

Appendix A5 – PSA Impact of Changing EDG Starter Motor

CONTROLLED DISCLOSURE

When downloaded from the document management system, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the system.

No part of this document may be reproduced without the expressed consent of the copyright holder, Eskom Holdings SOC Ltd, Reg No 2002/015527/30.

Appendix 3

PSA Analysis

Date:
21 February 2014

Enquiries:
L Jacobs
Tel +27 21 550 4871

PSA14-0011
Alternate Ref: FA-0135

PSA impact of changing EDG starter motor

1 Introduction

The Koeberg EDGs have not performed at satisfactory levels for a sustained period of time. The 2008 WANO peer review identified the Koeberg EDGs as an Area for Improvement (AFI) with a similar finding (related AFI) during the 2011 WANO peer review.

An Emergency Diesel Generator (EDG) Recovery Project Team was established in August 2012 to deal with the issues affecting the reliability and availability of the EDGs onsite. A project scope for execution within predetermined timelines was established following US benchmarking and various internal self-assessments. The EDG project scope was subsequently presented to and accepted by the PHC on 30 May 2013.

The project identified that obsolescence played a major part in the inability to resolve long standing equipment problems and as one of the solutions proposed a new cylinder injection start system to replace the existing pneumatic motor. The new direct air injection starting system shall be designed, analysed and manufactured in accordance with the applicable codes, standards and international best practices which shall be justified by the Contractor in collaboration with the Original Equipment Manufacturer (OEM).

In the current design, each EDG has two redundant and diverse starting mechanisms. The proposed modification retains redundancy but eliminates diversity, and thereby introduces a new common-cause failure mechanism that could potentially affect both starting mechanisms on all five EDGs. This memo estimates the risk increase associated with replacing the existing pneumatic starter motor with a second direct injection starter motor. It was concluded that this increase was not significant.

2 Analysis Method

Analyses were performed using the latest official release of the Koeberg PSA model, PSA13R11.rpp. An absolute cut-off of $1.0E-12$ was used for all analyses. Since the Riskspectrum PSA model does not specifically model the two starter motors on the emergency diesels, the model had to be modified to include the starter motors in the baseline model. This was done by adding two new events for each of the three emergency diesels modelled for Unit 1 (LHP, LHQ and 9LHS) and using failure data obtained from the report 'Unavailability of the Emergency Diesel Generators at Koeberg NPP' [Ref. 1] to populate

Koeberg Operating Unit
Nuclear Engineering
1027 09 West Coast Road Melkbosstrand Western Cape
Private Bag X10 Kenning 7440 SA
Tel +27 21 550 4911 Fax +27 21 550 5400 www.eskom.co.za



CONTROLLED DISCLOSURE

When downloaded from the document management system, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the system.

No part of this document may be reproduced without the expressed consent of the copyright holder, Eskom Holdings SOC Ltd, Reg No 2002/015527/30.

these new events. Generic common cause failure data was obtained from "Common Cause Failure Parameter Estimations" [Ref. 2] and new common cause groups were added to the model. The parameter information for the new basic events for all three diesels in the PSA model is given below:

- Diesel engine fails to start/ air motor: 4.62E-03 per year
- Diesel engine fails to start/ direct injection: 2.05E-03 per year

Automatic MGL common cause groups between the three emergency diesels were set up for the two different starter motors using the following parameters:

- Beta Factor: 3.70E-02
- Gamma Factor: 4.50E-01
- Delta Factor: 0.00

The base case was then modified to have two direct injection starter motors instead of one direct starter and one pneumatic starter motor. The common cause parameters were adjusted to account for common cause failure between all starters on all the diesels.

The new parameters are as follows:

- Diesel engine fails to start/ direct injection 1: 2.05E-03 per year
- Diesel engine fails to start/ direct injection 2: 2.05E-03 per year
- Beta Factor: 3.65E-02
- Gamma Factor: 6.65E-01
- Delta Factor: 6.56E-01

Both models were run to determine the CDF.

3 Results and Conclusion

The base case CDF was determined to be 7.882E-06 per year. The CDF for the modified case of two direct injection starters was determined to be 7.886E-06 per year. This gives a Δ CDF of 4.0E-09 per year. Therefore it can be concluded that the modification to change out the pneumatic starter motor for a second direct injection starter motor on the emergency diesels does not lead to a significant increase in risk in terms of 331-64 [Ref. 3], and that this proposed activity is therefore acceptable from a PSA perspective.

4 References

1. PSA-R-T09-18 Rev. 3 (FA-026), Unavailability of the Emergency Diesel Generators at Koeberg NPP, December 2012.
2. NUREG/CR-5497, Common Cause Failure Parameter Estimations, 1998
3. 331-64 (KGA-046), Guideline for Safety Issue Categorisation, 2012.

CONTROLLED DISCLOSURE

When downloaded from the document management system, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the system.

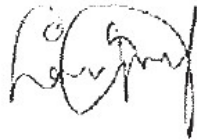
No part of this document may be reproduced without the expressed consent of the copyright holder, Eskom Holdings SOC Ltd, Reg No 2002/015527/30.

COMPILED:



Linda Jacobs
Senior Physicist, PSA
Nuclear Engineering

REVIEWED:



Emmanuel Lamprecht
Risk Analyst, PSA
Nuclear Engineering

APPROVED:



Lindley Perryman
Corporate Consultant
Nuclear Engineering

CONTROLLED DISCLOSURE

When downloaded from the document management system, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the system.

No part of this document may be reproduced without the expressed consent of the copyright holder, Eskom Holdings SOC Ltd, Reg No 2002/015527/30.