedule and consequently provides a roadmap of the expenditure on work activities appropriate to delivery of the business expectations. The OMS and EPS are the approved specification of the Right Work, Right Time and Right Way (which inherently defines the right cost for the work).

As with any map an EPS can only be used effectively if we are able to accurately identify and track our current position against the expected position and desired end point. To achieve this we need an appropriate level of forecast detail and must provide regular, timely and accurate feedback of actual versus expected progress at this same level of detail.

A usable rolling forecast will be made up of the;

- actual total cost for each EPS Activity, for each reporting interval, to date, plus
- projected distributions of expenditure for the remainder of the EPS time horizon.

For low sample rate Activities the actual values recorded in the EPS for a reporting interval will represent the outcomes for a single event. For high sample rate Activities the actual values recorded in the EPS for a reporting interval will represent the total and the average cost for multiple events.

There is very often a time lag between the occurrence of an Activity and the finalisation of actual costing data. If the EPS is only provided with feedback when actual costs are finalised this time lag can temporarily distort the understanding of the cost position and lead to inappropriate expenditure commitment decisions. To reduce the impact of this, the finalised actual costs should be reported to the EPS in the first measurement period in which they are finalised, which may mean that actual costs are reported over multiple periods. A solution to the time lag in actual costs, where it is feasible, is to feedback outstanding expenditure commitments as well as actual costs to the EPS.

The committed and/or actual costs should be extracted from the appropriate systems of record and recorded in the EPS to match the minimum forecast/measurement period for costing (typically monthly).

### Purpose

To track actual results against the EPS forecast.

### Quantity

The following information should be imported to the EPS.

For each low sample rate Activity in the EPS

- The finalised actual costs for an occurrence of the Activity in the measurement period they were finalised, and where feasible,
- The outstanding cost commitments for the Activity, in the measurement period they were committed.

For each high sample rate Activity in the EPS

- The sum of the finalised actual costs for all occurrences of the Activity in the measurement period, and where feasible,
- The outstanding cost commitments for the Activity, in the measurement period they were committed.

**Quality**

In the case of discrete event (e.g. work order) Activities, the frequency of Activity occurrence should be the number of number of work packages executed in the measurement period. This information should be derived from the work management system of record.

In the case of 'continuous' (e.g. crushing, grinding) Activities, the frequency of Activity occurrence should be the number of units of product processed in the measurement period. This information should be derived from the production system of record.

Actual and committed costs should be derived from the costing system of record.

**Time**

At each costing measurement interval (typically monthly).

**Resources**

Completion of this task is the accountability of the role nominated on the configured Expenditure Schedule flowchart.

AAOM Flowsheet

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# ES.05 Validate Most Likely Activity Cost

## Context

The creation of an Operating Master Schedule (OMS), or ExPenditure Schedule (EPS) is a reasonably significant piece of work and, having completed it, the aim should be to maintain their relevance by continual adjustment and refinement rather than recreating them. The Activities within these tools, and the timing or frequency of the Activity occurrence is maintained via the OMS. The EPS applies the resource quantity and pricing estimates to the OMS content in order to create a forecast of likely expenditures. Any changes in the underlying drivers for these parameters needs to be validated and applied in the appropriate place.

In some cases the changes in cost drivers (scope or resourcing/pricing) will either be deliberate, or predicted, and they should in these cases be adjusted in the EPS at the time the change is recognised. This is particularly the case for the high cost low sample rate Activities. The role accountable for the EPS should be reviewing the forecast of high cost, low sample rate Activities on a regular basis (typically each month) and considering whether there is anything that is likely to cause a change in the most likely cost of these forecast Activities.

In the case of the lower cost, high sample rate Activities, the EPS costing is based on average values across a population of different types of work, that are grouped for ease of management. In this case there may be changes to the resourcing or pricing of the work that is more difficult to recognise ahead of time. In response to this case we can monitor the distribution of the actual cost results to identify whether there is a unique outlying cost result, or whether a fundamental shift in Activity costs may be occurring. Throughout the Operating Model the principles of statistical process control are used to ensure that the monitoring and response to data are based on objective and proven criteria. Hence the distribution of measured cost results for high sample rate EPS Activities should be monitored via a control chart to identify points that are outside of the normal results distribution, or where a fundamental shift may be indicated by either a string of points above or below the mean or moving in the same direction. If any of these are indicated then an investigation should be undertaken to determine if the assumptions underpinning the most likely/average cost in the EPS are still valid.

Whenever a change to the cost drivers for an EPS Activity are recognised the forecasting data in the EPS should be updated.

## Purpose

To ensure that the cost forecasting data used in the EPS is valid.

## Quantity

- One validation or update for the most likely cost for each of the Activities of the EPS.

### Quality

All high cost low sample rate activities should be reviewed for a reasonable forward period - suggested 12 months.

Where changes to the underlying cost drivers for high sample rate Activities are able to be predicted these should be reviewed within 1 cost measurement period (typically 1 month).

Where changes to the underlying cost drivers for high sample rate Activities are not able to be predicted these should be reviewed immediately a special cause event in the cost measurements is recognised. This review should be initiated on the basis of standard statistical data review criteria;

- a single point outside of control limits,
- seven points above or below the mean,
- seven points moving in the same direction.

### Time

At each costing measurement interval (typically monthly).

### Resources

Completion of this task is the accountability of the role nominated on the configured Expenditure Schedule flowchart.

AAOM Flowsheet

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# ES.06 Estimate Best & Worst Case Costs, Opportunities & Threats

## Context

The ExPenditure Schedule (EPS) is a costed version of the OMS. That is, the forecast cost for the Resource Types (labour, equipment, materials/spares and utilities, etc.) that will be required to implement the OMS is combined with a quantity and price estimate, and the frequency/timing of the Activities, to forecast the expenditure profile over time. The figures used for the estimate should represent the Most Likely quantities and price. However, this estimate represents only one of many possible outcomes for the actual cost of the Activities. In practice there is a range of potential cost outcomes for each Activity, determined by the inherent variability in quantity use and pricing, with each potential cost outcome having a different probability of occurring (i.e. the cost of an activity is best represented by a probability histogram, with the Most Likely cost at the mode, or peak of the distribution).

For the Activities that have a high sample rate within a measurement period the distribution of the average value of the sample will converge around the average when compared to the distribution of the individual sample results. This is characteristics defined by the Central Limit theorem in statistics. The standard deviation of the population averages compared to the standard deviation of the population reduces in inverse proportion to the square root of the sample size.

In order to determine the confidence level at which a targeted cost can be delivered by the OMS/EPS the probability distribution for the Schedule cost outcomes must be estimated. To produce this estimate the shape of the probability distributions for the Activities must be defined. This can be done using a PERT value function with four parameters; the best case value, most likely case value, worst case value and the weighting factor to be applied to the most likely case value. When the sample size is significant the convergence towards the average will reduce the impact of the Activity on confidence levels to the point where the best and worst case outcomes can be ignored.

The most likely case cost has already been defined in the initial quantity and pricing estimates. The best case, worst case and weighting parameters must be estimated to finalise the distribution characteristics. These estimates do not need to be precise, and the historical records for the activities, the experience of appropriate personnel and a knowledge of intended changes to the either the process or Production and Service Strategies can allow these estimates to be made with adequate accuracy.

In making the estimates it is necessary to consider what can go well that will help the best case to be achieved and what can go badly to make the worst case occur. If these opportunities and threats are recorded then it is possible to implement some control actions that might increase the probability of a better outcome.

### Purpose

To specify the probability distribution for the cost forecast of the Activities of the EPS.

### Quantity

For each low sample rate activity listed in the EPS;

- the estimated best case cost of each occurrence,
- the estimated most likely case cost of each occurrence,
- the estimated worst case cost of each occurrence,
- the weighting factor to be applied to the cost distribution,
- the issues that will increase the probability of a best case outcome,
- the actions that are possible to increase the probability of a best case outcome,
- the issues that will increase the probability of a worst case outcome, and
- the actions that are possible to decrease the probability of a worst case outcome.

### Quality

The best case, worst case and distribution weighting parameters be based upon the historical records for the activities, the experience of appropriate personnel and a knowledge of intended changes to the either the process or Production and Service Strategies.

The control actions identified to increase the probability of a better case outcome shall be recorded in a system where the implementation of the action can be managed.

### Time

At each forecast update interval (typically quarterly).

### Resources

Completion of this task is the accountability of the role nominated on the configured Expenditure Schedule flowchart.

AAOM Flowsheet

SES Flowsheet

# ES.07 Calculate Cost Distributions & Confidence Level

## Context

The overall cost estimate derived for an ExPenditure Schedule (EPS) is a function of the variability in the likely frequency of occurrence for each activity (as defined in the Operating Master Schedule - OMS), and the variability in the likely cost of an activity at each occurrence (as defined in the EPS). The only practical way to represent these multitude of possible outcomes is by a probability histogram.

We have defined the probability distribution for the frequency of each Activity in the OMS and we have defined the probability distribution for the cost of each occurrence of each low sample rate Activity in the EPS. By running a Monte Carlo simulation of the schedule, using the Activity frequency and cost distributions we can predict the cost forecast probability distribution.

The confidence level for the process cost target can be calculated from the cost probability distribution.

## Purpose

To calculate the confidence level for the EPS meeting the process cost targets.

## Quantity

- One distribution for the cost forecast outcome for the EPS
- One confidence level for achieving the cost target for the process.

## Quality

The probability distribution for the EPS is determined by running a Monte Carlo simulation of the Activities, using the distribution for the Activity frequency and costs defined in the OMS and EPS.

The confidence level for achieving the cost target set for the process is the cumulative probability of the simulation output distribution that is below the target value. For example, if the cumulative probability of the Asset cost target in the distribution is 40%, then the confidence level is 40%.

A contingency figure shall be estimated by calculating the amount that must be added to the most likely budget value in order to achieve the required confidence level for the budget. For example if the ‘most likely’ outcome is at the 50% cumulative probability and the required confidence level is 80%, the contingency is the figure that must be added to the ‘most likely’ value to achieve a cumulative probability of 80%.

## Time

At each forecast update interval (typically quarterly).

## Resources

Completion of this task is the accountability of the role nominated on the configured Expenditure Schedule flowchart.

AAOM Flowsheet

SES Flowsheet

# ES.08 Extract Work Centre Demand

## Context

Operating Master Schedule (OMS) resource demand will in many cases vary over time, and sometimes quite significantly. There are a few principal reasons for this;

- The changing nature of the operation or the work. For example, as a mine matures the travel distances may increase at the same time as the available work places decreases, shifting the resource balance between breaking and moving material.
- Many elements of Service work occur irregularly, creating peaks and dips in demand for resources.
- The OMS is optimised primarily for process performance and only after this for resource demand. Hence peaks and dips in resource demand will not be eliminated.

If we are to achieve an optimum process output and cost result, then we will need a resourcing strategy that delivers the most cost effective resource when and where it is needed.

Resources such as materials and utilities (that are consumed in the course of completing work) are managed through a supply system, and are charged to the appropriate work order/cost receiver as used. The supply systems uses stock levels (either internal or external to the operation) to buffer the variability between the sourcing and consumption rates. For resources such as labour and equipment, that are continually reassigned to new work in a schedule, we also need to create a 'stock' of capacity that can be used to balance the demand across OMS Activities and to buffer the difference between the ability provide resource capacity and the variability in demand. An ERP utilises the concept of a Work Centre to manage these (a Work Centre is essentially a stock of capacity – e.g. a fleet of equipment or a team of skilled people). Supply systems typically provide a range of strategies for determining optimum stock levels. In a parallel way we need to determine the optimum 'stock' levels for equipment and labour Work Centres.

The critical issues for creating an effective Work Centre resourcing strategy are;

- the minimum demand, as this will be a guide to the minimum levels for Work Centre labour, equipment and contractor numbers,
- the mode, maximum and shape of the demand distribution, as this will be a guide to where the typical Work Centre labour, equipment and contractor numbers should be set, and what additional flexible capacity will need to be provided through the resourcing strategy, and
- the predictability of the level of demand changes, as this will be a guide to how flexible capacity should be provided. For unpredictable and urgent increases (which can be identified from the Activity that drives the change), then the additional resources will probably need to be built into the Work Centre equipment or contractor numbers. For predictable or slower demand changes resources can be adjusted to match the demand change as required.

In order to understand these critical issues we need an understanding of the distribution of Work Centre Resource Type demand over time.

Once the Work Centre Resource Types are defined, and an estimate for the quantities of each per Activity made, a projection of the OMS/EPS Work Centre demand over time can be created. The forecast can be displayed in both a control chart and histogram of the demand for specified intervals over time. Where rapid changes in demand for a resource occur, we can determine from the OMS/EPS the Activity(s) that create the demand, and hence the predictability and likely urgency of that demand.

**Purpose**

To determine the nature of the demand for each Work Centre Resource Type.

**Quantity**

- One control chart of the demand for each Work Centre Resource Type.
- One histogram of the demand for each Work Centre Resource Type.

**Quality**

A control chart should be produced for each Work Centre Resource Type in the OMS/EPS.

The control chart should indicate the total Work Centre Resource Type demand for at least two budget (typically 12 month) periods.

The control chart sample interval should be no larger than the Schedule Period for the execution schedule in which the Resource is used. That is if the schedule period is 1 day then the control chart needs to show at least the daily values of total demand. If the schedule period is 1 week then the control chart needs to show at least the weekly values of total demand.

A histogram shall be produced for each Work Centre Resource Type in the OMS/EPS.

The histogram should indicate the distribution of the forecast total demand for each Work Centre Resource Type for each stable period of the resource demand control chart.

The histogram data quantisation (bin size) should as a guide be around 5% of the maximum value of the Resource Type demand control chart.

**Time**

At each forecast update interval (typically quarterly).

**Resources**

Completion of this task is the accountability of the role nominated on the configured Expenditure Schedule flowchart.

AAOM Flowsheet

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# ES.09 Create/Update Expenditure Schedule (costed OMS working revision)

## Context

The Operational Planning process has culminated in the creation and modelling of a costed Operating Master Schedule (OMS) that has been iterated to align with the Business Expectations.

Delivery of those Business Expectations requires that the Work Management process apply discipline in ensuring that all work undertaken is consistent with the Operational Planning outcomes. Control of commitments during Work Approval is the foundation for this. Work Approval therefore requires a reference ‘document’ against which approval decisions can be tested. This ‘document is referred to as an ExPenditure Schedule (EPS), since it shows the activities, timing and cost estimates approved for delivery of the Business Expectations.

For work approval to be made effectively the EPS must show, in addition to the approved/forecast activities, timing and cost estimates, the actual commitments made to date – both activity frequency and costs. Hence approval decisions are made on the basis of actual information up to the current time and an approved forecast into the future. Since this actual data is also necessary for the Operational Planning process the Operating Model flowsheets show this information flowing through the Set Operating Master Schedule and Set Expenditure Schedule process flows to the Work Approval reference EPS. The actual commitment data update period is determined by the work Approval Process needs and consequently should not be less frequent than daily.

A properly functioning Operational Planning process should be continuous, with input from Business Expectations and feedback from Work Management and process performance driving the ongoing development of scenarios and strategies. To balance the needs for continuous improvement with stability in the process the rate at which changes to approved forecasts are fed through from Operational Planning to Work Management needs to be managed. One means of doing this in the Operating Model is to control the frequency of forecast revisions to the EPS. Hence, even while the Operational Planning process is developing and testing scenarios and strategies via modelling, the Work Management process operates with stability to an EPS that is updated with actual commitments on a continuous basis and forecasts in a controlled manner. A typical EPS forecast update interval is around 3 months.

This activity is the creation and updating of the Work Approval reference document – the ExPenditure Schedule.

## Purpose

To create a document that can be used to test decisions to approve work.

**Quantity**

- One document.

**Quality**

The EPS must provide clear and easy reference to;

- The Activities that make up the OMS.
- The timing or frequency of Activities.
- The forecast and actual costing during each measurement interval for each Activity up to the current time.
- The forecast cost for each Activity for each measurement interval in the future.

These criteria are likely to be best met if the EPS is an on-line electronic document derived from the schedule and costing model used for Operational Planning.

Revision/updating of the EPS must;

- Retain the forecast values that were approved during the revision interval for all historic data. That is a new revision of the EPS cannot change the forecasts that existed for past measurement intervals, only future ones.
- Update the actual frequency and cost of Activities for the current measurement interval on a regular and timely basis.

**Time**

As a guideline;

- The updating of actual frequency and cost of Activities for the current measurement period should occur daily.

- The updating of forecasts for future periods should occur quarterly.

- The measurement interval for Activity actual frequency and cost should be aligned with the shortest costing system reporting period – typically monthly.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Expenditure Schedule flowchart.

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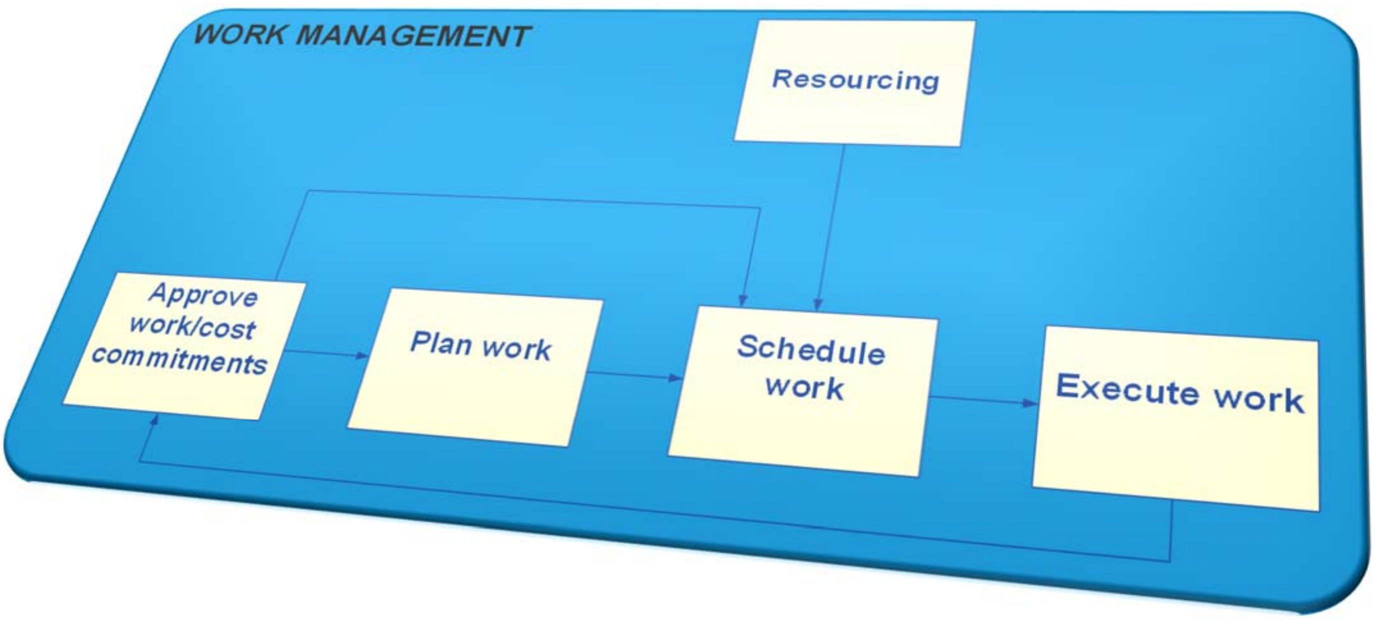
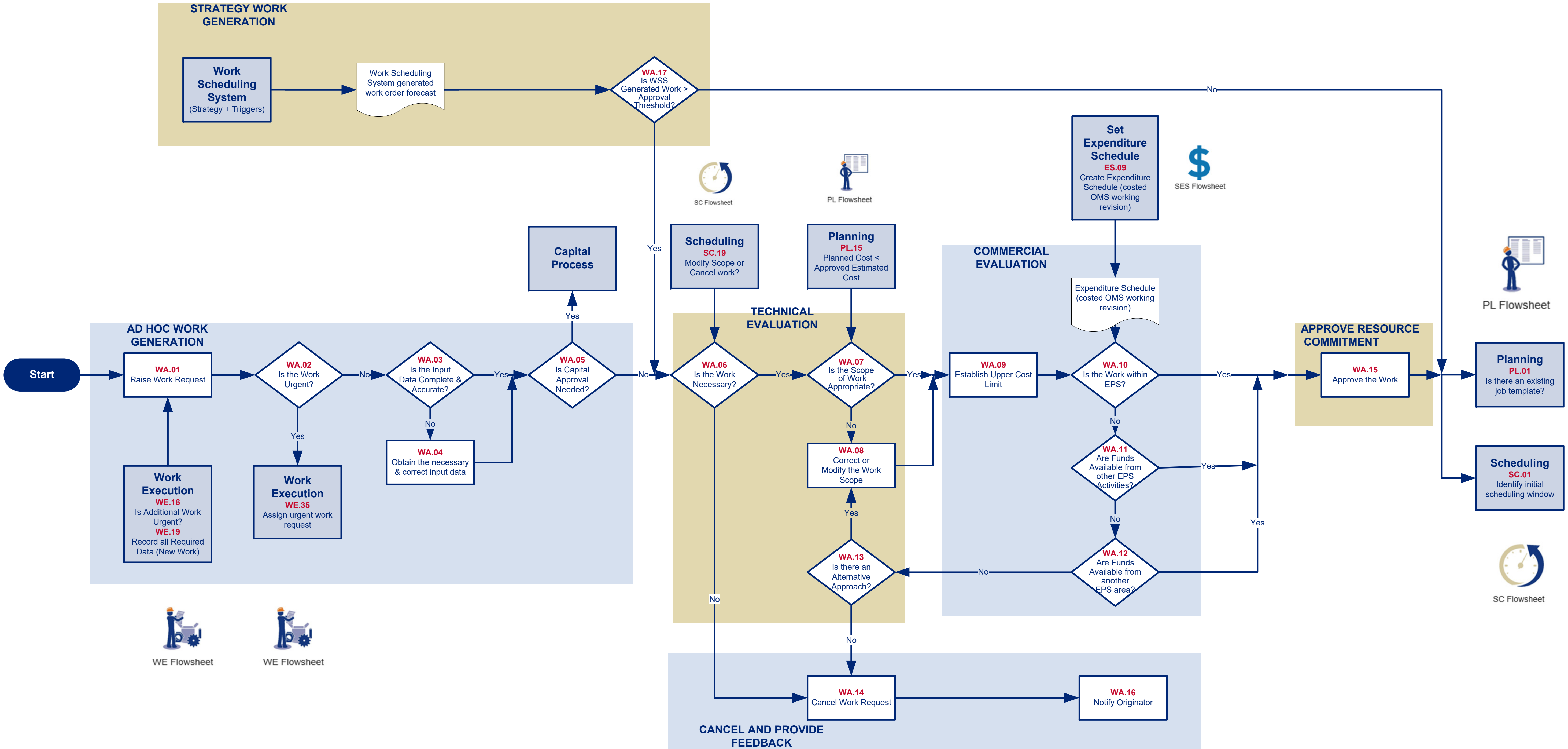
# AAOM Work Management



# WORK APPROVAL PROCESS

Purpose: To decide what work will be completed.

**Updated: 08/2018**

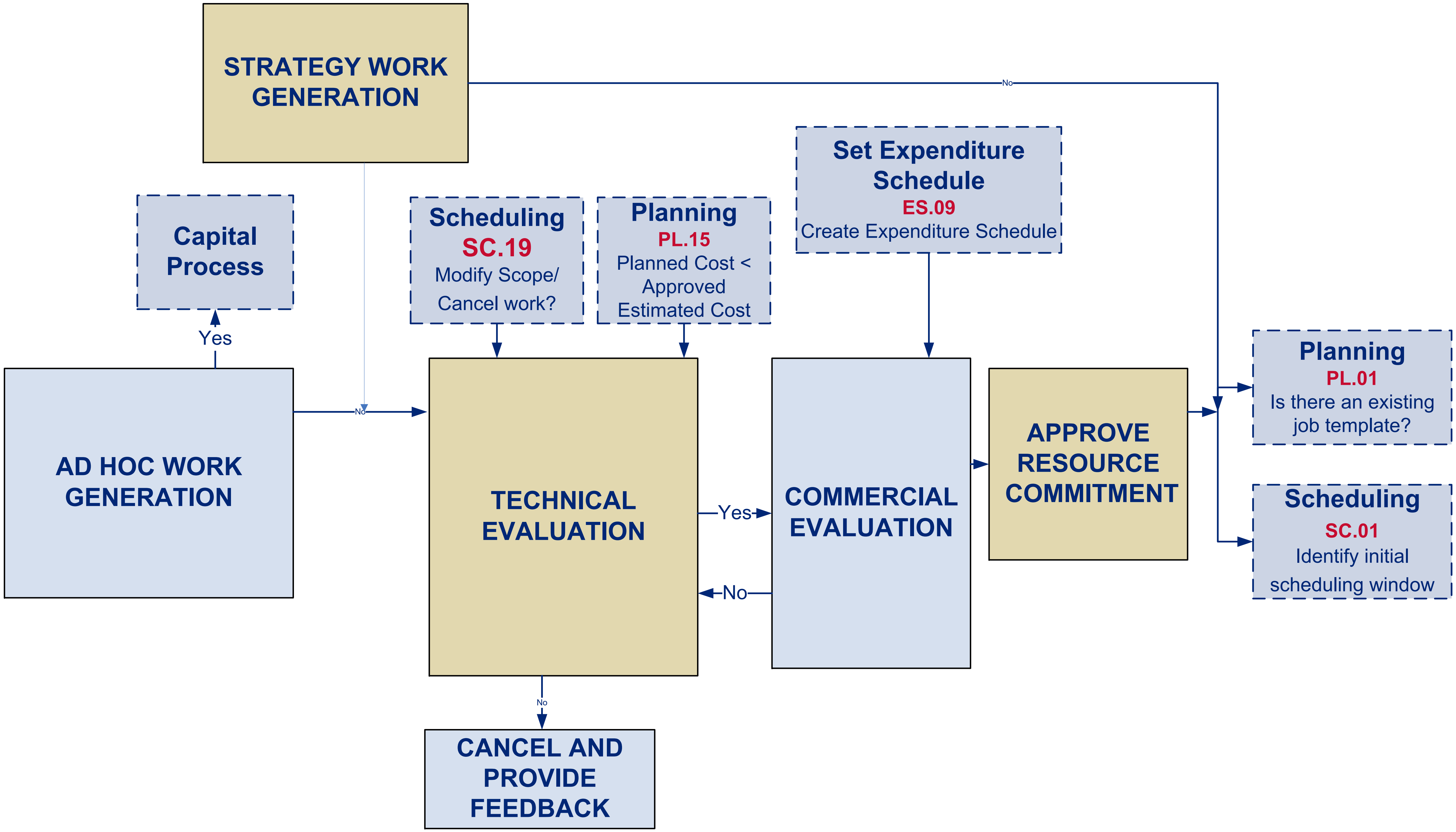



AAOM Flowsheet

# WORK APPROVAL PROCESS- High Level

Purpose: To decide what work will be completed.

**Updated: 05/2019**

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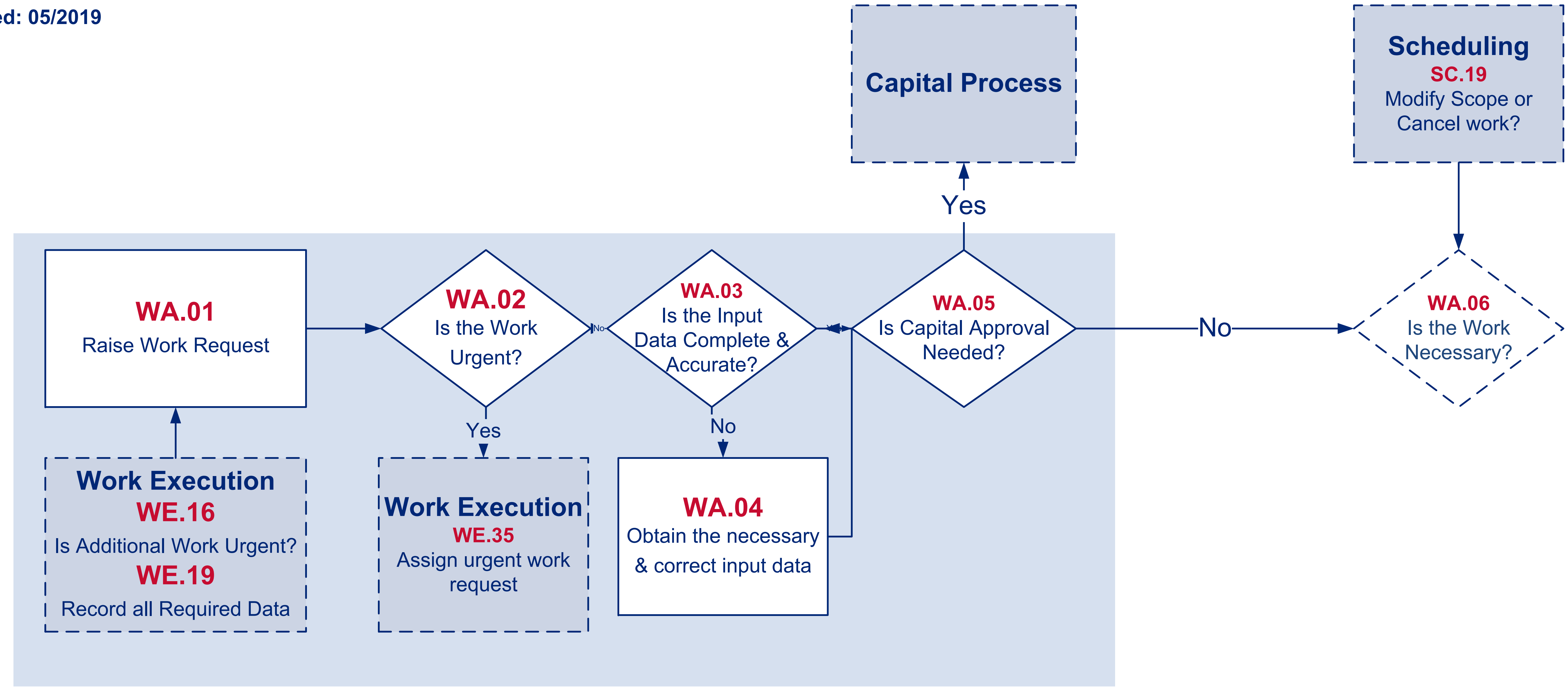
AAOM Flowsheet

WA Flowsheet

# WORK APPROVAL PROCESS- Ad Hoc Work Generation

Purpose: To decide what work will be completed.

**Updated: 05/2019**

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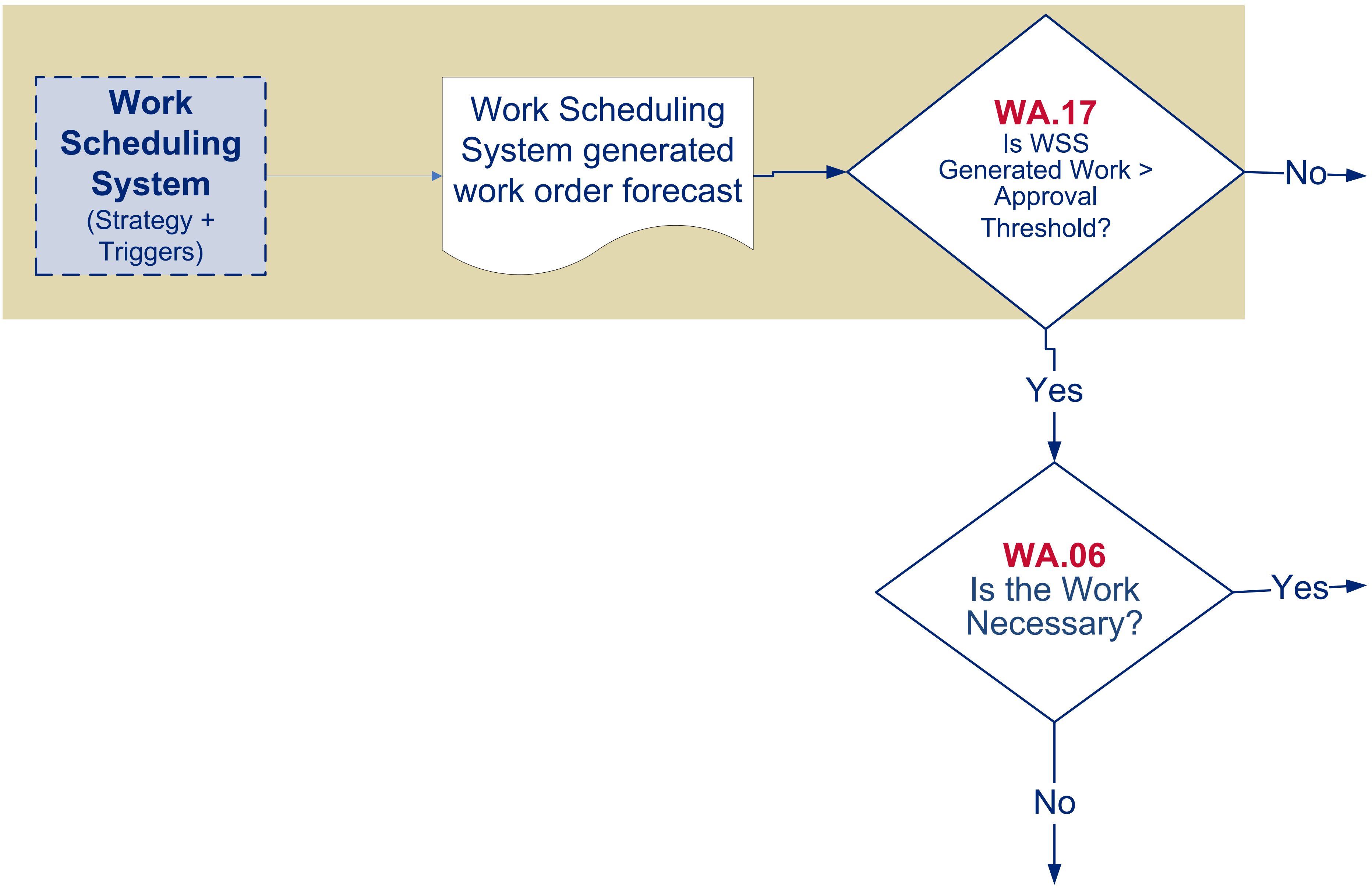
AAOM Flowsheet

WA Flowsheet

# WORK APPROVAL PROCESS- Strategy Work Generation

Purpose: To decide what work will be completed.

**Updated: 05/2019**

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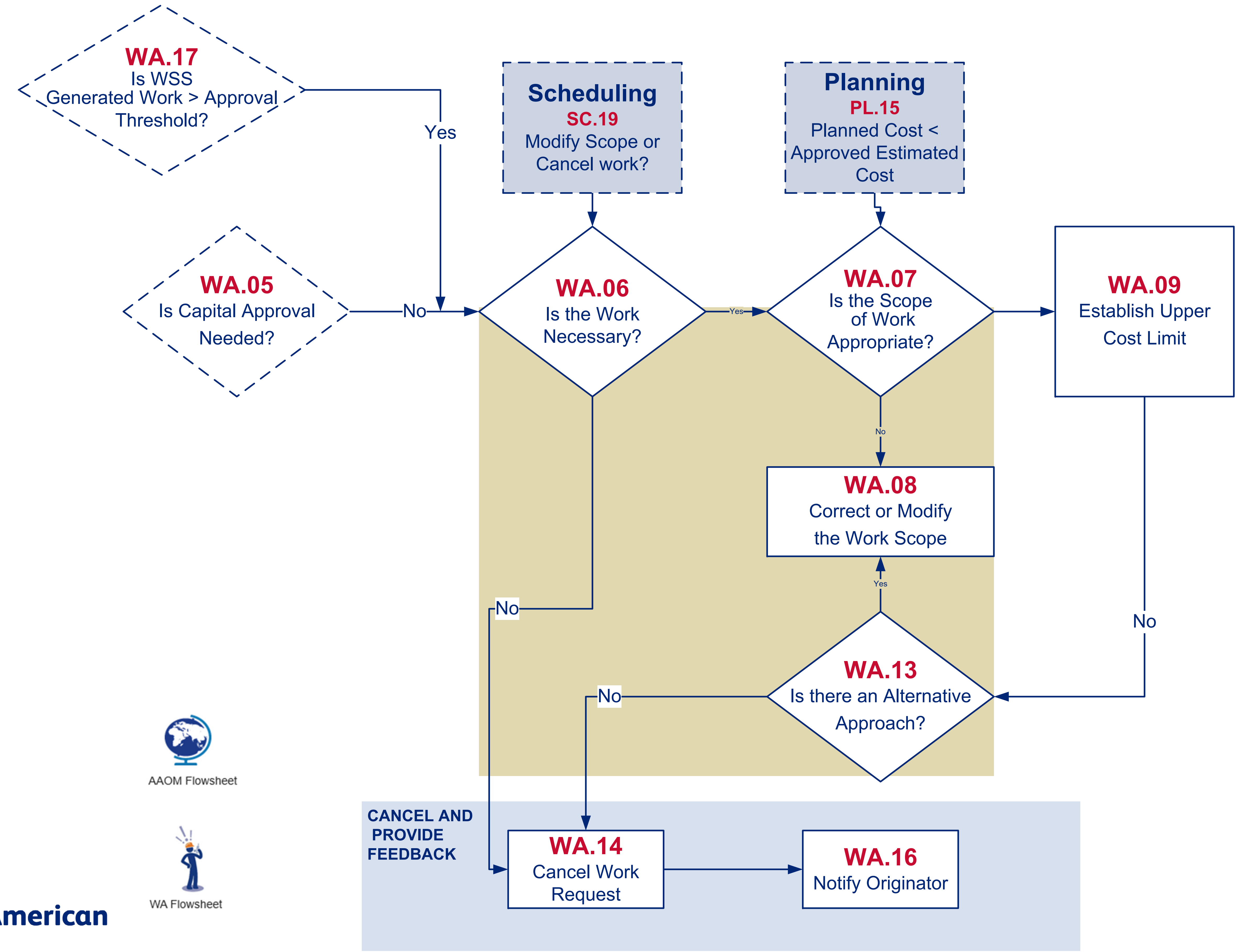
AAOM Flowsheet

WA Flowsheet

# WORK APPROVAL PROCESS- Technical Evaluation

Purpose: To decide what work will be completed.

**Updated: 05/2019**

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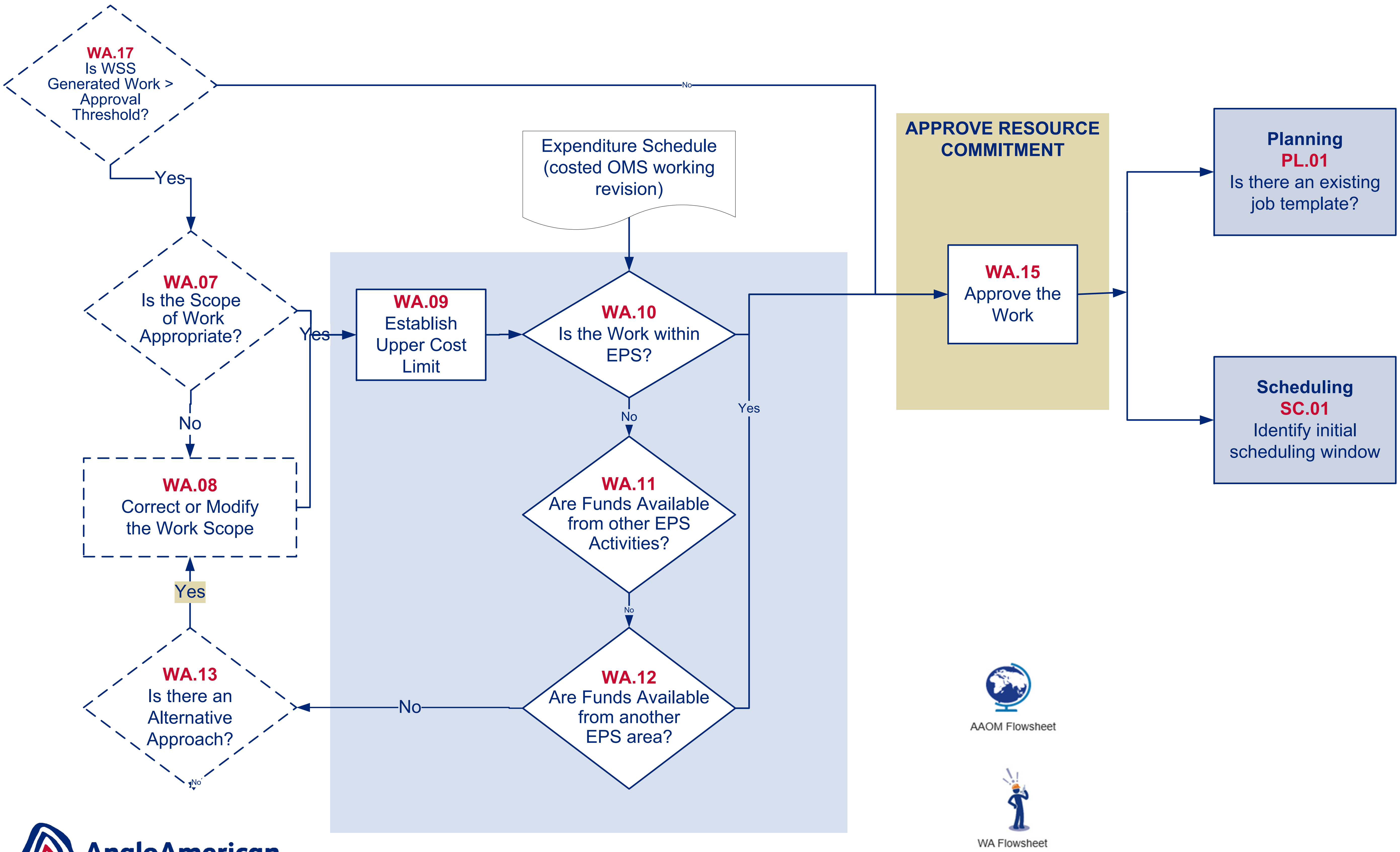
# WORK APPROVAL PROCESS- Commercial Evaluation, Approve Resources

Purpose: To decide what work will be completed.

**Updated: 05/2019**

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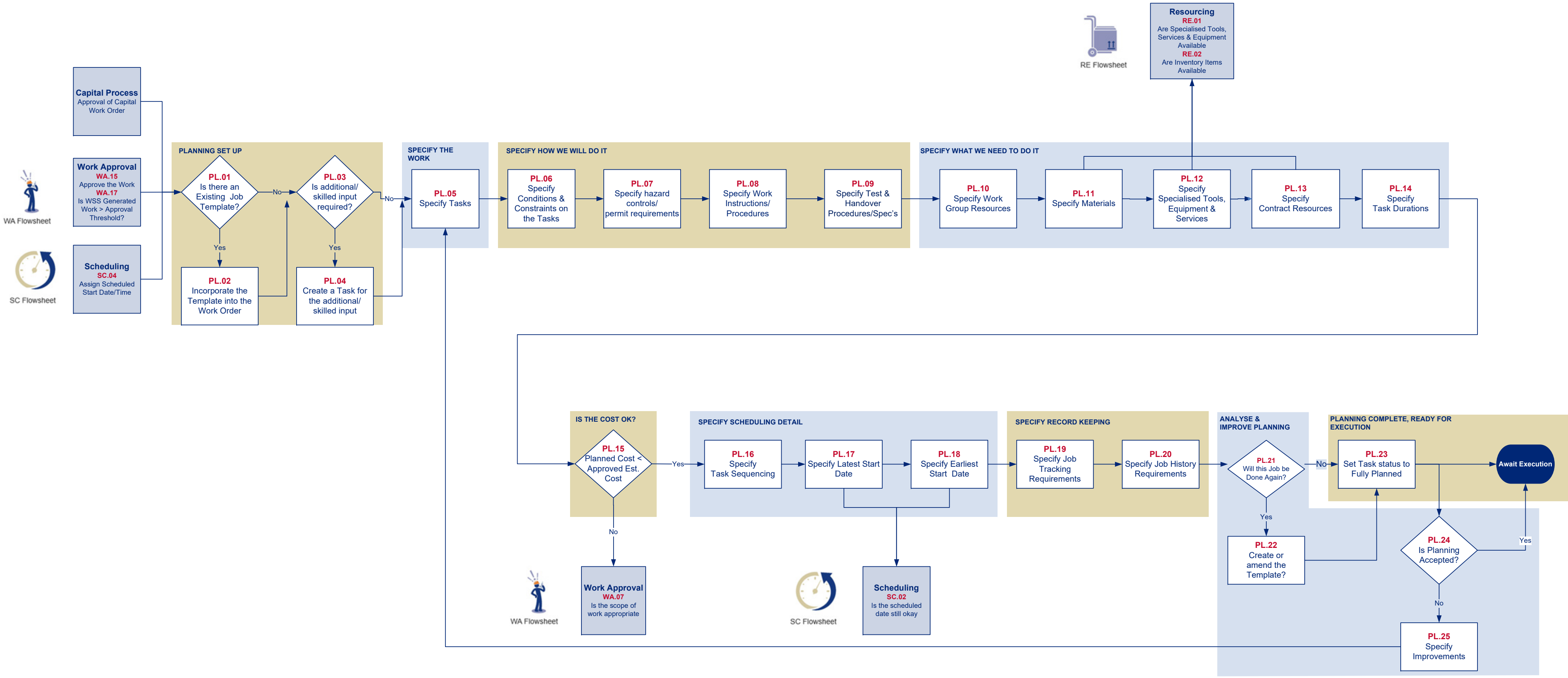
# PLANNING PROCESS

## Purpose: To specify all requirements for completing approved work.

**Updated: 08/2018**

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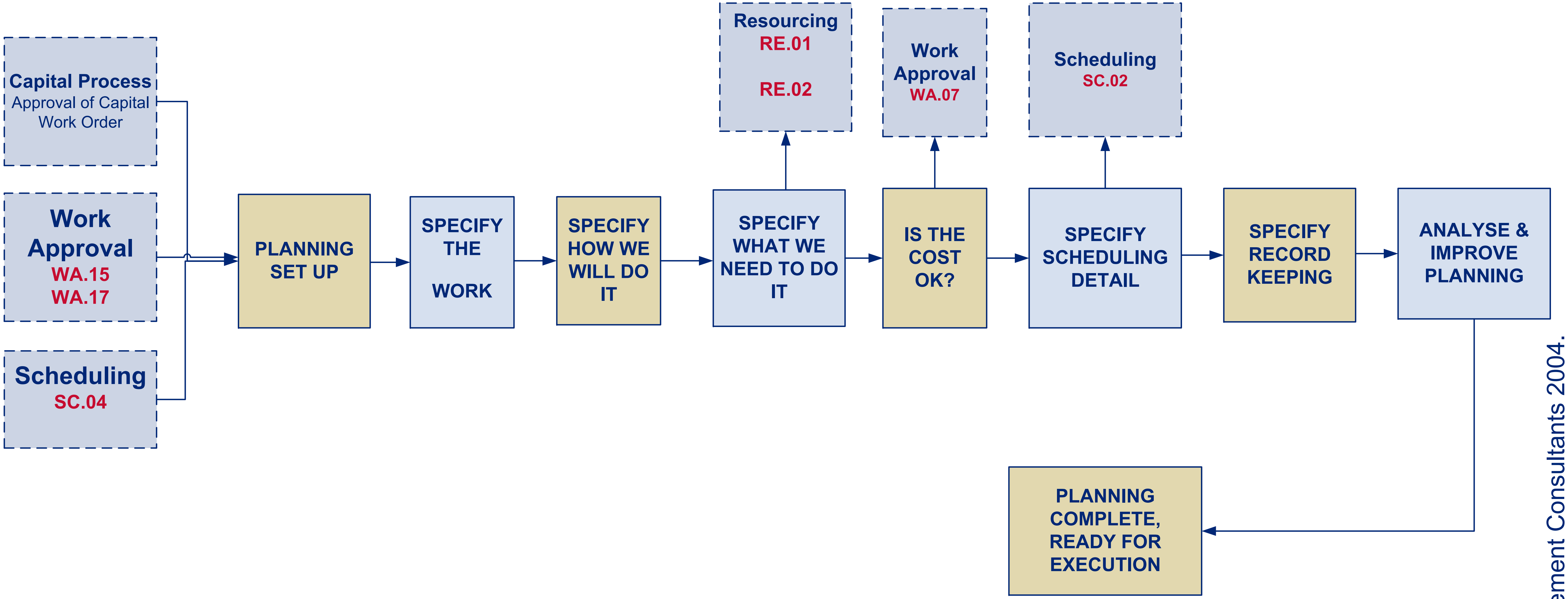
AAOM Flowsheet

# PLANNING PROCESS- High Level

Purpose: To specify all requirements for completing approved work.

Updated: 05/2019



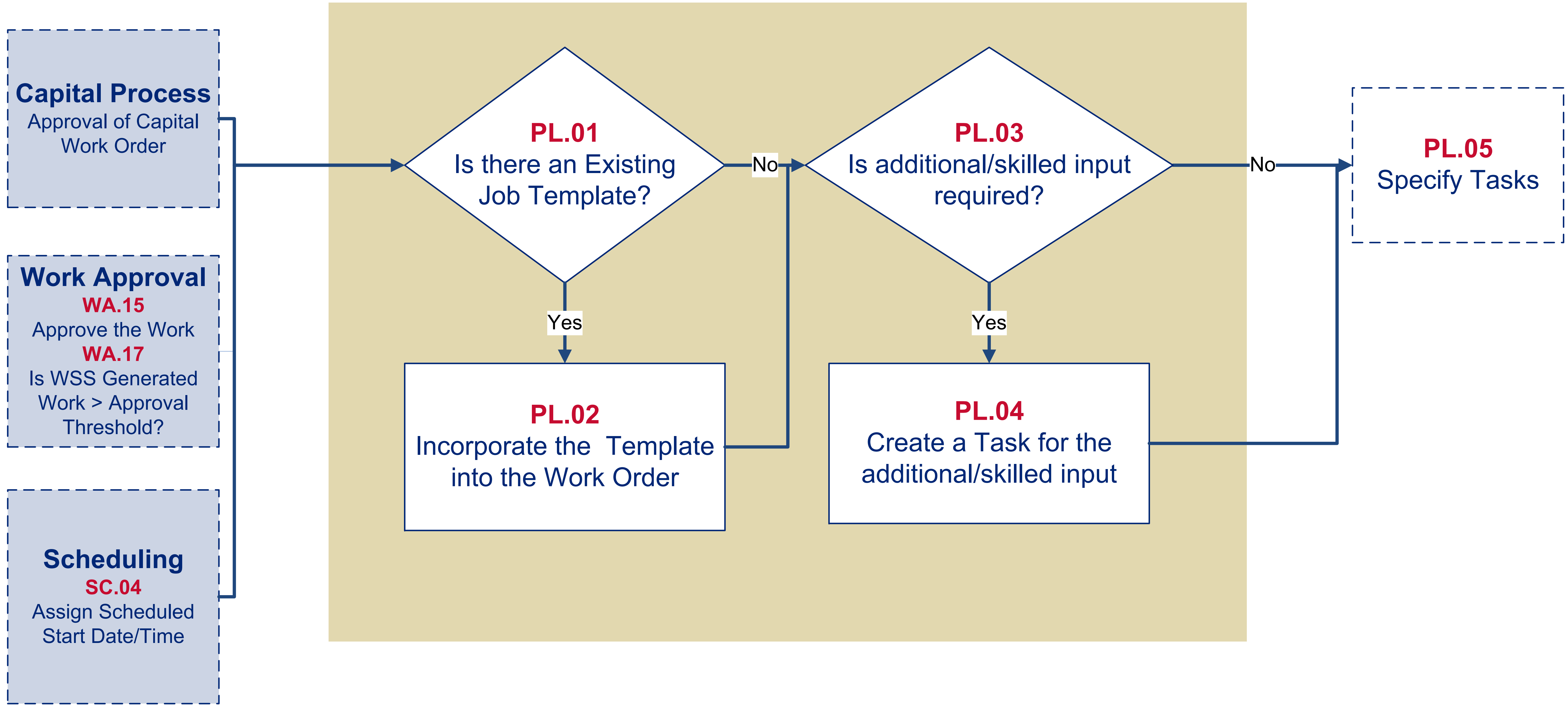

AAOM Flowsheet

PL Flowsheet

# PLANNING PROCESS- Planning Set Up

Purpose: To specify all requirements for completing approved work.

Updated: 05/2019

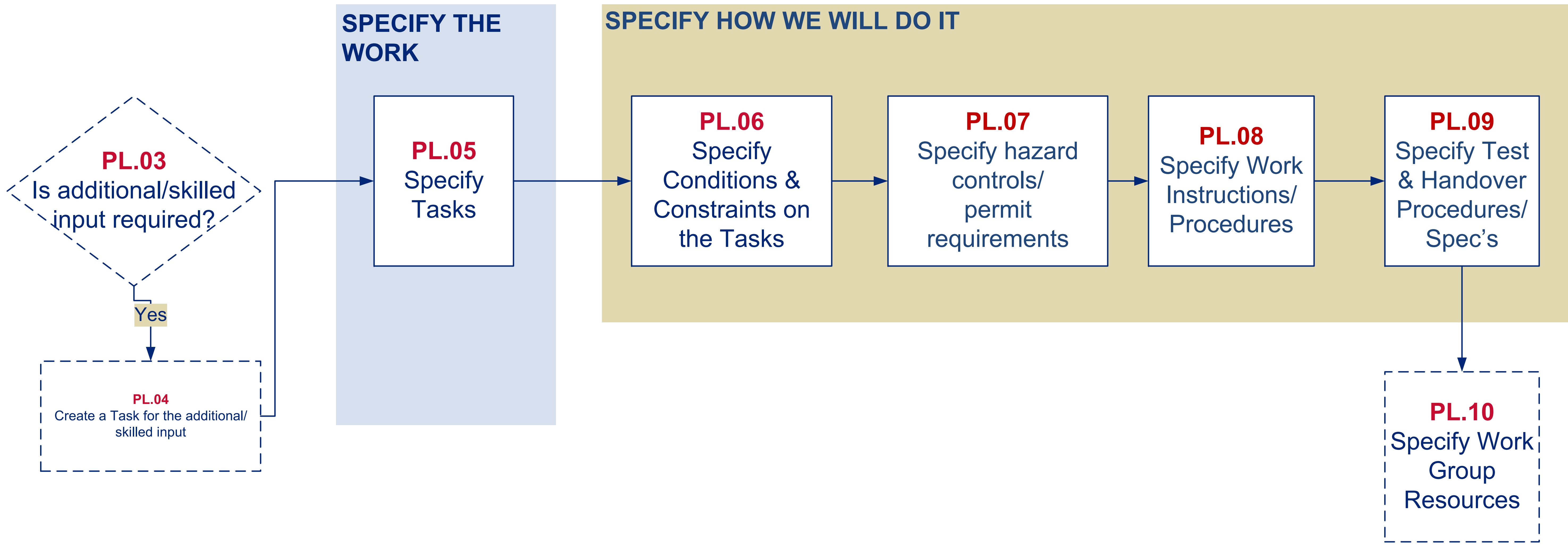



AAOM Flowsheet
PL Flowsheet

# PLANNING PROCESS- Specify the Work and How We Will Do It

Purpose: To specify all requirements for completing approved work.

Updated: 05/2019




AAOM Flowsheet PL Flowsheet

# PLANNING PROCESS- Specify What we Need to do it

Purpose: To specify all requirements for completing approved work.

Updated: 05/2019

**Resourcing**

**RE.01**

Are Specialised Tools, Services & Equipment Available

**RE.02**

Are Inventory Items Available

## SPECIFY WHAT WE NEED TO DO IT

**PL.09** Specify Test & Handover Procedures/ Spec's

**PL.10** Specify Work Group Resources

**PL.11** Specify Materials

**PL.12** Specify Specialised Tools, Equipment & Services

**PL.13** Specify Contract Resources

**PL.14** Specify Task Durations

**PL.15** Planned Cost < Approved Est. Cost

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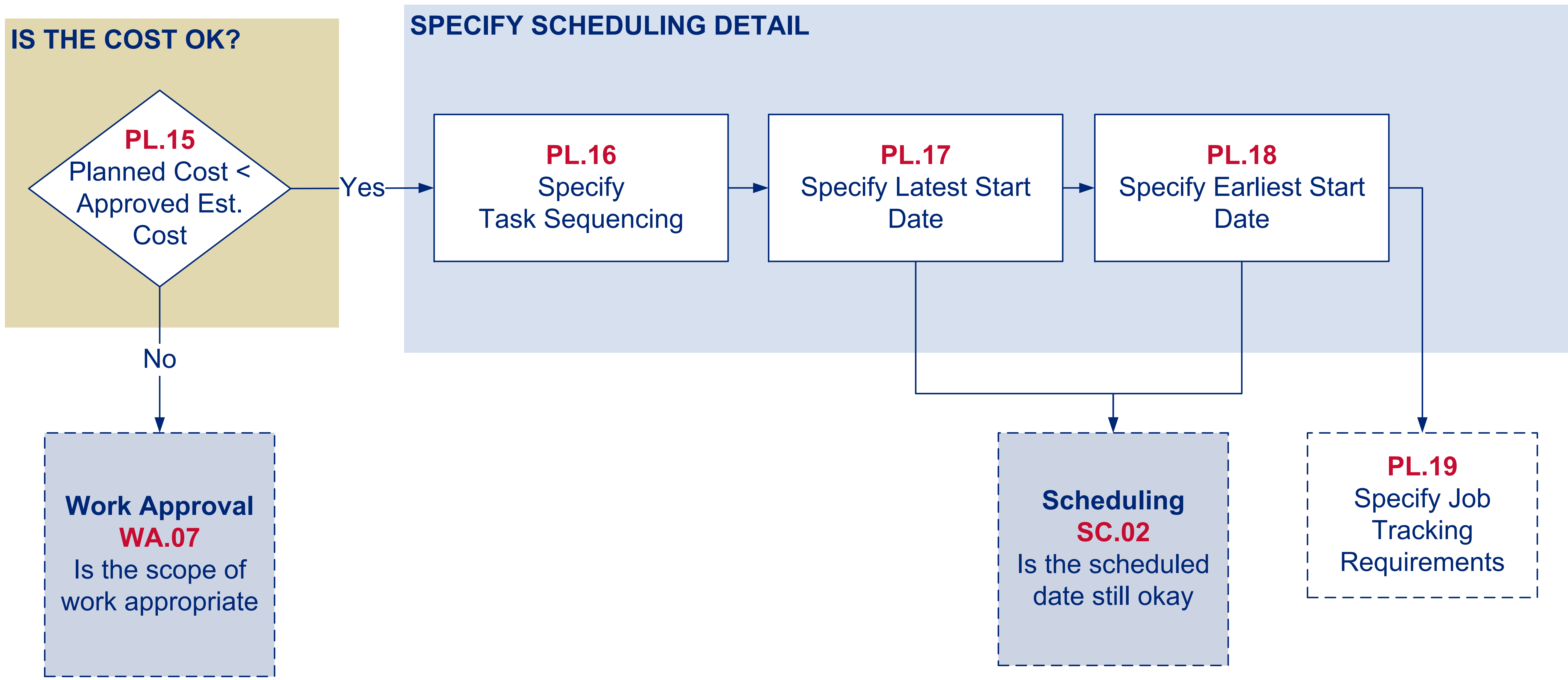
PL Flowsheet

# PLANNING PROCESS- Cost and Schedule Detail

Purpose: To specify all requirements for completing approved work.

Updated: 05/2019

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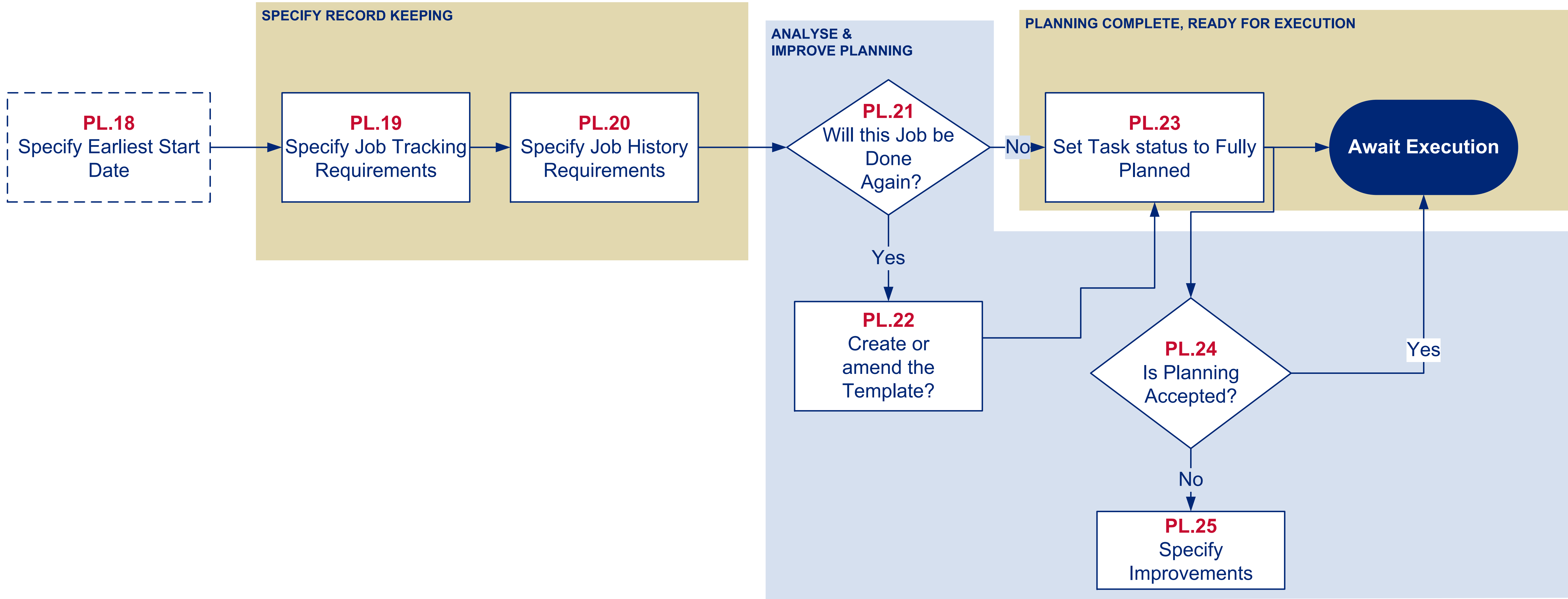
AAOM Flowsheet

PL Flowsheet

# PLANNING PROCESS- Specify Record Keeping and A&I

Purpose: To specify all requirements for completing approved work.

Updated: 05/2019




AAOM Flowsheet

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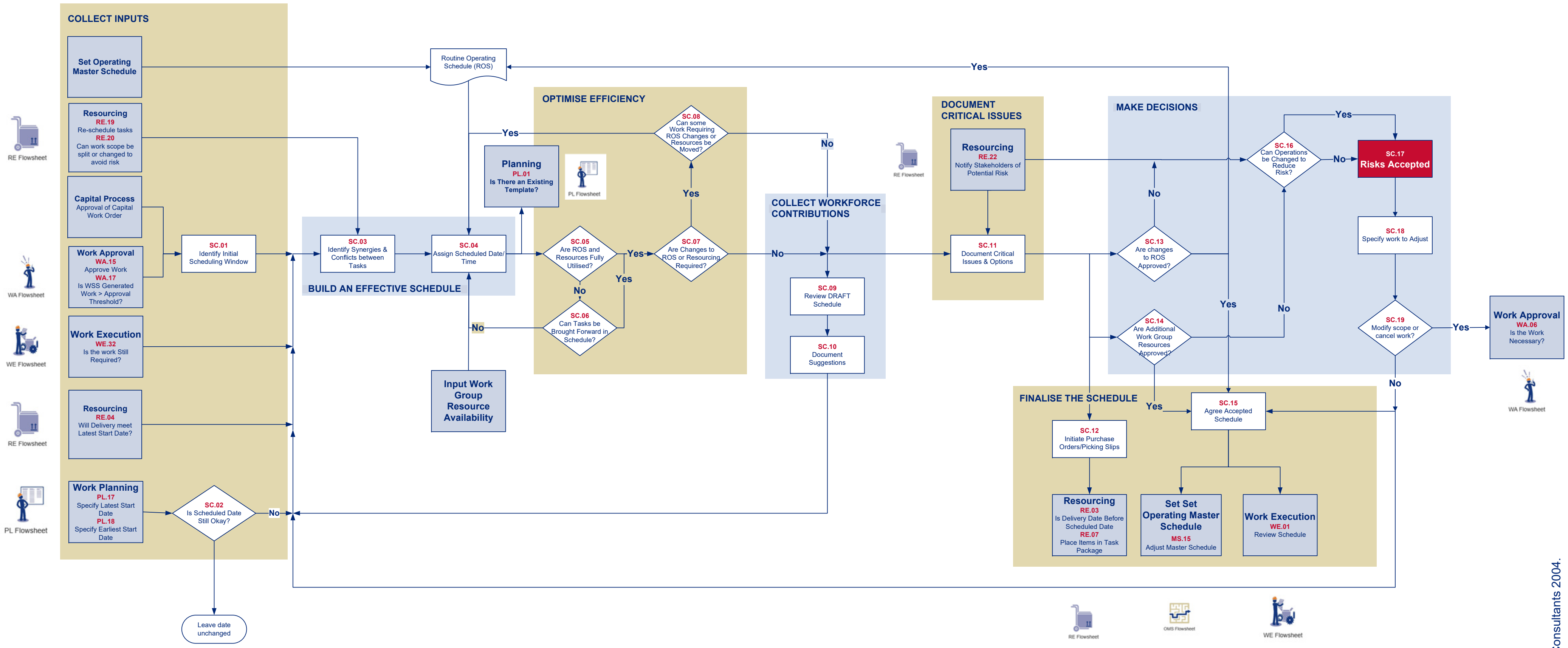
# SCHEDULING PROCESS

## Purpose: To allocate resources for all approved work to be completed at the right time.

**Updated: 05/2019**

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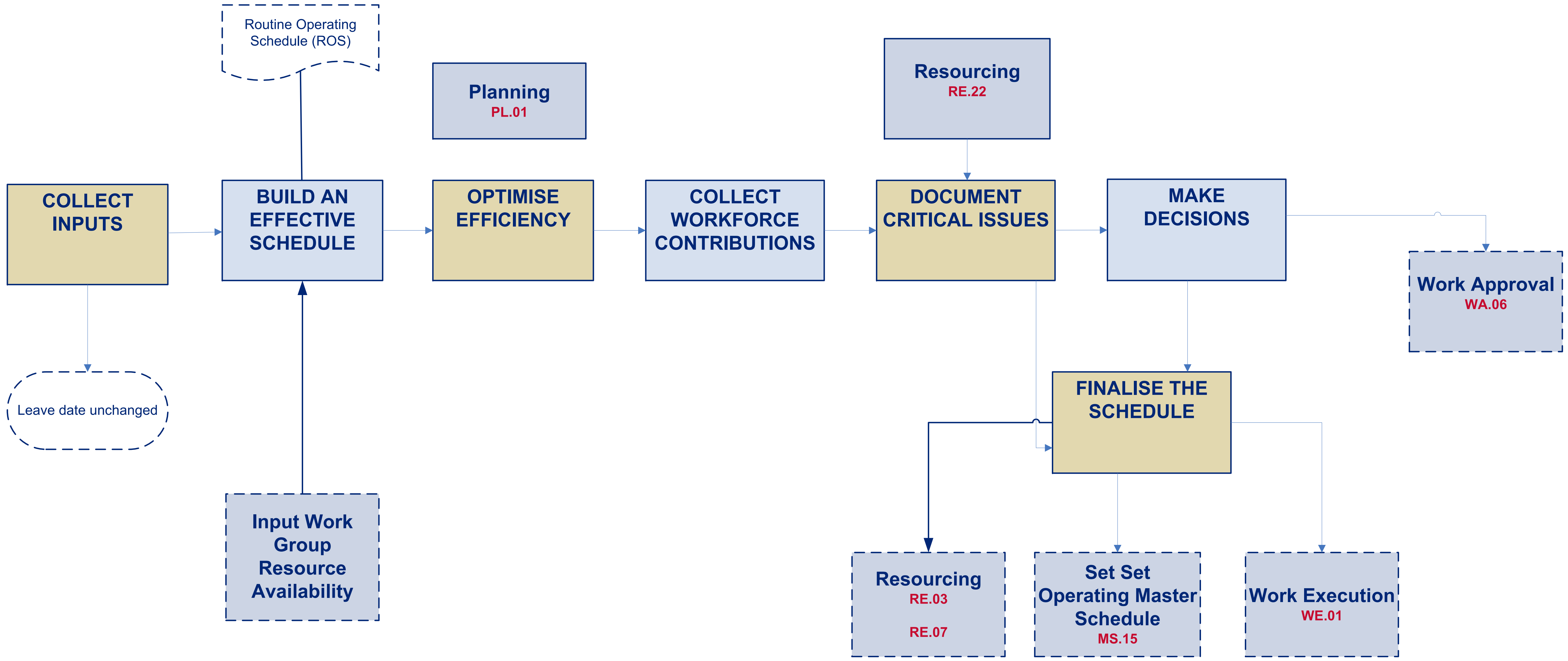
# SCHEDULING PROCESS- High Level

Purpose: To allocate resources for all approved work to be completed at the right time.

**Updated: 05/2019**




AngloAmerican

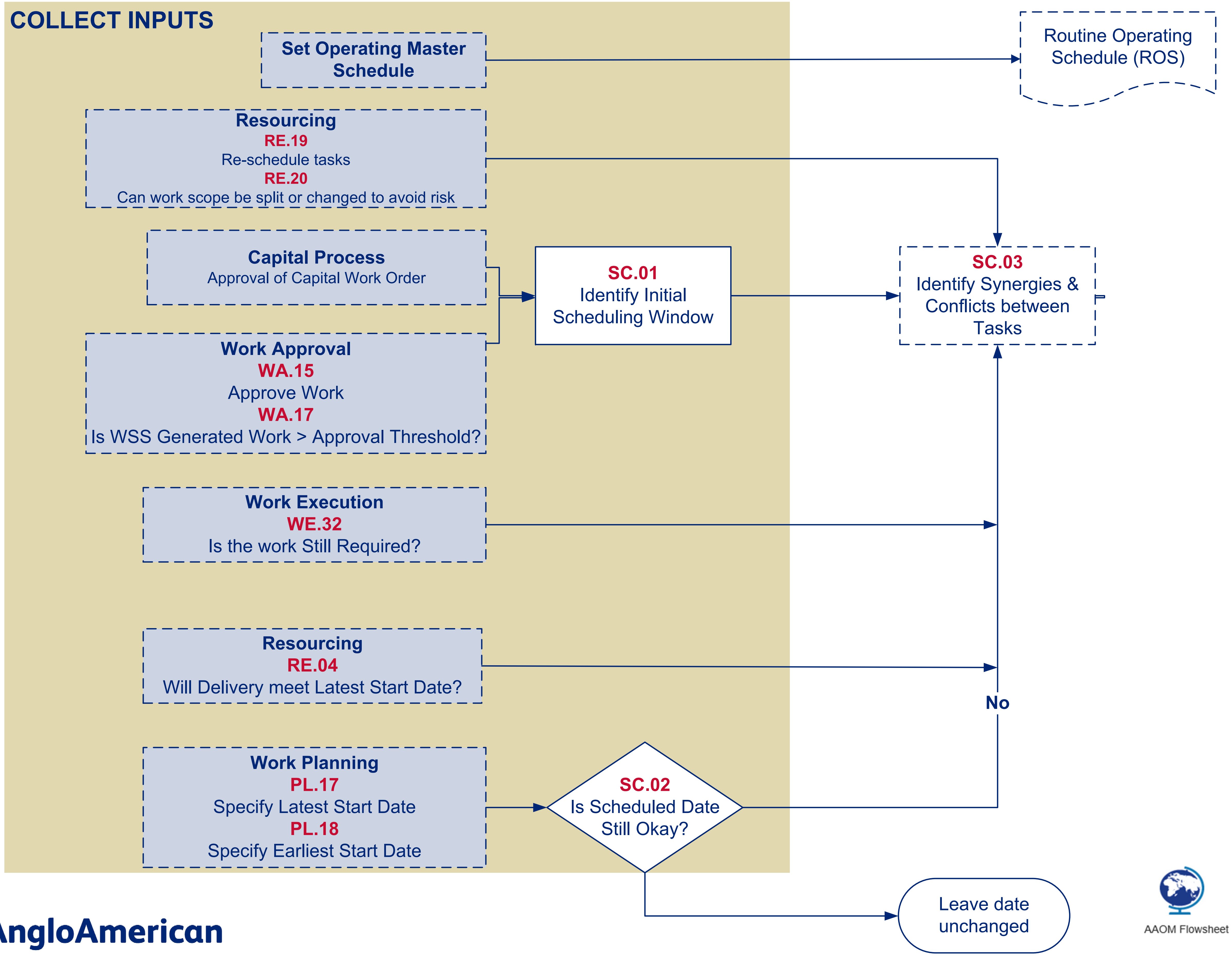
AAOM Flowsheet

SC Flowsheet

# SCHEDULING PROCESS- Collect Inputs

Purpose: To allocate resources for all approved work to be completed at the right time.

Updated: 05/2019




AngloAmerican

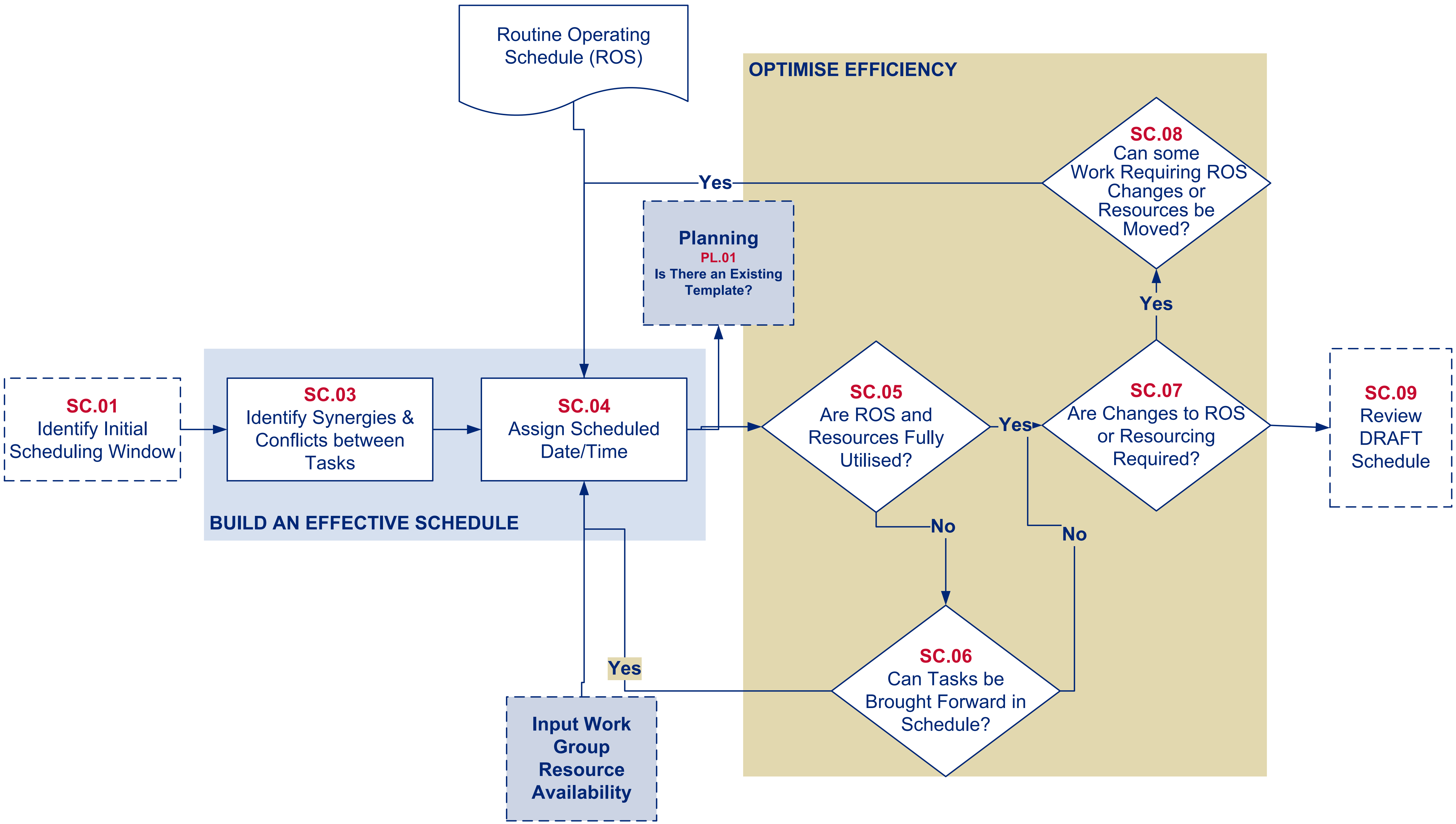
AAOM Flowsheet

SC Flowsheet

# SCHEDULING PROCESS- Build Effective Schedule and Optimise

Purpose: To allocate resources for all approved work to be completed at the right time.

Updated: 05/2019




AngloAmerican

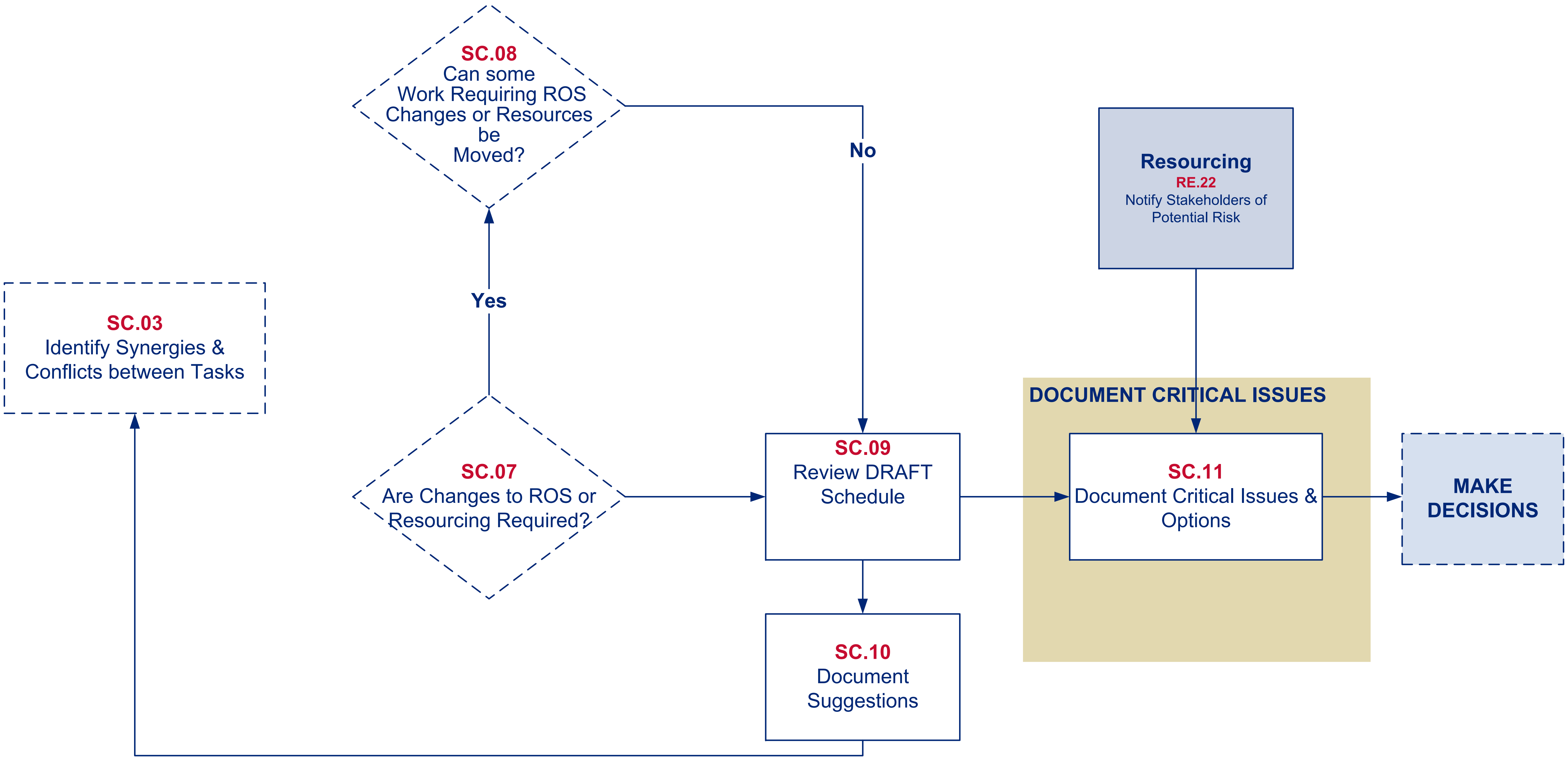
AAOM Flowsheet

SC Flowsheet

# SCHEDULING PROCESS- Build Effective Schedule and Optimise

Purpose: To allocate resources for all approved work to be completed at the right time.

