NSW DEPARTMENT OF PRIMARY INDUSTRIES

# ELECTRICAL ENGINEERING AUDIT OF POWERED WINDING SYSTEMS IN NSW

## 1. Introduction

There are approximately 48 powered mine winding systems in NSW excluding the Opal Mining industry.

The Department of Primary Industries – Mine Safety Operations Branch, places powered winding systems in the high risk category as a potential major hazard for multiple fatalities.

The OH&S regulations and the Coal Mining Regulations both require design and item registration for powered winding systems. The Metalliferous Industry is soon to follow suit.

## 1. Purpose

The purpose of the prescriptive audit is to measure the degree of design and operational safety of powered winding systems in respect to current standards and guidelines, to identify opportunities to improve the safe life cycle operation of powered winding systems and to identify non conformances resulting from the prescriptive audit where the outcomes may assist mines to upgrade using current technology.

## 3. Standards and Guidelines

The audit is Quality Assurance based and refers to the following standards and guidelines:-

**MDG 2005** – Electrical Technical Reference for the Approval of powered Winding Systems.

**MDG 33** – Guideline for the Design, Commissioning and maintenance of Drum Winders.

**MDG 12** – Guide for the Construction of Friction Winders.

**AS 42024.1** – Safety of Machinery.

**AS 61508** – Functional Safety of Electrical / Electronic Programmable Electronic Safety Related Systems.

**AS 62061** – Safety of Machinery – Functional Safety of Safety Related Electrical, Electronic and Programmable Electronic Control Systems.

## 3. Review

MDG 2005 is currently under review in to order to acknowledge changes in technology, coupled with the knowledge base obtained from the audit program.

The long term view is to recommend the establishment of an Australian Standard in respect to the Electrical Engineering Design, Operation, Maintenance and Commissioning of Powered Winding Systems.

## 4. Audit Program

The audit program provides for a report to operators on the outcome of the audit including itemised non conformances.

The percentage ratings are Quality Assurance based and refer to the total number of questions, not to the severity of the non conformance detected.

As part of the audit report, operators have been requested to provide a timed scheduled program of upgrade addressing the itemised non conformances.

There has been little response to this request; however I am aware that most operators are addressing upgrades.

There are three separate audit documents relating to powered winding systems namely:

Single Rope, Drift Winders.
Single Rope, Vertical Shaft Winders.
Multiple Rope, Vertical Shaft Friction Winders.

These documents are available on the DPI website.

The audit program consists of 150 to 200 questions related to the Electrical Engineering design, operation and maintenance of powered winding systems.

Itemised questions relate to all powered winding systems, hence some questions will not relate to specific installations as the design of every powered winding system is different.

The initial audit of all coal mine powered winding systems has been conducted and operators have received the initial audit report.

"Follow up" audits will be conducted to monitor progress towards registration.

## 5. Registration

For the purposes of the Electrical Engineering component of powered winding systems, there are two approaches that can be taken to achieve registration.

These are the **Functional Safety** approach and the **Prescriptive Compliance** approach.

**5.1** The **Functional Safety** approach primarily applies to new winder designs although this approach can be applied to existing powered winding systems if so desired.

Proof testing will be a critical element of the ongoing maintenance of SIL levels and where any safety related parts of the powered winding system have programmable electronic components, software management and change control of these systems are critical.

The system of "management of change" for the programming of PES systems shall be structured to prevent inadvertent and / or intentional mismanagement of the system.

**5.2** The **Prescriptive Compliance** approach for existing powered winding systems, generally requires compliance with the prescriptive audit questions, together with full compliance with the guidelines MDG 2005, MDG 33 and where applicable MDG 12.

The system of "management of change" for the programming of PES systems shall be structured to prevent inadvertent and / or intentional mismanagement of the system.

Both of the above methodologies incorporate the principle of primary and secondary safety circuits and include commissioning, testing, inspection and maintenance which are all critical components in the life cycle management of powered winding systems.

In general and for both methodologies, it is expected that a minimum SIL rating of 2 will be achieved for powered winding system safety circuits.

