

**386**

# **GENERATOR MAINTENANCE, INSPECTION AND TEST PROGRAMMES**

**Working Group  
A1.07**

**August 2009**



## WG A1.07

# Generator Maintenance, Inspection and Test Programmes

### Members

John Linton, Convener	AU
Vojislav Skundric	RS
Philippe Machard	FR

### Contributors

Helen Rooke	AU
Erlí Figueiredo	BR
Pedro Grossi	BR
Reijo Manninen	FI
Jean Ricoux	FR
Giorgio Maccio	IT
Kiyoshi Miyaike	JP
Feodor Polyakov	RU
Reinhard Joho	CH
Robert Fenton	US
Dave Berrong	US
Jim Michalec	US

### Copyright©2009

“Ownership of a CIGRE publication, whether in paper form or on electronic support only infers right of use for personal purposes. Are prohibited, except if explicitly agreed by CIGRE, total or partial reproduction of the publication for use other than personal and transfer/selling to a third party. Hence circulation on any intranet or other company network is forbidden”.

### Disclaimer notice

“CIGRE gives no warranty or assurance about the contents of this publication, nor does it accept any responsibility, as to the accuracy or exhaustiveness of the information. All implied warranties and conditions are excluded to the maximum extent permitted by law”.

© 2009 CIGRE. All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of CIGRE.

## TABLE OF CONTENTS

<b>1. EXECUTIVE SUMMARY.....</b>	<b>3</b>
1.1. Methodology.....	3
1.2. Access for Generator Maintenance.....	3
1.3. Generator Component Maintenance.....	5
1.4. Generator In-Service Diagnostic Testing.....	5
1.5. Generator Maintenance Practices.....	6
1.6. Conclusions.....	6
<b>2. RESPONSES.....</b>	<b>7</b>
2.1. Users.....	7
2.2. Manufacturers.....	7
<b>3. GENERATOR MAINTENANCE OUTAGE SCHEDULING PRACTICES.....</b>	<b>8</b>
3.1. Shutdown Maintenance Access.....	8
3.2. Shutdown Scheduling.....	8
3.3. Outage Duration.....	9
3.4. Generator Rotor Removal.....	9
3.5. Other Comments.....	10
<b>4. PLANNED MAINTENANCE TASKS FOR GENERATOR COMPONENTS.....</b>	<b>11</b>
4.1. Stator winding – slot content.....	12
4.2. Stator winding – end windings.....	13
4.3. Stator winding - terminal box.....	13
4.4. Bushings.....	13
4.5. Core & frame.....	14
4.6. Stator cooling water system.....	14
4.7. Stator water treatment.....	15
4.8. Rotor.....	15
4.9. Hydrogen cooling system.....	15
4.10. Hydrogen seals.....	16
4.11. Bearings.....	16
4.12. Seal oil system.....	16
4.13. Slip rings & brush gear (or diodes).....	17
4.14. Instrumentation.....	17
4.15. Neutral point grounding system.....	17
4.16. Generator electrical protection system.....	17
4.17. Excitation system.....	18
<b>5. GENERATOR IN-SERVICE DIAGNOSTIC TESTING.....</b>	<b>19</b>
5.1. Stator winding – slot content.....	19
5.2. Stator winding – end windings.....	19
5.3. Rotor.....	20
5.4. Core & frame.....	20
5.5. Hydrogen cooling system.....	20
5.6. Stator water treatment.....	20
5.7. Bearings.....	21
5.8. Slip rings & brush gear (or diodes).....	21
<b>6. GENERATOR MAINTENANCE PRACTICES.....</b>	<b>22</b>
6.1. Scenario 1:.....	22
6.2. Scenario 2:.....	23
6.3. Scenario 3:.....	23
6.4. Additional Comments:.....	24
<b>7. CONCLUSION.....</b>	<b>24</b>
<b>8. APPENDIX 1 - Appendix to Chapter 4.....</b>	<b>25</b>
<b>9. APPENDIX 2 - Appendix to Chapter 5.....</b>	<b>56</b>
<b>10. APPENDIX 3 - Appendix to Chapter 6.....</b>	<b>67</b>

## **1. EXECUTIVE SUMMARY**

The maintenance, inspection and testing of large hydrogen & water cooled turbo-generators remains one of the most significant costs of asset ownership for electricity generation companies worldwide. Competitive reforms in electricity marketing structures and ownership have imposed significant cost pressures in many countries that have resulted in decisions to reduce maintenance and inspection frequency and accept greater operating risk, albeit through managed risk assessment and mitigation programs. There is both factual and anecdotal evidence that in some instances the risk envelope is being stretched quite significantly compared to previous practice.

The objective of this study was to survey actual and recommended practice, and in so doing identify the reasons and justification for differences. In addition, innovative and/or best practice maintenance procedures and strategies were explored.

The information obtained may help all countries maintain or increase generator reliability, by providing data that can be used to support review of maintenance practices, and providing information on improved techniques.

The study covered four main topics:

1. Planned maintenance access – generating unit outage scheduling factors.
2. Planned maintenance tasks for generator components.
3. Generator in-service diagnostic testing.
4. Generator maintenance practices.

### **1.1. Methodology**

The study used the survey methodology whereby members of Study Committee A1 were asked to obtain responses from a cross-section of users (utilities) and manufacturers in their own countries. The responses have been correlated and analysed to produce this report. The survey was limited to turbo-generators with ratings > 250MVA.

The responses were segregated into users and manufacturers. These categories are reported separately in chapter appendices, but combined in analysis of the relevant maintenance practices. There is no reference to the origin of highlighted responses in the text, although the tables of responses in the chapter appendices at the end of the report are presented under the name of the country of origin.

The survey obtained responses on utility practice from 11 countries, 4 of which also included responses either from a manufacturer, or on behalf of their manufacturers. The responses cover a total of 423 utility generators from 250MVA to over 800MVA, as well as manufacturers with combined annual production of 72 units in the same capacity range annually.

The results are presented in the Technical Brochure, including appendices with the response detail.

### **1.2. Access for Generator Maintenance**

The study generally confirmed that generator outages for maintenance fall into two main categories – minor and major – as follows:

“Minor” outage – limited duration; repair of known defects; plant surveys and inspections; preventive maintenance.