Updated: 05/2019




AngloAmerican

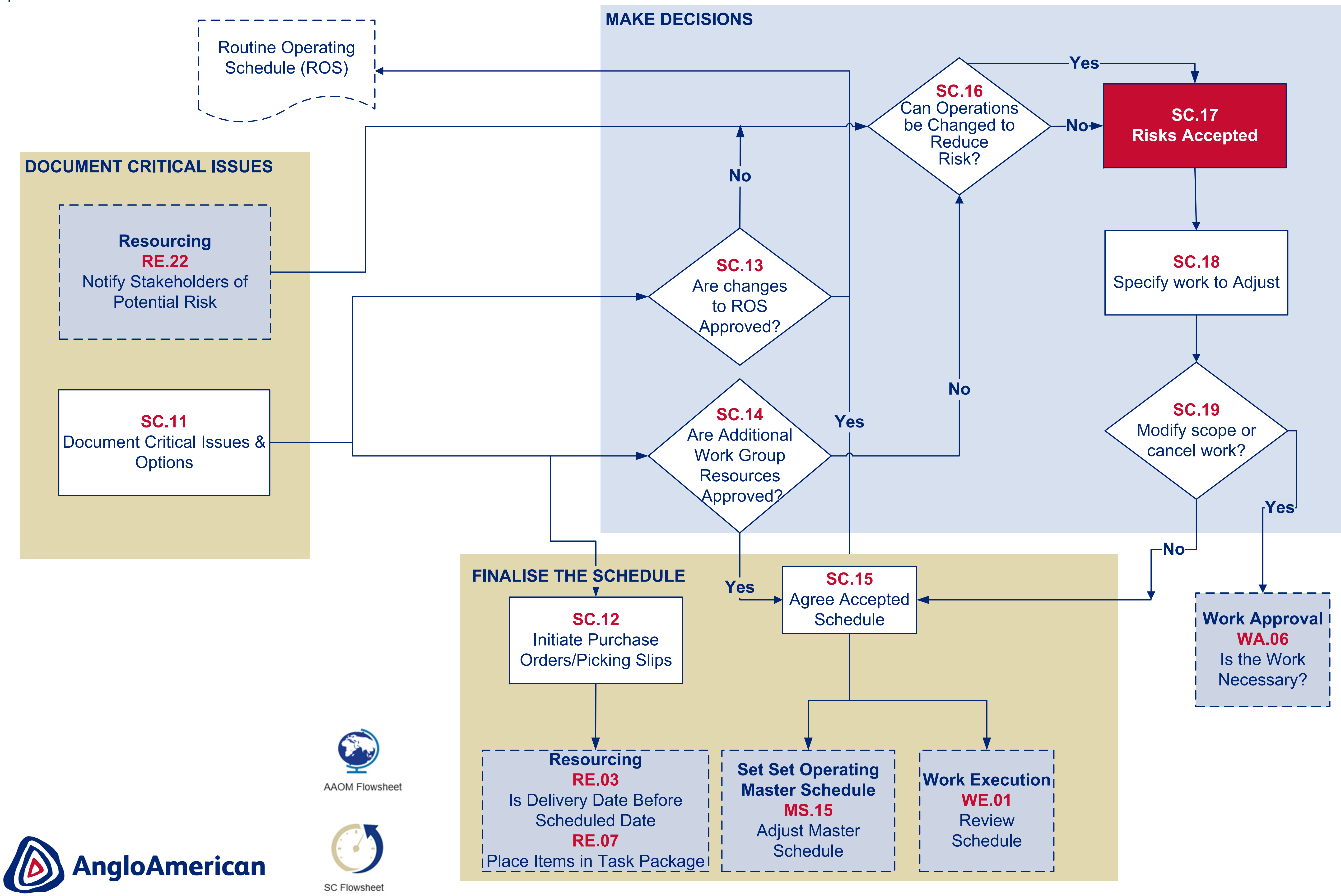
AAOM Flowsheet

SC Flowsheet

# SCHEDULING PROCESS- Make Decisions

Purpose: To allocate resources for all approved work to be completed at the right time.

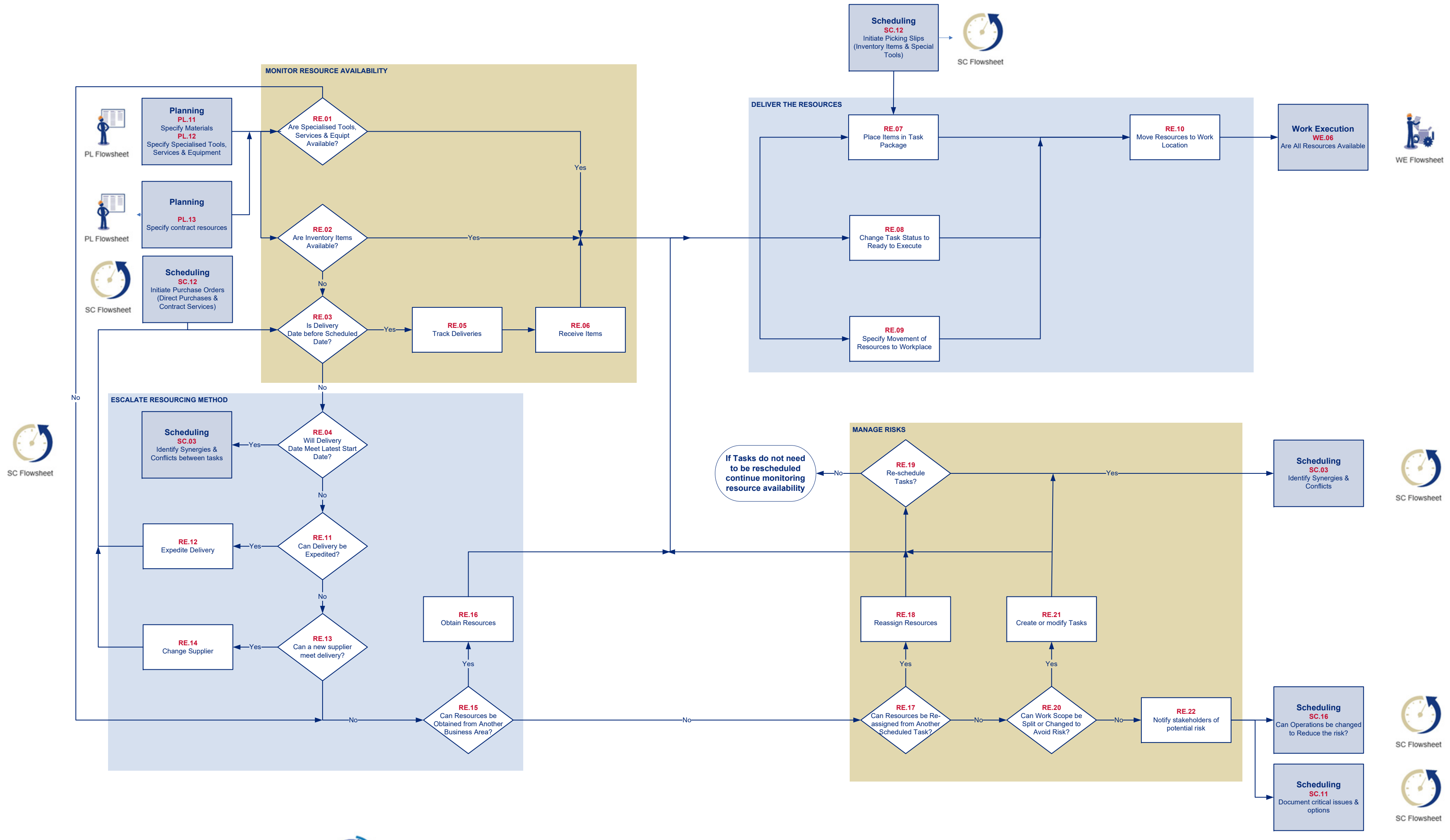
Updated: 05/2019



# RESOURCING: MATERIALS, TOOLS & SERVICES

Purpose: To deliver the requirements for every work package to be completed at the scheduled time.

**Updated: 08/2018**

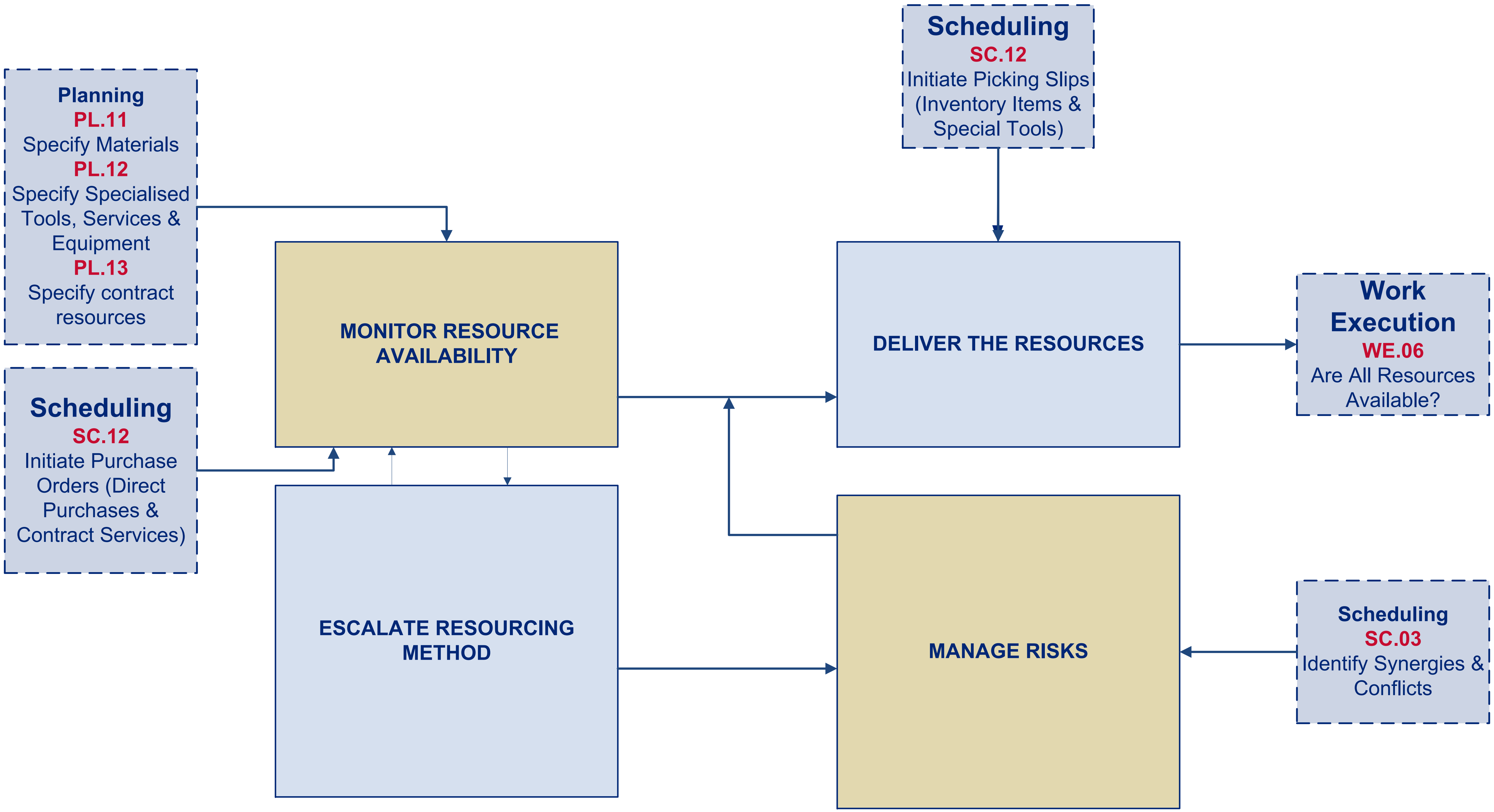



AAOM Flowsheet

# RESOURCING: MATERIALS, TOOLS & SERVICES- High Level

Purpose: To deliver the requirements for every work package to be completed at the scheduled time.

**Updated: 09/2019**




AngloAmerican

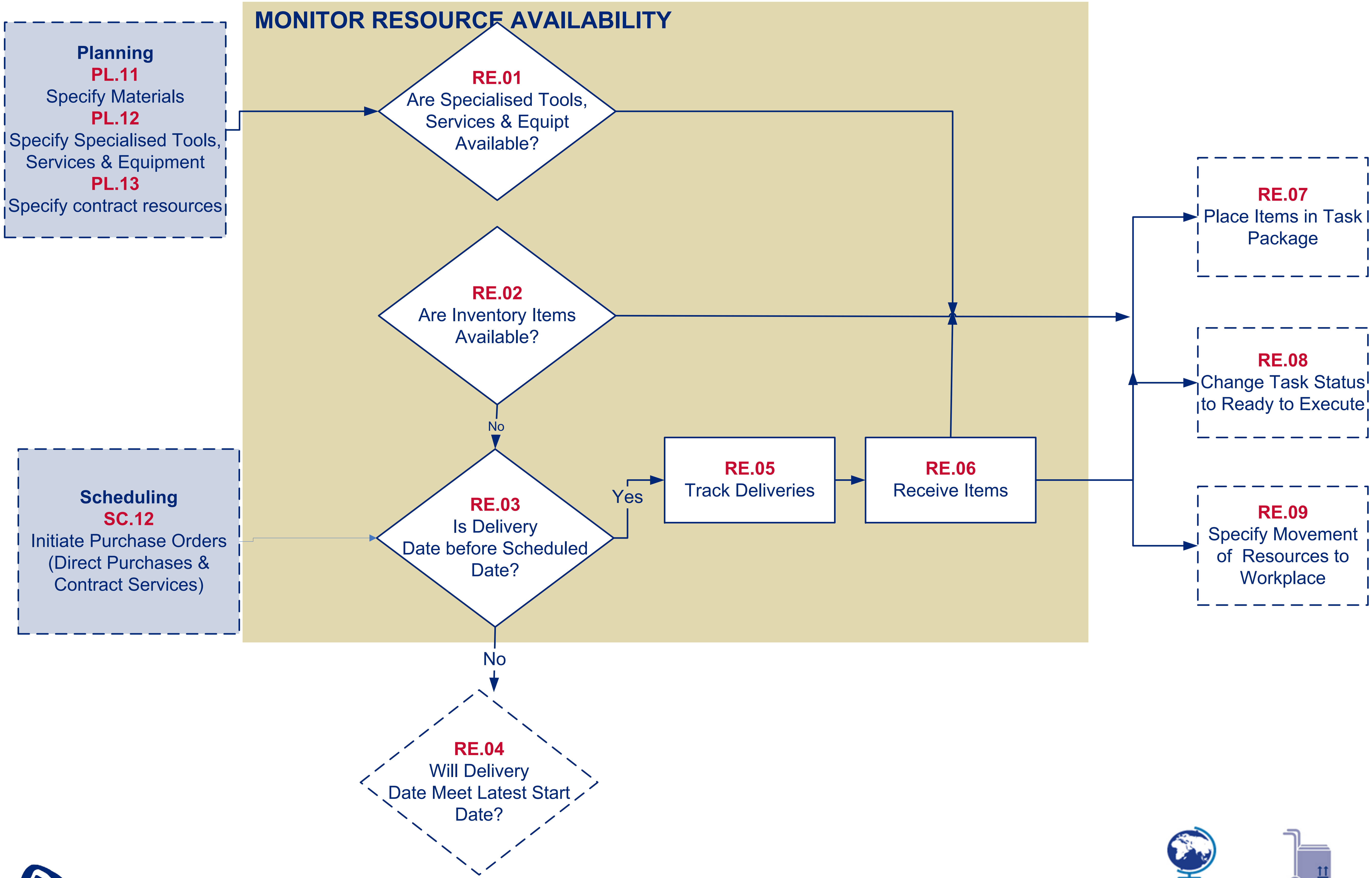
AAOM Flowsheet

RE Flowsheet

# RESOURCING: MATERIALS, TOOLS & SERVICES- Monitor Resource Availability

Purpose: To deliver the requirements for every work package to be completed at the scheduled time.

**Updated: 09/2019**




AngloAmerican

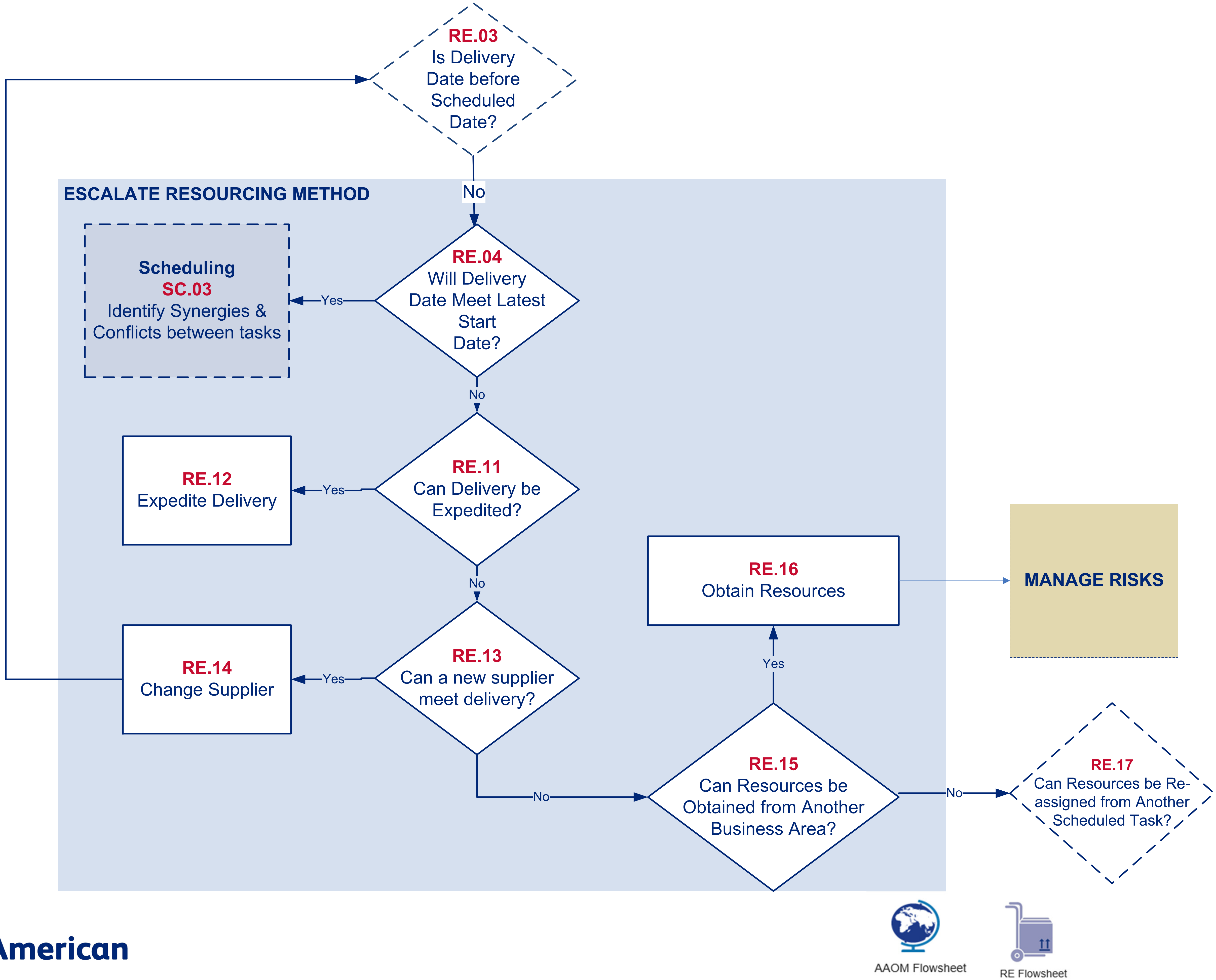
AAOM Flowsheet

RE Flowsheet

# RESOURCING: MATERIALS, TOOLS & SERVICES- Escalate Resourcing Method

Purpose: To deliver the requirements for every work package to be completed at the scheduled time.

Updated: 09/2019

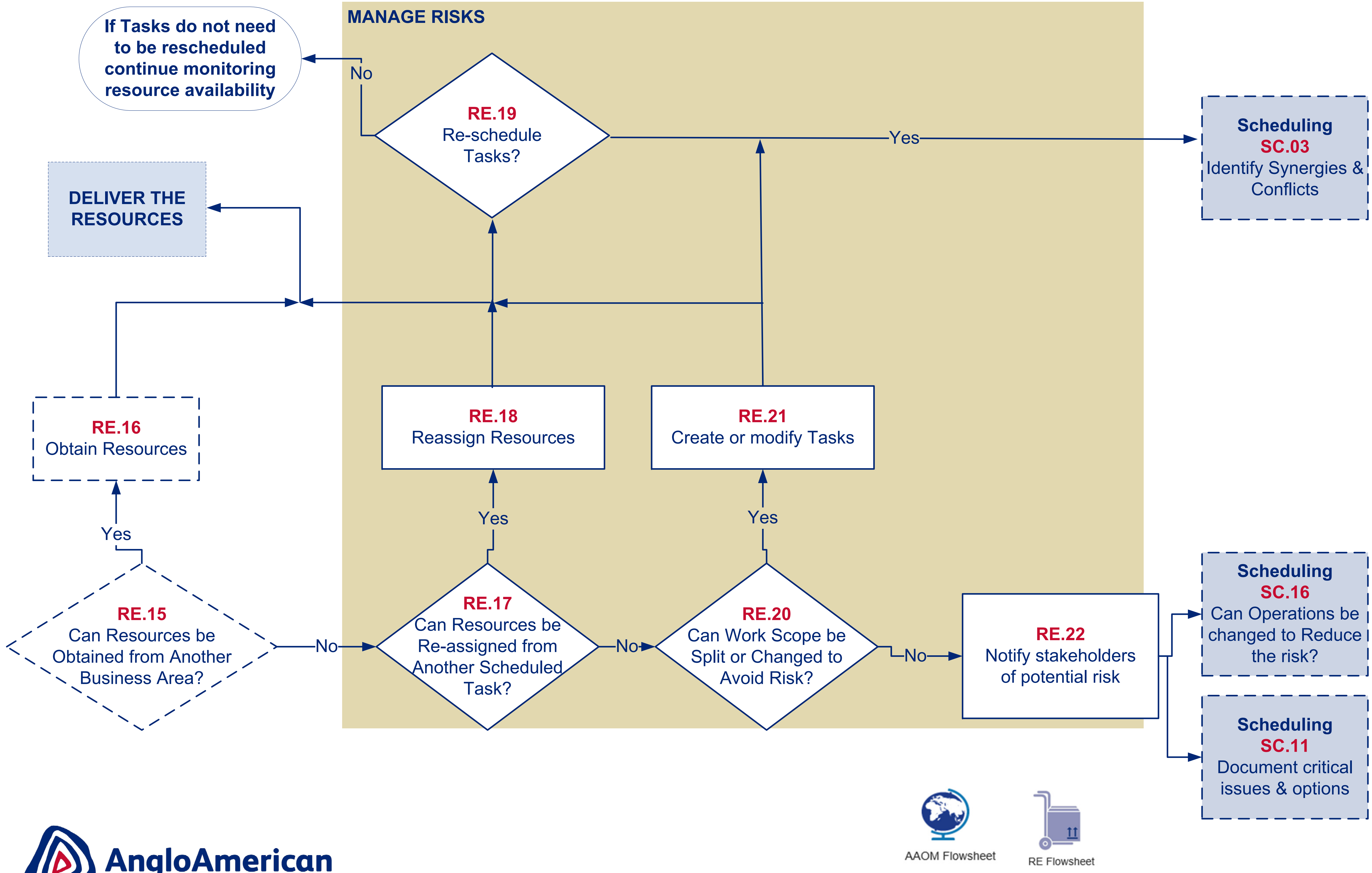



AngloAmerican

# RESOURCING: MATERIALS, TOOLS & SERVICES- Manage the Risks

Purpose: To deliver the requirements for every work package to be completed at the scheduled time.

**Updated: 09/2019**

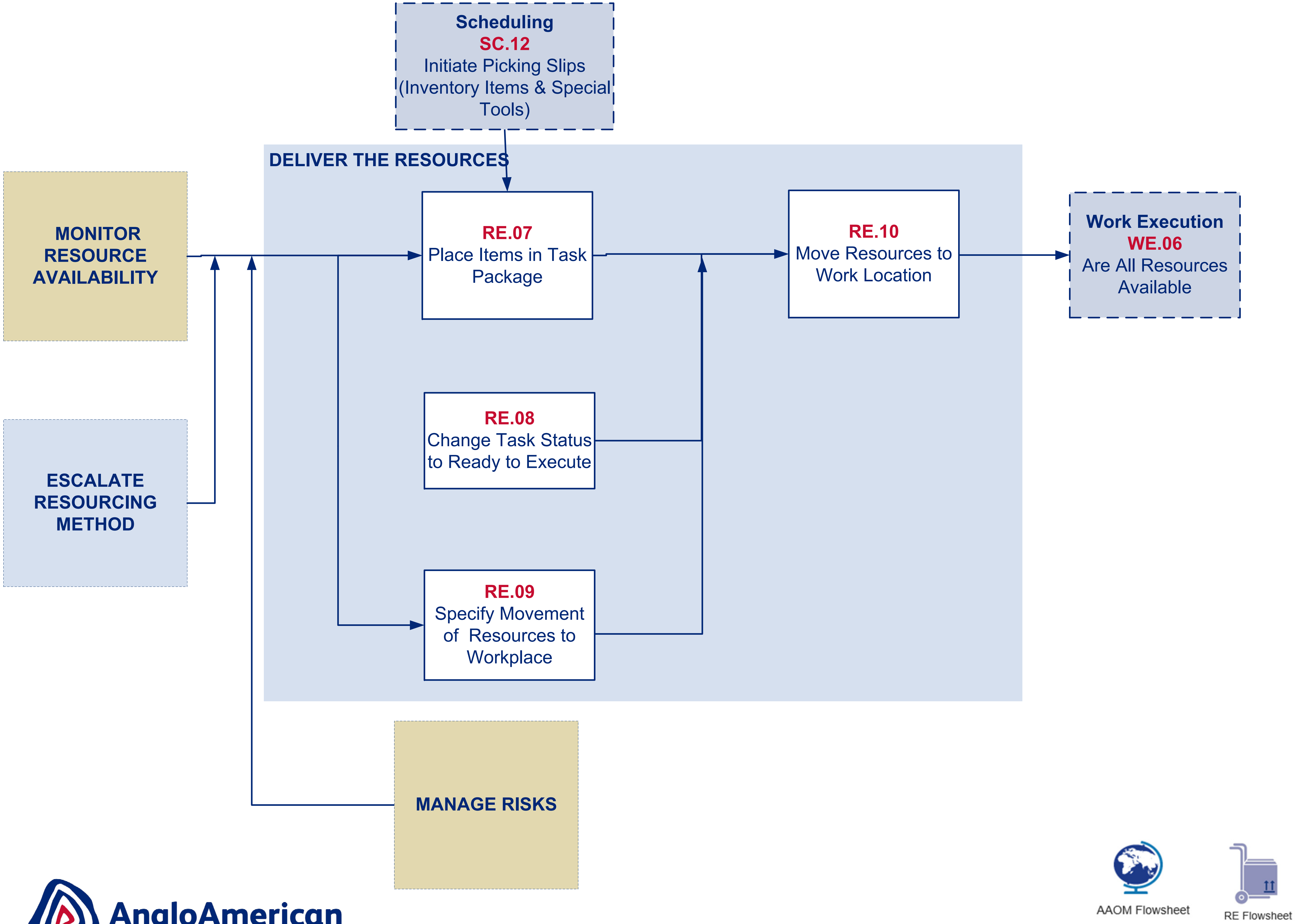



AngloAmerican

# RESOURCING: MATERIALS, TOOLS & SERVICES- Deliver the Resources

Purpose: To deliver the requirements for every work package to be completed at the scheduled time.

**Updated: 09/2019**

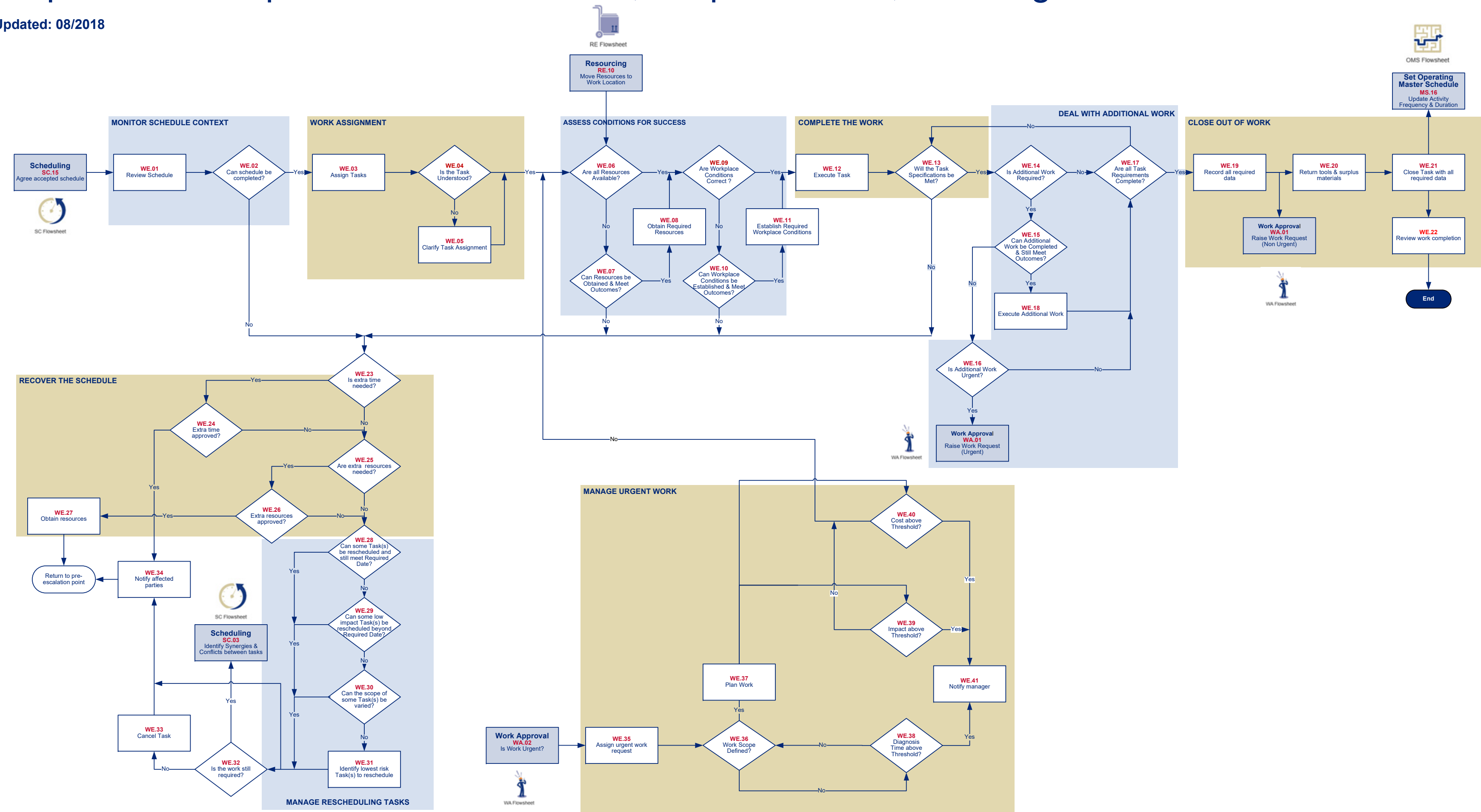



AngloAmerican

# WORK EXECUTION PROCESS

## Purpose: To complete all allocated work, to specification, at the right time.

**Updated: 08/2018**

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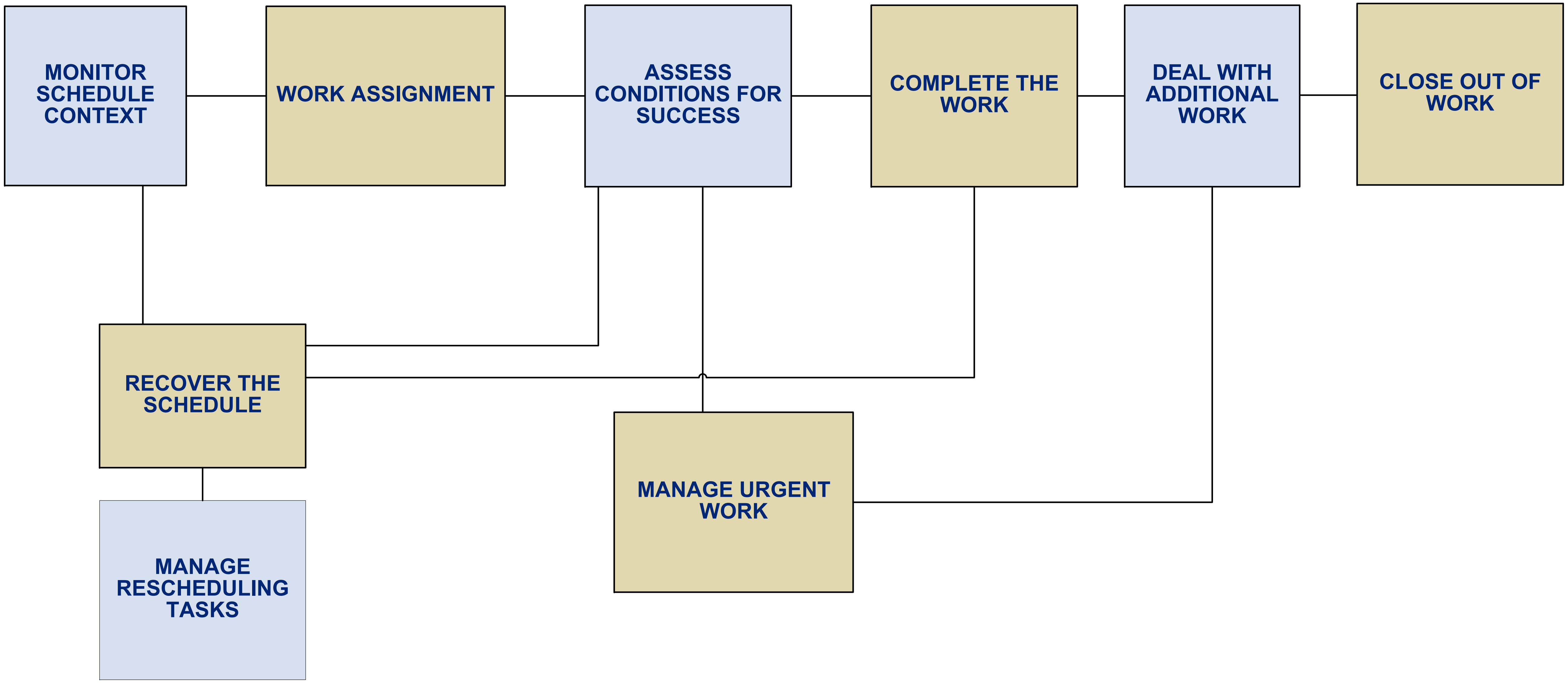
AAOM Flowsheet

# WORK EXECUTION PROCESS- High Level

Purpose: To complete all allocated work, to specification, at the right time.

**Updated: 05/2019**




AngloAmerican

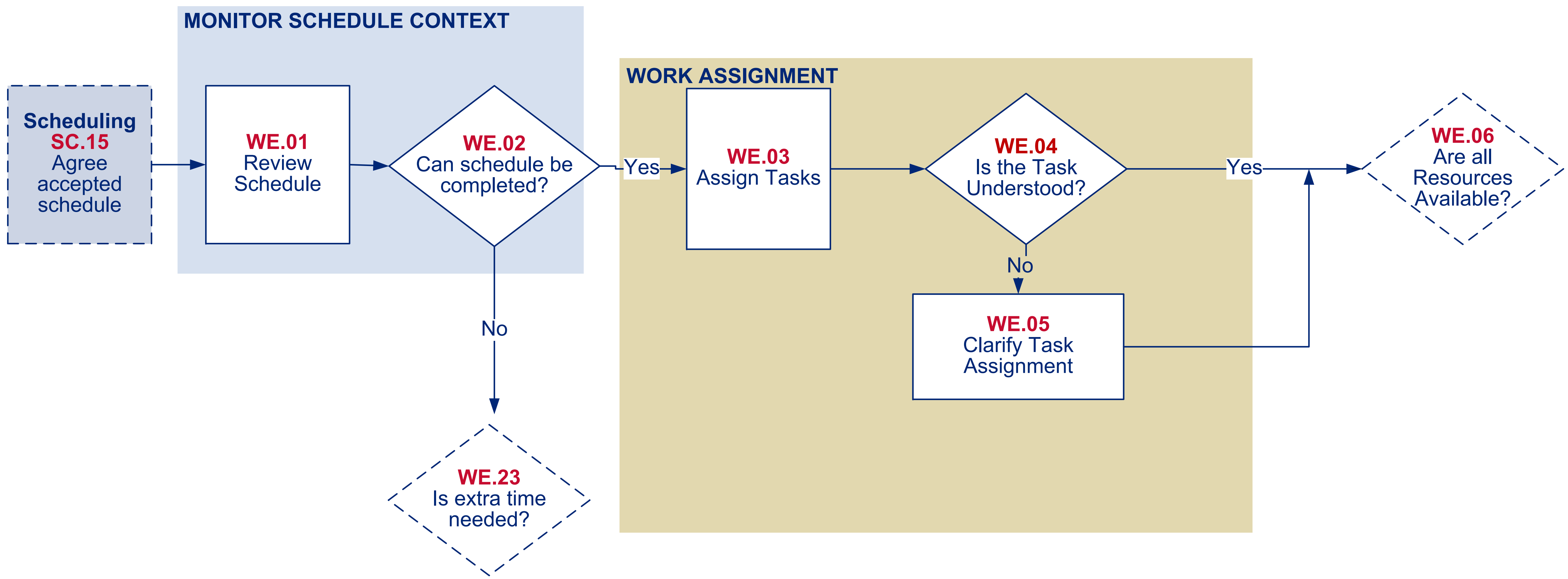
AAOM Flowsheet

WE Flowsheet

# WORK EXECUTION PROCESS- Monitor and Assign

Purpose: To complete all allocated work, to specification, at the right time.

**Updated: 05/2019**




AngloAmerican

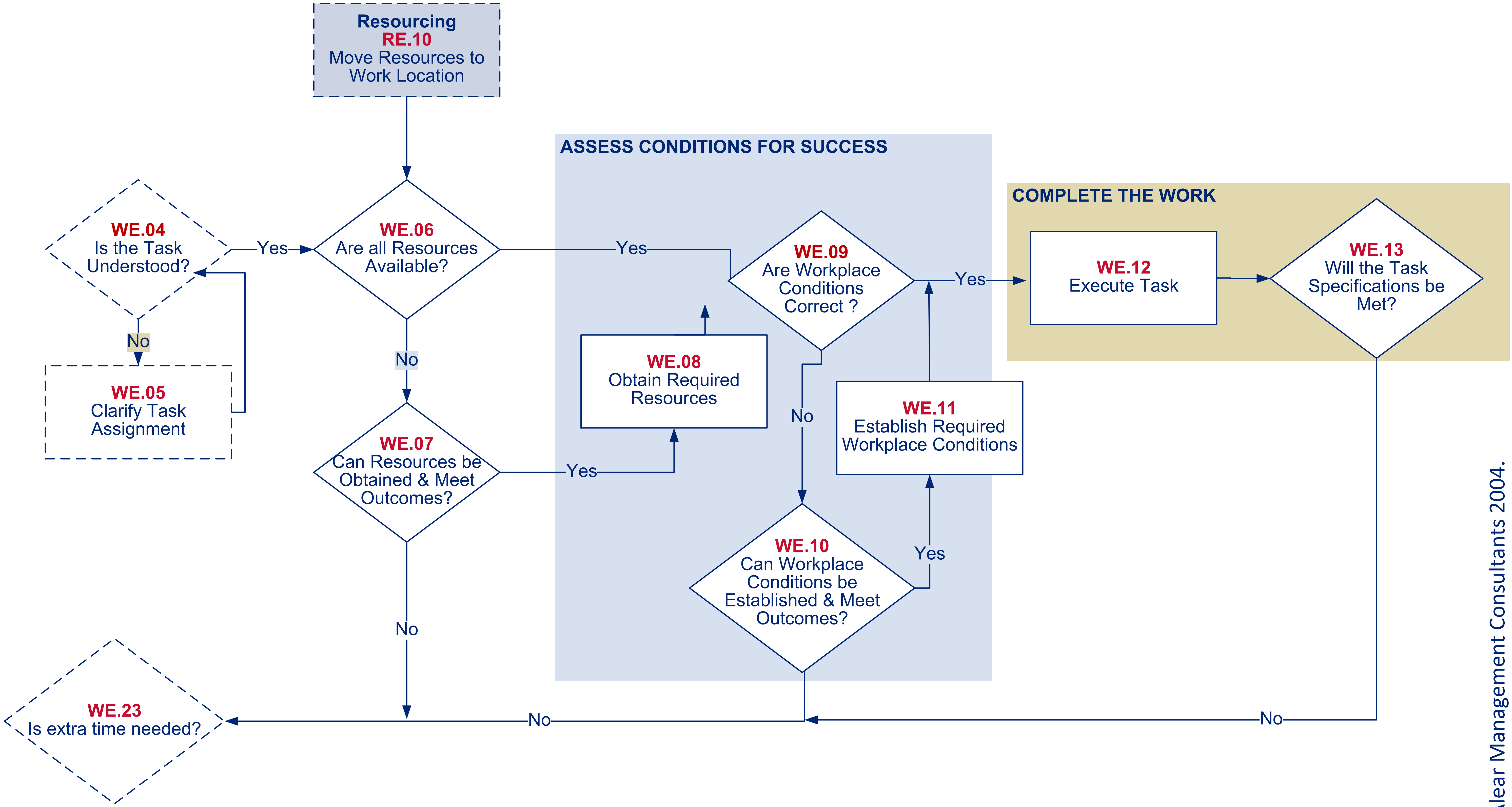
AAOM Flowsheet

WE Flowsheet

# WORK EXECUTION PROCESS- Assess and Complete

Purpose: To complete all allocated work, to specification, at the right time.

**Updated: 05/2019**

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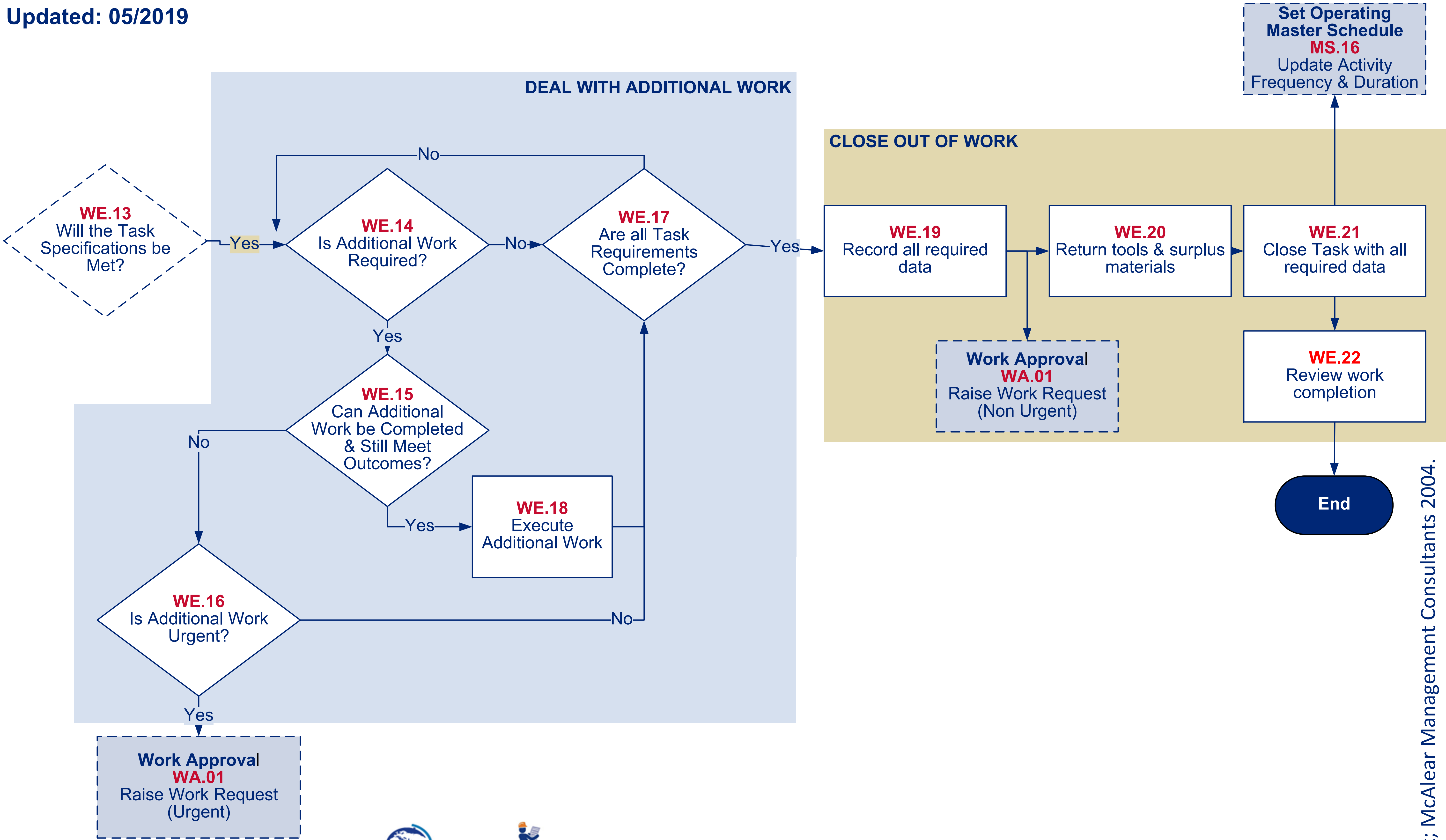
AAOM Flowsheet

WE Flowsheet

# WORK EXECUTION PROCESS- Additional Work, Close Out

Purpose: To complete all allocated work, to specification, at the right time.

**Updated: 05/2019**




AngloAmerican

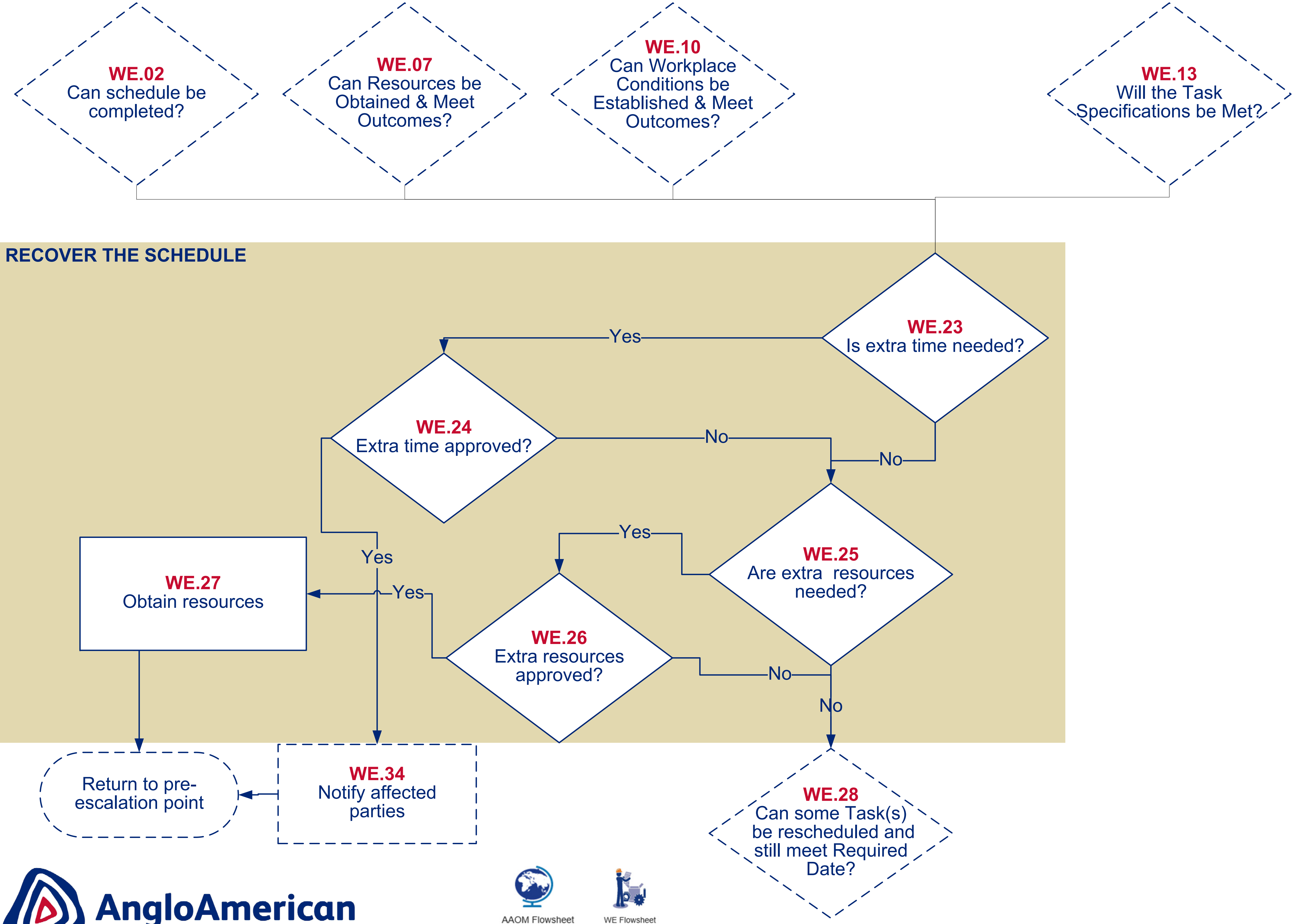
AAOM Flowsheet

WE Flowsheet

# WORK EXECUTION PROCESS- Recover the Schedule

Purpose: To complete all allocated work, to specification, at the right time.

**Updated: 05/2019**

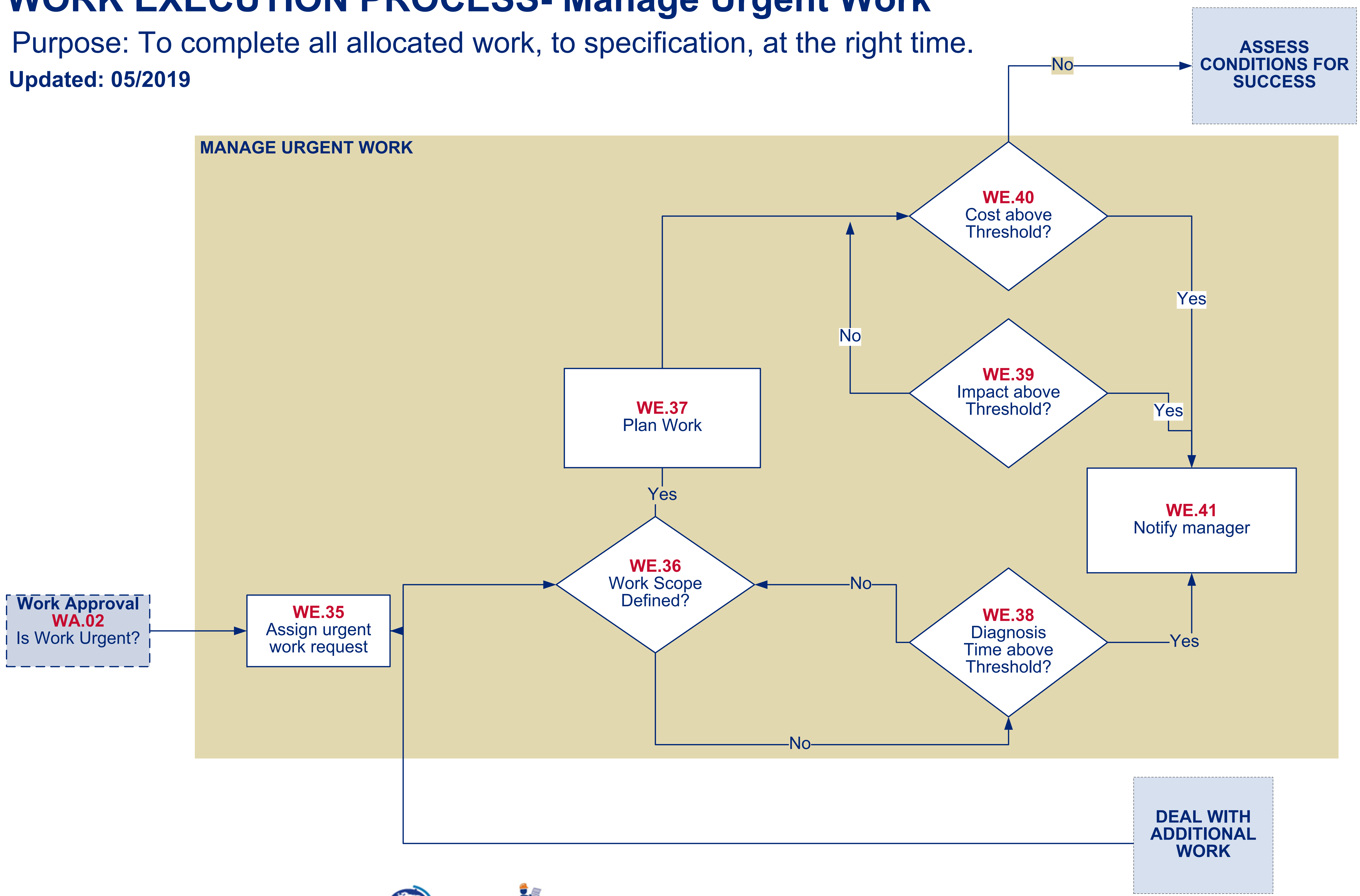



AngloAmerican

# WORK EXECUTION PROCESS- Manage Urgent Work

Purpose: To complete all allocated work, to specification, at the right time.

**Updated: 05/2019**





**INTERNAL**

# ANGLO AMERICAN OPERATING MODEL: WORK MANAGEMENT

## WORK APPROVAL

**UPDATED: AUGUST 2018**

**CONTENTS**



WA Flowsheet

AAOM Flowsheet

# WA.00 Approve Work/Expenditure Commitments

## Context

For a business area to be successful in delivering its agreed output targets, at the lowest practical cost, it must complete the Right Work at the Right Time and in the Right Way. This work must also be completed sustainably, i.e. by dealing responsibly with safety, the environment, employees, communities, governments and asset life.

Achieving these objectives entails a continuing series of decisions on the scope of work that is necessary to deliver the output targets, when the work needs to be done if ongoing performance sustainability is not to be compromised, and how all of the essential work can be completed within the constraints of the agreed expenditure budgets.

While there are a large number of work packages to be processed in most business areas, a relatively small number of these have the potential for significant impact on process effectiveness, sustainability, and efficiency (the Pareto principle suggests that 20% of the work packages will produce 80% of the possible impact). While the necessity, timing and value of all work needs to be considered before it is undertaken, it is the quality of the approval/commitment decisions made on the significant 20% of work packages that will dominate the results achieved.

Making these decisions requires consideration of;

- Whether the work is really necessary (i.e. considering the Impact of not completing the work on achievement of the effectiveness, sustainability, and efficiency targets of the business area).
- The standard or condition that the process needs to be operated or maintained in to meet future performance targets.
- The required timing of the work, i.e. the time window within which the work can be completed without unreasonable risk to performance, and whether the work can be completed in stages, without hazards and risk.
- The funds available to complete the work (i.e. were funds budgeted for the work, are resources available at no cost, or are funds available from another business area).
- Whether other intended work may need to be adjusted to make funds available.

There is frequently sufficient discretion within these parameters to enable effective management of work scope and timing to deliver all of the performance targets (effectiveness, sustainability, and efficiency). When there appears to be no available decision that allows all expectations to be met, it is essential that the potential unfavourable impacts be identified and escalated immediately.

The work to be managed arises from two sources.

1. Work Scheduling System (WSS). These Work Orders are created based only on approved production and service strategies that either have;

    a. a consistent pattern of recurrence and hence can be triggered by either a calendar or counter (run time, volume, cycles, etc), or else

    b. are always dependent on the completion of a previous task in a consistent schedule (e.g. where the designed mining block sequence defines the sequence and timing of the mining tasks.

2. Ad-hoc (i.e. as required). These Work Orders are created based on either;

    a. approved condition or performance-based production and service strategies that do not exhibit a consistent pattern of recurrence, or

    b. to deal with situations where either an operate to failure strategy is in place or an unexpected defect or failure has occurred.

    A condition or performance-based activity or failure/defect observation may be the outcome of a WSS generated inspection, or measurement, or may arise form casual observation by a diligent employee.

If a Work Order that is forecast by the WSS has a sustainability, output or cost impact that is greater than the threshold agreed by the responsible manager, that Work Order must undergo a technical and commercial review before approval and commitment of resources. Ad-Hoc work should always undergo a technical and commercial review before approval and commitment of resources.

**Purpose**

To decide what work will be completed.

WA Flowsheet

AAOM Flowsheet

**Quantity**

One process to decide whether a given work package is necessary, appropriate and funded.

**Quality**

The work packages to be considered in the work approval process include:

- work derived from selected Production and Service strategies that exceed the defined approval threshold, and

- any new (ad hoc) work identified during the operation or maintenance of the asset.

The approval to commit resources to any work package requires the following decisions;

*Technical*

- The work is operational and not capital.
- The work is necessary for sustainable delivery of the performance targets.
- The scope and outcomes of the work are appropriate for the sustainable delivery of the performance targets.
- The required completion time for the work is appropriate for the condition of the process and the impact of that condition on sustainable delivery of the performance targets.

*Commercial*

- The cost of the work is appropriate for the sustainable delivery of the performance targets.

and

- The cost of the work cannot have a significant impact on the expenditure budget for the business area

or else

- The work package was specifically included in the ExPenditure Schedule (EPS) and the estimated cost is less than the approved amount.
- The commitment of the expenditure for the work package will not cause an adverse variation to cost outcomes.
- There are adjustments to be made to other intended work to avoid an adverse variation to cost outcomes.

An approved work package must identify;

- The equipment/workplace requiring the work.
- The outcome of the work (comprising an action and an object – e.g. replace bucket lift cylinder, drill blast pattern at face 3, reconcile bank statement XYZ).
- The approved (upper limit) cost for the work.
- The date by which the work must be completed (Required Date).
- The impact of not completing the work by the Required Date.
- The person who approved the work.

Any other relevant information that is available at the time of approval should also be provided. This may include;

- Any qualifications to the scope (e.g. use second hand cylinder or short tip waste).
- Any conditions or constraints applying to the work (e.g. plant must be running/stopped, restrictions to access etc).
- Any requirements to meet sustainability standards.
- Resources required for the work etc.

The detailed activities for approving a work package shall conform to the specifications set out in Work Approval Flowchart and Task Assignments WA.01 to WA.17

The requirements for expenditure classification (operating or capital) are defined in the appropriate company standard.

Performance Targets (effectiveness, sustainability and efficiency) are defined via the OPERATING MODEL Operational Planning elements.

WA Flowsheet

AAOM Flowsheet

# WA.01 Raise Work Request

### Context

The people working within a business area generally know what is required to have that area functioning sustainably (i.e. dealing responsibly with safety, the environment, employees, communities, governments and asset life), effectively and efficiently, and can recognise when work is required to rectify something that will affect the achievement of these objectives. In order to make the fullest use of all of the potential information that our people can gather, we encourage and require that all personnel initiate a Work Request whenever they identify the need for work.

When a new Work Request is received, it must be evaluated to ensure that:

- It is the Right Work - that is, the work is necessary for the sustainable, effective and efficient functioning of the business area.
- We have a good estimate of the Right Time (Required Date) - the time by which the work must be completed before it will have an impact (consequence).
- We understand the Impact of not completing the work by the Required Date, so we can make informed decisions when there is contention for any resource necessary to complete approved work.
- We understand the Right Way to execute the work, so we can appropriately estimate and prepare the requirements for the work.

Work Requests can be evaluated more efficiently and reliably, if all of the information necessary to understand the request is provided in the correct form when the request is first made.

### Purpose

To provide the input data required for approval of a Work Request.

### Quantity

One secure record created for each Work Request.

### Quality

Completion of the following data is mandatory for each Work Request:

- The Equipment/Component or Workplace/Location for the work.
- Symptom or Outcome Description
- The manager accountable for reviewing/approving the Work Request.
- Required Date - the time by which the work must be completed before it will have an impact
- Impact - the consequence of not completing the work by the Required Date
- Originator’s identity.

The following data should be completed, or information supplied, where an employee has sufficient knowledge or experience of the work to do so;

- Outcome/action and object of each separate component of the work.
- Labour/equipment type(s) required for the work.
- Potential hazards and their associated risks.
- Conditions required for the work.
- Constraints on the work.
- Estimated duration of the work components.
- Other materials and tools required for the work.

**Notes**

Equipment/Component or Workplace/Location: This is the valid work management information system code identifying where the work is required.

Work Description: This is to clearly identify the reason the Work Request is being created - it should contain either the symptom observed or the action that is required. The description should be in the form of a symptom or action and an object e.g. in a mining/mineral processing environment a work description may be either Leaking pump gland or Repack pump gland.

Required Date: In determining the Required Date, the following need to be considered:

- What is the status of the equipment or workplace?
- What is the status of the process schedule?
- How do the existing or changing conditions influence exposure to hazards and risks?
- Is there an alternative way of operating that can provide some flexibility in the Required Date? (e.g. guarding/containment, alternate equipment/workplace, alternate time in the schedule or increased future processing rate)?

Considering the above, the Required Date is:

- The date by which an event that will create a safety or environmental threat is probable
- The date by which a delay in the completion of a scheduled critical path activity is probable.

or

- Not more than an agreed service level period (e.g. 6 weeks) from the date of Work Request creation.

WA Flowsheet

AAOM Flowsheet

Impact: In determining the Impact, the following need to be considered:

- What potential events could occur?
- What is the probability over time of an event occurring?
- What are the potential consequences?
- Is the threat containable?
- Is the loss recoverable?

Considering the above, the definitions of Impact are:

High –

- Significant *un-containable* safety or environmental threat, or
- Significant *un-recoverable* process throughput or quality reduction
    - *Un-containable* means that there is no practical way to contain exposure to a threat e.g. use temporary measures such as the installation of barricades, diverting spillage into sumps, drawing from or building stockpiles, subcontracting alternate suppliers for goods or services etc.
    - *Un-recoverable* means that there is no alternate equipment, schedule time, operating rate or alternate suppliers etc that will allow catch up to schedule.

Moderate –

- Less than significant *un-containable* safety or environmental threat, or
- Less than significant *un-recoverable* process throughput or quality reduction, or
- Containable safety or environmental threat, or
- Recoverable process throughput or quality reduction

Low –

- All other.

What constitutes a *significant* potential impact may vary between business areas and will need to be defined on a case by case basis. Safety and environmental impacts, and major operational disruptions may be classified based on the Company Risk Ranking matrix. For operational disruptions that fall below this level, a portion of the range of variation evident in the Control Chart/Capability Histogram of the performance (e.g. more or less than the value equal to 0.5 Sigma of the distribution) may be used to quantify what is considered significant or not.

**Time**

A Work Request shall be raised as soon as necessary or practical after the need for the work is identified.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Work Approval flowchart.

## WA.02 Is the Work Urgent?

### Context

The people working within a business area generally know what is required to have that area functioning sustainably (i.e. dealing responsibly with safety, the environment, employees, communities, governments and asset life), effectively and efficiently, and can recognise when work is required to rectify something that will affect the achievement of these objectives. In order to make the fullest use of all of the potential information that our people can gather, we encourage and require that all personnel initiate a Work Request whenever they identify the need for work.

Most Work Requests can be made with sufficient lead time that they do not require an urgent response, and hence should be approved, schedule, planned and executed for optimum results. The OPERATING MODEL Scheduling, Planning, Resourcing and Execution business processes define how non-urgent work is processed.

When work must be completed urgently it usually results in either:

- increased exposure to hazards,
- higher usage of labour and materials,
- excessive materials stocks,
- increased costs,
- compromised work outcomes,
- adverse impacts on other work, or
- all of the above.

Consequently, we should not complete work urgently unless it is necessary.

Urgent work can and will occur at any time of any day, and the situation requiring urgent work may be recognised by anyone within a business area. Making an appropriate response to urgent work requires that a decision be made promptly to initiate that response and hence, the decision whether work is urgent may be made by a diverse group of people. Clear and objective criteria to guide the consistent determination of urgent work are needed.

### Purpose

To determine whether a Work Request is urgent.

WA Flowsheet

### Quantity

- One decision whether the work is urgent or not.

AAOM Flowsheet

### Quality

The decision whether work is urgent or not is based on the Required Date and Impact determined for the work.

Required Date: In determining the Required Date, the following need to be considered:

- What is the status of the equipment or workplace?
- What is the status of the process schedule?
- How do the existing or changing conditions influence exposure to hazards and risks?
- Is there an alternative way of operating that can provide some flexibility in the Required Date? (e.g. guarding/containment, alternate equipment/workplace, alternate time in the schedule or increased future processing rate)?

Considering the above, the Required Date is:

- The date by which an event that will create a safety or environmental threat is probable
- The date by which a delay in the completion of a scheduled critical path activity is probable. or
- Not more than an agreed service level period (e.g. 6 weeks) from the date of Work Request creation.

Impact: In determining the Impact, the following need to be considered:

- What potential events could occur?
- What is the probability over time of an event occurring?
- What are the potential consequences?
- Is the threat containable?
- Is the loss recoverable? Or
- Not more than an agreed service level period (e.g. 6 weeks) from the date of Work Request creation.

Impact: In determining the Impact, the following need to be considered:

- What potential events could occur?
- What is the probability over time of an event occurring?
- What are the potential consequences?
- Is the threat containable?
- Is the loss recoverable?

Considering the above, the definitions of Impact are:

High –

- Significant *un-containable* safety or environmental threat, or
- Significant *un-recoverable* process throughput or quality reduction
    - *Un-containable* means that there is no practical way to contain exposure to a threat e.g. use temporary measures such as the installation of barricades, diverting spillage into sumps, drawing from or building stockpiles, subcontracting alternate suppliers for goods or services etc.
    - *Un-recoverable* means that there is no alternate equipment, schedule time, operating rate or alternate suppliers etc that will allow catch up to schedule.

Moderate –

- Less than significant *un-containable* safety or environmental threat, or
- Less than significant *un-recoverable* process throughput or quality reduction, or
- Containable safety or environmental threat, or
- Recoverable production or service activity throughput or quality reduction

Low –
- All other.

What constitutes a *significant* potential impact may vary between business areas and will need to be defined on a case by case basis. Safety and environmental impacts, and major operational disruptions may be classified based on the Company Risk Ranking matrix. For operational disruptions that fall below this level, a portion of the range of variation evident in the Control Chart/Capability Histogram of the performance (e.g. more or less than the value equal to 0.5 Sigma of the distribution) may be used to quantify what is considered significant or not.

Following is the decision matrix used to determine the urgency of work.

| | **Required Date** | | |
|---|---|---|---|
| **Impact** | **Today** | **This Period** | **Next Period +** |
| High | Urgent – respond immediately | Urgent – respond before required date | Not Urgent – schedule before required date |
| Moderate | Urgent – respond or contain immediately, | Urgent – respond or contain before required date | Not Urgent – schedule before required date |
| Low | Not used | Not used | Not Urgent – schedule before required date |

If work is declared high or moderate impact, with a Required Date within the current schedule period – it is processed as Urgent Work.

Task Status: If the work is determined to be urgent, the Work Order Task Status flag shall be set to Urgent.

All other work is to be handled through the normal work management processes.

WA Flowsheet

**Time**

This task must be completed as soon as the Work Request is understood.

AAOM Flowsheet

**Resources**

Completion of this task is the accountability of the role nominated on the configured Work Approval flowchart.

# WA.03 Is the Input Data Complete & Accurate?

### Context

The people working within a business area generally know what is required to have that area functioning sustainably (i.e. dealing responsibly with safety, the environment, employees, communities, governments and asset life), effectively and efficiently, and can recognise when work is required to rectify something that will affect the achievement of these objectives. In order to make the fullest use of all of the potential information that our people can gather, we encourage and require that all personnel initiate a Work Request whenever they identify the need for work.

The information supplied with a Work Request is used to ensure that:

- It is the Right Work - that is, the work is necessary for the sustainable, effective and efficient functioning of the business area.
- We have a good estimate of the Right Time (Required Date) - the time by which the work must be completed before it will have an impact (consequence).
- We understand the Impact of not completing the work by the Required Date, so we can make informed decisions when there is contention for any resource necessary to complete approved work.
- We understand the Right Way to execute the work, so we can appropriately estimate and prepare the requirements for the work.

The above criteria are the basis for the decision to approve a Work Request or not.

### Purpose

To verify the input data required for approval of a Work Request is available.

### Quantity

One decision whether the input data is complete or not.

### Quality

The following data must be validated or completed by the person reviewing a Work Request prior to approval of the request:

- The Equipment/Component or Workplace/Location for the work.
- Symptom or Outcome Description
- The manager accountable for reviewing/approving the Work Request.
- Required Date - the time by which the work must be completed before it will have an impact
- Impact - the consequence of not completing the work by the Required Date
- Originator’s identity.

The following data should be completed, or information supplied, where the reviewer/approver has sufficient knowledge or experience of the work to do so;

- Outcome/action and object of each separate component of the work.
- Labour/equipment type(s) required for the work.
- Potential hazards and their associated risks.
- Conditions required for the work.
- Constraints on the work.
- Estimated duration of the work components.
- Other materials and tools required for the work.

Refer to WA.01 for the specifications for input data, as well as applicable references.

If further information or clarification is required in order to adequately assess the Work Request, the reviewer/approver must obtain the information promptly, in order not to delay the processing of the request.

If the person reviewing the Work Request determines that the Impact and Required date entered on the Work Request were incorrect, and that the work is in fact urgent, they shall direct the work to the Urgent Work process.

**Time**

Review of a Work Request must be completed within 1 working day of the creation of the Work Request.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Work Approval flowchart.

WA Flowsheet

AAOM Flowsheet

# WA.04 Obtain the Necessary and Correct Input Data

### Context

The people working within a business area generally know what is required to have that area functioning sustainably (i.e. dealing responsibly with safety, the environment, employees, communities, governments and asset life), effectively and efficiently, and can recognise when work is required to rectify something that will affect the achievement of these objectives. In order to make the fullest use of all of the potential information that our people can gather, we encourage and require that all personnel initiate a Work Request whenever they identify the need for work.

The information supplied with a Work Request is used to ensure that:

- It is the Right Work - that is, the work is necessary for the sustainable, effective and efficient functioning of the business area.
- We have a good estimate of the Right Time (Required Date) - the time by which the work must be completed before it will have an impact (consequence).
- We understand the Impact of not completing the work by the Required Date, so we can make informed decisions when there is contention for any resource necessary to complete approved work.
- We understand the Right Way to execute the work, so we can appropriately estimate and prepare the requirements for the work.

The above criteria are the basis for the decision to approve a Work Request or not.

If invalid or incomplete information was provided by the Work Request originator, the data must be corrected before evaluation of the Work Request can be completed. This may involve contacting the originator, or the originator's immediate manager, for the additional input.

Where the person reviewing the Work Request decides to make a significant change to the data supplied with the request (e.g. Required Date, Impact), it is respectful to inform the originator that the work details have changed, and also supply the reasons why. This will provide an opportunity to ensure some wrong assumptions were not made while making the decision to change the information and will also provide feedback and coaching to the originator to improve and that will enhance the use of the work identification and request process. This feedback must be supplied to the originator through the originator's immediate manager.

### Purpose

To establish the input data required for approval of a Work Request.

### Quantity

- All required data entered for each Work Request

- Feedback to the originator through the originator’s immediate manager, where required

### Quality

The following Work Order fields must be validated or completed by the person reviewing a request prior to approval of the Work Request:

- The Equipment/Component or Workplace/Location for the work.
- Symptom or Action Description
- The manager accountable for reviewing/approving the Work Request.
- Required Date - the time by which the work must be completed before it will have an impact
- Impact - the consequence of not completing the work by the Required Date
- Originator’s identity.

The following Work Order fields should be completed, or information supplied, prior to approval of the request, where the person reviewing the request has sufficient knowledge or experience of the work to do so;

- Task Description(s) - outcome/action and object of each component of the work.
- Skill Types - Task Resource Work Group(s) and skill/equipment type(s) required for the work component.
- Skill Numbers - the number of each labour/equipment type for the work component.
- Task Duration - the estimated duration of the work component.
- Other materials and tools required for the work.

Where the person reviewing the Work Request decides to make a significant change to the data supplied with the request (e.g. Required Date, Impact), feedback to the originator shall include:

- The reason the details where altered,
- The individual who decided the changes were appropriate.

Feedback shall be provided to the originator through the originator's immediate manager.

### Time

Review of a Work Request must be completed within 1 working day of the creation of the Work Request.

WA Flowsheet

### Resources

Completion of this task is the accountability of the role nominated on the configured Work Approval flowchart.

AAOM Flowsheet

# WA.05 Is Capital Approval Needed?

### Context

The expense of performing work must be recorded in the Company's accounts. Both the taxation laws and Company policy require that Operating and Capital expenditures be correctly and separately identified in the Company's financial accounts.

In general, only a limited number of Company personnel have the authority to approve Capital. In the few instances where work that may be Capital is necessary to contain an emergency situation, the correct approval shall be obtained as soon as practical and may occur at the same time as the work is being started.

In a mining environment development is typically treated as a special case for work approval. Development costs are treated as capital expenditure in the Company's accounts, but development work is managed and executed in the same way as routine Production work. This situation arises because development is creating a new asset, and therefore needs to be capitalised, but the actual work of development is an ongoing activity that must progress steadily ahead of ore extraction. An approved (capital) budget for development is established based on a development Operating Master Schedule for the mine, in the same way that an approved operating budget is established based on the production and service work Operating Master Schedule. In this type of circumstance, where an approved capital budget exists, the approval of capital development work can be managed via the Work Approval process in exactly the same way as non-capital production and service work.

In all cases where it has been determined that the work is not urgent, and the work is of a Capital (excluding mine development) nature, then the capital approval process must be followed.

If the work is capital, the originator of the request should be notified of the status of the request, and of the reasons why.

### Purpose

To ensure the correct approval process is applied to the Work Request.

### Quantity

One decision whether the requested work is Operating/Development or Capital.

### Quality

The decision whether an expenditure is operating or capital shall be made in accordance with the Company standard for expenditure classification.

Approval of capital work shall follow the Company procedures for capital approval.

The originator of the request should be notified that the request is capital, and of the reasons why. Feedback shall be provided to the originator through the originator's immediate manager.

**Time**

Review of a Work Request must be completed within 1 working day of the creation of the Work Request.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Work Approval flowchart.

WA Flowsheet

AAOM Flowsheet

# WA.06 Is the Work Necessary?

## Context

The people working within a business area generally know what is required to have that area functioning sustainably (i.e. dealing responsibly with safety, the environment, employees, communities, governments and asset life), effectively and efficiently. They can recognise when work is required to rectify something that will affect the achievement of these objectives, and they can provide some basic information needed to process each Work Request.

While an employee may recognise a potential issue, they may not understand all of the circumstances surrounding the issue they observe, some of which may reduce or remove the need for action on the issue observed by the employee.

The technical review of each Work Request must establish that:

- Valid contributing causes of the issue are identified,
- Appropriate corrective actions are identified, and
- The issue that has been identified raises a genuine need for work.

There will be instances where an issue that is observed and raised by an employee will not require work. For example:

- A noise reported to be coming from equipment may, on further assessment, not indicate a problem,
- A minor oil leak on a truck transmission may not require repair if the transmission is due to be changed in the next few weeks, or
- A damaged drain line may not need repair if a new drain is due for installation.

If there are criteria or circumstances that make the Work Request unnecessary it should not be approved.

## Purpose

To approve only those Work Requests that are necessary.

## Quantity

One decision whether to approve or cancel the Work Request.

**Quality**

The decision criteria to be used are:

- Is the work necessary to meet the Sustainability objectives of the business area?
- Is the work necessary to meet the output or cost targets of the business area?
- Is there any other work or change of circumstance, that will occur before the Required Date for the work, that will make the request unnecessary?

This decision must be made by a person with the appropriate technical expertise.

If further information or clarification is required in order to adequately assess whether the work is necessary, the reviewer must consult with others.

**Time**

Review of a Work Request must be completed within 1 working day of the creation of the Work Request.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Work Approval flowchart.

WA Flowsheet

AAOM Flowsheet

# WA.07 Is the Scope of Work Appropriate?

### Context

The people working within a business area generally know what is required to have that area functioning sustainably (i.e. dealing responsibly with safety, the environment, employees, communities, governments and asset life), effectively and efficiently. They can recognise when work is required to rectify something that will affect the achievement of these objectives, and they can provide some basic information needed to process each Work Request.

While an employee may recognise a potential issue, they may not understand all of the technical details related to the issue they observe, and what is the most appropriate course of action.

The technical review of each Work Request must establish that:

- Valid contributing causes of the issue are identified,
- The issue that has been identified raises a genuine need for work,
- Appropriate corrective or control actions have been identified, and
- The corrective or control actions adequately address all requirements of workplace standards.

Some examples of multiple potential actions for an issue are;

- A high temperature reading on a bearing could require that either a damaged bearing or a faulty temperature sensor be replaced.
- An area of failing ground could require either that corroded ground support be replaced or that additional ground support be installed due to increased ground stresses.

It may not be possible to identify what the appropriate actions are without technical expertise and diagnostic tests.

### Purpose

To determine the most appropriate action to deal with an issue.

### Quantity

One decision on the appropriate corrective or control action.

### Quality

The Task description(s) must specify the action(s) that will most cost effectively deal with the contributing cause(s) of the issue underlying the work, as well as the object(s) that will be the subject of the work – each task description must be entered in the form of an action and an object – e.g. replace pump gland packing.

The Task(s) and specified actions must ensure that hazards and their associated risks are adequately addressed, and that workplace standards are met.

This decision must be made by a person with the appropriate technical expertise.

### Time

Review of a Work Request must be completed within 1 working day of the creation of the Work Request.

### Resources

Completion of this task is the accountability of the role nominated on the configured Work Approval flowchart.

WA Flowsheet

AAOM Flowsheet

# WA.08 Correct or Modify the Scope of Work

## Context

The people working within a business area generally know what is required to have that area functioning sustainably (i.e. dealing responsibly with safety, the environment, employees, communities, governments and asset life), effectively and efficiently. They can recognise when work is required to rectify something that will affect the achievement of these objectives, and they can provide some basic information needed to process each Work Request.

While an employee may recognise a potential issue, they may not understand all of the technical details related to the issue they observe, and what is the most appropriate course of action.

The technical review of each Work Request must establish that:

- Valid contributing causes of the issue are identified,
- The issue that has been identified raises a genuine need for work,
- Appropriate corrective or control actions have been identified, and
- The corrective or control actions adequately address all requirements of workplace standards.

Some examples of multiple potential actions for an issue are:

- A high temperature reading on a bearing could require that damaged bearing, or a faulty temperature sensor, be replaced.
- An area of failing ground could require that corroded ground support be replaced, or that additional ground support be installed due to increased ground stresses.

It may not be possible to identify what are the appropriate actions without technical expertise and diagnostic tests.

If the technical reviewer determines that the right actions have not been specified, they must specify appropriate actions for the contributing causes of the observed issue.

## Purpose

To correctly specify the most appropriate action for a necessary Work Request.

## Quantity

The most appropriate actions specified for each necessary Work Request.

**Quality**

The Right Action(s) is to be entered in the Task Description(s), in the form of an action and object – e.g. Replace gland packing, drill drain hole.

