Eskom	Standard	Technology

Title: **Power Generation Asset Criticality Classification Standard**

Unique Identifier: **240-72273656**

Alternative Reference Number: **N/A**

Area of Applicability: **Eskom Power Generation Plant**

Documentation Type: **Standard**

Revision: **2**

Total Pages: **17**

Next Review Date: **April 2023**

Disclosure Classification: **CONTROLLED DISCLOSURE**

APPROVED FOR AUTHORISATION
TECHNOLOGY ENGINEERING
DOCUMENT CENTRE ☎ X4962

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PCM Reference: **240-51093273**

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CONTENTS

1. INTRODUCTION

Eskom has a vast amount of equipment in numerous Power Generating Plants, on which a variety of operational, Maintenance and Engineering activities are performed. Equipment criticality classification is necessary to ensure proper operating and maintenance of all plant systems, equipment and components.

Each component, item or activity has a different degree of importance to plant/personnel safety and to the performance and production cost of the plant. It is therefore imperative for Eskom Generation to establish a standard for classifying the criticality of its plant and its equipment to ensure that:

- Only appropriate materials are used (typically OEM supplied spares) to maintain Generation plant classified as critical (Level 1).
- Effective maintenance strategies are in place for such a plant and its equipment.
- Plant and its components take priority in terms of costs as compared to non-critical plant.
- Only Eskom approved engineering design review process is followed for engineering changes on critical plant.
- All critical plant receive due care and attention (Maintenance and Operating Philosophies)
- Movement from continuous rework into the continuous improvement within Eskom.
- Eskom complies with legislative requirements to ensure:
  - Reduction of fatalities.
  - Prevent high cost catastrophic events.
  - Continuity of supply of electricity to South Africa.
  - Compliance to regulatory requirements.

2. SUPPORTING CLAUSES

2.1 SCOPE

This document provides a systematic approach to determine accurate functional criticality level for production facilities and associated systems. It shall form part of the basis for selection of redundancies, development of maintenance programs, spare parts evaluations and Life Cycle Cost evaluations/calculations.

2.1.1 Purpose

The purpose of this standard is to provide a method of classifying the criticality of Eskom Generation, Plant, Systems, Sub Systems, Structures and Components. This classification will be used to identify equipment with most serious potential consequences and negatively impact on business performance and also to identify what equipment is most likely to sustain or improve business performance business performance.

2.1.2 Applicability

This document shall be applicable within Eskom Power Generating Plant (throughout the lifecycle of such plant).

2.2 NORMATIVE/INFORMATIVE REFERENCES

Parties using this document shall apply the most recent edition of the documents listed in the following paragraphs

2.2.1 Normative

[1] 240-51093273: Process Control Manual (PCM) for Control Configuration Changes

[2] 240-43327398: Engineering Policy

[3] 240-53114002: Engineering Change Management Procedure

[4] 240-53113685: Design Review Procedure

[5] 240-53114026: Project Engineering Change Procedure

[6] 32-1286 Process Control Manual (PCM) for Manage Item Configuration

[7] 36-456: Classification Guideline

2.2.2 Informative

The documents referenced below will enhance the understanding of the reader on the subject covered in this document. The requirements of these documents are, however, not an extension of this document.

[8] 240-49104739: Registration Procedure for Engineering Work

[9] 240-53114190: Internal Audit Procedure

[10] 240-53665024: Engineering Quality Manual

2.3 DEFINITIONS

Definition	Description
Asset/Plant	Industrial site consisting of systems of technology (e.g. machinery, property, buildings, vehicles and other items and related systems) used to perform specific set of functions or service.
Component	A uniquely identifiable part that is required to make an equipment fully connected and functional i.e. Pump's motor, coupling, etc.
Critical Plant	Equipment which upon failure might result in fatalities, major costs, multiple power generating unit trips or power station shutdown.
Catastrophic Failure	A catastrophic failure implies to any failure which results in an event as described in the level 1 classification, e.g. a leak in the HP piping might not cause system downtime, but may result in serious injury or fatality.
Engineering Change	Any permanent or temporary change, deletion or addition to any system, equipment, structure including permanent changes to operating set points, software and technical documentation which will result in any deviation from original or existing System, Structure ,Component design and/or specification or established baseline. This includes the replacement of system, structure or components with equivalent components of a different make or type.
Engineering Change Criticality Classification	The categorisation of an Engineering Change depending upon its effect on safety, the environment, reliability, availability and costs of production lost if the proposed design failed.
Engineering Change Management	Activities for the control of a product after formal approval of its product configuration information.
Engineering Change Prioritisation	A selection criteria as part of the Engineering Change process that will guide the engineer and the CCCC/SCCC to prioritise the engineering change into different levels, i.e. P1, P2, P3.
Load Loss	Any loss off the power generating capability of a generating set (Unit) without a total shutdown or grid separation of the generating set.