## 6. Audit Results

I have conducted initial audits of all 33 powered winding systems at coal mines and 4 at metalliferous mines.

In the case of powered winding systems at coal mining operations, initial audits have shown that achievement toward registration varied from 34% to 98%.

The average state performance is 75%

In breaking up the three areas of the state, performance figures are:

Northern District 90%
Western District 76%
Southern District 60%

Winders from each district have been recommended for registration.

For Metalliferous mines, the average state performance is 72%.

There have been no recommendations for the registration of any metalliferous winder,

I have generally found that most powered winding systems have complied with the basic requirements of MDG 2005 and the "Markham Report", however with many operators; there are a substantial number of areas to be addressed in order to meet current standards and guidelines.

## 6.1 **Some of the issues related to coal mine winders are**:

- Lack of five yearly audit programs.
- Inadequate functional safety analyses.
- There is an understanding of the SIL concept of design, however there are short comings in the application and philosophy.
- Lack of identification of components forming part of the primary safety circuit.
- Inadequate “stand alone” protection systems in respect to safety circuits.
- Inadequate protection against the occurrence of the “first fault” in safety circuits.
- The use of “shunt trip mechanisms” without the provision of redundancy.
- Inadequate “back up” signalling and voice communications systems.
- Inadequate over travel protection and insufficient “back up” over travel protection.
- Lack of adequate drum pit flood protection.
- Very little knowledge of the possibility of brake path contamination due to changes in atmospheric temperature and humidity.
- Very little evidence of brake proving systems where the application of the mechanical braking system is proven prior to removal of electric power or regenerative braking / retardation from the motor. Brake proving is necessary to minimise the risk of “free wheeling” of the conveyance.
- The recording of emergency stop events.
- Earthing requirements for headframes and gantries.

- Inadequate protection systems on drift winder conveyances.
- Inadequate provision for automatic operation of shunting points on surface gantries.

**6.2 Further additional issues related to Metalliferous mine winders are:**

- Inadequate emergency stop systems
- Inadequate signalling systems
- Inadequate communication systems
- Inadequate "dead man" control systems
- Inadequate provision of facilities for static and dynamic brake testing
- Inadequate detection systems in respect to conveyance "hang ups" in mine shafts

**6.3 Areas where compliance with guidelines is reasonably adequate are**:

- The establishment of management systems
- Life cycle management
- Motor protection
- Emergency stopping (coal mine winders only)
- Over speed protection
- Gearbox protection
- Rope slip and unsafe coiling protection (coal mine winders only)
- Voice and signalling communication systems (coal mine winders only)
- Conveyance protective devices (coal mine winders only)Pre start visual and audible alarms (coal mine winders only)
- Torque sensing.
- Brake testing. (coal mine winders only)

## 7. Application of SIL Technology.

There appears to be a good knowledge base in conducting SIL assessments, however it is in the area application and interpretation that I consider there are shortcomings.

To cite one example:

The SIL rating and application to overwind limits including the cabling supplying them.

I have found that the design of these systems is as varied as the mind can conceive.

The guidelines require two physical over wind limits operating into "stand alone" protection systems. These over wind devices are required to have "back up" systems in place.

In applying the requirements of the guidelines and utilising SIL rated components, I would have expected to see four physical over wind limits, supported by "back up" systems and with four separate cables supplying the devices.

At least two electrical engineers have got it right.

### 7.1 Some of the examples I have seen are:

A single SIL rated overwind limit with dual contacts and one supply cable.

A single SIL rated overwind limit with dual contacts and two supply cables.

A single initiating device operating two SIL rated devices

Clearly the philosophy of multiple redundancies, coupled with the requirement of "stand alone" systems has NOT been applied even though SIL rated components have been utilised.

In fact, in the case where single rope shaft winders may have dispensation from the requirement to utilise detaching hooks, it is critical that multiple redundant systems are applied to over wind devices.

## 8. Conclusion.

In winding up, it is pleasing to say that for the purposes of the electrical engineering component of powered winding systems, five coal mine winding systems of the thirty three audited have been recommended for registration and several are nearing registration.

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