This task must be completed by a person with the appropriate technical expertise.

**Time**

Review of a Work Request must be completed within 1 working day of the creation of the Work Request.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Work Approval flowchart.

WA Flowsheet

AAOM Flowsheet

# WA.09 Establish Upper Cost Limit

**Context**

The review process for a Work Request has so far established a scope of work technically suitable to the sustainable (i.e. dealing responsibly with safety, the environment, employees, communities, governments and asset life), effective and efficient performance of a business area. However, these outcomes must be achieved at a cost that the business area can sustain.

Therefore, as part of the approval process, an assessment must be made whether:

- Funds are available in the budget,
- The funds are available for commitment, or
- There are lower cost alternatives for achieving the same outcomes, or
- Other work may need to be deleted from the budget, modified or deferred to make funds available for this work, and
- Any potential hazards and risks related to amendments of the budget activities are adequately addressed.

A cost estimate produced at this stage of the approval process will form the approved Upper Cost (expenditure) Limit for all future stages of the Work Order life. Note; if the cost appears likely to exceed this value at any future stage of the Work Order life, the issue must be referred back to the Work Approval process.

**Purpose**

To provide an Upper Cost Limit for work management decisions.

**Quantity**

One upper cost limit entered for each necessary and appropriate Work Request.

**Quality**

The cost estimates are to include all costs to complete the Work Request.
Total cost to include:

- Labour
- Materials
- Specialty tools
- Internal services
- External services

This task must be completed by a person with the appropriate technical expertise.

The upper cost limit for the work will be recorded in the Work Order.

**Time**

Review of a Work Request must be completed within 1 working day of the creation of the Work Request.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Work Approval flowchart.

WA Flowsheet

AAOM Flowsheet

# WA.10 Is the Work Within EPS?

### Context

As a business, most of the expenditure we incur is related to completing some work necessary to produce an outcome. Therefore, the key to effective forecasting and management of costs is the understanding and forecasting of the work and the resources required to complete it, and the management of cost commitments against that forecast. These key outcomes are achieved in the Operating Master Schedule (OMS) - define the work, the ExPenditure Schedule (EPS) - define the resources and cost, and the Work Approval process - understand and approve cost commitments.

The ExPenditure Schedule (EPS) is a costed version of the Operating Master Schedule (OMS). That is, the forecast cost for the Resource Types (labour, equipment, materials/spares and utilities etc) that will be required to implement the OMS is combined with a quantity estimate on each OMS Activity, and the frequency/timing of the Activities, to forecast the expenditure profile over time.

The review process for a Work Request has so far established a scope of work technically suitable to the sustainable (i.e. dealing responsibly with safety, the environment, employees, communities, governments and asset life), effective and efficient performance of a business area. However, these outcomes must be achieved at a cost that the business area can sustain, that is within the constraints of the approved Expenditure Schedule - the current working revision of the costed OMS.

To help make this decision an Upper Cost Limit was estimated for the scope of work that was defined during the review of the request.

Therefore, as part of the approval process, an assessment must be made whether:

- Funds are available in the forecast,
- The funds are available for commitment, or
- There are lower cost alternatives for achieving the same outcomes, or
- Other work may need to be deleted from the forecast, modified or deferred to make funds available for this work, and
- Any potential hazards and risks related to amendments of the forecast activities are adequately addressed.

### Purpose

To decide if funds forecast for the work are available for commitment.

### Quantity

One decision whether;

- Funds were included in the forecast for the requested work scope, and

- The forecast funds are available for commitment (i.e. they have not already been committed to another Work Order or re-allocated to another activity in the forecast).

**Quality**

This decision must be made based on a comparison of;

- the scope of work specified for the request,
- the activities (the work packages) specified in the forecast,
- the Upper Cost Limit estimated for the Work Request,
- the funds forecast for each occurrence of an activity, and
- the uncommitted funds forecast for the activity.

The work is within forecast if;

- the scope of work matches an activity that was included in the forecast, and
- the Upper Cost Limit estimated for the Work Request is consistent with the value forecast for each occurrence of a recurring activity, and
- there are sufficient uncommitted funds to cover the Upper Cost Limit estimated for the Work Order.

**Time**

Review of a Work Request must be completed within 1 working day of the creation of the Work Request.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Work Approval flowchart.

WA Flowsheet

AAOM Flowsheet

# WA.11 Are Funds Available from Other EPS Activities?

### Context

The review process for a Work Request has so far established a scope of work technically suitable to the sustainable (i.e. dealing responsibly with safety, the environment, employees, communities, governments and asset life), effective and efficient performance of a business area. However, these outcomes must be achieved at a cost that the business area can sustain, that is within the constraints of the approved ExPenditure Schedule (EPS) - the current working revision of the costed OMS.

To help make this decision an Upper Cost Limit was estimated for the scope of work that was defined during the review of the request.

Therefore, as part of the approval process, an assessment must be made whether:

- Funds are available in the forecast,
- There are lower cost alternatives for achieving the same outcomes, or
- Other work may need to be deleted from the forecast, modified or deferred to make funds available for this work, and
- Any hazards and risks related to amendments of the forecast activities are adequately addressed.

If the forecast did not specifically contain funds for the requested work, it must be decided if there are funds available from other forecast activities that can be committed to the request, without going outside of the purpose or expenditure limits of the forecast.

### Purpose

To decide if funds forecast for other activities are available for commitment to the Work Request.

### Quantity

One decision whether;

- The requested work scope is consistent with the purpose of the forecast, and
- Funds are available from another forecast activity for commitment to the Work Request (i.e. they have not already been committed to another work order or forecast activity), and
- These available funds will not be required for the forecast activity, or another activity, at a future time in the budget period.

### Quality

This decision must be made based on a comparison of;

- the purpose and scope of work for the request,
- the Upper Cost Limit estimated for the Work Request,

- the business purpose of the forecast,
- the predicted total business area expenditure compared to forecast (over or under),
- other forecast activities that are predicted to be underspent,
- the value of the predicted under expenditure,
- the probability that the unspent funds will not be required as forecast,
- other activities for which the unspent funds may be required,
- expectations of future demands on the forecast, and
- any potential hazards and risks related to amendments of the forecast activities.

The funds are available if;

- the scope of work is consistent with the purpose of the forecast, and
- a forecast activity is predicted to have uncommitted funds available, and
- there are sufficient uncommitted funds to cover the upper cost limit estimated for the Work Request, and
- the uncommitted funds will not be required at a future time in the budget year, and
- any potential hazards and risks related to amendments of the forecast activities are adequately addressed.

**Time**

Review of a Work Request must be completed within 1 working day of the creation of the Work Request.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Work Approval flowchart.


WA Flowsheet


AAOM Flowsheet

## WA.12 Are funds available from another EPS area?

### Context

The review process for a Work Request has so far established a scope of work technically suitable to the sustainable (i.e. dealing responsibly with safety, the environment, employees, communities, governments and asset life), effective and efficient performance of a business area. However, these outcomes must be achieved at a cost that the business area can sustain, that is within the constraints of the approved ExPenditure Schedule (EPS) - the current working revision of the costed OMS.

To help make this decision an Upper Cost Limit was estimated for the scope of work that was defined during the review of the request.

Therefore, as part of the approval process, an assessment must be made whether:

- Funds are available in the forecast,
- There are lower cost alternatives for achieving the same outcomes, or
- Other work may need to be deleted from the forecast, modified or deferred to make funds available for this work, and
- Any hazards and risks related to amendments of the forecast activities are adequately addressed.

If uncommitted forecast funds are not available for the Work Request from within a business area forecast, the request must be escalated to the person accountable for a larger group of business area forecasts. They will then decide whether funds are available within the larger group of area forecasts, and whether to approve the over expenditure against the individual forecast, offset the over expenditure against under expenditure in another area(s), and transfer the funds between areas in the next forecast update.

### Purpose

To decide if funds from other budget areas are available for commitment to the Work Request.

### Quantity

One decision whether;

- The requested work scope is consistent with the purpose of the Expenditure Schedule, and
- Funds are available from another EPS area for commitment to the Work Request (i.e. they have not already been committed to another work order) and,
- These available funds will not be required for the forecast activity, or another activity, at a future time in the Operating Master Schedule.

### Quality

This decision must be made based on a comparison of;

- the purpose and scope of work for the request,
- the Upper Cost Limit estimated for the Work Request,
- the business purpose of the forecasts,
- the predicted total expenditure across business areas compared to forecast (over or under),
- other forecast areas and activities that are predicted to be underspent,
- the value of the predicted under expenditure,
- the probability that the unspent funds will not be required as forecast,
- other areas and activities for which the unspent funds may be required,
- expectations of future demands on the forecasts, and
- any potential hazards and risks related to amendments of the forecast activities.

The funds are available if;

- the scope of work is consistent with the purpose of the forecast, and
- a forecast area is predicted to have uncommitted funds available, and
- there are sufficient uncommitted funds to cover the upper cost limit estimated for the Work Request, and
- the uncommitted funds will not be required at a future time in the budget year, and
- any potential hazards and risks related to amendments of the forecast activities are adequately addressed.

### Time

Review of a Work Request must be completed within 1 working day of the creation of the Work Request.

### Resources

Completion of this task is the accountability of the role nominated on the configured Work Approval flowchart.

WA Flowsheet

AAOM Flowsheet

# WA.13 Is There an Alternative Approach?

### Context

The review process for a Work Request has so far established a scope of work technically suitable to the sustainable (i.e. dealing responsibly with safety, the environment, employees, communities, governments and asset life), effective and efficient performance of a business area. However, these outcomes must be achieved at a cost that the business area can sustain, that is within the constraints of the approved expenditure budget or current approved forecast (the term forecast will be used to refer to either the budget or current approved forecast).

To help make this decision an Upper Cost Limit was estimated for the scope of work that was defined during the review of the request.

Therefore, as part of the approval process, an assessment must be made whether:

- Funds are available in the forecast,
- There are lower cost alternatives for achieving the same outcomes, or
- Other work may need to be deleted from the forecast, modified or deferred to make funds available for this work, and
- Any hazards and risks related to amendments of the forecast activities are adequately addressed.

If uncommitted funds are not available for the Work Request from other activities within the forecast of the business area, or from activities in a larger group of business area forecasts, either an alternative approach to meeting the purpose (or some of the purpose) of the request must be found, or the request cannot proceed.

### Purpose

To decide if there is alternative approach that will satisfy the purpose of the Work Request.

### Quantity

One decision whether there is any other option that will wholly or partly meet the purpose of the Work Request.

### Quality

The criteria to be used for this decision are:

- Is there a less expensive alternative to satisfy the purpose of the request?
- Is there a temporary correction or control, that the forecast can support, that will achieve the essential purpose of the Work Request and allow the more extensive work to be included in a future forecast?

- Can a practice, procedure or operation be modified to reduce or remove the need for the work?
- Are any hazards and risks associated with changes to work scope or method adequately considered and addressed?
- Is the consequence of not doing the work acceptable?
- Can action be taken to limit the consequences of not doing the work?
- Are the potential consequences of an alternative approach, delaying the work, or taking no action within the risk guidelines for the business area?

This decision must be made by a person with the appropriate technical expertise.

If a change to the work specification is possible, the request is to be directed back to the appropriate person for modification.

If the work is not required, the Work Request is to be cancelled.

**Time**

Review of a Work Request must be completed within 1 working day of the creation of the Work Request.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Work Approval flowchart.

WA Flowsheet

AAOM Flowsheet

# WA.14 Cancel the Work Request

**Context**

The review process for a Work Request has so far established a scope of work technically suitable to the sustainable (i.e. dealing responsibly with safety, the environment, employees, communities, governments and asset life), effective and efficient performance of a business area. However, these outcomes must be achieved at a cost that the business area can sustain, that is within the constraints of the approved expenditure budget or current approved forecast (the term forecast will be used to refer to either the budget or current approved forecast).

To help make this decision an Upper Cost Limit was estimated for the scope of work that was defined during the review of the request.

Therefore, as part of the approval process, an assessment must be made whether:

- Funds are available in the forecast,
- There are lower cost alternatives for achieving the same outcomes, or
- Other work may need to be deleted from the forecast, modified or deferred to make funds available for this work, and
- Any hazards and risks related to amendments of the forecast activities are adequately addressed.

If uncommitted funds are not available for the Work Request either from within the business area forecast or from within a larger group of business area forecasts, either an alternative approach to meeting the purpose (or some of the purpose) of the request must be found, or the request cannot proceed.

If there are no funds available to proceed with the Work Request, and no modified scope of work is necessary to control hazards, and the associated risks, that might otherwise arise if the Work Request were not approved, then the Work Request should be cancelled.

**Purpose**

To terminate processing of the Work Request.

**Quantity**

One status code indicating that the Work Request was cancelled.

**Quality**

Set Work Request status to Cancelled.

**Time**

Review of a Work Request must be completed within 1 working day of the creation of the Work Request.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Work Approval flowchart

WA Flowsheet

AAOM Flowsheet

# WA.15 Approve the Work

### Context

The review process for a Work Request has established that the work is necessary.

The process has also defined an appropriate scope of work – technically suitable and cost effective to maintain sustainable (i.e. by dealing responsibly with safety, the environment, employees, communities, governments and asset life), effective and efficient performance of the business area.

The process has also established that there are funds available to proceed with the Work Request.

With all of these conditions met the work can be approved.

### Purpose

To approve the continued processing of the Work Request.

### Quantity

One status code indicating that the Work Request is approved.

### Quality

The work order status code A (Approved) shall be entered on the Work Request and a Work Order created from the request.

### Time

Review of a Work Request must be completed within 1 working day of the creation of the Work Request.

### Resources

Completion of this task is the accountability of the role nominated on the configured Work Approval flowchart.

## WA.16 Notify Originator

### Context

The people working within a business area generally know what is required to have that area functioning sustainably (i.e. dealing responsibly with safety, the environment, employees, communities, governments and asset life), effectively and efficiently, and can recognise when work is required to rectify something that will affect the achievement of these objectives. In order to make the fullest use of all of the potential information that our people can gather, we encourage and require that all personnel initiate a Work Request whenever they identify the need for work.

During the process of reviewing the Work Request it may be determined that there are other circumstances that make the request un-necessary, or that funding is not available for the work. In these cases the Work Request will be cancelled.

When a Work Request is cancelled the originator of the request should be notified of the fact and explained the reasons for cancelling the request.

### Purpose

To provide a prompt explanation of the reasons a Work Request is cancelled.

### Quantity

One discussion with the originator of a cancelled Work Request.

### Quality

Feedback on the cancellation of a Work Request should include;
- Notification that the request has been cancelled, and
- Explanation of the reasons the request has been cancelled.

Wherever possible feedback should be given in person, preferably through the originator’s immediate manager.

### Time

WA Flowsheet

Review of a Work Request must be completed within 1 working day of the creation of the Work Request.

AAOM Flowsheet

Feedback should be provided during the originator’s next working shift that occurs after the cancellation of the Work Request.

### Resources

Completion of this task is the accountability of the role nominated on the configured Work Approval flowchart.

# WA.17 Is Work Scheduling System Generated Work > Approval Threshold

### Context

A Work Scheduling Systems (WSS) can be used to automatically create Work Orders for any work that recurs based on a measurable trigger parameter. WSS generated Work Orders are triggered from the measured values of parameters such as time, operating hours, volume transferred, or occurrence of an event such as another work activity etc.

The WSS scheduled Work Orders are established based on approved Production and Service strategies and should reflect the implementation of the Operating Master Schedule.

The Operating Master Schedule (OMS), and its regular revisions, are assessed for their ability to deliver the stable process performance at the confidence levels required for the process Performance Targets. The OMS specifically identifies those Activities that can have a high impact on the stability of the process performance around its target, and groups the bulk of the production and service work into other Activity populations for statistical modelling.

The OMS and its regular revisions must be approved by the appropriate manager, and hence, after the content of the WSS is updated to reflect the approved Operating Master Schedule we can say that Work Orders generated by the WSS are also approved in principle.

The majority of the WSS generated work packages will have work scope and timing that is well defined and regulated by the approved Production and Service strategies. However, where work packages have significant potential for variation between the OMS assumptions and their actual scope and timing when due, their approval should be considered when they become due. Based on the circumstances at that time, the scope and timing that is necessary, appropriate and funded may be revised.

If a Work Order that is forecast by the WSS has the potential to impact performance stability, that is greater than the threshold agreed by the responsible manager, that Work Order must be reviewed and approved before further commitment of resources.

### Purpose

To approve high impact WSS generated work packages before they are committed to the schedule.

### Quantity

All WSS scheduled work that is above a defined impact threshold processed through the Work Approval Process immediately they appear on the forecast.

**Quality**

The output target impact (process output or loss) for a WSS scheduled Work Order shall be the value that is compared to the threshold value for approval.

The Upper Cost Limit for a WSS scheduled Work Order shall be the value that is compared to the threshold value for approval.

The threshold value shall be defined and documented by the person responsible for the performance targets for a business area.

**Time**

Review of a WSS scheduled Work Order must be completed within 1 working day of the work first appearing on the forecast.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Work Approval flowchart.

WA Flowsheet

AAOM Flowsheet

AngloAmerican

INTERNAL

# ANGLO AMERICAN OPERATING MODEL: WORK MANAGEMENT
## PLANNING

**UPDATED: AUGUST 2018**

**CONTENTS**



PL Flowsheet

AAOM Flowsheet

# PL.00 Planning Work

## Context

For a business area to be successful in delivering its agreed output targets, at the lowest practical cost, it must complete the Right Work at the Right Time and in the Right Way. This work must also be completed sustainably, i.e. by dealing responsibly with safety, the environment, employees, communities, governments and asset life.

In all discussions relating to the Operating Model, the term planning is used to describe the activity of preparing a work package that defines;

- the work,
- the standards that the work must deliver or meet,
- any special procedures or requirements for doing the work and
- what is needed to do the work,

Work is planned to ensure that everything necessary to deliver the right work, safely and efficiently is identified before the work commences.

If work is well planned before it is started it is possible to ensure that all of the personnel and material requirements for the work are fit for purpose and in place when needed. This will help ensure that no outcome required of the work will be omitted or completed to the wrong standard, and there will be no delays chasing after people, parts or equipment after the work has started.

Well planned work also has a high correlation with the achievement of safe, and environmentally sound, outcomes, i.e. significant incidents and harm are commonly associated with unplanned, or poorly planned, work.

## Purpose

To specify the requirements for completing approved work.

## Quantity

One process to determine the appropriate work package content for approved work.

## Quality

A planned work package may include the following requirements for the work;

- Identification of equipment/ /component or workplace/location to which the work relates.
- The elements of the work that will need to be separately identified within a schedule,
- Each distinct outcome for the work (what must be achieved at each stage, and at completion, of the work).
- Tolerance or standard required for each outcome.
- Conditions or constraints applying to the work.

- Identification of potential hazards and management of the associated risks.
- Permits and isolations.
- Method or procedure for achieving the outcomes.
- People, knowledge and skills.
- Parts, materials, technical documents, tools and equipment.
- Acceptance tests and procedures for completion and handover.
- Acceptance standards for completion and handover.
- Duration and sequencing of job components.
- Earliest and latest start dates.
- Recording of work progress.
- Recording of job history.

If any proposed work outcome or work method is not consistent with established practice, or approved work procedures, then change management processes must be followed.

The planning of the work includes the preparation of all documents (Work Orders, specifications, procedures/instructions, purchase orders, service contracts, task schedules, report forms etc) required for the work.

The **minimum requirement** for a planned work package is a Work Order identifying;

- The equipment/component or workplace/location to which the work relates.
- An outcome for the work (comprising an action and an object – e.g. replace bucket lift cylinder, drill blast pattern at face 3, reconcile bank statement XYZ).
- The number and type of resources required (where components of the work occur at different times or require different types or numbers of resources these should be specified in separate Tasks within the work order).
- The duration of the work (and each Task comprising the work).
- The period in which the Task should be completed (defined by the earliest start date and the Required Date).
- The impact of not completing the work on time.

In deciding whether to include any additional elements in the planning of the work package the following guidelines should be used.

- If there is a specific workplace condition or constraint (e.g. shutdown, empty, restricted access etc) specify it.
- If any intermediate or additional Outcome must be achieved in the process of completing the work state it.
- If there is an Outcome standard or tolerance that must be met specify it.
- If there are any recognised potential hazards then these, plus the appropriate controls (permits, isolations, barriers, guarding, PPE etc) must be specified. If there is a general hazard assessment procedure that is applicable, then it should be referenced or provided.

PL Flowsheet

AAOM Flowsheet

- If there is a preferred method/procedure or sequence for doing the work provide it.
- If any special skills are needed specify them.
- If any parts, materials, technical documents, tools or equipment are needed (that are not readily accessible by the employee skill type assigned to the work) then specify them.
- If the work is complex and likely to extend over many hours, or more than one shift, then specify a method for job tracking.
- If information is required for future analysis then specify what must be recorded.

The detailed activities of planning a work package shall conform to the specifications set out in the Planning process flowchart and Task Assignments PL.01 to PL.25.

# PL.01 Is there an Existing Job Template?

## Context

In the simplest terms, the planning of a work package defines; the work, the standards that the work must meet, how the work should be done, and what is needed to do the work.

The content of a well specified work package may include;

- Identification of equipment/component or workplace/location to which the work relates.
- The elements of the work that will need to be separately identified within a schedule,
- Each distinct outcome for the work (what must be achieved at each stage, and at completion, of the work).
- Tolerance or standard required for each outcome.
- Conditions or constraints applying to the work.
- Identification of potential hazards and management of the associated risks.
- Permits and isolations.
- Method or procedure for achieving the outcomes.
- People, knowledge and skills.
- Parts, materials, technical documents, tools and equipment.
- Acceptance tests and procedures for completion and handover.
- Acceptance standards for completion and handover.
- Duration and sequencing of job components.
- Earliest and latest start dates.
- Recording of work progress.
- Recording of job history.

If any proposed work outcome or work method is not consistent with established practice, or approved work procedures, then change management processes must be followed.

Creating a well specified work package can take a considerable amount of time and, as many work packages are repeated through the operating life of a business area, it is efficient to create a template for work packages that will be repeated.

PL Flowsheet

Before starting the planning for a newly approved Work Order or Task a check should be made to determine if there is an existing template for the work.

## Purpose

AAOM Flowsheet

To identify if there is a template that will reduce the planning required for approved work.

**Quantity**

One decision whether there is a template that is substantially the same as the requirements of the approved work.

**Quality**

The decision criteria to be used are;

- there is a template that fits the known details of the approved work, and
- building the detail from the template will reduce the planning effort, or
- building the detail from the template will improve planning quality.

**Time**

This activity must be completed in time for all of the planning, scheduling and resourcing activities for the work to be completed before the Scheduled Start Date for the work.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Planning flowchart.

# PL.02 Incorporate the Template into the Work Order

## Context

In the simplest terms, the planning of a work package defines; the work, the standards that the work must meet, how the work should be done, and what is needed to do the work.

The content of a well specified work package may include;

- Identification of equipment/component or workplace/location to which the work relates.
- The elements of the work that will need to be separately identified within a schedule,
- Each distinct outcome for the work (what must be achieved at each stage, and at completion, of the work).
- Tolerance or standard required for each outcome.
- Conditions or constraints applying to the work.
- Identification of potential hazards and management of the associated risks.
- Permits and isolations.
- Method or procedure for achieving the outcomes.
- People, knowledge and skills.
- Parts, materials, technical documents, tools and equipment.
- Acceptance tests and procedures for completion and handover.
- Acceptance standards for completion and handover.
- Duration and sequencing of job components.
- Earliest and latest start dates.
- Recording of work progress.
- Recording of job history.

If any proposed work outcome or work method is not consistent with established practice, or approved work procedures, then change management processes must be followed.

Creating a well specified work package can take a considerable amount of time and, as many work packages are repeated through the operating life of a business area, it is efficient to create a template for work packages that will be repeated.


PL Flowsheet

If there is a job template that is a relatively close fit to the specifications for the work that is to be planned the planning time can be reduced and the quality improved if the template is incorporated into the Work Order/Task.


AAOM Flowsheet

A template may be for generic equipment/locations and work content, e.g. change a centrifugal pump seal, or for a specific equipment/location and work content, e.g. replace liners in Fine Ore Bin A. In the case of the generic template there will be some parameters of the work package that will need to be altered to suit the specific equipment/location, e.g. a part number or tolerance, or hazards and risks. In the case of a specific template there may still be some elements of the template that can vary from one execution to another e.g. exactly which liners are to be replaced.

Therefore, after the template has been incorporated into the Work Order/Task, each element of the template should be reviewed to identify and, where necessary, make any changes required for the specific Work Order/Task.

**Purpose**

To increase the return from previous planning effort by using it as a base for planning new work.

**Quantity**

All data from an appropriate job template incorporated into the Work Order/Task to be planned.

**Quality**

Incorporation of the job template is done in accordance with the Work Management System (WMS) procedure for merging a job template into a Work Order/Task.

The details incorporated from the job template should be reviewed, in accordance with remainder of the Planning flowchart, and any specific adjustments required for the work package made.

**Time**

This activity must be completed in time for all of the planning, scheduling, and resourcing activities for the work to be completed before the Scheduled Start Date for the work.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Planning flowchart.

# PL.03 Is Additional or Skilled Input Required?

## Context

Once a Work Order/Task is approved it contains a set of basic information defining the work, provided by the originator or approver of the work.

For relatively simple work packages this basic information may be sufficient to complete the planning.

For complex work packages, more, or skilled, information may need to be gathered and compiled to complete the planning. Gathering or compiling some of the additional information may require that resources and time be assigned to this activity. This may be a detailed inspection and assessment of the equipment/workplace, work site, parts or materials etc, or the preparation of specialised technical input such as a specification or work procedure. This activity requires the assignment of a resource (a miner, tradesman, operator, engineer etc) to do the work, and a time for the work to be completed. In order to ensure that the right information is gathered, by the right resource, at the right time, the Task of getting the information often needs to be scheduled, planned, and resourced.

At the commencement of planning it must be decided whether a Task needs to be added to the Work Order to gather additional or skilled planning information.

## Purpose

To determine whether a Task for additional/skilled input needs to be added to a Work Order.

## Quantity

One decision whether additional skilled information is required to complete the planning of a Work Order.

## Quality

If the person accountable for planning does not have the information required to correctly specify each of the following work package components that are relevant to the work;

- identification of equipment/component or workplace/location to which the work relates,
- the elements of the work that will need to be separately identified within a schedule,
- each distinct outcome for the work (what must be achieved at each stage, and at completion, of the work),
- tolerance or standard required for each outcome,
- conditions or constraints applying to the work,
- Identification of potential hazards and management of the associated risks,
- permits and isolations,

PL Flowsheet

AAOM Flowsheet

- method or procedure for achieving the outcomes,
- people, knowledge and skills,
- parts, materials, technical documents, tools and equipment,
- acceptance tests and procedures for completion and handover,
- acceptance standards for completion and handover,
- Duration and sequencing of job components,
- earliest and latest start dates,
- recording of work progress,
- recording of job history,

then additional or skilled input may be required in order to obtain the information.

**Time**

Review of the requirements for planning a Work Order/Task must be completed within 1 working day of the approval of the Work Order/Task.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Planning flowchart.

## PL.04 Create a Task for the Additional/Skilled Input

### Context

Once a Work Order/Task is approved it contains a set of basic information defining the work, provided by the originator or approver of the work.

For relatively simple work packages this basic information may be sufficient to complete the planning required to schedule, resource and execute the work.

For complex work packages, more, or skilled, information may need to be gathered and compiled to complete the planning. Gathering or compiling some of the additional information may require a resource and time be assigned to this activity. This may be a detailed inspection and assessment of the equipment/workplace, work site, parts or materials etc, or the preparation of specialised technical input such as a specification or work procedure. This activity requires the assignment of a resource (a miner, tradesman, operator, engineer etc) to do the work, and a time for the work to be completed. In order to ensure that the right information is gathered, by the right resource, at the right time, the Task of getting the information often needs to be planned, scheduled and resourced.

If a resource must be scheduled to provide additional/skilled planning input, a Task must be added to the Work Order.

### Purpose

To specify the requirements for additional/skilled information.

### Quantity

One Task added to the Work Order.

### Quality

A planned work package may include the following requirements for the work:

- Identification of equipment/ /component or workplace/location to which the work relates.
- The elements of the work that will need to be separately identified within a schedule.
- Each distinct outcome for the work (what must be achieved at each stage, and at completion, of the work).
- Tolerance or standard required for each outcome.
- Conditions or constraints applying to the work.
- Identification of potential hazards and management of the associated risks.
- Permits and isolations.
- Method or procedure for achieving the outcomes.
- People, knowledge and skills.
- Parts, materials, technical documents, tools and equipment.
- Acceptance tests and procedures for completion and handover.

PL Flowsheet

AAOM Flowsheet

- Acceptance standards for completion and handover.
- Duration and sequencing of job components.
- Earliest and latest start dates.
- Recording of work progress.
- Recording of job history.

If any proposed work outcome or work method is not consistent with established practice, or approved work procedures, then change management processes must be followed.

Some or all of the above detail may need to be specified for the task and may require additional or skilled input.

The Task for additional or skilled input shall specify the elements of the work package content for which planning input is required.

The additional or skilled information shall specify all details that matter to the execution or outcomes of the work.

**Time**

This activity must be completed in time for all of the planning and scheduling, resourcing activities for the work to be completed before the Scheduled Start Date for the work.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Planning flowchart.

# PL.05 Specify Tasks

## Context

To develop a quality work package each separate Task, and each outcome required for each Task, must be specified.

A Task is a separately schedulable component of the work package, i.e. a component that may be have different scheduling criteria from other components of the work. These may include a different time of execution or different types or levels of resources. For example, replacing a faulty pipe spool may have 3 Tasks identified:

- Field measure the existing pipe spool to determine critical dimensions to provide a fabrication drawing.
- Manufacture the pipe spool as per the drawing.
- Install the new pipe spool in place of the faulty pipe spool.

Each of these Tasks will likely have a different time of execution and different types or levels of resources.

A task may involve only a single outcome or may require a number of sub-outcomes to be achieved. An outcome is a condition or state that must be achieved in the process of completing the work to the standard required. If it is important **that something be achieved** during the work, then it is an outcome. If it is important **how something be achieved** during the work, then a work procedure is required.

For example, repairing a crack in a steel component may require the following outcomes and specifications:

- Test with dye penetrant to define the location and length of the crack,
- Grind out all of the indicated crack length + 25mm at each end;
- Test with dye penetrant to confirm that the crack has been ground out,
- Clean the ground surface with XXX.
- Fill weld the ground area with YYY.
- Grind the finished weld flat with the original component surface.

For example, crushing of ore feed prior to the grinding circuit may require the following outcomes and specifications:

- Set apron feeder to achieve a feed of 200tph.
- Run CV01at the speed to achieve no spillage.
- Set crusher gap to achieve 50mm product sizing.
- Operate crusher in a choke feed state.


PL Flowsheet


AAOM Flowsheet

Therefore, if a component of the work has different scheduling parameters a separate Task must be created for it. Each outcome that is necessary for the Task must be specified.

## Purpose

To specify all Tasks necessary for scheduling the work package.

**Quantity**

Each separately schedulable component of a work package shall be specified by;

- The creation of a separate Task within the Work Order, and
- defining the Task in the Task Description.

The specification for an outcome of a Task shall include the following elements:

- Description of the outcome,
- Standard, tolerance or acceptance limit.

**Quality**

- Each separately schedulable component of the work shall be specified as a separate Task in the work order. The Task Description shall, as a minimum, comprise an action and an object – e.g. replace bearing, hang fan.
- Each Outcome that is necessary for the successful completion of the Task must be specified. A Task may comprise a single Outcome or many Outcomes.
- Specific tolerances or limits on a Task Outcome, as necessary (e.g. bearing clearance 0.1mm).
- As the Planning process proceeds, other elements of a quality planned work package must be considered, and where appropriate specified, for each Task, i.e.
  - Conditions or constraints applying to the work.
  - Identification of potential hazards and management of the associated risks.
  - Permits and isolations.
  - Method or procedure for achieving the outcomes.
  - People, knowledge and skills.
  - Parts, materials, technical documents, tools and equipment.
  - Acceptance tests and procedures for completion and handover.
  - Acceptance standards for completion and handover.
  - Earliest and latest start dates.
  - Recording of work progress.
  - Recording of job history.
- If any proposed work outcome or work method is not consistent with established practice, or approved work procedures, then change management processes must be followed.

**Time**

This activity must be completed in time for all of the planning, scheduling and resourcing activities for the work to be completed before the Scheduled Start Date for the work.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Planning flowchart.

# PL.06 Specify Conditions & Constraints on the Tasks

### Context

Execution of a Task may require, or impose, specific conditions or constraints in the workplace. Some of these may affect the placement of the Task with other a Tasks in a schedule viz the conditions or constraints define the synergies and conflicts that need to be managed in the scheduling process. For example, a condition on a Task may require that a business area be shutdown or operating. Similarly, undertaking some Tasks may restrict access in or around an area e.g. where equipment used in the work will occupy what is normally an access way or, if the work creates a potential hazard then execution may require the constraint that there be no other work taking place at the same time in the immediate area. Note that while a hazard may result in a constraint, in the Planning process conditions and constraints are distinct from potential hazards, their associated risks, and the controls used to manage them. The planning of hazards and controls is dealt with in a separate Task Assignment.

In order to successfully schedule Tasks any conditions or constraints that are necessary for work must be specified. While some conditions or constraints may have been identified and recorded at the approval of the work, it is essential that all relevant conditions and constraints be specified during the planning of each Task.

### Purpose

To specify each condition/constraint that must be applied to each Task.

### Quantity

The Task documentation shall as a minimum specify each mandatory condition or constraint.

### Quality

The specification shall include anything that **must** be;

- established prior to the commencement of the work (e.g. areas either shutdown or operating, storage areas full or empty),
- maintained during the work (e.g. specific operating conditions or access to the work site),
- restricted during the work (e.g. access through/above/below the work site), and
- any other condition or constraint that is necessary for the work.

If the method of achieving a condition or constraint matters, the Task must also specify the required method.


PL Flowsheet


AAOM Flowsheet

### Time

This activity must be completed in time for all of the planning, scheduling and resourcing activities for the work to be completed before the Scheduled Start Date for the Task(s).

### Resources

Completion of this task is the accountability of the role nominated on the configured Planning flowchart.

# PL.07 Specify Hazard Controls & Permit Requirements

## Context

Execution of a Task may involve exposure to, or creation of, potential hazards and risks to the environment, employees and communities. To manage these potential hazards or risks we must build defences that will protect against harm, put these defences into action, continually review their integrity and upgrade their effectiveness.

Doing this effectively requires:
- Identification of hazards in and around the work area.
- Identifying and assessing the associated risks.
- Developing controls to guard against the risks.
- Ensuring that the controls are in workplace standards, work procedures and work packages.
- Ensuring that people are mindful about the risks around them.
- Monitoring to ensure that the controls are implemented and remain effective.
- Reviewing the integrity of the system over time.

In many cases the potential hazards can and have been anticipated ahead of time and standard controls and permits have been created, e.g. isolation and tagging of energy sources, work within a confined space or at heights.

Regardless of prior experience, it may not be possible to identify all potential hazards, risks and controls until a physical assessment of the work area has been made for unusual or unexpected conditions.

The preparation of a quality Task should include the identification of all obvious hazards and risks that may be associated with the work, plus specification of the appropriate control actions. Wherever practical, controls should be implemented as layers of defence, i.e. where multiple controls are in place, e.g. work permits, physical barriers, isolation and personal protective equipment. The Task should also include guidelines for the identification and control of hazards and risks that may only be obvious at the work area (e.g. using a Job Safety Analysis process).

## Purpose

To control all potential hazards and risks associated with a Task.

PL Flowsheet

AAOM Flowsheet

## Quantity

For each known or obvious potential hazard to employees, communities and the environment:
- Determine the potential events that may occur (e.g. electrocution, drowning, falling etc).
- Identify the potential hazards and risks that may cause or be associated with the particular event.

- Specify the methods for control.
- Specify how to evaluate the effectiveness of the controls.

Specify the approach to be used to assess the work/workplace and identify other potential hazards, risks and controls.

**Quality**

The minimum requirement is that a Job Safety Analysis (JSA) be completed prior to the commencement of a Task.

Any permit required for the work shall be supplied (either as a blank form or partially/fully completed document as appropriate).

**Time**

This activity must be completed in time for all of the planning, scheduling and execution activities for the work to be completed before the Scheduled Start Date for the Task(s).

**Resources**

Completion of this task is the accountability of the role nominated on the configured Planning flowchart.

# PL.08 Specify Work Instructions & Procedures

## Context

To develop a quality Task each outcome required from the work must be specified. If the required outcome must meet a specific tolerance or standard then it must also be specified.

In some cases, there may be several methods of achieving a specified outcome and tolerance, all of which are equally acceptable. In other cases, one particular method may be preferred for safety, environmental, technical, quality or other reasons. For example, the workshop manual for a car may not specify the sequence for tightening the wheel nuts, but it will almost certainly specify the sequence for tightening the head studs – because in the case of the wheel it doesn't matter, and in the case of the head the wrong sequence may lead to a gasket or head failure.

If it is important **that something be achieved** during the work, then it is an outcome. If it is important **how something be achieved** during the work, then a work procedure is required.

## Purpose

To specify each work method that is important to the achievement of the Task outcomes.

## Quantity

One job instruction/procedure for each activity where a specific work method is required.

## Quality

The level of detail required in the instruction/procedure will be determined by the answer to following question:

If a step in the procedure is not included, can assurance be given that the outcomes will be the same, regardless how the work is performed?

If the answer is no, the step is to be included.

The procedure may be included in the Task or identified by a reference in the Task to manuals or technical support documents. The location of these manuals or documents shall be identified in the Task.

PL Flowsheet

AAOM Flowsheet

**Time**

This activity must be completed in time for all of the planning, scheduling and resourcing activities for the work to be completed before the Scheduled Start Date for the Task(s).

**Resources**

Completion of this task is the accountability of the role nominated on the configured Planning flowchart.

# PL.09 Specify Test & Handover Procedures/ Specifications

### Context

A work package is to define all the requirements for sustainably (i.e. dealing responsibly with safety, the environment, employees, communities, governments and asset life), correctly and efficiently completing work.

When work is completed on/with an equipment/workplace it should be left in a condition and location that is appropriate to the next function scheduled for the equipment/workplace (which could be a Service or a Production task).

To achieve this, the last steps of each Task should be validating that the equipment/workplace is in an appropriate condition and/or location to perform its next intended function to the required standards.

In developing a quality work package the condition and/or location that the equipment/workplace must be left in should be specified. If it must meet a specific standard (performance, tolerance, cleanliness etc) at the end of the work package then this must also be specified.

In some cases, there may be several methods of validating equipment/workplace condition and/or location, all of which are equally acceptable. In other cases, one particular method may be preferred for safety, technical, quality or other reasons.

If it is important **that something be achieved** at completion the work, then it must be validated. If it is important **how the validation is made**, then a test and handover procedure is required.

### Purpose

To specify the test and handover procedures necessary to validate that an equipment/workplace is fit for its next intended function.

### Quantity

One specification for each criterion necessary to validate that an equipment/workplace is fit to hand over.

One job instruction/procedure for each criterion where a specific validation method is required.

### Quality

The level of detail required in the specification/procedure will be determined by the answer to following question:

PL Flowsheet

AAOM Flowsheet

If a criteria or step in the procedure is not included, can assurance be given that the equipment/workplace will be in the correct condition and location for its next intended function?

If the answer is no, the criteria or procedure step is to be included.

The handover condition and location should be specified in the Task.

The procedure may be included in the Task instructions or identified by a reference in the Task to manuals or technical support documents. The location of these manuals or documents shall be identified in the Task.

**Time**

This activity must be completed in time for all of the planning, scheduling and resourcing activities for the work to be completed before the Scheduled Start Date for the Task(s).

**Resources**

Completion of this task is the accountability of the role nominated on the configured Planning flowchart.

# PL.10 Specify Work Group Resources

### Context

A work package is to define all the requirements for sustainably (i.e. dealing responsibly with safety, the environment, employees, communities, governments and asset life), correctly and efficiently completing work.

Once the, Outcomes, Tolerances and Specifications, Conditions and Constraints and Work Instructions for each Task are specified it is possible to determine the number and types of Work Group resource that will be required for each Task.

The Work Group resource specifications from the Task will be used for matching re-assignable resources that have independent capability (e.g. manned equipment or labour skill type) to the Task in the scheduling process. Therefore, it is important that all Work Group resource requirements be defined for the specific Task in which they will be required.

Work Centre resources have independent capability, they are able to complete work without other resources being required - unlike Specialised Tools or Equipment.

The Work Group resource specification identifies the person(s) who will require the instructions for completing each Task.

### Purpose

To specify the Work Group resources required for each Task of a work package.

### Quantity

For each Task, specify all Work Group resources required for completion of the Task.

### Quality

Work Group resources may include;

- Labour Skill Type, and
- Manned Equipment.

For each resource requirement specify:

- the Work Group from which resource is to be supplied,
- each distinct capacity or skill type (100 truck off road truck, 12m3 loader, fitter, welder, electrician etc),
- the number of each resource.

PL Flowsheet

AAOM Flowsheet

NB.

- The Work Group resource assigned to a Task is assigned for the complete Duration of the Task.

- the period for which the Work Group resource must be scheduled will be identified by the Scheduled Start Date/time (assigned to the Task during Scheduling) and the Duration of the task (assigned later in the Planning process).

**Time**

This activity must be completed in time for all of the planning, scheduling and resourcing activities for the work to be completed before the Scheduled Start Date for the Task(s).

**Resources**

Completion of this task is the accountability of the role nominated on the configured Planning flowchart.

# PL.11 Specify Materials

### Context

A work package is to define all the requirements for sustainably (i.e. dealing responsibly with safety, the environment, employees, communities, governments and asset life), correctly and efficiently completing work.

Once the, Outcomes, Tolerances and Specifications, Conditions and Constraints and Work Instructions for each Task are specified it is possible to determine the materials that will be required for each Task.

The materials specifications from the Task will be used for the requisitioning and delivery of the materials for the scheduled start of each Task. Therefore, it is important that materials be specified for the Task in which they will be required so that they can be delivered for the scheduled start time for that Task.

The materials specifications will also form part of the instruction for the personnel completing each Task.

### Purpose

To specify the materials required for each Task of a work package.

### Quantity

For each Task specify each:

- stock material issue,
- direct purchase material,
- free issue material,

that is required for completion of the Task.

### Quality

Each material must be identified against the Task for which it is required.

The number of units of each material must be specified.

Each material must be identified in a manner that unambiguously specifies each characteristic that is important to the outcomes of the work. This may include;

- stock code,
- manufacturer and manufacturer item code,
- material type, dimensions, tolerances, finish or any other characteristic that is important to the outcome of the work.


PL Flowsheet


AAOM Flowsheet

### Time

This activity must be completed in time for all of the planning, scheduling and resourcing activities for the work to be completed before the Scheduled Start Date for the Task(s).

**Resources**

Completion of this task is the accountability of the role nominated on the configured Planning flowchart.

# PL.12 Specify Specialised Tools, Equipment & Services

## Context

A work package is to define all the requirements for sustainably (i.e. dealing responsibly with safety, the environment, employees, communities, governments and asset life), correctly and efficiently completing work.

Once the, Outcomes, Tolerances and Specifications, Conditions and Constraints and Work Instructions for each Task are specified it is possible to determine the specialised tools, equipment and services (air, water, electricity) and that will be required for each Task. Specialised tools and equipment include those items that are not normally held by, or readily accessible to, the skill type assigned to the work, but will be used by the assigned person. Specialised tools may include infrequently used or calibrated tooling (torque multiplier, quality calibration meter). Specialised equipment may include items such as manual handling equipment (e.g. forklift, utility, lifting frame).

The specialised Tools, Equipment and Services specifications from the Task will be used for the reservation and delivery of the tools and equipment for the scheduled start of each Task. Therefore, it is important that these be specified for the Task in which they will be required so that they can be delivered for the scheduled start time for that Task.

Specialised Tools and Equipment differ from Work Centre resources in that they do not have independent capability, they are used by another resource assigned to the Task.

The tooling and equipment specifications will also form part of the instruction for the personnel completing each Task.

## Purpose

To specify the specialised tools, services and equipment required for each Task of a work package.

## Quantity

For each Task specify;

- Each item of tooling that would not normally be held by, or readily accessible to, by a worker with the classification and skills specified for the Task.
- Each item of equipment (e.g. forklift, utility, lifting frame) required to undertake the Task.
- Each service (air, water, electricity etc) required to undertake the Task.

PL Flowsheet

AAOM Flowsheet

## Quality

If there is any doubt whether an item of tooling is specialised then specify the item.

The number of units of each tool and equipment must be specified.

Each tool or equipment must be identified in a manner that unambiguously specifies each characteristic that is important to the outcomes of the work. This may include;

- equipment number,
- serial number,
- tool store code,
- manufacturer and manufacturer item code,
- rating, dimensions, tolerances, or any other characteristic that is important to the outcome of the work.

The quality and capacity/quantity of each service must be specified.

**Time**

This activity must be completed in time for all of the planning, scheduling and resourcing activities for the work to be completed before the Scheduled Start Date for the Task(s).

**Resources**

Completion of this task is the accountability of the role nominated on the configured Planning flowchart.

# PL.13 Specify Contract Resources

### Context

A work package is to define all the requirements for sustainably (i.e. dealing responsibly with safety, the environment, employees, communities, governments and asset life), correctly and efficiently completing work.

Once the, Outcomes, Tolerances and Specifications, Conditions and Constraints and Work Instructions for each Task are specified it is possible to determine the contract resources or services needed for each Task.

The contract resource/service requirements from the Task will be used during scheduling to assign resources to the work for the scheduled start of each Task. Therefore, it is important that these be specified for the Task in which they will be required so that they can be assigned for the scheduled start time for that Task.

### Purpose

To specify the contract resources/services required for each Task of a work package.

### Quantity

For each Task specify each resource/service type that is required for completion of the Task.

### Quality

For each resource/service requirement specify:

- the provider nominated to supply the resource/service,
- the units of each resource/service type,
- qualification, specifications, capacity, ratings or any other characteristic that is important to the outcome of the work.

NB.

- The contract resource/service assigned to a Task is assigned for the complete Duration of the Task.
- The period for which the contract resource/service must be scheduled will be identified by the Scheduled Start Date/time (assigned to the Task during Scheduling) and the duration of the task (assigned later in the Planning process).

PL Flowsheet

### Time

This activity must be completed in time for all of the planning, scheduling and resourcing activities for the work to be completed before the Scheduled Start Date for the Task(s).

AAOM Flowsheet

### Resources

Completion of this task is the accountability of the role nominated on the configured Planning flowchart.

## PL.14 Specify Task Durations

### Context

A work package is to define all the requirements for sustainably (i.e. dealing responsibly with safety, the environment, employees, communities, governments and asset life), correctly and efficiently completing work.

The detailed planning process has defined the outcomes and specifications for the work, the procedures for doing the work, and resourcing of the work for each Task. With this planning complete it is now possible to specify the duration of each Task.

The Task duration is the time taken to complete all of the specifications of the Task.

This information will be used in the scheduling of the work, and as an instruction to the persons completing the work.

### Purpose

To specify the estimated duration of each Task.

### Quantity

One specification for the duration of each Task within a work package.

### Quality

For independent Tasks (those that have no dependencies on other Tasks or where there some dependent Tasks do not lie on the critical path of a significant milestone), the duration should be the average time required for the Task to be completed by a competent and experienced crew member (measure from assignment to close out). For repetitive work the most common historical actual duration of the Task may be used as a guide.

For dependent Tasks (such as the steps in a constrained mining production sequence or equipment shutdown), and that will lie on the critical path of the schedule, the best case, most likely case and worst-case durations should be specified. These three values can be used in defining a schedule with the float necessary to meet expected confidence levels for the schedule outcomes.

PL Flowsheet

AAOM Flowsheet

### Time

This activity must be completed in time for all of the planning, scheduling and resourcing activities for the work to be completed before the Scheduled Start Date for the Task(s).

### Resources

Completion of this task is the accountability of the role nominated on the configured Planning flowchart.

# PL.15 Planned Cost Less Than Approved Estimated Cost

## Context

The Work Orders directed to the planning process were approved based on a cost estimate (Upper Cost Limit - UCL) calculated with the information known at the time of approval.

The planning process has taken the Work Order and Tasks through various activities to ensure all the required outcomes are satisfied and work methods and resources defined. In doing so, the scope of the work has been better defined and a Planned Cost estimate developed. The Planned Cost estimate must be compared to the approved Work Order UCL to check that the work is still within the amount approved.

While a Planned Cost that is below the approved Work Order UCL is the desired outcome, if the Planned Cost is **significantly less** than the Upper Cost Limit this suggests that there may be a difference between what the Approver intended and the Planner developed.

While it is mandatory that a Planned cost above the UCL be notified to the Approver, a Planned cost that is significantly below the UCL should also be notified to the Approver.

## Purpose

To determine if the approval for the work is still valid.

## Quantity

One decision whether the Planned Cost is less (but not significantly less) than the approved Upper Cost Limit.

## Quality

The Planned Cost for the Work Order is the sum of the following for all tasks;

- labour costs (total resource hours x current labour cost rate),
- materials costs,
- equipment hire costs,
- tool hire or purchase costs (including specialty tools),
- contract service costs, and
- any other costs.

If the Planned Cost is less than the approved Upper Cost Limit then the approval of the work is still valid and processing of the work may proceed.

Immediately it becomes evident that the Planned Cost will exceed the Upper Cost Limit, the person accountable for planning the work is to notify the person accountable for the approval of expenditure for the Work Order. If it appears that the Planned Cost will be significantly less than the approved Upper Cost

Limit notification should also be made. Note it is not necessary that the Planned Cost value calculated on the Work Order exceed the Upper Cost Limit – if only part of the planning is complete and it can already be foreseen that the final Planned Cost will exceed the Upper Cost Limit the issue must be escalated.

**Time**

This task must be completed immediately it becomes evident that the Planned Cost for a Work Order is likely to exceed the approved Upper Cost Limit.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Planning flowchart.

PL Flowsheet

AAOM Flowsheet

## PL.16 Specify Task Sequencing

### Context

A work package is to define all the requirements for sustainably (i.e. dealing responsibly with safety, the environment, employees, communities, governments and asset life), correctly and efficiently completing work.

The detailed planning process has defined the Outcomes, Specifications, Hazards and Controls, Work Method, Resourcing and Duration of the Tasks comprising the work.

In a work package that comprises multiple Tasks it is possible that some Tasks can/must be completed concurrently, and that some must be completed consecutively. There may also be constraints on the time interval between Tasks, either for technical (for example the minimum curing time for concrete) or for sustainability (i.e. dealing responsibly with safety, the environment, employees, communities, governments and asset life) reasons (for example to minimise disruption to a community). This information will determine the duration of the work periods in which the Tasks comprising the work package will be scheduled.

Whenever the sequencing of, and time between, Tasks is important to the outcome of the work it must be specified in the work package.

This information will be used in the scheduling of the work, and as an instruction to the persons completing the work.

### Purpose

To specify the sequence for completion of work package Tasks.

### Quantity

One specification for the scheduling constraints/precedents on Tasks within a work package.

### Quality

Unless otherwise specified, the sequence of Task numbering within the Work Order will indicate the sequence for scheduling and completing the Tasks. In this case the work package duration will be the sum of the Task durations.

When the sequence of Task numbering is not adequate for communicating the sequencing and dependencies of Tasks, an appropriately detailed Gantt chart shall be constructed and incorporated into the work package. The Gantt chart should indicate the sequencing of the Tasks, the dependencies (including critical time intervals) between Tasks, the best case, most likely case and the worst case duration for the Tasks and for the work package as a whole.

**Time**

This activity must be completed in time for all of the planning, scheduling and resourcing activities for the work to be completed before the Scheduled Start Date for the Task(s).

**Resources**

Completion of this task is the accountability of the role nominated on the configured Planning flowchart.

PL Flowsheet

AAOM Flowsheet

# PL.17 Specify Latest Start Date

### Context

A work package is to define all the requirements for safely, correctly and efficiently completing work.

The detailed planning process has defined the Sequence, Duration and Dependencies of the Tasks comprising the work. The combination of these factors determines the minimum duration for the whole work package.

The Required Date, the Task sequencing and dependencies, and the Task Durations define the Latest Start Date for each Task.

The Latest Start Date is essential information for scheduling the work, and must be specified as soon as progress with the detailed planning allows.

### Purpose

To specify the Latest Start Date for each Task.

### Quantity

One date by which a Task must be started.

### Quality

All elements of the work must be completed prior to the Required Date.

The Latest Start Date for a Task cannot be later than the Required Date less the sum of the durations of each other Task that is a precedent (i.e. forming part of the critical path for the work package).

### Time

This activity must be completed in time for all of the planning, scheduling and resourcing activities for the work to be completed before the Scheduled Start Date for the Task(s).

### Resources

Completion of this task is the accountability of the role nominated on the configured Planning flowchart.

# PL.18 Specify Earliest Start Date

### Context

A work package is to define all the requirements for sustainably (i.e. dealing responsibly with safety, the environment, employees, communities, governments and asset life), correctly and efficiently completing work.

The detailed planning process has defined the Outcomes, Specifications, Work Method, Sequence, Duration and Dependencies of the Tasks comprising the work. The combination of these factors determines the minimum duration for the whole work package.

While work **must be commenced** by the Latest Start Date, it may be more effective to schedule work ahead of this date to take advantage of opportunities in the Routine Operating Schedule or synergies with other work packages etc. However, there is a boundary on how far work can easily be pulled forward on the schedule, defined by the normal lead time necessary to obtain resources. This boundary on how far work can be pulled forward in the Schedule is known as the Earliest Start Date.

The Earliest Start Date is essential information for scheduling the work, and must be specified as soon as progress with the detailed planning allows.

### Purpose

To specify the earliest start date for each Task.

### Quantity

One date by which all resources for a Task can be available.

### Quality

The Earliest Start Date can be determined from the latest promised delivery or available date for;

- labour,
- stock items,
- purchased materials,
- contract resources,
- specialised tools, services and equipment.

PL Flowsheet

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### Time

This activity must be completed in time for all of the planning, scheduling and resourcing activities for the work to be completed before the Scheduled Start Date for the Task(s).

**Resources**

Completion of this task is the accountability of the role nominated on the configured Planning flowchart.

# PL.19 Specify Job Tracking Requirements

## Context

A work package is to define all the requirements for sustainably (i.e. dealing responsibly with safety, the environment, employees, communities, governments and asset life), correctly and efficiently completing work.

Tasks for some major activities may be complex and may be executed over an extended period of time, possibly several shifts or days. In such instances it can be difficult to keep track of progress, particularly when the Tasks are probably going to be handed over from one work team/team member to another. It is easy for everyone to assume that someone else has completed, or will complete, a part of the Task, and hence it does not get done. It is also easy to assume that a Task hasn't been done yet, and hence do it again. This situation can create significant risk.

To ensure that every person involved in a long and/or complex Task can quickly and accurately determine what has been completed, and what is yet to be done, an appropriate system for specifying and recording the progress, completion and results of each job stage is required.

The form and content of the information that must be recorded to successfully keep track of progress on long and/or complex work packages, and the method for recoding this information must be specified during planning.

## Purpose

To provide a means for team members to record the progress of each stage of a Task.

## Quantity

One feedback form to be included in the Task.

## Quality

The following criteria should be considered when defining a job tracking record keeping system:

- Separately identify in the tracking record each job step that must be completed and each outcome that must be achieved.
- If there is a detailed job procedure it may adequately define the steps that should be tracked for the job.
- If any step in the job will take longer than a couple of hours then divide it into sub-steps for the purpose of tracking progress.
- Provide a means for the team member completing each job step or outcome to record the completion/results and sign it.
- Record and communicate information related to changing hazards, risks and controls.
- Ensure that the completion/result of each job step is recorded progressively (as soon as it is finished).

PL Flowsheet

AAOM Flowsheet

- Provide a means of protecting against loss or damage of the progress record (e.g. make copies at the end of each shift and secure them in an office).

Use the tracking form for the handover between personnel working on the job.

**Time**

This activity must be completed in time for all of the planning, scheduling and resourcing activities for the work to be completed before the Scheduled Start Date for the Task(s).

**Resources**

Completion of this task is the accountability of the role nominated on the configured Planning flowchart.

# PL.20 Specify Job History Requirements

### Context

The sum of all the work that is done within a business area determines the performance that it delivers and the cost of achieving that performance. In order to analyse and improve on sustainability (i.e. dealing responsibly with safety, the environment, employees, communities, governments and asset life) output, and cost performance, we therefore need to have as a minimum a simple history of work performed; what equipment/workplaces were worked on, what the work was, what resources it used, and when it was completed. This information will support analysis of business area performance and work management performance, to identify the areas of significant opportunity - but it may not provide all of the information necessary to understand all contributing factors to, and identify controls for, performance issues. Once an Analyse and Improve activity has been initiated, it will define additional information that will be required for detailed analysis and validation purposes.

A Task may also be executed to collect information that is required for statutory or quality records, or is necessary for condition or performance assessment, or for the evaluation of compliance to workplace standards. In these cases the regulations, quality system or strategy specifications will define the records that must be kept.

This task is to define the content and recording method for the information that will form the Job History for a Work Order/Task.

### Purpose

To specify the Job History that must be recorded for a Work Order/Task.

### Quantity

One specification for items to be reported upon completion of a Work Order/Task.

### Quality

Correct completion of the following components of a Work Order will provide the minimum job history records;

- Equipment/ /Component or Workplace/Location Identity,
- Task Descriptions correctly specifying the action and object of the actual work completion (which may be different to that originally specified),
- Time and materials accurately recorded against each task,
- Date of Task completion accurately recorded.

PL Flowsheet

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The following additional criteria should be considered when specifying Job History record keeping:

- Are statutory records required for the work?

 

- Are quality records required for the work?
- Are any condition parameters required for regular condition or performance monitoring and analysis?
- Are records of compliance with workplace standards required?
- Is any information required for analysis or validation purposes for a current Analysis and Improvement activity?

**Time**

This activity must be completed in time for all of the planning, scheduling and resourcing activities for the work to be completed before the Scheduled Start Date for the Task(s).

**Resources**

Completion of this task is the accountability of the role nominated on the configured Planning flowchart.

# PL.21 Will this Job be Done Again?

### Context

Many of the Tasks that we undertake as part of operating and servicing a business area are repetitive. In some cases the work package detail is almost exactly the same in each repetition, in other cases there may be some detail changes.

Whenever there is significant similarity in repeated work there are advantages to creating a template for the work package.

A template improves the efficiency of creating the work package, because most of the elements of a quality work package will be saved in the template and can therefore be created for the new package with only a few keystrokes. Any changes necessary for a specific instance of work can be made to the work package created from the template.

A template can also help improve the quality of a work package. Some of the time saved through creating the work package from a template can be used to improve the quality of the package. The improvements can be saved within the template for future use.

If a work package is likely to be done again, storing the planning detail in a job template should be considered.

### Purpose

To determine if the work package will be executed again.

### Quantity

One decision as to whether the job is likely to be executed again.

### Quality

The following criteria are to be considered.
- Has this task been completed in the past?
- Is it likely that this task will be required in the future?
- Is it more efficient to create a work package for this task from a template or from scratch? (will a template reduce planning effort?)
- Will a template improve planning quality?

PL Flowsheet

### Time

This activity must be completed at completion of the detailed planning for a work package.

AAOM Flowsheet

### Resources

Completion of this task is the accountability of the role nominated on the configured Planning flowchart.

# PL.22 Create or Amend the Template

### Context

Many of the Tasks that we undertake as part of operating and servicing a business area are repetitive. In some cases the work package detail is almost exactly the same in each repetition, in other cases there may be some detail changes.

Whenever there is significant similarity in repeated work there are advantages to creating a template for the work package.

A template improves the efficiency of creating the work package, because most of the elements of a quality work package will be saved in the template and can therefore be created for the new package with only a few keystrokes. Any changes necessary for a specific instance of work can be made to the work package created from the template.

A template can also help improve the quality of a work package. Some of the time saved through creating the work package from a template can be used to improve the quality of the package. The improvements can be saved within the template for future use.

If a work package is likely to be regularly done again, the planning detail should be stored in a job template.

### Purpose

To capture planning details for use in future work packages.

### Quantity

- Amend an existing job template.
  or
- Create a new job template.

### Quality

A template may include the following requirements for the work;

- Identification of equipment/component or workplace/location to which the work relates.
- The elements of the work that will need to be separately identified within a schedule.
- Each distinct outcome for the work (what must be achieved at each stage, and at completion, of the work).
- Tolerance or standard required for each outcome.
- Conditions or constraints applying to the work.
- Identification of potential hazards and management of the associated risks.
- Permits and isolations.
- Method or procedure for achieving the outcomes.

- People, knowledge and skills.
- Parts, materials, technical documents, tools and equipment.
- Acceptance tests and procedures for completion and handover.
- Acceptance standards for completion and handover.
- Duration and sequencing of job components.
- Earliest and latest start dates.
- Recording of work progress.
- Recording of job history.

If any proposed work outcome or work method is not consistent with established practice, or approved work procedures, then change management processes must be followed.

**Time**

This activity must be completed at completion of the detailed planning for a work package.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Planning flowchart.

PL Flowsheet

AAOM Flowsheet

# PL.23 Set Task Status to Fully Planned

### Context

A Work Order/Task is assigned a Scheduled Start Date soon after it is approved. This start date is set based on the Required Date plus some preliminary information about the details and likely resourcing of the work.

Finalisation of a Scheduled Start Date for each Task requires accurate and detailed information that is available only when the planning for a Task is complete.

The Fully Planned Task status is set by the person accountable for completing the Task planning and preparation. It indicates to those who are scheduling and resourcing the work that all of the information is available to finalise the scheduling of the Task, and the delivery of resources.

### Purpose

To indicate that the planning for a Task is complete.

### Quantity

The Task Status set to ***Planned***.

### Quality

The status shall be set at the earliest time that planning is considered to be complete for the Task.

### Time

This activity must be completed in time for all of the planning, scheduling and resourcing activities for the work to be completed before the Scheduled Start Date for the Task(s).

### Resources

Completion of this task is the accountability of the role nominated on the configured Planning flowchart.

# PL.24 Is Planning Effective?

### Context

The purpose of the Operating Model is to deliver the performance required from a process. Part of the underlying theory for achieving this is that if the Right Work is done, at the Right Time, and in the Right Way, then the required results will be delivered.

Planning is an activity, undertaken with the purpose of ensuring that everything that is necessary for the sustainable (i.e. dealing responsibly with safety, the environment, employees, communities, governments and asset life), correct and efficient execution of the Right Work, at the Right Time, and in the Right way has been specified. The quality of the results delivered by the planning process has a direct impact on the work teams that will execute the work, and on the business area performance achieved through completing the work. That is, if the planning is not to the correct standard then the work teams will have a greater difficultly delivering the Right Work, at the Right Time and in the Right Way.

The Work Management measures specified in the Operating Model cover all of the elements of its underlying theory, including the measurement of the Planning Quality. The Planning Quality KPI provides the overall indication of the performance of the planning function. If this KPI is not meeting the required specifications the Analyse and Improve process should be used to understand and correct the contributing causes.

From an organisational perspective the first level of management that has 24/7 accountability for a technical discipline and/or business area is accountable for the performance of the work completed in this discipline and/or area. Since planning is a support for the preparation of this work, and hence may affect the performance of the work, this manager has the prerogative to review and input to the planning quality of the work. The manager is not required to review every Work Package and may choose to only exercise this prerogative on Work Packages that are particular interest to them. They may also choose to review the planning content at any stage of the planning process, and should not be constrained to reviewing the content only when the Work Package status has been set to Planned.

PL Flowsheet

AAOM Flowsheet

### Purpose

To validate that the planning for a Task is being completed to the required standard.

### Quantity

- A review of the planning content of selected Work Packages.

- One decision whether additions or changes to the planning content are needed.

**Quality**

A planned work package may include the following requirements for the work;

- Identification of equipment/ /component or workplace/location to which the work relates.
- The elements of the work that will need to be separately identified within a schedule,
- Each distinct outcome for the work (what must be achieved at each stage, and at completion, of the work).
- Tolerance or standard required for each outcome.
- Conditions or constraints applying to the work.
- Identification of potential hazards and management of the associated risks.
- Permits and isolations.
- Method or procedure for achieving the outcomes.
- People, knowledge and skills.
- Parts, materials, technical documents, tools and equipment.
- Acceptance tests and procedures for completion and handover.
- Acceptance standards for completion and handover.
- Duration and sequencing of job components.
- Earliest and latest start dates.
- Recording of work progress.
- Recording of job history.

If any proposed work outcome or work method is not consistent with established practice, or approved work procedures, then change management processes must be followed.

**Time**

This activity must be completed in time for any changes to the planning content to be made prior to the resourcing and execution of the work.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Planning flowchart.

# PL.25 Specify Improvements

## Context

The purpose of the Operating Model is to deliver the performance required from a process. Part of the underlying theory for achieving this is that if the Right Work is done, at the Right Time, and in the Right Way, then the required results will be delivered.

Planning is an activity, undertaken with the purpose of ensuring that everything that is necessary for the sustainable (i.e. dealing responsibly with safety, the environment, employees, communities, governments and asset life), correct and efficient execution of the Right Work, at the Right Time, and in the Right way has been specified. The quality of the results delivered by the planning process has a direct impact on the work teams that will execute the work, and on the business area performance achieved through completing the work. That is, if the planning is not to the correct standard then the work teams will have a greater difficultly delivering the Right Work, at the Right Time and in the Right Way.

The Work Management measures specified in the Operating Model cover all of the elements of its underlying theory, including the measurement of the Planning Quality. The Planning Quality KPI provides the overall indication of the performance of the planning function. If this KPI is not meeting the required specifications the Analyse and Improve process should be used to understand and correct the contributing causes.

From an organisational perspective the first level of management that has 24/7 accountability for a technical discipline and/or business area is accountable for the performance of the work completed in this discipline and/or area. Since planning is a support function for the preparation of this work, and hence may affect the performance of the work, this manager has the prerogative to review and input to the planning quality of the work. The manager is not required to review every Work Package, and may choose to only exercise this prerogative on Work Packages that are particular interest to them. They may also choose to review the planning content at any stage of the planning process, and should not be constrained to reviewing the content only when the Work Package status has been set to Planned.

If the reviewing manager has suggestions for improving the quality of the planning for a Work Package these should be fed back to the appropriate person as soon as practical.

PL Flowsheet

## Purpose

To specify changes required to improve the quality of planning.

AAOM Flowsheet

## Quantity

- One list of the suggested planning improvements.

**Quality**

The specification for the required changes must;

- Identify the element(s) of the planning that require change.
- Communicate the required work package content, including;
  - additional content,
  - removal of content, and
  - changes to the detail of the content.
- Set out the reason for the change.

All suggestions for improvement should be provided through an effective coaching style.

**Time**

This activity must be completed in time for any changes to the planning content to be made prior to the resourcing and execution of the work.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Planning flowchart.

INTERNAL

# ANGLO AMERICAN OPERATING MODEL: WORK MANAGEMENT
## SCHEDULING

**UPDATED: AUGUST 2018**

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# SC.00 Scheduling

### Context

For a business area to be successful in delivering its agreed output targets, at the lowest practical cost, it must complete the Right Work at the Right Time and in the Right Way. This work must also be completed sustainably (i.e. by dealing responsibly with safety, the environment, employees, communities, governments and asset life).

In all discussions relating to the Operating Model, the term scheduling is used to describe the process of defining the start time, sequence of execution and resource allocation (including workplace space and time, labour, equipment etc) for Tasks.

The objectives of scheduling are firstly to ensure that all Tasks are completed at the right time, and secondly to make the most efficient use of resources while doing this.

Every Task has a distinct window that defines the Right Time for completion. This window is bounded by the earliest date that all requirements for completion of the work can be assembled, and by the date at which an unacceptable outcome is likely to result if the work has not been completed.

Typically there are many Tasks that need to be scheduled and some of these will be competing for resources (ie Equipment/Workplace access, labour or equipment). The scheduling process is where the resourcing requirements, synergies and conflicts of the outstanding Tasks are considered and balanced to ensure that work is scheduled for completion at the right time.

In most cases there will be sufficient flexibility in the completion windows and resourcing options to ensure that Tasks can be scheduled at the right time. In some instances conflicts in workplace access, labour or equipment demands may require a decision to either alter Equipment/Workplace operating patterns and times, approve additional labour or equipment, or to accept the cost or risk of stretching the completion window for some work packages. In such cases these decisions are escalated to the key stakeholders for decision.

### Purpose

To allocate resources for all approved work to be completed at the right time.

### Quantity

One process to determine the schedule for completing all approved work.

### Quality

Determining the schedule for executing tasks may include the following activities;

- Defining a Task start time that fits the completion window (ie between the earliest time resources can be available and the latest date that the work can be started and meet the required completion date),
- Allocating Equipment/Workplace access time,
- Confirming labour and equipment availability,
- Aligning Tasks that can be completed together,
- Separating Tasks that cannot be completed together,
- Sequencing Tasks that have dependencies,
- Consulting with personnel who will execute the work on the schedule,
- Obtaining decisions on actions to manage Critical Issues,
- Obtaining the agreement (and commitment) to the schedule from all affected parties.

The scheduling of the work includes, after approval of the schedule, the release or initiation of all documents (job cards, specifications, procedures/instructions, purchase orders, service contracts, task schedules, report forms etc) required for the work.

The **minimum requirement** for a schedule is a group of Tasks, sorted by; Work Group, Scheduled Date and Equipment/Workplace identifying;

- The Tasks to be completed.
- The Equipment/Workplace requiring the work.
- The conditions necessary for the work.
- Any workplace constraints created by the work.
- The number and type of people and equipment required for each Task and in total.
- The status of people, materials, equipment and tooling availability.
- The start date for each Task.
- The duration of each Task.
- The impact of not completing the work on time.

If a schedule includes events that have complex or interdependent Tasks (activities such as mining or plant shutdowns) then the schedule for these events should be presented in the form of a project that includes the following additional information

- The sequencing of Tasks.
- Dependencies between Tasks.
- The allocation of specific people, equipment or other specialised resources to Tasks.
- Project tracking and control activities.

The detailed activities of preparing a work schedule shall conform to the specifications set out in Scheduling Flowchart and TAs SC.01 to SC.19.

SC Flowsheet

AAOM Flowsheet

# SC.01 Identify Initial Scheduling Window

## Context

In all discussions relating to the Operating Model, the term scheduling is used to describe the process of defining the start time, sequence of execution and resource allocation for Tasks.

The objectives of scheduling are firstly to ensure that all Tasks are completed at the right time, and secondly to make the most efficient use of resources while doing this.

Achieving the first objective requires the construction of a schedule that completes each Work Order, and all of its Tasks, by its Required Date. To help achieve this every Task must have a Scheduled Date (start date) allocated soon after approval.

Work Orders and Tasks created via the Work Scheduling System are automatically allocated a Scheduled Start date based on the trigger event and are also allocated an earliest and latest start date that is based on the specified trigger tolerance. However, when other Work Orders/Tasks are approved and first enter the scheduling process they will not have a Scheduled Start Date allocated. They will probably only have the basic requirements of an approved Work Order (including just a single Task) to define the work and provide guidance to set the Scheduled Start Date. An earliest and latest start date will not yet have been specified.

To maximise the time available to effectively plan and resource each newly approved Work Order the first Task should be allocated a Scheduled Start Date as close to the Required Date as practical, while taking into account the most likely time required to complete all of the work (its most likely duration). The schedule period that falls ahead of the Required Date less the most likely duration for the work should be identified as the initial scheduling window. The Scheduling Process can then take into account the synergies and conflicts that may exist with other work in this schedule period when allocating a Scheduled Start Date for the first Task of the Work Order.

## Purpose

To identify the schedule period from which the initial Scheduled Start Date for each newly approved Work Order/Task will be chosen.

## Quantity

A scheduled period identified as the initial scheduling window for each newly approved Task within a Work Order.

**Quality**

The scheduled period that will be used as the initial scheduling window shall be the schedule period prior to;

- the Required Date for the Work Order, less
- the most likely Duration for the Work Order.

**Time**

A Scheduled Start date shall be allocated to each Task within 1 working day of its approval.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Scheduling flowchart.

SC Flowsheet

AAOM Flowsheet

# SC.02 Is Scheduled Date Still Okay?

### Context

Every work package has a distinct window that defines the right time for scheduling. This window is bounded by the earliest date that all requirements for completion of the work can be assembled (the Earliest Start Date), and by the latest date by which the work must be started (the Required Date less the work duration = Latest Start Date).

Work Orders and Tasks created via the Work Scheduling System are automatically allocated a Scheduled Start date based on the trigger event and are also allocated an earliest and latest start date that is based on the specified trigger tolerance. However, when other Work Orders/Tasks are approved and first enter the scheduling process they will not have a Scheduled Start Date allocated. They will probably only have the basic requirements of an approved Work Order (including just a single Task) to define the work and provide guidance to set the Scheduled Start Date. An earliest and latest start date will not yet have been specified.

As planning of the Tasks comprising a Work Order is completed, and the procurement of resources undertaken, the Earliest and Latest Start Dates for the Tasks will be defined or adjusted. As information on this scheduling window becomes available the Scheduled Start Date assigned to each Task must be checked to ensure that there are no critical issues that will prevent the Work Order being completed by its Required Date.

This question asks whether the Scheduled Date for each Task is within the period bounded by the Earliest and Latest start Dates that have been established during planning.

### Purpose

To determine if the Scheduled Date is within the scheduling window for a Task.

### Quantity

One decision whether to;

- leave the Scheduled Date for a Task unchanged,
- adjust the Scheduled Date for a Task to fit within the Earliest and Latest Start Dates, or
- identify a critical issue for completion of the Work Order by its Required Date.

### Quality

A Scheduled Date cannot be set such that a Work Order will be completed after the Required Date without the express approval of the responsible manager.

**Time**

This task must be performed, for all approved and incomplete Tasks, at least once within each Schedule Period.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Scheduling flowchart.

SC Flowsheet

AAOM Flowsheet

# SC.03 Identify Synergies & Conflicts Between Tasks

### Context

The objectives of work scheduling are firstly to ensure that all work packages are completed at the right time, and secondly to make the most efficient use of resources while doing this.

Every work package has a distinct window that defines the right time for scheduling. This window is bounded by the earliest date that all requirements for completion of the work can be assembled (the Earliest Start Date), and by the latest date by which the work must be started (the Required Date less the work duration = Latest Start Date).

The initial Scheduled Start Date for a Work Order may be allocated either manually or by the Work Scheduling System (WSS). The independence in these processes may result in two activities for the same Equipment/ Workplace being scheduled a few days apart, when there could be synergies from scheduling these together.

There may also be some Tasks that cannot be scheduled together because of conflicts between workplace conditions, resource or access requirements etc. These Tasks must be separated in the schedule.

Recognising and optimising the management of the potential synergies and conflicts that can lie within a schedule is a large part of the skill of an effective scheduler.

When it is determined that there are synergies and/or conflicts in performing specific Tasks, they must be linked or de-linked on the schedule.

### Purpose

To maximise productivity by scheduling into the same time slots all Tasks that can be efficiently executed together, while ensuring that all Tasks that cannot be completed together are separated in the schedule.

### Quantity

The Scheduled Start Date/Time of each Task set to ensure that work with an inherent synergy is completed together, and incompatible Tasks are separated in time.

### Quality

In completing this task consider the following;

- the scheduling parameter tolerance on WSS scheduled Tasks,
- the scheduling window for Work Orders/Tasks,
- required Equipment/Workplace condition (operating, isolated, empty etc),
- potential hazards and risks associated with the work,

- permit requirements,
- access (clearways, platforms, scaffolding, barricades etc),
- available working area (space for people, materials and equipment),
- service equipment (cranes, forklifts, scissor trucks, etc),
- services (power, air, water, lighting etc),
- special skills. (For example, do both Tasks require special skills that only one worker has, and that worker cannot work on both Tasks concurrently).

**Time**

This task must be performed, for all approved and incomplete Tasks, at least once within each Schedule Period.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Scheduling flowchart.

SC Flowsheet

AAOM Flowsheet

# SC.04 Assign Scheduled Date and Time

### Context

Once the synergies and conflicts between Tasks have been determined, the Tasks must be allocated to an appropriate place in the Routine Operating Schedule (ie within the equipment/plant operating pattern or capacity distribution defined by the agreed Operating Master Schedule), and within the scheduling window (between the Earliest and Latest Start Dates) defined for the Task.

Where there is flexibility in the scheduling window for the Tasks, and the appropriate operating conditions are available, the forecast of available resource (labour, special tools and equipment, services etc) capacity can also be consulted in order to achieve the best labour utilisation possible in each period.

This process of allocating a Scheduled Date/time and resources to Tasks will define the draft schedule – NB all of the Schedule is considered to be 'draft' except the current Accepted Schedule (typically 1 schedule period agreed to at the last schedule review meeting).

### Purpose

To allocate all approved Tasks an appropriate Schedule Date/time.

### Quantity

One Scheduled Date (and Scheduled Time if necessary) for every approved Task.

### Quality

In building the draft schedule the following criteria are to be considered;

- all approved Work Orders/Tasks must be scheduled for completion before the Work Order Required Date,
- the equipment/plant operating pattern or capacity demand for the scheduled Tasks shall, where possible, fit within the Routine Operating Schedule for the area,
- the synergies and conflicts established in SC.03 should be reflected in the schedule,
- provided all of the prior criteria can be met, labour demands should be kept within the forecast of labour availability,
- any issue that may affect the achievement of the above criteria shall be flagged as a critical issue for the draft schedule.

### Time

This task must be performed, for all approved and incomplete Tasks, at least once within each Schedule Period, prior to the review and commitment of the schedule.

## Resources

Completion of this task is the accountability of the role nominated on the configured Scheduling flowchart.

SC Flowsheet

AAOM Flowsheet

# SC.05 Are Routine Operating Schedule & Resources Fully Utilised?

### Context

A draft schedule is built by determining the potential synergies and conflicts between Tasks and allocating to each Task an appropriate Scheduled Date and time around the Routine Operating Schedule (ROS) and forecast resource (labour and special tools and equipment, services etc) availability.

The most critical factors shaping the draft schedule are;

- all approved Tasks must be scheduled for completion before the Work Order Required Date,
- the equipment/plant operating pattern or capacity demand for the scheduled Tasks shall, where possible, fit within the ROS for the area,
- the synergies and conflicts established in SC.03 should be reflected in the schedule.

After the above criteria are achieved for the draft schedule we should ensure that we are utilising the available time/capacity within the ROS, and the available resources to the best possible level.

This can be seen by comparing;

- the operating/down time or capacity forecast from the draft schedule with that from the ROS, and
- the resource demands from the draft schedule with the resources forecast to be available during each scheduling period.

If this is done several weeks in advance it may be possible to adjust the Scheduled Date of some work to optimise equipment/plant productivity and resource utilisation.

### Purpose

To identify opportunities to optimise the resource productivity of the Schedule.

### Quantity

- One decision whether the draft schedule has made optimum use of the ROS.
- One decision whether the resource demands of the draft schedule have made optimum use of the available resources.

### Quality

In making these decision consider the following criteria;

- the Routine Operating Schedule,
- the demand operating/down time or capacity forecast for the draft schedule,
- the demand and available resources forecast for the draft schedule,

- the resources that will remain unscheduled to deal with unpredicted events (uncommitted hours vary with the amount of unscheduled activities occurring at each business area - the % of resource hours to remain uncommitted shall be guided by the performance evident in the underlying data showing scheduled and unscheduled hours related to the Scheduled Work KPI”

Note that each business area will have its own specifications it will be working to, with an improvement program in place to reduce the unscheduled hours.

**Time**

This task must be performed, for all approved and incomplete Tasks, at least once within each Schedule Period, prior to the review and commitment of the schedule.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Scheduling flowchart.

SC Flowsheet

AAOM Flowsheet

# SC.06 Can Tasks be Brought Forward in Schedule?

**Context**

A draft schedule is built by determining the potential synergies and conflicts between Tasks and allocating to each Task an appropriate Scheduled Date/Time around the Routine Operating Schedule (ROS) and resource capacity limits.

The most critical factors shaping the draft schedule are;

- all approved Tasks must be scheduled for completion before the Work Order Required Date,
- the equipment/plant operating pattern or capacity demand for the scheduled Tasks shall, where possible, fit within the ROS for the area,
- the synergies and conflicts established in SC.03 should be reflected in the schedule.

After the above criteria are achieved for the draft schedule we should ensure that we are utilising the available time/capacity within the ROS, and the available resources (labour, equipment, special tools and equipment, services etc) to the best possible level.