“Major” outage – extended duration; major plant item(s) dismantled for inspection / repair / replacement; repair of known defects; plant surveys and inspections; preventive maintenance.

The duration of outages varied as represented in Fig 1 that shows the most common duration for minor outages is about 2 weeks, and for major outages 5 - 7 weeks. There was no consistency at all reported in the intervals between outages – refer to the Technical Brochure.

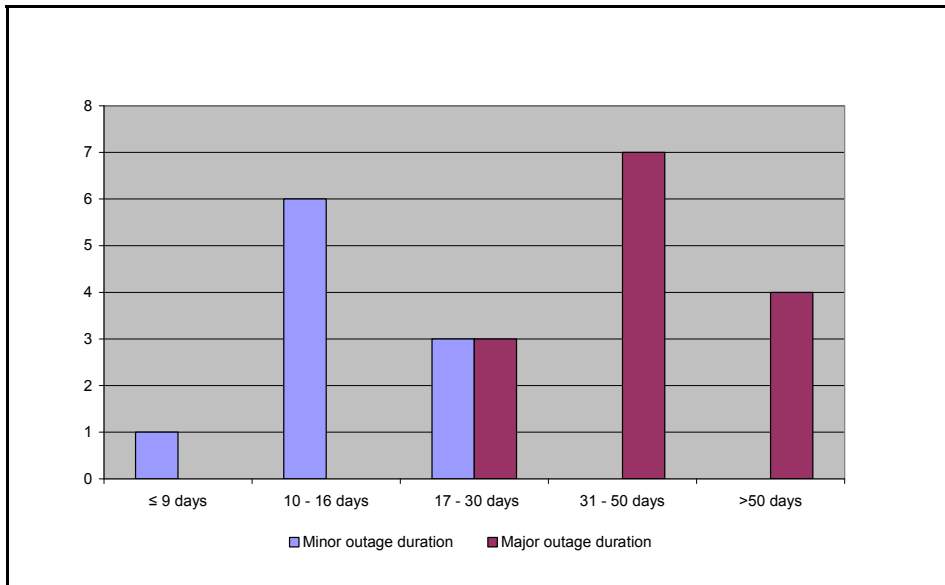


Fig 1: Outage durations reported.

In regard to practice in removing generator rotors for inspection, once again there was no consistency in the durations reported between such events. Fig 2 shows that the most common period however is 8 years.

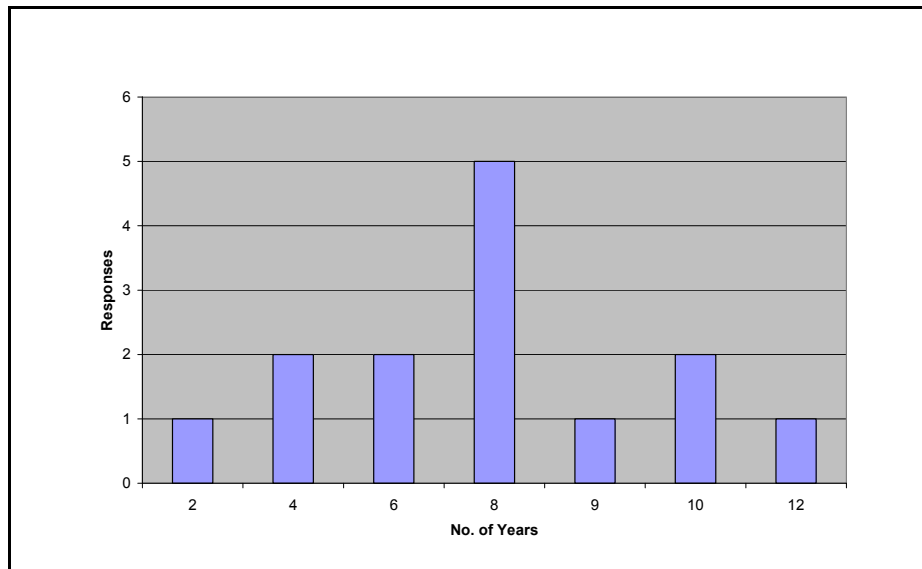


Fig 2: Periods Reported for Rotor Removal for Inspection

In general, a common response in regard to issues affecting access to generators for maintenance, was that the timing and periodicity of such maintenance is determined by other factors, typically maintenance

requirements on turbines, boilers and nuclear reactors (including re-fuelling) around which the generator maintenance program must fit.

### **1.3. Generator Component Maintenance**

Seventeen generator components, most including sub-components, were identified by the Working Group and included in the survey questionnaire. For each item, the following information was sought from users:

- Recommended maintenance interval and the source of the recommendation.
- Actual maintenance intervals.
- The decision basis if actual interval is different to that recommended.

On the other hand, manufacturers were asked only for:

- Maintenance intervals recommended, and
- An acceptable basis for changing their recommendation.

As per the previous section, there was a significant disparity in responses, so for many or most items, it was not possible to identify a preferred maintenance interval and accordingly the working group decided to include the full set of responses for the benefit of readers of the Technical Brochure. However some general remarks were possible:

- There was no general preference for either time based or service hour scheduling for maintenance tasks.
- The dominant source of interval recommendation was manufacturers, followed by company standards.
- There was a trend towards accepting the recommendation from the nominated source without change.
- The dominant reason from users for changing the recommendation was prior maintenance experience.
- One manufacturer stated an acceptable reason for changing their recommendation was through risk assessment; another market driven needs, while others did not nominate an acceptable reason.

The Technical Brochure includes a brief summary of the responses received for each item.

### **1.4. Generator In-Service Diagnostic Testing**

The Working Group identified eight generator components and systems for which in service diagnostic tests were applicable, and a total of seventeen tests were listed. The survey sought information on:

- The past, present and/or future application of each test;
- Mode (i.e. continuous or intermittent) and frequency of testing; and
- Reasons for the test application.

Several of the identified diagnostic tests were reported as commonly used.

- For the generator stator, partial discharge monitoring is generally applied on an intermittent basis, typically 6 monthly.
- For the generator rotor shorted turns detection is generally intermittently applied.
- For the Hydrogen cooling system, hydrogen dew-point and hydrogen purity are monitored on a continuous basis.
- For the stator water system, stator cooling water conductivity is continuously monitored, as is hydrogen leakage into stator water. Oxygen and copper concentration of the stator water are also monitored in a variety of modes.
- For the generator bearings, journal vibration is continuously monitored using dual probe monitors. Shaft grounds are also monitored but in a variety of modes.