2.3.1 Disclosure Classification

Controlled Disclosure: Controlled Disclosure to external parties (either enforced by law, or discretionary).

2.4 ABBREVIATIONS

Abbreviation	Description
AA	Authorising Authority
BU	Business Unit
CC	Change Coordinator
CCCC	Central Change Control Committee
CM	Configuration Management
CoE	Centre of Excellence
DMS	Document Management System
EC	Engineering Change
ECM	Engineering Change Management
ECN	Engineering Change Notification
ECN	Engineering Change Notice
ECR	Engineering Change Request
EWL	Engineering Work Lead
FLOC	Functional Location Code (i.e. AKZ, KKS etc.)
LCC	Life Cycle Costing
OEM	Original Equipment Manufacturer
PM	Plant Maintenance
SCCC	Site Change Control Committee
SE	System Engineer
SGM	Senior General Manager
SPO	Smart Plant Enterprise Owner/Operator
URS	User Requirements Specifications
WI	Works Information

2.5 ROLES AND RESPONSIBILITIES

All parties interfacing with Eskom are required to comply with the principles contained in this Standard. All other departments mentioned in the document will be responsible for the activities related to them as defined in this Guideline.

Role	Responsibility
Group Technology	Responsible for organisational development, adaption and implementation of the principles contained in the Standard.
Business Unit Manager	Responsible for development, adaption and implementation of the principles contained in this Standard within the Business Unit.
Business Unit Engineering Manager	Responsible for local development, adaption and implementation of the principles contained in the Standard within the Business Unit.
Central Change Control	To ensure that plant criticality is considered in the classification of changes

Role	Responsibility
Committee (CCCC)	and according to the principles established by this standard.
BU Engineering	Responsible to coordinate and classify plant components. Consider the classification of plant in the execution of their day-to-day duties, e.g. planning maintenance, executing engineering changes, etc. Responsible for Engineering Change Classification.
BU Operating and Maintenance	Responsible for criticality classification of plant, systems, sub-systems, equipment and components.
BU Change Coordinator (CC)	The person(s) in charge of managing the permanent or temporary configuration changes to structures, systems, components or technical content of prescriptive or descriptive documentation that form part of the design and/or asset base and updating the engineering change management application to reflect the latest status of an EC. The CC must ensure the minutes/decisions made by the SCCC and CCCC are recorded on the system and stored in a central location. All decision documents should be linked to the ECR on the engineering change management application.
Design Review Team	The members of this team's responsibilities include: • Compliance with the design review processes applied to the engineering design or engineering change. • Ensuring that all design input has been adequately considered. In particular to ensure that the engineering change has been adequately reviewed with regard to interface issues between various disciplines, contractors etc. • Ensuring that all review cycles have been complied with • Making recommendations regarding engineering change approval
Engineering Design Work Lead (EDWL)	Typically an appropriate ECSA professionally registered person (engineer/technologist, P15-P18) who is designated through the work allocation process. He/She is delegated with the authority to perform the following functions: • Ensure that all steps are performed according to procedure • Perform a further technical review, if required, of the feasibility study and/or the engineering change package • Put together an engineering team led by himself/herself, who is responsible for ensuring that Level 1 and Level 2 classified Engineering Change Requests have been subjected to the appropriate review cycles and are acceptable for implementation. It may have, as its members, specialists and/or external consultant personnel on an ad hoc basis • Perform conceptual, basic and detail design (if applicable) • Coordinate compilation of a design report including all the necessary supporting documents for loading onto Hyperwave or Legacy Document Management System (DMS) • Package the initial detail review thereof * If the EDWL is not ECSA professionally registered, the assigned EDWL may complete the design under the supervision of an ECSA professionally registered person. The registered person will be accountable for all tasks to be completed by EDWL.
Site/BU Change Control Committee	A committee/individual at an Eskom BU/site appointed by the Power Station Manager who: • Performs change level classifications. • Forward Level 1 and 2 changes to the CCCC for authorization.