If time from the Routine Operating Schedule, or resources available to the schedule, are not fully utilised it may be possible to bring work forward from future periods and still schedule the work between its Earliest and Latest Start Dates.

**Purpose**

To optimise the resource productivity of the Schedule without exceeding the Earliest Start Date or Latest Start Date on any Task.

**Quantity**

One decision whether time in the ROS, and/or resources, are available bring Tasks forward in the draft schedule.

One list of Tasks to be rescheduled.

**Quality**

In bringing Tasks forward from a future schedule period the following criteria are to be considered;

- all approved Work Orders/Tasks must be scheduled for completion before the Required Date,
- the demands of the work shall, where possible, fit within the Routine Operating Schedule and resource availability,
- potential hazards and risks associated with the work and the changes to the Scheduled Date,
- the synergies and conflicts established in SC.04 should be reflected in the schedule,

- the Earliest and Latest Start Date for the Tasks.

Any issue that may affect the achievement of the above criteria shall be flagged as a critical issue for the draft schedule.

**Time**

This task must be performed, when necessary to optimise resource loading, prior to the review and acceptance of the schedule.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Scheduling flowchart.

SC Flowsheet

AAOM Flowsheet

# SC.07 Are changes to Routine Operating Schedule or Resourcing Required?

### Context

The objectives of work scheduling are firstly to ensure that all Tasks are completed at the right time, and secondly to make the most efficient use of resources while doing this.

Every work package has a distinct window that defines the right time for scheduling. This window is bounded by the earliest date that all requirements for completion of the work can be assembled (the Earliest Start Date), and by the latest date by which the work must be started (the Required Date less the work duration = Latest Start Date).

The draft schedule must deliver the completion of every Task so that each Work Order is completed prior to its Required Date, regardless of any apparent constraint from workplace or resource availability.

If the draft schedule indicates that either changes to the Routine Operating Schedule (ROS) or changes in the available resources are required in order to complete all Work Orders by their Required Date then one of two options exist;

- the schedule has not been optimised and some Task(s) may be able to be moved to another Scheduled Date and time where it will not create the need for changes to the ROS or available resources but will still meet the Work Order Required Date, or
- the need for changes to the ROS or available resources is a critical issue for delivery of the schedule and must be escalated to the appropriate authority for a decision.

### Purpose

To check that the ROS/resource demands of the draft schedule are within the available capacities.

### Quantity

One decision whether or not the draft schedule fits within the constraints of the ROS and forecast of available resources.

One list of ROS or resource critical issues, with possible actions to deal with them.

### Quality

In making this decision consider the following criteria;

- the operating/downtime or capacity forecast of the Routine Operating Schedule,
- the operating/downtime or capacity demand of the draft schedule ,
- the forecast availability for resources,
- the resource demands of the draft schedule,

- the resources that will remain unscheduled to deal with unpredicted events (uncommitted hours vary with the amount of unscheduled activities occurring at each business area - the % of resource hours to remain uncommitted shall be guided by the performance evident in the Unscheduled Work (hours view) KPI).

**Time**

This task must be performed, for all approved and incomplete Tasks, at least once within each Schedule Period, prior to the review and commitment of the schedule.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Scheduling flowchart.

SC Flowsheet

AAOM Flowsheet

 

# SC.08 Can Some Work Requiring Routine Operating Schedule Changes or Resources be Moved?

**Context**

The objectives of work scheduling are firstly to ensure that all Tasks are completed at the right time, and secondly to make the most efficient use of resources while doing this.

Every work package has a distinct window that defines the right time for scheduling. This window is bounded by the earliest date that all requirements for completion of the work can be assembled (the Earliest Start Date), and by the latest date by which the work must be started (the Required Date less the work duration = Latest Start Date).

The draft schedule must deliver the completion of every Task so that each Work Order is completed prior to its Required Date, regardless of any apparent constraint from workplace or resource availability.

If the draft schedule indicates that either changes to the Routine Operating Schedule (ROS) or changes in the available resources are required in order to complete all Work Orders by their Required Date then one of two options exist;

- the schedule has not been optimised and some Task(s) may be able to be moved to another Scheduled Date and time where it will not create the need for changes to the ROS or available resources but will still meet the work Order Required Date, or
- the need for changes to the ROS or available resources is a critical issue for delivery of the schedule and must be escalated to the appropriate authority for a decision.

**Purpose**

To minimise changes to the ROS/resources, demanded by the draft schedule, without exceeding the Earliest Start Date or Latest Start Date for any Task.

**Quantity**

One decision whether some Tasks can be moved in the draft schedule to minimise changes required to either the ROS, or available resources.

One list of Tasks to be rescheduled.

One list of critical issues arising from the draft schedule.

**Quality**

In identifying Tasks that can be moved within a draft schedule the following criteria are to be considered;

- all approved Work Orders/Tasks must be scheduled for completion before the Work Order Required Date,

- the demands of the work shall, where possible, fit within the Routine Operating Schedule and resource availability,
- potential hazards and risks associated with the work,
- the synergies and conflicts established in SC.03 should be reflected in the schedule,
- the Earliest and Latest Start Date for the Tasks,
- any specialised resource demands for the work.

Any issue that may affect the achievement of the above criteria shall be flagged as a critical issue for the draft schedule. The list of Tasks with critical issues should provide the following information:

- equipment/workplace identity and component,
- Work Order number(s) and Tasks requiring changes to ROS,
- Work Order number(s) Tasks requiring additional resources,
- work description,
- changes required to ROS,
- work impact,
- additional resource types required,
- additional resource units (number and duration) required,
- time of additional resource requirements.

**Time**

This task must be performed, for all approved and incomplete Tasks, at least once within each Schedule Period, prior to the review and commitment of the schedule.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Scheduling flowchart.

SC Flowsheet

AAOM Flowsheet

# SC.09 Review Draft Schedule

### Context

Each work team and its leader have the accountability for sustainably (ie dealing responsibly with safety, the environment, employees, communities, governments and asset life) completing all scheduled work and urgent work requests assigned to them, on time and to specification. Achievement of this is fundamental to the theory of the Operating Model and hence to the delivery of the purpose of the business area in which the work is being completed.

Each work team and its leader also have knowledge of the workplace, and experience in completing their work, that is not present in any other roles. It is therefore prudent to ensure that this knowledge and experience is drawn on to optimise the planning and scheduling of work.

There are three points in the life cycle of work where this knowledge and experience are specifically tapped.

The first point is during the identification and reporting of work requirements. Work team members are requested to record all work requirements that can be identified during the course of completing their assigned work, or during their movement about the workplace. All such work is reported through a Work Request, where work team members provide as much planning information for the identified work as can be gathered from their observations. The approver of the work is required to review and add to this information where necessary.

The second point is during the planning process. No single person can provide all of the knowledge, experience and capacity to develop quality work packages for all work at all times. The work team and its leader are an ideal resource to utilise in circumstances where the person accountable for the planning lacks the necessary knowledge, experience or capacity. In this case a Task is raised within the Work Order for the purposes of specifying the type of planning input required, and scheduling the allocation of resources to compete that planning in time for the Scheduled Date of the work.

The third point is as the schedule of approved Tasks is being developed. The person accountable for building the schedule does so by;

- assigning all Tasks a Scheduled Date so that the Work Order they are part of will be completed before its Required Date,
- utilising synergies and resolving conflicts between Tasks, and
- optimising the use of the ROS for the area and resources.

A regular review of the developing schedule by the work team and its leader will allow them to identify ways to further optimise the schedule, to recognise potential critical issues that will threaten the schedule being achieved, and to suggest how to deal with those issues at an early stage.

**Purpose**

To provide work team members with an understanding of the draft schedule that will assist them to identify opportunities to optimise it.

**Quantity**

One draft schedule.

One review meeting held with each work team (either individually or collectively as appropriate).

**Quality**

The draft Schedule issued for review by a Work Group must;

- provide a view of all work that the team will be involved in over the next several weeks,
- be in a format that is accessible and meaningful to the team members,
- provide a facility for recording suggestions and critical issues raised by the team.

The review of the draft schedule shall be conducted in accordance with the meeting agenda for the ***Area Scheduling Meeting*** set out in Appendix 1 to this Task Assignment.

**Time**

The work team review of the draft schedule shall be conducted at least once during each block of shifts for each work team.

The meeting should take no more than 15 to 30 minutes.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Scheduling flowchart.

SC Flowsheet

AAOM Flowsheet

## Appendix 1 - Meeting Agenda

1. **Context**

- Explain the context in which the schedule will be executed. This may include;
  - business area output situation and expectations,
  - area operating pattern (operating, shutdown periods),
  - significant activities in other areas/work teams that may be relevant,

2. **Content Review**

- Identify and discuss significant work within the schedule with the work team.
- Identify critical issues already recognised for the schedule and explain intended controls.
- Ask for contributions from the work team. This may include suggestions;
  - to optimise synergies and conflicts between work,
  - for optimising ROS and resource usage,
  - of additional critical issues, and
  - for improved or additional control actions.

3. **Decisions and Actions**

- After discussion with the work team, the leader shall make decisions on what suggestions to feed back to the schedule and shall advise the work team members of those decisions.
- If the person accountable for building the schedule is not present at the review (and this may not be possible if several work team reviews occur concurrently in different locations) the supervisor shall record the decisions for transmission and discussion after the meeting.

# SC.10 Document Suggestions

### Context

A work team and its leader have the accountability for safely completing all scheduled work and urgent work requests assigned to them, on time and to specification. Achievement of this is fundamental to the theory of the Operating Model, and hence to the delivery of the purpose of the business area in which the work is being completed.

Each work team and its leader also have knowledge of the workplace, and experience in completing their work, that is not present in any other roles. It is therefore prudent to ensure that this knowledge and experience is drawn on to optimise the planning and scheduling of work.

There are three points in the life cycle of work where this knowledge and experience are specifically tapped.

The first point is during the identification and reporting of work requirements. Work team members are requested to record all work requirements that can be identified during the course of completing their assigned work, or during their movement about the workplace. All such work is reported through a Work Request, where work team members provide as much planning information for the identified work as can be gathered from their observations. The approver of the work is required to review and add to this information where necessary.

The second point is during the planning process. No single person can provide all of the knowledge, experience and capacity to develop quality work packages for all work at all times. The work team and its leader are an ideal resource to utilise in circumstances where the person accountable for the planning lacks the necessary knowledge, experience or capacity. In this case a Task is raised within the Work Order for the purposes of specifying the type of planning input required, and scheduling the allocation of resources to compete that planning in time for the Scheduled Date of the work.

The third point is as the schedule of approved Tasks is being developed. The person accountable for building the schedule does so by;

- assigning all Tasks a Scheduled Date so that the Work Order they are part of will be completed before its Required Date,
- utilising synergies and resolving conflicts between work packages, and
- optimising the use of plant and resources.

A regular review of the developing schedule by the supervisor and work team will allow them to identify ways to further optimise the schedule, to recognise potential critical issues that will threaten the schedule being achieved, and to suggest how to deal with those issues.

SC Flowsheet

AAOM Flowsheet

### Purpose

To identify any work team suggestions to improve the draft schedule.

**Quantity**

One set of suggestions for further optimisation of the schedule.

One set of suggestions for managing potential critical issues for completion of the schedule.

**Quality**

In identifying suggested improvements to the draft schedule the following criteria are to be considered;

- all approved Tasks must be scheduled for completion before the Work Order Required Date,
- the demands of the work shall, where possible, fit within the Routine Operating Schedule and resource availability,
- potential hazards and risks associated with the work and suggested changes,
- the synergies and conflicts established in SC.03 should be reflected in the schedule,
- the Earliest and Latest Start Date for the Tasks,
- any specialised resource demands for the work,

The identification of suggestions shall be conducted in accordance with the meeting agenda set out in Appendix 1 to this Task Assignment.

Any issue that may affect the achievement of the above criteria or the completion of the draft schedule shall be flagged as a critical issue for the draft schedule.

The work team shall define the critical issues, control actions and person accountable for following through on each control action that is within their capacity to implement.

The work team shall define the critical issues, suggested control actions and person accountable for following through on each critical issue that is outside of their capacity to implement.

Critical issues, control actions and accountabilities shall be documented before the completion of the review.

**Time**

The work team review of the draft schedule shall be conducted at least once during each block of shifts for each work team.

The meeting should take no more than 15 to 30 minutes.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Scheduling flowchart.

## Appendix 1 - Meeting Agenda

### 4. Context

- Explain the context in which the schedule will be executed. This may include;
    - business area output situation and expectations,
    - area operating pattern (operating, shutdown periods),
    - significant activities in other areas/work teams that may be relevant,

### 5. Content Review

- Identify and discuss significant work within the schedule with the work team.

- Identify critical issues already recognised for the schedule and explain intended controls.

- Ask for contributions from the work team. This may include suggestions;
    - to optimise synergies and conflicts between work,
    - for optimising ROS and resource usage,
    - of additional critical issues, and
    - for improved or additional control actions.

### 6. Decisions and Actions

- After discussion with the work team, the leader shall make decisions on what suggestions to feed back to the schedule and shall advise the work team members of those decisions.

- If the person accountable for building the schedule is not present at the review (and this may not be possible if several work team reviews occur concurrently in different locations) the supervisor shall record the decisions for transmission and discussion after the meeting.

SC Flowsheet

AAOM Flowsheet

# SC.11 Document Critical Issues & Options

### Context

The draft schedule must deliver the completion of every Task so that each Work Order is completed prior to its Required Date, regardless of any apparent constraint from workplace or resource availability.

While every effort has been made to optimise the draft schedule, and to remove constraints on its completion, there may still be critical issues that will prevent the schedule being completed unless they are managed. There are three basic types of critical issues;

- A material, service or specialised tool/equipment that is necessary for the completion of the schedule cannot be made available at the Scheduled Date.
- The schedule cannot be completed without changes being made to the Routine Operating Schedule (ROS).
- The schedule cannot be completed without changes being made to the labour available for executing it.

For each critical issue there will potentially be a range of options to remove or reduce the risk that the issue may pose. The adoption of any of these options may impact on a range of people associated with the operation and, depending on the options, may require authorisation from different roles. Consequently, the critical issues and options should be presented to the full range of stakeholders for review, discussion and decisions. This process occurs at a regular (typically weekly) Schedule Review Meeting.

Prior to this Schedule Review Meeting the critical issues and the options for managing them must be documented in a meeting agenda.

### Purpose

To prepare the agenda of critical issues for the Schedule Review Meeting.

### Quantity

One list of critical issues identified for the draft schedule.

One list of potential control options for each critical issue.

### Quality

The list of critical issues shall include all issues evident within the draft schedule – ie all schedule periods beyond the current one. The further ahead that a critical issue is identified the more potential options there may be to manage it.

For each critical issue identify;

- The type of issue – resourcing/ROS/labour availability
- The details of the issue – what Tasks are affected and how the Tasks will be affected.

- The potential impact of the issue.

For each potential control option;

- the decisions/actions required,
- the stakeholders affect by the decisions/actions, and
- the benefits/consequences of each decision/action.

All critical issues and potential control options shall be documented in an agenda for the Schedule Review Meeting.

**Time**

This task must be performed at least once per Schedule Period and at least one working day prior to the Schedule Review Meeting.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Scheduling flowchart.

SC Flowsheet

AAOM Flowsheet

## SC.12 Initiate Purchase Orders & Picking Slips

### Context

The draft schedule must deliver the completion of every Task so that each Work Order is completed prior to its Required Date, regardless of any apparent constraint from plant or resource availability.

All approved Tasks will be assigned a Scheduled Date/time and therefore a position in the schedule. The draft schedule, extending beyond the next few schedule periods, is reviewed on a regular basis by the work teams and continually evolves towards the final committed schedule.

In the case of Tasks that require the purchase of materials or services, the purchase orders for these documents must be released prior to the lead time for supply of the materials or services. However, it is also desirable to consolidate purchase orders and deliveries so that materials and or services will be delivered in a coordinated fashion, when and where required, neither too early nor too late for the Scheduled Date of the work.

In the case of Tasks that require the picking and issue of inventory items, the picking slips for these must be released in time for warehouse personnel to issue and place the items in the appropriate staging area prior to the work execution.

As the draft schedule develops, the purchase orders that are near the lead time for the materials and services specified on them should be released for fulfilment, and the picking slips for inventory items should be released for issue of goods.

### Purpose

To fulfil materials and services supply for Tasks just in time for the Scheduled Date of each Task.

### Quantity

Each purchase order, that has reached the lead time for supply, activated for fulfilment.

Each picking slip for inventory issues released for fulfilment.

### Quality

Purchase orders shall be released in accordance with the supply system specifications, but in any case, ahead of the maximum expected lead time for the goods or services.

Picking slips for inventory issues shall be released in accordance with the supply system specifications but in any case in time to allow for the orderly and efficient issue of the goods.

## Time

This task shall be performed at least once per Schedule Period

## Resources

For purchases of materials and services with short lead times, and inventory items, this action may be automated by having the work management/supply system initiate purchase orders/picking slips at a specified interval ahead of the Scheduled Date of the Task that the materials or services are required for.

For long and variable lead time items, completion of this task is the accountability of the role nominated on the configured Scheduling flowchart.

SC Flowsheet

AAOM Flowsheet

# SC.13 Are Changes to the Routine Operating Schedule Approved

### Context

The draft schedule must deliver the completion of every Task so that each Work Order is completed prior to its Required Date, regardless of any apparent constraint from workplace or resource availability.

While every effort has been made to optimise the draft schedule, and to remove constraints on its completion, there may still be critical issues that will prevent the schedule being completed unless they are managed. There are three basic types of critical issues;

- A resource (material, service or specialised tool/equipment) that is necessary for the completion of the schedule cannot be made available at the Scheduled Date.
- The schedule cannot be completed without changes being made to the Routine Operating Schedule (ROS).
- The schedule cannot be completed without changes being made to the labour available for executing it.

The ROS is developed from the approved Operating Master Schedule (OMS). The approved OMS represents an integrated schedule of Production and Service work that has been modelled to confirm that, if it is followed, the Performance Targets and confidence levels can be met. That is, the closer the actual schedule for execution of Production and Service work fits to the approved OMS and ROS, the more likely that the Performance Targets and confidence levels will be delivered.

All real processes exhibit variation and hence it is inevitable that as the actual Production and Service work execution schedule is developed there will be potential deviations from the approved ROS. However, any deviations from the approved ROS should be minimised and, when deviations are necessary, operations should be brought back in line with the approved ROS as quickly as possible.

### Purpose

To decide whether a change to the ROS, required for execution of the draft schedule, will be approved.

### Quantity

One decision on the ROS that will be applied to the Schedule construction.

For a ROS that represents the operating pattern for an area, the;

- number,
- start time, and
- duration

of operating/down times that will be available for assignment in the schedule.

For a ROS that represents the number of available units for a group or fleet of units, the;

- the number of units,
- start time, and
- duration

of each time period where a different number of units are available for the assignment in the schedule.

For a ROS that represents the critical path Gantt chart for an area, the;

- start time,
- duration, and
- dependencies

of critical path tasks that will be available for assignment in the schedule.

**Quality**

When contemplating changes from the approved ROS consider the following:

- Only necessary, appropriate and funded Service Work will be approved in the Operating Model.
- Service Work is **necessary** for future production – if it is not completed, on time, short term production goals may be met but longer term ones will not be.
- The potential sustainability (ie dealing responsibly with safety, the environment, employees, communities, governments and asset life), and cost consequences if work is not completed on time.
- potential hazards and risks associated with the work and suggested changes,
- Keep changes from the approved ROS as limited and as short in duration as possible.
- Change the timing (pattern) of Production and Service work in the ROS in preference to changing the balance of Production and Service work.
- The potential to use proposed changes in the ROS for other necessary activities, hence reducing their potential impact elsewhere in the ROS.
- Alternate operating strategies that may provide the potential to recover Production Work displaced by Service Work.
- The impact on output targets if the changes are approved. These may be timing changes only, or they may be permanent volume changes.

Once a decision on changes to the ROS has been made the potential critical issues associated with that decision must be specified. This shall include;

- what each critical issue is,
- the control actions (quantity and quality) that will be put in place,
- when the control action will be taken,
- who is accountable for the control action implementation,
- the resources available to implement the control action.

These shall be documented before the completion of the review.

SC Flowsheet

AAOM Flowsheet

**Time**

This task must be performed at least once per Schedule Period and at least one working day prior to the end of the Schedule Period.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Scheduling flowchart.

# SC.14 Is Additional Work Group Resource Approved

### Context

The draft schedule must deliver the completion of every Work Order prior to its Required Date, regardless of any apparent constraint from workplace or resource availability.

While every effort has been made to optimise the draft schedule, and to remove constraints on its completion, there may still be critical issues that will prevent the schedule being completed unless they are managed. There are three basic types of critical issues;

- A material, service or specialised tool/equipment that is necessary for the completion of the schedule cannot be made available at the Scheduled Date.
- The schedule cannot be completed without changes being made to the Routine Operating Schedule (ROS).
- The schedule cannot be completed without changes being made to the Work Group Resources available for executing it.

If additional Work Group Resources are required they could come from; overtime, other Work Groups within the area or wider organisation, or from outside sources. The approval of additional Work Group Resources should make the most productive use of internal capacity before outside sources are used.

The approval of additional Work Group Resources must also take into account the availability and capability of additional capacity, and the ability of the workplace infrastructure and environment to accommodate them.

This Task Assignment applies when the draft schedule identified that it is not possible to complete all Production and all Service Work, by its Required Date, with the available Work Group Resources. Therefore, regardless of whether additional capacity is approved or not, there will be critical issues to manage either to reduce the potential consequences of having insufficient capacity or to mobilise additional capacity.

### Purpose

To decide whether additional Work Group Resources, required for execution of the draft schedule, will be approved.

### Quantity

One decision on the approval of;

- additional Work Group Resource numbers,
- the source of additional Work Group Resources,
- the Tasks that the additional Work Group Resources will be assigned to.

SC Flowsheet
AAOM Flowsheet

**Quality**

The decision criteria to be used are:

- The potential to use Work Group Resources from other Work Groups and areas.
- The potential outside sources of resources.
- The availability and capability of additional resources.
- The capacity of the workplace infrastructure and environment to accommodate the additional resources.

Once a decision on changes to the available Work Group Resources has been made any potential critical issues associated with that decision shall be specified. This shall include;

- what each critical issue is,
- the control actions (quantity and quality) that will be put in place,
- when the control action will be taken,
- who is accountable for the control action implementation,
- the resources available to implement the control action.

These shall be documented before the completion of the review.

**Time**

This task must be performed at least once per Schedule Period and at least one working day prior to the end of the Schedule Period.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Scheduling flowchart.

# SC.15 Agree Accepted Schedule

**Context**

The draft schedule must deliver the completion of every Work Order prior to its Required Date, regardless of any apparent constraint from workplace or resource availability.

While every effort has been made to optimise the draft schedule, and to remove constraints on its completion, there may still be critical issues that will prevent the schedule being completed unless they are managed. There are three basic types of critical issues;

- A resource (material, service or specialised tool/equipment) that is necessary for the completion of the schedule cannot be made available at the Scheduled Date.
- The schedule cannot be completed without changes being made to the Routine Operating Schedule (ROS).
- The schedule cannot be completed without changes being made to the labour available for executing it.

The critical issues for the schedule are reviewed each schedule period by the stakeholders of the operation, and decisions are made by each accountable manager on how the critical issues will be handled.

When all the decisions and actions that are necessary to decide upon and finalise the schedule are complete, the accepted schedule can be released.

The accepted schedule will advise all personnel of;

- the work committed for the next schedule period,
- the work anticipated in future schedule periods,
- the ROS for each Productive Unit,
- the windows that have been defined to complete the scheduled work,
- the disposition of all equipment and workplaces during the next scheduling period, and
- the output forecast for the next schedule period.

**Purpose**

To communicate the accepted schedule, so that all stakeholders are aware of what they are committed to deliver.

**Quantity**

One schedule identifying all tasks required to be completed within future schedule periods.

**Quality**

The accepted schedule shall be firm for the next schedule period and draft for schedule periods beyond that. It shall identify all scheduled Work Order Tasks sorted by the following criteria:

SC Flowsheet

AAOM Flowsheet

- Work Group
- Scheduled Date and time
- Equipment / Workplace
- Impact.

For each task in the schedule the following additional information (as a minimum) shall be provided:

- Task Description
- Task number
- Task Status
- Total number of Tasks in the Work Order
- Plant conditions and constraints (running, isolated etc)
- Task duration
- Specific work locations (eg. Bay 1 in Mobile Workshop)
- Number and type of skills, and supplying Work Group.

**Time**

This task must be performed at least once per Schedule Period and at least one working day prior to the end of the Schedule Period.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Scheduling flowchart.

# SC.16 Can Operations be Changed to Reduce the Risk

## Context

The draft schedule must deliver the completion of every Work Order prior to its Required Date, regardless of any apparent constraint from workplace or resource availability.

While every effort has been made to optimise the draft schedule, and to remove constraints on its completion, there may still be critical issues that will prevent the schedule being completed unless they are managed. There are three basic types of critical issues;

- A resource (material, service or specialised tool/equipment) that is necessary for the completion of the schedule cannot be made available at the Scheduled Date.
- The schedule cannot be completed without changes being made to the Routine Operating Schedule (ROS).
- The schedule cannot be completed without changes being made to the labour available for executing it.

This Task Assignment applies when the draft schedule identified one or more of the above critical issues and it has been decided by the accountable manager that;

- a resource cannot be available at the Scheduled Date,
- that the ROS will compromise the scheduling of some work before its Required Date,
- Work Group capacity availability will compromise the scheduling of some work before its Required Date.

One possibility in this situation is to change the operation of the business in order to reduce or remove this risks that may arise if some work cannot be completed by its Required Date.

## Purpose

To decide whether the method/parameters for operating the business area can be modified in order to reduce/remove the risks arising from delayed completion of some work.

## Quantity

One decision whether operations can be modified to reduce the risk.

SC Flowsheet

## Quality

The decision criteria to be used are:

- The options for operation (including approving partial completion of the work where practical, reduced loading, reduced operating rate, alternate output routing etc) that will reduce/remove the risk.

AAOM Flowsheet

- The potential sustainability (ie dealing responsibly with safety, the environment, employees, communities, governments and asset life), and cost consequences if work is not completed on time.
- The current output position in relation to budget (ahead/on/behind).
- The impact on output and/or cost targets of the alternate options for operation,
- The size of the potential impact when compared to the usual range of output variation that occurs.
- The potential to reduce or recover losses in future schedule periods.

Once a decision on changes to the operations has been made any potential critical issues associated with that decision shall be specified. This shall include;

- what each critical issue is,
- any hazards or risks associated with the change,
- the control actions (quantity and quality) that will be put in place,
- when the control action will be taken,
- who is accountable for the control action implementation.
- the resources available to implement the control action.

These shall be documented before the completion of the review.

**Time**

This task must be performed at least once per Schedule Period and at least one working day prior to the end of the Schedule Period.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Scheduling flowchart.

# SC.17 Risks Accepted?

## Context

The draft schedule must deliver the completion of every Work Order prior to its Required Date, regardless of any apparent constraint from workplace or resource availability.

While every effort has been made to optimise the draft schedule, and to remove constraints on its completion, there may still be critical issues that will prevent the schedule being completed unless they are managed. There are three basic types of critical issues;

- A resource (material, service or specialised tool/equipment) that is necessary for the completion of the schedule cannot be made available at the Scheduled Date.
- The schedule cannot be completed without changes being made to the Routine Operating Schedule (ROS).
- The schedule cannot be completed without changes being made to the labour available for executing it.

This Task Assignment applies when the draft schedule identified one or more of the above critical issues and it has been decided by the accountable manager that;

- a resource cannot be available at the Scheduled Date,
- that the ROS will compromise the scheduling of some work before its Required Date,
- labour availability will compromise the scheduling of some work before its Required Date.

In this case, the deferred completion of high impact work may produce a sustainability (ie dealing responsibly with safety, the environment, employees, communities, governments and asset life), output or cost risk.

If all other options have been considered, and there is no alternative to delaying the completion of some work beyond the Required Date, then the risks arising from the delay (including the residual risk after changing operating methods or parameters) must be accepted by the accountable manager.

## Purpose

To record that the risks of changing the ROS, changing operations or delaying completion of work beyond the Required Date have been accepted by the manager.

SC Flowsheet

AAOM Flowsheet

**Quantity**

One record of the agreed changes.

One list of risks associated with the changes.

One signature of the manager authorised to accept the specified risks.

**Quality**

The outcomes of this task shall be recorded in a standard form and filed for reference for a period of 12 months.

**Time**

This task must be performed at least once per Schedule Period and at least one working day prior to the end of the Schedule Period.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Scheduling flowchart.

# SC.18 Specify Work to Adjust

## Context

The draft schedule must deliver the completion of every Work Order prior to its Required Date, regardless of any apparent constraint from workplace or resource availability.

While every effort has been made to optimise the draft schedule, and to remove constraints on its completion, there may still be critical issues that will prevent the schedule being completed unless they are managed. There are three basic types of critical issues;

- A resource (material, service or specialised tool/equipment) that is necessary for the completion of the schedule cannot be made available at the Scheduled Date.
- The schedule cannot be completed without changes being made to the Routine Operating Schedule (ROS).
- The schedule cannot be completed without changes being made to the labour available for executing it.

This Task Assignment applies when the draft schedule identified one or more of the above critical issues and it has been decided by the accountable manager that;

- a resource cannot be available at the Scheduled Date,
- that the ROS will compromise the scheduling of some work before its Required Date,
- labour availability will compromise the scheduling of some work before its Required Date.

In this case, the deferred completion of high impact work may produce a sustainability (ie dealing responsibly with safety, the environment, employees, communities, governments and asset life), output or cost risk.

If all other options have been considered, and there is no alternative to delaying the completion of some work beyond the Required Date, then the risks arising from the delay (including the residual risk after changing operating methods or parameters) must be accepted by the accountable manager.

It is possible that all, or only part, of a work package may need to be delayed because it cannot be accommodated in the schedule.

After the decision has been made to accept the risk of delaying the work, the components of the work that are to be delayed, and the date/time to which they may be delayed must be specified. Where only a portion of the work is delayed it may also be necessary to modify the work package.

Changes to the draft schedule, or to the work packages comprising it, must be specified for implementation in the final schedule and issue to the work teams.

SC Flowsheet

AAOM Flowsheet

**Purpose**

To specify the changes to the schedule and work packages arising from the delay of some work beyond its Required Date.

**Quantity**

One agreed latest completion date for the delayed work.

One specification of any changes to be made to work packages as a result of the delay.

**Quality**

The outcomes of this task shall be recorded on the same standard form used to record the acceptance of the risks of delaying work (as per Task Assignment SC.17 – Manager Accepts Risk) and filed for reference for a period of 12 months.

The new latest completion date for Tasks shall be used to revise the schedule.

Instructions for modifications to the work package shall be transmitted to the person accountable for the development of work package and Task specifications.

**Time**

This task must be performed at least once per Schedule Period and at least one working day prior to the end of the Schedule Period.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Scheduling flowchart.

# SC.19 Modify Scope or Cancel Work

### Context

The draft schedule must deliver the completion of every Work Order prior to its Required Date, regardless of any apparent constraint from workplace or resource availability.

While every effort has been made to optimise the draft schedule, and to remove constraints on its completion, there may still be critical issues that will prevent the schedule being completed unless they are managed. There are three basic types of critical issues;

- A resource (material, service or specialised tool/equipment) that is necessary for the completion of the schedule cannot be made available at the Scheduled Date.
- The schedule cannot be completed without changes being made to the Routine Operating Schedule (ROS).
- The schedule cannot be completed without changes being made to the labour available for executing it.

This Task Assignment applies when the draft schedule identified one or more of the above critical issues and it has been decided by the accountable manager that;

- a resource cannot be available at the Scheduled Date,
- that the ROS will compromise the scheduling of some work before its Required Date,
- labour availability will compromise the scheduling of some work before its Required Date.

In this case, the deferred completion of high impact work may produce a n this case, the deferred completion of high impact work may produce a sustainability (ie dealing responsibly with safety, the environment, employees, communities, governments and asset life), output or cost risk.

If all other options have been considered, and there is no alternative to delaying the completion of some work beyond the Required Date, then the risks arising from the delay (including the residual risk after changing operating methods or parameters) must be accepted by the accountable manager.

It is possible that all, or only part, of a work package may need to be delayed because it cannot be accommodated in the schedule.

After the decision has been made to accept the risk of delaying the work, the components of the work that are to be delayed, and the date/time to which they may be delayed must be specified. Where only a portion of the work is delayed it may also be necessary to modify the work package.

It is also possible that the delay of a Task may render it unnecessary – for example a weekly inspection that is missed will not need to be rescheduled.

If a work package, or part of it, may need to be modified or cancelled this should be done in accordance with the Work Approval process.

SC Flowsheet
AAOM Flowsheet

**Purpose**

To redirect work packages/Tasks that may require modification or cancellation to the Work Approval process for re-evaluation.

**Quantity**

One decision that modification or cancellation of a work package, or part of it, may be required.

**Quality**

If any change to work outcomes or stages are proposed as part of accepting the delay of all or part of a work the package/Task, it must return to the Work Approval process.

If the proposed delay of the Scheduled Start Date for a part of the work package that is Work Scheduling System (WSS) generated may be longer than the trigger parameter for used by the WSS the work package must return to the Work Approval process.

**Time**

This task must be performed at least once per Schedule Period and at least one working day prior to the end of the Schedule Period.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Scheduling flowchart.

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# ANGLO AMERICAN OPERATING MODEL: WORK MANAGEMENT
## RESOURCING

**UPDATED: AUGUST 2018**

**CONTENTS**




RE Flowsheet

AAOM Flowsheet

## RE.00 Resourcing - Materials, Special Tools and Services

### Context

For a business area to be successful in delivering its agreed output targets, at the lowest practical cost, it must complete the Right Work at the Right Time and in the Right Way. This work must also be completed sustainably, i.e. by dealing responsibly with safety, the environment, employees, communities, governments and asset life.

Every work package has a distinct window that defines the Right Time for completion. This window is bounded by the earliest date that all requirements for completion of the work can be assembled, and by the date at which an unacceptable outcome is likely to result if the work has not been completed. The objective of the scheduling process is to allocate the resources necessary to complete each work package within this time window.

The processes that deliver materials, special tools and contracted resources to the workplace for each Task must therefore ensure that all the specified items will be available for the Scheduled Date of each Task.

In most cases there will be sufficient flexibility in the completion windows and resourcing options to ensure that work can be scheduled and resourced using standard arrangements for the acquisition and delivery of materials, special tools and services. In some instances meeting the scheduled start time for a Task may require a decision to either approve the expediting of items, or changing from a routine supplier, or re-allocating resources from other work. In such cases these decisions are escalated to the key stakeholders (those accountable for any potential risks that may arise) for a decision.

### Purpose

To deliver the requirements for every Task to be completed at the scheduled time.

### Quantity

One process to deliver the materials, special tools and services for completing all approved work.

### Quality

The delivery of materials, special tools and services may include the following activities;

- Determining promised supply dates,
- Validating that supply dates will meet the Scheduled Dates for Tasks,
- Collating materials and tools for each work package and Task,
- Delivering materials, tools and services to the specified workplace prior to the scheduled start time for each Task.
- Checking that the delivered materials, tools and services meet the required specifications for the Task,

- Escalating each item where a supply date will not meet the scheduled start time,
- Expediting supplies when approved to do so, and
- Changing suppliers when appropriate.

The detailed activities of the delivery of materials, special tools and services shall conform to the specifications set out in the Resourcing Flowchart and TAs RE.01 to RE.22.

RE Flowsheet

AAOM Flowsheet

# RE.01 Are Specialised Tools, Services & Equipment Available?

### Context

The objective of the work management processes is to deliver the agreed performance targets of a business area by completing the Right Work, at the Right Time, in the Right Way.

Every work package has a distinct window that defines the right time for completion. This window is bounded by the earliest date that the requirements for completion of the first elements of the work can be assembled, and by the date at which an unacceptable outcome is likely to result if all of the work has not been completed. The objective of the scheduling process is to allocate the resources necessary to complete each Task of the work package within this time window.

The processes that deliver materials, special tools and contracted resources to the workplace for each Task must therefore ensure that all the specified items will be available for the Scheduled Date of each Task.

Since the Schedule Date for a Task can move as the preparation of the work package progresses, the resourcing process must continually monitor the Scheduled Date for each Task and ensure that specialised tools, services and equipment and will be available for the current Scheduled Date.

### Purpose

To check that specialised tools, services and equipment will be available for the Scheduled Date for each Task.

### Quantity

One decision whether the availability of specialised tools, services and equipment will allow them to be in place for the Scheduled Date/time for each Task.

### Quality

Use the Resources Status Report to identify critical issues with availability of specialised tools, services and equipment.

The decision criteria to be used are:

- All specialised tools, services and equipment required to meet the outcomes of a Task will be available at the workplace in time for the Scheduled Date/Time of the work.

In making the decision consider the following;

- the Task Scheduled Date/Time,
- list of required specialised tools, services and equipment,
- the quantity of the resource available,

- other demands for the resources at the Scheduled Date/Time,
- whether the resource can be mobilised to the workplace in time to meet the Scheduled Date/Time.

**Time**

This task shall be performed at least once per working day.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Resourcing flowchart.

RE Flowsheet

AAOM Flowsheet

# RE.02 Are Inventory Items Available?

### Context

The objective of the work management processes is to deliver the agreed performance targets of a business area by completing the Right Work, at the Right Time, in the Right Way.

Every work package has a distinct window that defines the right time for completion. This window is bounded by the earliest date that the requirements for completion of the first elements of the work can be assembled, and by the date at which an unacceptable outcome is likely to result if all of the work has not been completed. The objective of the scheduling process is to allocate the resources necessary to complete each Task of the work package within this time window.

The processes that deliver materials, special tools and contracted resources to the workplace for each Task must therefore ensure that all the specified items will be available for the Scheduled Date of each Task.

Since the Schedule Date for a Task can move as the preparation of the work package progresses, the resourcing process must continually monitor the Scheduled Date for each Task and ensure that inventory items will be available for the current Scheduled Date.

### Purpose

To check that the inventory items will be available for the Scheduled Date for each Task.

### Quantity

One decision whether the availability of inventory items will allow them to be delivered to the workplace for the Scheduled Date/time for each Task.

### Quality

Use the Resources Status Report to identify critical issues with availability of resources.

The decision criteria to be used are:

- All inventory required to meet the outcomes of a Task will be available at the workplace in time for the Scheduled Date/Time of the work.

In making the decision consider the following;

- the Task Scheduled Date/Time,
- list of required inventory items,
- the availability status indicated on the Resources Status Report,
- whether the materials can be picked, packaged and moved from the storage/staging location to the workplace in time to meet the Scheduled Date/Time.

**Time**

This task shall be performed at least once per working day.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Resourcing flowchart.

RE Flowsheet

AAOM Flowsheet

# RE.03 Is Delivery Date before Scheduled Start Date?

### Context

The objective of the work management processes is to deliver the agreed performance targets of a business area by completing the Right Work, at the Right Time, in the Right Way.

Every work package has a distinct window that defines the right time for completion. This window is bounded by the earliest date that the requirements for completion of the first elements of the work can be assembled, and by the date at which an unacceptable outcome is likely to result if all of the work has not been completed. The objective of the scheduling process is to allocate the resources necessary to complete each Task of the work package within this time window.

The processes that deliver materials, special tools and contracted resources to the workplace for each Task must therefore ensure that all the specified items will be available for the Scheduled Date of each Task.

Since the Schedule Date for a Task can move as the preparation of the work and the schedule progresses, the resourcing process must continually monitor the Scheduled Date for each Task and ensure that the Delivery Date for purchased materials and contracted activities can meet the Scheduled Date.

### Purpose

To check that the promised Delivery Date for materials and contracted activities will meet the current Scheduled Date/Time for each Task.

### Quantity

One decision whether the promised Delivery Date will allow materials to be delivered to the workplace for the Scheduled Date/time for each Task.

### Quality

Use the Resource Status Report to identify critical issues with deliveries.

The decision criteria to be used are:

- All materials and contracted activities required to meet the outcomes of a Task will be available at the workplace in time for the Scheduled Date/Time of the work.

In making the decision consider the following;

- the Task Scheduled Date/Time,
- list of required materials,
- the Delivery Date quoted by the supplier,
- the credibility of the supplier’s promised Delivery Date

- whether the materials can be moved from the plant site receiving location to the workplace in time to complete the work before the Required Date.

**Time**

This task shall be performed at least once per working day.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Resourcing flowchart.

RE Flowsheet

AAOM Flowsheet

# RE.04 Will Delivery Date Meet Latest Start Date?

### Context

The objective of the work management processes is to deliver the agreed performance targets of a business area by completing the Right Work, at the Right Time, in the Right Way.

Every work package has a distinct window that defines the right time for completion. This window is bounded by the earliest date that the requirements for completion of the first elements of the work can be assembled, and by the date at which an unacceptable outcome is likely to result if all of the work has not been completed. The objective of the scheduling process is to allocate the resources necessary to complete each Task of the work package within this time window.

The processes that deliver materials, special tools and contracted resources to the workplace for each Task must therefore ensure that all the specified items will be available for the Scheduled Date of each Task.

Since the Schedule Date for a Task can move as the preparation of the work and the schedule progresses, the resourcing process must continually monitor the Scheduled Date for each Task and ensure that the delivery date for materials and contracted activities can meet the Scheduled Date.

If delivery cannot be made by the Scheduled Date but can be made in time for the work to be completed before the Required Date, it may be possible to reschedule the work to accommodate both the promised Delivery Date and the Required Date.

### Purpose

To check that the promised Delivery Date for materials and contracted activities will allow completion of the work before the Required Date.

### Quantity

One decision whether the promised Delivery Date will allow materials and contracted activities to be delivered to/at the workplace for each Task to be completed by the Required Date.

### Quality

Use the Resource Status Report to identify critical issues with deliveries.

The decision criteria to be used are:

- All materials and contracted activities required to meet the outcomes of a Task will be available at the workplace in time for the work to be completed by the Required Date.

In making the decision consider the following;

- the Required Date for the work,
- the work Duration,
- list of required materials and contracted activities,
- the Delivery Date quoted by the supplier,
- the credibility of the supplier’s promised Delivery Date,
- whether the materials can be moved from the plant site receiving location to the workplace in time to complete the work before the Required Date.

**Time**

This task shall be performed at least once per working day.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Resourcing flowchart.

RE Flowsheet

AAOM Flowsheet

# RE.05 Track Deliveries

### Context

The objective of the work management processes is to deliver the agreed performance targets of a business area by completing the Right Work, at the Right Time, in the Right Way.

Every work package has a distinct window that defines the right time for completion. This window is bounded by the earliest date that the requirements for completion of the first elements of the work can be assembled, and by the date at which an unacceptable outcome is likely to result if all of the work has not been completed. The objective of the scheduling process is to allocate the resources necessary to complete each Task of the work package within this time window.

The processes that deliver materials, special tools and contracted resources to the workplace for each Task must therefore ensure that all the specified items will be available for the Scheduled Date of each Task.

The resourcing process must therefore track the delivery of items, including where appropriate confirming the progress of items in transit and at transfer and staging points in order to confirm that items are on track for the execution of the work, or alternately to escalate any threat to the achievement of the Schedule Date.

When the resourcing process has confidently confirmed that; specialised tools and equipment, purchased materials and contracted activities, and inventory items will be available at the work site for the Scheduled Start Date and time of the work the Task Status is changed from Fully Planned to Ready to Execute.

### Purpose

To monitor the progress of resource deliveries.

### Quantity

One regular report of delivery status collating information from suppliers and logistics providers.

### Quality

The report shall include;

- Task number,
- Scheduled Start Date
- items that are on order for each scheduled Task,
- supplier of each item,
- promised delivery date of items,
- location of items,
- date on which items are received, and
- any items that are overdue the promised delivery date.

The report shall be sorted by;

- responsibility for Tasks,
- Scheduled Start Date for Tasks
- equipment number,
- Task number.

**Time**

This task shall be performed at least once per working day.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Resourcing flowchart.

RE Flowsheet

AAOM Flowsheet

# RE.06 Receive Items

## Context

The objective of the work management processes is to deliver the agreed performance targets of a business area by completing the Right Work, at the Right Time, in the Right Way.

Every work package has a distinct window that defines the right time for completion. This window is bounded by the earliest date that the requirements for completion of the first elements of the work can be assembled, and by the date at which an unacceptable outcome is likely to result if all of the work has not been completed. The objective of the scheduling process is to allocate the resources necessary to complete each Task of the work package within this time window.

The processes that deliver materials, special tools and contracted resources to the workplace for each Task must therefore ensure that all the specified items will be available for the Scheduled Date of each Task.

As items purchased for Tasks are delivered the resourcing process must receive them for storage, staging, packing and/or onward delivery to the workplace.

## Purpose

To record the receipt of items from suppliers.

## Quantity

One record of items received.

## Quality

The process of receipting items must confirm that;

- The items match the order specification,
- The quantity is correct, and
- The items are in good order and condition.

## Time

This task shall be performed within the working day in which materials are received.

## Resources

Completion of this task is the accountability of the role nominated on the configured Resourcing flowchart.

# RE.07 Place Items in Task Package

## Context

The objective of the work management processes is to deliver the agreed performance targets of a business area by completing the Right Work, at the Right Time, in the Right Way.

Every work package has a distinct window that defines the right time for completion. This window is bounded by the earliest date that the requirements for completion of the first elements of the work can be assembled, and by the date at which an unacceptable outcome is likely to result if all of the work has not been completed. The objective of the scheduling process is to allocate the resources necessary to complete each Task of the work package within this time window.

The processes that deliver materials, special tools and contracted resources to the workplace for each Task must therefore ensure that all the specified items will be available for the Scheduled Date of each Task.

Items for a Task may be delivered from different suppliers or inventory locations and at different times. If items were delivered to the workplace in this manner they would probably end up misplaced or used for some other Task. To avoid this, the resourcing process assembles appropriate items into Task packages at a controlled storage location in readiness for movement to the workplace prior to the Scheduled Start Date for each Task.

## Purpose

To assemble a single, complete package of the materials, special tools and equipment for each Task.

## Quantity

One package of materials, special tools and equipment for each Task.

## Quality

The materials, special tools and equipment package shall be assembled in a container suitable for the storage of the items and for transport of the complete package to the workplace.

Each container shall be labelled with the;

- Work Order number,
- Task number,
- Scheduled Date for the Task, and
- Task Status.

RE Flowsheet

AAOM Flowsheet

**Time**

This task shall be performed in time for the materials, special tools and equipment to be transported to the workplace prior to the Scheduled Date/Time for the Task.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Resourcing flowchart.

# RE.08 Change Task Status to Ready to Execute

### Context

The objective of the work management processes is to deliver the agreed performance targets of a business area by completing the Right Work, at the Right Time, in the Right Way.

Every work package has a distinct window that defines the right time for completion. This window is bounded by the earliest date that the requirements for completion of the first elements of the work can be assembled, and by the date at which an unacceptable outcome is likely to result if all of the work has not been completed. The objective of the scheduling process is to allocate the resources necessary to complete each Task of the work package within this time window.

The processes that deliver materials, special tools and contracted resources to the workplace for each Task must therefore ensure that all the specified items will be available for the Scheduled Date of each Task.

When the resourcing process has confidently confirmed that all materials, special tolls and equipment will be available at the workplace for the Scheduled Date for the Task the Task Status is changed from Fully Planned to Ready to Execute.

### Purpose

To communicate that a Task will be resourced to execute at the Scheduled Date/Time.

### Quantity

The Task Status field changed from ***Planned*** to ***Ready to Execute***.

### Quality

The Task Status cannot be changed to ***Ready to Execute*** unless it has first been set to ***Planned***.

The status shall be changed when there is a satisfactory level of confidence that all materials, special tools and equipment will be available for delivery to the workplace by the Scheduled Date/Time for the Task.

RE Flowsheet

If the Scheduled Date for a Task is moved forward after the Task Status has been set to ***Ready to Execute***, the status shall be reset to ***Planned*** until the availability of resources for the new start date have been confirmed.

AAOM Flowsheet

### Time

The Task Status shall be set to ***Ready to Execute*** within one working day of all materials, special tools and equipment being confidently confirmed as available.

The Task Status shall be confirmed as ***Ready to Execute***, or reset to ***Planned***, within one working day of the Scheduled Date being moved forward.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Resourcing flowchart.

# RE.09 Specify Movement of Resources to Workplace

### Context

The objective of the work management processes is to deliver the agreed performance targets of a business area by completing the Right Work, at the Right Time, in the Right Way.

Every work package has a distinct window that defines the right time for completion. This window is bounded by the earliest date that the requirements for completion of the first elements of the work can be assembled, and by the date at which an unacceptable outcome is likely to result if all of the work has not been completed. The objective of the scheduling process is to allocate the resources necessary to complete each Task of the work package within this time window.

The processes that deliver materials, special tools and contracted resources to the workplace for each Task must therefore ensure that all the specified items will be available for the Scheduled Date of each Task.

The materials, special tools and equipment and contract resources for each task may be assembled or mobilised from different locations. The procedure for moving items from this location to the workplace, and the date(s) on which these movements must occur in order to be ready for the Scheduled Date, will depend on;

- the nature of the items,
- where the items will be assembled and staged, or where contract resources will be mobilised from,
- the workplace to which the items must be moved,
- the means/resources available to make the movement,
- the route that the movement must take.

The resourcing process must specify how and when these movements should occur.

### Purpose

To specify the movement of each of the resources for a Task to the workplace.

### Quantity

One method/procedure for each resource movement for a Task.

One date/schedule for each stage of the movement for each resource for a Task.

One set of resources assigned to each movement.

RE Flowsheet
AAOM Flowsheet

**Quality**

In setting the method/procedure and resource assignments for movements consider the following;

- nature of the items,
- the route of the movement(s)
- conditions and constraints from origin to destination,
- time available to complete the movement,
- established procedures and practices for item movement,
- resources required and available for the movement(s).,
- potential hazards and management of the associated risks.

In setting the date(s) for movements consider the following;

- Scheduled Date/Time for the Task,
- receiving/staging/mobilisation area for resources,
- method of resource movement,
- constraints on movement options, capacity or times,
- time required to complete the movements.

**Time**

This task shall be performed in time for all Task resources to be at the workplace prior to the Scheduled Date/Time for the Task.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Resourcing flowchart.

# RE.10 Move Resources to Work Location

## Context

The objective of the work management processes is to deliver the agreed performance targets of a business area by completing the Right Work, at the Right Time, in the Right Way.

Every work package has a distinct window that defines the right time for completion. This window is bounded by the earliest date that the requirements for completion of the first elements of the work can be assembled, and by the date at which an unacceptable outcome is likely to result if all of the work has not been completed. The objective of the scheduling process is to allocate the resources necessary to complete each Task of the work package within this time window.

The processes that deliver materials, special tools and contracted resources to the workplace for each Task must therefore ensure that all the specified items will be available for the Scheduled Date of each Task.

The materials, special tools and equipment and contract resources for each task may be assembled or mobilised from different locations. The date on which these must commence movement to the workplace, in order to be ready for the Scheduled Date, will depend on where the items will be assembled and staged, or where contract resources will be mobilised from.

The resourcing process must specify when these movements should occur and must at these dates ensure that each resource is moved to the workplace.

## Purpose

To move all resources required for a Task to the workplace in time for the Scheduled Date.

## Quantity

The movement of all Task resources from their assembly, staging or mobilisation point to the workplace.

## Quality

All movements shall be completed to have the Task resources at the workplace for the Scheduled Date/Time of the Task.


RE Flowsheet

The task shall consider the potential hazards in the movement of resources, and management of the associated risks.


AAOM Flowsheet

## Time

This task shall be performed at the specified time for movement of each resource.

### Resources

Completion of this task is the accountability of the role nominated on the configured Resourcing flowchart.

# RE.11 Can Delivery be Expedited?

**Context**

The objective of the work management processes is to deliver the agreed performance targets of a business area by completing the Right Work, at the Right Time, in the Right Way.

Every work package has a distinct window that defines the right time for completion. This window is bounded by the earliest date that the requirements for completion of the first elements of the work can be assembled, and by the date at which an unacceptable outcome is likely to result if all of the work has not been completed. The objective of the scheduling process is to allocate the resources necessary to complete each Task of the work package within this time window.

The processes that deliver materials, special tools and contracted resources to the workplace for each Task must therefore ensure that all the specified items will be available for the Scheduled Date of each Task.

If normal delivery of purchased materials or contact activities cannot be made by the Scheduled Date for the work, it may be possible to expedite the delivery of all or some of the Task requirements in order to meet the Scheduled Date.

Expediting delivery may incur additional expense. If additional expense would be incurred, the impact of this on the final cost of the work, compared to the approved Upper Cost Limit, must be considered. Where the total cost of the Work Order, after expediting, may exceed the approved Upper Cost Limit the consent of the approver of the work must be obtained before delivery can be expedited.

**Purpose**

To check whether delivery of an item can be expedited to meet the current Scheduled Date for a Task.

**Quantity**

One decision whether expedited delivery will meet the Scheduled Date for a Task.

One decision whether the cost of the expedited delivery needs to be approved.

**Quality**

The decision criteria to be used are;

- if there are means of expediting delivery,
- the quoted Delivery Date if expedited,
- any additional cost if expedited,
- the Planned Cost, expediting cost and approved Upper Cost Limit,
- The Scheduled Date for the Task,

RE Flowsheet

AAOM Flowsheet

- the credibility of the supplier’s expedited Delivery Date, and
- whether the items can be at the workplace before the Scheduled Start Date.

Note: If items for a Task must be expedited at additional cost, and the Planned Cost plus expediting cost is less than the approved Upper Cost Limit, then the expediting of the item does not need to be referred back to the approver of the Work Order. If the planning for the full Work Order is not yet complete (i.e. the Planned Cost is not yet finalised) the decision on whether to expedite should be referred back to the approver of the Work Order.

**Time**

This task shall be performed as soon as the critical issue with delivery is recognised.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Resourcing flowchart.

# RE.12 Expedite Delivery

### Context

The objective of the work management processes is to deliver the agreed performance targets of a business area by completing the Right Work, at the Right Time, in the Right Way.

Every work package has a distinct window that defines the right time for completion. This window is bounded by the earliest date that the requirements for completion of the first elements of the work can be assembled, and by the date at which an unacceptable outcome is likely to result if all of the work has not been completed. The objective of the scheduling process is to allocate the resources necessary to complete each Task of the work package within this time window.

The processes that deliver materials, special tools and contracted resources to the workplace for each Task must therefore ensure that all the specified items will be available for the Scheduled Date of each Task.

If normal delivery of purchased materials or contact activities cannot be made by the Scheduled Date for the work, it may be possible to expedite the delivery of all or some of the Task requirements in order to meet the Scheduled Date.

Expediting delivery may incur additional expense. If additional expense would be incurred, the impact of this on the final cost of the work, compared to the approved Upper Cost Limit, must be considered. Where the total cost of the Work Order, after expediting, may exceed the approved Upper Cost Limit the consent of the approver of the work must be obtained before delivery can be expedited.

### Purpose

To expedite the delivery of resources so that the Scheduled Date for a Task can be met.

### Quantity

One new set of delivery arrangements made with each supplier.

### Quality

For each supplier who could not originally meet the required Delivery Date agree on;

- new Delivery Date,
- delivery method,
- possible assistance with the delivery,
- possible negotiation with another customer who could delay delivery of a particular item, and
- any extra costs of expediting.

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Note: If items for a Task must be expedited at additional cost, and the Planned Cost plus expediting cost is less than the approved Upper Cost Limit, then the expediting of the item does not need to be referred back to the approver of the Work Order. If the planning for the full Work Order is not yet complete (i.e. the Planned Cost is not yet finalised) the decision on whether to expedite should be referred back to the approver of the Work Order.

**Time**

This task shall be performed as soon as it has been established that expediting is necessary and the total cost is either within the approved Upper Cost Limit or else the additional cost approved by the appropriate person.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Resourcing flowchart.

Any approval of an increased Upper Cost Limit must be made by the role nominated as accountable in the configured Work Approval flowchart.

# RE.13 Can a New Supplier Meet Delivery?

### Context

The objective of the work management processes is to deliver the agreed performance targets of a business area by completing the Right Work, at the Right Time, in the Right Way.

Every work package has a distinct window that defines the right time for completion. This window is bounded by the earliest date that the requirements for completion of the first elements of the work can be assembled, and by the date at which an unacceptable outcome is likely to result if all of the work has not been completed. The objective of the scheduling process is to allocate the resources necessary to complete each Task of the work package within this time window.

The processes that deliver materials, special tools and contracted resources to the workplace for each Task must therefore ensure that all the specified items will be available for the Scheduled Date of each Task.

If delivery cannot be expedited to meet the Schedule Date for the work, it may be possible to change supplier for all or some of the items in order to meet the Scheduled Date.

Changing suppliers may incur additional expense. If additional expense would be incurred, the impact of this on the final cost of the work, compared to the approved Upper Cost Limit, must be considered. Where the total cost of the Work Order, after changing suppliers, may exceed the approved Upper Cost Limit the consent of the approver of the work must be obtained before suppliers can be changed.

### Purpose

To check if a different supplier is able to deliver items to meet the Scheduled start Date for a Task.

### Quantity

One decision whether a different supplier can deliver items to meet the Scheduled Start Date for the Task.

One decision whether the cost of the change of supplier needs to be approved.

RE Flowsheet

### Quality

AAOM Flowsheet

The decision criteria to be used are;

- is there any contractual agreement to use only items from a particular supplier?
- are there any potential alternate suppliers of the items?
- does the item from the alternate supplier meet the Task specifications?
- the Scheduled Date for the Task.

- can an alternate supplier deliver the items to meet the Scheduled Date?
- the credibility of the alternate supplier's Delivery Date, and
- whether the items can be at the workplace before the Scheduled Date.

Note: If suppliers for items for a Task must be changed at additional cost, and the Planned Cost plus additional cost is less than the approved Upper Cost Limit, then the change of supplier for the item does not need to be referred back to the approver of the Work Order. If the planning for the full Work Order is not yet complete (i.e. the Planned Cost is not yet finalised) the decision on whether to change supplier should be referred back to the approver of the Work Order.

**Time**

This task shall be performed as soon as the critical issue with delivery is recognised.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Resourcing flowchart.

# RE.14 Change Supplier

### Context

The objective of the work management processes is to deliver the agreed performance targets of a business area by completing the Right Work, at the Right Time, in the Right Way.

Every work package has a distinct window that defines the right time for completion. This window is bounded by the earliest date that the requirements for completion of the first elements of the work can be assembled, and by the date at which an unacceptable outcome is likely to result if all of the work has not been completed. The objective of the scheduling process is to allocate the resources necessary to complete each Task of the work package within this time window.

The processes that deliver materials, special tools and contracted resources to the workplace for each Task must therefore ensure that all the specified items will be available for the Scheduled Date of each Task.

If delivery cannot be expedited to meet the Schedule Date for the work, it may be possible to change supplier for all or some of the items in order to meet the Scheduled Date.

Changing suppliers may incur additional expense. If additional expense would be incurred, the impact of this on the final cost of the work, compared to the approved Upper Cost Limit, must be considered. Where the total cost of the Work Order, after changing suppliers, may exceed the approved Upper Cost Limit the consent of the approver of the work must be obtained before suppliers can be changed.

### Purpose

To change the supplier of items so that the Scheduled Date for a Task can be met.

### Quantity

One set of delivery arrangements made with a new supplier.

### Quality

For each instance of a change of supplier;

- the specification of items from the new supplier
- new Delivery Date,
- delivery method,
- any extra cost in changing suppliers,
- cancelling commitments with the originally proposed supplier,
- establishing commitments with the new supplier.

Note: If suppliers for items for a Task must be changed at additional cost, and the Planned Cost plus additional cost is less than the approved Upper Cost

RE Flowsheet

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Limit, then the change of supplier for the item does not need to be referred back to the approver of the Work Order. If the planning for the full Work Order is not yet complete (i.e. the Planned Cost is not yet finalised) the decision on whether to change supplier should be referred back to the approver of the Work Order.

**Time**

This task shall be performed as soon as it has been established that a change in supplier is necessary and the total cost is either within the approved Upper Cost Limit or else the additional cost approved by the appropriate person.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Resourcing flowchart.

Any approval of an increased Upper Cost Limit must be made by the role nominated as accountable in the configured Work Approval flowchart.

# RE.15 Can Resources be Obtained from Another Business Area?

### Context

The objective of the work management processes is to deliver the agreed performance targets of a business area by completing the Right Work, at the Right Time, in the Right Way.

Every work package has a distinct window that defines the right time for completion. This window is bounded by the earliest date that the requirements for completion of the first elements of the work can be assembled, and by the date at which an unacceptable outcome is likely to result if all of the work has not been completed. The objective of the scheduling process is to allocate the resources necessary to complete each Task of the work package within this time window.

The processes that deliver materials, special tools and contracted resources to the workplace for each Task must therefore ensure that all the specified items will be available for the Scheduled Date of each Task.

If delivery cannot be expedited, or an alternate supplier found, to meet the Schedule Date for the Task, it may be possible to obtain some or all of the resources from another business area in order to meet the Scheduled Date.

### Purpose

To check if another business area is able to supply resources to meet the Scheduled Date for a Task.

### Quantity

One decision whether another business area can deliver resources to meet the Scheduled Date for a Task.

One decision whether the cost of the change of obtaining resources from another business area needs to be approved.

### Quality

The decision criteria to be used are;

- is there any other business area with the resources needed?
- can the resources be made available from the other business area?
- can the resources be made available for/before the Scheduled Date for the Task?
- any extra cost in obtaining resources,
- whether the resources can be moved to the work location in time to meet the Scheduled Start Date, and
- any potential hazards and management of the associated risks in relocating resources between business areas.

RE Flowsheet

AAOM Flowsheet

Note: If items for a Task can be obtained from another business area, but there is an additional cost, and the Planned Cost plus additional cost is less than the approved Upper Cost Limit, then additional cost for the item does not need to be referred back to the approver of the Work Order. If the planning for the full Work Order is not yet complete (i.e. the Planned Cost is not yet finalised) the decision on whether to obtain the item should be referred back to the approver of the Work Order.

**Time**

This task shall be performed as soon as it is determined that there is no way to obtain the resources from the original or alternate external supplier.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Resourcing flowchart.

The commitment of resources from another business area must be approved by the person accountable for that business area.

# RE.16 Obtain Resources

**Context**

The objective of the work management processes is to deliver the agreed performance targets of a business area by completing the Right Work, at the Right Time, in the Right Way.

Every work package has a distinct window that defines the right time for completion. This window is bounded by the earliest date that the requirements for completion of the first elements of the work can be assembled, and by the date at which an unacceptable outcome is likely to result if all of the work has not been completed. The objective of the scheduling process is to allocate the resources necessary to complete each Task of the work package within this time window.

The processes that deliver materials, special tools and contracted resources to the workplace for each Task must therefore ensure that all the specified items will be available for the Scheduled Date of each Task.

If delivery cannot be expedited, or an alternate supplier found, to meet the Schedule Date for the Task, it may be possible to obtain some or all of the resources from another business area in order to meet the Scheduled Date.

**Purpose**

To obtain resources from another business area for the execution of a Task.

**Quantity**

One set of delivery arrangements made with another business area to supply resources.

**Quality**

Any commitments with the originally proposed supplier of the resources shall be cancelled or re-assigned to the business areas from which the resources were obtained.

The resource source on the Task (or other appropriate logistics documents) shall be changed to the new business area source.

The resource commitment shall be indicated in the schedule (and other appropriate logistics documents).

Any potential hazards associated with moving resources between business areas shall be identified and controls for the associated risks put in place.

Note: If items for a Task can be obtained from another business area, but there is an additional cost, and the Planned Cost plus additional cost is less than the approved Upper Cost Limit, then additional cost for the item does not need to be referred back to the approver of the Work Order. If the planning for the full

RE Flowsheet

AAOM Flowsheet

Work Order is not yet complete (i.e. the Planned Cost is not yet finalised) the decision on whether to obtain the item should be referred back to the approver of the Work Order.

**Time**

This task shall be performed as soon as another plant area indicates that they can supply the resources and the total cost is either within the approved Upper Cost Limit or else the additional cost approved by the appropriate person.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Resourcing flowchart.

# RE.17 Can Resources be Reassigned from Another Scheduled Task?

### Context

The objective of the work management processes is to deliver the agreed performance targets of a business area by completing the Right Work, at the Right Time, in the Right Way.

Every work package has a distinct window that defines the right time for completion. This window is bounded by the earliest date that the requirements for completion of the first elements of the work can be assembled, and by the date at which an unacceptable outcome is likely to result if all of the work has not been completed. The objective of the scheduling process is to allocate the resources necessary to complete each Task of the work package within this time window.

The processes that deliver materials, special tools and contracted resources to the workplace for each Task must therefore ensure that all the specified items will be available for the Scheduled Date of each Task.

If delivery cannot be expedited, or an alternate supplier found, or resources obtained from another business area to meet the Schedule Date for the Task, it may be possible to reassign some or all of the resources from another scheduled Task without putting at risk the outcomes of either Task.

### Purpose

To check if resources may be able to be reassigned from another Task.

### Quantity

One decision whether resources can be reassigned from another Task to meet the Scheduled Date for the Task at risk.

### Quality

The decision criteria to be used are;

- is there any other Task that will have the resources needed?
- can the resources be diverted from another Task and then resupplied to that Task for completion before its Required Date?
- can the resources be diverted to be available for/before the Scheduled Date for the Task at risk?
- any extra cost in obtaining resources,
- potential hazards and the associated risks arising from reassigning resources,
- whether the resources can be moved to the work location in time to meet the Scheduled Date.
- any extra cost in reassigning resources.

RE Flowsheet

AAOM Flowsheet

Note: If items for a Task can be reassigned from another Task, but there is an additional cost, and the Planned Cost plus additional cost is less than the approved Upper Cost Limit, then additional cost for the item does not need to be referred back to the approver of the Work Order. If the planning for the full Work Order is not yet complete (i.e. the Planned Cost is not yet finalised) the decision on whether to obtain the item should be referred back to the approver of the Work Order.

**Time**

This task shall be performed as soon as it is determined that there is no way to obtain the resources from the original or alternate external supplier, or from another business area.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Resourcing flowchart.

The commitment of resources from another Task must be approved by the person accountable for that Task.

## RE.18 Re-assign Resources

### Context

The objective of the work management processes is to deliver the agreed performance targets of a business area by completing the Right Work, at the Right Time, in the Right Way.

Every work package has a distinct window that defines the right time for completion. This window is bounded by the earliest date that the requirements for completion of the first elements of the work can be assembled, and by the date at which an unacceptable outcome is likely to result if all of the work has not been completed. The objective of the scheduling process is to allocate the resources necessary to complete each Task of the work package within this time window.

The processes that deliver materials, special tools and contracted resources to the workplace for each Task must therefore ensure that all the specified items will be available for the Scheduled Date of each Task.

If delivery cannot be expedited, or an alternate supplier found, or resources obtained from another business area to meet the Schedule Date for the Task, it may be possible to reassign some or all of the resources from another scheduled Task without putting at risk the outcomes of either Task.

### Purpose

To re-assign resources to complete all approved Tasks by the Required Date.

### Quantity

One set of arrangements made to re-assign resources between Tasks.

### Quality

Any commitments with the originally proposed supplier of the resources shall be cancelled or reassigned to the Task from which resources will be diverted.

The resource source on the Tasks (or other appropriate logistics documents) shall be changed to reflect the new arrangements.

The resource commitment shall be indicated in the schedule (and other appropriate logistics documents).

Any potential hazards, and the associated risks, associated with reassigning resources shall be identified and appropriate controls put in place.

### Time

This task shall be performed as soon as it is agreed to reassign resources between Tasks.

RE Flowsheet
AAOM Flowsheet

**Resources**

Completion of this task is the accountability of the role nominated on the configured Resourcing flowchart.

The commitment of resources from another Task must be approved by the person accountable for that Task.

# RE.19 Re-schedule Tasks?

## Context

The objective of the work management processes is to deliver the agreed performance targets of a business area by completing the Right Work, at the Right Time, in the Right Way.

Every work package has a distinct window that defines the right time for completion. This window is bounded by the earliest date that the requirements for completion of the first elements of the work can be assembled, and by the date at which an unacceptable outcome is likely to result if all of the work has not been completed. The objective of the scheduling process is to allocate the resources necessary to complete each Task of the work package within this time window.

The processes that deliver materials, special tools and contracted resources to the workplace for each Task must therefore ensure that all the specified items will be available for the Scheduled Date of each Task.

If it is not possible to obtain resources from another Task or to modify work scope, or to split work in order to meet a Scheduled Date and/or Required Date for either all, or the most critical portion of, work then some Tasks may need to be re-scheduled.

## Purpose

To check whether Tasks need to be re-scheduled as a result of resource allocations or work scope changes made in order to meet a Scheduled Date and/or Required Date.

## Quantity

One decision whether any Tasks need to be re-scheduled.

## Quality

The decision criteria to be used are;

- will any of the changes made in order to meet a Scheduled Date and/or Require Date need a change to the Scheduled Date for any Task.

## Time

This task must be performed prior to the review and commitment of the schedule.

## Resources

Completion of this task is the accountability of the role nominated on the configured Resourcing flowchart.

RE Flowsheet

AAOM Flowsheet

## RE.20 Can Work Scope be Split or Changed to Avoid Risk?

### Context

The objective of the work management processes is to deliver the agreed performance targets of a business area by completing the Right Work, at the Right Time, in the Right Way.

Every work package has a distinct window that defines the right time for completion. This window is bounded by the earliest date that the requirements for completion of the first elements of the work can be assembled, and by the date at which an unacceptable outcome is likely to result if all of the work has not been completed. The objective of the scheduling process is to allocate the resources necessary to complete each Task of the work package within this time window.

The processes that deliver materials, special tools and contracted resources to the workplace for each Task must therefore ensure that all the specified items will be available for the Scheduled Date of each Task.

If delivery cannot be expedited, or an alternate supplier found, resources obtained from another plant area, or reassigned from another Task to meet the Schedule Date and/or Required Date for the work, it may be possible to modify the work scope or split the work in order to deliver the most critical outcomes by the Scheduled Date and/or Required Date.

### Purpose

To check if the work scope can be modified or split in order to deliver critical outcomes by the Scheduled Date and/or Required Date for a Task.

### Quantity

One decision whether the work scope can be modified or split to deliver critical outcomes by the Scheduled and/or Required Date for the Task at risk.

One decision whether the cost of the modified work scope or splitting of the work needs to be approved.

### Quality

The decision criteria to be used are;

- will modification or partial completion of the work remove, reduce or delay the impact of not completing all of the work by its Required Date,
- can resources be delivered to complete that (part of the) work that will remove, reduce or delay the impact,
- can the work be modified or split?
- any potential hazards, and the associated risks, associated with modifying or splitting the work shall be identified and appropriate controls put in place.

- any extra cost resulting from modifying the work scope or splitting the work,
- any potential impact on sustainability (i.e. dealing responsibly with safety, the environment, employees, communities, governments and asset life) or output targets as a result of modifying or splitting the work.

Note: If work scope can be modified, or the work split, but there is an additional cost, and the Planned Cost plus additional cost is less than the approved Upper Cost Limit, then the additional cost does not need to be referred back to the approver of the Work Order. If the planning for the full Work Order is not yet complete (i.e. the Planned Cost is not yet finalised) the decision on whether to obtain the item should be referred back to the approver of the Work Order.

**Time**

This task shall be performed as soon as it is determined that there is no way to obtain the resources from the original or alternate external supplier, from another business area or from another Task.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Resourcing flowchart.

Any approval of an increased Upper Cost Limit must be made by the role nominated as accountable in the configured Work Approval flowchart.

RE Flowsheet

AAOM Flowsheet

# RE.21 Create or Modify Tasks

### Context

The objective of the work management processes is to deliver the agreed performance targets of a business area by completing the Right Work, at the Right Time, in the Right Way.

Every work package has a distinct window that defines the right time for completion. This window is bounded by the earliest date that the requirements for completion of the first elements of the work can be assembled, and by the date at which an unacceptable outcome is likely to result if all of the work has not been completed. The objective of the scheduling process is to allocate the resources necessary to complete each Task of the work package within this time window.

The processes that deliver materials, special tools and contracted resources to the workplace for each Task must therefore ensure that all the specified items will be available for the Scheduled Date of each Task.

If delivery cannot be expedited, or an alternate supplier found, resources obtained from another plant area, or reassigned from another Task to meet the Schedule Date and/or Required Date for the work, it may be possible to modify the work scope or split the work in order to deliver the most critical outcomes by the Scheduled Date and/or Required Date.

### Purpose

To amend the Task details as required by the modified/split work scope.

### Quantity

One set of modified Task details.

### Quality

All modifications to Tasks must comply with the requirements of Planning.

Any potential hazards, and the associated risks, associated with modifying or splitting the work shall be identified and appropriate controls put in place.

### Time

As soon as practical after the decision to modify the work scope.

### Resources

Completion of this task is the accountability of the role nominated on the configured Resourcing flowchart.

# RE.22 Notify Stakeholders of Potential Risk

## Context

The objective of the work management processes is to deliver the agreed performance targets of a business area by completing the Right Work, at the Right Time, in the Right Way.

Every work package has a distinct window that defines the right time for completion. This window is bounded by the earliest date that the requirements for completion of the first elements of the work can be assembled, and by the date at which an unacceptable outcome is likely to result if all of the work has not been completed. The objective of the scheduling process is to allocate the resources necessary to complete each Task of the work package within this time window.

The processes that deliver materials, special tools and contracted resources to the workplace for each Task must therefore ensure that all the specified items will be available for the Scheduled Date of each Task.

If no viable strategy can be identified to deliver the resources required for the Scheduled Date and/or Required Date for a Task then this critical issue must be escalated to the stakeholders as soon as it is known.

## Purpose

To notify all stakeholders that a Task cannot be resourced for its Scheduled Date and/or Required Date.

## Quantity

One communication to the stakeholders.

## Quality

This critical issue for the schedule shall be recorded on the agenda for the next Scheduling Meeting.

The communication shall identify;

- the Work Order number,
- the Work Order Description,
- The Task number,
- The Task Description,
- the Scheduled Date and/or Required Date that cannot be met,
- the description of the resources that cannot be delivered, and
- any potential sustainability (i.e. dealing responsibly with safety, the environment, employees, communities, governments and asset life), output or cost target impact, associated with the delay of the work.

RE Flowsheet

AAOM Flowsheet

### Time

The communication shall be made at the next Schedule Meeting after the critical issues has been identified or, if there is no Schedule Meeting prior to the Scheduled Date, as soon as all options to supply the required resources have been exhausted.

### Resources

Completion of this task is the accountability of the role nominated on the configured Resourcing flowchart.

INTERNAL

# ANGLO AMERICAN OPERATING MODEL: WORK MANAGEMENT
## WORK EXECUTION

**UPDATED: AUGUST 2018**

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# WE.00 Work Execution

## Context

For a business area to be successful in delivering its agreed output targets, at the lowest practical cost, it must complete the Right Work at the Right Time and in the Right Way. This work must also be completed sustainably, i.e. by dealing responsibly with safety, the environment, employees, communities, governments and asset life.

The primary objectives when executing a Task are to ensure that the work is completed when scheduled, that all required outcomes, specifications and tolerances are achieved in the allocated time, and that the sustainability expectations of the Company are met.

A secondary but important outcome when executing any work package is to look more widely at the workplace and ensure that any other identifiable defects or hazards are both corrected/controlled and recorded, or else reported in sufficient detail to allow effective planning and scheduling of the corrective or control action.

## Purpose

To complete all allocated work, to specification, at the right time.

## Quantity

One process to for executing work.

## Quality

Execution of a Task may include the following requirements;

- Identifying potential hazards and managing the associated risks.
- Implementing permits and isolations.
- Achieving each distinct Outcome for the work.
- Confirming the tolerances or specifications required for each Outcome.
- Following the method, procedure and/or sequence of job steps specified for achieving the Outcome.
- Meeting the duration specified for the Task.
- Ensuring that correct parts, materials, technical documents, tools and equipment are used.
- Performing acceptance tests and procedures for completion and handover.
- Verifying and recording acceptance standards for completion and handover.
- Recording of work progress.
- Recording of job history.
- Returning unused parts and materials to the designated storage location.

WE Flowsheet

AAOM Flowsheet

- Returning tools and equipment to the designated storage locations.

Where additional Equipment/Workplace defects are identified while executing work, or a safety or environmental incident occurs with actual or potential loss, these must be dealt with in one of the following ways;

- An immediate response to the incident, which may include correcting or controlling the defect or situation, if this can be done without compromising the outcomes, specifications, tolerances or duration of the initial Task.
- Immediately classify and report the defect or incident using the Urgent Work Process if it cannot be corrected or controlled without compromising completion of the initial Task, and if the Impact and Required Date for the defect or incident mean that action is required before a corrective or control action can be completed using the routine work management process.
- Classify and report the defect or incident after completion of the initial Task if the Impact and Required Date for the defect or incident mean that a corrective or control action can be completed using the routine work management process.

All work shall;

- be in accordance with all safety policies, procedures and standards,
- be in accordance with all procedures, specifications and tolerances specifically identified in the work package,
- be performed to the standards expected of a skilled and diligent worker,
- be performed to a standard that will ensure reliable, capable and efficient operation of plant.

The detailed activities of executing a maintenance work package shall conform to the specifications set out in Work Execution Flowchart and TAs WE.01 to WE.41.

# WE.01 Review Schedule

## Context

The objective of the work management processes is to deliver the agreed performance targets of a business area by completing the Right Work, at the Right Time, in the Right Way.

The processes of work approval, planning, scheduling and resourcing have all contributed to delivering a schedule of fully planned and resourced work packages (comprising one or more Tasks) to a work team for execution.

The primary objectives when executing a Task are to ensure that the work is completed when scheduled, that all required outcomes, specifications and tolerances are achieved in the allocated time, and that the sustainability (i.e. dealing responsibly with safety, the environment, employees, communities, governments and asset life) expectations of the Company are met.

The schedule of Tasks assigned to a work team was committed ahead of the start time for their execution – perhaps by only a few days for Tasks at the start of the Schedule Period, and by many days for those at the end of the Schedule Period.

In a dynamic work environment many changes occur each day, some of which can impact on the ability of a work team to deliver the schedule exactly as it was committed. Some Tasks within the schedule will have rigid time constraints that must be met, however, other Tasks will have flexibility to move them within the committed schedule.

The person accountable for execution of the committed schedule must continually review the balance of the schedule they have to complete, considering changes occurring in the work environment. The purpose of this review is to adjust Tasks that can have flexible timing within the schedule, where appropriate, and to recognise any critical issue that may affect the completion of the schedule as soon as it becomes apparent – so that appropriate action can be taken to try to complete, or minimise the impact on, the schedule.

## Purpose

To identify any Tasks that may not be completed within the projected work environment.

WE Flowsheet

## Quantity

One list of Tasks for which scheduled completion may be threatened by the projected work environment.

AAOM Flowsheet

## Quality

The criteria that may adversely affect the completion of the schedule include;

- reduction to the labour available to complete the work,
- changes to the Routine Operating Schedule,
- failure to complete, or slow completion of, some work as per the schedule,
- a high level of un-scheduled work,
- lack of materials, tools or services,
- unforeseen hazards and risks,
- other changing workplace conditions (e.g. weather).

The criteria that may favourably affect the completion of the schedule include;

- additional labour available to complete the work,
- changes to the plant operating schedule,
- quicker completion of some scheduled work,
- a low level of un-scheduled work.

**Time**

This task shall be performed at least once per working shift.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Work Execution flowchart.

# WE.02 Can the Schedule be Completed?

### Context

The objective of the work management processes is to deliver the agreed performance targets of a business area by completing the Right Work, at the Right Time, in the Right Way.

The processes of work approval, planning, scheduling and resourcing have all contributed to delivering a schedule of fully planned and resourced work packages (comprising one or more Tasks) to a work team for execution.

The primary objectives when executing a Task are to ensure that the work is completed when scheduled, that all required outcomes, specifications and tolerances are achieved in the allocated time, and that the sustainability (i.e. dealing responsibly with safety, the environment, employees, communities, governments and asset life) expectations of the Company are met.

The schedule of Tasks assigned to a work team was committed ahead of the start time for their execution – perhaps by only a few days for Tasks at the start of the Schedule Period, and by many days for those at the end of the Schedule Period.

In a dynamic work environment many changes occur each day, some of which can impact on the ability of a work team to deliver the schedule exactly as it was committed. Some Tasks within the schedule will have rigid time constraints that must be met, however, other Tasks will have flexibility to move them within the committed schedule.