Available diagnostic tests that were less commonly used included:

- Stator end windings vibration monitors.
- Stator core/frame vibration monitoring. This was nominated as being used generally only if a vibration condition was occurring and known. Audio detection of stator core lamination vibration was also not commonly applied.
- Hydrogen make up rate monitoring.
- Brush gear on-line condition monitoring, and diode breakdown detection, even though the latter was generally recommended by manufacturers.

The information provided on reasons for using in-service diagnostics was patchy – the most common reason being that it was company usual practice. All but two of the countries who responded said they did not use any form of expert system to diagnose monitored variables and generate alarms or other actions.

## **1.5. Generator Maintenance Practices**

The survey questionnaire sought to identify best practice techniques for major preventive and corrective maintenance tasks on generators, based on three common maintenance scenarios, ranging from a short inspection shutdown with the generator de-gassed, to a long shutdown with the rotor removed. The scenarios and responses to listed maintenance techniques applicable to each scenario, are detailed in the Technical Brochure.

The most consistently used maintenance practices used included:

- Use of formal quality control systems;
- Formal confined space entry procedures for generator casing access;
- Controls on internal inspections and inspectors;
- Use and control of clean condition enclosures; and
- Documented procedures at critical stages.

## **1.6. Conclusions**

The survey has provided a basis for comparison by utility engineers of maintenance practices across a range of countries. The responses included with the Technical Brochure provide a library of maintenance task recommendations and actual practices that could be considered by generator owners if new or modified practices are being contemplated.

The most significant conclusion is that there is a considerable diversity in approach and practice in use internationally. It has proven unrealistic to anticipate that a study such as this can identify best or preferred practice in any particular area of generator maintenance.

## 2. RESPONSES.

The response details including number and rating of generators included is summarised in the following tables – countries reported in alphabetical order:

### 2.1. Users.

The following table summarises the responses received from users (utilities). The response is taken to be typical of country practice unless otherwise indicated. In this report, all separate responses have been analysed and reported

In the case of Italy, two separate responses were received that related to base load and mid-load units. For Australia, there were 3 separate responses received that were sufficiently different to not sensibly enable combination to a unified response. For both countries, the responses are reported separately.

COUNTRY	GENERATOR SIZE RANGE			COMMENTS
	250-500 MVA	500-800 MVA	> 800 MVA	
Australia 1, 2 & 3	4	8		Responses from 3 separate utilities
Brazil	2			Utility – 2 synchronous condensers
Croatia	2			
Finland	12	1	2	
France	14	12	58	
Italy – Base load	27	4		Base load units
Italy – Mid load	8	12		Mid load units
Japan	52	22		Thermal plant only
Serbia-Montenegro	10	2		
Russia	108	14	1	
USA	20	10	15	Single utility.
Switzerland	2		1	

### 2.2. Manufacturers.

The following table summarises the responses received from manufacturers. Note that the generator size range relates to the number of units in the size range manufactured annually. USA-2 is a response from a consultant with significant experience in manufacturing.

COUNTRY	GENERATOR SIZE RANGE Annual production numbers			COMMENTS
	250-500 MVA	500-800 MVA	> 800 MVA	
France	16	2	1	
Italy	1			
Japan	8	1		
USA – 1	37	5	1	
USA - 2				Response from consultant

### 3. GENERATOR MAINTENANCE OUTAGE SCHEDULING PRACTICES.

The questionnaire explored the practices amongst utilities associated with maintenance outage scheduling for generators. The initial assumption was that planned unit shutdowns follow a pattern that includes regular minor outages, interspersed with less frequent major outages, with the following characteristics:

“Minor” outage – limited duration; repair of known defects; plant surveys and inspections; preventive maintenance.

“Major” outage – extended duration; major plant item(s) dismantle for inspect / repair / replace; repair of known defects; plant surveys and inspections; preventive maintenance.

Respondents were requested to confirm or otherwise their adherence to a pattern of this nature, and to answer some questions on the basis and frequency of scheduling, and typical outage durations.

#### 3.1. Shutdown Maintenance Access

13 of 14 respondents confirmed that they followed a shutdown pattern as described above. The exception was a utility with significant nuclear generation where shutdowns were dependent on reactor refuelling requirements.

The reasons for major and minor shutdowns were generally associated with maintenance access for boilers/reactors and/or turbines. 5 utilities advised they may schedule a major outage for generator maintenance primarily, with two advising similarly for minor outages.

#### 3.2. Shutdown Scheduling

The contributing determinants of planned shutdown schedules could be time (calendar based) periods; service hours; plant cycles; or another factor or combination. The total response is included in the following table:

Factor	Time (calendar) periods	Service hours	Plant cycles – eg. no. of starts	Other factor, or combination of nominated factors
Outage Type				
Minor outage	8	2		8
Major outage	8	4		9

It is clear that time period scheduling is more dominant than service hours. Other factors affecting scheduling that were nominated included:

- Plant condition (includes boiler, turbine and generator)
- Regulated inspection periods
- Reactor refuelling
- Market drivers
- Financial drivers

The period of time advised between calendar scheduled major outages was quite variable, ranging from two to ten years. For service hour scheduled majors, the range was from 40K hours to >55K hours. There was significant variation in the number of scheduled minor outages between majors, with some respondents maintaining an evenly programmed major/minor/major schedule, whilst others had more than one minor between consecutive major outages. A summary of reported patterns is included in the following table:

Outage Pattern	Number of Respondents	Comments
Major – Minor @ 1 yrs – Major @ 2 yrs	2	
Major – Minor @ 1-2 yrs – Major @ 3 yrs	1	
Major – Minor @ 2 yrs – Major @ 4 yrs	3	
Major – Minor @ 3 yrs – Major @ 6 yrs	1	
Major – Minor @ 4 yrs – Major @ 8 yrs	1	
Major – Minor @ 20K+ hrs – Major @ 40K+ hrs	1	
Major – Minor @ 40K+ hrs – Major @ 80K+ hrs	1	Intermediate load plant
Major – Minor @ 2 yrs – Minor @ 4 yrs – Major @ 6 years	1	
Major – Several Minors @ 1 yrs – Major @ 6+ yrs	2	
Major – Several Minors @ 1-2 yrs – Major @ 10 yrs	1	Nuclear plant

### 3.3. Outage Duration

Reported major outage durations were in the range 17 to >50 days. The reported minor outage duration range was <9 to 50 days. Response numbers are summarised in the following table:

Duration	9 days or less	From 10 to 16 days	From 17 to 30 days	From 31 to 50 days	Greater than 50 days
Outage Type					
Minor outage	1	6	3		
Major outage			3	7	4

### 3.4. Generator Rotor Removal

Few countries reported removal of a generator rotor for inspection at minor outages, and then only on a condition basis.