Role	Responsibility
	• Authorize Level 3 changes for implementation. • Periodically report details of Level 3 changes to the CCCC. • The responsibilities of the committee could be delegated to one person in certain instances.
System Engineer	An appropriate and qualified site-based Discipline or System Engineer, who has the training, technical qualification and expert knowledge of the plant or systems affected by the engineering change. His/her function is: • To prepare the engineering change. • Preparation of a feasibility study/conceptual design followed by an engineering design/engineering change. • Package the initial detail review thereof.

2.6 PROCESS FOR MONITORING

Compliance to the plant criticality classification process and an engineering change management application will be compulsory for all Eskom Generation Business units and this standard shall be monitored via 240-53114190: Internal Audit Procedure [9], 240-53665024: Engineering Quality Manual [10] and self-assessments.

2.7 RELATED/SUPPORTING DOCUMENTS

- None

3. CLASSIFICATION PROCESS

The process in each level of classification shall be used to manage and control technical queries and all engineering changes that affect the integrity of the design baseline.

3.1 EQUIPMENT CLASSIFICATION CRITERIA

This standard utilizes multi-criteria equipment classification model based on hybrid criteria i.e. a combination between serial and parallel criteria. Serial criteria consist of government regulation and public services, while parallel criteria consist of safety, production, reliability, spares availability, frequency of failure and applicability of condition monitoring technique. Both models are used to assess equipment criticality rating. The criteria is assessed one by one using combination model of serial and parallel criteria, such as shown at Appendix B. The equipment criticality rating is divided into two broad classes, namely critical equipment and non-critical equipment.

3.1.1 Critical equipment

Refers to all equipment damage that:

- Can lead to plant shutdown.
- Can cause catastrophic failure and high maintenance costs.
- Can cause production loss and/or moderate maintenance cost.

3.1.2 Non Critical Equipment

Refers to all supporting equipment that is used for production process where equipment damage does not have any impact on production.

3.2 ENGINEERING CHANGE CLASSIFICATION AND PRIORITISATION

The classification of engineering changes shall be consistently implemented for systems, components, structures and parts according to the classification categories (Level 1, 2 and 3) as below. Furthermore every engineering change will be prioritised according to High, Medium and Low categories. This classification is also applied in the Engineering classification tool. The high priority requires a more urgent response than a medium or low priority engineering change.

Engineering change classification is divided into three levels and an engineering change management application drop down menu will be used to select the classification.

Components within a system shall be classified with respect to the safety function they fulfil and these may be different from the overall system or equipment classification. Components with multiple functions shall be classified according to the function that gives the highest safety classification. A level 1 plant is subjected to more stringent specifications and processes than a Level 2 or a Level 3 plant.

The classifications and related descriptions provide a guideline for the classification of an Engineering Change as follows:

3.2.1 Level 1

Should the change fail, it will have major impact i.e. unit trip, major equipment damage, environmental breach, and compromises personnel safety.

3.2.2 Level 2

Should the change fail, it will results in a decreased plant availability and reliability.

3.2.3 Level 3

All changes which do not meet the criteria for Level 1 or Level 2.

4. CRITICALITY CLASSIFICATION CATEGORIES

The criticality classification category is based on equipment classification model taking into consideration the industrial experience gained from the effect of plant failures with regard to the technical plant design and the location of the particular equipment in the plant.

4.1 COMPONENT CLASSIFICATION (IMPACT ON BUSINESS SHOULD THE COMPONENT FAIL)

Potential impact of the equipment failure is assessed in each of the following categories: safety, environmental integrity, quality, customer service and operating costs. The rating levels in each assessment category ensures that equipment impacting on the operational objectives of the organization when failure occurs is addressed and also failure resulting in safety and environmental consequences is emphasized. The results of equipment criticality rating assessment are classified into three classes, those are: Level 1, Level 2 and Level 3

4.1.1 Level 1 (L1)

- Serious personnel injury or fatalities,
- Catastrophic plant or equipment failure,
- Multiple Unit trip or
- Serious contravention of legislative requirements.