The person accountable for execution of the committed schedule must continually review the balance of the schedule they have to complete, considering changes occurring in the work environment. The purpose of this review is to adjust Tasks that can have flexible timing within the schedule, where appropriate, and to recognise any critical issue that may affect the completion of the schedule as soon as it becomes apparent – so that appropriate action can be taken to try to complete, or minimise the impact on, the schedule.

### Purpose

To identify if any issue requires intervention in order to complete the schedule.

WE Flowsheet

### Quantity

One decision whether an intervention is required in order to deliver the schedule.

AAOM Flowsheet

### Quality

The criteria to be used in making this decision is;

- all of the Company's sustainability expectations will be met,

- all of the committed schedule will be completed,
- Tasks with rigid time constraints will completed within these constraints
- all of the Tasks and work outcomes will be completed,
- all tolerances and specifications for each outcome will be achieved,
- acceptance testing and handover procedures will be executed,
- acceptance test limits and plant handover will be achieved.

If any of the above requirements of the schedule will not be delivered without an intervention, then an intervention must be initiated.

**Time**

This task shall be performed as soon as it becomes apparent that the schedule will not be delivered or at least once per working shift.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Work Execution flowchart.

# WE.03 Assign Tasks

### Context

The primary objectives when executing a Task are to ensure that the work is completed when scheduled, that all required outcomes, specifications and tolerances are achieved in the allocated time, and that the sustainability (i.e. dealing responsibly with safety, the environment, employees, communities, governments and asset life) expectations of the Company are met.

Once a schedule is issued, Tasks within that schedule must be assigned to individuals.

The person assigning Tasks must ensure that the requirements of the work, and the knowledge, experience and skills of the individuals assigned to the work are matched.

The person assigning Tasks must also ensure that each individual assigned to a Task;

- has an adequate specification of the work?
- understands the specification and how to meet it,
- accepts that the specification is appropriate,
- is able to complete the work to specification.

The interactions necessary to establish all of the above occur at the time a Task is assigned.

### Purpose

To complete an effective assignment of work to an individual.

### Quantity

An assignment of Task(s) to individuals.

### Quality

The person assigning a Task must ensure that the work is clearly communicated to, and fully understood by, the person it is being assigned to. The minimum requirements for doing this are;

- set the context and purpose for the work,
- review the outcomes and specifications (planning elements) for the work,
- review the resources required and available for the work,
- seek contributions and suggestions for workplace planning, set-up and execution from the person being assigned the work,
- agree on critical issues and actions to control them,
- agree on the completion time for the work.

WE Flowsheet

AAOM Flowsheet

**Time**

This task shall be performed as required to ensure that all Tasks are completed to schedule.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Work Execution flowchart.

# WE.04 Is the Task Understood?

## Context

The primary objectives when executing a Task are to ensure that the work is completed when scheduled, that all required outcomes, specifications and tolerances are achieved in the allocated time, and that the sustainability (i.e. dealing responsibly with safety, the environment, employees, communities, governments and asset life) expectations of the Company are met.

The documentation provided with a Task is not intended to specify every possible detail of the work. Many elements of the work can be left to the person to whom the Task is assigned, to use their knowledge, experience and skill to determine as part of the workplace planning and set-up. Where there is a preferred specification or standard then it should be set out in the documentation.

As a Task is assigned to a person they must ensure that they have a full and correct understanding of all requirements for the work, whether specified or not. Even if a Task assignment seemed clear when discussed away from the workplace it may not make sense when the workplace is inspected.

If the person assigned a Task is uncertain of their understanding of any element of the Task, at any time, they should clarify their understanding rather than risk producing a potential hazard or an inappropriate outcome from the work.

## Purpose

To decide whether any aspect of a Task assignment requires clarification.

## Quantity

One decision that an element of the Task assignment is unclear.

## Quality

A Task may include the following requirements for the work;

- Identification of equipment/workplace.
- Conditions or constraints applying to the work.
- Identification of potential hazards and management of the associated risks.
- Permits and isolations.
- Each distinct outcome for the work (what must be achieved at each stage, and at completion, of the work).
- Tolerance or standard required for each outcome.
- Method or procedure for achieving the outcome.
- Duration and sequencing of job components.
- People, knowledge and skills.
- Parts, materials, technical documents, tools and equipment.
- Acceptance tests and procedures for completion and handover.

WE Flowsheet

AAOM Flowsheet

- Acceptance standards for completion and handover.
- Recording of work progress.
- Recording of job history.

If the person assigned a Task is unclear on any of the above requirements (whether the requirements are stated in the Task documentation or not), or if any proposed work outcome or work method is not consistent with established practice, or approved work procedures, they must seek clarification.

**Time**

The person assigned a Task must test their understanding of the work throughout the duration of the work. They must seek clarification immediately they become uncertain of any element of the work.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Work Execution flowchart.

# WE.05 Clarify Task Assignment

### Context

The primary objectives when executing a Task are to ensure that the work is completed when scheduled, that all required outcomes, specifications and tolerances are achieved in the allocated time, and that the sustainability (i.e. dealing responsibly with safety, the environment, employees, communities, governments and asset life) expectations of the Company are met.

The documentation provided with a Task is not intended to specify every possible detail of the work. Many elements of the work can be left to the person to whom the Task is assigned, to use their knowledge, experience and skill to determine as part of the workplace planning and set-up. Where there is a preferred specification or standard then it should be set out in the documentation.

As a Task is assigned to a person they must ensure that they have a full and correct understanding of all requirements for the work, whether specified or not. Even if a Task assignment seemed clear when discussed away from the workplace it may not make sense when the workplace is inspected.

If the person assigned a Task is uncertain of their understanding of any element of the Task, at any time, they should clarify their understanding rather than risk producing a potential hazard or an inappropriate outcome from the work.

### Purpose

To clarify an aspect of a Task assignment.

### Quantity

One set of specifications or instructions relating to a point of clarification.

### Quality

The person seeking clarification must specify;
- what requirement for the work is unclear,
- why they are unclear on the requirement,
- what they need to clarify the requirement.


WE Flowsheet

The person providing clarification must provide the necessary specifications or instructions in a form that is understood by the individual.

### Time


AAOM Flowsheet

This task shall be performed as soon as practical after a person recognises the need for clarification of a Task assignment.

## Resources

Completion of this task is the accountability of the role nominated on the configured Work Execution flowchart.

# WE.06 Are all Resources Available

## Context

The Task assigned to a person may include the following resource specifications;

- special tools required,
- materials required,
- internal resources required,
- external resources required,
- services required, and
- equipment required.

**As part of the scheduling and resourcing processes the resources specified in the Work Package were confirmed as:**

- **present at the job site/staging area, or**
- **being transported to the specified location at the appropriate time.**

**However, there are many possible reasons for resources to be missing or unfit when it comes time to do the work.**

The consequences of commencing a Task without having all the resources that are necessary can include;

- a risk to output, cost or sustainability (i.e. dealing responsibly with safety, the environment, employees, communities, governments and asset life) expectations,
- the failure to deliver some or all the outcomes,
- delay in completing the work.

It is more efficient to verify that all essential resources are available and fit for purpose before starting work rather than to discover the situation after the work has commenced.

## Purpose

To check whether all resources necessary for the work are available and fit for purpose before work commences.

## Quantity

One decision whether all the required resources are available and fit for purpose.

WE Flowsheet

## Quality

Using the list of materials, tools and other necessary resources provided with the Task;

- check that each item is at the specified location,
- verify that the resources meet specifications and are fit for purpose.

AAOM Flowsheet

The individual assigned the Task shall use their own knowledge, experience and skill to identify if any resource that will be required for the work (whether it is specified in the Task documentation or not) is not available. If they are uncertain on any point they should seek clarification from the person who assigned the work.

**Time**

This task shall be performed at the earliest opportunity after assignment of a Task.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Work Execution flowchart.

# WE.07 Can Resources be Obtained & Meet Outcomes?

### Context

The Task assigned to a person may include the following resource specifications;

- special tools required,
- materials required,
- internal resources required,
- external resources required,
- services required, and
- equipment required.

The person assigned the Task may find that some of the specified resources are missing, are not fit for purpose, or that a resource necessary for the work was not specified.

In either case the person can often use their own initiative to find or obtain the necessary resources.

They should do this if it is within their authority to do so, and if in doing so they can still meet all of the outcomes required of the work – including the agreed time for completion of the work.

If they cannot obtain the resources to meet all of the work outcomes they need to escalate the issue.

### Purpose

To decide whether resources needed to complete a Task can be obtained by the individual to whom it was assigned.

### Quantity

One decision whether to obtain resources or escalate the issue.

### Quality

People assigned a Task should use their own initiative to resolve issues relating to completing it wherever possible.

WE Flowsheet

In deciding that they can obtain the resources the person assigned the Task must confirm that;

- it is within their authority to obtain the resources, and
- they will meet all of the outcomes required from the work if they undertake to obtain the resources.

AAOM Flowsheet

### Time

This task shall be performed as soon as practical after the need for additional resources is recognised.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Work Execution flowchart.

# WE.08 Obtain Required Resources

### Context

The Task assigned to a person may include the following resource specifications;

- special tools required,
- materials required,
- internal resources required,
- external resources required,
- services required, and
- equipment required.

The individual assigned the Task may find that some of the specified resources are missing, or that a resource necessary for the work was not specified.

In either case the person can often use their own initiative to find or obtain the necessary resources.

They should do this if it is within their authority to do so, and if in doing so they can still meet all of the outcomes required of the work – including the agreed time for completion of the work.

### Purpose

To obtain additional resources required to complete a work package.

### Quantity

The resources necessary to complete the Task.

### Quality

In obtaining the resources the person assigned the Task must confirm that;

- it is within their authority to obtain the resources,
- they will meet all of the outcomes required from the work if they undertake to obtain the resources, and
- the resources are correctly specified for the work and fit for purpose.

### Time

WE Flowsheet

This task shall be performed as soon as practical after the need for additional resources is recognised.

### Resources

AAOM Flowsheet

Completion of this task is the accountability of the role nominated on the configured Work Execution flowchart.

# WE.09 Are Workplace Conditions Correct?

## Context

Where it is material to the execution of a Task, workplace conditions for the work will be specified in the Task documentation. However, there are potentially many workplace variables that can affect the capacity of the individual assigned the Task to complete it. The individual must use their knowledge, experience and skill to identify these before starting the work.

The consequences of commencing a Task without having all the correct conditions can include;

- a risk to output, cost or sustainability (i.e. dealing responsibly with safety, the environment, employees, communities, governments and asset life) expectations,
- the failure to deliver some or all the outcomes,
- delay in completing the work.

It is more efficient to verify that all conditions essential for the success of the work are established before starting work rather than to discover the situation after the work has commenced.

## Purpose

To check that all workplace conditions necessary for the work are correct before work commences.

## Quantity

One decision whether all the required workplace conditions are established.

## Quality

Using the list of necessary workplace conditions provided with the Task;

- check that each condition has been established,
- verify that the conditions meet specifications and are fit for completing the work.

The individual assigned the Task shall use their own knowledge, experience and skill to identify if any condition that will be required for the work has not been established (whether it is specified in the Task documentation or not). If they are uncertain on any point they should seek clarification from the person who assigned the work.

## Time

This task shall be performed at the commencement, and during execution, of a Task.

## Resources

Completion of this task is the accountability of the role nominated on the configured Work Execution flowchart.

WE Flowsheet

AAOM Flowsheet

# WE.10 Can Workplace Conditions be Established & Meet Outcomes?

**Context**

Where it is material to the execution of a Task, workplace conditions necessary for execution will be specified in the Task documentation. However, there are potentially many workplace variables that can affect the ability or the capacity of the individual assigned the Task to complete it. The individual must use their knowledge, experience and skill to identify these before starting the work.

The consequences of commencing a Task without having all the correct conditions can include;

- a risk to output, cost or sustainability (i.e. dealing responsibly with safety, the environment, employees, communities, governments and asset life) expectations,
- the failure to deliver some or all the outcomes,
- delay in completing the work.

The person assigned a Task may find that some of the specified workplace conditions are not established, or that a workplace condition necessary for the work was not specified.

In either case the person can often use their own initiative to establish the necessary conditions.

They should do this if it is within their authority to do so, and if in doing so they can still meet all of the outcomes required of the work – including the agreed time for completion of the work.

If they cannot establish the necessary conditions and still meet all of the work outcomes they need to escalate the issue.

**Purpose**

To check whether the workplace conditions needed to complete a Task can be established by the person to whom the Task was assigned.

**Quantity**

One decision whether to establish the necessary workplace condition or escalate the issue.

**Quality**

People assigned a Task should use their own initiative to resolve issues relating to completing the Task wherever possible.

In deciding that they can establish the necessary conditions the person assigned the Task must confirm that;

- it is within their authority to do so, and
- they will meet all of the outcomes required from the work if they undertake to do so.

**Time**

This task shall be performed as soon as practical after the need to establish different workplace conditions is recognised.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Work Execution flowchart.

WE Flowsheet

AAOM Flowsheet

# WE.11 Establish Required Workplace Conditions

## Context

Where it is material to the execution of a Task, workplace conditions for the work will be specified in the Task documentation. However, there are potentially many workplace variables that can affect the ability or the capacity of the individual assigned the Task to complete it. The individual must use their knowledge, experience and skill to identify these before starting the work.

The consequences of commencing a Task without having all the correct conditions can include;

- a risk to output, cost or sustainability (i.e. dealing responsibly with safety, the environment, employees, communities, governments and asset life) expectations,
- the failure to deliver some or all the outcomes,
- delay in completing the work.

The person assigned a Task may find that some of the specified workplace conditions are not established, or that a workplace condition necessary for the work was not specified.

In either case person can often use their own initiative to establish the necessary conditions.

They should do this if it is within their authority to do so, and if in doing so they can still meet all of the outcomes required of the work – including the agreed time for completion of the work.

## Purpose

To establish the workplace conditions required to complete a Task.

## Quantity

The workplace conditions necessary to complete the Task.

## Quality

In establishing the workplace conditions the person assigned the Task must confirm that;

- it is within their authority to do so, and
- they will meet all of the outcomes required from the work if they undertake to establish the workplace conditions,
- the workplace conditions they establish must meet the sustainability (i.e. dealing responsibly with safety, the environment, employees, communities, governments and asset life) expectations of the Company.

### Time

This task shall be performed as soon as practical after the need to establish different workplace conditions is identified.

### Resources

Completion of this task is the accountability of the role nominated on the configured Work Execution flowchart.

WE Flowsheet

AAOM Flowsheet

## WE.12 Execute Task

### Context

The primary objectives when executing a Task are to ensure that the work is completed when scheduled, that all required outcomes, specifications and tolerances are achieved in the allocated time, and that the sustainability (i.e. dealing responsibly with safety, the environment, employees, communities, governments and asset life) expectations of the Company are met.

A secondary but important outcome when executing any work package is to look more widely at the workplace and ensure that any other identifiable defects or hazards are both corrected/controlled and recorded, or else reported in sufficient detail to allow effective planning and scheduling of the corrective or control action.

### Purpose

To complete every Task to specification at the right time.

### Quantity

Completion of each assigned Task to specification.

### Quality

Execution of a Task may include the following requirements:

- Identification of hazards and management of the associated risks.
- Implementing permits and isolations.
- Achieving each distinct outcome for the work.
- Confirming the tolerance or standard required for each outcome.
- Following the method or procedure specified for achieving the outcome.
- Following a specified sequence of job steps.
- Meeting the duration specified for job steps.
- Ensuring that correct parts, materials, technical documents, tools and equipment are used.
- Performing acceptance tests and procedures for completion and handover.
- Verifying and recording acceptance standards for completion and handover.
- Recording of work progress.
- Recording of job history.
- Returning unused parts and materials to the warehouse.
- Returning tools and equipment to storage locations.

If the person assigned a Task is unclear on any of the above requirements (whether the requirements are stated in the Task documentation or not), or if any proposed work outcome or work method is not consistent with established practice, or approved work procedures, they must seek clarification.

Where additional Equipment/Workplace defects are identified while executing work, or a safety or environmental incident occurs with actual or potential loss, these must be dealt with in one of the following ways;

- An immediate response to the incident, which may include correcting or controlling the defect or situation, if this can be done without compromising the outcomes, specifications, tolerances or duration of the initial Task.
- Immediately classify and report the defect or incident using the Urgent Work Process if it cannot be corrected or controlled without compromising completion of the initial Task, and if the Impact and Required Date for the defect or incident mean that action is required before a corrective or control action can be completed using the routine work management process.
- Classify and report the defect or incident after completion of the initial Task if the Impact and Required Date for the defect or incident mean that a corrective or control action can be completed using the routine work management process.

**Time**

This task shall be performed in time to meet the agreed outcomes and completion time for the assigned Task.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Work Execution flowchart.


WE Flowsheet


AAOM Flowsheet

# WE.13 Will the Task Specifications be Met?

**Context**

The primary objectives when executing a Task are to ensure that the work is completed when scheduled, that all required outcomes, specifications and tolerances are achieved in the allocated time, and that the sustainability (i.e. dealing responsibly with safety, the environment, employees, communities, governments and asset life) expectations of the Company are met.

In order to consistently meet these objectives the person assigned the Task must, throughout its execution, maintain a check on both the rate of progress of the work and on the achievement of the work outcomes.

As soon as it becomes apparent that the person assigned the Task cannot meet the outcomes, or completion time, they should escalate the issue. This will create the opportunity for support to be provided in time to meet all of the task objectives.

**Purpose**

To check that the progress of the work is consistent with the expected outcomes and completion time.

**Quantity**

One decision whether work progress is consistent with meeting the expected outcomes and completion time.

One notification to the person who assigned the Task if the decision is made that any work outcome, or the completion time, will not be met.

**Quality**

In making the decision, consider the following;

- the work outcomes and specifications set out in the Task.
- the completion time set out in the Task.
- the time required to complete the remaining work on the Task, as well as the time required to complete any additional work that has been identified.

Having considered the above, make the following judgement:

- less than 80% sure (not reasonably sure) you will meet outcomes, escalate, or
- greater than 80% sure (reasonably sure) you will meet outcomes, continue with work.

**Time**

This task shall be performed in time to meet the agreed outcomes and completion time for the assigned Task.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Work Execution flowchart.

WE Flowsheet

AAOM Flowsheet

# WE.14 Is Additional Work Required?

### Context

The primary objectives when executing a Task are to ensure that the work is completed when scheduled, that all required outcomes, specifications and tolerances are achieved in the allocated time, and that the sustainability (i.e. dealing responsibly with safety, the environment, employees, communities, governments and asset life) expectations of the Company are met.

A secondary but important outcome when executing any work package is to look more widely at the workplace and ensure that any other identifiable defects or hazards are both corrected/controlled and recorded, or else reported in sufficient detail to allow effective planning and scheduling of the corrective or control action.

If the person assigned the Task identifies additional work there are a series of decisions that they must make about how to deal with that work.

### Purpose

To decide if there is any additional work required.

### Quantity

One decision whether additional work is required.

### Quality

Additional work is required if there is indication of a condition (that will not be corrected by the current work) and if not corrected could lead to:

- a potential hazard with associated risks,
- the business area, or part of it, not operating to specification (rate and quality),
- an interruption to the business area before the next scheduled opportunity to complete the work,
- increased future costs,
- reduced economic life for the business area, or
- a situation that results in other business areas not being able to perform to specification.

### Time

This task shall be performed in time to meet the agreed outcomes and completion time for the Task.

### Resources

Completion of this task is the accountability of the role nominated on the configured Work Execution flowchart.

# WE.15 Can Additional Work be Completed & Still Meet Outcomes?

### Context

The primary objectives when executing a Task are to ensure that the work is completed when scheduled, that all required outcomes, specifications and tolerances are achieved in the allocated time, and that the sustainability (i.e. dealing responsibly with safety, the environment, employees, communities, governments and asset life) expectations of the Company are met.

A secondary but important outcome when executing any work package is to look more widely at the workplace and ensure that any other identifiable defects or hazards are both corrected/controlled and recorded, or else reported in sufficient detail to allow effective planning and scheduling of the corrective or control action.

If the person assigned the Task identifies additional work that is within their authority and capacity to complete, then they should proceed if the resources are available and they can still finish their assigned Task on time.

### Purpose

To decide whether additional work that has been identified can be completed and still meet the requirements of the assigned Task.

### Quantity

One decision whether the individual can complete the extra work without detriment to the work outcomes and completion time of their assigned Task.

### Quality

The decision criteria to be used are;

- all of the work outcomes specified in the assigned Task will be completed,
- all tolerances and specifications for each outcome will be achieved,
- all specified work procedures will be followed,
- acceptance testing and handover procedures will be executed,
- acceptance test limits and plant handover will be achieved,
- the resources required to complete the extra work,
- the resources available to the crew member(s),
- all of the above, plus the additional work, will be completed within the time specified for the assigned Task.

WE Flowsheet

AAOM Flowsheet

### Time

This task shall be performed in time to meet the agreed outcomes and completion time for the assigned Task.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Work Execution flowchart.

# WE.16 Is Additional Work Urgent?

### Context

The primary objectives when executing a Task are to ensure that the work is completed when scheduled, that all required outcomes, specifications and tolerances are achieved in the allocated time, and that the sustainability (i.e. dealing responsibly with safety, the environment, employees, communities, governments and asset life) expectations of the Company are met.

A secondary but important outcome when executing any work package is to look more widely at the workplace and ensure that any other identifiable defects or hazards are both corrected/controlled and recorded, or else reported in sufficient detail to allow effective planning and scheduling of the corrective or control action.

If the person assigned the Task identifies additional work that is within their authority and capacity to complete, then they should proceed if the resources are available and they can still finish their assigned Task on time.

If the person assigned the Task identifies additional work that they do not have the authority or capacity to complete without adversely affecting the completion of their assigned Task, then they must decide if the completion of the extra work can wait, or if it needs urgent attention.

If the situation requiring additional work is likely to result in a risk to achieving sustainability (i.e. by dealing responsibly with safety, the environment, employees, communities, governments and asset life) output or cost targets before the next scheduled opportunity to complete the additional work, then the individual should notify the Urgent Work Process to deal with the extra work. This decision must be based on the assessment of the probable **Impact** of not dealing with the identified issue and the probable time at which this Impact can no longer be avoided – **Required Date**.

This will ensure that the assigned Tasks are completed on time and to specification, and that any situation that could result in a risk is dealt with in time to prevent the potential consequences.

Otherwise the individual who identified the additional work should record the details of the work and report them after completing their assigned Task.

WE Flowsheet

AAOM Flowsheet

### Purpose

To determine if additional work is urgent.

### Quantity

One decision whether the work is urgent.

### Quality

The criteria to be used for this decision are:

- the Required by Date for the work,
- the Impact of not completing the work by the Required Date, and
- the next scheduled opportunity to complete the work.

The full task assignment for determining if work is urgent is defined in - WA.02 Is the work urgent?

**Time**

This task shall be performed in time to meet the outcomes and completion time for the assigned Task and to prevent potential risks arising from the situation needing the additional work.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Work Execution flowchart.

# WE.17 Are all Task Requirements Complete

### Context

The primary objectives when executing a Task are to ensure that the work is completed when scheduled, that all required outcomes, specifications and tolerances are achieved in the allocated time, and that the sustainability (i.e. dealing responsibly with safety, the environment, employees, communities, governments and asset life) expectations of the Company are met.

In order to consistently meet these objectives the person assigned the Task must, throughout its execution, maintain a check on both the rate of progress of the work and on the achievement of the work outcomes.

When all of the elements of the assigned Task have been completed, and there is no extra work outstanding, it is time to demobilise and close the Task (i.e. return tools, equipment and unused materials and finalise all record keeping).

### Purpose

To check that all required work outcomes have been completed.

### Quantity

One decision whether the work is complete.

### Quality

The criteria to be used are;

- all elements of the assigned Task have been completed,
- all extra work that cannot be delayed until the next scheduled opportunity has been completed or escalated via the Urgent Work Process, and
- all other extra work has been specified for recording in the Work Management process.

### Time

This task shall be performed when the person assigned the Task considers that the work has been completed.

### Resources

Completion of this task is the accountability of the role nominated on the configured Work Execution flowchart.


WE Flowsheet


AAOM Flowsheet

## WE.18 Execute Additional Work

### Context

The primary objectives when executing a Task are to ensure that the work is completed when scheduled, that all required outcomes, specifications and tolerances are achieved in the allocated time, and that the sustainability expectations of the Company are met.

A secondary but important outcome when executing any work package is to look more widely at the workplace and ensure that any other identifiable defects or hazards are both corrected/controlled and recorded, or else reported in sufficient detail to allow effective planning and scheduling of the corrective or control action.

Once it has been determined that all of the work outcomes specified in the original Task will be completed on time, and that any extra work can be completed within the time allocated for the assigned Task, then the extra work can be executed.

### Purpose

To complete extra work to the appropriate standard.

### Quantity

All actions to achieve the necessary and appropriate outcomes, tolerance and standards for the extra work.

### Quality

Executing the extra work may include the following requirements:

- Identification of potential hazards and management of the associated risks.
- Implementing permits and isolations.
- Achieving each distinct outcome for the work.
- Confirming the tolerance or standard required for each outcome.
- Following the method or procedure specified for achieving the outcome.
- Following a specified sequence of job steps.
- Meeting the duration specified for job steps.
- Ensuring that correct parts, materials, technical documents, tools and equipment are used.
- Performing acceptance tests and procedures for completion and handover.
- Verifying and recording acceptance standards for completion and handover.
- Recording of work progress.
- Recording of job history.
- Returning unused parts and materials to the warehouse.

- Returning tools and equipment to storage locations.

All work shall be:

- in accordance with the Company’s safety policies, standards, and procedures,
- in accordance with all procedures, specifications, tolerances and practices normally associated with this work,
- performed to a standard that will ensure reliable, capable and efficient function.

**Time**

This task shall be performed in time to meet the agreed outcomes and completion time for the assigned Task.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Work Execution flowchart.

WE Flowsheet

AAOM Flowsheet

# WE.19 Record all Required Data

### Context

The primary objectives when executing a Task are to ensure that the work is completed when scheduled, that all required outcomes, specifications and tolerances are achieved in the allocated time, and that the sustainability expectations of the Company are met.

A Task is not complete until all of the necessary data and records required for the work are created.

In some cases the Task will require the collection of data for analysis or prediction of performance. Where this type of data is required the Task instructions will specify what data needs to be collected, and where and how it must be collected.

In all cases, completion of the work requires the reporting of:
- the assigned work completed
- any extra work completed
- any extra work to be scheduled for future execution.

To ensure that all necessary information is accurate the person completing the work should record all of the information that will required before they leave the workplace.

### Purpose

To record the details of work execution.

### Quantity

One set of notes/documents recording the details of the assigned Task completion, and of extra work.

### Quality

For the **assigned Task**:
- Sign off all items/outcomes completed.
- Record all measurements/tolerances requested.
- Complete the relevant sections of the Job Card.
- Transfer data to other locations referenced in the job instructions e.g. Government log books.

For **extra work completed** (not part of the originally assigned Task), create a new Work Order and or additional Tasks in accordance with the standards defining when a Work Order or Task are to be used. The minimum requirement is to specify:
- Equipment/Workplace reference.
- Task (action and object).
- Labour used (including Work Group and Skill Type),

- Other resources used (typically materials),
- Work Type, and
- Reason for the extra work (i.e. situation addressed).

For **extra work identified** but not completed (not part of the originally assigned Task), create a new Work Request in accordance with the specifications of task assignment WA.01 Raise Work Request.

**Time**

This task shall be performed immediately work is completed.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Work Execution flowchart.

WE Flowsheet

AAOM Flowsheet

# WE.20 Return Tools & Surplus Materials

### Context

A Task specifies all the requirements for the successful execution of work. Included in this specification are the materials, special tools and equipment, services and labour that are likely to be used in the work.

Some materials may be included in a Task because they have a high probability, rather than a certainty, of being needed. In cases where the lack of such a material can risk the success of the work it is better to issue and return un-needed materials than create the risk. If there is material remaining after work is complete the material must be removed from the workplace and returned to the appropriate location (e.g. inventory).

Also, all special tools and equipment must be removed and returned to the appropriate storage location.

### Purpose

To avoid waste of materials and tools.

### Quantity

All material special tools and equipment provided for a Task must be accounted for – either utilised in the execution of the work, returned to inventory, or returned to the appropriate storage location.

### Quality

***Special Tools and Equipment:***

- Rented from an external supplier – return to the supplier, or arrange for the tools to be picked up.
- Borrowed from another business area – return, or arrange for the tools to be picked up.
- Issued from a storage location – return to the appropriate location.

***Materials:***

- Free Stock items – return to the holding bins for these materials.
- Catalogued items (warehouse stock) – return to the warehouse for a credit against the Work Order.
- Non-Catalogued items (non-warehouse stock) – return to the supplier for a credit against the Work Order.

### Time

This task shall be performed immediately the work is completed.

## Resources

Completion of this task is the accountability of the role nominated on the configured Work Execution flowchart.

WE Flowsheet

AAOM Flowsheet

# WE.21 Close Task with Required Data

### Context

The primary objectives when executing a Task are to ensure that the work is completed when scheduled, that all required outcomes, specifications and tolerances are achieved in the allocated time, and that the sustainability expectations of the Company are met.

When the physical execution of the work is complete and the work site, materials and special tools and equipment cleaned up and returned to the correct condition/location the Task and/or Work Order must be closed in the Work Management System (WMS). This will ensure that all stakeholders involved in the Work Management process know that the work is complete and will deal with it appropriately.

The completed Task and/or Work Order will also form part of the records used for reporting and analysis of business area and work management performance.

### Purpose

To close the active life cycle of the Task/Work Order, with information providing an accurate history of the work completed.

### Quantity

Each field of the Work Order must be updated in the WMS with actual data, including:

- Task(s) description,
- Task(s) Resource Work Group,
- Task(s) materials,
- Task(s) duration,
- Measurements,
- Date completed.

### Quality

Data entered into the WMS shall meet the standards set down for the use of each field of the Task/Work Order.

### Time

This task shall be performed within the working shift in which a Task/Work Order is completed.

### Resources

Completion of this task is the accountability of the role nominated on the configured Work Execution flowchart.

# WE.22 Review Work Completion

### Context

When all the requirements for execution of a Task have been completed by the person assigned the Task they should notify their manager and request review of the work performance.

### Purpose

To initiate review of the performance of work.

### Quantity

One communication between the person(s) executing the work and their manager.

### Quality

The communication shall preferably be made in person or by telephone, however other methods of communication (e.g. a shift log) may be used where this is not practical.

The communication should include discussion of;

- what was achieved (outcomes, tolerances, specifications etc) and was anything outside of the Task planning required to achieve it,
- what potential critical issues (hazards, conditions, constraints, resources, time etc) were encountered and how these were managed,
- any follow-up (e.g. additional work, correction of planning errors, communication to other stakeholders) needed and how this will be done,
- what was learned and how can this be applied in the future,
- any outstanding question about the work,
- any other matter that the team member or team leader considers appropriate for the specific Task.

The communication should aim to;

- recognise the performance of the worker(s),
- provide coaching and development, and
- specify follow-up actions and accountabilities.

WE Flowsheet

### Time

This task shall be performed immediately after all other aspects of the work are complete.

AAOM Flowsheet

### Resources

Completion of this task is the accountability of the role nominated on the configured Work Execution flowchart.

## WE.23 Is Extra Time Needed?

### Context

The primary objectives when executing a Task are to ensure that the work is completed when scheduled, that all required outcomes, specifications and tolerances are achieved in the allocated time, and that the sustainability expectations of the Company are mete.

Throughout the execution of the schedule, and the Tasks in it, a check is maintained on both the rate of progress and on achievement of the specified outcomes.

If it becomes apparent that the schedule, Task outcomes or Task completion time cannot be met, an assessment of potential control actions must be made. A prompt control action may create the opportunity to meet the work outcomes.

There are two actions that can taken to achieve the completion of the schedule or a Task within it. One is to extend the duration of the Task(s) causing the issue, the other is to provide additional resources to accelerate the completion of the Task(s). Where the issue can be resolved by allocating extra time this is the first choice option.

In some cases an extension of the Task duration may have no impact on other work (e.g. service work on a backup unit that is not immediately required for duty), however, where an extended duration may affect other work (e.g. service of a unit that is due to return to operation at the scheduled completion time) the appropriate stakeholder(s) should be consulted.

### Purpose

To decide if additional execution time will allow a schedule/Task to be completed successfully.

### Quantity

One decision whether additional time will allow the outcomes of a schedule or Task to be delivered successfully.

### Quality

The decision criteria to be used are:

- the actual duration of work will be greater than the allocated time,
- the work can be completed if additional execution time is provided.

### Time

This task shall be performed immediately it becomes apparent that the schedule, or a Task within it, may not be completed as committed.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Work Execution flowchart.

WE Flowsheet

AAOM Flowsheet

## WE.24 Extra Time Approved?

### Context

The primary objectives when executing a Task are to ensure that the work is completed when scheduled, that all required outcomes, specifications and tolerances are achieved in the allocated time, and that the sustainability expectations of the Company are mete.

Throughout the execution of the schedule, and the Tasks in it, a check is maintained on both the rate of progress and on achievement of the specified outcomes.

If it becomes apparent that the schedule, Task outcomes or Task completion time cannot be met an assessment of potential control actions must be made. A prompt control action may create the opportunity to meet the work outcomes.

There are two actions that can taken to achieve the completion of the schedule or a Task within it. One is to extend the duration of the Task(s) causing the issue, the other is to provide additional resources to accelerate the completion of the Task(s). Where the issue can be resolved by allocating extra time this is the first choice option.

In some cases an extension of the Task duration may have no impact on other work (e.g. service work on a backup unit that is not immediately required for duty), however, where an extended duration may affect other work (e.g. service of a unit that is due to return to operation at the scheduled completion time) the appropriate stakeholder(s) should be consulted.

If other tasks have been completed in less than the allocated time, or there is 'float' time in the schedule, then this time may be able to be utilised to extend a Task duration with no impact on other business areas. In this case approval of the extended Task duration is the accountability of the manager of the business area. If extending a Task duration may affect other business areas then approval of the change is the accountability of the crossover manager for the business areas.

### Purpose

To decide if additional time should be approved to allow the completion of a scheduled work package.

### Quantity

One decision whether to approve additional time for the completion of a scheduled work package.

### Quality

The decision criteria to be used are:

- the duration of the is work greater than the scheduled time, and

- the work can be completed if additional time is provided, and
- time is available from either quicker completion of other work, or
- ‘float’ time is available within the schedule, or
- the impact on the schedule outcomes, produced by extending the duration of the work, is accepted by the accountable manager.

**Time**

This task shall be performed immediately it becomes apparent that the schedule, or a Task within it, may not be completed as committed.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Work Execution flowchart.

WE Flowsheet

AAOM Flowsheet

# WE.25 Are Extra Resources Needed?

### Context

The primary objectives when executing a Task are to ensure that the work is completed when scheduled, that all required outcomes, specifications and tolerances are achieved in the allocated time, and that the sustainability expectations of the Company are mete.

Throughout the execution of the schedule, and the Tasks in it, a check is maintained on both the rate of progress and on achievement of the specified outcomes.

If it becomes apparent that the schedule, Task outcomes or Task completion time cannot be met an assessment of potential control actions must be made. A prompt control action may create the opportunity to meet the work outcomes.

There are two actions that can taken to achieve the completion of the schedule or a Task within it. One is to extend the duration of the Task(s) causing the issue, the other is to provide additional resources to accelerate the completion of the Task(s). Where the issue can be resolved by allocating extra time this is the first choice option.

Where increasing the time allocated to Task(s) will not allow the business expectations to be met, it may be possible to add resources to complete the Task within the allocated time.

This should be considered when it is practical, and the cost of the additional resources may be less than the cost of the consequences of not completing the Task as scheduled.

### Purpose

To decide if additional resources will allow a schedule/Task to be completed successfully.

### Quantity

One decision whether additional resources will allow the outcomes of a schedule/Task to be delivered successfully.

### Quality

The decision criteria to be used are:

- the Task outcomes and duration cannot be met with the assigned resources,
- the Task can be completed on time if additional resources are provided, and
- the cost of the additional resources is less than the cost of the consequences of not completing the Task as scheduled.

**Time**

This task shall be performed immediately it becomes apparent that the schedule, or a Task within it, may not be completed as committed.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Work Execution flowchart.

WE Flowsheet

AAOM Flowsheet

# WE.26 Extra Resources Approved?

## Context

The primary objectives when executing a Task are to ensure that the work is completed when scheduled, that all required outcomes, specifications and tolerances are achieved in the allocated time, and that the sustainability expectations of the Company are mete.

Throughout the execution of the schedule, and the Tasks in it, a check is maintained on both the rate of progress and on achievement of the specified outcomes.

If it becomes apparent that the schedule, Task outcomes or Task completion time cannot be met an assessment of potential control actions must be made. A prompt control action may create the opportunity to meet the work outcomes.

There are two actions that can taken to achieve the completion of the schedule or a Task within it. One is to extend the duration of the Task(s) causing the issue, the other is to provide additional resources to accelerate the completion of the Task(s). Where the issue can be resolved by allocating extra time this is the first choice option.

Where increasing the time allocated to Task(s) will not allow the business expectations to be met, it may be possible to add resources to complete the Task within the allocated time.

This should be considered when it is practical, and the cost of the additional resources may be less than the cost of the consequences of not completing the Task as scheduled.

## Purpose

To decide if additional resources should be approved to allow the completion of a schedule/Task.

## Quantity

One decision whether it is cost effective to approve additional resources for the completion of a schedule/Task.

## Quality

The decision criteria to be used are:

- the outcomes and scheduled duration of the Task(s) cannot be met with the assigned resources, and
- the Task(s) can be completed if additional resources are provided,
- appropriate additional resources can be made available, and
- the cost of the additional resources is less than the cost of extending the Task(s) duration, or

- the cost of the additional resources is less than the cost of the consequences of not achieving the Task(s) outcomes.

**Time**

This task shall be performed immediately it becomes apparent that the schedule, or a Task within it, may not be completed as committed.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Work Execution flowchart.

WE Flowsheet

AAOM Flowsheet

## WE.27 Obtain Resources

### Context

The primary objectives when executing a Task are to ensure that the work is completed when scheduled, that all required outcomes, specifications and tolerances are achieved in the allocated time, and that the sustainability expectations of the Company are mete.

Throughout the execution of the schedule, and the Tasks in it, a check is maintained on both the rate of progress and on achievement of the specified outcomes.

If it becomes apparent that the schedule, Task outcomes or Task completion time cannot be met an assessment of potential control actions must be made. A prompt control action may create the opportunity to meet the work outcomes.

There are two actions that can taken to achieve the completion of the schedule or a Task within it. One is to extend the duration of the Task(s) causing the issue, the other is to provide additional resources to accelerate the completion of the Task(s). Where the issue can be resolved by allocating extra time this is the first choice option.

Where increasing the time allocated to Task(s) will not allow the business expectations to be met, it may be possible to add resources to complete the Task within the allocated time.

When it is possible to add resources to complete the Task and the addition of resources have been approved, the mobilisation of the resources must be expedited.

### Purpose

To mobilise the extra resources approved to successfully complete a schedule/Task.

### Quantity

One set of actions that will mobilise the resources to the workplace(s) in time to deliver the committed schedule/Task.

### Quality

The resources mobilised must be of the correct specification and fit for purpose.

Actions necessary to mobilise the resources must comply with Company policies and procedures.

### Time

This task shall be performed immediately it becomes apparent that the schedule, or a Task within it, may not be completed as committed.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Work Execution flowchart.

WE Flowsheet

AAOM Flowsheet

## WE.28 Can Some Task(s) be Rescheduled & Still Meet Required Date?

### Context

The primary objectives when executing a Task are to ensure that the work is completed when scheduled, that all required outcomes, specifications and tolerances are achieved in the allocated time, and that the sustainability expectations of the Company are mete.

Throughout the execution of the schedule, and the Tasks in it, a check is maintained on both the rate of progress and on achievement of the specified outcomes.

If it becomes apparent that the full committed schedule cannot be completed in the available time, and with the resources that can be mobilised, then some work from the schedule will have to be re-scheduled. In such cases an analysis of all of the work remaining on the schedule must be made to determine which work can be re-scheduled with the lowest potential impact on the business area. It is not uncommon that the first reaction to difficulty in executing a Task is to re-schedule the Task presenting the difficulty. This may be a good option but, where the potential impact of not completing the Task is high, it may be better to re-schedule other work in order to make time or resources available to complete the more critical Task.

There are several types of variation that can be made to the schedule. A variation that results in no risk is to defer from the current schedule period a Task, and any Tasks that are dependent on its completion, that has been scheduled far enough ahead of its Required Date that it can be re-scheduled for completion before its Required Date.

### Purpose

To decide if a Task in the current schedule period, that can be deferred and still be completed prior to its Required Date, will be rescheduled.

### Quantity

One decision to defer completion of a Task(s) from the current schedule period.

### Quality

The decision criteria to be used are:

- it is not possible to complete all of the Tasks assigned to the current schedule period, and
- a Task assigned to this scheduled period can be rescheduled and still meet its Required Date, and
- the cost of rescheduling the Task is less than the cost of rescheduling other Tasks.

**Time**

This task shall be performed in time to maximise the achievement of the schedule.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Work Execution flowchart.

WE Flowsheet

AAOM Flowsheet

# WE.29 Can Some Low Impact Task(s) be Rescheduled Beyond Required Date?

### Context

The primary objectives when executing a Task are to ensure that the work is completed when scheduled, that all required outcomes, specifications and tolerances are achieved in the allocated time, and that the sustainability expectations of the Company are mete.

Throughout the execution of the schedule, and the Tasks in it, a check is maintained on both the rate of progress and on achievement of the specified outcomes.

If it becomes apparent that the full committed schedule cannot be completed in the available time, and with the resources that can be mobilised, then some work from the schedule will have to be re-scheduled. In such cases an analysis of all of the work remaining on the schedule must be made to determine which work can be re-scheduled with the lowest potential impact on the business area. It is not uncommon that the first reaction to difficulty in executing a Task is to re-schedule the Task presenting the difficulty. This may be a good option but, where the potential impact of not completing the Task is high, it may be better to re-schedule other work in order to make time or resources available to complete the more critical Task.

There are several types of variation that can be made to the schedule. A variation that results in low risk is to defer beyond its Required Date a Task, and any Tasks that are dependent on its completion, that has Low Impact.

### Purpose

To decide if a Task in the current schedule period, that can be deferred with low/no impact on the operations, will be rescheduled.

### Quantity

One decision to defer completion of a Task(s) from the current schedule period.

### Quality

The decision criteria to be used are:

- it is not possible to complete all of the Tasks assigned to the current schedule period, and
- a Task assigned to this scheduled period can be rescheduled with low/no impact on operations, and
- the cost of rescheduling the Task is less than the cost of rescheduling other Tasks.

**Time**

This task shall be performed in time to maximise the achievement of the schedule.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Work Execution flowchart.

WE Flowsheet

AAOM Flowsheet

# WE.30 Can the Scope of Some Task(s) be Varied?

## Context

The primary objectives when executing a Task are to ensure that the work is completed when scheduled, that all required outcomes, specifications and tolerances are achieved in the allocated time, and that the sustainability expectations of the Company are mete.

Throughout the execution of the schedule, and the Tasks in it, a check is maintained on both the rate of progress and on achievement of the specified outcomes.

If it becomes apparent that the full committed schedule cannot be completed in the available time, and with the resources that can be mobilised, then some work from the schedule will have to be re-scheduled. In such cases an analysis of all of the work remaining on the schedule must be made to determine which work can be re-scheduled with the lowest potential impact on the business area. It is not uncommon that the first reaction to difficulty in executing a Task is to re-schedule the Task presenting the difficulty. This may be a good option but, where the potential impact of not completing the Task is high, it may be better to re-schedule other work in order to make time or resources available to complete the more critical Task.

There are several types of variation that can be made to the schedule. A variation that can result in lowered risk, but additional effort, is to vary the scope of a Task(s) (including splitting the Task up) in order to reduce the amount of work within the schedule period. The work that will not be completed as originally scheduled can then either be rescheduled or cancelled.

## Purpose

To decide if the scope of a Task in the current schedule period will be altered.

## Quantity

One decision to alter the scope of a Task(s) within the current schedule period.

## Quality

The decision criteria to be used are:

- it is not possible to complete all of the Tasks assigned to the current schedule period, and
- a Task assigned to this scheduled period can have the scope varied or split for rescheduling without impact on operations, and
- the cost of varying the scope/splitting and rescheduling the Task is less than the cost of rescheduling other Tasks.

**Time**

This task shall be performed in time to maximise the achievement of the schedule.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Work Execution flowchart.

WE Flowsheet

AAOM Flowsheet

# WE.31 Identify Lowest Risk Task(s) to Reschedule

## Context

The primary objectives when executing a Task are to ensure that the work is completed when scheduled, that all required outcomes, specifications and tolerances are achieved in the allocated time, and that the sustainability expectations of the Company are mete.

Throughout the execution of the schedule, and the Tasks in it, a check is maintained on both the rate of progress and on achievement of the specified outcomes.

If it becomes apparent that the full committed schedule cannot be completed in the available time, and with the resources that can be mobilised, then some work from the schedule will have to be re-scheduled. In such cases an analysis of all of the work remaining on the schedule must be made to determine which work can be re-scheduled with the lowest potential impact on the business area. It is not uncommon that the first reaction to difficulty in executing a Task is to re-schedule the Task presenting the difficulty. This may be a good option but, where the potential impact of not completing the Task is high, it may be better to re-schedule other work in order to make time or resources available to complete the more critical Task.

If the options of;

- rescheduling Task(s) being completed prior to their Required Date, and
- rescheduling Low Impact Task(s), and
- varying the scope of Task(s) within the current scheduled period,

have all been considered and the schedule still cannot be completed, then the last option is to identify the lowest risk Task(s) that can be rescheduled.

## Purpose

To identify the Task(s) within the current schedule period that can be rescheduled with the lowest risk.

## Quantity

One decision to defer completion of a Task(s) from the current schedule period.

## Quality

The decision criteria to be used are:

- it is not possible to complete all of the work assigned to the current schedule period, and
- a work package assigned to this scheduled has the lowest risk to operations of any work package if rescheduled, and
- the cost of rescheduling the work package is less than the cost of rescheduling other work packages with the same risk.

**Time**

This task shall be performed in time to maximise the achievement of the schedule.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Work Execution flowchart.

WE Flowsheet

AAOM Flowsheet

## WE.32 Is the Work Still Required?

### Context

When any Task, or part thereof, in the current schedule period is deferred, it is possible that the work may no longer be required.

For example, this is probably the case when a weekly inspection is deferred from the current schedule period. If a new inspection has been or will be generated for the next scheduled period it will make no sense to conduct 2 inspections within the same week.

In such circumstances the deferred Task/Work Order should be cancelled and the reason recorded if required.

### Purpose

To check if work that is deferred from the current schedule period is still required.

### Quantity

One decision whether to re-schedule or cancel deferred work.

### Quality

The decision criteria to be used are:

- the outcomes of the work will not be made redundant by the scheduled execution of another Task, and
- the outcomes of the work will not be made redundant by any change to the configuration or operation of the business area.

### Time

This task shall be performed in time to include the task in the next schedule period if it is required.

### Resources

Completion of this task is the accountability of the role nominated on the configured Work Execution flowchart.

# WE.33 Cancel the Task

## Context

When any Task, or part thereof, in the current schedule period is deferred, it is possible that the work may no longer be required.

For example, this is probably the case when a weekly inspection is deferred from the current schedule period. If a new inspection has been or will be generated for the next scheduled period it will make no sense to conduct 2 inspections within the same week.

In such circumstances the deferred Task/Work Order should be cancelled and the reason recorded if required.

## Purpose

To terminate processing of the Task/Work Order.

## Quantity

One status code indicating that the Task/Work Order was cancelled.

## Quality

The status code CA (cancelled) shall be entered on the Task/Work Order.

## Time

This task shall be performed in time to exclude the Task/Work Order from the next schedule review.

## Resources

Completion of this task is the accountability of the role nominated on the configured Work Execution flowchart.

WE Flowsheet

AAOM Flowsheet

# WE.34 Notify Affected Parties

### Context

Any change made to a committed schedule will have the potential to affect the work of many different parties.

If such a change is decided, each of the parties that may be affected by it must be notified immediately.

### Purpose

To notify all parties potentially affected by a change to the committed schedule (current schedule period).

### Quantity

One communication to all potentially affected parties.

### Quality

Communication of the change to the committed schedule should include;

- notification of the Task(s) that has been moved within the current schedule period, moved out of the current schedule period or cancelled, and
- explanation of the reasons for the change.

### Time

The communication must be made as soon as practical after the decision to modify the schedule has been made.

### Resources

Completion of this task is the accountability of the role nominated on the configured Work Execution flowchart.

# WE.35 Assign Urgent Work Request

### Context

In every business area is inevitable that some urgent work needs will arise, although the frequency of such needs may vary significantly. It is also important that these urgent needs be assessed, prioritised and dealt with in a consistent and timely manner, without causing unnecessary disruption to the regular scheduled activities of the business area.

The first step in appropriately dealing with urgent work is to ensure that there is one, clearly identified, and easily reached, contact point for urgent work. All urgent work requests must be directed to the nominated contact.

The nominated contact should review each urgent work request to confirm that it is in fact urgent, or if it is not shown to be urgent, to reassign the work to the routine work management process.

When a request is accepted as urgent, the appropriate resources must be assigned to deal with it.

### Purpose

To assign an urgent Work Request for processing.

### Quantity

One acceptance of a Work Request to be completed urgently.

One assignment of resources to deal with accepted urgent work.

Re-assignment of a non-urgent Work Request to the routine work management process.

### Quality

There should be a single, consistent point of contact for urgent work.

There should be a consistent, accessible method of contact.

A request for urgent work should provide the same information as is specified for a normal Work Request (see task assignment WA.01).


WE Flowsheet

The urgent work point of contact shall evaluate the work request against the criteria of task assignment WA.02 Is the Work Urgent, and only accept as urgent requests that conform to the specifications set out in that task assignment.


AAOM Flowsheet

Requests that do not conform to these specifications for urgent work shall be re-assigned to the routine work management process by entering the appropriate Impact and Required Date on the Work Request. The person who initiated the urgent Work Request should be advised of the reason for its re-assignment.

**Time**

Assignment of an urgent Work Request (either to urgent work resources or the routine work management process) shall be made as soon as possible.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Work Execution flowchart.

# WE.36 Work Scope Defined?

### Context

In every business area is inevitable that some urgent work needs will arise, although the frequency of such needs may vary significantly. It is also important that these urgent needs be assessed, prioritised and dealt with in a consistent and timely manner, without causing unnecessary disruption to the regular scheduled activities of the business area.

The first step in appropriately dealing with urgent work is to ensure that there is one, clearly identified, and easily reached, contact point for urgent work. All urgent work requests must be directed to the nominated contact.

Where there appears to be a valid need for urgent work, the urgent work point of contact will either investigate, or assign a person to investigate, the issue reported to make the initial diagnosis.

The time taken to complete the initial diagnosis will depend on:
- The number of urgent calls in the queue
- The relative impact of the calls
- The complexity of the issues that have been identified

The role of the urgent work process is to promptly control, contain and (where possible) remove the immediate cause of an urgent safety, environmental or operational threat. It is not the role of the urgent work process to try to find and remove any underlying common cause issues that are inherent in the business area design, operation or maintenance.

For most urgent Work Requests the immediate cause of the request will be fairly obvious and the person investigating will quickly identify it.

Once the immediate cause is identified the scope of work necessary to control, contain or remove the immediate cause can be determined.

### Purpose

To identify the scope of work necessary to deal with the immediate cause of each urgent Work Request.

### Quantity

One diagnosis of the immediate cause of an urgent Work Request.

### Quality

The diagnosis must identify the work scope necessary to control. contain and/or remove the issue that prompted the request for urgent work.

WE Flowsheet

AAOM Flowsheet

**Time**

A request for urgent work shall be investigated within the time nominated on the configured Work Execution flowchart.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Work Execution flowchart.

# WE.37 Plan Work

### Context

An urgent task has been identified, the immediate cause has been diagnosed and the scope of work necessary to control, contain and/or remove the cause has been defined.

The person assigned the accountability for dealing with the immediate cause of the issue must consider and plan the requirements for completing the work before proceeding with its execution.

### Purpose

To specify the requirements for safely, correctly and efficiently completing approved urgent work.

### Quantity

The plan may include the specifying the following items:

- each potential hazard and control,
- each isolation,
- each permit,
- each necessary work outcome,
- each tolerance or acceptance limit on work outcomes,
- each work procedure where only one work method is acceptable,
- all materials,
- all labour,
- all tools and equipment,
- all resources,
- the work duration,
- acceptance testing and handover procedures,
- acceptance limits on acceptance tests and handover.

### Quality

The detail required in the planning will be determined from the complexity of the work. A simple task may be planned by considering a mental checklist of the plan elements and may require minimal documentation prior to undertaking the work. Complex tasks may require detailed analysis, consideration of alternatives and preparation of documentation before work can commence.

WE Flowsheet

In all cases, a separate Task or Work Order shall be raised for each urgent task. For simple tasks, the Task/Work Order may be raised as a record after completion. For complex tasks, the Task/Work Order shall be raised as part of the documentation of the plan for the work.

AAOM Flowsheet

Further specifications / definitions can be obtained by referring to task assignment PL.00 Planning.

**Time**

This task must be performed as soon as the scope of the work has been defined, and before the work is commenced.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Work Execution flowchart.

# WE.38 Diagnosis Time above Threshold

## Context

In every business area is inevitable that some urgent work needs will arise, although the frequency of such needs may vary significantly. It is also important that these urgent needs be assessed, prioritised and dealt with in a consistent and timely manner, without causing unnecessary disruption to the regular scheduled activities of the business area.

The first step in appropriately dealing with urgent work is to ensure that there is one, clearly identified, and easily reached, contact point for urgent work. All urgent work requests must be directed to the nominated contact.

The urgent work point of contact will either investigate, or assign a person to investigate, the issue reported and make the initial diagnosis.

The time taken to complete the initial diagnosis will depend on:

- The number of urgent calls in the queue
- The relative impact of the calls
- The complexity of the issues that have been identified

The role of the urgent work process is to promptly control, contain and (where possible) remove the immediate cause of an urgent safety, environmental or operational threat. It is not the role of the urgent work process to try to find and remove any underlying common cause issues that are inherent in the business area design, operation or maintenance.

For most urgent work requests the immediate cause of the request will be fairly obvious and the person investigating will quickly identify it. In some cases the diagnosis of the immediate cause of a request may be more difficult and may therefore take longer.

In order for the urgent work process to work, and hence to avoid un-necessary disruption of the rest of the business area, the people assigned to investigate an urgent issue must be given the opportunity and time to diagnose it. This must be balanced with limiting the potential impact on the business area if response to, or diagnosis of, a request takes excessive time.

Hence for every urgent work case there must be a clear specification of what is the ‘reasonable’ time to respond to and diagnose each request before it must be escalated to obtain assistance. As soon as it is determined that the agreed time is likely to be exceeded this must be escalated so that action can be taken to speed the diagnosis.

WE Flowsheet

AAOM Flowsheet

**Purpose**

To check whether the agreed diagnosis time for each urgent work request is likely to be exceeded.

**Quantity**

One decision that the diagnosis will, or will not, be completed within the agreed time.

**Quality**

The agreed diagnosis time for urgent is specified on the configured Work Execution flowchart.

**Time**

This task must be performed immediately after an urgent work request has been made, and until either the diagnosis of the immediate cause is made or the agreed diagnosis time is likely to be exceeded.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Work Execution flowchart.

# WE.39 Impact above Threshold?

### Context

In every business area is inevitable that some urgent work needs will arise, although the frequency of such needs may vary significantly. It is also important that these urgent needs be assessed, prioritised and dealt with in a consistent and timely manner, without causing unnecessary disruption to the regular scheduled activities of the business area.

The first step in appropriately dealing with urgent work is to ensure that there is one, clearly identified, and easily reached, contact point for urgent work. All urgent work requests must be directed to the nominated contact.

The role of the urgent work process is to promptly control, contain and (where possible) remove the immediate cause of an urgent safety, environmental or operational threat. It is not the role of the urgent work process to try to find and remove any underlying common cause issues that are inherent in the business area design, operation or maintenance.

For most urgent Work Requests, removing the immediate cause of the request will take only a limited time. In some cases the removal of the immediate cause of a request may be more difficult and may therefore take longer.

In cases where completing an urgent work request will require a business area disruption, or affect output rate or quality, there is the potential for an additional impact on the operation.

In order for the urgent work process to work, and hence to avoid un-necessary disruption of the rest of the organisation, the people assigned to deal with an urgent issue must be given the opportunity and time to remove the immediate cause of all urgent work requests. This must be balanced with limiting the potential impact on the operation if dealing with the immediate cause takes excessive time.

Hence for every urgent work case there must be a clear specification of what is the ‘reasonable’ impact that can be incurred because of the work before it must be escalated to obtain assistance or authority to proceed. As soon as it is determined that the agreed impact is likely to be exceeded this must be escalated so that action can be taken to speed the work or have the additional impact authorised.

WE Flowsheet

### Purpose

To check whether the agreed impact for the completion of each urgent Work Request is likely to be exceeded.

AAOM Flowsheet

### Quantity

One decision that the urgent work will be completed within the agreed impact threshold.

**Quality**

The agreed impact threshold for urgent is specified on the configured Work Execution flowchart.

**Time**

This task must be performed immediately after an urgent work request has been diagnosed, and until either the immediate cause is removed or it is recognised that the agreed impact threshold will be exceeded.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Work Execution flowchart.

# WE.40 Cost above Threshold?

## Context

In every business area is inevitable that some urgent work needs will arise, although the frequency of such needs may vary significantly. It is also important that these urgent needs be assessed, prioritised and dealt with in a consistent and timely manner, without causing unnecessary disruption to the regular scheduled activities of the business area.

The first step in appropriately dealing with urgent work is to ensure that there is one, clearly identified, and easily reached, contact point for urgent work. All urgent work requests must be directed to the nominated contact.

The role of the urgent work process is to promptly control, contain and (where possible) remove the immediate cause of an urgent safety, environmental or operational threat. It is not the role of the urgent work process to try to find and remove any underlying common cause issues that are inherent in the business area design, operation or maintenance.

For most urgent Work Requests, removing the immediate cause of the request will take only a limited time and resources. In some cases the removal of the immediate cause of a request may be more substantial and may therefore cost more.

In cases where completing an urgent work request will require significant expenditure there is the potential for an adverse impact on the costs/budget for the business area

In order for the urgent work process to work, and hence to avoid un-necessary disruption of the rest of the organisation, the people assigned to deal with an urgent issue must be given the first opportunity to remove the immediate cause of all urgent work requests. Providing this opportunity must be balanced with limiting the potential impact on the operation if removing the cause of the request requires significant expenditure.

Hence for every urgent work case there must be a clear specification of what is the ‘reasonable’ cost that can be incurred because of the work before it must be escalated to obtain assistance or authority to proceed. As soon as it is determined that the agreed cost is likely to be exceeded this must be escalated so that action can be taken to speed the work or have the expenditure authorised.

WE Flowsheet

## Purpose

To check whether the cost threshold for the execution of each urgent work request is likely to be exceeded.

AAOM Flowsheet

**Quantity**

One decision that the urgent work will be completed within the agreed cost threshold.

**Quality**

The agreed cost threshold for urgent is specified on the configured Work Execution flowchart.

**Time**

This task must be performed immediately after the scope of work for an urgent work request has been determined, and until the work is completed.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Work Execution flowchart.

# WE.41 Notify Manager.

### Context

In every business area is inevitable that some urgent work needs will arise, although the frequency of such needs may vary significantly. It is also important that these urgent needs be assessed, prioritised and dealt with in a consistent and timely manner, without causing unnecessary disruption to the regular scheduled activities of the business area.

The first step in appropriately dealing with urgent work is to ensure that there is one, clearly identified, and easily reached, contact point for urgent work. All urgent work requests must be directed to the nominated contact.

The role of the urgent work process is to promptly control, contain and (where possible) remove the immediate cause of an urgent safety, environmental or operational threat. It is not the role of the urgent work process to try to find and remove any underlying common cause issues that are inherent in the business area design, operation or maintenance.

The people assigned to deal with urgent work will have the capability and authority to complete most urgent work requests. In some cases the diagnosis, impact or cost of the work may be beyond their capability or authority and require escalation to the appropriate manager.

### Purpose

To escalate an urgent work request to the appropriate manager.

### Quantity

One discussion with the appropriate manager.

### Quality

The appropriate manager is the person identified in the configured work execution flowchart.

The manager shall be advised of the;

- equipment/workplace,
- the nature of the incident (where a safety or environmental incident is the underlying cause for the urgent work),
- immediate cause if known,
- the scope/description of the proposed work,
- estimated impact if known,
- estimated cost if known,
- action required from the manager.

WE Flowsheet

AAOM Flowsheet

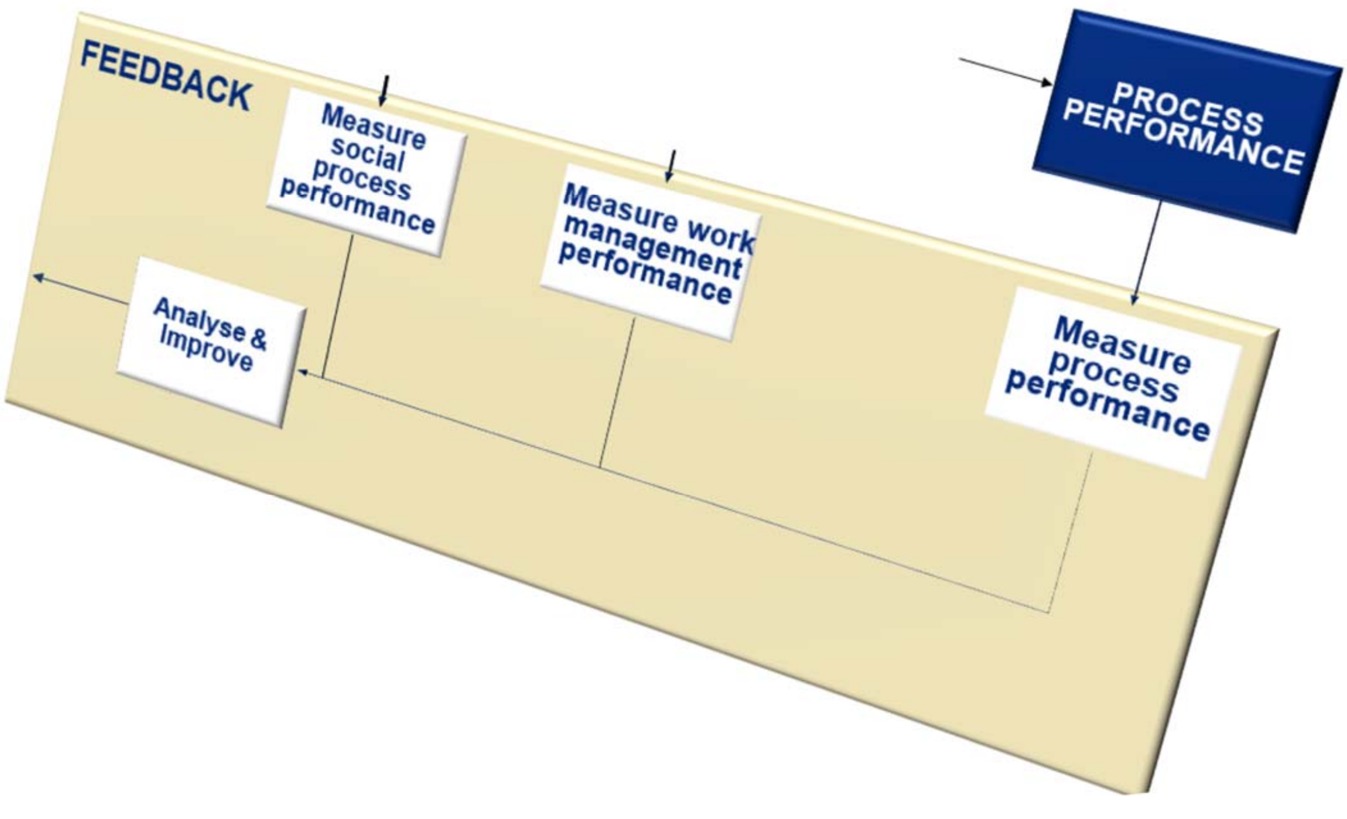
**Time**

This task must be performed immediately after a trigger for escalation is recognised.

**Resources**

Completion of this task is the accountability of the role nominated on the configured Work Execution flowchart.

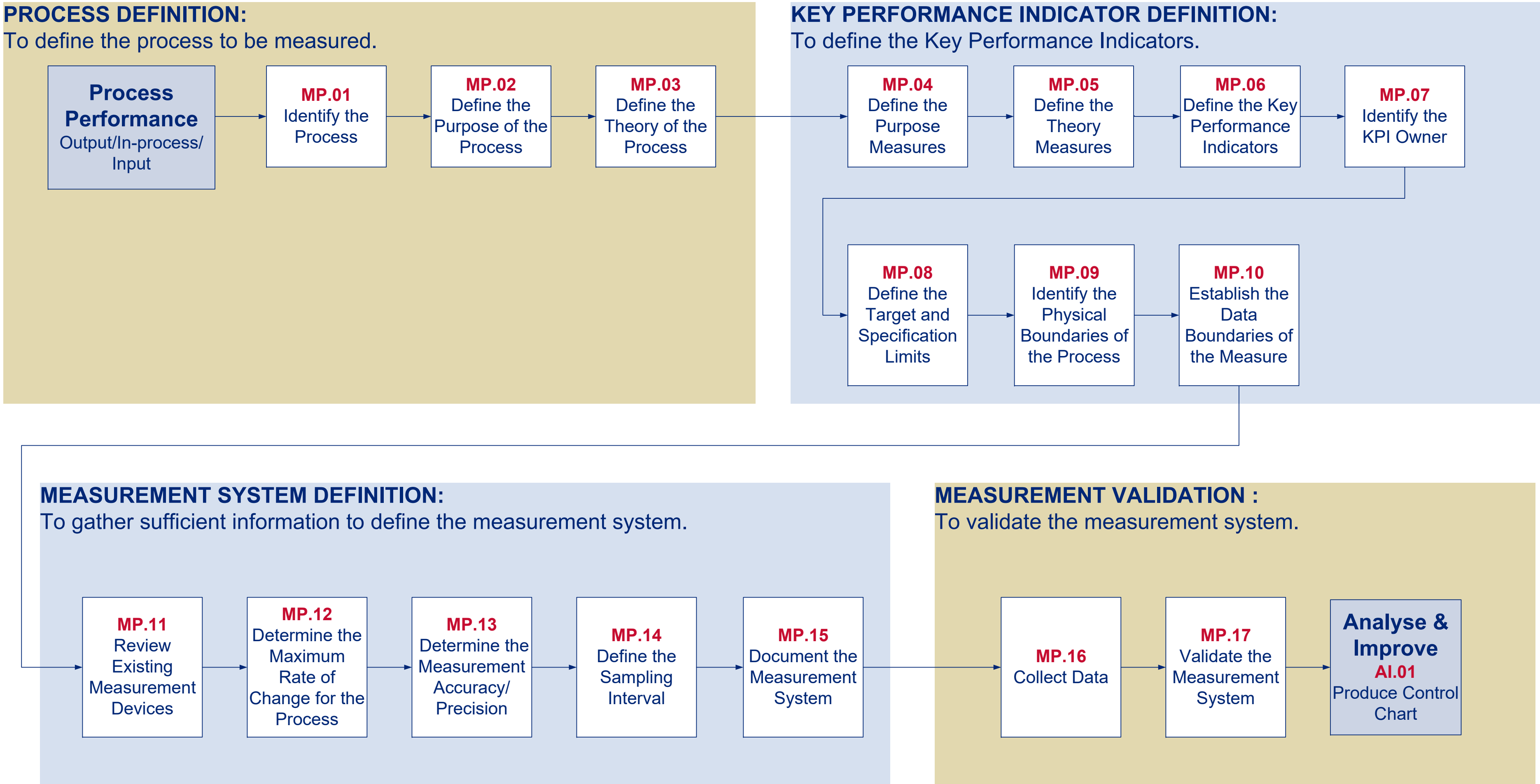
# AAOM Feedback



# MEASURES

Purpose: To indicate when an intervention in the process may be required.

VERSION 1.0.1
Revised 05/2019

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AAOM Flowsheet

# MEASURES- High Level

Purpose: To indicate when an intervention in the process may be required.

Revised 05/2019

**PROCESS DEFINITION:**
To define the process to be measured.

**KEY PERFORMANCE INDICATOR DEFINITION:**
To define the Key Performance Indicators.

**MEASUREMENT SYSTEM DEFINITION:**
To gather sufficient information to define the measurement system.

**MEASUREMENT VALIDATION:**
To validate the measurement system.

AngloAmerican

AAOM Flowsheet

# MEASURES- Process Definition

## Purpose: To define the process to be measured.

Revised 05/2019

**Process Performance**
Output/In-process/ Input

→ **MP.01** Identify the Process

→ **MP.02** Define the Purpose of the Process

→ **MP.03** Define the Theory of the Process

→ **MP.04** Define the Purpose Measures

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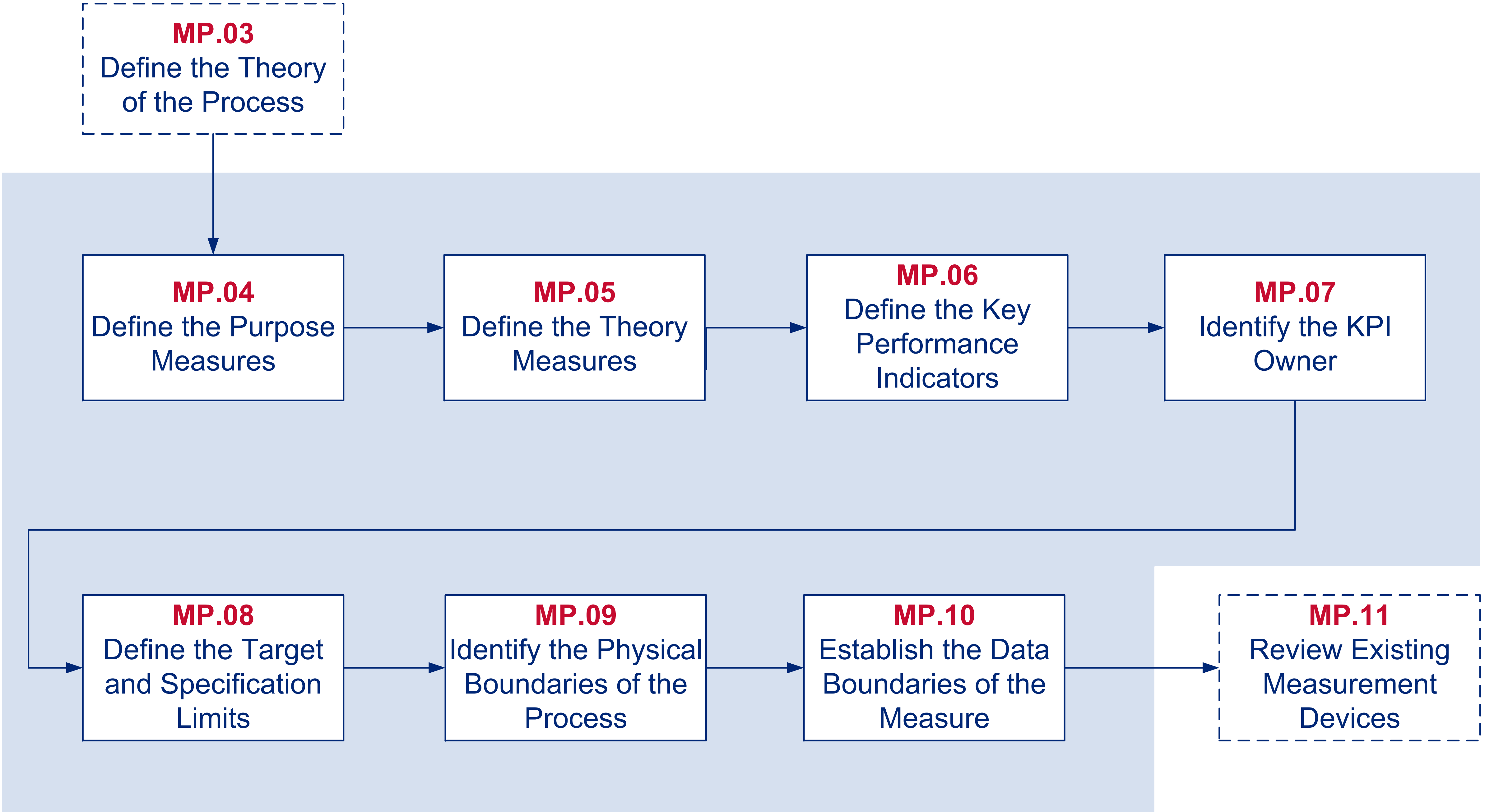
AAOM Flowsheet

# MEASURES- KPI Definition

## Purpose: To define the Key Performance Indicators.

Revised 05/2019

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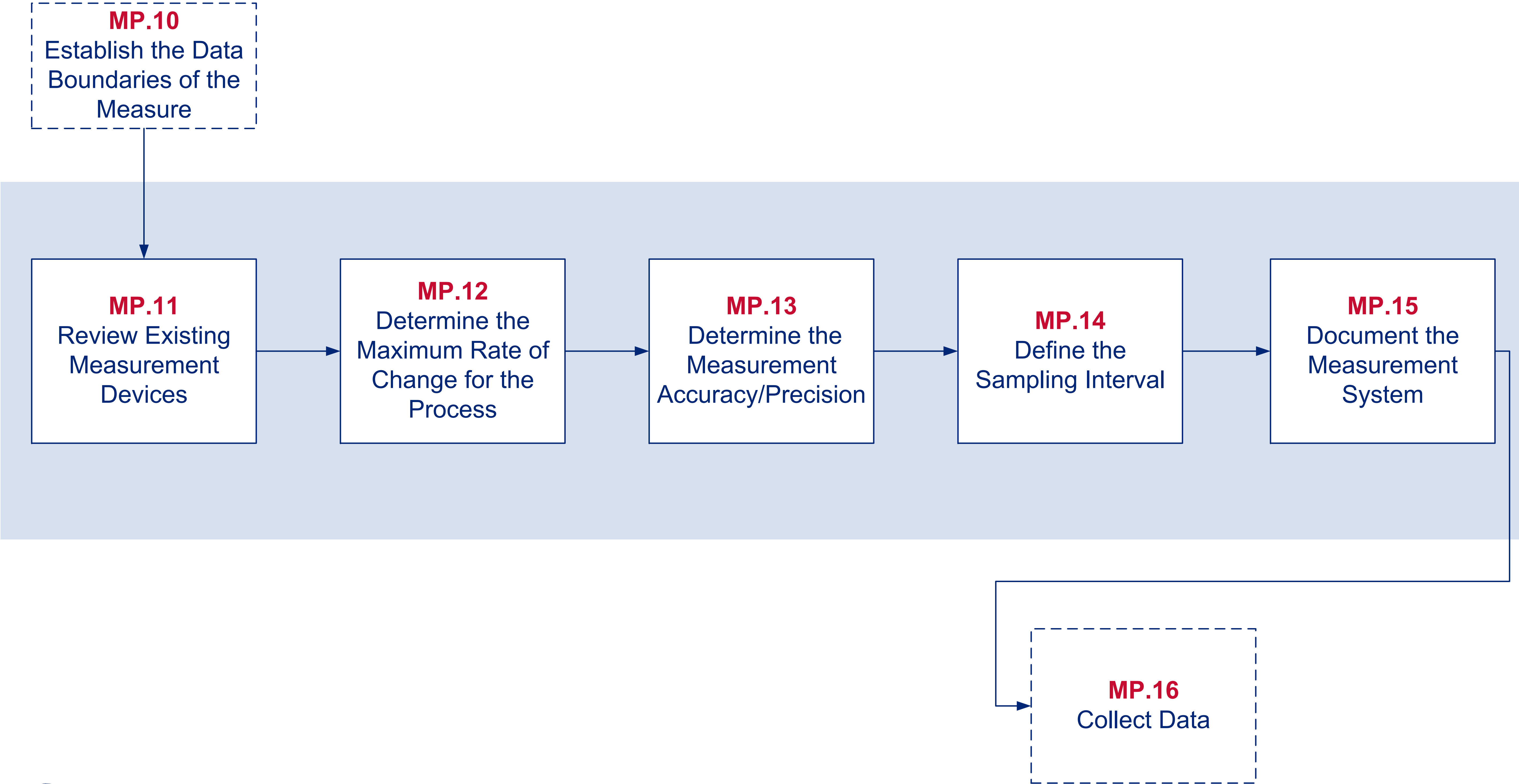
# MEASURES- MEASUREMENT SYSTEM DEFINITION

Purpose: To gather sufficient information to define the measurement system.

Revised 05/2019

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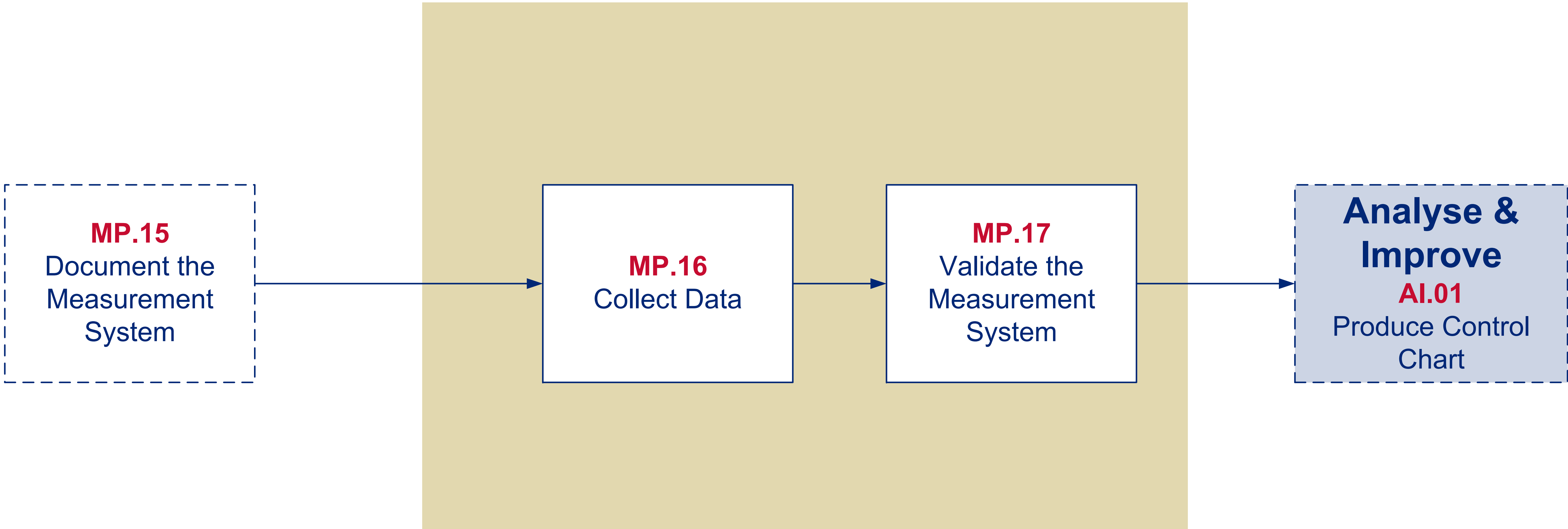
AAOM Flowsheet

# MEASURES- MEASUREMENT VALIDATION

Purpose: To Validate the measurement system.

