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Program area Nuclear
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Strategy plan

Vibrations

- Analysis and avoidance of vibration related problems

Period: 2016-01-01 to 2018-12-31

Summary

The Vibrations R&D program aims at reducing vibration problems that might affect outages and also cause power reductions. This is obtained through an increased knowledge on measurement, analysis and mitigation of vibrations in key components in the nuclear power plant. Several mapping activities were initiated during the 2014-2015 period, and the challenges identified in these mapping projects will now be processed in this program period.

1 Vision

The vision of the program is to increase knowledge and awareness on how to avoid vibration problems in Nuclear Power Plants and thereby reduce vibration related disturbances, leading to higher plant availability and better predictability.

2 Benefits and deliverables

2.1 Receivers of expected benefits/deliverables

The receivers are the owner companies and the personnel at the nuclear power plants (NPPs). The deliverables will be directly used by the NPP staff in maintenance and in the plant development and improvement for a safer and more predictable operation of the plants.

2.2 Expected benefits

The activities within Vibrations will provide benefits to the owner companies through higher availability and predictability.

Through increased knowledge there will be less vibration problems in the NPP's and as a consequence better availability and predictability.

2.3 Expected deliverables

Guideline and recommendation on how to measure pipe vibrations will be developed. Also best practice on how to analyse and mitigate pipe vibrations, diesel engine generator sets and turbine/generator vibrations will be reported. There is a lack of clear standards and requirements for some equipment in the NPPs today. There will also be activities to close these gaps.

3 Focus areas and activity plan

The focus areas for Vibrations R&D program for 2016-2018 are:

1. Vibrations in piping, including valves and pipe supports
2. Emergency diesel generator (EDG) sets vibrations
3. Turbine and generator vibrations

3.1 Vibrations in piping, including valves and pipe supports

3.1.1 Introduction

Pipe vibrations have caused large problems during power uprate projects at the NPP's. Pipe vibrations can be induced by flow along surfaces or around discontinuities, acoustic resonance or by some mechanical excitation. There are also fluid structure interaction phenomena where vibrations of structures influence the vibrations of adjacent structures by vibration induced pressure waves through the medium.

3.1.2 Objectives

Develop recommendations/guidelines concerning pipe vibration levels, measurements and mitigation.

3.1.3 Activities

Further develop the outcomes from the mapping project carried out within the 2014-2015 phase and:

- Perform an extended literature survey of pipe related vibrations problems in NPPs worldwide
- Map vibration problems caused by load following. Literature study and interviews are suggested.
- Develop a recommendation of allowable vibration levels on valves
- Develop recommendations/guidelines on how to measure pipe vibrations in different locations. Which transducers should be used to measure different kinds of vibrations at different locations?
- Develop recommendations/guidelines on how to analyse and mitigate pipe vibration

3.2 Emergency diesel generator (EDG) sets vibrations

3.2.1 Introduction

Vibrations in EDGs can be induced by coincidence of excitation frequencies and Eigen frequencies of the connected piping, equipment or structures.

3.2.2 Objective

Assemble knowledge and experience in the area of EDG vibration problems and study in some depth how they were investigated and mitigated. This information shall be put together in a report that can be used when changing components, flows, pressures and/or temperatures in the plants.

3.2.3 Activities

A mapping project within this area was initiated during 2015. This activity is expected to identify problem areas, that will be further investigated in the 2016-2018 phase of the program.

3.3 Turbine and generator vibrations

3.3.1 Introduction

Although turbines and generators are not a safety related issue it is of course crucial to have them functioning properly to have a high availability and efficiency in the plant. During the years there have been different problems related to turbine and generator vibrations and therefore it is very important to improve the performance and minimize the risk for vibration problems.

3.3.2 Objective

Assemble knowledge and experience in the area of turbine/generator vibration problems and study in some depth how they were investigated and mitigated. This information shall be put together in a report that can be used when changing components, load etc. in the plants.

3.3.3 Activities

A mapping project within this area has commenced in 2015. This activity is expected to identify problem areas, that will be further investigated in the 2016-2018 phase of the program.

4 Governance

The steering group consists of:

Forsmark: Magnus Adolfsson and Ylva Vidhög

Fortum: Heikki Haapaniemi and Jari Tenhunen

OKG: Tobias Törnström(chairman), Carl Möller and Kent Andersson

Ringhals: Stefan Melby and Lena Skoglund

Swedenergy: Inge Pierre

TVO: Paul Smeeke and Petri Lemettinen

5 Background

5.1 Needs and challenges of the nuclear industry

Vibration problems are often complex and cause long periods of shut down or reduced power leading to large losses of income. Especially during power uprate projects there have been large vibration problems at the nuclear power plants. For instance at Oskarshamn Unit 3 there have been vibration problems in the steam lines caused by the new MSIV (Main Steam Isolation Valves). Moreover Forsmark 2 had vibration problems when changing HPT (High Pressure Turbine) inlet valves some years ago. Ringhals 3 encountered high vibration levels in the steam lines due to the design of the steam generator outlet nozzle. The problems at Ringhals 3 were not related to a power increase but due to a planned change of the steam generators.

The current situation with low electricity prices has led to a new situation where the NPPs are down regulated. This might lead to increased wear, tear and vibration levels.

The vibration experts at the nuclear power plants have expressed a desire to increase the in-house knowledge on measurement, analysis and mitigation of vibrations in different components. There are only a few experts within the field, and many of them are close to retirement. The situation is the same at the nuclear power plants, at the suppliers and at consultancy companies, which makes it hard to solve the problem by recruitment. Instead new candidates must be educated in the field of vibrations, through a knowledge transfer from the experts about to retire.

5.2 Previous achievements

The Vibrations program was started in 2014. A number of activities and workshops have been carried out to map the area and identify knowledge gaps. Through this work the three focus areas were identified, and mapping projects were started to prepare for the 2016-2018 program period.