This level covers all plant that can severely jeopardise personnel safety, surrounding plant and equipment and have a major impact on production costs that should the component fail, will impact the structural integrity, design parameters and have an impact on or include:

a) The pressure boundary of all components and piping, together with one or all of the following:
   - Operate at a pressure in excess of 4MPa.
   - Convey steam or hazardous substances.
   - Operate at a temperature of above 250°C.

b) Rotating machinery having high kinetic energy (i.e. Turbines, ID, FD, PA fans etc.)

c) Equipment, components and piping support structures which have a direct impact on related equipment and systems e.g. Main steam pipe supports.

d) Mechanical safety devices and all plant protection and control logic.

e) Live electrical equipment housed in a flammable gas environment e.g. Hydrogen Plant.

f) Electrical equipment operating above 1000 volts or covered under the high voltage regulations.

g) Electrical equipment providing standby power for plant controls and protection equipment.

h) Equipment or components that contain combustible gas or dangerous toxic substances.

i) Equipment that can result in major contravention of legislative requirements.

j) Equipment that can result in a multiple unit trip or station shutdown.

4.1.2 Level 2 (L2)

- Safety and health impact,
- Line trip,
- Generation Unit trip or load loss and
- Minor contravention of legislative requirements.

This level covers all plant components and spares in which component failure, with a limited impact on production costs, would directly result in:

a) A partial load loss, or

b) A decrease in plant availability, or

c) A decrease in plant reliability, or

d) Create unsafe conditions or result in personnel injuries, or

e) An impact on legislative requirements.

6.1.3. Level 3 (L3)

No impact on safety, plant, legislation, URS etc.

This level covers all plant components that will have no impact on plant (and is not covered by L1 and L2):

a) Reliability, or

b) Availability, or

c) Safety, or

d) Legislation.

5. METHODOLOGY

In order to make the classification of components meaningful, it is necessary to consider the logical hierarchy of the equipment and the relationship between system components and their parent systems.

To illustrate the concept, the plant hardware must be broken down into a hierarchy containing 3 levels i.e. equipment level, component level and item or part level. Appendix A provides a typical turbine feed pump set and is explained as follows:

Equipment Level

The equipment level which represents the entire feed pump set.

The Boiler Feed Pump set operates at high temperature and pressure (typically 20MPa and > 100°C respectively) and its rotating items contains high kinetic energy. The classification assigned to the equipment is Level 1 based upon the following rationale (As shown in *Appendix A1*). There are two major failures that can challenge the structural integrity of the unit, failure of the pressure boundary due to crack failure of the casing, and the disintegration of the high kinetic energy rotating parts. Failure of the latter is less likely, as operating experience of the component indicates that an increase in monitored vibration levels are likely to occur before failure. A crack failure of the casing may go undetected and result in a catastrophic failure and/or serious personnel injury.

The two failures outlined above will also have a major impact on production costs.

Component Level

Both turbine and pump are assigned a classification Level 1 as both components operate at high temperature and pressure conditions. The gearbox however is classified as a Level 2 item as its failure will result in a pump set trip. However, if no redundancy exists, the potential high cost impact can make this component a Level 1.

The rationale for not initially classifying the gearbox as a Level 1 component is that its indicates that a catastrophic disintegration of the high kinetic energy gears and the casing is unlikely and that a failure is likely to be detected before significant damage occurs.

Each component is broken down further into its individual Items. Each item is then classified by the impact that their failure may have on the parent component.

Item Level

Once again, using the turbine as an example, the casing and rotor are classified as Level 1 items. The pressure gauge, however, is classified as a Level 3 component, as it would not affect the operation of the turbine.

6. THE IMPACT OF CRITICALITY CLASSIFICATION ON MANAGEMENT PROCESSES

The application of an asset classification system on equipment and activities has a significant impact on plant maintenance, engineering, operations and the skill level required to ensure availability and reliability of such plant. This approach cascades down to include:

- Procurement Specifications,
- Configuration Management,
- Occurrence Reporting and
- Engineering Change Control.

Quality requirements corresponding with each level of classification shall be developed. The application of the plant criticality classification concept within Eskom Generation is described below. These requirements shall be included and applied in all technical plant related processes as prescribed by this standard.

6.1 APPLICATION WITHIN ENGINEERING

The application of the criticality assessment provides a means of identifying the equipment most likely to impact on business performance by improving reliability. There are several areas where the functional criticality classification is utilised. A few examples of how criticality classification results can be used are described below.

6.1.1 Design Evaluation

The functional criticality, combined with the probability of failure will highlight equipment or design solutions which may need further attention such as engineering judgement. All components shall be classified in accordance with this Standard during the engineering design process. *Appendix C: Equipment Classification Flowchart* shall be used to classify components.