Revised 05/2019

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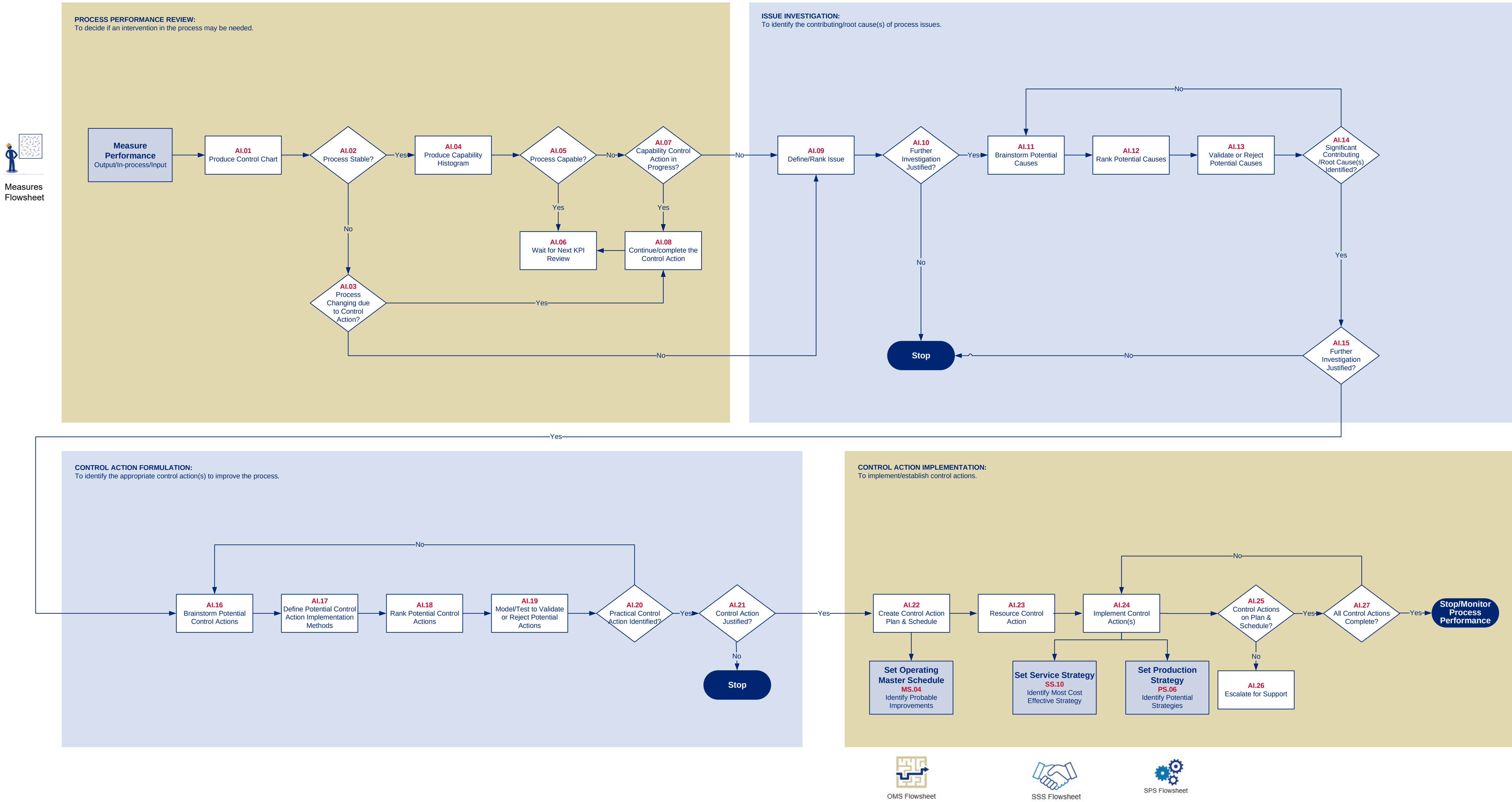
AAOM Flowsheet

# ANALYSE AND IMPROVE

Purpose: To respond correctly to measurement data.

**VERSION 1.2.1**

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AAOM Flowsheet

# ANALYSE AND IMPROVE- High Level

Purpose: To respond correctly to measurement data

**Revised 05/2019**

**PROCESS PERFORMANCE REVIEW:**
To decide if an intervention in the process may be needed.

**ISSUE INVESTIGATION:**
To identify the contributing/ root cause(s) of process issues.

**CONTROL ACTION FORMULATION:**
To identify the appropriate control action(s) to improve the process.

**CONTROL ACTION IMPLEMENTATION:**
To implement/establish control actions.

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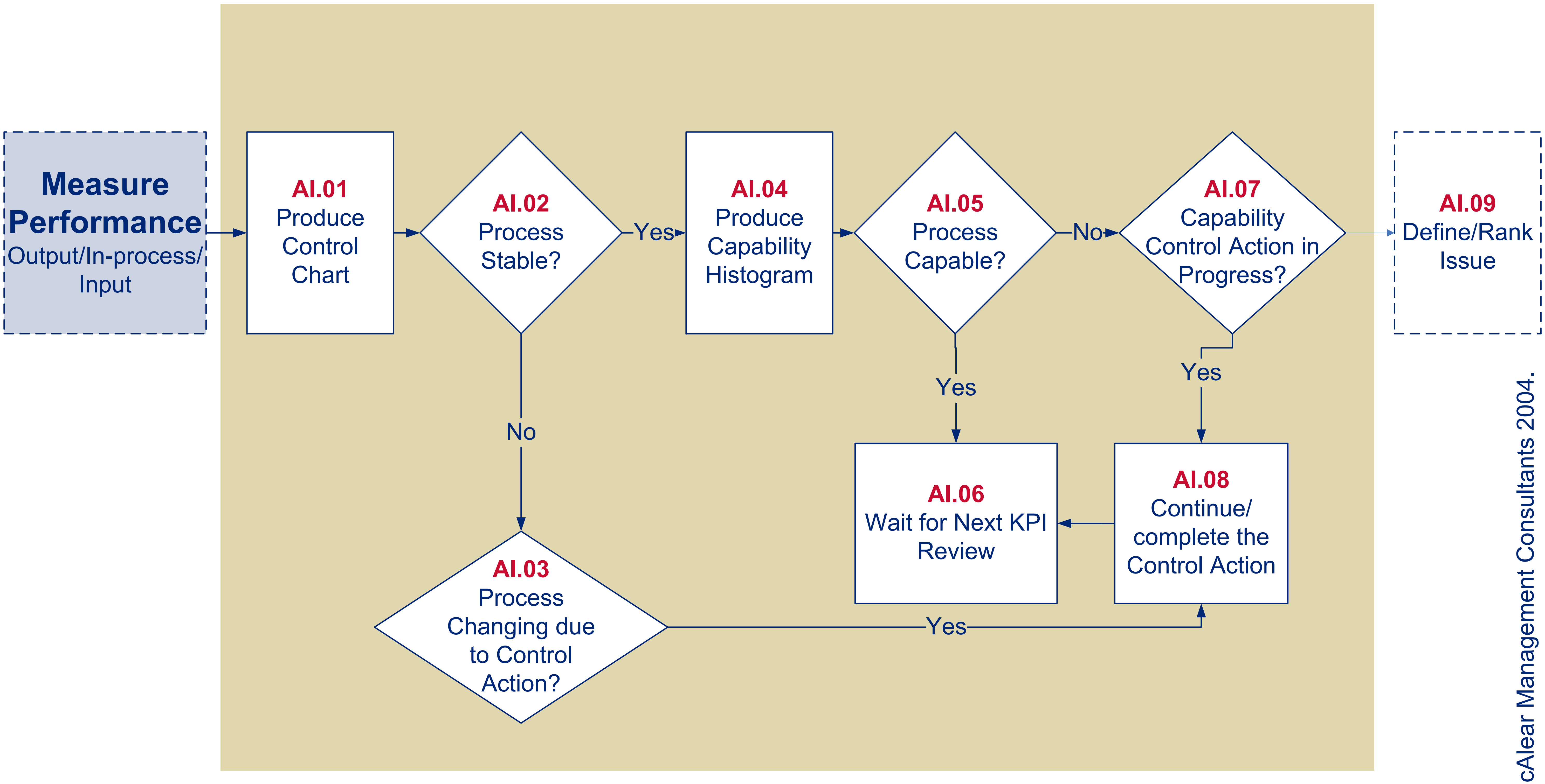
AAOM Flowsheet

A&I Flowsheet

# ANALYSE AND IMPROVE- PROCESS PERFORMANCE REVIEW

## Purpose: To decide if an intervention in the process may be needed.

**Revised 05/2019**

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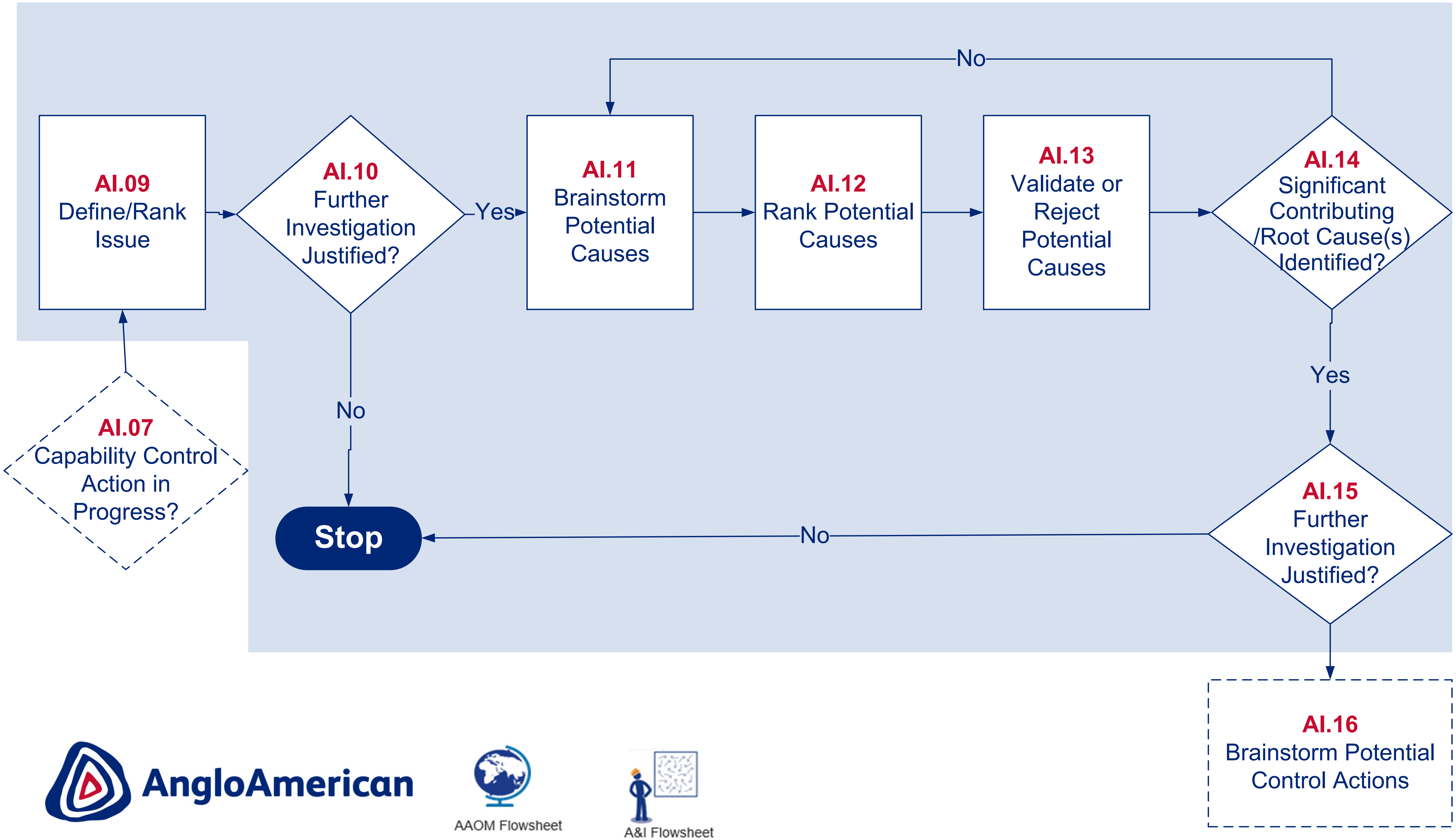
AAOM Flowsheet

A&I Flowsheet

# ANALYSE AND IMPROVE- ISSUE INVESTIGATION

Purpose: To identify the contributing/root cause(s) of process issues.

**Revised 05/2019**

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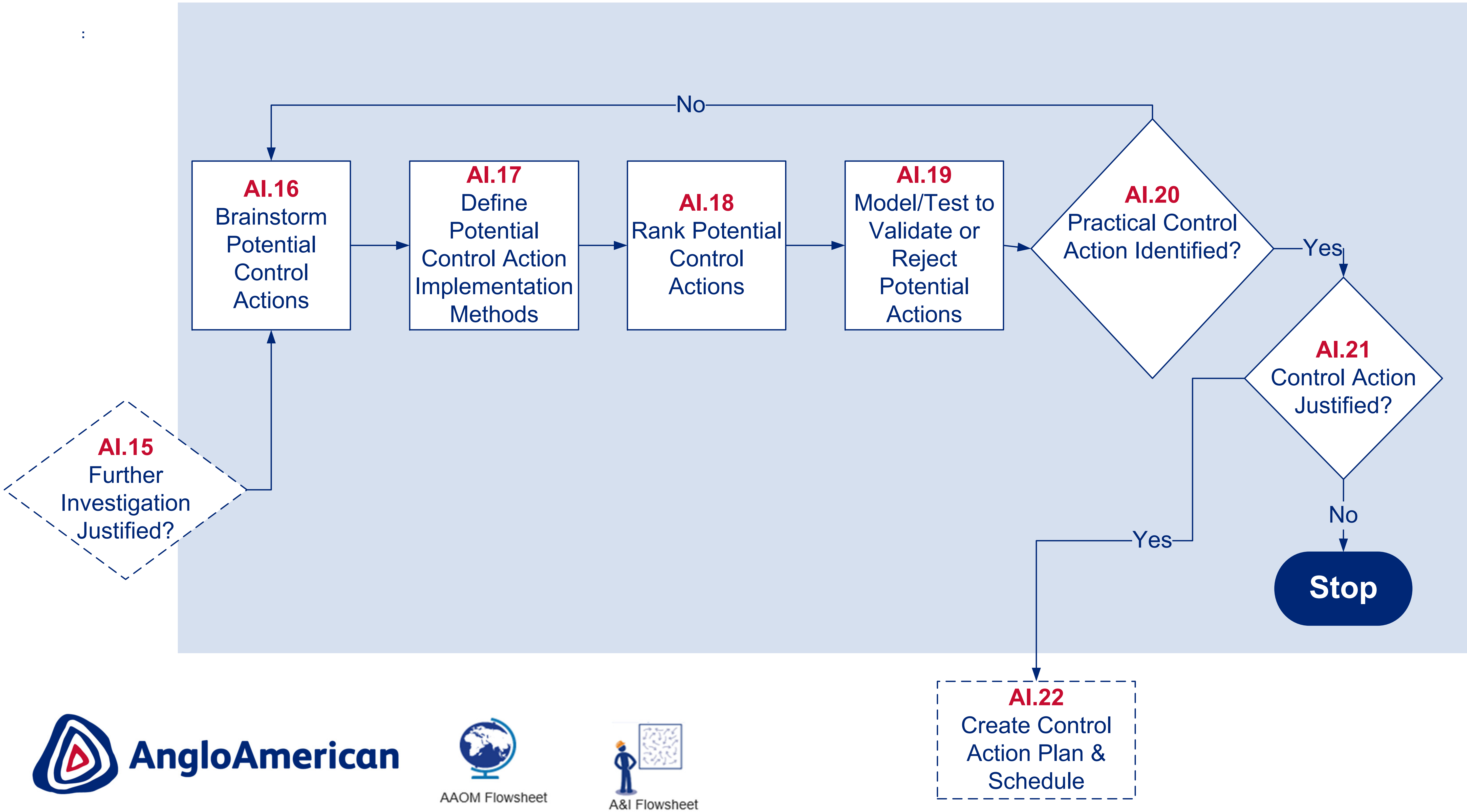
AAOM Flowsheet

A&I Flowsheet

# ANALYSE AND IMPROVE- CONTROL ACTION FORMULATION

Purpose: To identify the appropriate control action(s) to improve the process.

**Revised 05/2019**

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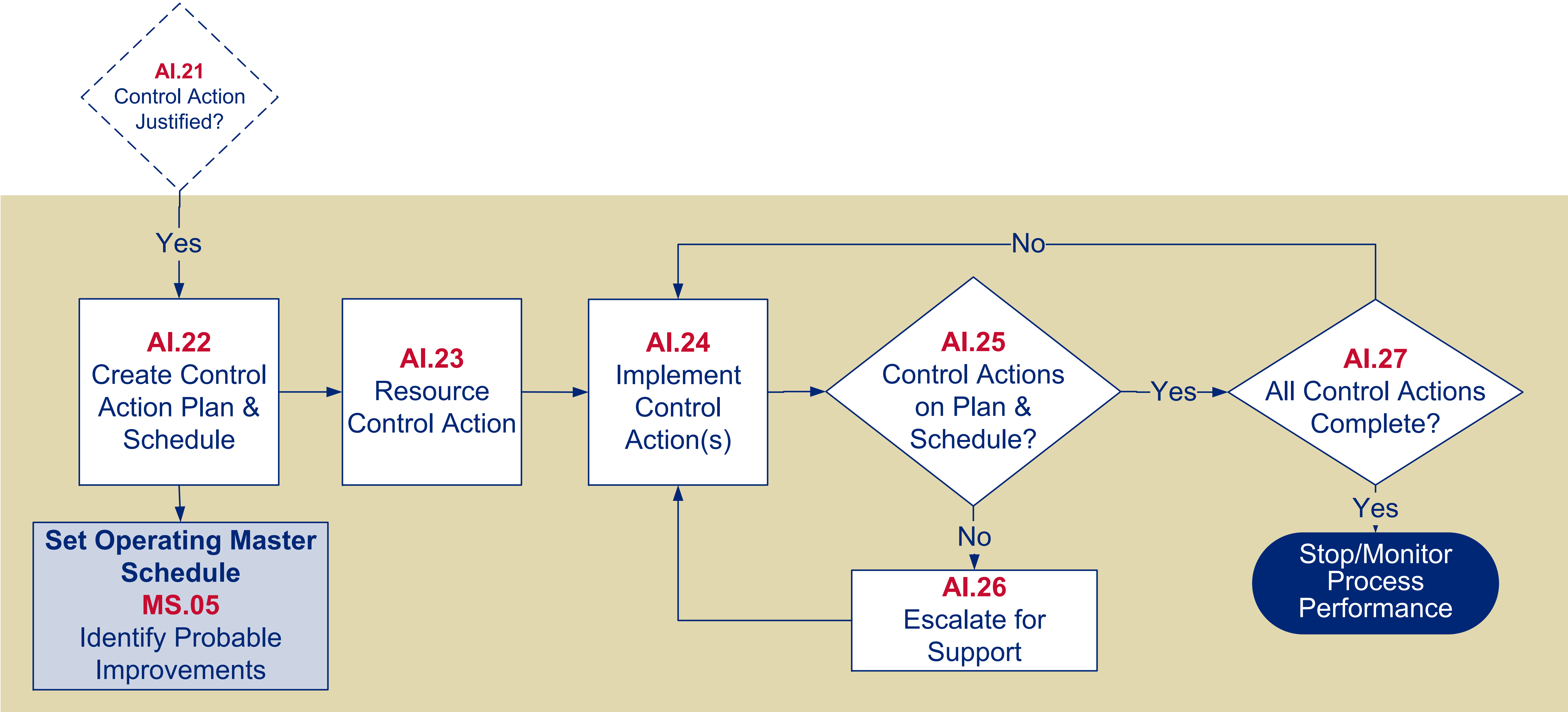
AAOM Flowsheet

A&I Flowsheet

# ANALYSE AND IMPROVE- CONTROL ACTION IMPLEMENTATION

Purpose: To implement/establish control actions.

**Revised 05/2019**

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INTERNAL

# ANGLO AMERICAN OPERATING MODEL: FEEDBACK

## MEASURES

**UPDATED: JULY 2017**

**CONTENTS**



Measures Flowsheet

AAOM Flowsheet

# MP.00 Measure Process Performance

## Context

In the context of this task assignment the word process (in lower case letters) applies to any element of business structure defined in the Business Process Framework (the Company, Region, Operation, Process or Productive Unit).

The Business Process Framework defines the purpose of a measure as 'to indicate when an intervention in a process may be required'. So the first question to answer is, when is an intervention required?

Every justifiable process must contribute value to an enterprise - the precise manner in which it delivers value is defined by the Purpose of the process. Sustainable value is derived when a process can economically continue to deliver the required output. If sustainable value is not being delivered, then an intervention in the process is required. The above definition of a process Purpose leads to three measurable parameters;

- Effectiveness - does the process deliver the output that is required in a period or by a time (quality product in/by time),
- Efficiency - what is the output delivered compared to the resources used in producing it (e.g. recovery of product, unit cost of output, return on investment etc), and
- Sustainability - is the process positioned to continue delivering the output into the future (does it have the resources, asset condition and licence to operate).

Effectiveness, Efficiency and Sustainability are the three significant characteristics that indicate the achievement of the purpose of a process, and hence its viability. These should, wherever practicable, be measured. However, the measures of Effectiveness, Efficiency and Sustainability will vary at different levels of the enterprise, based on the audience for performance at the level, and the factors that can be controlled at each level. For example, the CEO of a company is held accountable to a set of measures that represent the Purpose of the company as seen by the external stakeholders. If the shareholder view is taken, then the purpose may be viewed as 'the delivery of sustainable dividends and share price growth that represent a high rate of return on the money invested'. One possible set of measures for this purpose are set out in row 1 of the table in **Appendix 2**. The purpose of the Manager for a process may be defined as 'to sustainably deliver the agreed product volumes (and quality) over time, while efficiently using feed stock and cash'. One possible set of measures for this purpose are set out in row 4 of the table in **Appendix 2**.

Assigning accountability for process Purpose measures is only applicable at and above the process manager role. Those roles reporting to the process manager contribute to the Purpose of the process through their influence on the process operating in the right way and at the right time. Therefore, for those roles reporting to a process manager, the most appropriate measures of performance are the execution KPIs over which each role has direct influence. In the BPF these KPIs are based on the Theory of the process.

The successful delivery of the Purpose of a process requires that we understand and apply a valid Theory to the operation of the process. The definition of a Theory is that it makes reliable predictions about the results that will be produced from a set of actions or conditions. Therefore the theory measures are leading indicators of process performance. Hence, if the underlying theory of a process is not being delivered an intervention in the process is required.

The Theory applied to the operation of a process is defined by the;

- 'technical' design of the process, and
- Production and Service Strategies applied to the process.

The technical theory of a process is specific to its design, and is typically related to the physics, chemistry and/or hardware applied to the transformation, transfer or storage activities involved in the process. For example, in mining we can predict the fragmentation and movement of a blasted section of ore based on the blast-hole pattern and size, the charge specification and the firing sequence. In mineral processing we can predict the dissolution of gold in a leach circuit based on the grind size of the ore, the chemistry of the circuit and the residence time in solution. In safety we can predict the tendency towards an individual being involved in an accident based on their knowledge and experience of a situation, and their attitude to risk. Each of the characteristics mentioned in the above examples are theory parameters that could be measured.

The Production and Service Strategies (refer to the BPF elements of Set Production Strategy and Set Service Strategy) relate to choices around the approach to operating and servicing (managing potential threats) a designed process. One area of strategy choice relates to the incremental adjustment of the 'technical' parameters inherent in the process design, e.g. powder factor, solution pH or concentration etc. Another set of strategy choices relate to, or affect, the operating approach applied to the process. These include;

- use of time (utilisation),
- rate of operation (throughput),
- quality (input and/or output specification), and
- service strategy (actions to predict, prevent or mitigate threats).

The combination of the above strategy choices will determine the process;

- reliability (frequency of disruption to the process),
- process efficiency (recovery),
- fixed costs, and
- variable costs,

which will in turn determine the process Effectiveness, Efficiency and Sustainability.

Measures Flowsheet

AAOM Flowsheet

For example;

Output (on-spec units per time period) =

Utilisation x Output Rate x Quality =

$$\frac{\text{Operating Time}}{\text{Time Period}} \times \frac{\text{Units Output}}{\text{Operating Time}} \times \frac{\text{Units On-spec}}{\text{Units Output}}$$

or

Utilisation x Input Rate x Process Efficiency x Quality =

$$\frac{\text{Operating Time}}{\text{Time Period}} \times \frac{\text{Units Input}}{\text{Operating Time}} \times \frac{\text{Units Output}}{\text{Units Input}} \times \frac{\text{Units On-spec}}{\text{Units Output}}$$

The same Output capacity can be achieved with different combinations of these characteristics.

Unit Cost (cost per on spec unit of output) =

Total Costs / Units on Spec =

(Fixed Costs + Variable Costs) / Units on Spec

The same Unit Cost can be achieved with different combinations of these characteristics.

Hence, for a given set of Effectiveness and Efficiency targets there may be many possible sets of choices of strategy. The production strategy choice is in effect a choice of operating theory for the process and, hence, measures of Production Strategy parameters such as Operating Time, Rate, Quality etc can be viewed as a set of potential theory measures.

In a process where the overall performance responds linearly, and quickly, to changes in an underlying theory parameter there is no necessity to constantly monitor that theory parameter to determine if an intervention is required - because the result of a change in a theory parameter will be almost immediately evident in a purpose parameter. In this case either the purpose parameter can be measured directly, or the theory parameter may be measured as proxy for the purpose parameter. The choice between these two approaches should be guided by the practicality and cost of the two alternatives.

Where there are discontinuous (step) changes in process outcomes (as in blasting), and/or significant time lags between theory changes and the resulting changes in an outcome being evident (as in leaching) it is essential to measure the theory parameters in order to determine when a timely intervention is required to maintain process outcome stability and capability.

Not every Production strategy parameter will be significant for every process. For example a process that transforms product will have a quality dimension that is significant, whereas a process that transfers product should not have a quality dimension that is significant. Any dimension must be considered significant to a process if it can produce more than a few percent impact on the delivery of the Purpose of the process.

The BPF defines the minimum set of measures that support the timely identification of a change in either the Purpose or Theory delivery as the Key Performance Indicators (KPIs) of the process. The KPIs should be continually measured and monitored. Other measures of the technical theory or strategy are used during the Analyse and Improve process, to help in understanding issues and opportunities around the stability or capability of the process. These non-KPI measures, referred to as control measures in the BPF, do not need to be monitored continually, and hence may not need to have permanent measurement systems installed.

The decision on whether permanent measurement systems are required for control measures should be guided by two considerations. These are; the rate at which the process can undergo a change and, the 'visibility' of the change. In a chemical process where changes in concentrations or reactions can occur fairly rapidly (perhaps in minutes or hours), and cannot be easily or safely detected by human senses, specialised instruments will be needed to measure the change. Since significant time may be required to put these instruments in place, it will typically be necessary to install permanent instrumentation for this type of control measure. Then, when a KPI indicates that an intervention is required, the data from the measure will be available in time to make an appropriate analysis and intervention. In a process such as a mine shovel loading broken ore, many of the potential control measures are readily observable, either directly or with simple tools, and therefore do not require permanent instrumentation. For example, if a control chart of the daily loading rate (an effectiveness measure for the process) indicates a drop in performance, it is relatively quick and easy to take a stop watch and measure by observation the times for the loading cycle steps, to determine if the swing time or dig time are longer than target.

Examining process performance via these Purpose and Theory parameters allows performance to be assessed, using the same measures and definitions, for a process comprising a single activity or item of equipment, or for a process comprising several activities or items of equipment. This ensures that there is consistency in the measures through the Business Structure.

When constructing measures we also need to consider the boundary conditions, i.e. what is included in the measure and what is excluded. Two types of boundary conditions need to be considered, the physical boundaries of the process and the data boundaries for the measure. Within the BPF the physical boundaries of a process are defined by the Business Structure, specified by constructing a layered series of flow sheets based on the transfer, transform and store activities that can be identified within a layer of the flowsheet. Each of these transfer, transform and store activities can be viewed as a process with its distinct purpose and theory measures. The physical boundaries are therefore the boundaries of these flow sheet elements. Since the measures of a process are intended to indicate the delivery of the Purpose or the Theory, the conditions in which these are delivered should guide the specification of the data boundary conditions for

Measures Flowsheet
AAOM Flowsheet

the measure. For example, if we are measuring the utilisation of a process, the time boundaries should be set to enclose the period when the process is performing its Purpose, and to exclude the period when the process is not performing its Purpose. The boundary conditions for the theory and purpose measures should be matched.

When processes interconnect, as they always do, people often get confused trying to decide whether a particular measure is of a lagging or leading nature. This is understandable because the nature of a measure is relative. The output parameters for one process are typically elements of the theory measures (input in this case) for the following process. For example if you are looking at the grind quality from a mill, it is a lagging measure of the mill operating performance. For the leach circuit described in the example above, the grind quality will be a leading measure of the process performance.

The output performance of a process will always exhibit some variation. Variation can arise from two types of cause – common causes and special causes. Common causes are defined as those that regularly recur when the process is behaving in a consistent way (this does not mean that the process is meeting specification – it might consistently not be meeting specification). The characteristics of consistent performance are that over time the average and the variation around that average are predictable. Special causes are defined as those instances where the process did not behave in a consistent way. Statistically, special causes account for less than 1% of the variation that occurs in stable process. You can readily identify the common and special cause variation in performance using a control chart to present the measures of the process purpose and theory.

Each special cause should be investigated as soon as it becomes evident in the Control Chart, because it indicates that the process is probably changing (unstable) and hence may require an immediate intervention. Common causes do not need to be investigated in each instance. If the process is stable and meeting specifications, or if it is stable but not meeting specifications and you do not intend to take any immediate action (you have bigger fish to fry), then it is not necessary to collect the reasons for common causes. Importantly you only need to collect a representative sample of common causes, since in a stable process the same common causes will continually recur. See the BPF paper Quantify Common Causes for more detail.

## Purpose

To create the data necessary to indicate when an intervention in the Process may be required.

## Quantity

The Purpose of a Process shall be measured using the following parameters:

- Effectiveness (output units on spec per time period)
- Efficiency (Recovery, Unit Cost, ROI etc)

- Sustainability (process resourcing, asset condition and licence to operate)

The process theory resulting from the Production and Service Strategy shall, depending on the linearity and time lag of the process, be measured using the following parameters

- Use of Time (Utilisation),
- Rate (may be input or output when reported in conjunction with process efficiency),
- Input Quality,
- Reliability,
- Process Efficiency (recovery),
- Fixed Cost,
- Variable Cost.

The technical theory measures for a process shall be defined based on the researched and validated theory description or formula for the process.

The following shall be delivered for each of the above specified measures:

- One specification for the boundary conditions to be applied to the measure.
- One specification for the conditioning filter to be applied to the measure.
- One specification for the measurement accuracy at which data is to be collected.
- One specification for the sampling interval at which data is to be collected.
- One Control Chart of the performance.
- One Capability Histogram of the performance.

## Quality

1. Measurements of Purpose characteristics shall be reported to the following definitions or, where a direct measure is not available, the most effective proxy(s) for the intended measure;

- Effectiveness
    - On Spec Output Units per Time Period
- Efficiency
    - Process Efficiency = Units Out / Units Input
    - Unit Cost = Total Dollars Spent / Total Units of Product
    - ROI = Net Earnings / Total Investment

Measures Flowsheet
AAOM Flowsheet

- Sustainability (the following are examples only)
    - Process Sustainability = total resources available / rate of consumption of resources.
    - Asset Condition
        - Integrity = Number of Threats Below Threshold / Total Number of Threats
        - Fleet Life = Actual Life / Target Life

2. Measurements of Theory Parameters resulting from Strategy shall be reported to the following definitions;

- Use of Time

  Single Line process

    - Utilisation = Operating Time / Calendar Time

  **NB** A Single Line process is one that has only one entry and exit point for a single product (or a single entry and exit point for each separate product). If a process has a single entry and exit point but has some parallel activities within the process, it is still a Single Line process.

  Parallel Line process

    - Utilisation = Sum of Operating Time for each 'Line' / (Sum of number of installed Lines * Calendar Time)

  **NB** A Parallel Line process is one that has multiple, paired entry and exit points (i.e. completely separate and parallel process lines) for a single product – e.g. a fleet of mobile equipment. If a process has a single entry and exit point but has some parallel activities within the process, it is still a Single Line process.

- Rate = Units of Product / Unit of Time
- Quality = Units of On-spec Product / Total Units of Product
- Reliability
    - Time Between Interruptions = Operating Time / Number of Unscheduled Interruptions
    - Time Between Incidents = Operating Time / Number of Unscheduled Interventions

2. Measurements of technical theory shall be made based on the definition of the theory. There are no common standards for measures of theory.

3. The physical boundary conditions for measurements shall be as defined in the Business Structure flow sheets. The data boundaries shall be based on the boundaries to the process delivering its purpose - see examples in Appendix 1.

4. Measurements can contain ‘noise’, i.e. values that are not a true representation of the performance. Noise may arise from various sources but is identifiable as changes that are either not physically possible for the process, or changes that are too rapid for the process to actually deliver. Noise is not a relevant component of the measure and should be excluded from it.

   Examples of measured values that are not possible include; a bin level that is either negative or higher than the physical bin, a speed for a transfer mechanism that is beyond its capacity. With regard to rate of change, each area of a process will have a maximum throughput rate limited by the physical design and capacities of the equipment, as for the transfer mechanism just discussed. This limit will affect the rate of change that can occur in all of the quantities that we may need to measure, whether they be product level in a tank, chemical concentration in a solution, or temperature in a furnace. For example, the maximum rate of level change in a tank will be determined by the tank volume and geometry and the maximum rate of either the inflows or outflows. The maximum rate of change of the concentration of a solution will be determined by the volume of the solution and the maximum rate at which a chemical can be added. The maximum rate of change of temperature in a furnace is determined by the maximum difference between the heat injection and thermal losses.

   A conditioning filter must be specified, based on the above criteria, and applied to the measure so that impossible values are recognised and rates of change that are irrelevant are removed.

5. The measurement accuracy will determine the minimum level of variation that can be identified (referred to as the quantisation level). Any variation that is less than this will not be seen. Selecting the quantisation level for measuring performance is a trade off between the detail needed to determine that performance is within specifications and the effort/cost of achieving that accuracy. In most instances today we have inexpensive and highly accurate technology that can provide a much higher level of resolution than is necessary to help us understand the capability of a process. In practice, a Capability Histogram that is based on 15 to 20 quantisation steps of the full range of variation typically provides enough detail. The quantisation level can generally therefore be set to the minimum level of variation that you wish to observe.

Measures Flowsheet
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6. Storage capacity within, or between, processes provides a natural filter that smooths variation (noise) within a process, and buffers connected processes against the effects of variation occurring in one of the

connected elements. The capacity of these storage elements, coupled with the maximum throughput rate of the process, help us to determine how quickly a significant change in the process can occur and hence how frequently we need to look at a measure - the sampling interval.

For example, if you must maintain the concentration of a solution within specification limits, and the accuracy of the measuring device is 5%, you will probably wish to be able to identify any 5% change in concentration. The minimum time interval in which this can occur is the determined by the volume of the solution and the maximum rate at which a chemical can be added. If we take a measurement more frequently than the minimum time in which a 5% change can occur then we will always detect the change. If we take the measure much less frequently than the minimum time in which a 5% change can occur then variation that occurs between sampling intervals will not be seen. Selecting the sampling interval for a measure is a trade-off between the maximum rate of variation that you will identify and the effort required to collect the measurement. The Nyquist criteria states that the maximum frequency of variation that can be represented by the data has a period of twice the sampling rate. Stated another way – you must sample at less than half the time interval in which the change you wish to detect can occur.

Select a sampling interval after considering the above information.

**NB**

- If the sampling interval is equal to or greater than the Nyquist rate then reconstructing a graph by connecting the instantaneous values at the sampling interval represents the relevant performance of the process between samples.

- If the sampling interval is set to less than the Nyquist rate the maximum frequency of variation cannot be observed, and a graph reconstructed by joining the instantaneous values at the sampling intervals does not represent the relevant performance of the process between samples.

7. Construct a measurement system that conditions the data (filters out irrelevant points), before capturing and recording data at the specified sampling interval and accuracy.

**Note** – it is critical that the sample intervals be strictly adhered to or the data will not accurately represent the true variation.

**Note** – the record is based on the value of the measurement at the sampling interval.

8. All purpose and theory measures shall be reported in both a Control Chart and Capability Histogram.

9. Update the performance Control Chart with the new measurement at each sampling interval.

10. Update the performance Capability Histogram with the new measurement at each sampling interval.

### Time

Measures of Purpose and Theory should be put in place during the establishment of a Process.

### Resources

Establishment of performance measures is the accountability of the manager of a process.

Measures Flowsheet

AAOM Flowsheet

# Appendix 1

## Measure Parameter Boundary Definitions

### Purpose Statements

Transfer Process - to move a product or service from one location to another.

Transform process - to alter the specification of a product or service.

Store Process - to isolate variation in supply and demand between two processes.

### Operating Time

**Transfer Process**
The time the process is receiving, moving or discharging product or service.

**Transform Process**

The time the process is receiving, transforming or discharging product or service.

**Store Process**
The time the process is receiving or discharging product or service.

**Note** – Where a process has storage at its entry or exit (within the defined process boundaries), the time measures should be based on receiving from or discharging to this storage.

### Rate

**Transfer Process**

The volume of product or service moved by the process divided by the cycle time (defined by the utilisation boundaries) for the movement.

**Transform Process**

The volume of product or service transformed by the process divided by the cycle time (defined by the utilisation boundaries) for the transformation.

**Store Process**

The difference between the volume of product or service delivered to and from the process divided by the cycle time (defined by the utilisation boundaries) for the delivery.

**Note** – processes are defined at the Region, Operation, Process and Productive Unit level. The 'product' used for the measurement each of these is defined by the Purpose of the process (e.g. produce ore, produce matte, produce gas/electricity etc).

### Quality

On-spec product or service is that which meets all quality specifications.

**Reliability**

**Unscheduled Interruption**
A period of non-operating time, or zero operating rate, that was not specifically identified in the operating schedule.

**Unscheduled Intervention**
A Service task that was not specifically identified in the operating schedule.

Measures Flowsheet

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# Appendix 2

The following table illustrates some examples of potential Purpose Measures applicable at three different levels within an organisation.

| Role | Effectiveness | Efficiency | Sustainability |
|---|---|---|---|
| CEO | Dividends<br><br>Share Price Growth | Return on Investment | Resources/Reserves<br><br>Market Position<br><br>Stakeholder Relationships |
| Regional Manager | Cash Flow | Return on Investment | Resources/Reserves<br><br>Asset Integrity<br><br>Stakeholder Relationships |
| Operation Manager | Product Output | Operation Efficiency<br><br>Unit Costs | Production Resources<br><br>Asset Integrity<br><br>Safety/Environment |
| Department Manager | Process Output | Process Efficiency<br><br>Unit Costs | Process Resources<br><br>Asset Integrity<br><br>Safety/Environment |

# WP.00 Measure Work Management Performance

## Context

The current performance levels of a process are dependent on the quality and timeliness of production and service work completed up to the current time, perhaps going back as far back as several years. The future performance levels of a process are dependent on the correct and timely execution of all the right production and service work from the current time forward – doing the

- right work (necessary, appropriate and funded) at the
- right time and in the
- right way

is a leading indicator of process performance, including; Effectiveness, Efficiency and Sustainability.

The consistency of achieving these outcomes will be greatly influenced by the

- correct timing, sequencing and integration (scheduling) of the work,
- quality of the planning, carried out in preparing the specifications for the work, and
- effectiveness of the resourcing process that ensures everything is in place to complete the work successfully, as scheduled.

Therefore the quality and extent of scheduling, planning and resourcing are leading indicators of work completion.

Even with poor preparation, the efforts of a skilled work team can often ensure that the necessary work outcomes are achieved (i.e. the technical outcomes are achieved). However, without good scheduling, planning and resourcing there will be more resources and time used to achieve those outcomes. The efficiency of resource use, and hence the cost of the work, is dependent on the extent and quality of work scheduling and planning, and on the availability and, quality of resourcing. These are leading indicators of the efficiency of work execution.

Work management KPIs indicate:

- The degree to which the work necessary to ensure the ongoing performance and sustainability of a process is correctly completed, in a timely manner, as defined by the Production and Service strategy.
- Whether the commitment of expenditure is in line with the approved Expenditure Schedule.
- The extent and quality of prior scheduling, planning and resourcing of work - factors which affect the consistency and efficiency of work, and hence costs.

Measures Flowsheet

AAOM Flowsheet

Work Management performance should be measured at two levels;

- the Purpose of the Work Management Process - compliance to the approved Production and Service strategy as laid out in the Operating Master Schedule and Expenditure Schedule of the Operational Planning process, and

- the Theory of Work Management, the timely and effective approval, scheduling, planning, resourcing and execution of the Production and Service work.

**Right Work.** The right work is what is necessary, appropriate and funded in order to produce consistently, and to prevent, predict and correct threats to outputs before these threats cause an interruption.

The right work may comprise the following types of tasks;

- Production tasks specified in the Production Strategy,
- Service tasks specified in the Service Strategy, to;
    - prevent, predict or mitigate the failure or deterioration of the process, or
    - prepare a process for future production tasks, and
- Service tasks necessary to correct a defect that will adversely impact the performance of the process.

If the Operational Planning and Work Management process is in control and capable then the level of Scheduled Work (work that is identified, scheduled, planned and resourced appropriately ahead of execution) is an indicator that the Right Work is being completed. The balance of Schedule/Unscheduled Work should be consistent with the balance of proactive (predict and prevent) and reactive (operate to failure) strategies defined in Operational Planning.

The approved work Estimated Costs are an indicator of cost outcomes. If the approved cost is in control and capable, relative to the Expenditure Schedule, then the approved work is commercially the Right Work

**Right Time.** The right time to complete work is defined by the Production and/or Service strategy and the approved Operating Master Schedule (OMS).

Compliance to the OMS is a measure that one facet of the Purpose of Work Management, timely delivery of the major Production and Service strategy elements, is being achieved.

Execution Schedule Effectiveness (tasks scheduled ahead of their required date) and Execution Schedule Compliance (tasks completed when scheduled) indicate the likely timely completion of the minor elements of the Production and Service strategy elements. These are leading measures for strategy delivery.

**Right Way.** The right way to complete the work is in accordance with the specification set out in the Production and/or Service strategy and the

Task/Work Package. The common components to completing work in the right way are;

- correct work location,
- hazards identified and controlled,
- permits and isolations correctly executed,
- work procedures correctly executed,
- materials, tools and equipment correctly applied,
- work outcomes achieved,
- work outcome specifications and tolerances verified,
- test and handover procedures correctly executed,
- test and handover specifications and tolerances verified,
- every readily identifiable defect either corrected and reported, or specified and reported, and
- work record and history requirements recorded.

**Planning.** The right standard for planning the work is to specify in the Task/Work Package everything that matters to the safe, correct and efficient achievement of the work outcomes. The common components to quality work planning are;

- work location specified,
- work outcomes specified,
- work outcome specifications and tolerances defined,
- recognised task hazards and controls specified,
- recognised permits and isolations specified,
- mandatory work procedures specified,
- necessary materials, tools and equipment specified,
- test and handover procedures specified,
- test and handover specifications and tolerances defined, and
- work record and history requirements specified.

**Scheduling.** The effectiveness of scheduling is indicated by the level of work that is scheduled for completion at the right time (i.e. the scheduled start date is either within the tolerance specified in the Production/Service strategies and OMS, or before the Required Date),

**Resourcing.** The effectiveness of the resourcing process is indicated by the extent of the resources specified for the work that are available and fit for purpose at the scheduled time and work location.

Measures Flowsheet
AAOM Flowsheet

## Purpose

To create the data necessary to indicate when an intervention in the Anglo American Operating Model work management process may be required.

## Quantity

The Purpose of Work Management shall be measured using the following parameters:

- Effectiveness – compliance to OMS,
- Efficiency – Unit Cost of work execution, and
- Sustainability – workforce risk profile

The Work Management Theory shall be measured using the following parameters;

- Right Work – Scheduled Work, Cost Commitment,
- Right Time – Execution Schedule Completion,
- Right Way – Work Quality,
- Planned – Planning Quality,
- Scheduled – Schedule Effectiveness, and
- Resourced – Resourcing Effectiveness.

## Quality

1. Measures of Work Management Purpose shall be reported to the following definitions;

   - Effectiveness
     - OMS major tasks completed within approved tolerance
   - Efficiency
     - Unit Cost = Total Dollars Spent on Work Management / Total Units of Product
   - Sustainability
     - Risk profile on workforce availability, skills and engagement.

2. Measures of Work Management Theory shall be reported to the following definitions;

   - Right Work
     - Scheduled Work - Work scheduled and completed within a nominated schedule period compared to the total work completed in the period.

= <u>№ Tasks Scheduled & Completed in measured Schedule Period</u>
№ of Tasks Completed in measured Schedule Period

- Cost Commitment - Task Costs (Estimated Costs) approved in line with Expenditure Schedule.

  = <u>Sum of Approved Estimated Costs</u>
  Sum of Budgeted Costs

- Right Time
  - Execution Schedule Completion - Work scheduled and completed within a nominated schedule period compared to the work scheduled in the period.

    = <u>№ Tasks Scheduled & Completed in measured Schedule Period</u>
    № Tasks Scheduled in measured Schedule Period

- Right Way
  - Work Execution Quality - Work execution action compliance to task specifications.

    = <u>№ Actions Completed to Specification</u>
    № Actions Specified

- Planned
  - Planning Quality - Executed work package content compliance to planning quality specifications.

    = <u>№ Actions Planned to Specification</u>
    № Actions Requiring Planning

- Scheduled
  - Schedule Effectiveness – Tasks with a Scheduled Start Date within Tolerance.

    = <u>№ of Tasks Scheduled In Tolerance</u>
    № of Tasks in Schedule

    Note – the Tolerance for production and service strategy work shall be the date range determined based on the tolerance specified in the strategy. The Tolerance for non-strategy work shall be the Required Date less the planned Task Duration.

- Resourcing
  - Resourcing Effectiveness - Resources available to specification at execution compared to resources specified in a work package.

    = <u>№ of Resources Available</u>
    № of Resources Planned

Measures Flowsheet
AAOM Flowsheet

- The measurement interval for Work Management measures shall be each schedule period

- All work management measures will be reported in both a Control Chart and Capability Histogram.

- Update the Control Charts with the new measurement at each measurement interval.

- Update the Capability Histograms with the new measurement at each measurement interval.

## Time

Measures of Purpose and Theory should be put in place during the establishment of a Work Management process.

### Resources

Establishment of performance measures is the accountability of the manager of a process.

# SP.00 Measure Social Process Performance

## Context

The goal of a business is to profitably deliver a desired product.

At one time in human history almost all of the activities of a business were completed by people. As technology has advance there has been a trend to transfer the execution of more and more activities from people to machinery. In the mining and processing industries almost all production work is mechanised, however, the work performed by people is still a critical contributor to most business activities - even mechanised ones.

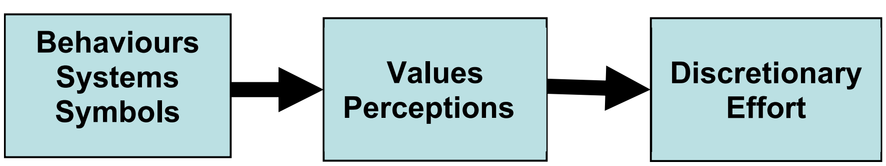
Machinery will only deliver its full capability, reliably, when it is used and maintained appropriately. The use and maintenance of machinery are functions that still largely depend on activities performed by people.

The Anglo American Operating Model (AAOM) defines how we manage the use and care of production a process. If you examine the process flowcharts you will observe that most actions and decisions will be executed by a person.

Consequently, the Anglo American Operating Model can only deliver its full potential when people willingly work to their full capability. People have discretion over how they will apply their capability. They can choose to exercise that discretion in favour of the business in which they work, or against it.

A theory that provides guidance for how we can achieve the goal of having people willingly apply their full capability to their work is as follows.

***If management behaviours, systems, and symbols, are seen by employees as on the left side of the Values Continua (MAC Consultants), then employees are more likely to contribute discretionary effort to achieve the business purpose.***




Values perceptions are the judgements that people make of the management behaviours, systems and symbols, based on how they perceive the effects of these on themselves and others in the workplace, in the six categories set out in the following values continuum.

Measures Flowsheet
AAOM Flowsheet

**Values Continuum**

Loving ---------------------------------------------------------------- Unloving

Respectful ---------------------------------------------------- Disrespectful

Fair ------------------------------------------------------------------------ Unfair

Truthful ------------------------------------------------------------ Untruthful

Trustworthy --------------------------------------------------- Untrustworthy

Courageous --------------------------------------------------------- Cowardly

People's perceptions of management behaviours will be formed by the direct interactions that they have with management, and also by the observations they make of management outside of these direct interactions.

The above theory is described in detail in the Working Together and Core Skills training (MAC Associates Consultancy).

If managers adopt the principles set out in Working Together and Core Skills as the standard for the management behaviour it will lead most people to perceive that management has values that lie on the left side of the Values Continua.

Our desired outcome is to have people willingly contribute their full discretionary effort (capability). It is not easy to reliably measure this, however it is possible to measure employee's perceptions of the values of their management. It is also possible to measure whether management's actions comply with the Working Together and Core Skills standards. These form the key performance measures for the social process that operates in conjunction with the Anglo American Operating Model.

## Purpose

To create the data necessary to indicate when an intervention in the social processes may be required.

## Quantity

The social process shall be measured in two components;

- Purpose
  - Employee perceptions of management Values.
- Theory
  - Compliance of management behaviours to Working Together and Core Skills models.

## Quality

- Data for Social Measures shall be collected directly from employees working within an area.

- Data shall be collected from randomly selected representative samples of the employees.
- Data shall be collected using a standard and consistent survey process.
- Performance shall be measured at a specified regular interval.
- Data supplied by employees shall not be traceable to an individual.
- All social process measures will be reported in both a Control Chart and Capability Histogram.
- Update the Control Charts with the new measurement at each measurement interval.
- Update the Capability Histograms with the new measurement at each measurement interval.

### Time

Measures of Purpose and Theory should be put in place during the establishment of a Work Management process.

### Resources

Establishment of performance measures is the accountability of the manager of a process.

Measures Flowsheet

AAOM Flowsheet

# MP.01 Identify the Process

## Context

In the context of this task assignment the word process (in lower case letters) applies to any element of business structure defined in the Business Process Framework (the Company, Region, Operation, Process or Productive Unit).

## Purpose

To name the process for which measures are to be developed.

## Quantity

One statement that names the process.

## Quality

A clear, concise, and unambiguous description of the process that should include:

- Process name
- Location

## Resources

This task is completed by the person responsible for the process.

## Time

The task should be completed prior to measures being developed

# MP.02 Define the Purpose of the process

## Context

Every justifiable process must contribute value to an enterprise - the precise manner in which it delivers value is defined by the ‘Purpose’ of the process. Sustainable value is derived when a process can economically continue to deliver the required output. If sustainable value is not being delivered then an intervention in the process is required.

## Purpose

To define how the process delivers value to the organisation.

## Quantity

One statement that defines the process purpose

## Quality

The purpose statement shall be one sentence that contains no ‘ands’.

A process purpose leads to three measurable parameters:

- Effectiveness - does the process deliver the output that is required in a period of time (quality product per calendar period),
- Sustainability - is the process positioned to continue delivering the output into the future (does it have the resources, asset condition and licence to operate), and
- Efficiency - what is the output delivered compared to the resources used in producing it (e.g. recovery of product, unit cost of output, return on investment etc).

## Resources

This task is completed by the manager responsible for the process.

## Time

The task should be completed prior to measures being developed

Measures Flowsheet

AAOM Flowsheet

# MP.03 Define the Theory of the process

## Context

The successful delivery of the Purpose of a process requires that we understand and apply a valid Theory to the operation of the process. The definition of a Theory is that it makes reliable predictions about the results that will be produced from a set of actions or conditions. Therefore the theory measures are leading indicators of process performance. Hence, if the underlying theory of a process is not being delivered an intervention in the process is required.

## Purpose

To list the process elements that allow reliable predictions to be made about the results to be produced.

## Quantity

One statement that defines the theory of the process

## Quality

The Theory applied to the operation of a process is defined by the;

- 'technical' design of the process, and
- Production and Service Strategies applied to the process.

The technical theory of a process is specific to its design, and is typically related to the physics, chemistry and/or hardware applied to the transformation, transfer or storage activities involved in the process

The Production and Service Strategies relate to choices around the approach to operating and servicing (managing potential threats to the process or posed by the process) a designed process. One area of strategy choice relates to the incremental adjustment of the 'technical' parameters inherent in the process design, e.g. powder factor, solution pH or concentration etc. Another set of strategy choices relate to, or affect, the operating approach applied to the process. These include:

- use of time (availability/utilisation),
- rate of operation (throughput),
- quality (input and/or output specification), and
- service strategy.

The combination of the above strategy choices will determine the process:

- reliability (frequency of disruption to the process),
- process efficiency (recovery),
- fixed costs, and
- variable costs,

which will in turn determine the process Effectiveness, Sustainability and Efficiency.

## Resources

This task is completed by the manager responsible for the process.

## Time

The task should be completed prior to measures being developed

Measures Flowsheet

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## MP.04 Define Purpose Measures

### Context

Purpose measures indicate the performance of the process by measuring output. The output performance of a process will always exhibit variation. Variation can arise from two types of cause – common causes and special causes. Common causes are defined as those that regularly recur when the process is behaving in a consistent way (this does not mean that the process is meeting specification – it might consistently not be meeting specification). The characteristics of consistent performance are that over time the average and the variation around that average are predictable. Special causes are defined as those instances where the process did not behave in a consistent way. Statistically, special causes account for less than 1% of the variation that occurs in a stable process. You can readily identify the common and special cause variation in performance using a control chart to present the measures of the process purpose and theory.

Each special cause should be investigated as soon as it becomes evident in the Control Chart because it indicates that the process is probably changing (unstable) and hence may require an immediate intervention. Common causes do not need to be investigated in each instance. If the process is stable and meeting specifications, or if it is stable but not meeting specifications and you do not intend to take any immediate action (you have bigger fish to fry), then it is not necessary to collect the reasons for common causes. Importantly you only need to collect a representative sample of common causes, since in a stable process the same common causes will continually recur.

### Purpose

To identify the output measures that reflect the purpose of the process.

### Quantity

The purpose of a process shall be measured using the following parameters:

- Effectiveness (output units on spec per time period (Time, Rate, Reliability & Quality)
- Sustainability (process resourcing, asset condition and licence to operate)
- Efficiency (Recovery, Unit Cost, ROI etc.)

### Quality

Measurements of Purpose characteristics shall be reported to the following standards or, where a direct measure is not available, the most effective proxy(s) for the intended measure;

- Effectiveness
    - On Spec Output Units per Time Period

- Sustainability (the following are examples only)
    - Process Sustainability = total resources available / rate of consumption of resources.
    - Asset Condition
        - Integrity = Number of Threats Below Threshold / Total Number of Threats
        - Fleet Life = Actual Life / Target Life
- Efficiency
    - Process Efficiency = Units Out / Units Input
    - Unit Cost = Total Dollars Spent / Total Units of Product
    - ROI = Net Earnings / Total Investment

## Resources

This task is completed by the manager responsible for the process.

## Time

The task should be completed prior to measures being developed

Measures Flowsheet

AAOM Flowsheet

# MP.05 Define Theory measures

## Context

The successful delivery of the Purpose of a process requires that we understand and apply a valid Theory to the operation of the process. The definition of a Theory is that it makes reliable predictions about the results that will be produced from a set of actions or conditions. Therefore the theory measures are leading indicators of process performance. Hence, if the underlying theory of a process is not being delivered an intervention in the process is required.

The Theory applied to the operation of a process is defined by the;

- 'technical' design of the process, and
- Production and Service Strategies applied to the process.

The technical theory of a process is specific to its design, and is typically related to the physics, chemistry and/or hardware applied to the transformation, transfer or storage activities involved in the process. For example, in mining we can predict the fragmentation and movement of a blasted section of ore based on the blast hole pattern, the charge specification and the firing sequence. In mineral processing we can predict the dissolution of gold in a leach circuit based on the grind size of the ore, the chemistry of the circuit and the residence time in solution. In safety we can predict the tendency towards an individual being involved in an accident based on their knowledge and experience of a situation, and their attitude to risk. Each of the characteristics mentioned in the above examples are theory parameters that could be measured.

The Production and Service Strategies (refer to the BPF elements of Set Production Strategy and Set Service Strategy) relate to choices around the approach to operating and servicing (managing potential threats to the process or posed by the process) a designed process. One area of strategy choice relates to the incremental adjustment of the 'technical' parameters inherent in the process design, e.g. powder factor, solution pH or concentration etc. Another set of strategy choices relate to, or affect, the operating approach applied to the process. These include;

- use of time (availability/utilisation),
- rate of operation (throughput),
- quality (input and/or output specification), and
- service strategy.

The combination of the above strategy choices will determine the process;

- reliability (frequency of disruption to the process),
- process efficiency (recovery),
- fixed costs, and
- variable costs,

which will in turn determine the process Effectiveness, Sustainability and Efficiency.

For example;

Output (on-spec units per time period) =

Utilisation x Output Rate x Quality =

$$\frac{\text{Operating Time}}{\text{Time Period}} \times \frac{\text{Units Output}}{\text{Operating Time}} \times \frac{\text{Units On-spec}}{\text{Units Output}}$$

or

Utilisation x Input Rate x Process Efficiency x Quality =

$$\frac{\text{Operating Time}}{\text{Time Period}} \times \frac{\text{Units Input}}{\text{Operating Time}} \times \frac{\text{Units Output}}{\text{Units Input}} \times \frac{\text{Units On-spec}}{\text{Units Output}}$$

The same Output capacity can be achieved with different combinations of these characteristics.

Unit Cost (cost per on spec unit of output) =

Total Costs / Units on Spec =

(Fixed Costs + Variable Costs) / Units on Spec

The same Unit Cost can be achieved with different combinations of these characteristics.

Hence, for a given set of Effectiveness and Efficiency targets there may be many possible sets of choices of strategy. The production strategy choice is in effect a choice of operating theory for the process and, hence, measures of Production Strategy parameters such as Operating Time, Rate, Quality etc. can be viewed as a set of potential theory measures.

In a process where the overall performance responds linearly, and quickly, to changes in an underlying theory parameter there is no necessity to constantly monitor that theory parameter to determine if an intervention is required - because the result of a change in a theory parameter will be almost immediately evident in a purpose parameter. In this case either the purpose parameter can be measured directly, or the theory parameter may be measured as proxy for the purpose parameter. The choice between these two approaches should be guided by the practicality and cost of the two alternatives.

Where there are discontinuous (step) changes in process outcomes (as in blasting), and/or significant time lags between theory changes and the resulting changes in an outcome being evident (as in leaching) it is essential to measure the theory parameters in order to determine when a timely intervention is required to maintain process outcome stability and capability.

Measures Flowsheet

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Not every Production strategy parameter will be significant for every process. For example a process that transforms product will have a quality dimension that is significant, whereas a process that transfers product should not have a quality dimension that is significant. Any dimension must be considered significant to a process if it can produce more than a few per cent impact on the delivery of the Purpose of the process.

## Purpose

To identify the elements of the process that relate to either the underlying technical theory or the strategies employed to operate the process.

## Quantity

One statement for each theory measure identified

## Quality

Measurements of Theory Parameters resulting from Strategy shall be reported to the following standards;

- Use of Time

  Single Line process

  - Availability = Available Time / Calendar Time
  - Utilisation = Operating Time / Calendar Time

  **NB** A Single Line process is one that has only one entry and exit point for a single product (or a single entry and exit point for each separate product). If a process has a single entry and exit point but has some parallel activities within the process, it is still a Single Line process.

  Parallel Line process

  - Availability = Sum of Available Time / for each 'Line' / (Sum of number of installed Lines * Calendar Time)
  - Utilisation = Sum of Operating Time for each 'Line' / (Sum of number of installed Lines * Calendar Time)

  **NB** A Parallel Line process is one that has multiple, paired entry and exit points (i.e. completely separate and parallel process lines) for a single product – e.g. a fleet of mobile equipment. If a process has a single entry and exit point but has some parallel activities within the process, it is still a Single Line process.

- Rate = Units of Product / MSR

  The MSR is defined as the $95^{th}$ percentile of the historic measured rate distribution of the process for a period that is representative of the 'personal best' of the process, as the process is designed today.

- Quality = Units of On-spec Product / Total Units of Product

- Reliability

- Time Between Interruptions = Operating Time / Number of Unscheduled Interruptions

- Time Between Incidents = Operating Time / Number of Unscheduled Interventions

Measurements of technical theory shall be made based on the definition of the theory. There are no common standards for measures of theory.

The technical theory measures for a process shall be defined based on the researched and validated theory description or formula for the process.

### Resources

This task is completed by the manager responsible for the process.

### Time

The task should be completed prior to measures being developed

Measures Flowsheet

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# MP.06 Define Key Performance Indicators

## Context

The BPF defines the minimum set of measures that support the timely identification of a change in either the Purpose or Theory delivery as the Key Performance Indicators (KPIs) of the process. The KPIs should be continually measured and monitored. Other measures of the technical theory or strategy are used during the Analyse and Improve process, to help in understanding issues and opportunities around the stability or capability of the process. These non-KPI measures do not need to be monitored continually.

## Purpose

To identify the minimum set of measures that fully inform us of the delivery of the purpose and the theory of the process.

## Quantity

One list of purpose and theory measures for each KPI.

## Quality

The list of measures shall have attached the name of the person/position responsible for the individual measure. Measures are monitored at the addition of each data point as specified by the sampling interval.

## Resources

This task is completed by the manager responsible for the process.

## Time

The task should be completed prior to measures being developed

# MP.07 Identify the KPI owner

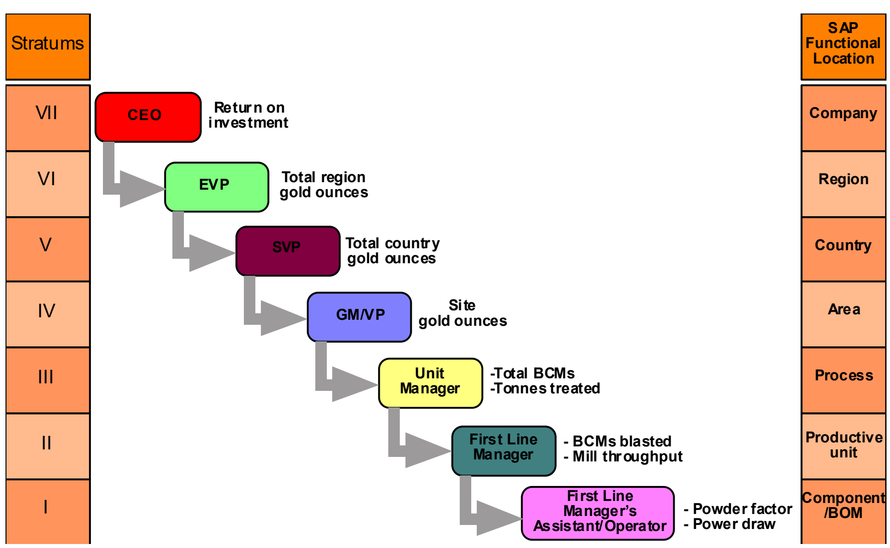
## Context

The BPF defines the minimum set of measures that support the timely identification of a change in either the Purpose or Theory delivery as the Key Performance Indicators (KPIs) of the process. The KPIs should be continually measured and monitored. Other measures of the technical theory or strategy are used during the Analyse and Improve process, to help in understanding issues and opportunities around the stability or capability of the process. These non-KPI measures do not need to be monitored continually.

Assigning accountability for process Purpose measures is only applicable to the First Level Manager (FLM) role. Those roles reporting to the FLM contribute to the Purpose of the process through their influence on the process operating in the right way and at the right time. Defining what is the right work, the right time and the right way is, at a minimum, the accountability of the FLM. Therefore, for those roles reporting to an FLM, the most appropriate measures of performance are the execution KPIs over which each role has direct influence. In the BPF these KPIs are based on the Theory of the process.

The primary purpose of KPIs is to indicate when an intervention is required in the measured process. One person (the KPI Owner) must have the direct accountability for a KPI, i.e. the accountability for making an intervention when the need is indicated. This person shall be the first role that is in charge of all significant activities that influence the KPI. Consequently, the accountability for individual measures within the suite of KPIs will have been distributed across several roles.

The diagram below gives a pictorial example of roles and accountability. See also the document *"Levels of Work"* at the end of this task assignment.





### Purpose

To identify the person accountable for the sustainable delivery of the agreed process output included with each KPI.

### Quantity

One accountable person or position for each KPI.

### Quality

The name of the person/position responsible for the KPI shall be recorded for each KPI. The name of the person/position accountable for each individual measure shall be attached to the list of measures within the KPI. Measures are monitored at the addition of each data point as specified by the sampling interval.

### Resources

This task is completed by the manager responsible for the process.

### Time

The task should be completed prior to measures being developed

# Levels of Work

## Context

On every occasion that a person is promoted to a new level within the structure of an organisation, or promoted to a new level in a different organisation, they are faced with the challenge of understanding what the work of the new role (level) is. Often, there is not much concrete guidance on how the expectations of the new role differ from those of the old role. The Business Process Framework is an operating model that defines the processes and the work necessary to deliver business expectations. It therefore makes sense to describe the levels of work around the elements of the BPF that fall within the work of the different roles in an organisation.

Acknowledgement is made to material used here with the permission of Fred Stanford whom I worked with at Inco, Canada. Fred and I collaborated on the introduction of a change to the way that work is managed at Inco's Ontario operations. Fred wrote an original version of a discussion paper on levels of work, and I have drawn from this.

## Purpose

To describe the work of roles in a managerial hierarchy, in terms of the BPF.

## Definitions

There are a few words and phrases, which are used a great deal in conversations about "work", which may have different meanings for people. Four of these are very relevant to this document; accountability, to be accountable, work practice, and manager. For this document, the following definitions are used.

Accountability – A measurable business outcome.

To be Accountable – A requirement for a person to give an account of <u>their</u> work practices, such that a judgment can be made on their personal effectiveness in achieving the business outcome.

Work Practice – A work related observable action.

Manager – A person who is accountable for their own work, and for the output and work practices, of the people reporting to them.

Measures Flowsheet

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The above definitions of *accountability* and *work practice* are often used interchangeably but will be differentiated in this paper. For example, the above definition suggests that conducting an annual performance review is a work practice rather than an accountability. It is the observable action that is intended to advance the achievement of a business outcome, however, it is not the business outcome itself. This is not to suggest that an annual performance review is optional. It is a work practice that has been designated as essential, and managers will be called to give an account of their effectiveness in performing this work practice.

Note that the definition of "*to be accountable"* is not that a role holder will be considered a success if an accountability is achieved, or a failure if an accountability is not achieved. "To be accountable" means being called to give an accounting of the work undertaken to deliver the accountability. A judgment is then made whether the work undertaken was appropriate given the hurdles encountered. It is possible that the judgment could be positive even though the accountability was not completely delivered. The hurdles encountered by the role holder might have been much higher than expected, and even though all the appropriate actions were taken, the result could not be delivered. It is also possible that the judgment may be negative even though the accountability was completely delivered. If the role holder did not effectively deliver their expected contribution to the achievement of the accountability, but it was achieved through either the work of others or through fortuitous circumstances outside of the control of the role holder.

The following are examples of a few business outcomes that those in operations and maintenance roles would be expected to deliver on. Thy are expressed in "results to resources" ratios and are indicators of how well the business is being managed:

- Environment/Community/Safety
    - time interval between incidents,
    - severity of incidents.
- Operational Effectiveness
    - units produced per time interval.
- Operational Efficiency
    - process yield/recovery
    - unit cost.
- Operational Sustainability/Integrity
    - process buffer/stockpiles,
    - asset predicted life to required life.

The challenge then becomes: "What are the measurable accountabilities that must be delivered by each level of the managerial hierarchy in order to deliver on these business outcomes"?

## Levels of Work

In defining levels of work we should avoid duplication of work between levels. In this document the work of different levels of the organisation and the boundaries between those levels, will be described in terms of the work required in the Business Process Framework. Boundaries between one level of the organisation and another will be tied to which role has the authority to make the changes required to deliver these outcomes.

The following diagram employs a control chart to illustrate the results expected from the work that must be done by the managerial hierarchy. The language of BPF, and the Control Chart changes, are used to describe the shift from one level of complexity to the next. A shift to an increased level of complexity means the work shifts to the next level up the hierarchy. This is just an introduction to the concept. Additional details will follow later, including where the supervisor fits into the picture.

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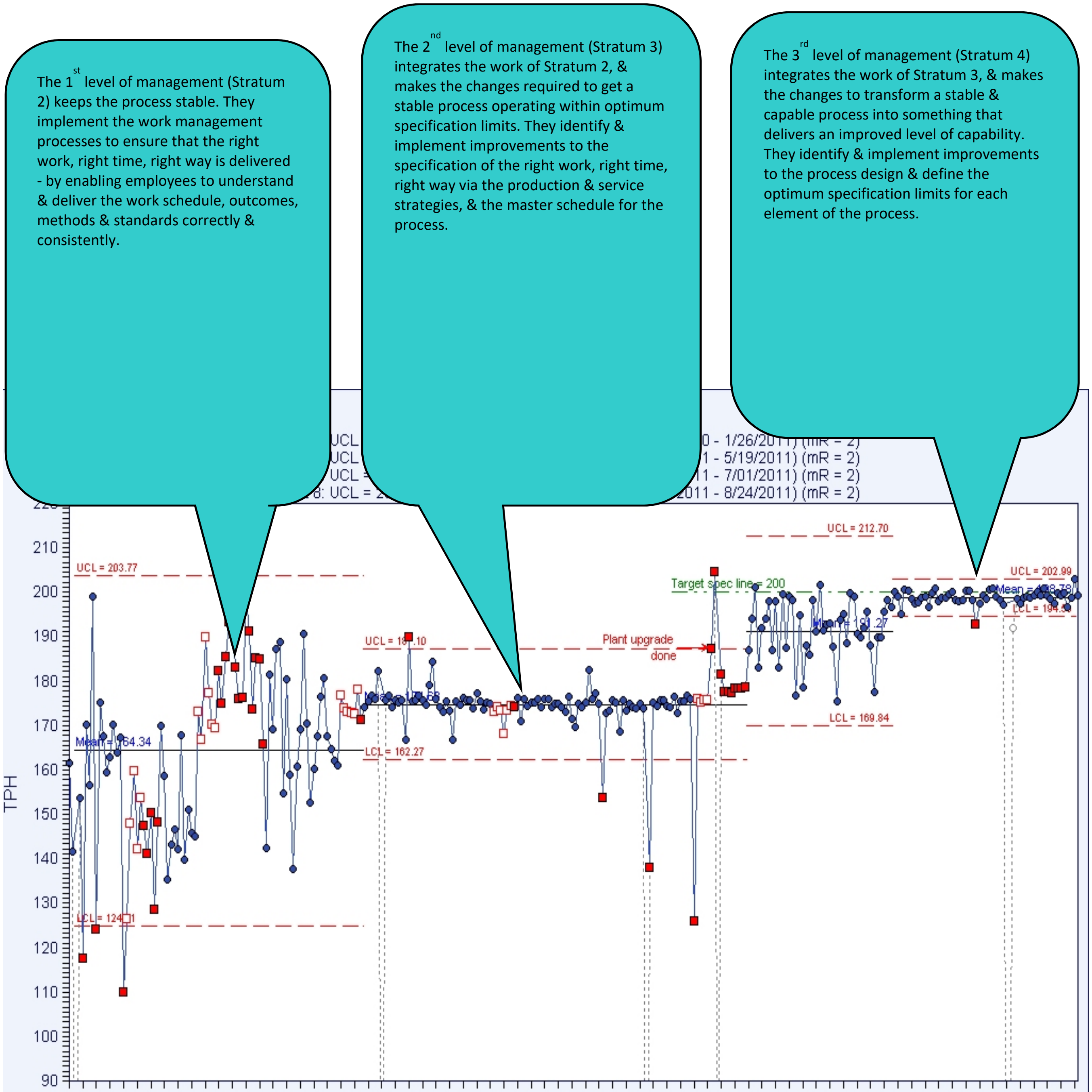
The 1st level of management (Stratum 2) keeps the process stable. They implement the work management processes to ensure that the right work, right time, right way is delivered - by enabling employees to understand & deliver the work schedule, outcomes, methods & standards correctly & consistently.
The 2nd level of management (Stratum 3) integrates the work of Stratum 2, & makes the changes required to get a stable process operating within optimum specification limits. They identify & implement improvements to the specification of the right work, right time, right way via the production & service strategies, & the master schedule for the process.
The 3rd level of management (Stratum 4) integrates the work of Stratum 3, & makes the changes to transform a stable & capable process into something that delivers an improved level of capability. They identify & implement improvements to the process design & define the optimum specification limits for each element of the process.
TPH
UCL = 203.77
UCL = 212.70
LCL = 169.84
LCL = 162.27
Target spec line = 200
Plant upgrade done
UCL = 202.99
210
200
190
180
170
160
150
140
130
120
110
100
90

The term First Level of Management is used rather than any specific job title, as job titles vary from organisation to organisation. The First Level of Management refers to the first level of the organisation structure that has a 24 hour, 7 day per week accountability for the performance of an operation. This is in contrast to personnel on continuous shift work who have an accountability only during their working shift. The supervisor accountabilities are dealt with at the end of the document.

**First Level Manager**

Following this model, the things that differentiate the work of the first level manager are:

- Deliver processes that, internally, operate in statistical control, i.e. no special causes originating from within the process (the FLM does not have control over special causes that originate from outside of the process).
- Implement the work policies, procedures, systems, practices and standards that have been designed to deliver correct and consistent operation of the process.

The first level of management evaluates process data to identify whether the process is stable, i.e. behaving consistently over time. Where this is not the case they identify special cause issues and define and implement controls to bring the process into stability. The key areas of investigation for internal process improvement will be effective resourcing and consistent execution of the master schedule of production and service strategies, and the timely identification and control of uncommon threats. They also identify special cause events arising from other processes and systems whose performance contributes to instability in the processes for which they are accountable. In such cases they escalate the issue to the crossover manager and contribute to the management of the cause and/or effect. They deal with special cause issues in a way that will bring the process to a stable performance base from which the performance can be optimised.

The following are work practices that if executed properly would be predictors of the first level managers' success in achieving the accountabilities. In the language of "to be accountable" they would be the actions that are judged for appropriateness under the circumstances that impacted the process.

People

- Build productive relationships with team members. Know them well, their likes, dislikes, hobbies, ambitions for themselves and their families, etc. Know them well enough to assess capabilities and problem solving skills.
- Identify the individuals in their organisation that are likely to be involved in a special cause event and design an appropriate intervention. The special cause event could be related to safety, environment, quality, production throughput, cost, or any other chosen business outcome.

Measures Flowsheet
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- Find solutions to employee concerns that are within approved practices.
- Involve supervisors and selected employees in identifying potential special causes and identifying solutions (encouraging contribution).
- Translate policies, procedures, systems, and standards into acceptable practices for your workplace(s). As required, create standards for your area where none are established externally.
- Call supervisors to account for their actions in ensuring that schedules, standards, and practices are adhered to by team-members.
- Consistently model appropriate values and behaviours.

Programming - organise your work such that you;

- Use BPF processes and systems for the timely and correct assessment and approval of the work that is necessary, appropriate and funded for the delivery of the process performance requirements.
- Apply resources to meet business expectations.
- Monitor the quality of the planning, scheduling and resourcing activities occurring to set up for the timely and successful completion of work in your area of accountability.
- Monitor the relevant function level purpose and theory measures for special cause events, and respond appropriately to;
  - deal with those you have the authority to correct,
  - escalate those that you do not have the authority to correct.
- Frequent all areas/aspects of the process, including those that are off the beaten path. Confirm that everything is as it should be or identify the risks to the business from a possible unanticipated threat.
- Monitor that standards and practices are adhered to in all areas of accountability and on all shifts.

Technical

- Continuously acquire knowledge and skills relating to interacting with people.
- Continuously acquire knowledge and skills relating to the technical capabilities and risks to the process and people.
- Support the work of the second level manager by contributing ideas to:
  - Identify interdependencies with other processes or systems.
  - Optimise production and service strategies.
  - Optimise operating master and expenditure schedules.

## Second Level Manager

Following this model, the things that differentiate the work of the second level of management are;

- Deliver processes that meet the business‘s current optimum specification limits.
- Specify any work practices necessary to implement the policies, procedures, systems, and standards that have been designed to limit process variation, and/or prevent special cause events.

The second level of management evaluates process data to identify whether the process is meeting the current optimum specification limits. Where this is not the case they identify common cause issues and define and implement controls to bring the process into specification. The key areas of investigation for internal process improvement will be the effectiveness and efficiency of production and service strategies and the integration of these in the operating master and expenditure schedules. From this they will specify improvements to production and service strategy specifications, scheduling, execution and resourcing. They also identify dependencies on other processes and systems whose performance contributes to variation in the processes for which they are accountable. In such cases they escalate the issue to the crossover manager and contribute to the management of the cause and/or effect. They deal with common cause issues in a way that will bring the process to a performance level that meets specifications.

The following are work practices that if executed properly would be predictors of the second level of management‘s success in achieving the accountabilities. In the language of “to be accountable” they would be the actions that are to be judged for appropriateness under the circumstances that impacted the process.

People

- Build productive relationships between the various other teams with whom your team interacts. Know them well enough to know their names and:
  - Who are the 'go to' people to get the straight goods on common causes.
  - Who are the people that can work well together; or not.
- Consider the needs of the people affected by a system change when designing such changes
- Call first level managers to account for their actions in delivering their accountabilities
- Assess the capability of first level managers to perform the work of their role
- Consistently model appropriate values and behaviours.

Programming- organise your work such that you;

- Integrate the work of the first level managers reporting to you.
- Assign resources to meet business expectations.
- Monitor the relevant department level purpose and theory measures for operation within specification limits, and respond appropriately to;
  - deal with those deviations that you have the authority to correct,
  - escalate those deviations that you do not have the authority to correct.
- Use BPF processes and systems for the analysis and improvement of the production and service strategies, operating master schedule, and expenditure schedule necessary, and appropriate for the delivery of the process performance requirements.

Measures Flowsheet

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- Put suitable control measures in place during a period where there is an activity to improve process stability or capability.
- Deal with the special cause circumstances that are outside the authority of the first level manager to correct.
- Consistently utilise the authorised work practices of second level managers.
- Escalate the special cause and common cause circumstances that you do not have the authority to correct.

Technical

- Continuously acquire knowledge and skills relating to interacting with people
- Continuously acquire knowledge and skills relating to the technical capabilities and risks to the process and people
- Continuously acquire knowledge and skills relating to new production and service strategies that are applicable to the process.
- Demonstrate understanding of the optimum specification limits and current capability of the process.
- Demonstrate expertise in applying the BPF analyse and improvement process
- Support the work of the third level manager by contributing ideas to:
    - Identify interdependencies between processes.
    - Optimise process specification limits.
    - Improve the process design.

## Third Level Manager

Following this model, the things that differentiate the work of the third level of management are;

- Design processes and specification limits that will meet the business's future performance requirements.
- Specify how policies, procedures, systems, and standards are applied to deliver stable and capable process performance.

The third level manager evaluates process data and uses process models to identify the causes of constraints to performance capability. The key areas of investigation will be process dependencies, variation and capacity. From this evaluation they design the process and/or specification limit changes that will release constraints on the process and deliver performance at a "new and improved" level, required to meet future enhanced specifications. They also identify dependencies on other processes and systems whose performance produces a constraint on the processes for which they are accountable. In such cases they escalate the issue to the crossover manager and contribute to the management of the cause and/or effect. They deal with process design and specifications in a way that will bring the process to a performance level that meets future requirements.

The following are work practices that if executed properly would be predictors of a third level manager's success in achieving the accountabilities. In the language of "to be accountable" they would be the actions that are to be judged for appropriateness in light of the circumstances that impacted the process.

Measures Flowsheet

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People

- Build productive relationships with the people in your organisation, particularly the second and third level managers. Know them well enough to be able to implement policies, procedures, systems and

standards to leverage their strengths and minimise the impact of their weaknesses.
- Build productive relationships with people outside of your own organisation whose support is critical to your output and that of your direct reports.
- Call second level managers to account for their actions in delivering on their accountabilities.
- Specify what behaviours are expected from people.
- Decide what competences and qualifications are required by employees in your organisation to meet future requirements. Work out a resources plan to train, recruit, or contract the required skills
- Consistently model appropriate values and behaviours.