Rotors were routinely removed at major outages – a summary of the reported periods between removals follows:

Years, or equivalent service hours, between removal	Number of respondents.
2	1
4	2
6	2

8	5
9	1
10	2
12	1
No firm program	1

### 3.5. Other Comments

Other comments made by respondents relevant to this topic included:

- Outage pattern is set by boiler or turbine maintenance. Generator work scope is determined prior to each outage based on the condition of the machine.
- We have base load or mid merit units. The schedule of generator major outages depends on the boiler, reactor refuelling, or the turbine and must find their time properly in synchronism with these works.
- Following the manufacturer's instructions we plan an outage after 8 to 10K working hours for new generators to check winding fixation. We do the same after rewinding (partial or full), core replacement, etc.
- Since the generating fleet is old, well used, and been inspected several times we have a good history and this utility puts a lot of emphasis on maintaining inspection and maintenance records. We are fortunate that we have several generators in a given series, e.g. one series has 9 identical units. These two issues allow us to develop a dependable trend on generator condition. Another major advantage that keeps outage time to a minimum is our spare part philosophy. We have a spare generator rotor for every major unit and we have spare stator coils for the vast majority of our units. This keeps major outage time to a minimum with regards to the generator.
- Period between shutdowns depends on the number of years in service. For generators having more than 25 years of service and depending on fleet experience and application of video-inspection, the overhaul intervals may be extended or shortened.
- For base load plants, service hours or years determine the frequency. For intermediate or peak load plants, a combination of hours and starts determine the frequency.
- For good plants, the outage time between major outages should be 5 to 8 years (40,000 to 64,000 hours). One or two minor outages (rotor in place) should be scheduled between major outages.
- A few generator designs are known to have deficiencies that require a schedule different from the average. Thus there are some designs which require a minor outage every year (I know of one design requiring a minor every 6 months) and a major every 2 to 3 years. These are small in number and exist for all manufacturers. A lot depends on the early history/reliability record
- Q2.4 depends on the number of years in service: For generators having more than 25 years of service and depending on fleet experience and application of video-inspection the overhaul intervals may be extended or shortened.
- Mid-life stator rewinding due to crevice corrosion and cracked strands is occurring at age about 20 – 25 years. Mid-life rotor inspections (and insulation repairs based on CM) at about 20 – 25 years. Replace 18/05 retaining rings with 18/18 based on CM at 20 – 25 years.

#### **4. PLANNED MAINTENANCE TASKS FOR GENERATOR COMPONENTS.**

Information was sought on the recommended and actual frequencies of maintenance for a range of generator components and systems, and maintenance tasks including long period diagnostic tests.

This was broken down into 3 major and 6 minor categories, with multiple choice responses recommended as follows:

##### Recommended maintenance intervals – including:

- the basis of the recommendation:
  - elapsed time;
  - service hours;
  - operation (speed) cycles;
  - a combination of these; or
  - on condition.
- the period between recommended maintenance tasks; and
- the source of the recommendation:
  - manufacturer;
  - government;
  - company standard;
  - national standard;
  - international standard; or
  - other source.

##### Actual service intervals:

- the type of outage in which maintenance inspections are done:
  - minor outage;
  - major outage – rotor in;
  - major outage – rotor out;
  - major outage – either of the above;
  - no outage required; or
  - task not done.
- the actual period between maintenance tasks.

##### The basis of the decision if the actual interval adopted is different to that recommended:

- not applicable (recommendation being followed);
- risk assessment;
- prior maintenance experience;
- maintenance cost saving;
- market needs – maximise availability; or
- other.

Utilities were asked to respond to all questions.

Manufacturers were asked to respond only to the three questions:

- maintenance interval basis (as above);
- period between maintenance tasks; and
- an acceptable basis for changing a manufacturer's recommendation.

There were 17 generator components addressed in the question, and a number of potential maintenance tasks per component identified. In general, there was a significant disparity in responses – and for this reason the full responses received have been included in appendices linked to this chapter, for

reference. In the appendices, blank cells either indicate no response or a response that was considered to be inconsistent with the question.

Note that as an aid to understanding the USA utility response, the respondent provided the following explanation:

We did not respond for 'Recommended maintenance intervals'. For 'Actual period' we took the liberty of using CB (condition based) in several situations. For every task, 'Actual/recommended change decision basis' could be nominated as 'risk assessment'; 'prior maintenance experience'; 'maintenance cost saving'; or 'market needs – maximise availability' or a combination of these. Basically, the "calendar" does not dictate maintenance.

Where possible, dominant practices are summarised in this report under each listed task. Attention is also drawn to any exceptions that may be of interest.

Some general observations can be made:

- There was no general preference overall for planning of periodic maintenance tasks between time based scheduling and service hour scheduling – some countries preferred one, some the other. The inclusion of operational cycles in the scheduling was present in some applications, but was not widespread.
- Manufacturer recommendation was a dominant factor in the source of planned maintenance scheduling. However company standard was significant also. There was a lesser reliance on national standards. International standards and government requirements were also present in a limited number of specific areas.
- There was a trend towards accepting the recommendation from the nominated source for maintenance task scheduling. The main reason for changing this was prior maintenance experience, while cost savings and market needs also featured to a small extent. Risk assessment was nominated by utilities on a small number of specific tasks.
- Manufacturers, however, advised that the dominant acceptable reasons for altering their recommended schedules were risk assessment and market needs.

## **4.1. Stator winding – slot content.**

### **4.1.1. Inspect wedges and repair or replace**

- Major outage task generally with rotor removed – frequency depends on actual scheduling of major outage (rotor removed). Some condition based scheduling nominated. Main reason for changing recommended interval is prior experience.