6.1.2 Engineering Changes

The philosophy used to classify engineering changes to plant, equipment and structures is the same as that used for component classification; however, the accent is on the impact of the possible failure of the design on personnel safety, plant reliability and availability, and contraventions of statutory requirements. Cost in terms of production loss is also taken into account. The engineering change classification tool shall be used to classify engineering changes.

6.1.3 Configuration Management

The aim of Eskom asset Configuration Management is to ensure that the physical asset reflects the current approved baseline with regards to the physical and functional characteristics of such asset. This discipline was introduced to and applied to the Nuclear and Aviation industry as required by legislation for many years, therefore a World's Best Practice.

Plant criticality classification provides the means to identify assets within Eskom that require Configuration Management to ensure compliance to statutory requirements, safety of personnel and continuity of supply of electricity.

6.1.4 Design Base Back-fit (Manage Item Configuration (MIC), Verification)

In the event that baselines (Asset designs at a specific point in time) need to be verified, Level 1 items are to be considered a priority for Configuration Management.

6.2 APPLICATION WITHIN OPERATIONS

Asset Criticality Classification shall be applied in operational activities including the areas of test procedures, approval levels and authority levels for the issue of permit to work. All isolations on Level 1 plant are therefore Level 1 activities.

All maintenance activities on Level 1 plant requiring isolations should be highlighted as such on the PM order. The philosophy used to classify routine and special tests is similar to that used determining the level of classification of an engineering change. The classification assigned to the test will determine the level of review and approval of the test procedure.

When assigning a classification level, the proposed test procedure must be assessed in terms of its impact on plant, personnel safety and performance. Typically a test that could jeopardise plant and personnel safety if not developed and performed correctly would be assigned a Level 1 activity and the procedure would be subjected to a stringent review and approval process.

6.3 APPLICATION WITHIN MAINTENANCE

The three levels of criticality classification have a significant influence on the Maintenance strategy for plant and components.

Quality plans for maintenance activities are provided for each classification level. Within these plans, the criticality of activities and the necessary controls are stated, commensurate with the classification level of the component, to ensure that it receives the attention required in order to function safely and reliably after maintenance activities have been performed.

Critical activities performed on Level 1 components for example would be assigned a different training, knowledge and skill level of artisan and more stringent controls, than those applied to activities performed on Level 3 equipment.

6.4 APPLICATION WITHIN SKILLS AND PERSONNEL DEVELOPMENT

To ensure that activities on components (Eskom assets) are performed in accordance with requirements as stipulated within this Standard and other applicable Eskom Standards, the appropriate skill level of the individual should be graded accordingly. The new inexperienced individual is utilised on Level 3 equipment. As the individual gains more experience and knowledge and his competence increases, he/she will be upgraded to work on Level 2 equipment, and eventually Level 1 equipment.

6.5 APPLICATION WITHIN PROCUREMENT

The plant component classification when related to the procurement process should determine the level of control and input from engineering required during the manufacturing and purchasing process or any particular plant component or a plant spare part.

This would require that all plant spares be classified using the same rationale. The quality assurance control requirements necessary for a component classified as Level 1 will be more stringent than those required for a Level 2 or 3 components. All Level 1 equipment shall be purchased from the OEM only.

7. AUTHORISATION

This document has been seen and accepted by:

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8. REVISIONS

Date	Rev.	Compiler	Remarks
November 2013	0.1	P. Meiring	First Draft for Review
June 2014	1	P. Mhlongo	Final Document for Authorisation and Publication
Jan 2018	1.1	L. Koech	Updated draft for internal review process
Feb 2018	1.2	L. Koech	Updated draft for formal review process
March 2018	1.3	L. Koech	Final Draft Document for Business Comments Review
April 2018	1.4	L. Koech	Updated Final Draft after Business Review Process
April 2018	2	L. Koech	Final Rev 2 Document for Authorisation and Publication