Programming- organise your work such that you;
- Integrate the work of the second level managers reporting to you.
- Authorise and organise resources to achieve business expectations
- Establish the measures that are required at each level of the organisation to determine that all processes are in control and capable.
- Monitor the relevant organisation level purpose and theory measures for stability and operation within specification limits, and respond appropriately to;
  - deal with those deviations that you have the authority to correct,
  - escalate those deviations that you do not have the authority to correct.
- Use BPF processes and systems for the modelling, analysis and improvement of the process design and specification limits to meet future requirements.
- Put suitable control measures in place during a period where there is an activity to improve stability or capability at the organisation level.
- Consistently utilise the authorised work practices of third level managers.
- Deal with the special and common cause circumstances that have been identified by second and third level managers escalated to you
- Escalate the special cause and common cause circumstances that you do not have the authority to correct

Technical
- Use a structured, systematic approach when changing or designing processes and systems.
- Demonstrate understanding of the dependencies and capabilities of current process design and specification limits and of those required to meet future business expectations.
- Identify meaningful benchmark comparisons. Analyse comparative data to identify potential opportunities for improvement.
- Demonstrate expertise in applying the BPF analyse and improvement problem process to abstract problems.

- Determine specifications for materials, commodities, or other inputs to future production processes. Agree to service, quality and quantity requirements with supply chain partners.
- Recommend changes to technical policies, where appropriate, to improve safety performance, asset management or production
- Keep up with developments in technical standards, legislation, markets, and technology that may affect systems and standards for which you are accountable
- Support the work of the fourth level manager by contributing ideas to:
    - Optimise the divisional portfolio of operations.

Measures Flowsheet

AAOM Flowsheet

## Supervisor

The term Supervisor is used in this paper for the roles that lead teams of people directly executing the production and service work of the process. A supervisor has accountability for the performance of their team and for the process during their working time, but does not have the accountability outside of their working time.

At the end of the day supervisors and their teams are about the execution of specific tasks to deliver performance. Senior roles have designed policies, processes, systems and standards that are intended to deliver the required business outcomes, now and into the future. The supervisor role is where it all comes together. Supervisors must use the designed processes and systems and lead their team such that they work within the approved standards to deliver the process outcomes.

For many of the senior roles the differentiating contribution of that level could be described with one or two broadly descriptive bullets points. At the level of the supervisor, the differentiating contributions are many, and are more precisely defined. This will not be an exhaustive list; the intention is to capture the essence of the role.

In terms of accountability:

- Apply the standards, processes and systems so that the teams can deliver the business outcomes with minimal variability.
- Develop team awareness of all workplace risks to themselves and the business. (Risks are not limited to safety, health, environment, but also includes risks to volume, quality, stocks, costs, and any other designated business outcomes).
- Develop team awareness of the means to control all of those risks
- Develop team discipline such that those means to control risks are applied in all circumstances where the risks are present.

The following are identifiable behaviours or "work process expectations" that if executed properly would be predictors of a supervisor's success in achieving the accountabilities. In the language of accountability they would be the actions that are judged for appropriateness under the circumstances.

People

- Get to know the members of the team. Know them well, likes, dislikes, capabilities, hobbies, ambitions for themselves and their families, etc.
- Assess their individual level of awareness of risks to themselves and the business. (Safety, quality, costs, reliability, etc.). Prepare and implement plans to fill knowledge gaps.
- Assess their individual level of awareness of means to control those risks. Prepare and implement plans to fill knowledge gaps
- Assess their commitment to reliably execute according to the work standards and specifications. Prepare and implement a plan to gain the required commitment
- Call team-members to account for their actions

- Consistently utilise the authorised work practices of supervisors.
- Consistently model appropriate values and behaviours.

Programming

- Organise your work such that you are always on top of the process theory measures.
- Organise your work such that you can assess team-members knowledge of risks and controls and their commitment to using those controls
- Organise and manage the boundaries between teams, and between support and service groups such that the teams can organise their work, and have the necessary service and support to achieve the process outcomes
- Organise your work such that you attend to the areas that will have challenges in delivering the business outcomes on this shift. Assist the teams in managing the challenges such that the process outcomes are achieved

Technical

- Continuously acquire knowledge and skills relating to interacting with people
- Continuously acquire knowledge regarding risks to individuals and the process and the means to control the same.
- Continuously acquire knowledge and skills relating to the technical operation of the process.
- Apply this knowledge and work with the teams to develop solutions to on-shift challenges, solutions that fall within accepted standards.
- Support to the work of the first level manager by contributing ideas to:
  - Avoid special cause events
  - Identify where new standards are required or existing standards need upgrading

Measures Flowsheet

AAOM Flowsheet

# MP.08 Define specification limits

## Context

All processes exhibit variation. The question is whether the variation is both predictable (stable) and acceptable (capable). If either of the conditions is present, an intervention may be warranted. Variation can come from two sources: common causes and special causes. Common cause variation can be thought of as recurring, a normal part of the process operation and output. They are a predictable part of the process and are the result of the process operating in a consistent manner. This consistent, predictable performance, however, may not be meeting specification. The process may be predictably, consistently performing poorly! Special cause variation occurs when the process fails to perform in a predictable, consistent manner. Statistically special causes account for less than 1% of the variation in the process. A control chart is used to identify common and special cause variation and thus to assess the stability of the process.

If the process is stable an assessment about the capability of the process to meet specifications is made. This task is performed using a capability histogram. For this to occur, the distribution of the performance measures (process width and location) is compared to the location of the specifications.

## Purpose

To define the target value and the upper and/or lower limits for each measure

## Quantity

One statement that identifies the target and at least one specification for each measure.

## Quality

Specification limits are based on the performance values that stakeholders (suppliers/customers/owners) care about.

A specification must include at least an upper limit or a lower limit but may include an upper limit and a lower limit, and may also include a target mean.

## Resources

This task is completed by the manager responsible for the process.

## Time

The task should be completed prior to measures being developed

# MP.09 Identify the physical boundaries of the process

## Context

When constructing measures we also need to consider the boundary conditions, i.e. what is included in the measure and what is excluded. Two types of boundary conditions need to be considered, the physical boundaries of the process and the data boundaries for the measure.

## Purpose

To identify the beginning and the end points of the process to be measured

## Quantity

One statement that defines the beginning and end points of the process

## Quality

Within the BPF the physical boundaries of a process are defined by the Business Structure, specified by constructing a layered series of flow sheets based on the transfer, transform and store activities that can be identified within a layer of the flow sheet. Each of these transfer, transform and store activities can be viewed as a process with its distinct purpose and theory measures. The physical boundaries are therefore the boundaries of these flow sheet elements.

### Resources

This task is completed by the manager responsible for the process.

## Time

The task should be completed prior to measures being developed

Measures Flowsheet

AAOM Flowsheet

# MP.10 Establish data boundaries

## Context

When constructing measures we also need to consider the boundary conditions, i.e. what is included in the measure and what is to be excluded. Two types of boundary conditions need to be considered, the physical boundaries of the process and the data boundaries for the measure.

Since the measures of a process are intended to indicate the delivery of the Purpose or the Theory, the conditions in which these are delivered should guide the specification of the data boundary conditions for the measure. Data boundaries are applicable when measuring time. For example, if we are measuring the utilisation of a process, the time boundaries should be set to enclose the period when the process is performing its Purpose, and to exclude the period when the process is not performing its Purpose. The boundary conditions for the theory and purpose measures should be matched.

When processes interconnect, as they always do, people often get confused trying to decide whether a particular measure is of a lagging or leading nature. This is understandable because the nature of a measure is relative. The output parameters for one process are typically elements of the theory measures (input in this case) for the following process. For example if you are looking at the grind quality from a mill, it is a lagging measure of the mill operating performance. For a leach circuit, the grind quality will be a leading measure of the process performance.

## Purpose

To determine the data to be included and excluded from the measure

## Quantity

One statement that defines data boundaries of the measurement

## Quality

The data boundaries shall be based on the boundaries to the process delivering its purpose - see examples in Appendix 1 below.

## Resources

This task is completed by the manager responsible for the process.

## Time

The task should be completed prior to measures being developed

# Appendix 1

## Measure Parameter Boundary Definitions

### Purpose Statements

Transfer Process - to move a product or service from one location to another.

Transform process - to alter the specification of a product or service.

Store Process - to isolate variation in supply and demand between two processes.

### Operating Time

**Transfer Process**
The time the process is receiving, moving or discharging product or service.

**Transform Process**

The time the process is receiving, transforming or discharging product or service.

**Store Process**
The time the process is receiving or discharging product or service.

### Available Time

**Transfer Process**

The time that the process is able (i.e. equipment is not out of service) to receive, move or discharge a product or service.

**Transform Process**

The time that the process is able (i.e. equipment is not out of service) to receive, transform or discharge a product or service.

**Store Process**
The time that the process is able (i.e. equipment is not out of service) to receive or discharge of a product or service.

**Note** – Where a process has storage at its entry or exit (within the defined process boundaries), the time measures (both operating time and available time) should be based on receiving from or discharging to this storage.

Measures Flowsheet

### Rate

**Transfer Process**

The volume of product or service moved by the process divided by the cycle time (defined by the utilisation boundaries) for the movement.

AAOM Flowsheet

### Transform Process

The volume of product or service transformed by the process divided by the cycle time (defined by the utilisation boundaries) for the transformation.

### Store Process

The difference between the volume of product or service delivered to and from the process divided by the cycle time (defined by the utilisation boundaries) for the delivery.

### Maximum Statistical Rate (MSR)

For rate measures, the following must be considered when setting the MSR:

- The MSR is used to represent the 'Personal Best' of the process. It is used as the benchmark to compare current performance against, much as an athlete compares their most recent performance to their 'personal best'.
- The MSR is not constantly adjusted up and down based on the last performance data. It is a benchmark that represents the best that the process has done.
- Use the data that characterises the historical performance of the process in its current design configuration, i.e. do not include data from periods where the process comprised equipment or configurations of a different capacity - such as before or after an expansion, contraction or upgrade.
- Use the data set that provides the best representation of the range of process variation over the periods where the process exhibited its highest rate performance.
- Set at the MSR at the 95$^{th}$ percentile of the capability indicated by this data.
- If the process performance moves higher due to changes in strategy, work execution or resourcing, then recalculate the MSR considering each of the above points. This is equivalent to an athlete resetting their 'personal best' after an exceptional performance.
- Do not recalculate the MSR as a result of the process performance moving lower due to changes in strategy, work execution or resourcing - as this is not a result of a change to the process design. An athlete does not move their 'personal best' downwards because of a few poor outings.

**Note** – processes are defined at the Region, Operation, Process and Productive Unit level. The 'product' used for the measurement each of these is defined by the Purpose of the process (e.g. produce ore, produce matte, produce gas/electricity etc.).

## Quality

On-spec product or service is that which meets all quality specifications.

## Reliability

### Unscheduled Interruption
A period of non-operating time, or zero operating rate, that was not specifically identified in the operating schedule.

### Unscheduled Intervention
A Service task that was not specifically identified in the operating schedule.

Measures Flowsheet
AAOM Flowsheet

# MP.11 Review the capability of measurement equipment/devices.

## Context

Most processes will have a number of measurement devices available to automatically measure certain critical characteristics. An understanding of the device’s ability to measure is required prior to establishing a measurement system.

KPIs should be continually measured and monitored. Other measures of the technical theory or strategy are used during the Analyse and Improve process, to help in understanding issues and opportunities around the stability or capability of the process. These non-KPI measures do not need to be monitored continually, and hence may not need to have permanent measurement systems installed.

The decision on whether permanent measurement systems are required for control measures should be guided by two considerations. These are; the rate at which the process can undergo a change and, the 'visibility' of the change. In a chemical process where changes in concentrations or reactions can occur fairly rapidly (perhaps in minutes or hours), and cannot be easily or safely detected by human senses, specialised instruments will be needed to measure the change. Since significant time may be required to put these instruments in place, it will typically be necessary to install permanent instrumentation for this type of control measure. Then, when a KPI indicates that an intervention is required, the data from the measure will be available in time to make an appropriate analysis and intervention. In a process such as a mine shovel loading broken ore, many of the potential control measures are readily observable, either directly or with simple tools, and therefore do not require permanent instrumentation. For example, if a control chart of the daily loading rate (an effectiveness measure for the process) indicates a drop in performance, it is relatively quick and easy to take a stop watch and measure by observation the times for the loading cycle steps, to determine if the swing time or dig time are longer than target.

## Purpose

To produce a list of available measuring devices detailing measurement capability

## Quantity

One statement for each device detailing the capability of the equipment

## Quality

The list of devices shall include a description of:

- Accuracy of the device
- Calibration intervals
- Reliability of the device

- Does the device record data automatically or is some manual recording required?
- At what frequency is the device capable of taking measurements?

## Resources

This task is completed by the manager responsible for the process.

## Time

The task should be completed prior to measures being developed

Measures Flowsheet

AAOM Flowsheet

# MP.12 Determine the maximum rate of change for the process

## Context

Measurements can contain ‘noise’, i.e. values that are not a true representation of the process performance. Noise may arise from various sources but is identifiable as changes that are too rapid for the process to actually deliver. Noise is not a relevant component of the measure and should be excluded.

For example, each area of a process will have a maximum throughput rate limited by the physical design and capacities of the equipment. This limit will affect the rate of change that can occur in all of the quantities that we may need to measure, whether they be product level in a tank, chemical concentration in a solution, or temperature in a furnace.

A simple approach to maximum rate of change is to understand the maximum period over which a process can change during normal operation. This obviously guides sampling intervals.

For example:

- The maximum rate of level change in a tank will be determined by the tank volume and the maximum rate of the inflows and outflows.

- The maximum rate of change of the concentration of a solution will be determined by the volume of the solution and the maximum rate at which a chemical can be added.

- The maximum rate of change of temperature in a furnace is determined by the maximum difference between the heat injection and thermal losses.

## Purpose

To develop an appropriate filter to remove irrelevant data (noise).

## Quantity

One definition for the appropriate conditioning filter.

## Quality

A conditioning filter must be specified, based on the above criteria, and applied to the measure so that rates of change that are irrelevant are removed.

## Resources

This task is completed by the manager responsible for the process.

**Time**

The task should be completed prior to measures being developed

Measures Flowsheet

AAOM Flowsheet

# MP.13 Determine the required measurement precision/accuracy

## Context

The measurement precision/accuracy will determine the minimum level of variation that can be identified (referred to as the quantisation level). Any variation that is less than this will not be seen. Selecting the quantisation level for measuring performance is a trade-off between the detail needed to determine that performance is within specifications and the effort/cost of achieving that accuracy. In most instances today we have inexpensive and highly accurate technology that can provide a much higher level of resolution than is necessary to help us understand the capability of a process.

## Purpose

To identify the minimum level of accuracy required to expose significant variation

## Quantity

One statement of the level of accuracy required for each measure.

## Quality

In practice, a Capability Histogram that is based on 15 to 20 quantisation steps of the full range of variation typically provides enough detail. The quantisation level can generally therefore be set to the minimum level of variation that you wish to observe.

## Resources

This task is completed by the manager responsible for the process.

## Time

The task should be completed prior to measures being developed

# MP.14 Define the sampling interval

## Context

Storage capacity within, or between, processes provides a natural filter that smooths variation (noise) within a process, and buffers connected processes against the effects of variation occurring in one of the connected elements. The capacity of these storage elements, coupled with the maximum throughput rate of the process, help us to determine how quickly a significant change in the process can occur and hence how frequently we need to look at a measure - the sampling interval.

For example, if you must maintain the concentration of a solution within specification limits, and the accuracy of the measuring device is 5%, you will probably wish to be able to identify any 5% change in concentration. The minimum time interval in which this can occur is the determined by the volume of the solution and the maximum rate at which a chemical can be added. If we take a measurement more frequently than the minimum time in which a 5% change can occur then we will always detect the change. If we take the measure much less frequently than the minimum time in which a 5% change can occur then variation that occurs between sampling intervals will not be seen. Selecting the sampling interval for a measure is a trade-off between the maximum rate of variation that you will identify and the effort required to collect the measurement.

## Purpose

To determine the sampling frequency for each measure

## Quantity

One sampling plan for each measure

## Quality

The Nyquist criteria state that the maximum frequency of variation that can be represented by the data has a period of twice the sampling rate. Stated another way – you must sample at less than half the time interval in which the change you wish to detect can occur.

Select a sampling interval after considering storage capacities, maximum throughput and the implication of the Nyquist criteria.

Measures Flowsheet

AAOM Flowsheet

- If the sampling interval is equal to or greater than the Nyquist rate then reconstructing a graph by connecting the instantaneous values at the sampling interval represents the relevant performance of the process between samples.

- If the sampling interval is set to less than the Nyquist rate the maximum frequency of variation cannot be observed and a graph reconstructed by joining the instantaneous values at the sampling intervals does not represent the relevant performance of the process between samples.

## Resources

This task is completed by the manager responsible for the process.

## Time

The task should be completed prior to measures being developed

# MP.15 Document the measurement system

## Context

A measurement system is used to provide high quality, reliable data to produce control charts and capability histograms so that good decisions can be made about the need to intervene in the process. A measurement system will include the combined input of the following to produce a set of procedures that will ensure a reliable collection of data:

- The process being measured
- The purpose of the process
- The theory underpinning the process
- The purpose and theory measures
- The physical boundaries of the process
- The measurement (data) boundaries for each measure
- The owner of each measure
- The collection of measures to be used as a KPI
- The target and specification limits for each measure
- A list of the measurement devices showing each gauge's capability
- The maximum throughput of the process
- The required level of measurement accuracy required to adequately identify significant variation
- The sampling interval for each measure

## Purpose

To define a measurement system that conditions the data before capturing and recording data at the specified sampling interval and accuracy.

## Quantity

One procedure for collecting data for each measure shall be delivered for the specified measures:

- One specification for the boundary conditions to be applied to the measure.
- One specification for the conditioning filter to be applied to the measure.
- One specification for the measurement accuracy at which data is to be collected.
- One specification for the sampling interval at which data is to be collected.
- One Control Chart of the performance.
- One Capability Histogram of the performance.

Measures Flowsheet

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## Quality

It is critical that the sample intervals be strictly adhered to or the data will not accurately represent the true variation.

The record is based on the value of the measurement at the sampling interval.

### Resources

This task is completed by the manager responsible for the process.

### Time

The task should be completed prior to measures being developed

# MP.16 Collect data

## Context

The Business Process Framework defines the purpose of a measure as 'to indicate when an intervention in a process is required'. So the first question to answer is: when is an intervention required?

Every justifiable process must contribute value to an enterprise - the precise manner in which it delivers value is defined by the Purpose of the process. Sustainable value is derived when a process can economically continue to deliver the required output. If sustainable value is not being delivered then an intervention in the process is required.

Decisions on making a process intervention or not are made using control charts and capability histograms. Both these tools rely on collections of good, honest, and reliable data that genuinely represents process variation produced by a well-developed measurement system.

## Purpose

To produce a collection of data for input into control charts and capability histograms.

## Quantity

One collection of data for each measure

## Quality

Data should be collected in a consistent manner following the procedures specified in the measurement system documentation.

## Resources

This task is completed by the manager responsible for the process.

## Time

The task should be completed after the measurement system is developed.

Measures Flowsheet
AAOM Flowsheet

# MP.17 Validate and test the measurement system

## Context

Any system that is used to decide on making process changes will require approval for use. The measurement system feeds data to control charts and capability histograms which are used to make the decision to intervene in a process or not. These decisions can potentially have negative effects on meeting our business objectives and so should not be made lightly. It is of paramount importance that the data used for analysis should have a high degree of integrity.

## Purpose

To validate that the measurement system is producing reliable data for assessing process performance.

## Quantity

One decision that a reliable measurement systems has been delivered.

## Quality

An examination of the control charts and capability histograms for the process measures produced by the measurement system should indicate the integrity of the data. The integrity of the individual components of the measurement system can be checked prior to approval being granted.

## Resources

This task is completed by the manager responsible for the process.

## Time

The task should be completed after the measurement system has been developed and tested.

INTERNAL

# ANGLO AMERICAN OPERATING MODEL: FEEDBACK

## ANALYSE AND IMPROVE

**UPDATED: JULY 2017**

**CONTENTS**



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INTERNAL

# AI.00 Analyse & Improve

## Context

No process can be left unattended or indefinitely, two inevitable factors will over time create the need for an intervention. The first is that the natural pattern is for all things is to degenerate over time (something significant enough to be stated in the second law of thermodynamics), and the second is that new and stronger competitors will always emerge to take our place in the landscape if we do not continue to improve (encapsulated in Darwin's theory of natural selection). In the Anglo American Operating Model (AAOM) the Analyse and Improve process has the dual functions of preventing the degradation of process performance and delivering continuous process improvement.

Businesses face the potential for competition from new sources of supply, more efficient facilities and alternative materials. If they are going to sustain a viable business they must continually become a stronger competitor on reliability and capacity to supply, and on the quality and price of product or service.

This means that we cannot blindly accept that what we have done in the past is going to be adequate to provide us with a secure future. We must continually examine our performance and look for opportunities to improve.

### *Measure*

To manage a process well we use a collection of Key Performance Indicators (KPIs). In the AAOM context the KPIs of a process are defined as the minimum set of measures that fully inform us about the delivery of the Purpose (outcomes) of the process, and of the appropriate elements of the Theory of the process. Theory measures may include in-process and input measures.

The purpose of a measure is to indicate when an intervention in the process may be required.

An effective measurement process must;

- exclude noise (ie data values generated from sources external to the measured process) but include all data values that represent what the process is doing,
- reveal all meaningful changes in the process (in terms of both the quantum and the rate of change).

### *Assess Stability & Capability*

Without proper processes and guidelines for interpretation of measures, the most common outcomes are that people either do not respond when necessary, or they overreact by making a change when none is required. The result of both these situations is poorer performance from the process.

The discipline of Statistical Process Control defines two characteristics of a measure that need to be assessed in order to determine whether an intervention in the process may be required. These are the Stability and the Capability of the process.

Stability is an indication of process predictability - is it behaving consistently over time. Capability is an indication of how well the process meets specifications - to what extent do the outputs fit within the specification limits.

Control charts and capability histograms of Key Performance Indicators are used to test for the above conditions. The indication that a process is Stable is a Control Chart where;

- there aren't unexpected extreme values (outliers) amongst the results, and
- the distribution of results is consistent with only random variation occurring in the process, i.e. data points are uncorrelated.

The indication that a process is capable is a Capability Histogram where:

- the range of the variation in the results is less than the width of the specification limits, and
- the results are located within the specification limits.

If the above tests are positive then we need to keep doing what we are doing, and any intervention to change that will probably be detrimental to performance (an overreaction). If there is a negative to any of the above four tests, then an action to change what is happening may be required. Adherence to the next steps in the Analyse and Improve will help ensure that the correct action is taken when needed.

***Investigate Causes***

In large and complex processes there are likely to be many potential opportunities to improve performance, more than may be practical to pursue at any one time. Not all potential opportunities will provide the same benefit (the Pareto principle suggests that 80% of the benefit will come from 20% of the opportunities), hence, each opportunity should be evaluated objectively and consistently to ensure that we focus on those with the best realisable value. Appropriate criteria for ranking opportunities may include; the potential benefits, cost, ease and timing of delivery and likely sustainability of the change.

Recognising an opportunity and its potential doesn't mean that we understand what needs to be changed in order to realise the opportunity. Some form of investigation of contributing causes will be required to identify exactly what is disturbing the process or inhibiting it meeting specifications. Investigation and analysis should be systematic and objective, as changes based on a false conclusion will at best be a waste of valuable resources, or at worst will cause a harmful change to the process we are trying to correct or improve. Hence, before any action is taken we must measure or test to confirm that the conclusions of the investigation and analysis are valid.

A&I Flowsheet

AAOM Flowsheet

***Select Controls***
Improvement opportunities are delivered through changes to:

- The design of a process,
- The production or service strategies adopted for the process,
- The preparation, organisation and execution of activities involved with the process, and/or
- The cost effectiveness of resources employed in the process.

In a relatively stable process that has been performing to the required specification, but has drifted away from specification, the appropriate control action may be well understood and defined. This is a situation where standard trouble shooting guides and procedures can be used to help workers quickly and accurately select the correct control action.

When a process exhibits recurring failures, or must perform to specifications that it has not consistently met, it is likely that new controls must be devised. There may be many potential changes, or combinations of changes, that could produce an effective control. The objective is to develop the broadest range of options, from which the most effective and economical can be selected. In cases where controls are novel it is generally advisable to validate them through tests or trials before full implementation.

***Implement***

As with any task, success in implementing a control action will depend on how well it is specified, prepared and executed. This might be achieved through the application of standard tasks and procedures for common control actions, through to the development and delivery of a substantial change project for a significant shift in process performance. The key is to plan, schedule, resource and manage the control action to the level of detail that will provide the required confidence of achieving the outcome.

***Validation***

The final step after implementing any control action is to return to the measure(s) that initiated the Analyse and Improve process to confirm that either:

- The desired outcomes were achieved and the performance is stable and capable, or
- The desired outcomes have not been achieved, and hence we need to return to the analysis of the cause, or the choice of control.

## Purpose

To use information created from performance measures to improve the process.

## Quantity

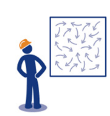
One process to guide the systematic and objective analysis and improvement of performance.

## Quality

The Analyse and Improve process should include the following key steps:

- Review Key Performance Indicator control charts and capability histograms at the appropriate time.
- Apply standard statistical tests for identification of process stability or capability improvement opportunities.
- Rank/Prioritise issues and opportunities based on consistent, objective criteria.
- Apply systematic investigation and analysis techniques to identify contributing/root causes underlying issues and opportunities.
- Use measures, tests and data to validate that suspected causes are correct.
- Apply systematic investigation and analysis techniques to develop options for control actions.
- Use measures, tests and data to validate the efficacy of selected control actions.
- Use task appropriate methods for planning, scheduling, resourcing and managing the activities required to implement a control action.
- Use control charts and capability histograms of KPIs to validate control action results.

The detailed activities of conducting performance analysis and improvement shall conform to the specifications set out in the Analyse and Improve Flowchart and associated Task Assignments AI.01 to AI.27.


A&I Flowsheet


AAOM Flowsheet

# AI.01 Produce Control Charts

## Context

A Key Performance Indicator or Control Measure is produced for the purpose of helping us make the decisions necessary to control or improve a process.

An appropriate intervention in a process, taken at the right time, can ensure that the performance is maintained or improved. Every un-necessary intervention in a process tends to increase the variation in, and losses produced by, the process.

It is therefore essential that only the necessary and appropriate interventions be made. Making the right decision on the need for intervention is dependent on having the right data, and on making the correct interpretation of the data.

The Set Performance Targets process established what the Key Performance measures are for each process and the TAs related to Measure Output, Work Management and Social performance defined how these are measured. Control measures are defined through the tools used during the Analyse and Improve process.

Statistical analysis tools help us to take the guesswork out of interpretation of the data, and to decide the appropriate and in-appropriate times for intervention in a process.

The most common tools we will use for guiding the decision to intervene in a process are Control charts and Capability Histograms.

## Purpose

To provide the information necessary for making a decision that intervention in a process is required.

## Quantity

One set of appropriate Control Charts for each of the measured variables.

## Quality

Each chart shall be constructed;

- To a common format;
  - display the data, Upper Control Limit, Lower Control Limit and Mean on the Control Chart,
  - display the data, Upper Specification Limit, Lower Specification Limit, Mean and total number of data points on the Capability Histogram.
- Using standardised out of control tests – as a guide, start by using the following basic tests;
  - a point outside of a Control Limit,
  - seven points above or below the Mean,
  - seven points ascending or descending
  - a recurring pattern or tendency
- Using standardised rules for setting and changing control limits, See Appendix 1 for detailed Guidelines.

- For rate measures – in the event that process capability has changed – consideration needs to be given to whether it's appropriate to change the MSR. The following must be considered when setting the MSR:
  - The MSR is used to represent the 'Personal Best' of the process. It is used as the benchmark to compare current performance against, much as an athlete compares their most recent performance to their 'personal best'.
  - The MSR is not constantly adjusted up and down based on the last performance data. It is a benchmark that represents the best that the process has done.
  - Use the data that characterises the historical performance of the process in its current design configuration, ie do not include data from periods where the process comprised equipment or configurations of a different capacity - such as before or after an expansion, contraction or upgrade.
  - Use the data set that provides the best representation of the range of process variation over the periods where the process exhibited its highest rate performance.
  - Set at the MSR at the 95$^{th}$ percentile of the capability indicated by this data.
  - If the process performance moves higher due to changes in strategy, work execution or resourcing, then recalculate the MSR considering each of the above points. This is equivalent to an athlete resetting their 'personal best' after an exceptional performance.
  - Do not recalculate the MSR as a result of the process performance moving lower due to changes in strategy, work execution or resourcing - as this is not a result of a change to the process design. An athlete does not move their 'personal best' downwards because of a few poor outings.

## Resources

This task is the responsibility of the manager of the process.

## Time

As soon as sufficient data to produce valid charts has been collected.

A&I Flowsheet

AAOM Flowsheet

# Appendix 1: Setting and Changing Control Limits

## Setting Initial Control Limits

Create and display the initial control chart, calculating temporary control limits using all of the data points. Ideally, you should have 25 to 100 points on the chart, but this is not an absolute requirement. There is no need to look at thousands of data points at this early stage. If the control chart is built on a boundary limited measure, and the calculated Control Limits lie outside of the boundary, set the value to the boundary value, eg if a measure has an upper value limited at 100, and the calculated Upper Control Limit is 115, manually set the upper Control Limit to 100.

If there are points outside of the control limits on the chart, you should study each one, looking for the special cause. For any special cause you discover, do your best to remove it from the process – ensure that it will not happen again. Exclude the special causes from the calculation of the Control Limits and Mean and display the same control chart using newer Control Limits and Mean.

Next, starting from the data at the beginning of the Control Chart, look for shifts, runs or changes in the range of the data that might indicate that the process changed. If a change appears to have occurred, and to have been sustained, calculate new control limits for the data up to the point where the change occurred and use temporary control limits (based on all of the data points occurring after the change has been established) for the rest of the chart.

Repeat the above 2 steps until you reach the end of the data/chart.

If there no shifts, runs or changes in the range of the data contained within the last section of the control limits on the chart extend these control limits as each new data point is added to the chart. At this point you can use the control chart for ongoing monitoring of the process. When you see an out-of-control condition, it means that some special cause is present. This should be investigated and understood. Steps should be taken to ensure it does not happen again.

If there is a shift, run or change in the range of variation evident in the data contained within the last points on the chart, it means that a special cause may be present. This should be investigated and understood, and the appropriate Control Action taken.

## Changing Control Limits

If a change appears to have occurred in the process (i.e. there is a shift, run or change in the range of variation evident in the data) then a special cause is indicated and this should be investigated and understood immediately, and the appropriate Control Action taken.

If the change in the process is only temporary then do not alter the Control Limits.

If the change in the process is going to be sustained then calculate new temporary control limits as each new point is added (using all of the points occurring after the change is established) until you have at least 25 points in the calculation. Extend these control limits as each new data point is added to the chart. At this point you can use the control chart for ongoing monitoring of the process.

A&I Flowsheet

AAOM Flowsheet

# AI.02 Process Stable?

## Context

A Key Performance Indicator or Control Measure is produced for the purpose of helping us make the decisions necessary to control or improve a process.

The first question to be asked when assessing process performance is whether the process is stable. This is not whether there is variation in the process (there always will be normal variation), or whether there is too much normal variation, but is whether there is an abnormal variation that indicates either an uncommon event or that the process has changed. The event or change may be un-intended, as when there is wear, drift or failure of a component of machinery used in the process, or where an operator has altered the setting of a parameter away from the specification. The change may also be intentional, as when a higher performance component or new process setting is being trialled. A stable process is one that is performing consistently, that is, nothing unusual has happened and the process is not changing.

A control chart is used to determine if a process is stable.

If the control chart indicates that the process is not stable the situation should be investigated immediately. If the control chart indicates that the process is stable, then the capability of the process should be reviewed.

## Purpose

To determine if the process is stable.

## Quantity

One decision on each KPI - is the process stable or not?

## Quality

A test for stability should be conducted at the time each new measurement point is added to the control chart.

The tests to be applied for determining stability are;

- No data point outside of the control limits
- No 7 consecutive points above or below the mean
- No 7 consecutive points ascending or descending
- No recurring tendency or pattern in the data

## Resources

This task is completed by the person responsible for the process performance at the time a new measurement point is added to the control chart.

## Time

Process stability should be reviewed each time a new data point is added to a control chart.

# AI.03 Process Changing due to Control Action?

## Context

The first question to be asked when assessing process performance is whether the process is stable.

A stable process is one that is performing consistently, that is, nothing unusual has happened and the process is not changing.

A control chart is used to determine if a process is stable.

If the control chart indicates that the process is unstable, that is, something unusual has happened or the process is changing, the question must be asked - is this due to the effects of a control action that has been taken or is there another special cause for the change?

If the change is the beneficial result of a control action then complete or continue the action. If the change is the detrimental result of a control action then stop or reverse the action. If the change is due to another special cause then an immediate investigation is required.

This task is to determine whether a process change is the result of a deliberate control action or some other cause.

## Purpose

To decide if a process change is the result of a control action.

## Quantity

One decision on the probable causes of a change in process stability.

## Quality

Review current control actions to identify any that would produce the observed change in process stability.

Confirm that a control action with the potential to produce the observed change has progressed to the extent that the change is expected.

Examine any other data that will validate that the observed change is caused by the control action.

## Resources

This task is completed by the person responsible for the process performance at the time a change in process stability is recognised.

## Time

As soon as a change in process stability is recognised.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# AI.04 Produce Capability Histograms

## Context

A Key Performance Indicator or Control Measure is produced for the purpose of helping us make the decisions necessary to control or improve a process.

An appropriate intervention in a process, taken at the right time, can ensure that the performance is maintained or improved. Every un-necessary intervention in a process tends to increase the variation in, and losses produced by, the process.

It is therefore essential that only the necessary and appropriate interventions be made. Making the right decision on the need for intervention is dependent on having the right data, and on making the correct interpretation of the data.

The Set Performance Targets process established what the Key Performance measures are for each process and the TAs related to Measure Output, Work Management and Social performance defined how these are measured. Control measures are defined through the tools used during the Analyse and Improve process.

Statistical analysis tools help us to take the guesswork out of interpretation of the data, and to decide the appropriate and in-appropriate times for intervention in a process.

The tools we have used for guiding the decision to intervene in a process thus far are Control charts, from which we can now produce Capability Histograms.

## Purpose

To provide the information necessary for making a decision that intervention in a process is required.

## Quantity

One set of appropriate Control Charts and Capability Histograms for each of the measured variables.

## Quality

The Capability Histogram shall be constructed;

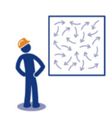
- To a common format;
- Including only the most current period of representative process performance from the control chart in Capability Histograms,
- Excluding validated special (assignable) cause events from the Histogram, and
- Using Standardised Capability Tests;
    - the shape of Histogram matches expectations,
    - the range of variation is less than the difference between the Specification Limits,
    - all of the variation lies between the specification limits.

## Resources

This task is the responsibility of the manager of the process.

## Time

As soon as sufficient data to produce valid control charts has been collected a capability histogram can be produced.



A&I Flowsheet

AAOM Flowsheet

# AI.05 Is the Process Capable?

## Context

The Capability Histogram and Control Charts of a process can be used to track its KPI's. If review of a KPI determines that the process is stable, the next step is testing for process capability. In the least demanding case, a capable process is one where the range of variation in performance fits the specification to the required confidence level (the confidence level specifies the percentage of the variation that must lie within the specification limits).

If the process is meeting specifications then nothing further needs to be done until either the process or specifications change. If the process is not meeting specifications then the issue should be evaluated to determine if the impact justifies further analysis and implementation of control actions.

## Purpose

To determine if the process is capable of meeting its specifications.

## Quantity

One decision on each KPI – is the process capable or not?

## Quality

The Capability of a process is not tested if the process is not stable.

The tests to be applied for determining capability are:

- The distribution fits the expected shape.
- The range of variation evident in the performance will fit within the specification limits to the required confidence level, and
- The performance is located within the specification limits to the required confidence level.

## Resources

This task is completed by the manager responsible for the process performance.

## Time

Process capability will only change after there is either an indicated change in process stability or the process specifications are changed. Therefore the minimum requirement is to review capability after;

- a change in process stability, and
- the process performance has reached a stable state, and
- there are sufficient data points to make a reasonable judgement (hopefully 25 but certainly more than 7), or
- there is a change to the process specifications.

# AI.06 Wait for Next KPI Review

## Context

If a KPI review determines that a process is both stable and capable then no intervention that will change the process should be made. The only action that is required is to wait and examine the next point on the control chart.

If a process is not capable but there is a control action(s) to improve the capability, then no further intervention that will change the process should be made. The actions that are required are to continue the implementation of the control action(s) and wait to examine the next point on the control chart for the start of the anticipated improvement.

## Purpose

To prevent over-reaction (unnecessary interference) reducing the stability or capability of a process.

## Quantity

One decision that no intervention in the process should be made.

## Quality

No intervention should be made if the process is both stable and capable.

If the process is not stable or capable but control action(s) are already in place to deal with this then no further intervention should be made.

## Resources

This task is completed by the person(s) responsible for the review of the process stability and capability.

## Time

Immediately after reviewing a KPI.

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# AI.07 Capability Control Action in Progress

## Context

If a KPI review determines that a process is stable but incapable of meeting the required specifications, it must be determined if there are any current analyse and Improve activities that will improve the process capability.

If there are no activities in place to improve capability then the issue should be referred for further investigation. If activities are in place to address the capability issue then implementation of these should continue.

## Purpose

To decide if a new capability issue investigation should be initiated.

## Quantity

One decision whether there is a current Analyse and Improve activity that will improve the process capability.

## Quality

Review current active issues to identify any intended to improve the capability of the process.

## Resources

This task is completed by the manager responsible for the process.

## Time

Process capability will only change after there is either an indicated change in process stability or the process specifications are changed. Therefore the minimum requirement is to review capability after;

- a change in process stability, and
- the process performance has reached a stable state, and
- there are sufficient data points to make a reasonable judgement (hopefully 25 but certainly more than 7), or
- there is a change to the process specifications.

# AI.08 Continue/Complete the Control Action

## Context

If a KPI review determines that process changes identified in control charts are the result of a control action and/or that there are current Analyse and Improve activities targeted at improving inadequate process capability, we should focus our efforts on completing these rather than initiating new investigations.

The response that is required is to continue the action(s)/activities and wait to examine the next point on the control chart for the start of the anticipated improvement.

## Purpose

To provide the constancy of purpose necessary to deliver improvement.

## Quantity

One decision to;

- Continue implementation of the plan and schedule for each active Analyse and Improve issue.
- Continue gathering all data required to produce the control charts and capability histograms.

## Quality

All process stability and capability issues shall be dealt with in accordance with the Analyse and Improve process, as specified in the Asset Management Framework design.

## Resources

This task is completed by the responsible for the KPI review.

## Time

Immediately after reviewing a KPI.


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# AI.09 Define / Rank Issue

## Context

If a KPI review identifies that there is either a change to process stability or that a process is not capable, or there is no active Analyse and Improve issue related to this, an investigation must be initiated. Each of the process phases will require leadership, and depending on the significance of the issue, a leader may need to be formally appointed.

When it is decided a leader is to be assigned to investigate a process issue, they will then need to create a work order against which all relevant information pertaining to the analysis of the issue will be kept. The analysis and improvement of process performance always creates important additional knowledge that should be recorded in both a secure and easily accessible work management system.

Once the KPI review process has selected an issue for analysis, the next step is to identify the contributing/root cause(s) of the issue. The first step is to accurately define what the issue is.

A poor definition of the issue can easily jeopardise the investigation. Some common outcomes of poor issue definitions are:

- Dealing with symptoms rather than the root of the problem, eg 'The hydraulic system is overheating' - so install additional oil coolers rather than fix the bypassing cylinder that is creating unnecessary heat; or large rocks are being produced by blasting, so increase the number of holes in the drill pattern, rather than looking at the accuracy of the drilling, or
- Heading down a blind alley, eg 'The hydraulic system is overheating' - so clean or replace the coolers, test the cylinders for bypassing, when in fact the temperature sensor had failed and falsely indicated an over temperature condition.

Correct definition of the issue will lead to a better probability of efficiently removing its cause.

In order to correctly define the issue you must have a clear understanding of the system that is being studied and the measurement that is being used. If these are not clearly understood it will be helpful to;

- create a process flowchart for the system,
- identify the source(s) of the data used in the measurement, and
- identify how that data is processed to produce the measure.

Once the issues have been defined, a relative ranking for each (based on its potential business value) is evaluated so that we can focus resources on the most significant process issues.

It is the natural tendency of people to focus on events and issues that are recent, and hence fresh in their mind. Consequently, an issue that has just occurred will often distract us from a more significant unresolved issue that is less recent.

Not effectively controlling this tendency will mean a lot of time and effort will be wasted trying to pursue too many, constantly changing, priorities. The result is that many significant process issues will not be resolved or not resolved as soon as possible.

## Purpose

To accurately define and rank each process issues to be investigated

## Quantity

One statement defining the issue.

One quantitative measure of the ranking for each process issue.

## Quality

A flowchart of the system being studied should be constructed only to the level of detail necessary to produce and adequate understanding of the issue. Too much detail may become confusing! Start with a simple flowchart and add detail if it becomes necessary. It is generally helpful to construct the flowchart by considering the transformation, transfer or storage steps within the system.

The definition must be based on what is proven with data, not speculation or opinion.

The issue definition statement shall comprise three components;

- What is affected by the issue (Object),
- What exactly is wrong with it (Fault or Opportunity),
- What is the impact of the issue (Consequence).

The relative ranking of each process issue shall be evaluated using a standard evaluation process.

Consider the following criteria;

- Potential benefit to the business.
- Probability of delivering the benefit.
- Cost to deliver.
- Time for benefit achievement.
- Availability of necessary resources.
- Probability of sustaining the benefit.

## Resources

This task is completed by the Investigation Leader.

## Time

As soon as practical after the investigation leader has been appointed and before any detailed investigation of the issue commences.

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# AI.10 Further Investigation Justified?

## Context

It is the natural tendency of people to focus on events and issues that are recent, and hence fresh in their mind. Consequently, an issue that has just occurred will often distract us from a more significant unsolved issue that is less recent.

Not effectively controlling this tendency will mean a lot of time and effort will be wasted trying to pursue too many, constantly changing, priorities. The result is that many significant process issues will not be resolved or not resolved as soon as possible.

To help avoid this tendency, a quantitative measure of the relative ranking of each issue is produced.

If the ranking of a new issue indicates that resources should not be diverted from current activities to further investigate it, then it should be parked for consideration at a future time. If ranking indicates resources should be diverted it may be beneficial to identify a team with the combined characteristics necessary to maximise the probability of a successful outcome.

## Purpose

To select the process issues to which resources will be allocated.

## Quantity

One decision whether to allocate resources to a process issue.

## Quality

Resources should be allocated to the issues with the highest relative ranking.

The decision to proceed with or stop the investigation should be recorded with the Investigation Work Order.

## Resources

This task is completed by the manager responsible for the process.

## Time

After the issue ranking has been determined.

# AI.11 Brainstorm Potential Causes

## Context

Once a performance issue has been approved for investigation, and the team members selected, the next step is to identify the contributing/root cause(s) of the process issue.

Generally a team of knowledgeable people can arrive at more potential causes of an issue quicker than one individual. Brainstorming is a technique that assists a team to identify a wide range of potential causes in a relatively short time.

In order to brainstorm the issue effectively you must have a clear understanding of the system that is being studied and the measurement that is being used. To ensure that these are clearly understood by all of the participants it will be helpful to;

- review or create a process flowchart for the system,
- identify the source(s) of the data used in the measurement, and
- identify how that data is processed to produce the measure.

As the investigation progresses, the potential causes will be ranked tested and validated in order to arrive at the significant Contributing/Root Cause(s).

This task is to develop the broadest possible list of possible causes without passing judgement on them.

## Purpose

To identify all potential contributing causes to an issue

## Quantity

One list of potential contributing causes to the issue.

## Quality

A flowchart of the system being studied should be constructed only to the level of detail necessary to produce and adequate understanding of the issue. Too much detail may become confusing! Start with a simple flowchart and add detail if it becomes necessary. It is generally helpful to construct the flowchart by considering the transformation, transfer or storage steps within the system.

The list of potential contributing causes is to contain potential causes, not potential solutions.

Suggested causes that may be implausible or improbable should not be eliminated at this stage – that will occur later.

Make the definition of the potential cause specific enough that you will remember what it was in several months time. Too often a few words are used and no-one knows what they meant a week later.

A&I Flowsheet

AAOM Flowsheet

### Resources

The Investigation Leader is accountable for this task.

Team members contribute.

### Time

As soon as practical after the investigation has been justified.

# AI.12 Rank Potential Causes

## Context

Brainstorming should result in the identification of many potential causes for an issue. Because the brainstorming process is deliberately free flowing and non judgemental, the list of potential causes generated may include many that have a common theme, or that are similar if not essentially the same.

Identification of these common themes and similarities can make the further investigation easier and quicker. There are a number of techniques, such as fishbone diagrams, affinity tables etc, that can be used to identify and record these themes or similarities.

Before we can conclude which is the significant contributing/root cause(s) of the issue we must collect and evaluate the data necessary to validate whether any of the potential causes is significant. For an issue with a large number of potential causes this may be a lot of work.

In order to make this workload manageable we interpose a step to rank the potential causes from the most to least likely. We then validate from the most probable cause and proceed until we have confidently identified the significant contributing/root cause(s).

## Purpose

To rationally organise and rank the potential causes for an issue from most to least likely.

## Quantity

One list of potential causes in descending order of ranking.

## Quality

For smaller numbers of potential causes and categories fishbone diagrams can be effective for grouping. For a large number an affinity table may be more effective. Suggested causes that are identified to be the same during this process may be grouped into a single definition that captures the essence of the separate suggestions.

In ranking the potential causes consider;

- The probability that it is contributing to the issue.
- The extent that it is contributing to the issue.

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Consider using an exponential weighting system to clearly differentiate potential causes – as per the following table;

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| | | | |
|---|---|---|---|
| Probability | High | 3 | 9 |
| | Low | 1 | 3 |
| | | Low | High |
| | Contribution | | |

Use the knowledge and experience of the team to produce the 'first cut' ranking of the potential causes.

Have each member of the team provide their own valuation of the potential cause. If all team members provide the same value assign that value to the potential cause. If team members provide different value have the team discuss the reasons for their valuation and arrive at a consensus rationale and value. Assign the consensus value to the potential cause.

Rank the potential causes based on the consensus values determined by the team.

### Resources

The Investigation Leader is responsible for this task.

Team members contribute.

### Time

Immediately after the brainstorming of ideas is complete.

# AI.13 Validate or Reject Potential Causes

## Context

Brainstorming should result in the identification of many potential causes for an issue. Even after these have been organised and rationalised there may still be a large number of potential causes.

There is a natural tendency at this point to want to rush into action, that is, make some change to the process based on the causes we have listed. However, at this time none of these potential causes has been proven. A change made where there was no issue will generally make the process perform worse, not better. Before any control action is taken we need to validate that a potential cause is both a real and significant contributor to the process issue we are investigating.

We ranked the potential causes to help reduce the workload required to validate them. We start the validation from the highest ranked cause and proceed until we have confidently identified the significant contributing/root cause(s).

Some common techniques for validating the contribution of a probable cause to an issue include;

- Determining the correlation between the KPI in which the issue was observed and a control measure believed to influence the KPI.
- Producing a Pareto diagram of the measured (actual) impact of the common causes affecting a KPI or control measure.
- Designing and conducting an experiment to test an hypothesis on the cause of the issue.

This task is to specify and collect the data necessary to validate or reject the most probable causes.

## Purpose

To validate the contributing/root cause(s) for a process issue.

## Quantity

One specification for validation data for each probable cause.

One set of validation data for each probable cause.

## Quality

Consider the following;

- Type of data to be collected (is it a measured value, a characteristic, a cause of variation),
- The decision that is required from the data (is the cause real, what is the extent of influence of a cause on a variable),
- Characteristics of the data,
- Potential sources of the data,
- For measured values the quantisation level, based on the minimum value of change that is significant for the variable to be measured.

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- The data sampling/measurement frequency, based on the rate of variation that is likely for the variable to be measured.
- For concurrent causes of variation, the ranking order for causes and the identification of primary and secondary causes.

The discussion paper Quantify Common Causes/Reasons for Asset Performance Loss specifies a method for collecting cause data related to Asset output KPIs. A similar method may be applied to in-process, input and control measures.

Assessment of the correlation between measures and the design of experiments can require expertise. Where such techniques are required ensure that an appropriately skilled resource is utilised.

### Resources

The Investigation Leader is responsible for this task.

Team members contribute.

### Time

As soon as practical after the identification of the probable causes.

# AI.14 Significant Contributing/Root Causes Identified?

## Context

The investigation team ranked the potential causes for a process issue identified during brainstorming from the most to least probable. This was done in the hope of reducing the validation workload by examining the most probable causes first.

A method of measuring, testing or modelling the contribution of each probable cause was devised and executed to provide the data necessary to decide whether the significant contributing/root cause(s) have been identified.

In the event that a significant contributing/root cause cannot be validated from amongst those that were ranked most probable, the team need to continue the validation process working further down the list of ranked potential causes.

If all of the identified potential causes have been tested with data, and no significant contributing/root cause has been identified, the team needs to revisit the brainstorming process to identify more potential causes.

## Purpose

To decide whether the significant contributing/root cause(s) of the process issue have been identified.

## Quantity

One decision whether the validation data has confirmed that the one (or more) of the identified potential cause(s) will substantially deliver the improvement expected in the process.

## Quality

If one, or a few, potential causes account for greater than 50% of the expected benefit identified for the process issue, then these should be identified as significant contributing/root causes.

## Resources

The identification of the significant contributing/root causes is the accountability of the Investigation leader.

## Time

As soon as practical after validation data has been analysed.

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# AI.15 Further Investigation Justified

## Context

If a significant contributing/root cause has been confirmed we will likely have created more data about the impact of the issue during the investigation and validation process. In this case we should use the new data to re-evaluate the impact of the issue (previously done in AI.09 Determine Issue Ranking). If the issue continues to rank high enough then we should proceed to the development of appropriate control actions. However, if the issue ranking is significantly reduced the issue may be put aside or closed in order to deal with higher ranked issues.

## Purpose

To decide, after investigation, whether resources should continue to be allocated to the issue.

## Quantity

One decision whether to continue to allocate resources to a process issue.

## Quality

The ranking identified from the validation data shall be compared to the expected ranking specified during TA AI.10.

If the issue ranking calculated on the validation data is high enough to justify the continued resourcing of the Analyse and Improve process, the issue can be approved to proceed to the development of control actions.

The decision to proceed with or to stop the investigation should be recorded with the Investigation Work Order.

## Resources

This task is completed by the manager responsible for the process.

## Time

As soon as practical after validation data has been analysed.

# AI.16 Brainstorm Potential Control Actions

## Context

Having identified the contributing/root cause(s) of a process issue, and confirmed that continued analysis of the issue is justified, the next step is to identify the appropriate control action(s) to deliver the expected benefit. There is nearly always a great temptation to rush into action, often before we have even validated a cause and certainly once we have. We should always carefully consider all possible control actions, and validate their relative effectiveness and feasibility before finalising the choice of control action.

Generally a team of knowledgeable people can arrive at more potential control actions quicker than one individual. Brainstorming is a technique that assists a team to identify the broadest possible range of potential control actions in a relatively short time. This may require a different set of skills to those required to find the significant/root cause(s) of the issue, and hence may require different resources to be assigned to the task. This may require the appointment of a different leader or team for the development of the control action.

As we progress, the potential control actions will be ranked tested and validated in order to arrive at the most practical control action(s).

This task is to develop the broadest possible list of possible control actions without passing judgement on them.

## Purpose

To identify all control actions with the potential to deal with the contributing/ root cause(s) of a process issue.

## Quantity

One list of potential control actions to deal with the contributing/root cause(s).

## Quality

The list is to contain potential control actions, not symptoms or causes.

Suggested control actions that may be implausible or improbable should not be eliminated at this stage – that will occur later.

Make the definition of the potential control actions specific enough that you will remember what it was in several months time. Too often a few words are used and no-one knows what they meant a week later.

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## Resources

The Control Action Development Leader is accountable for this task.

Team members contribute.

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## Time

As soon as practical after approval to develop control actions is given.

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# AI.17 Define Potential Control Action Implementation Method

## Context

Brainstorming control actions (TA AI.16) will provide a number of potential actions to address the contributing/root cause. These will have to be sorted to determine which are most viable. Identification of common themes and similarities can make the further development of control options quicker and easier. There are a number of techniques, such as fishbone diagrams, affinity tables etc, that can be used to identify and record these themes or similarities. The relative viability of control actions will be determined by factors such as technical difficulty, confidence, cost, implementation time, resource requirements, fit with other current initiatives, and support from other areas of the company. These factors cannot be determined without a basic understanding of the implementation method for the control action.

This activity is to define the implementation method for each potential action in enough detail to be able to make an assessment of the relative viability of each.

## Purpose

To specify the implementation method for each potential control action.

## Quantity

One diagram/data table with unique potential control actions grouped by category.

At least one implementation method for each potential control action.

## Quality

The implementation method specification must at least comprise a brief statement describing how the action will be implemented.

The specification need only provide sufficient detail to compare the viability of alternate control actions.

In specifying implementation methods consider the following:

- the significant steps/stages of the method,
- the sequence of implementing steps/stages.

## Resources

The Control Action Development Leader is responsible for this task.

Team members contribute.

## Time

As soon as practical after the brainstorming of ideas is complete.

# AI.18 Rank Potential Control Actions

## Context

Brainstorming generally results in the identification of many potential control actions for an issue. We have briefly defined the implementation method for the actions in order to allow assessment of the practicality of each.

Before we can conclude which is the most practical control action(s) for the process issue we may have to model, or test the control actions to validate whether they will be feasible and effective. For a cause(s) with a large number of potential control actions this may be a lot of work.

In order to make this workload manageable we interpose a step to rank the potential control actions. We then start the modelling or testing from the highest ranked control action and proceed until we have confidently identified a practical control action(s).

This task is to evaluate the important characteristics of each control action in order to rank them based on practicality.

## Purpose

To select the most practical control action to address the contributing/root cause(s) of a process issue.

## Quantity

One list of possible control actions ranked from most to least practical.

## Quality

In ranking the potential control actions consider;

- The feasibility of the action.
- The extent to which it will deliver the expected benefit (effectiveness).

Consider using an exponential weighting system to clearly differentiate potential control actions – as per the following table;

| | | | |
|---|---|---|---|
| Feasibility | High | 3 | 9 |
| | Low | 1 | 3 |
| | | Low | High |
| | Effectiveness | | |

Use the knowledge and experience of the team to produce the 'first cut' ranking of the potential control actions.

Have each member of the team provide their own valuation of the potential control action. If all team members provide the same value assign that value to the action. If team members provide different values have the team discuss the reasons for their valuation and arrive at a consensus rationale and value. Assign the consensus value to the potential control action.

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Rank the potential control actions based on the consensus values determined by the team.

### Resources

The Control Action Development Leader is responsible for this task.

Team members contribute.

### Time

Immediately after defining potential control action implementation methods.

# AI.19 Model/Test to Validate or Reject Potential Actions

## Context

Brainstorming may result in the identification of many potential control actions for an issue. Even after these have been organised and rationalised there may still be a number of potential actions.

There is a natural tendency at this point to want to rush into action, that is, implement some of the control actions we have listed. However, at this time none of these potential control actions has been proven. An inappropriate action will generally make the process perform worse, not better. Before any control action is taken we need to validate that it will have a positive and a significant contribution to the process issue we are investigating.

We ranked the potential control actions to help reduce the workload required to model/test and validate them. We start the validation from the highest ranked action and proceed until we have confidently identified suitable control action(s).

The validation must be based on data, hence this task is to specify, model and or test the control actions to collect the data necessary to validate or reject a control action as practical or not.

## Purpose

To specify the method of validating each potential control action.

## Quantity

One specification for modelling/testing each high potential control action, to confirm that it is (or is not) the most practical.

One set of validation data for each high potential control action.

## Quality

Consider the following;

- Type of data to be collected (is it a measured value, a characteristic, a cause of variation),
- The decision that is required from the data (what is the impact of the action on a cause and on the KPI of interest),
- Characteristics of the data,
- Potential sources of the data,
- For measured values the quantisation level, based on the minimum value of change that is significant for the variable to be measured.
- The data sampling/measurement frequency, based on the rate of variation that is likely for the variable to be measured.
- For concurrent causes of variation, the ranking order for causes and the identification of primary and secondary causes.

Once completed, collect all necessary data.

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## Resources

The Control Action Development Leader is responsible for this task.

Team members contribute.

Time

As soon as practical after the identification of the potential control actions.

# AI.20 Practical Control Action Identified?

## Context

The potential control actions identified during brainstorming have been ranked from the most to least practical. This was done in the hope of reducing the validation workload by examining the most practical actions first.

A method of measuring, testing or modelling the impact of each control action was devised and executed to provide the data necessary to decide whether a practical control action(s) had been identified.

In the event that a practical control action cannot be validated from amongst those that were ranked most highly, the team need to continue the validation process working further down the list of ranked potential actions.

If all of the identified potential actions have been tested with data, and no practical control action has been identified, the team needs to revisit the brainstorming process to identify more potential control actions.

This task is to decide whether a practical control actions been identified.

## Purpose

To decide if there is a practical control action to implement.

## Quantity

One decision on each potential control action modelled/tested.

## Quality

If one, or a few, potential control actions account for greater than 50% of the expected benefit identified for the process issue, then these should be identified as practical control actions.

## Resources

The identification of the practical control actions is the accountability of the Control Action Development Leader.

## Time

As soon as practical after collection of the validation data.

A&I Flowsheet

AAOM Flowsheet

# AI.21 Control Action Justified?

## Context

If a practical control action(s) has been identified we will likely have created more data about the impact of the issue during the development and validation process. In this case we should use the new data to re-evaluate the impact of the issue (previously done in AI.09 Determine Issue Ranking). If the issue continues to rank high enough then we should proceed to the implementation of the control actions. However, if the issue ranking is significantly reduced the issue may be put aside or closed in order to deal with higher ranked issues.

## Purpose

To decide, after control action development, whether resources should continue to be allocated to the issue.

## Quantity

One decision whether to continue to allocate resources to a process issue.

## Quality

The ranking identified from the validation data shall be compared to the expected ranking specified during TA AI.10.

If the issue ranking calculated on the validation data is high enough to justify the continued resourcing of the Analyse and Improve process, the issue can be approved to proceed to the implementation of control actions.

The decision to proceed with or to stop the investigation should be recorded with the Investigation Work Order.

## Resources

This task is completed by the manager responsible for the process.

## Time

As soon as practical after validation data has been analysed.

INTERNAL

# AI.22 Create Control Action Plan and Schedule

## Context

Once the implementation Control Actions for each cause of a process issue is approved and if appropriate, an Implementation Leader is assigned, work on the control actions can begin. The analysis and improvement of process performance always creates important additional knowledge that should be recorded in both a secure and easily accessible work management system. Any work orders for the implementation of Control Actions should be created as ‘children’ of the appropriate Analyse work order so that we can easily identify the connection between investigation and consequent actions.

Once a Work Order has been created for a Control Action the detailed plan and schedule for the work must be developed. A relatively simple Control Action may be adequately specified, planned and scheduled using a standard work order. However, a complex Control Action with many activities, and/or activities distributed over many weeks or months, will probably require multiple tasks, additional specifications, and project schedules in order to adequately define and control the activities.

After the schedule for the Control Action implementation is developed we have;

- An estimate of the Control Action benefit (from the impact analysis), and
- An estimate of when (and perhaps to what extent for a progressive change) the benefit will be delivered.

This information is fed back through the Set Service Strategy and Set Operating Master Schedule processes to allow the impact of the Control Action to be incorporated into the modelling and forecasting of the asset performance.

This task is about defining and documenting the planning details and schedule for the Control Actions.

## Purpose

To create the planning details and schedule for a control action.

## Quantity

One set of specification documents (plans and schedules) for the Control Action implementation.

A&I Flowsheet

One set of forecasts for strategy/schedule changes provided to the Set Service Strategy and Set Operating Master Schedule processes.

AAOM Flowsheet

## Quality

The detail required in the planning will be determined from the complexity of the Control Action(s). A simple Control Action may be planned by considering a mental checklist of the plan elements and may require minimal documentation prior to commencement. A complex Control Action may require detailed development, preparation and documentation before work can commence.

In addition to the Work Order content specified in TA 16.29 (Create Control Action Work Order), the planning of the work must;

- specify the estimated completion date for the control action (to be entered into the Required Date field of the Work Order), and
- create a separate task for each separately schedulable activity required to deliver the Control Action (the minimum requirement for each task is a description in the form of an action and object).

The Control Action Work Order must also include the following elements, where appropriate (ie they matter);

- potential project hazards and controls,
- isolations required for project work,
- permits (work or change control),
- necessary outcomes,
- acceptance limits on outcomes,
- work procedure where only one work method is acceptable,
- materials,
- labour,
- tools and equipment,
- duration,
- earliest and latest start dates,
- acceptance testing and handover procedures,
- acceptance limits on acceptance tests and handover.

For a complex Control Action, involving a significant number of separately schedulable activities, an overall project schedule may be required to successfully manage all of the tasks required to deliver the Control Action. The schedule should be presented in a tool similar to Microsoft Project. The following should be included:

- The description for each Task,
- The sequencing of Tasks,
- The dependencies between Tasks,
- The start time for Tasks,
- The duration of Tasks,
- The resources assigned to Tasks,
- The critical path for the schedule.

The minimum standards for control action schedule specification is set out the standard Control Action Implementation.

In order to produce a forecast of the impact of the Control Action on the projections for Asset Performance Losses:

- the service strategy details and expected changes to performance and costs arising from implementation of the control actions must be fed through to the Set Service Strategy process, and

- the timing of control action implementation, and hence their effect on performance, must be fed through to the Set Operating Master Schedule process.

## Resources

This task is completed by the Implementation Leader.

## Time

As soon as practical after assignment of the implementation task.


A&I Flowsheet


AAOM Flowsheet

INTERNAL

# AI.23 Resource Control Action

## Context

Once the implementation Control Actions for each cause of a process issue is approved, work can begin. Once a Work Order has been created for a Control Action and the plan and schedule for the work have been developed, resourcing for the Control Action can begin.

For a Control Action to be successful in delivering output targets it must have the necessary resources allocated at the right time in the right way. The processes that deliver materials, special tools and contracted resources to the workplace for the Control Action must therefore ensure that all the specified items will be available for the Scheduled Date of each Action.

Often there will be sufficient flexibility in the resourcing options to ensure that work and resourced using standard arrangements for the acquisition and delivery of materials, special tools and services. In some instances meeting the scheduled start time for a Control Action may require a decision to either approve the expediting of items, or re-allocating resources from other work. In such cases these decisions are escalated to the key stakeholders (those accountable for any potential risks that may arise) for a decision.

## Purpose

To deliver the requirements for the approved control action to be completed at the scheduled time.

## Quantity

One list of resources required to deliver the materials, special tools and services for completing the Approved Control Action.

## Quality

The detail required in resourcing a Control Action will be determined from its complexity. A simple Control Action may be resourced by considering a mental checklist of the plan elements and may require minimal documentation prior to commencement. A complex Control Action may require detailed development, preparation and documentation before work can commence.

For the more complex control actions, consideration needs to be given to the delivery of materials, special tools and services may include the following activities;

- Determining promised supply dates,
- Validating that supply dates will meet the Scheduled Dates for Tasks,
- Collating materials and tools for each work package and Task,
- Delivering materials, tools and services to the specified workplace prior to the scheduled start time for each Task.

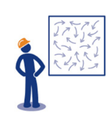
- Checking that the delivered materials, tools and services meet the required specifications for the Task,
- Escalating each item where a supply date will not meet the scheduled start time,
- Expediting supplies when approved to do so, and
- Changing suppliers when appropriate.

## Resources

This task is completed by the Implementation Leader.

## Time

As soon as practical after assignment of the implementation task.


A&I Flowsheet


AAOM Flowsheet

# AI.24 Implement Control Action(s)

## Context

During the regular review of a KPI, it was determined that a process was not performing in a stable or capable manner. Since then, there has been an analysis of the issue, potential causes and control actions have been identified, and work orders, plans and schedules for implementation of the actions have been established.

This task is to execute the control actions.

## Purpose

To implement the approved control actions.

## Quantity

One completed sets of control actions.

## Quality

The control actions shall be delivered to the approved;

- specification,
- schedule, and
- budget.

The work management process should be applied to the management of planning, scheduling and execution for Analyse and Improve work orders.

## Resources

This task is completed by the Implementation Leader

## Time

In accordance with the approved plans and schedule.

# AI.25 Control Actions on Plan & Schedule?

## Context

To ensure that every Analyse and Improve issue meets expectations, and that any threat to the achievement of these is identified and dealt with as early as possible, a process for the regular review of the status of the progress of each issue is required.

A step in this review process is to assess whether each activity necessary for completion of the issue is progressing to schedule.

Failure to stay on schedule could lead to delayed delivery of benefits, increased resources or costs, loss of resources and delay to start of other issues, etc.

This question asks whether the current status of each issue matches the scheduled progress milestones.

## Purpose

To determine if each issue is progressing to schedule.

## Quantity

One decision whether each Analyse and Improve issue is on schedule.

## Quality

A issue is on schedule when:

- Each activity is being completed in the sequence specified in the schedule,
- Each activity is progressing in line with the timeframe specified in the schedule,
- The resources specified in the schedule are engaged on the activity,
- All activities are being executed by the specified method,
- The deliverable(s) for all activities are developing to the quality specifications set for the deliverable.

## Resources

This task is completed by the manager responsible for the process.

## Time

The decision is made during a progress review.

A&I Flowsheet

AAOM Flowsheet

# AI.26 Escalate for Support

## Context

To ensure that every Analyse and Improve issue meets expectations, a review process is required to assess whether each activity is progressing to schedule, and that any threat is identified and dealt with as early as possible. A process for the regular review of the status of the progress of each issue is required as failure to stay on schedule could lead to delayed delivery of benefits, increased resources or costs, loss of resources and delay to start of other issues, etc.

If it is found that the Control Actions will not meet the planned outcomes and scheduled progress, and no viable action can be identified to rectify the issue, then the issue must be escalated to the stakeholders for further support as soon as it is known.

## Purpose

To escalate a Control Action for further support if it cannot meet expected schedule or outcomes.

## Quantity

One communication of the Control Action being escalated to the appropriate stakeholders.

## Quality

This critical issue for the Escalation of the Control Action shall be communicated including

- the Control Action identification,
- the Control Action Description,
- the Scheduled Date and/or Required Date that cannot be met,
- the description of the resources that cannot be delivered, and
- any potential sustainability (ie dealing responsibly with safety, the environment, employees, communities, governments and asset life), output or cost target impact, associated with the delay of the work.

## Time

The Escalation shall be made as soon as it becomes apparent that all options to rectify the outcome and schedule of the Control Action have been exhausted.

## Resources

Escalation is the accountability of the manager responsible for the Control Action.

# AI.27 All Control Actions Complete?

## Context

Each set of control actions were initiated from an issue that affected the performance of a process. Action on the issue was justified on the basis that it was significant to the business and would deliver outcomes/benefits that more than compensated for the cost of undertaking it.

The final steps in any issue are to measure that the anticipated outcomes/ benefits were achieved. If so the issue that initiated the project may be closed. If not, then a new approach to resolving the issue may be needed.

This task asks whether the measured outcomes/benefits meet or exceed the requirements for success set out in the issue justification.

## Purpose

To decide if the outcomes/benefits have been realised.

## Quantity

One comparison of expected and measured outcome/benefit for each control action.

## Quality

The outcomes/benefits should meet or exceed the requirements for success set out in the issue justification and validated at AI.19 .

If the expected outcomes/benefits have not been met the issue is referred back to the start of the investigation phase to determine if further investigation is justified.

## Resources

This decision is the accountability of the manager responsible for the process.

## Time

As soon as practical after measurement of the project outcomes/benefits

A&I Flowsheet

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Real Mining. Real People. Real Difference.

# OPERATING MODEL

# MANAGEMENT ROUTINES

December 2019

AAOM Flowsheet

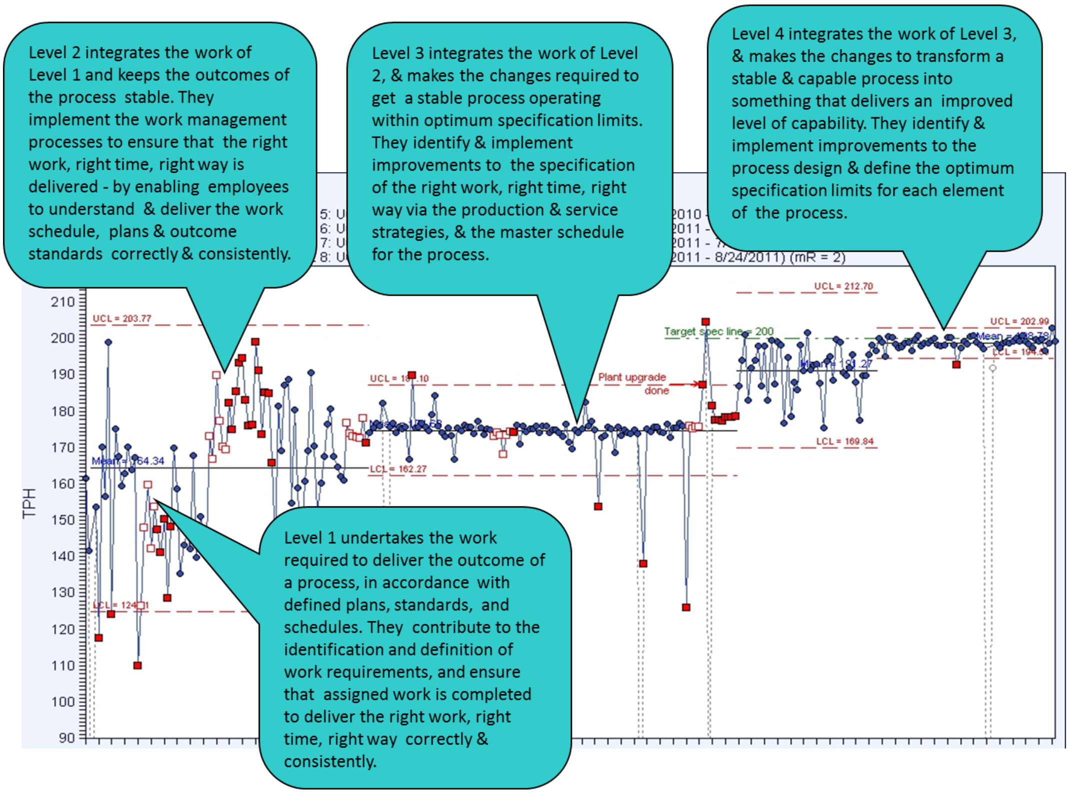
# Table of Contents

## 1. MANAGEMENT ROUTINES CONTEXT

The Business Process Framework (BPF) provides a comprehensive specification of the actions and decisions that are required for the definition, programming and execution of the work needed to successfully operate a process. These specifications are set out in the Flowsheets and Task Assignments of the BPF documentation. This information defines a significant part of the work of the various Roles working in a process.

The BPF design covers both the routine work of the Roles (Operational Planning, Work Management and Process Performance Review), and the non-routine work that is involved in the Analyse and Improve activities (Issue Investigation, Control Action Development, Control Action Specification and Issue Progress Review).

The significant elements of the work of management roles is the integration of the work of their subordinates and application of the Analyse and Improve process, as illustrated in the following diagram;




Application of the BPF delivers greatly improved clarity of role accountabilities, authorities and boundaries of discretion, reducing the time that managers must allocate to integrating the work of roles. The significant integration accountabilities are also defined in the BPF process. Therefore, a significant portion of the time of a manager should now be spent in either following the A&I process steps as personal work to improve the process, or in leading teams in process improvement activities.
The BPF is based on the Requisite Organisation principle of identifying unique accountability for each measurable outcome - an individual can have more than one accountability, but two people cannot have the same accountability.

Every action and decision of the BPF flow sheets is an individual role accountability, the performance of which must be reviewed by their manager. In the context of the BPF an Accountability is defined as a measurable outcome (usually a purpose or theory measure in a Value Stream Map or Value driver Tree) for which the Role has unique authority to take decisions or actions. There are also some instances where different role Accountabilities directly connect, and some situations where teams may be involved in supporting the A&I activities of a role.

A basic principle of the BPF is that individual work does not require a meeting, and most of the BPF actions and decisions are individual work. While the accountability for each TA is unique, there are times when a meeting may be appropriate. The BPF specifies only four circumstances that may require a meeting;

- Communication meetings – a meeting of interested parties where a common message is to be communicated efficiently.
- Cross over accountability action/decision integration – a meeting of Accountability holders when an action or decision is likely to affect more than a single role holder's Accountability.
- Problem Solving – A meeting of people with knowledge, experience or skill that is relevant to a specific process issue currently undergoing performance review, for the purpose of supporting the accountable role holder in their process improvement activities.
- Management of Performance – a one on one meeting to manage performance of the accountabilities of an individual.

The BPF defines a set of guidelines for these key interactions - these are referred to as Management Routines. They include:

- Work Management and Operational Planning communication;
  - Crew Start of Shift Meeting
  - Crew Schedule Review Meeting
  - Communication of Business Expectations
- Work Management and Operational Planning action/decision integration;
  - Pre-shift Supervisor's Meeting
  - Area Schedule Review
  - Scenario Review
  - Operating Master Schedule and Expenditure Schedule Review
- A&I team leadership;
  - Issue Investigation.
  - Control Action Development.
  - Control Action Specification.
  - Issue Progress Review.
- Management of performance;
  - Accountability Review.
  - Crew Follow-up.
- General Communications;
  - Management Communication.

# 2. WORK MANAGEMENT & OPERATIONAL PLANNING COMMUNICATION

## 2.1 CREW START OF SHIFT MEETING

### 2.1.1 Context

A Supervisor and crew have the accountability for safely completing all scheduled work, plus urgent work requests, on time and to specification. Achievement of this purpose is fundamental to the theory of the Operating Model and hence to the delivery of the purpose of the process on which the work is being completed.

Further, it is an accountability of each Supervisor to ensure that every Crew Member commences their work shift with an understanding of;

- any activity within, or affecting, the business that will be of interest to the Crew Members,
- what is expected to happen within their work environment during the shift,
- any unusual circumstances that might be present during the shift, and
- what work will be assigned to them during the shift.

In order to complete work safely, to specification and on time, a Crew Member must, as a minimum, understand the;

- context and purpose for the work,
- location of the work,
- requirements for safely executing the work,
- outcomes and specifications (planning elements) for the work,
- resources required and available to them for the work, and
- time in which the work must be completed.

The Supervisor assigning Tasks must also ensure that the requirements of the work, and the knowledge, experience and skills of the individuals assigned to the work are matched.

The Supervisor must ensure that all the above is communicated to and understood by the Crew Member(s) reporting to them.

The Crew Member(s) assigned to work must ensure that all of this is understood, and that assigned work can be completed by them.

An important outcome of the task assignment process is also connected to “The Three Questions”:

1. What do you want me to do?
2. How am I doing?
3. What is my future?

When individuals are able to answer these questions at work, they are able to concentrate on their work and give the best they’ve got. The start of shift conversations that occur are an important component of helping the Crew Member understand the answer to “What do you want me to do?”. They contribute to clear task assignments, clarity around role relationships (including authority) and strategy (how their work fits with others’ and the wider business strategy).

Work is assigned to Crew Members at the start of each new shift. This Task Assignment sets out the specifications for the Crew Start of Shift Meeting, in which the above communications occur.

### 2.1.2 Purpose

To provide the information necessary for Crew Members to have a successful shift.

### 2.1.3 Quantity

One meeting between each Supervisor and the Crew Members reporting to them for a shift.

### 2.1.4 Quality

Prior to the Crew Start of Shift Meeting, the Supervisor must obtain the following information for the shift;

- relevant safety message(s),
- operational situation and expectations,
- operating pattern (equipment operating and shutdown during the shift),
- significant activities in other areas and work teams,
- the work for the crew for this shift.

The Supervisor must review the schedule and determined that it can be completed.

Use the key principles and guidelines consistent with Systems Leadership.

The meeting shall be conducted in a venue that provides comfortable, undisturbed conditions.

### 2.1.5 Resources

This task is completed by the Supervisor and members of each crew accountable for executing work.

The meeting is chaired by the Supervisor.

### 2.1.6 Time

At the start of each work shift but after the Pre-Shift Supervisor’s Meeting.

The meeting should take no more than 15 to 30 minutes.

**Meeting Agenda**

**Safety:**

*Purpose: To provide information that will assist Crew Members to identify and control hazards.*

- cascade any specific safety message,
- communicate any relevant incidents from previous shift(s),

- update crew on any non-standard workplace conditions,
- remind Crew Members to use their existing safety tools over the course of the shift.

**Cascaded information:**

*Purpose; To ensure Crew Members have up-to-date, relevant business information.*

- cascade information that may be of interest to the crew (e.g. outside events potentially affecting the company, company initiatives, site visitors, unusual plant activities etc).
- communicate
  - operational situation and shift expectations,
  - operating pattern (equipment operating and shutdown during the shift),
  - any non-standard operating situations.
- update crew on activities in their work area since their last shift (particularly important on first shift, after days off).

**Work Assignment:**

*Purpose; To complete an effective task assignment for all work required for the shift.*

- Nominate the 'Rapid Response' personnel for the shift.
- assign all work packages for the shift to the appropriate Crew Members,
- allow Crew Members to review the work package content,
- discuss work assignment with individual Crew Members;
  - context and purpose of work,
  - critical issues,
  - Crew Members contributions and clarifications,
  - decisions and actions necessary to proceed (can either be resolved immediately or a time for follow-up decided).
- Crew Member confirms that:
  - each work package is adequately specified,
  - the work will deliver the expected outcomes,
  - all elements of the work package are understood, and
  - all requirements of the or work package can be completed to specification.
- remind Crew Member to inform the Supervisor as soon as they know if the work cannot be completed as assigned.

**Outcomes from the Meeting:**

At the end of the meeting, the Supervisor has confidence that every Crew Member understands what work is expected during the shift and when it needs to be done. Outstanding questions from Crew Members are addressed outside the meeting at the agreed time.

At the end of the meeting, the Crew Member has confidence that they understand what is expected from them and feel that any contributions they had during the meeting were heard. If they have further questions – they have time booked with the Supervisor to clarify.

## 2.2 CREW SCHEDULE REVIEW MEETING

### 2.2.1 Context

A Supervisor and crew have the accountability for safely completing all scheduled work, plus urgent work requests, on time and to specification. Achievement of this purpose is fundamental to the theory of the Operating Model and hence to the delivery of the purpose of the process on which the work is being completed.

Each Supervisor and crew have knowledge of the workplace, and experience in completing their work, that is not present in any other roles. It is therefore prudent to ensure that this knowledge and experience is drawn on to optimise the planning and scheduling of work.

There are three points in the life cycle of work where this knowledge and experience are specifically tapped.

The first point is during the identification and reporting of work requirements. Crew Members are requested to record all work requirements that can be identified during the course of completing their assigned work, or during their movement about the workplace. All such work is reported through a work request, where Crew Members provide as much planning information for the identified work as can be gathered from their observations. The Supervisor is required to review and add to this information where necessary.

The second point is during the planning process. No Planner can provide all of the knowledge, experience and capacity to develop quality work packages for all work at all times. The Supervisor and crew are an ideal resource to utilise in circumstances where the Planner lacks the necessary knowledge, experience and capacity. In this case the Planner raises a task within the Work Order for the purposes of specifying the type of planning input required and scheduling the allocation of resources to compete that planning in time for the scheduled execution of the work.

The third point is as the schedule of approved work is being developed. The Scheduler builds the schedule by;

- assigning all work, a Scheduled Start Date ahead of its Required Date,
- utilising synergies and resolving conflicts between work packages, and
- optimising the use of plant and resources.

A regular review of the developing schedule by the Supervisor and crew will allow them to identify ways to further optimise the schedule, to recognise potential critical issues that will prevent the schedule being achieved, and to suggest how to deal with those issues.

To ensure that this third contribution from the Supervisor and crew occurs, a regular review of the draft schedule is conducted by each Supervisor and their crew. This Task Assignment sets out the specifications for that review.

### 2.2.2 Purpose

To gather crew (including its Supervisor) input for the development of the schedule.

### 2.2.3 Quantity

One meeting to review the draft work schedule per scheduling period for each Supervisor / Crew.

### 2.2.4 Quality

The draft schedule shall be clearly visible to the Supervisor and all crew members.

The draft schedule shall include all work for which the Supervisor is directly accountable plus all work that the crew members will be required to execute.