### **4.1.2. Inspect slot insert migration**

- As for 4.1.1

### **4.1.3. General inspection, clean, and paint as required.**

- Generally per 4.1.1 – some more frequent attention including inspection in outages with rotor in.

### **4.1.4. Electrical tests: IR; PI; winding resistance; DLA/DDF/tan $\delta$ .**

- Generally per 4.1.1. However some advise more frequent testing, including annual tests.

### **4.1.5. HV withstand.**

- Variety of responses, including either not recommended or condition based. Refer Appendix.

## **4.2. Stator winding – end windings**

### **4.2.1. Test for water leaks, and repair**

- Wide range of responses received – known condition of winding or prior experience is a key determinant.

### **4.2.2. Test for water leaks – no repair**

- As for 4.2.1. Survey did not explore reasons for not repairing leaks if found during tests.

### **4.2.3. Inspect end windings, including supports, spacers and phase connection rings**

- Commonly done during a major outage.

### **4.2.4. Inspect/test/repair temperature sensors**

- Commonly done during a major outage. In some cases this was nominated as a minor outage task also.

### **4.2.5. General inspection for contamination and insulation state; clean as required.**

- Commonly done during a major outage. In some cases nominated as a minor outage task also.

### **4.2.6. Capacitance mapping**

- Variety of responses. Common major outage test – however not done in some countries, and not recommended by one manufacturer.

### **4.2.7. Tracer gas leak test**

- Commonly recommended as a standard or condition based test. Timing either follows the recommended interval, or is modified based on prior experience. Manufacturers all recommend this test but based on condition.

### **4.2.8. Modal response**

- Generally either not a recommended test, or performed if condition dictates. However it is a routine test for some.

## **4.3. Stator winding - terminal box**

### **4.3.1. General inspection and clean; including support insulators, flexibles & CT stack.**

- Common and regular maintenance task, averaging every 4 years or hours equivalent. Few reasons given for deferral, but these were prior experience or market needs.

### **4.3.2. Disconnect flexibles; inspect; replace as required; reconnect.**

- Similar to 4.3.1. Not recommended by one manufacturer.

### **4.3.3. CT electrical and ratio tests etc.**

- Variety of responses, including not done or condition based.

## **4.4. Bushings**

### **4.4.1. Inspection & clean, external.**

- Responses were similar to 4.3.1. The test was not recommended by one manufacturer.

#### **4.4.2. Internal inspection – gas cooled bushings**

- Similar to 4.3.1. Not done in one country, and on condition in another. Not recommended by one manufacturer.

#### **4.4.3. Leakage test - replace gaskets and seals if required.**

- Variety of responses received – on condition basis of test was common.

#### **4.4.4. Leakage test - replace bushings if required.**

- Some time or hours based maintenance nominated, but mainly on condition.

### **4.5. Core & frame**

#### **4.5.1. Visual inspection & clean.**

- This is a common major outage task. Change to the recommended period in a few cases was based on prior maintenance experience

#### **4.5.2. Frame cracking NDT & repair.**

- Routine task for some – condition based for others. Not done or recommended in a few responses.

#### **4.5.3. Check liquid level detectors**

- This is a routine task for many utilities with widely varying frequency. Majority of manufacturers recommend condition based.

#### **4.5.4. Check longitudinal core tightening screws.**

- Major outage task for a majority of utilities. Varying response from manufacturers, split between not recommended, and major outage task.

#### **4.5.5. Check gas flow control rings, baffles etc.**

- There was a varied response from utilities. This was a consistent recommendation from manufacturers at about 5 year intervals.

#### **4.5.6. Inspect end shields.**

- Common major outage task for utilities, although not done by some. Not recommended by one manufacturer only.

#### **4.5.7. EI-Cid test**

- A common major outage with rotor removed task for utilities, however condition based for some, and also not done by others. Manufacturer response varied.

#### **4.5.8. Ring flux test**

- Generally condition based – not done in some cases. One country only nominates as a regular major/rotor out task.

### **4.6. Stator cooling water system**

#### **4.6.1. Inspect heat exchangers**

- This is a regular utility outage task with a variety of nominated frequencies, ranging from annual to 7-10 years. Consistently recommended by manufacturers, at periods ranging from 2 years to 90K hours.

#### **4.6.2. Mechanical maintenance of pumps, valves etc.**

- As per 4.6.1.

#### **4.6.3. Pressure test**

- Major outage task for some utilities; condition based for others; and not done or recommended by some utilities and one manufacturer. Some manufacturers recommend on condition.

#### **4.6.4. Vacuum test**

- Generally consistent with 4.6.3.

### **4.7. Stator water treatment**

#### **4.7.1. Replace resin**

- This is a common relatively frequent task, often condition based. It is recommended generally by manufacturers.

#### **4.7.2. Component inspection & repair**

- There were a variety of responses, however the task is commonly periodically performed by utilities and recommended by manufacturers.

#### **4.7.3. Calibrate conductivity instruments.**

- This is a common periodic task.

### **4.8. Rotor**

#### **4.8.1. Remove rotor for inspection - inspect accessible rotor components, including fan; NDT of rotor bore.**

- The task is done or recommended by all respondents in major outages with rotor removed. Time period ranged from 3-5 years to 15 years. Change from the recommended period where applicable was prior experience for utilities, and market needs for manufacturers.

#### **4.8.2. Remove retaining rings – inspect & NDT rings, wedges & slots.**

- Responses generally followed 4.8.1, except that a decision based on condition was nominated in some cases.

#### **4.8.3. Electrical tests: IR; PI; RSO; winding resistance.**

- This task is also commonly done at varying frequencies by all utilities – not recommended by one manufacturer.

#### **4.8.4. Time of flight diffraction**

- Rarely done. Not recommended by any manufacturer.

### **4.9. Hydrogen cooling system**

#### **4.9.1. Remove, inspect & repair hydrogen coolers.**

- This is a common task done by all utilities, generally in a major outage. Reasons for interval variance given were prior experience or cost saving.

#### **4.9.2. Pressure test cooling water piping.**

- A task generally done by utilities on a periodic basis, with some exceptions. Not recommended by one manufacturer.

#### **4.9.3. Calibrate dewpoint instrumentation**

- Periodically done by the majority of utility respondents at varying frequency. Not recommended by one manufacturer.

### **4.10. Hydrogen seals**

#### **4.10.1. Inspect, including NDT**

- A common major outage task with some exceptions.