9. DEVELOPMENT TEAM

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10. ACKNOWLEDGEMENTS

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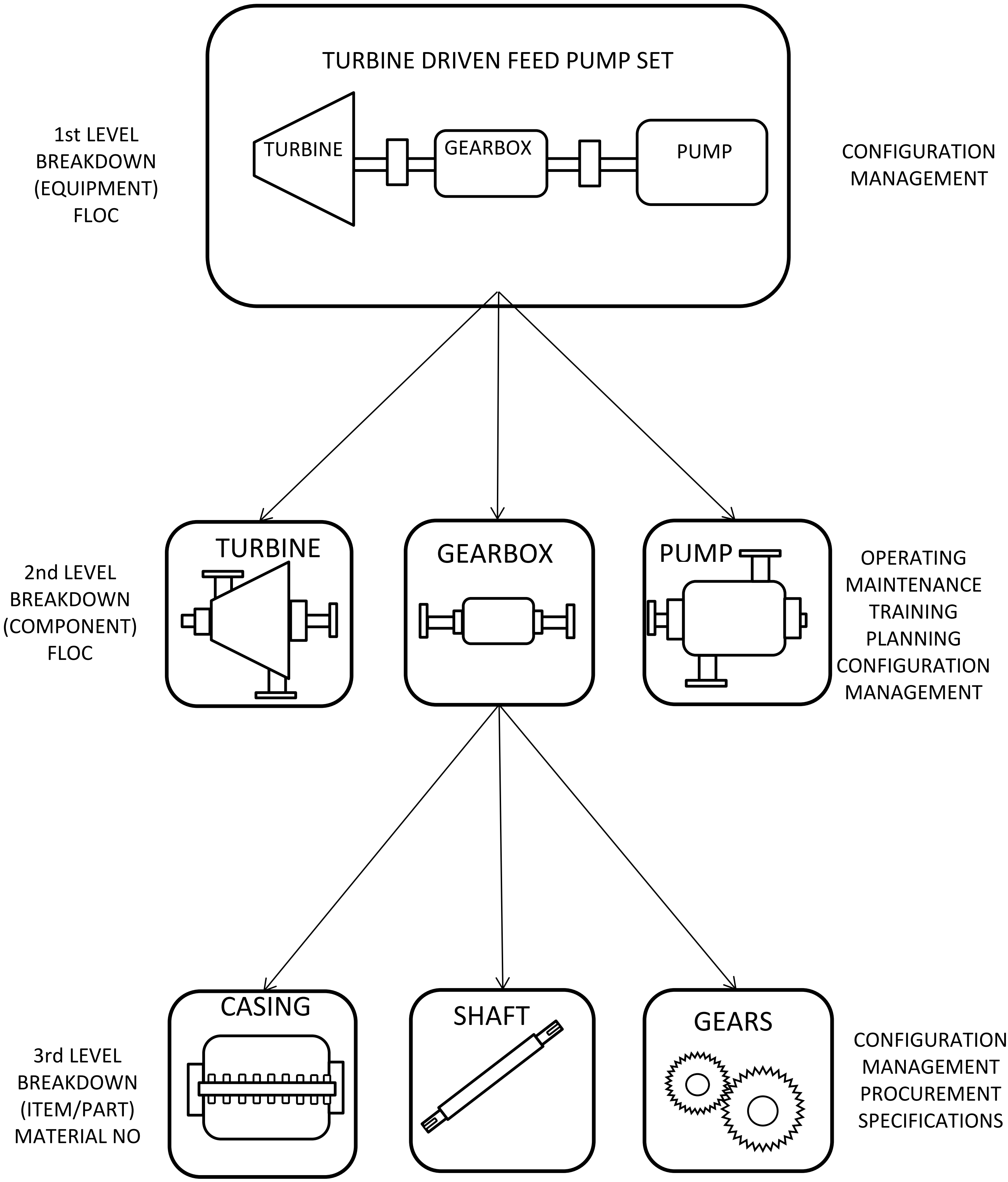
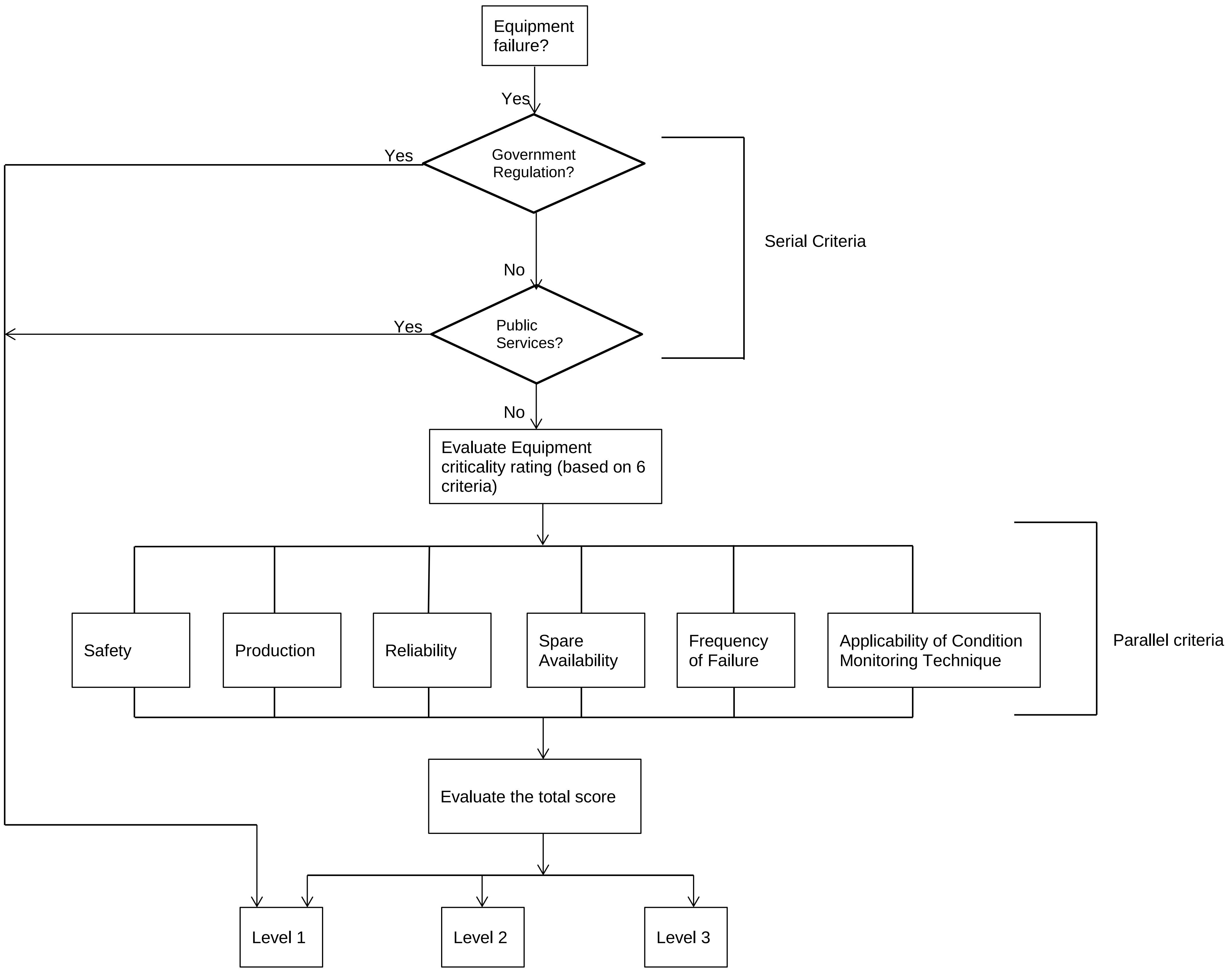
APPENDIX A: TURBINE FEED PUMP, EQUIPMENT, COMPONENT AND ITEM PBS