Prior to the start of the meeting, the Supervisor will:

- Have reviewed the Schedule/Task Status Report, highlighting significant activities – both within their area and outside the area that may affect the crew's ability to deliver the schedule.
- Understand the expected operating pattern for the coming weeks (operating, shutdown periods),
- Have had discussions with the Scheduler – understanding the critical issues already recognised for the schedule and intended controls.
- Have up to date versions of the Schedule/Task Status Report.

Use the key principles and guidelines  consistent with Systems Leadership.

The meeting shall be conducted in a venue that provides comfortable, undisturbed conditions and suitable means of displaying the schedule for all to see.
Use the meeting agenda;

### 2.2.5 Resources

This task is completed by the Supervisor and members of each crew accountable for executing work.

The meeting is chaired by the Supervisor.

Scheduler (if available)

### 2.2.6 Time

The review of the draft schedule shall be conducted at;

- the day prior to the Area Scheduling meeting for crews working a fixed shift pattern, or
- at the start of one shift during each block of shifts for crews working rotating shifts.

The meeting should take no more than 15 to 30 minutes.

**Meeting Agenda**

**Context:**

- Explain the context in which the schedule will be executed. This may include;
    - operational situation and expectations,
    - operating pattern (operating, shutdown periods),
    - significant activities in other areas and work teams.

**Content Review:**

- Identify and discuss significant work within the schedule with the crew.
- Identify critical issues already recognised for the schedule and explain intended controls.
- Ask for contributions from the crew. This may include suggestions;

  - to optimise synergies and conflicts between work,
  - for optimising plant and resource usage,
  - of additional critical issues, and
  - for improved or additional control actions.

**Decisions and Actions*:***

- After discussion with the crew, the Supervisor shall make decisions on what suggestions to take back to the Scheduler and shall advise the Crew Members of those decisions.
- If the Scheduler is not present at the review (and this may not be possible if several crew reviews occur concurrently) the Supervisor shall record the decisions and discuss them with the Scheduler (as per TA ***SC.10 Document Suggestions***).

**Outcomes from the Meeting**

At the end of the meeting, the Supervisor will be prepared to;

- Communicate relevant information to the Scheduler based on this crew input:
  - suggestions received for optimisation of the schedule, and
  - suggestions received for managing potential critical issues for completion of the schedule.
- Have any follow-up discussions with Crew Members where input was not incorporated into the feedback – including the rationale

## 2.3 COMMUNICATION OF BUSINESS EXPECTATIONS

### 2.3.1 Context

Business Expectations are ultimately defined by the expectations of the many stakeholders of that business. These may include shareholders, employees, communities, regulators and others affected by the presence of that business. It is the role of the executive levels of the business to understand, balance and integrate these many expectations. In the Business Process Framework these expectations are summarised in three areas of measurable performance; sustainability, effectiveness and efficiency.

Targets for each of these areas need to have a; specification, confidence expectation and time horizon for achievement of the target confidence because of the inevitable presence of variation in the performance of any Business Unit or Operation.

Business conditions and therefore Business Expectations are not constant but are affected by many economic, social and political variables. In setting Business Expectations executives must understand the external conditions that shape product demand, costs, price etc over the most likely economic cycles of the communities in which the organisation operates.

Cycle movements would typically lead to a different level or balance of Business Expectations if value creation is to be optimised. Therefore, the work of the executive is to define the:

- suite of operating scenarios that would best characterise the economic cycle,
- scenario that each Operation should be implementing under the current and near forecast economic conditions, and

- time when an operation should be transitioning between operating scenarios.

It is the role of operations management to understand the capabilities of the various elements of the operation and to;

- develop Production, Service and resourcing strategies that optimise value creation for each of the operating scenarios.
- develop strategies and plans for optimum transition between operating scenarios, and,
- implement and transition between operating scenarios to deliver the Business Expectations.

Communication of relevant message to many stakeholders is a situation where these of a meeting is appropriate.

### 2.3.2 Purpose

To provide a set of Business Expectation scenarios for the next 5+ years.

### 2.3.3 Quantity

One meeting held quarterly and/or whenever there are changing business expectations. The meeting should communicate;

- The current economic cycle forecast.
- Any changes to the operating scenarios that the Operations management are accountable for incorporating in their Operational Planning work.
- Any changes to made to the active operating scenario.

### 2.3.4 Quality

Provide Business Expectations for the next 5+ years in terms of:

- Sustainability – Safety, Environment, Health, People, Socio-Political, Asset Integrity, License to operate, Stockpile requirements
- Effectiveness - Output units on spec per time period
- Efficiency - Unit Cost, ROI etc

All targets shall include a

- Specification,
- Confidence Level, and
- Time horizon for assessment.

Operating Scenarios for an Operation should define the range of expectations for;

- Product volumes
- Product quality, and
- Operating costs.

### 2.3.5 Resources

Communication is between Business Unit Executive(s) and General Manager

#### 2.3.6 Time

Every quarter and/or whenever there are changing business expectations
The meeting should take no more than 2 hours.

**Meeting Agenda**

The meeting shall be chaired by the Executive.

**Safety:** Purpose: To discuss relevant safety topic in current month and next period.

**Review Business Expectations**

- Review business expectations and confidence levels for the coming business planning cycle.

**Review Critical Issues and action options**

**Decide selected option.**

- Agree business expectations

**Agree Business Expectations**

## 3. WORK MANAGEMENT ACTION/DECISION INTEGRATION

### 3.1 PRE SHIFT SUPERVISOR'S MEETING

#### 3.1.1 Context

All Supervisors working within a common workplace must share a common understanding of the scheduled and unscheduled activities for the shift.
The committed schedule is the foundation of that common understanding, but in the real world some variations to the timing and content of the work for each shift will occur. It is important that any variations that may affect other work groups are communicated and where necessary actions to deal with the variations agreed. A pre-shift meeting, chaired by the designated Supervisor, and attended by other Supervisors in the area provides the opportunity to maintain alignment between areas.
Supervisors have the first opportunity to agree on the appropriate actions and can escalate any significant or unresolved issues to the department heads.

This Task Assignment sets out the specifications for the Pre-shift Supervisor's meeting, in which the above communications occur.

#### 3.1.2 Purpose

To provide the information necessary for multiple work teams operating within a common area to maintain alignment to the completion of the committed schedule.

### 3.1.3 Quantity

One meeting held at the start of each shift in each area.

### 3.1.4 Quality

In this context, an area is all or a portion of a plant that is strongly integrated – where work on one equipment/workplace often has impact on another equipment/workplace. Its scope is defined during the configuration discussions.

Prior to the start of the meeting, the Supervisor will:

- Have reviewed the previous shifts' activities and any incident reports.
- Have reviewed the Schedule/Task Status Report.
- Understand any new work identified and have determined the appropriate actions within their span of discretion.
- Understand where tasks were not completed per schedule and have determined the appropriate actions within their span of discretion.
- Have up to date versions of the Schedule/Task Status Report.

Use the key principles and guidelines consistent with Systems Leadership.

### 3.1.5 Resources

This task is completed by all Supervisors working within an area.

### 3.1.6 Time

At the start of each shift, prior to the Crew Start of Shift Meeting.

The meeting should take no more than 15 minutes.

The meeting shall be conducted in a venue that provides comfortable, undisturbed conditions.

**Meeting Agenda**

The meeting shall be chaired by one of the Supervisors (the chair may be rotated if appropriate).

**Safety:**

*Purpose: To gain alignment in the safety conversations to be had across all areas for the shift that will assist in the crew's ability to identify and control hazards.*

- Chair leads a discussion including:
    - Relevant incidents from previous shift(s).
    - Non-standard workplace conditions.
    - Safety message to be presented to crews.

**Urgent work review:**

*Purpose: To manage critical issues arising from urgent work that has to be completed.*

- Prior to this meeting, each Supervisor has already identified new Urgent work and determined intended actions where the issues (and resolution) are within their span of discretion. In the event that either the issue or its resolution has a cross functional impact, a discussion needs to be held with all those affected to determine the appropriate action.
- Chair leads a discussion including:
  - Identification of new Urgent Work with a cross functional impact.
  - Reach agreement on proposed actions.

**Schedule Review:**

*Purpose: To manage critical issues arising from variations from the committed schedule.*

- Prior to this meeting, each Supervisor has already identified schedule variations and determined intended actions where the variation (and resolution) are within their span of discretion. In the event that either the issue or its resolution has a cross functional impact, a discussion needs to be held with all those affected to determine the appropriate action.
- Chair leads a discussion including:
  - Current variations from schedule.
  - Impacts on schedule arising from Urgent Work.
  - Who will be affected by the changes.
  - Any cross functional schedule changes required.
  - Will the changes result in any tasks missing their required dates?
  - Are the resources (workplace, people, materials, equipment and time) required to deliver on an adjusted schedule available?
  - Will the proposed changes affect operational performance for the Schedule Period?

**Unresolved issues**:

*Purpose: To identify issues that need to be escalated.*

- Items to be escalated may include:
  - Requirements for additional resources.
  - Tasks that may miss their Required Dates.

Impacts on operational performance for the Schedule Period.
Issues outside the span of discretion of the Supervisors – for example, procurement issues.

**Outcomes from the Meeting**:

At the end of the meeting, each Supervisor will be prepared to;
Make essential adjustments to their schedule for the shift.
Conduct the Start of Shift Crew meeting.
Escalate critical issues requiring assistance.

## 3.2 AREA SCHEDULE REVIEW MEETING

### 3.2.1 Context

The Work Management Scheduling process has the purpose of allocating resources (Workplace/Equipment, time, labour, specialised tools & equipment etc) so that all approved work is completed by the Right Time.

Building an execution schedule that delivers this purpose requires the following information;
- where the work will occur (Workplace or Equipment)
- when the work must be completed (Required Date)
- the Duration of the work
- Earliest and Latest Start Dates/Times
- Conditions and Constraints on the work (operating, shutdown, full or empty, etc)
- dependencies between work packages and activities
- labour, equipment, materials and specialised tools required
- the forecast of labour, equipment, materials and specialised tools availability
- the Routine Operating Schedule (ROS) that underpins the approved approach to delivering performance targets

In the business process all of the above information is provided from the processes that surround and support scheduling, ie;
- the ROS,
- the Work Scheduling System (WSS),
- Work Group capacity planning,
- Work Approval, and
- Planning.

This information defines the boundaries of discretion for a person to build an execution schedule.

If all of this information is made available from these processes, at the right time and to the right standard, then one person can resolve conflicts, optimise potential synergies, allocate time, space and resources to develop an effective execution schedule. It does not take a team or a meeting to build a schedule. It takes a team to provide the necessary information.

In most cases a Scheduler (the individual assigned to build the execution schedule) can do it to a very high standard. However, there is always the possibility that there will be a few Critical Issues where there are conflicts and issues that cannot be resolved with the boundaries of discretion defined by the above data. Critical issues may include;
- labour, equipment or specialised tools availability does not match the requirements of the schedule,
- work cannot be set out in space and time to match the ROS constraints,
- materials and contract services availability do not match the requirements of the schedule.

**Note**, Scheduling work to be completed beyond it's Required Date will not be a critical issue in the draft execution schedule, because the Scheduler does not have the authority to allow this.

Managing critical issues will involve decisions around changing resource availability, varying the ROS or accepting some degree of risk if some work is not completed by the Required Date. In every case one role in the management team will have the accountability for the consequences, and hence for the decision. However there may be alternative options or consequences that may require contributions or decisions from more than one role holder.

An ***Area Schedule Review Meeting*** provides the forum for the critical issues for an execution schedule to be raised with the appropriate role holders, for alternative options to manage the critical issues to be discussed, and for actions and residual risks to be defined and approved by the accountable persons.

### 3.2.2 Purpose

To decide on the actions/risks to deal with critical issues for the execution schedule.

### 3.2.3 Quantity

One meeting held prior to the start of each scheduling period.

### 3.2.4 Quality

In this context, an area is all or a portion of a plant that is strongly integrated – where work on one equipment/workplace often has impact on another equipment/workplace. It's scope is defined during the configuration discussions.

Use the meeting agenda appended to this Task Assignment.

Prior to the start of the meeting (with sufficient time to permit adequate review), the Scheduler will:

- Confirm required attendees – those who can contribute to the discussion and make recommendations as well as those who are accountable to make the decisions.
- Construct the meeting agenda – comprising of outstanding critical issues and options.
- Distribute the meeting agenda to allow participants to consider and consult on the meeting content.

Discussion should be confined to the critical issues, options, decisions and follow-up actions.

The meeting shall be conducted in a venue that provides comfortable and undisturbed conditions.

Use the key principles and guidelines consistent with Systems Leadership.

### 3.2.5 Resources

Scheduler

All role holders with accountability for the decisions and actions that are likely to arise from the meeting (as indicated by the agenda options) should attend.

### 3.2.6 Time

The Area Schedule Review Meeting shall be held;

- prior to the end of the current schedule period, and

- allowing sufficient time to complete actions required to finalise the next schedule period before it commences.

The meeting should typically take no more than 15 to 30 minutes.

**Meeting Agenda**

The meeting shall be chaired by the Scheduler (the individual accountable for building the execution schedule).

**Context**:

- Explain the context in which the schedule will be executed. This may include;
  - operational situation and expectations,
  - operating pattern (operating, shutdown periods),
  - significant activities in other areas and work teams.

**Content Review:**

- Communicate significant and/or unusual work within the schedule that may create abnormal workplace situations and/or affect multiple work groups within the area.
- Identify critical issues recognised in the schedule and explain possible options to resolve them.
- Ask for contributions regarding critical issue controls.

**Decisions and Actions:**

- After discussion of critical issues and control options, the accountable role(s) shall make decisions on the actions to be taken and or risks to be accepted.
- Decisions and actions shall be noted and recorded in the minutes of the meeting.

**Outcomes from the Meeting:**

At the end of the meeting, the Scheduler will:

- Document decisions/actions on how critical issues will be managed (in meeting minutes).
- Adjust the schedule based on the discussions.

## 3.3 SCENARIO REVIEW MEETING

### 3.3.1 Context

The management team for an Operation (the General Manager and Heads of Department) have accountabilities to define the performance targets for each department and to develop the Production and Service strategies, resourcing strategies and transition plans for the Operating Scenarios defined by the business executive.

The work of the General Manager is to translate Operating Scenario expectations into performance targets for each element of the Operation and to integrate the work of the HODs. The work of the HOD is to develop Production, Service and resourcing strategies that deliver the Performance targets set for the department. Most of this work is individual work, with consultation and contribution sought and provided as needed. The exception is the activity of integrating the HOD outputs.

The independent work of the role holders should be monitored, and coaching provided, within the Accountability Review process.

When it comes to integration of the HOD work there will be areas of interdependence between the Production, Service and resourcing options for departments. This creates the potential for conflict between the optimum choice for one department and that for another. This is similar to the situation in Work Management where the accountable roles are trying to optimize an Execution Schedule that integrates the work of more than one area. This creates the situation where decisions that affect more than one accountability must be made in order to resolve critical issues for effective Operating Scenario development.

Resolution of crossover accountability issues is an area where use of a meeting is appropriate.

### 3.3.2 Purpose

To decide on the actions/risks to deal with critical issues for Operating Scenarios.

### 3.3.3 Quantity

- One meeting agenda setting out critical issues and options.
- One meeting to review the critical issues and options.
- One record of decisions/actions on how critical issues will be managed.

### 3.3.4 Quality

- Use the meeting agenda appended to this Task Assignment.
- The meeting agenda should be distributed ahead of the meeting to allow participants to consider and consult on the meeting content.
- Discussion should be confined to the critical issues, options, decisions and follow-up actions.
- The meeting shall be conducted in a venue that provides comfortable and undisturbed conditions.

### 3.3.5 Resources

This review is completed by the General Manager of the Operation and Head of Departments participate.

### 3.3.6 Time

Every quarter and whenever there are changing business expectations
The meeting should take no more than 2 hours.

### Meeting Agenda

The meeting shall be chaired by the General Manager of the Operation.

**Safety:** Purpose: To discuss relevant safety topic in current month and next period.

**Review Performance Targets**

- Review performance targets for each scenario

**Review Critical Issues and action options**

- Each scenario must be modelled in the Business Performance Structure model

**Decide selected option.**

- Agree and approved operating scenarios.

**Agree Performance Targets**
Lock-in performance targets for each productive unit

## 3.4 OPERATING MASTER SCHEDULE & EXPENDITURE SCHEDULE REVIEW

### 3.4.1 Context

At any point in time the management team for an Operation should be implementing the Operating Scenario that is optimal for the business conditions specified by the executive.

The Operating Master Schedule (OMS), and Expenditure Scheduled (EPS) represent the implementation of a given Operating Scenario. They are similar to the route calculated between your current position and your desired destination by a car GPS. As the GPS route shows the optimum roads, distances, speeds and turns over time, The OMS and EPS show the key Activities, durations, rates, product and dependencies over time.

The GPS route has very limited value if it is not updated with current position as the journey progresses. So also the OMS and EPS are of limited value if they are not updated over time with the actual Activity timing, outcomes and cost information.

As the GPS position is updated the software checks whether the vehicle is on the correct track to the desired destination at the estimated arrival time. If not, it will update the route directions and if necessary, the estimated arrival time. It is quite possible that the route may not change but the estimated arrival time does, or the route changes but the estimated arrival time does not, or both may change. The need for change will depend on the accuracy of route execution, the actual vs estimated car speed, and the time buffer included in the route calculation. Similarly, the accountable HOD needs to monitor the actual performance against the approved OMS/EPS. The HOD must decide if any changes to the forward OMS/EPS are required, are practical and if so whether the forecast outcomes and costs for a measurement/reporting period will need to be amended.

The independent work of the role holders should be monitored, and coaching provided, within the Accountability Review process.

When it comes to integration of the HOD work there will be areas of interdependence between the OMS/EPS for departments. This creates the potential for conflict between the optimum choices for one department and that for another. This is similar to the situation in Work Management where the accountable roles are trying to optimize an Execution Schedule that integrates the work of more than one area. This creates the situation where decisions that affect more than one accountability must be made in order to resolve critical issues for an effective OMS/EPS update.

Resolution of crossover accountability issues is an area where use of a meeting is appropriate.

### 3.4.2 Purpose

To maintain a realistic OMS/EPS forecast.

### 3.4.3 Quantity

- One meeting agenda setting out critical issues and options.
- One meeting to review the critical issues and options.
- One record of decisions/actions on how critical issues will be managed.
- OMS/EPS updated as per critical issue resolution decisions.
- Escalation of significant OMS/EPS variations when identified.

### 3.4.4 Quality

- Use the meeting agenda appended to this Task Assignment.
- The meeting agenda should be distributed ahead of the meeting to allow participants to consider and consult on the meeting content.
- Discussion should be confined to the critical issues, options, decisions and follow-up actions.
- The meeting shall be conducted in a venue that provides comfortable and undisturbed conditions.

### 3.4.5 Resources

This review is completed by the General Manager and Heads of Department accountable for each Service Strategy function i.e. Human Resources, Social Performance, Supply Chain, Finance, Protection Services, Safety, Health and Environment, Information Management, Engineering and Asset Management etc.

### 3.4.6 Time

OMS and EPS reviewed monthly.
The review shall be no more than 2 hours.

**Meeting Agenda**

The meeting agenda shall be prepared by the General Manager and the meeting shall be chaired by the General Manager.

**Safety:** Purpose; To discuss relevant safety topic in current month and next period.

**Review actual vs forecast OMS/EPS major features**

- Review the actual vs. forecast OMS Activities schedule and forecast capability (histogram, month & YTD).

**Review Critical Issues and action options**

- Each option must modelled as an updated Activity Schedule OMS/EPS forecast.

**Decide selected option.**

- Agree OMS/EPS changes within the allowed boundaries of discretion for the approved operating scenarios.
- Escalate OMS/EPS changes outside the allowed boundaries of discretion for the approved operating scenarios

**Agree updated OMS/EPS**

- Lock-in an accepted OMS/EPS.

# 4. A&I TEAM LEADERSHIP

## 4.1 ISSUE INVESTIGATION

**PERFORMANCE ISSUE INVESTIGATION**

| Document ID | Equipment | Work Order Number |
|---|---|---|
| | | |

**Workshop Date:** **Workshop Leader:**

**Issue Definition:**

The issue definition must include the;

- Outcome (measure that is affected),
- Type of issue that is evident (e.g. unstable, multi-model, excessive variation, level of performance) and is to be investigated, and
- Consequence/opportunity (the result of the issue, which may be good or bad).

The issue definition must be based on what is proven, not opinion.

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**Impact Analysis:**
Complete the following table to evaluate the potential impact of dealing with the Issue.

| Dimension | Low =1 | Medium = 3 | High = 9 | Rating |
|---|---|---|---|---|
| Benefit to the business. | Less than $10,000 pa. | Less than $100,000 pa. | Greater than $100,000 pa. | |
| Probability of delivering the bene | Less than 40%. | Less than 80%. | Greater than 80%. | |
| Cost to implement controls. | Greater than $100,000. | Greater than $10,000. | Less than $10,000. | |
| Time for benefit achievement. | Greater than 12 months. | Greater than 3 months. | Less than 3 months. | |
| Resourcing. | Difficult to commit. | Rearrangement of Priorities required. | Readily available. | |
| Probability of susta ing the benefit. | Less than 40%. | Less than 80%. | Greater than 80%. | |
| **Overall Rating** (sum of element ratings). | | | | |

**Impact Review**

Consider the impact of dealing with this Issue in relation to the other process improvement priorities.

*Recommendation:* No Further Action ☐ Investigate ☐

| Recommendation Approved by: (Print name) | Signature: | Date: |
|---|---|---|
| | | / / |

If the recommendation is no further action on this Issue then do not complete any more of this form. Attach the completed sections of the form to the Process Review Checklist from which the investigation was initiated and to the Analyse Work Order.

If the recommended action is to analyse this Issue then proceed to form an Analysis Team and complete the following sections of the form.

| Team Members | Department | Job Role |
|---|---|---|
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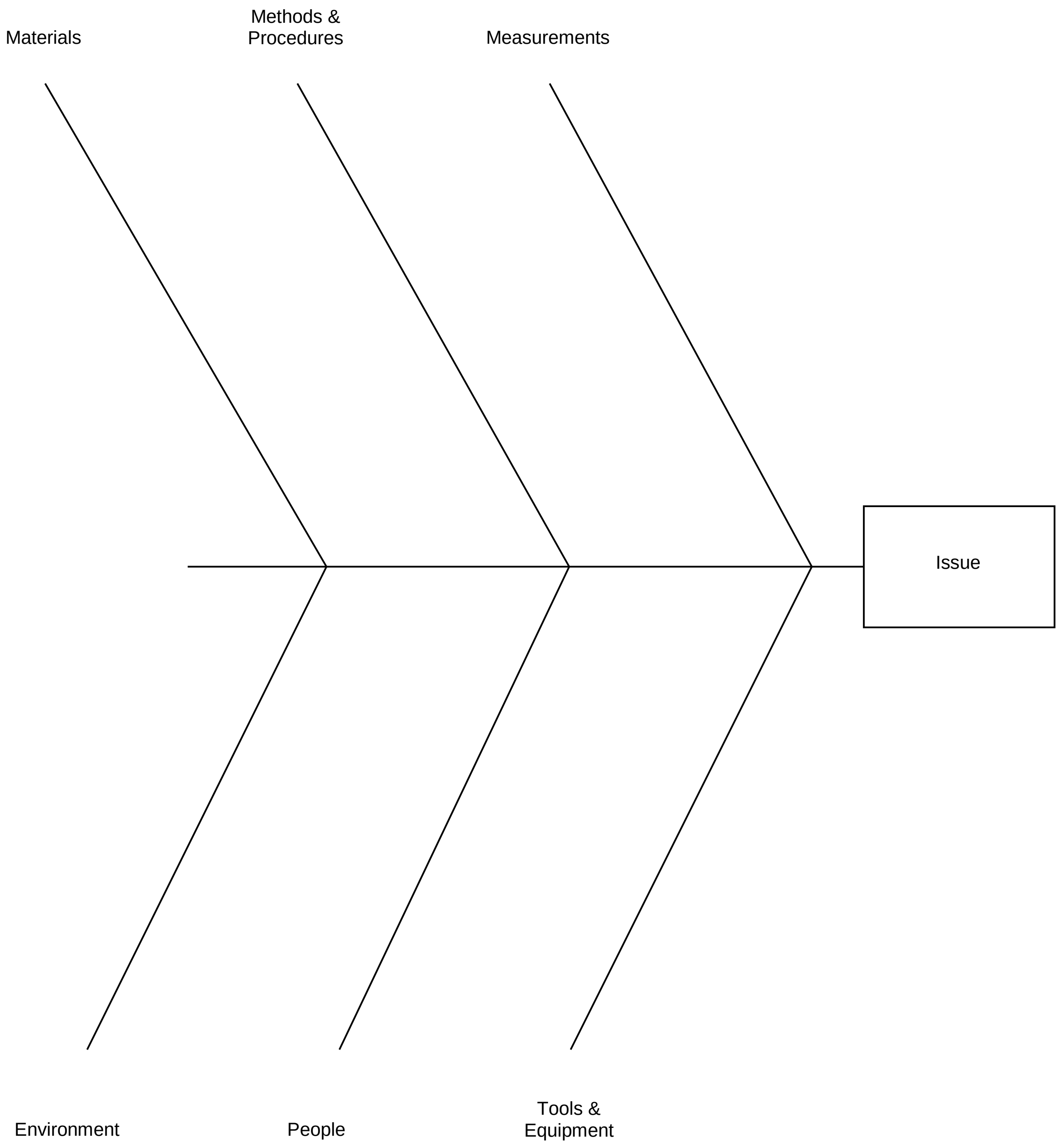
**Potential Cause Identification:** Review the Process Flowchart and measurement specification. Using tools such as “Brainstorming” and “Ask Why 5 Times” complete a Cause and Effect diagram such as that below. Identify all the possible factors that may have contributed to the Issue. Record the potential causes directly on the diagram. Change the grouping (Affinity) categories if required.



**Potential Cause Ranking:**

In the Table below record:

- The potential issue causes in the left hand column.
- The names of the team members at the head of the next columns.
- The rankings assigned to each cause by each team member the ranking should be based on;
    - Probability – how likely it is that the cause is present.
    - Contribution – how much the cause would contribute to the issue.

| | | | |
|---|---|---|---|
| Probability | High | 3 | 9 |
| | Low | 1 | 3 |
| | | Low | High |
| | Contribution | | |

- The consensus ranking of the team in the right hand column.

| Cause | Team Member Names & Cause Rankings | | | | Consensus Ranking |
|---|---|---|---|---|---|
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**Contributing/Root Cause Validation:**

In the table below record the most probable Contributing/Root Causes (the highest ranked potential causes nominated above). Enter also:

- The means to measure and validate the contribution of that cause to the Issue.
- The person responsible for the validation.
- The quantified contribution to the Issue (based on Pareto analysis or similar).

| Potential Root Cause | Method of Validation | Person Responsible | Contribution | Validation Activity WO Number |
|---|---|---|---|---|
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**If no significant Contributing/Root Cause has been identified** return to the identification and ranking of potential causes.

**If a significant Contributing/Root Cause has been identified and accepted** an improvement action and Implementation Plan should now be developed to eliminate or establish (depending on whether the change was good or bad) the significant Contributing/Root Cause(s) of the Issue. Record the Improvement Project Number next to the appropriate Contributing/Root Cause in the above Table.

**Completion:**

Attach the completed Process Investigation form to the Process Review Checklist from which the investigation was initiated.

**Contributing/Root Causes(s):**

**Impact Analysis:**
Using the data gathered during the investigation and validation process complete the following table to re-evaluate the potential impact of dealing with the Issue.

| **Dimension** | **Low =1** | **Medium = 3** | **High = 9** | **Rating** |
|---|---|---|---|---|
| Benefit to the business. | Less than $10,000 pa. | Less than $100,000 pa. | Greater than $100,000 pa. | |
| Probability of delivering the bene | Less than 40%. | Less than 80%. | Greater than 80%. | |
| Cost to implement controls. | Greater than $100,000. | Greater than $10,000. | Less than $10,000. | |
| Time for benefit achievement. | Greater than 12 months. | Greater than 3 months. | Less than 3 months. | |
| Resourcing. | Difficult to commit. | Rearrangement of Priorities required. | Readily available. | |
| Probability of susta ing the benefit. | Less than 40%. | Less than 80%. | Greater than 80%. | |
| **Overall Rating** (sum of element ratings). | | | | |

Consider the impact of dealing with this Issue in relation to the other process improvement priorities.

*Recommendation:* No Further Action ☐ Develop Control Action(s) ☐

| **Recommendation Approved by:** (Print name) | **Signature:** | **Date:** |
|---|---|---|
| | | / |

## 4.2 CONTROL ACTION DEVELOPMENT

**CONTROL ACTION DEVELOPMENT**

| **Document ID** | Equipment | Work Order |
|---|---|---|
| | | |

**Workshop Date:** **Workshop Leader:**

**Issue Definition:**

Record the definition of the issue identified with the Process. The issue definition must include the Object (product or service affected), Issue (what has changed or does not meet specification) and the Consequence (the result of the issue, which may be good or bad). The issue definition must be based on what is proven, not opinion.

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Form a Control Action Development Team and complete the following sections of the form.

| **Team Members** | **Department** | **Job Role** |
|---|---|---|
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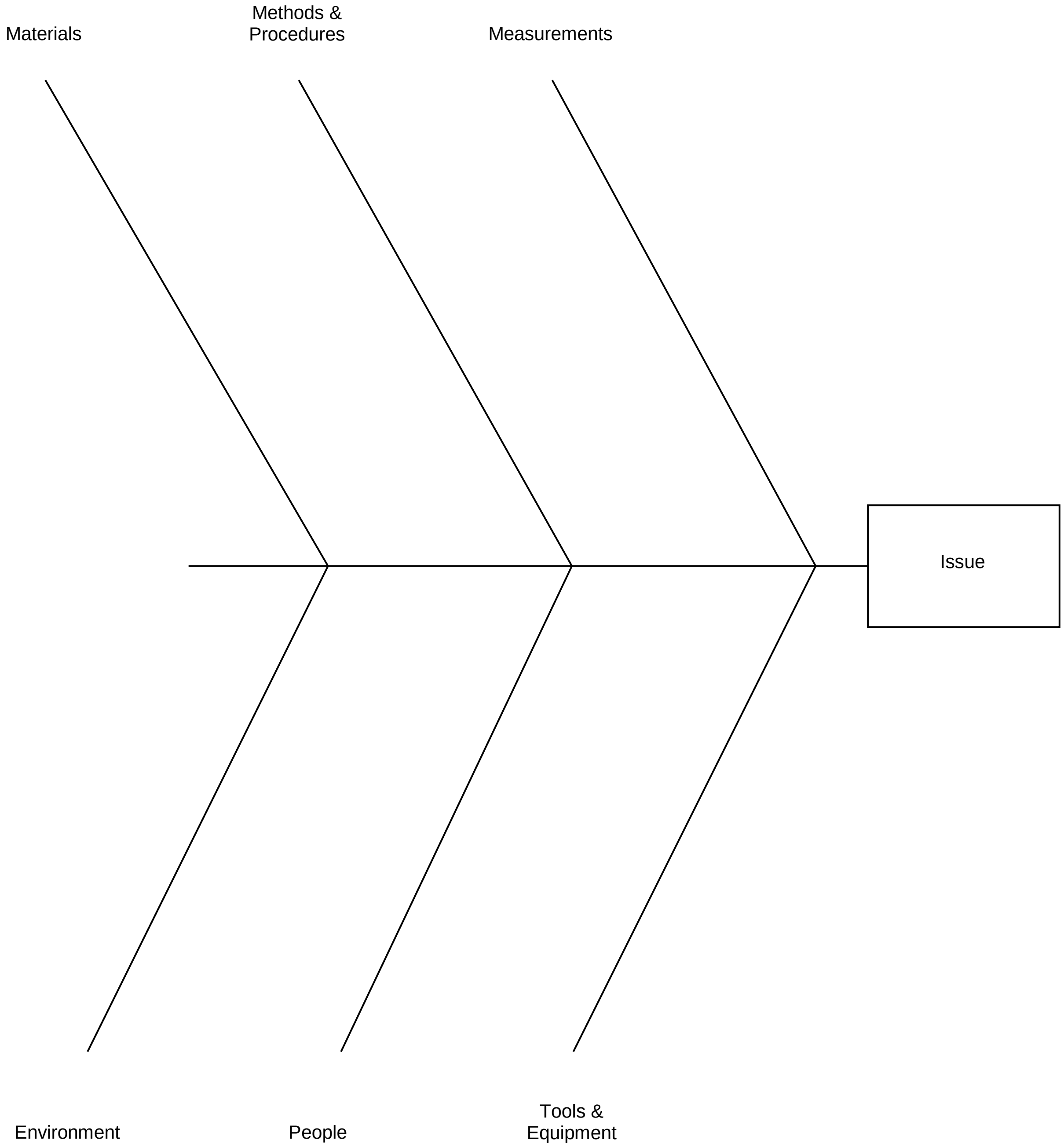
**Potential Action Identification:** Using tools such as "Brainstorming" and "Ask What 5 Times" complete a Cause and Effect diagram such as that below. Identify all the possible ways to eliminate, or establish the Issue identified in the Performance Review. Record the potential actions directly on the diagram. Change the grouping (Affinity) categories if required.



**Potential Action Ranking:**

In the Table below record:

- The potential control actions – the action is **what** we need to do to eliminate or establish the Issue.
- The practical methods – the method is **how** we will do it.
- The team member's rating for the actions based on
  - Effectiveness – how much the action will contribute.
  - Feasibility – a rating based on time, cost, practicality, acceptance etc of the control action.

| | | | |
|---|---|---|---|
| Effectiveness | High | 3 | 9 |
| | Low | 1 | 3 |
| | | Low | High |
| | Feasibility | | |

- The consensus ranking of the team in the right hand column.

| **Action** | **Method** | **Team Member Names and Ratings** | | | | **Consensus Rating** |
|---|---|---|---|---|---|---|
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**Potential Action Validation:**

In the table below record the most practical potential actions (the highest ranked potential actions nominated above). Enter also:

- The means to validate the effectiveness of that action to the control the Issue.
- The person responsible for the validation.
- The quantified contribution of the action (based on test or model results).

| Potential Action | Method of Validation | Person Responsible | Contribution | Control Project Number |
|---|---|---|---|---|
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**If no Practical Control Action has been identified** return to the identification and ranking of potential actions.

**If a Practical Control Action has been identified and accepted** a project Work Order must be raised and a Control Project Specification created. The Control Project objective is to eliminate or establish the significant Contributing/Root Cause(s) of the Issue. Record the project Work Order Number next to the appropriate action in the above Table.

**Completion:**

Attach the completed Control Action Development form to the Process Review Checklist from which the investigation was initiated.

**Recommended Control Action(s):**

**Impact Analysis:**
Using the data gathered during the control action development and validation process complete the following table to re-evaluate the potential impact of dealing with the Issue.

Consider the impact of dealing with this Issue in relation to the other process improvement priorities.

Complete the following table to evaluate the potential impact of dealing with the Issue.

| Dimension | Low =1 | Medium = 3 | High = 9 | Rating |
|---|---|---|---|---|
| Benefit to the business. | Less than $10,000 pa. | Less than $100,000 pa. | Greater than $100,000 pa. | |
| Probability of delivering the bene | Less than 40%. | Less than 80%. | Greater than 80%. | |
| Cost to implement controls. | Greater than $100,000. | Greater than $10,000. | Less than $10,000. | |
| Time for benefit achievement. | Greater than 12 months. | Greater than 3 months. | Less than 3 months. | |
| Resourcing. | Difficult to commit. | Rearrangement of Priorities required. | Readily available. | |
| Probability of susta ing the benefit. | Less than 40%. | Less than 80%. | Greater than 80%. | |
| **Overall Rating** (sum of element ratings). | | | | |

*Recommendation:* No Further Action ☐ Implement Control Actions ☐

| Recommendation Approved by: (Print name) | Signature: | Date: |
|---|---|---|
| | | / / |

## 4.3 CONTROL ACTION SPECIFICATION

**CONTROL ACTION SPECIFICATION**

| Document ID | Equipment | Work Order No |
|---|---|---|
| | | |

**Implementation Leader:**

**Issue Definition:**

Record the Object (product or service to be improved), the Proposal (what control action will be taken), the Result (the quantifiable benefit of the project) and the Measurement (method of validating the benefit).

| | |
|---|---|
| **Object** | |
| | |
| **Proposal** | |

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| | |
| **Result** | |
| | |
| **Measurement** | |
| | |

**Schedule:**

If the control action implementation is not complex, record the principal actions, persons responsible and completion dates in the table below.

If the control action implementation is complex, develop an MS-Project schedule detailing the actions, timing and responsibilities. Include the MS-Project schedule as an embedded object in this specification document.

| Action | Person Responsible | Completion Date |
|---|---|---|
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**Embedded schedule:**

**Completion:**

Record the actual Measured Benefit of the issue:

| **Completed Accepted by:**<br>(Print name) | **Signature:** | **Date:**<br>/ / |
|---|---|---|

## 4.4 ISSUE PROGRESS REVIEW

### 4.4.1 Context

A comprehensive and well specified plan and schedule of action will greatly improve the understanding of a work assignment – including the outcomes, standards, resources and time necessary to deliver the assignment. This principle permeates the design of the Asset Management Framework (AMF), and is relevant for the successful management of the three components of the Analyse and Improve process - root cause analysis, solution development and solution implementation.

The Team Leadership model that is applied in the execution of the AMF identifies 8 steps to effective Team Leadership. These are;

- Explain context and purpose
- Identify Critical Issues
- Seek & listen to contributions
- Make decisions
- Assign work packages
- Follow up
- Review progress
- Coach.

The first 4 of these Team Leadership steps are applied during assignment of Issue Investigation, Control Action Development or Control Action Implementation tasks.

Once an investigation, solution development or implementation task has been assigned, the responsible individual must develop the plan and schedule for the delivery of that assignment.

The last three steps are included in the Team Leadership model to ensure that progress is not stalled or misdirected, and to help make each work assignment a learning and development opportunity. These last three elements of the Team Leadership model can be practised at any opportunity during the course of a work assignment. However, to be certain that they are applied, and that analyse and improve activities are delivered to the best possible standard, a regular Issue Progress Review should incorporate these principles.

The Issue Progress Review, is a short-interval control process to ensure that all tasks are being progressed to plan and schedule, that milestones are being maintained, that sign-off by key stakeholders is occurring for completion of major milestones, and that results are being achieved in line with expectations. These reviews should ensure that there are no surprises (e.g. late delivery) and should allow for corrective action in response to any identified shortfalls.

Throughout this discussion, it is important to note that all actions – regardless of their source must clearly identify who is responsible and by when it must be completed. All actions will be incorporated into the schedule for tracking – to clearly identify the linkages/dependencies on other tasks – as well as their impact on the overall completion schedule.

### 4.4.2 Purpose

| **Agenda Item** | **Purpose** |
|---|---|
| Identify key elements of progress since last review | To communicate progress since last review. |
| Identify tasks scheduled but not achieved | To put approved actions in place to get tasks experiencing slippage back on track. |
| Key elements of progress expected before next review | To communicate expectations for coming review period. |
| Issues requiring management attention | To put approved actions in place to resolve critical issues. |

### 4.4.3 Quantity

1 review for each active issue.

### 4.4.4 Quality

<u>Preparation Required:</u>

- Task Leaders (those to whom the A&I task has been assigned) to update MS Project schedule, including;
  - Activity progress to completion (not time spent on it but the extent to which the intended outcomes have been delivered).
  - Forecast to completion for each task
  - Milestone changes on the schedule
  - Objective measures of delivery up to date and available.
  - Impacts on other Tasks identified.
  - Control actions specified.
- Task Leaders to have validation and measurement data available if questioned (e.g. brainstorming output, survey results, validation measures etc).
- Task Leaders to prepare Project update showing;
  - Project Baseline,
  - Current Forecast,
  - Control actions within relevant project task grouping.

The Issue Progress Review, led by the Role Holder accountable for the performance measure that the issue relates to, must include the following activities:

<u>Identify key elements of progress since last review</u>

- *Purpose: To communicate progress since last review*

- Task Leader, using the updated msProject schedule discuss:
    - Tasks completed as per schedule
    - Tasks progressed, but not yet completed
    - Additional work undertaken, but not on the schedule
    - Impact on overall project schedule
    - Resolved issues

<u>Identify tasks scheduled but not achieved</u>

- *Purpose: To put approved actions in place to get tasks experiencing slippage back on track.*
- Task Leader, using the updated msProject schedule discuss tasks not completed as per schedule:
    - reasons for variation from schedule to be reported (Pareto chart or root cause analysis).
    - Impacts on other project Tasks
    - Recommended action(s) to be taken:
        - Remedial actions,
        - Additional resourcing,
        - Absorbed in project float,
        - Adjust schedule.
- Accountable Role Holder to make decisions on:
    - Remedial actions,
    - Additional resources,
    - Adjustments to schedule (include remedial or additional actions in schedule and/or adjust schedule resources and milestones).Not the Baseline.

<u>Key elements of progress expected before next review</u>

- *Purpose: To communicate expectations for coming review period.*
- Task Leader, using the updated msProject schedule discuss:
    - Tasks to be undertaken over the next week (or longer, if appropriate)
    - Critical issues
    - Tasks that may not progress as expected, given the progress to date and the manager's decisions re. Actions
- Impact on overall project schedule

<u>Issues requiring management attention</u>

- *Purpose: To put approved actions in place to resolve critical issues.*
- Task Leader to discuss any further issues and challenges requiring management attention.
- Issues raised during progress reviews can have one of 3 possible responses, or a combination of these responses;
    - Accept the consequences of the issue and adjust project expectations accordingly,
    - Adjust task resourcing to remove or reduce the consequences of the issue, or
    - Authorise corrective action to remove or reduce the consequences of the issue. Whatever the chosen response(s) to an issue, all components of the response(s) must be reflected in an update of the project tasks, resourcing and timing.

- In the event an issue does not yet have a fully specified plan to address it; it should be recorded on an issues log – and revisited at the next meeting.

*Outcomes from the Meeting:*

- At the end of the meeting, the Task Leader will update the msProject schedule (not baseline) with the approved actions (along with their expected start/completion dates and any linkages/dependencies with other tasks on the schedule)
- Review notes, recording the updated schedule (with rationale) as well as the key points of discussion should be distributed within 24 hours of the review to a defined list of stakeholders.

### 4.4.5 Resources

- Role Holder accountable for the issue.
- Task Leader

### 4.4.6 Time

The interval between Issue Progress Reviews should be based on the duration of the agreed schedule for the Task Assignment. Typically, a review should occur at significant milestones in the schedule, or at least at each quartile of the scheduled task duration.

## 5. MANAGEMENT OF PERFORMANCE

## 5.1 ACCOUNTABILITY REVIEW

### 5.1.1 Context

Numerous research activities have indicated that in order for any group of people to maintain disciplined adherence to a defined set of expectations, there is a need for individuals to be accountable for their contribution to meeting expectations. The definition used in this document of 'To be Accountable' is that there is a requirement for a person to give an account of both their results and the actions taken in achieving them. The research finds that regardless of whether it is adherence to behavioural norms, the rules of a game, laws, or the completion of tasks, when there is no regular check that expectations are being met the delivery will deteriorate. This characteristic of our human nature creates the need for us to implement a process that helps maintain a focus on accountability.

Holding a person accountable is not intended to be an onerous or unpleasant process. When done effectively it should;

- keep a person on track to delivering tasks and outcomes,
- provide assistance and guidance where needed,
- acknowledge, challenge, and inspire the person to do their best.

Each of the organisational levels from Level 2 and up is accountable for two types of expectations[1];

- one or more specific process outcomes (e.g. product output and costs, or return on capital and free cash flow), and
- the completion of distinct tasks that are necessary to maintain or improve results (e.g. deal with a special cause of variation, reduce variation in a part of the process, or shift process capability to a new level).

Everyone in these levels should be called to account for both the outcomes and the tasks that are assigned to them, via a review of both the progress on tasks and the outcomes achieved.

People can, and should, be called to account at any appropriate time. However, it is important to ensure that this occurs at a frequency, and with a consistency, that limits the degree of variation between expectations and results. The appropriate frequency of review is linked to the rate at which outcomes can change, and the duration of the assigned tasks. In general outcomes change quickly at Level 1 and 2 of an organisation and much slower at Levels 5 and 6. Similarly, the duration of the tasks is shorter at Levels 1 and 2, and longer at Levels 5 and 6. Therefore, an appropriate review interval may be weekly at Levels 1and 2, monthly at Levels 3 and 4, and quarterly at Levels 5 and 6.

It is critical to note that the existence of a review meeting does not replace the requirement that an individual must inform their manager as soon as they believe that they may not be able to deliver an expectation on time or to specification. The review adds an opportunity for the manager to help in identifying potential risks that have not otherwise been identified.

Calling a person to account is the task of the individual's manager, and is an interaction between two people - since only one person should be accountable for any single outcome

[1] Level 1 of the organisation is accountable for the delivery of work outcomes only.

or a task. Therefore an accountability review can be achieved via a one on one discussion. However, when we look at the set of performance outcomes at a single level of the organisation, and the tasks related to improving the stability or capability of these, what happens with the results or tasks of one individual will frequently have implications for their peers. It is also possible that the peers may be able to provide ideas or support to each other. Where this is the case, then completing the accountability review in a meeting of peers can ensure that there is communication, alignment and support across the group.

In a Requisite Organisation[2] the career development of an individual is the accountability of the manager two levels of the organisation structure above them (Manager Once Removed - MOR). This role is also accountable for the effectiveness of the leadership and coaching that the direct managers of those employees provide. Attending the Accountability Review is an opportunity for the MOR to assess the current and potential capability of the people whose career they should be developing, as well as the effectiveness of the manager of that group. The Accountability review should therefore be attended by the peers within an organisational level, the manager of the group, and the MOR - as illustrated in this diagram.


### 5.1.2 Purpose

To decide if a management intervention is required to support delivery of an individual's accountabilities.

### 5.1.3 Quantity

Each subordinate to the manager should account for;

- Routine Accountabilities
  - the stability of the measures for which they are directly accountable,
  - the capability of the measures for which they are directly accountable (at Level 3 and above),
- Critical Tasks
  - the completion or progress of tasks to schedule,
  - the quality of the task outcomes,
  - the results/effects of tasks on routine accountabilities.

The manager should;

- provide coaching,
- provide additional resources where appropriate,
- approve suggested changes to the outcome, plan or schedule for Critical Tasks,
- assign additional Critical Tasks.

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[2] as described by Elliot Jacques.

### 5.1.4 Quality

Following are the details that should be covered when giving an account.

- Routine Accountability Review
    - Control Charts - provide a brief report on;
        - the investigations and contributing factors for each special cause that occurred since the last review.
        - the controls put in place to either eliminate/mitigate, or entrench the effects of the special cause.
    - Capability Histograms - provide a brief report on (only if the control limits for the measure have been reset since the last review);
        - the current confidence level against budget specifications,
        - the significance (criticality) to budget achievement if the required confidence is not met,
        - the Critical Task (A&I activity) put in place.

- Critical Task Review - provide a brief report on;
    - actions completed to schedule and quality,
    - actions not completed to schedule or quality that can be recovered, with explanation of how,
    - actions not completed to schedule or quality that cannot be recovered, with explanation of consequences,
    - results/effects expected on routine accountabilities and achieved,
    - results/effects expected on routine accountabilities and not achieved, actions being taken,
    - critical issues that may prevent the achievement of the expectations, and how these will be managed,
    - additional support required from the manager.

### 5.1.5 Resources

The Three Level Accountability Review should be attended by;

- the group of subordinates reporting to a single manager at the level of review
- the manager of the group,
- the MOR of the group.

### 5.1.6 Time

The Three Level Accountability Review should be conducted on a regular schedule. The frequency of review must be matched to the rate at which measured outcomes can change, and the duration of the Critical Tasks that people are assigned. As a general guide, an appropriate review interval may be;

- Levels 1 and 2 - weekly,
- Levels 3 and 4 - monthly,
- Levels 5 and 6 - quarterly.

## 5.2 CREW FOLLOW UP

### 5.2.1 Context

A Supervisor and crew have the accountability for safely completing all scheduled work, plus urgent work requests, on time and to specification. Achievement of this purpose is fundamental to the theory of the Operating Model and hence to the delivery of the purpose of the process on which the work is being completed.

Further, it is an accountability of each Supervisor to ensure that every crew member completes their work shift;

- safely, and in a fit condition to return home,
- having provided appropriate feedback on the completion or progress of the work assigned to them,
- with all required follow-up actions from the work reported, and
- with appropriate recognition and/or coaching on their performance.

An important outcome of this communication is also connected to "The Three Questions":

4. What do you want me to do?
5. How am I doing?
6. What is my future?

When individuals are able to answer these questions at work, they are able to concentrate on their work and give the best they've got. The end of shift conversations that occur are an important component of helping the Crew Member understand the answer to "How am I doing?". These conversations are a component of a company's Performance Review System.

This Task Assignment sets out the specifications for the end of shift discussion between a Supervisor and Crew Member, in which the above communications occur.

### 5.2.2 Purpose

To improve a Crew Member's performance in their current role.

### 5.2.3 Quantity

One discussion with each Crew Member at least once per shift.

### 5.2.4 Quality

Prior to the Crew Follow-up conversation, the Supervisor has:

- delivered a clear Task Assignment to the Crew Member,

The conversation between Supervisor and Crew Member should include:

- recognition and/or coaching on the Crew Member's performance for the day,
- assessment that the Crew Member has had a safe shift and is fit to return home safely,
- Crew Member feedback on work progress/completion,

- Crew Member feedback on what went well; what can be improved next time,
- reporting of follow-up actions arising from the work,

Use the key principles and guidelines consistent with Systems Leadership. Consider the following:

- First clarify what was expected.
- The team member comments on his/her own performance first.
- Ask open and closed questions to explore detail and demonstrate what is of importance to you.
- Address both issues of output and issues of process.
- Avoid being a persecutor or a rescuer. Interact adult to adult.
- Do not be distracted by peripheral issues, such as a third party's behaviour.
- Where there is a problematic issue, be specific about the behaviour you do not want, and the behaviour you require in future.
- Admit to any of your own shortcomings in relation to the work. If this is an issue, commit to improvement and deliver on this.
- Focus on learning from the work, for you, the organisation, and the team member.
- Give appropriate recognition for both the achievement of the task, and for the way the goal was achieved.

The discussion should preferably take place face to face but may be conducted by phone etc if this is not practical.

### 5.2.5 Resources

This task is completed by the Supervisor and their Crew Member.

### 5.2.6 Time

This discussion shall be completed shortly before each Crew Member completes their shift.

# Anglo American Operating Model Glossary of Terms



AAOM Flowsheet

AAOM Flowsheet

# Set Performance Targets

## Asset Integrity

The term **Asset Integrity** is used to refer to the health of the long life components of an asset. These are typically steel and concrete structures, services infrastructure (air, water, electricity), dams, buildings etc. Asset Integrity is measured by the percentage of potential significant threats related to the operation that are below the acceptable threshold.

## Business Structure

A Business Structure is a hierarchal structure, defining the significant elements that comprise a Company, and the relationships between the performance of those elements.

## Company

Is the highest level in the Business Structure. It is the level at which the Business Expectations are first defined in specific and measureable Performance Targets covering the characteristics of Effectiveness, Efficiency and Sustainability.

## Dependent Variation

The component of variation in an observed result that has been caused by factors outside of the process being observed, ie variation arising because of the influences of either an input or output of the process. eg variation in flow caused by empty feed stockpiles or full output stockpiles.

## Effectiveness

A performance characteristic of a process, indicating the output delivered over time. The measure of Effectiveness will vary based on the level within the Business Structure. For example;

- Company - share price growth and/or dividends,
- Operation - Units of product/service.

(How useful was what we did?)

## Efficiency

A performance characteristic of a process, indicating the ratio between output delivered and resources consumed over time. The measure of Efficiency will vary based on the level within the Business Structure. For example;

- Company - return on invested funds,
- Operation - Units Cost of product/service.

(How well do we do something?)

## Facility

Is defined as an element of the foundation, structure, housing or containment systems of an Operation where a loss of function;

- will expose people to a risk of harm, or
- will expose the environment to a risk of harm, or
- will harm the performance of a production or service process.

A Facility is generally not directly involved in the transformation, transfer or storage of a product or service. Hence a Facility is not directly identified in any of the business structure flowcharts, but should be identified on an appropriate site layout drawing.

## Flow Sheet

A graphic representation of the flow of steps within a process. In the OPERATING MODEL design two types of flow sheets used. The first is the flowsheet describing a Production process, where the steps comprise transformation, transfer and storage activities, it also indicates the inputs and outputs of the process. This type of flow sheet is referred to in Set Performance Targets. The second type of flowsheet is that used in to describe the OPERATING MODEL processes themselves. In these flow sheets the steps comprise the actions and decisions inherent in the OPERATING MODEL design.

## Independent Variation

The component of variation in an observed result that has been caused by factors inside of the process being observed, ie variation arising because of the process; design, operator influence, equipment performance, etc.

## Operation(s)

The separable elements of a Regional asset portfolio. That is, decisions about investment in, or divestment of, an Operation can be substantially independent of such decisions about other Operations within the Regional portfolio. For example:

- Mines,
- Process Plants,
- Power Generation Plants.

## Monte Carlo Simulation

A method of calculating results for systems that have many variables, with differing degrees of independence and inter-dependence between the variables. Such systems do not lend themselves to deterministic modelling. The approach uses repeated random sampling, of defined probability distributions for each of the variables, plus the mathematical and logical connections between the variables, to compute results.

## Performance Model

A simplified statistical representation of a process – used to make predictions about the performance of that process. Within the OPERATING MODEL such models are used at the Company, Region, Operation, Process and Productive unit level of the Business Structure.

Two types of model are used with the OPERATING MODEL. One is based on a value driver tree of the hierarchical relationships between the Operations, Regions and Company, and the other based on a flowchart of the steps for each Process and Productive Unit. Value driver tree models are used to predict the effect of variation in the individual Operation and Region performance, over a nominated time period, on aggregate goods/service volumes and costs. Process flow sheet models are used to predict the effect on goods/service flow and costs of the interacting effects of variation in the performance of each step of the Process/Productive Unit.

## Performance Targets

The specific, measurable objectives for a the success of a process. Performance Targets should typically consider characteristics such as

- Effectiveness - the delivery of the required output (which should include quantity, quality and time).
- Efficiency - the resources used in producing the output.
- Sustainability - the confidence, or time, that the level of process performance is can be sustained.

Each Performance Target should include a Specification, Confidence Level and Time interval over which the performance is required to meet the Specification and Confidence level.

## PERTValue Function

Uses three input parameters (minimum, most likely and maximum) to describe the betaPERT distribution that can be used in Monte Carlo simulation to model expert opinion, in which the Most Likely value has more credence than the minimum and maximum values. An optional Weight parameter can be used to increase or decrease the impact of the Most Likely value.

## Process

An element within an Operation that performs a distinct transformation, transfer or store function on goods or services. For example:

- Production Drilling
- Crushing
- Grinding
- Power Distribution

## Productive Unit

An elements within a Process that can make a separate contribution to the performance of the Process eg different loading/truck fleets within a mine, multiple crushing or grinding circuits within a mineral processing plant. They are the lowest level at which we set separate Performance Targets.

## Sustainability

A performance characteristic of a process, indicating the resources/condition(s) available to underpin the continued operation of the process. The measure(s) of Sustainability will vary based on the type of resource or condition being assess. For example;

- Goods/Services - quantity of resources available for production (usually expressed as a time period - eg 2 years/months/weeks/days of production),
- Asset Integrity - percentage of recognised threats below accepted threshold.

# Set Production / Service Strategy

## Completion Tolerance

The range of Trigger Interval values that a Service strategy defines as an acceptable window in which to complete the Service activity, eg +/- 5 days, +/- 50 hours, +/- 10,00 tonnes etc.

## Component/Location

A Component is an element of an Equipment that:

- cannot transform, transfer or store a product or service on its own, but will be removed (changed-out) and repaired as an independent unit, and
- performs a distinct function within the Equipment (the chassis, drive system and tray of the truck; the structure, drive system and belting of the conveyor etc), and
- for which work packages are likely to be independent of the work packages for other Components of the Equipment, and
- that identify the likely Pareto set (the 20% of items that include 80% of the work) for service strategy actions on that Equipment, and
- must have a distinct service strategy

A Location is an element of a Workplace;

- at which work is undertaken, and
- for which work packages are likely to be independent of the work packages for other elements of the Workplace, and
- that identify the likely Pareto set (the 20% of items that include 80% of the work) for work at that Workplace

## Corrective Action

When any of the condition or performance monitoring, predefined interval servicing or operate to failure Service Strategies are selected, a subsequent Corrective Action will be required. The OPERATING MODEL classifies the Corrective Actions into three types;

- stabilisation,
- reconditioning, and
- replacement.

A Corrective Action specification comprises and action and an object – eg replace engine oil.

## Criticality Rating

A value calculated to assess the maximum potential risk associated with a Threat. It is based on the safety, environment, production, quality and cost rankings for a Threat, and to the probabilities of occurrence and exposure.

The Criticality Rating (CR) is calculated based on the formula;
CR = Sum of Consequences × Probability of Failure During Functional Life × Probability of Exposure.

## Design Specifications

The range of values for process parameters that are nominated as acceptable for the safe and effective operation of the process, eg temperature, chemical concentration, load etc.

## Detectable Threat Onset

The situation where the existence of a developing Threat can be determined from a detectable characteristic – eg measurement of wear, vibration, temperature, change of performance etc.

## Equipment/Workplace

An element of a Productive Unit:

- that can transform, transfer or store a product or service on its own, and
- that performs a distinct function (eg each truck within a fleet; the feed chute, crusher and discharge feeder within a crushing system; each draw point within a mining stope etc), and
- for which work packages are likely to be independent of the work packages for other elements of the Productive Unit, and
- for which a service strategy is developed.

## Fulfilment Lead Time

The minimum length of time between when the need for a resource can be identified and when that need must be fulfilled if unacceptable losses are to be avoided.

## Functional Life

The period for which the function of a Process, Productive Unit or Facility will be required. The Functional life may be different to the Production Life for a process that the Facility/component is part of. For example a tailings dam will have a functional life that will extend for many years beyond the time at which disposal into the dam ends (the Production Life).

## Function of an asset

A statement, that should contain a verb, object and a desired standard of performance? For example, to pump water from tank 'A' to tank 'B' at a rate no less than 'X' litres per hour.

## Functional failure

The inability of any asset to fulfil a function to a standard of performance, that is acceptable to the user. For example, Pumping at a rate below the standard as described by the function statement. *Source Physical Asset Management Definitions*

## Operating Parameters

These are the elements of the Production Strategy that can be changed in order to alter the performance of a process. They are;

- Design specifications,
- Operating Time,
- Operating Rate,
- Feed quality, and
- Output quality.

## Operating Rate

The amount of product or service delivered by a process in a specified period of time.

## Operating Time

The time in which the process is delivering its Purpose, eg a drill - drilling holes, a truck - moving material, a grinding mill - processing material etc. Operating time is different to running time, which may include periods where plant is running but not delivering its purpose.

## Part

Each assembly of items within a Component where the most common service strategy will be replacement of the assembly on the functional failure of any item of the assembly (the simplest may be a single item).

## Production Strategy

Defines the combination of Operating Parameters that will be adopted to deliver the Performance Targets for the Process.

## Production Work

1. The activities directly involving transferring, transforming or storing goods or services within a process. For example:
2. in a mining/mineral processing environment; blasting, hoisting, stockpiling, grinding, smelting.

 

3. in a power generation environment; transferring fuel, transforming energy (eg oil to heat, rotation of alternator to electricity), transforming voltage & current levels and transmitting power over lines.
4. in a procurement and supply environment, placing orders, receiving, warehousing and issuing goods.

## Service Strategy

The approach adopted to manage the Threat. The OPERATING MODEL categorises the Service Strategies as;

- modification of the process,
- condition/performance based servicing,
- predefined interval/life based servicing,
- utilise backup or containment systems,
- operate to failure, and
- closure of the process.

## Service Work

Activities involved in identifying and managing threats related to a process (ie to both the process and to its environment).

## Support Work

Activities that predominantly serve the purpose of improving the effectiveness or efficiency of a Process. That is, Production and Service work can proceed without effective Support work, but the outcomes and or cost may not be optimal. Many of the elements of the OPERATING MODEL are Support work. These include Setting Performance Targets, Setting Production and Service Strategies, Setting an Operating Master Schedule, Setting an Expenditure Schedule, Approving Work, Planning Work, Scheduling Work, Measuring results and applying Analyse and Improve.

## Threat

A a condition or action that has potential to cause harm, either to communities, employees, the environment or the process performance. The cause of a Functional Failure. The OPERATING MODEL categorises the types of Threat as;

- Stress
- Chemical,
- Wear,
- Fouling,
- Obsolescence.

## Threat Consequence

The potential type and seriousness of the consequences of Threat. These may include;

- Safety,
- Environment,
- Production losses,
- Off-specification product,
- Cost of damage to plant, and
- Customer impact.

A standardised 6x6 table of Consequence types and seriousness is used.

## Threat Description

A brief description that includes the action and object that will result in a Threat occurring. eg for engine wear it might be coke build-up in oil. For engine corrosion it might be acid build-up in oil.

## Threat Exposure Probability

The probability (expressed as a percentage) that a specified consequence will result when a failure occurs – eg there is a 10% probability that a disabling injury will result when the failure occurs.

## Threat Mechanism

A Threat Mechanism is the means through which a probable Threat is created/initiated. The OPERATING MODEL categorises the types of Threat Mechanism as;

- Design,
- Operation,
- People,
- Environment,
    - Commercial,
    - Natural, and
    - Social.

## Threat Probability Distribution

The shape of the histogram for the probability of occurrence for a Threat over the time. Probability distributions are generalised into three basic components in the OPERATING MODEL; Running In (decreasing over time), Random (constant over time), or Age Related (increasing over time). These one, or combination of, these three components may represent the probability of a threat.

## Threat Rating

A calculated value used to compare the current level of Threat compared to the maximum (the Criticality Rating) Note that for Threats that have a early failure or wear out pattern the Threat Rating varies with time (decreasing and increasing respectively).

## Trigger Interval

The value of the Trigger Parameter at which a Service work activity should be initiated, eg 30 days, 250 hrs, 50,000 tonnes, prior event etc.

## Trigger Parameter

The characteristic that is used to determine that a Service work activity should be initiated, eg calendar time, operating time, throughput, a precedent event etc.

## Warning Interval

The period between the earliest ability to detect a developing Threat and the occurrence of that Threat. Due to the inevitable variation in Warning Interval between Threat events, the Warning Interval is defined by a probability distribution. The OPERATING MODEL uses the minimum, most likely and maximum Warning Interval to define this distribution. It is also common to specify a Warning Interval at a nominated confidence level, eg the Warning interval will be greater than 1 month at a 90% confidence.

## Work Package

Work Packages are created for efficient execution of the actions defined from selected Service strategies. In some cases a single work package combines actions from several Service strategies. A Work Package comprises all of the elements necessary for the work, which may include a Work Order, Tasks, Bills of Materials, Work Instructions, Drawings etc. Each Service Work Package will have distinct scheduling parameters such as a Trigger Parameter and Trigger Interval.

## Work Scheduling System (WSS)

A system that is used to monitor the trigger conditions for Production and Service Work Packages, and to create the appropriate Work Packages, from Standard Jobs, when the trigger conditions have been met.

AAOM Flowsheet

# Operating Master Schedule / Expenditure Schedule

## Accumulation Rates

Rate of change of a counter (hour meter, tonnes, etc) used to forecast the timing of an OMS Activity.

## Activity

A single line within the OMS that represents either;

- a single Work Package - for the most significant elements of the OMS, or
- a grouping - to represent the many minor Work Packages in a meaningful way within the OMS.

## Direct Resource Types

Those resources that have significant contribution to the cost of individual Production or Service work packages. The cost of these resources can be accurately forecast and recorded for individual work packages via the quantity and value of the units of Resource Type.

## Expenditure Schedule (EPS)

The EPS adds the resourcing and their forecast costs to the OMS. It provides a forecast of the resource demand and cash flow over the Forecasting Period.

## Forecasting Interval

The smallest increment that a schedule is broken into (e.g. weeks)

## Forecasting Period

The period of time into the future – that a schedule will forecast (e.g. 5 years).

## Operating Master Schedule (OMS)

The OMS identifies the nature, timing and frequency of Activities over the Forecasting Period. It should be used as the roadmap to the achievement of the Performance Targets, ie the Work Management process should ain to stay close to, or converge back onto the approved OMS. All Production and Service work is included in the OMS, either as individual Activities for the most significant work, or as grouped activities for the many minor work items.

## Overhead Resource Types

Those resources that that do not have significant contribution to the cost of individual Production or Service work packages. The cost of these resources can be determined but are not forecast or recorded for individual Work Packages. They are incorporated into overhead costs in the financial budget.

## Production Work Costs

The expenses incurred for the transform, transfer and store activities undertaken to deliver the process performance.

## Resource Type Costs

The expenses required to effectively deliver the labour and equipment used in executing Production and/or Service work for one or many processes.

## Schedule Commencement Date

The date at which forecasting of an Activity on the OMS commences. For example, when a new item of equipment that will start in operation in 12 months time.

## Schedule Termination Date

The date at which forecasting of an Activity on the OMS ceases. For example, when a piece of equipment will be removed from operation in 12 months time.

## Service Work Costs

The expenses incurred for the activities to monitor and control potential threats related to a process.

# Work Management

## Work Management

The collective term used for the OPERATING MODEL elements for the Approval, Planning, Scheduling and Execution of work

## Work Management System

The system used for work order management, work flow - recording, planning scheduling, costing, etc. – for example, SAP, Ellipse, Maximo.

## Work Request

A request for work to be completed. A work request is not an authority to complete work – it must be approved before any cost commitments can be made. All work requests must include

1. The Equipment/Component or Workplace/Location.
2. Work Description
3. The Work Group that will be responsible for approving the work.
4. Required Date
5. Impact
6. Originator.

## Work Order

Work Orders are the document used to specify a set of Tasks, resources and expenditures. A separate work Order should be used for each independent work outcome (ie the work outcome is not dependent on the completion of any other Work Order).

## Task

**Tasks** are used to specify an activity within a Work Order that has scheduling characteristics that are distinct from other Tasks of the Work Order.

A separate Work Order Task should be created whenever a component of the work;

- can be scheduled at a different time to other components of the work, eg;
    - in a different schedule period, or
    - on different days (or shifts) of a schedule period, or
    - within the same day (or shift) but with a time gap (as for example during a 16 hour shutdown when progress of a work package may be suspended due to conflicts with other critical path work packages), or

- has a different combination of resource types (trades/skills or equipment types), or
- has a different combination of resource quantities.

## Parent Work Order

A **Parent Work Order** is used to identify a group of independent Work Orders that comprise a program of work. A group of independent Work Orders may, either for convenience, or due to the pursuit of a developing issue, be linked into a program of work.

One example is a group of Work Orders, on different components of a Productive Unit within the Business Structure, that must be completed as part of a single work program (eg concurrent overhaul of the engine, transmission, brakes and axles on a truck).

Another example is a group of Work Orders, with different Work Types, undertaken in the analysis of a performance issue and implementation of improvement actions arising from the analysis.

A Parent Work Order is used to identify related Work Orders in each instance of;

- a program of concurrent work on a Productive Unit,
- analysis of a performance issues using the analyse and improve process.

## Project Work Order

Project Work Orders can be used to identify the complex and unusual planning, scheduling and execution relationships that exist between a group of Work Orders specifically for an activity such as a plant outage.

For example, all of the preparation work for a plant outage, all of the work during the plant outage proper, all of the re-commissioning work and all of the post outage clean-up.

## Required Date

- The date by which an event that will create a safety or environmental threat is probable
- The date by which delayed completion of a scheduled ***Production*** or ***Service*** activity is probable.

A ***Production*** activity is one that is directly involved in the transformation or transportation of a product or service.
A ***Service*** activity is one that is directly involved in the identification or control of Threats related to the process.

or

- Not more than 6 weeks (this is a typical value but can vary) from the date of Work Order approval/creation.

> If work is best completed during a shutdown that will not occur within 6 weeks, the Required Date should be during the next appropriate shutdown.
>
> For integrity management work the Required Date may be months or years away.

## Impact

Impact 1 – Significant ***un-containable*** safety or environmental threat, or Significant ***un-recoverable*** production or service activity throughput or quality reduction

> ***Un-containable*** means that there is no practical way to contain (use temporary measures such as the installation of barricades, diverting spillage into sumps, drawing from or building stockpiles, etc) exposure to a threat.
>
> ***Un-recoverable*** means that there is no alternate equipment, schedule time or operating rate etc that will allow catch up to schedule.

Impact 2 – **Containable** safety or environmental threat, or **Recoverable** production or service activity throughput or quality reduction

Impact 3 – All other

## Urgent Work

Urgency is driven by Required Date and the Impact of not completing work by that date.

| | **Required Date** | | |
|---|---|---|---|
| **Impact** | **Today** | **Within 7 days** | **Beyond** |
| 1 | Urgent – respond immediately | Urgent – respond before Required Date | Not Urgent – schedule before Required Date |
| 2 | Urgent – respond or contain immediately, | Urgent – respond or contain before Required Date | Not Urgent – schedule before Required Date |

| | | | |
|---|---|---|---|
| 3 | Not used | Not used | Not Urgent – schedule before Required Date |

If work is declared Impact 1 or 2; with a Required Date of today, or within 7 days of creation, it is processed as Urgent Work.  All other work is to be handled through the regular Scheduling and Planning process.

## Planning

Planning is the process of preparing a Work Package that defines;

- what the work is,
- how the work is to be executed,
- what is needed to do the work,
- the standards that the work must meet.

Work is planned to ensure that everything necessary to deliver the right work, safely and efficiently, is identified before the work commences.

## Checklist

A list of actions, steps, or outcomes needed to complete a task.  Each item is checked off as it is completed.

## Scheduling

Scheduling is the process of allocating time, space, labour and equipment to work, while managing the synergies and conflicts between work.

## Critical Path

The series of dependant Tasks in a schedule that define the minimum duration of the schedule. That is, any delay to a Task on the critical path will be added to the completion time, unless another Task on the Critical Path is accelerated or eliminated.  Likewise, the completion time can be reduced by accelerating any Task on the Critical Path.

The objectives of scheduling are firstly to ensure that all work packages are completed at the right time, and secondly to make the most efficient use of resources while doing this.

## Job Template

A template that is used to improve the speed and accuracy of preparing a Work Order for repetitive activities. The Job Template will normally include at least all of the consistent elements of the work, and may also include some optional elements.

## Work Instructions

Step-by-step procedure defining each of the steps that matter in executing a Task.

## Workgroup

An identifier for accountability for an element of a work package. The Workgroup is used in 2 ways;

- The first is to identify the overall accountability for a Work Package, that is who is ultimately accountable for the outcomes and cost of the work, and
- The second is to identify the accountability for providing resources for the execution of a Task within the Work Package.

Resources (including labour and equipment) used in work execution are assigned to a Workgroup.

A resource cost is calculated for Direct Workgroups. The Workgroup cost rate is used to assign costs to Work Orders.

## Delivery Date

Used in the Resourcing process, this refers to the date that the materials or contract services specified on a purchase order will be available to the work team for execution of the work.

## Measures / Analyse & Improve

### Capability Histogram

The probability distribution of a measured or modelled result. It shows the relative frequency of occurrence for different results. The purpose of a Capability Histogram is to indicate how well a process can meet specifications over a nominated period of time. It provides a graphic of the variability that occurs in the result. The Capability Histogram also provides an easy way to identify the minimum, most likely (mode) and maximum values of the result.

### Common Cause

Variation in process performance that regularly recurs – that is it is a 'normal' part of the process.

The tests commonly used to differentiate common and special cause variation are;

- A point outside of the $\pm 3\sigma$ values.
- Seven points above or below the mean.
- Seven points moving in the same direction.

The probability of each of these events is similar, and is less than 1%.

### Contributing Cause(s)

The items that are at the foundation (or root of) creating an issue identified by a measure.

### Control Action

The activity taken in response to a validated contributing cause for an issue identified by a measure. The Control Action may be aimed at preventing the cause recurring (in the case of an undesirable issue), or at enduring that the cause is maintained (in the case of a desirable issue).

### Control Chart

A chart that shows a measured result over time, and adds upper and lower control limits, plus a mean or centre line. Tests can be applied to the data to provide a quantitative, consistent and reliable indication of the stability of a process.

The purpose of a Control Chart is to indicate whether a process is behaving consistently over time.

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## Control Measure

If a KPI indicates that a process is changing, or is likely to change, or an activity has been initiated to create a change in the KPI, other measures may be needed in order to make visible the factors that produce(d) the change. There may literally be dozens of factors that can influence a KPI. It is neither necessary nor practical to consistently monitor all of the possible factors that influence a KPI. These need only be measured and monitored when a KPI change is indicated or wanted. These many other possible measures are often called Control Measures since they are only necessary when a change in process control is occurring.

## Key Performance Indicators – KPI:

The OPERATING MODEL definition of process KPI's is the minimum set of measures that can fully inform us about the performance of the process. These can be classified into two groups;

- Those that tell us about the outputs (purpose) of the process – these should cover the characteristics of Effectiveness, Efficiency and Sustainability. Note that the output of one process is always the input to another process.
- Those that tell us about what is happening in (the theory of) the process; eg Right Work, Right Time, Right Way.

All characteristics of the Purpose of the process should always be measured, either directly or through proxy measures, as these should be critical to the stakeholders of the process. When there is no significant hysteresis (ie a time lag between the theory and the ouput) or step change in the process the Theory measures do not need to be included in KPIs, unless it is as a proxy for a Purpose measure that is not practical to measure directly.. Where there is any significant hysteresis or step change in the process then the related Theory measures should always be included in the KPI set as they leading indicators of the future outputs.

Since KPI's are related to the Purpose and Theory of the process, they should not be altered unless the purpose and/or theory (ie design) of the process is altered.

## Lagging Measure

A lagging metric is one where there is a time delay between an event that will cause a change in the measure and when the resulting change is seen in the measure.

The measures of the Purpose (output) of a process often significantly lag the measures of the Theory of the process.

## Leading Measure

A leading measure is one where a change in the measure occurs at some time interval before the result of that change will be evident a related lagging measure.

The measures of the Theory of a process often significantly lead the measures of the Purpose (output) of the process.

## Limiting Value

The constant defined for calculating the value of each output measure when that measure is expressed as the ratio of a variable and a constant. For example, for Utilisation and Availability measures the limiting value is 24/7 time. For rate measures it is the $95^{th}$ percentile of the measured performance histogram for a process as it is currently designed.

## Losses

The difference between the measured performance at a sampling point and the limiting value defined for that measure for the process.

## Pareto Chart

A type of chart that contains both bars and, generally, a line graph. Categories of data are represented by the bars, the height of the bars (presented in descending order) indicate the value of the category, and the cumulative total of the category values is represented by the line. It is used to illustrate the relative contribution of different categories to a total result.

## Primary Cause

The cause of performance loss observed at a Sampling Interval that is identified as the primary cause of the loss. That is, in the hierarchy of losses this cause has the highest placing.

There can be only one primary cause for the loss at any sampling interval.

## Sampling Interval

The interval at which values are sampled when measuring a parameter.

## Sampling Period

The interval over which data is collected in order provide to a representative sample of performance.

## Secondary Cause

Any cause of performance loss observed at a Sampling Interval that is not identified as the primary cause of the loss. That is, in the hierarchy of losses these cause are placed below the Primary Cause.

There can be more than one secondary cause for the loss at any sampling interval.

## Special cause

A source of variation that is uncharacteristic of the process – that is it is not a ‘normal’ part of the process.

The tests commonly used to differentiate common and special cause variation are;

- A point outside of the $\pm 3\sigma$ values.
- Seven points above or below the mean.
- Seven points moving in the same direction.

The probability of each of these events is similar, and is less than 1%.

## Social Theory

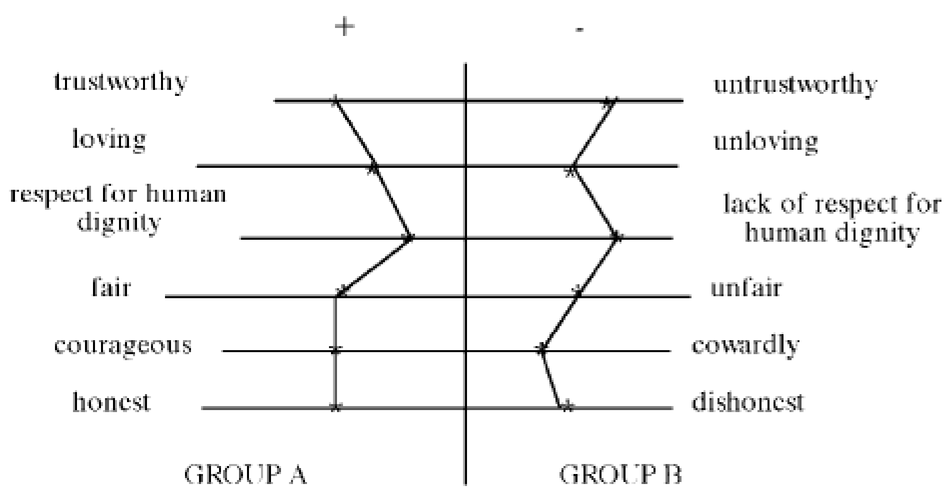
### CPQQTR

Also known as a Task Assignment. The vehicle by which a task is specified and assigned. Each task assignment includes

- **Context** – the rationale for the task and any relevant underlying theory.
- **Purpose** – the outcome required from the task. The purpose should be one sentence with no conjunctions.
- **Quantity** – the checklist of the deliverables from the task.
- **Quality** – the acceptance standards/specifications for each relevant deliverable.
- **Time** – the time constraints applying to the task.
- **Resourcing** – the resources available/assigned to the task.

### Culture

Not everyone will put an action in the same place on the Values Continua. Take a simple example; expenses for travel and/or overnight accommodation. Does the organization have set rates, are they fair and what are the procedures for claiming? Does this demonstrate that the organisation trusts you? There is no guarantee that any system will be perceived as fair and honest. However, if you rate beliefs about expense treatment you may find that some people regard them towards the fair end, others towards the unfair end. You may end up with a distribution of views about an organisation as follows




Group A and Group B form two different CULTURES. A culture is formed when people share assumptions about whether behaviours demonstrate positive or negative values, in other words they share mythologies.

## Dissonance

An experience where our expectations or predictions are challenged. *Source: Systems Leadership*

## Discretionary Effort

The effort that an individual can choose to apply, or not.

## Engagement

The condition where a worker wants to come to work to do the best that they can.

Engagement is most likely to occur when there is a positive perception of the Values Continuum, and workers feel that they are **acknowledged**, **challenged** and **inspired** in their workplace.

## Escalation

The action of letting your immediate supervisor know that you cannot meet one of the elements of a task assigned to you, as soon as you are aware that it cannot be met.

## Mythologies

Mythologies are the assumptions/beliefs that one person uses in making Values Continua judgements about the actions of another person. They are not necessarily correct, but they are believed by the individual who uses them. For example, Jim did not act on the suggestion that I made during the safety meeting, therefore he does not respect me or my opinion. It be the case that Jim did not hear the suggestion among several that were being made at the same time.

## Task Assignment

A Task Assignment is a specific piece of work to be carried out by an individual. Unless expectations are clear, it is impossible to hold that individual accountable. Clarity is achieved through a Task Assignment, that is underpinned by the authority of the manager to assign tasks. There has to be an accepted understanding, that team members must carry out the tasks assigned, assuming the task is safe, legal, and that they have the capability to do it.

## Values Continua

The continuum of six key values that people use to form judgements about the actions of others. People are likely to give their discretionary effort to others whom they perceive to consistently act in a way that is interpreted as lying towards the left of the Values Continua. People are not likely to give their discretionary effort to others whom they perceive to consistently act in a way that is interpreted as lying towards the right of the Values Continua.

**Values Continua**

Caring…………………………………………………………………………...Uncaring
Respectful…………………………………………………………………Disrespectful
Fair………………………………………………………………………………. Unfair
Truthful……………………………………………………………...……… Untruthful
Trustworthy…………………………………………………………… Untrustworthy
Courageous…………………………………………………………….... Cowardly

## Work

**Mechanical** - The application of a force to move a mass through space. (Isaac Newton)

**Mental** - The application of discretionary effort within defined boundaries of authority to achieve a specified outcome. (Elliot Jacques)

AAOM Flowsheet

# Operating Model
# Interactive Handbook

Please click on icon below for further details