#### **4.10.2. IR testing**

- Similar to 4.10.1 – more frequent for some.

### **4.11. Bearings**

#### **4.11.1. Inspection including NDT**

- A regular maintenance task at mainly major outages. Similarly recommended by manufacturers. Variation is due to prior maintenance experience or market needs.

#### **4.11.2. IR testing**

- Similar to 4.11.1 but more frequent for some.

#### **4.11.3. Shaft earthing system inspect & repair**

- A frequent inspection task – annual or at a major outage.

### **4.12. Seal oil system**

#### **4.12.1. Mechanical maintenance of pumps, strainers etc.**

- A regular task at major outages, or more frequently.

#### **4.13. Slip rings & brush gear (or diodes)**

##### **4.13.1. Inspection, including brush wear**

- Frequent inspection nominated for most – on average with annual frequency. Performed more often for some – responses include a recommendation of daily inspection by one manufacturer.

##### **4.13.2. Cleaning, including clean/replace filters**

- Recommendation or actual inspection interval ranges from one week to more than two years

##### **4.13.3. Slipping grinding**

- Generally done or recommended on condition. Time based intervals for some utilities.

##### **4.13.4. IR testing**

- A regular task based on time or service hours. Condition based for one utility, and not recommended by one manufacturer.

#### **4.14. Instrumentation**

##### **4.14.1. Calibration & circuit checks**

- A regular task – varied frequency. Condition based for two utilities,

#### **4.15. Neutral point grounding system**

##### **4.15.1. Inspection & cleaning**

- A regular task with varied frequency. On condition for one utility.

##### **4.15.2. Resistance or impedance measurement**

- Similar to 4.15.1.

#### **4.16. Generator electrical protection system**

##### **4.16.1. Protection trip checks**

- A common major outage task – more frequent by some utilities.

##### **4.16.2. Relay injection**

- Similar to 4.16.1.

##### **4.16.3. Circuit checks**

- There was a varied response in terms of maintenance period – however task is done by most.

##### **4.16.4. CT IR and continuity**

- Similar to 4.16.3 – however several utilities advised condition based.

## **4.17. Excitation system**

### **4.17.1. AVR characteristic checks**

- There were varied time intervals advised – however 3-5 years was common.

### **4.17.2. AVR limit checks**

- Generally the same as 4.17.1.

### **4.17.3. Demagnetisation checks.**

- A task done on time or condition basis – not done or recommended by one manufacturer and two utilities.

Comments made relevant to this section of the survey were:

- Replies to Q3 were difficult to condense. Some generators have e.g. good service openings for access to internals, some not. This kind of things in addition to service hours and type of loading affect to the scope of revisions.
- Standard recommendation for steam turbine generators based on 'equivalent operating hours' (eoh):
  - 1. minor overhaul after 25,000eoh
  - 2. minor overhaul after 50,000eoh
  - 3. major overhaul after 75,000eoh
  - 4. minor overhaul after 100,000eoh
  - 5. minor overhaul after 125,000eoh
  - 6. major overhaul after 150,000eoh – etc.
- Standard recommendation for eoh count:  $eoh = oh + 20 * (\text{no. of starts})$
- In addition: rotor sealing tightness test at >90K hours.
- For the most part, on the generator and exciter, the calendar does not dictate maintenance intervals. The machine history, the last inspection, the present condition, and the judgement of the inspection engineer determine the next inspection interval or maintenance activity.

### **Appendices (at end of report):**

- ❖ Planned maintenance tasks for generator components – Utilities (30 pages)
- ❖ Planned maintenance tasks for generator components – Manufacturers (11 pages)

## **5. GENERATOR IN-SERVICE DIAGNOSTIC TESTING**

This section of the questionnaire sought information on the usage and frequency of in service diagnostic tests for eight generator components and systems. One or more tests were nominated for each, and the respondents were asked to advise information on the usage of the diagnostic test; the mode and frequency of use; and the reason it was used.

A standard set of responses were listed as follows:

### Usage of diagnostic test:

- Not used
- Used now
- Used in the past, (but not now)
- Will be used in the near future (but not used now).

### Mode and frequency of use.

- Continuous use – data stored & reviewed regularly
- Continuous use – data monitored and alarmed continuously
- Intermittent use – weekly testing
- Intermittent use – monthly testing
- Intermittent use – 6 monthly testing
- Intermittent use – greater than 6 months between tests.
- Initiated if specific known condition arises

### Reason for use

- Manufacturer's recommendation
- Company usual practice
- Test equipment supplier recommendation
- Response to potential fault in generator
- Other reason

For this question also, the responses received are included in an appendix linked to this chapter. The following summaries highlight any commonality or significant exceptions present in the responses.

### **5.1. Stator winding – slot content**

#### **5.1.1. Partial discharge monitoring – various types**

- Where used by utilities, monitoring is generally on an intermittent basis – typically at 6 month intervals. The testing is recommended by most manufacturers on a continuous or intermittent basis.

### **5.2. Stator winding – end windings**

#### **5.2.1. Stator end winding vibration monitor.**

- A variety of responses – recommended by some manufacturers.

### **5.3. Rotor**

#### **5.3.1. Rotor shorted turns detection**

- Generally used by utilities, but not universally, with intermittent monitoring at typically 6 month intervals. Recommended by manufacturers with one exception.

#### **5.3.2. Shaft torsional oscillation monitoring**

- Generally not used with two exceptions – one advising use on known condition only. One manufacturer similarly advises use on a known condition basis.

### **5.4. Core & frame**

#### **5.4.1. Stator core/frame vibration monitoring**

- Where used, generally on a known condition basis – exceptions are one country using the diagnostic with continuous monitoring; another advising that it will be used in the future continuously with regular review of data (manufacturer's response from the same country concurs).

#### **5.4.2. Stator core lamination vibration – audio detector**

- Not commonly used – some exceptions. Not recommended in any manufacturers response.

### **5.5. Hydrogen cooling system**

#### **5.5.1. Dew point monitoring**

- Generally used – mainly continuously but some intermittently. Not used in one country, nor recommended in the country's manufacturer response.

#### **5.5.2. Hydrogen make up rate monitoring**

- Some usage – not recommended in the response of manufacturers in three countries, nor used in the utility response for the same countries.