APPENDIX A1: EXAMPLE SUMMARY OF TURBINE DRIVEN FEED PUMP CLASSIFICATION

Breakdown	Classification Level	Rationale
Turbine Driven Pump Set	1	Catastrophic failure of the set will severely jeopardise the safety of personnel and could result in major equipment damage.
— Pump	1	Pressure boundary. High Personnel and plant safety impact.
— — Pump Casing/Bolting	1	Pressure boundary. High Personnel and plant safety impact.
— — Impeller	1	High energy rotating component. Will cause significant damage on failure.
— — Thrust Beatings	2	Failure will result in pump trip and reduce availability.
— — Pressure Gauge	3	No significant impact on safety, reliability and availability.
— Gearbox	2	Failure will result in pump set unavailability.
— — Gear Casing	2	Failure will result in pump set trip.
— — Gearbox Internals	2	Failure will result in pump set trip.
— — Oil Level indicator	3	No significant impact on safety, reliability and availability.
— Turbine	1	Pressure boundary. High Personnel and plant safety impact.
— — Turbine Casing	1	Pressure boundary. High Personnel and plant safety impact.
— — Turbine Rotor	1	High energy rotating component. Will cause significant damage on failure.
— — Bearings	2	Failure will result in pump set trip.

APPENDIX B: COMBINATION MODEL OF SERIAL AND PARALLEL CRITERIA.



APPENDIX C: EQUIPMENT CLASSIFICATION FLOWCHART