#### **5.5.3. Hydrogen purity analysis**

- Universal continuous usage (one exception only). Recommended by all manufacturers.

### **5.6. Stator water treatment**

#### **5.6.1. Stator cooling water conductivity**

- Universal continuous usage – recommended by all manufacturers.

#### **5.6.2. Hydrogen leakage into stator water**

- Generally used in continuous mode, however intermittent for some. Not used in one country, nor recommended in the same country's manufacturer response (although it had been recommended in the past).

#### **5.6.3. Oxygen concentration**

- Used generally by utilities – mode & frequency of use vary. Not used in one country, nor recommended in the same country's manufacturer response.

#### **5.6.4. Copper concentration**

- Commonly used most often in continuous mode, but some intermittent monitoring was reported. Not used in one country, nor recommended in the same country's manufacturer response.

### **5.7. Bearings**

#### **5.7.1. Bearing journal vibration – dual probe monitor.**

- Universal continuous usage was reported (one exception only). Recommended by all manufacturers.

#### **5.7.2. Shaft grounding monitoring**

- Commonly used, but not universally – a variety of modes and frequency. Not recommended by one manufacturer.

### **5.8. Slip rings & brush gear (or diodes)**

#### **5.8.1. Brush on-line condition monitor**

- Rarely used by utilities. Not recommended in manufacturer responses with one exception.

#### **5.8.2. Diode breakdown detection**

- Generally recommended by manufacturers. Used by utilities in some countries.

Utilities were also asked if they have and use an expert system that considers some or all of the tests performed and synthesises a diagnosis or actions (eg. alarms, or auto-generation of maintenance work orders). All but two countries – Switzerland and Finland – answered in the negative.

Additional comments made were:

- Some techniques of monitoring systems already used all over the world should be included such as:
  - AGMS - air gap monitoring systems;
  - SBV - Stator bar vibration;
  - FOA - Fiber optics accelerometers;
  - MFM - Magnetic flux measurement;
  - Capacitive proximity sensors;
  - Digital temperature monitoring systems - stator and rotor.

#### **Appendix (at end of report):**

- ❖ Generator in service diagnostic testing – Utilities & manufacturers (7 pages)

## 6. GENERATOR MAINTENANCE PRACTICES

The questionnaire sought to identify best practice techniques for major preventive and corrective maintenance tasks on generators. Three scenarios were postulated for different levels of generator outage maintenance, and typical maintenance techniques listed under each. Respondents were also invited to add additional techniques used, and to advise any additional maintenance practices used. The results are included in the following tables – the number of respondents answering in each category was counted and entered into the tables. Total numbers may not be consistent as there were some responses received in which some of the table cells were left blank. Total response number was 15 (the Swiss response for this question was provided from two utilities).

From the responses, the most consistently used maintenance practices include:

- Application of formal quality control systems.
- Formal confined space entry procedures for access to generator casings.
- Control of internal inspections and inspectors, including training; protective clothing; and tool control
- Use and control of clean condition enclosures for stator work (rotor in or out) and for work on a rotor after its removal.
- Documented inspection procedures at critical stages, especially on final box-up of stator casings.

### 6.1. Scenario 1:

Short shutdown – generator de-gassed to air. Covers removed for internal inspection.

Usage Maintenance technique	Always	Sometimes	Never
1. Dry air circulation, or heaters installed	4	3	7
2. Continuous internal air quality monitoring	1	5	7
3. Internal human access for inspection.	11	3	0
4. Formal confined space entry procedures.	10	3	1
5. Formal checks on internal inspectors:	10	3	0
– training & certification;	12	1	0
– protective clothing;	11	3	0
– tool controls.	11	3	0
6. Internal inspection by remote device only – eg. video.	0	7	5
7. Documented inspection procedure before box-up	9	1	4

## 6.2. Scenario 2:

Generator de-gassed to air. Covers removed for internal inspection. End-shields fully or partially removed. Rotor not removed.

Usage	Always	Sometim es	Never
Maintenance technique			
1. Formal Quality Control system used?	9	5	1
2. Dry air circulation, or heaters installed	4	7	4
3. Clean condition enclosure set up.	10	2	0
a. Security & access controls for enclosure.	8	3	4
b. Formal checks on workers in enclosure – Training & certification; protective clothing.	9	3	3
c. Component tracing & tool control procedures.	8	3	4
4. Formal confined space procedures for generator entry.	10	2	3
5. Robot coil capacitance tests	0	5	10
6. Physical coil capacitance tests	1	8	6
7. Robot wedge tightness checks	0	7	7
8. Tracer gas winding leakage tests	3	10	2
9. Documented inspection procedure before box-up	9	2	4
10. Other – please add below			
Internal inspection by remote device	1		

## 6.3. Scenario 3:

Long outage – generator rotor removed.

Usage	Always	Sometim es	Never
Maintenance technique			
1. Formal Quality Control system used?	10	3	1
2. Dry air circulation, or heaters installed	4	6	3
3. Clean condition enclosure set up for stator.	10	3	0
a. Security & access controls for enclosure.	7	2	4
b. Formal checks on workers in enclosure – Training & certification; protective clothing.	9	2	3
c. Component tracing & tool control procedures.	8	2	4

4. Clean condition enclosure set up for rotor.	9	5	1
a. Security & access controls for enclosure.	8	3	3
b. Formal checks on workers in enclosure – Training & certification; protective clothing.	8	2	4
c. Component tracing & tool control procedures.	7	1	5
5. Documented inspections before rotor re-installation	10	0	3
6. Documented inspections before box-up.	9	1	3

#### 6.4. Additional Comments:

##### USA:

- This utility relies heavily on ElectroMagnetic Interference (EMI) testing for all large electrical rotating equipment. This testing is performed at frequencies from 10 K Hz through 1 G Hz. We have been successfully using this non-invasive, on line, condition evaluation technique for over 20 years now. EPRI is very familiar with this testing having held three seminars on the topic and performing a few industry studies.
- Maintaining a history of inspection records in mandatory to a quality inspection program.
- The industry must not overlook the significance of a thorough visual inspection by a qualified and experienced machinery engineer. Money spent on the education and training of an engineer provides the greatest return on investment that any utility can earn. Relying on OEMs is not always the most cost effective inspection method.

##### Switzerland:

- Responsibilities between generator-owner and maintenance supplier have to be clarified and agreed on by both parties.
- Another item to check for old units is for asbestos fibre concentration in the generator.

## 7. CONCLUSION

The survey has provided a basis for comparison by utility engineers of maintenance practices across a range of countries. The responses reported in the appendices provide a library of maintenance task recommendations and actual practices that could be considered if new or modified practices are being contemplated.

The aims of the study have largely been met, although the reasons for the differences in approach highlighted in the various areas of maintenance practice surveyed were not adequately explained by the data received. The most significant conclusion is that there is a considerable diversity in approach and practice in use internationally. It has proven unrealistic to anticipate that a study such as this can identify best or preferred practice in any particular area of generator maintenance.

**8. APPENDIX 1 – Appendix to Chapter 4**

**Planned maintenance tasks for generator components – Utilities (pp 26 to 55)**

		Australia 1	Australia 2	Australia 3	Serbia - Montenegro	Italy - Base Load	Italy - Mid Load	Brazil
<b>Stator winding – slot content</b>								
<b>1. Inspect wedges and repair or replace</b>								
Recommended	<b>Basis</b>	Time	Time	Time	Time	Service hours	Service hours & operation cycles	Service hours
	<b>Period</b>	3-5 years	10 years	7- 10 years	5-7 years	60K to 90K hours	60K to 90K hours	> 90K hours
	<b>Source</b>	Manufacturer	Manufacturer	Manufacturer	National Standard	Company standard	Company standard	Manufacturer
Actual	<b>Outage type</b>	Major - rotor out	Major - rotor out	Major - rotor out	Major - rotor out	Major - rotor out	Major - rotor out	Major - rotor out
	<b>Period</b>	7-10 years	15 years	7- 10 years	5-7 years	60K to 90K hours	60K to 90K hours	> 90K hours
Actual/Recommended change	<b>Decision Basis</b>	Prior mtce experience	Prior mtce experience	Not applicable	Not applicable	Not applicable	Not applicable	Prior mtce experience
<b>2. Inspect slot insert migration</b>								
Recommended	<b>Basis</b>	Time	Time	Time	Not recommended	Service hours	Service hours & operation cycles	Service hours
	<b>Period</b>	> 10 years	10 years	7- 10 years		20K to 40K hours	40K to 60K hours	> 90K hours
	<b>Source</b>	Manufacturer	Manufacturer	Manufacturer		Company standard	Company standard	Manufacturer
Actual	<b>Outage type</b>	Major - rotor out	Major - rotor out	Major - rotor out	Major - rotor out	Any	Major - rotor out	Major - rotor out
	<b>Period</b>	> 10 years	15 years	7- 10 years	Only if necessary	20K to 40K hours	40K to 60K hours	> 90K hours
Actual/Recommended change	<b>Decision Basis</b>	Risk assessment	Prior mtce experience	Not applicable	Prior mtce experience	Not applicable	Not applicable	Prior mtce experience
<b>3. General inspection, clean, and paint as required.</b>								
Recommended	<b>Basis</b>	Time	Time	Condition Based	Time	Service hours	Service hours & operation cycles	Service hours
	<b>Period</b>	3-5 years	4 years	3 - 5 years	5-7 years	60K to 90K hours	60K to 90K hours	> 90K hours
	<b>Source</b>	Manufacturer	Manufacturer	Manufacturer	National Standard	Company standard	Company standard	Manufacturer
Actual	<b>Outage type</b>	Major - rotor out	Major - rotor in or out	Any	Major - rotor out	Major - rotor out	Major - rotor out	Major - rotor out
	<b>Period</b>	7-10 years	4 years	2 years	5-7 years	60K to 90K hours	60K to 90K hours	> 90K hours
Actual/Recommended change	<b>Decision Basis</b>	Prior mtce experience	Not applicable		Not applicable	Not applicable	Not applicable	Prior mtce experience
<b>4. Electrical tests: IR; PI; winding resistance; DLA / DDF/ tan δ.</b>								
Recommended	<b>Basis</b>	Time	Time	Time	Time	Service hours	Service hours & operation cycles	Service hours
	<b>Period</b>	3-5 years	4 years	3 - 5 years	5-7 years	60K to 90K hours	60K to 90K hours	> 90K hours
	<b>Source</b>	Manufacturer	Manufacturer	International standard	National Standard	Company standard	Company standard	Manufacturer
Actual	<b>Outage type</b>	Major - rotor out	Major - rotor in or out	Any	Major - rotor out	Major - rotor out	Major - rotor out	Major - rotor out
	<b>Period</b>	7-10 years	4 years	3 - 5 years	5-7 years	60K to 90K hours	60K to 90K hours	> 90K hours
Actual/Recommended change	<b>Decision Basis</b>	Prior mtce experience	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Prior mtce experience
<b>5. HV withstand</b>								
Recommended	<b>Basis</b>	Not recommended	Condition based	Condition Based	Time	Service hours	Service hours & operation cycles	Service hours
	<b>Period</b>				5-7 years	60K to 90K hours	60K to 90K hours	> 90K hours
	<b>Source</b>		Manufacturer	National standard	National Standard	Company standard	Company standard	Manufacturer
Actual	<b>Outage type</b>		Task not done		Major - rotor out	Major - rotor out	Major - rotor out	Major - rotor out
	<b>Period</b>				5-7 years	60K to 90K hours	60K to 90K hours	> 90K hours
Actual/Recommended change	<b>Decision Basis</b>				Not applicable	Not applicable	Not applicable	Prior mtce experience

		Finland	Russia	USA	Japan	France	Croatia	Switzerland
<b>Stator winding – slot content</b>				(Refer note - p9 of report)				
<b>1. Inspect wedges and repair or replace</b>								
Recommended	<b>Basis</b>	Time, service hours or cycles	Condition based		Time	Service hrs or Condition based	Service hours	Service hours & operation cycles
	<b>Period</b>	5-7 or 7-10 years	3-5 years		3-5 years	40K - 60K hrs	40K to 60K hours	20K - 40K hrs 60K - 90K hrs
	<b>Source</b>	Mfr or Company standard	Mfr or Company standard		Manufacturer	Manufacturer	Manufacturer	Manufacturer
Actual	<b>Outage type</b>	Major - rotor out	Major - rotor out	Major - rotor out	Major - rotor out	Major - rotor out	Major - rotor out	Any
	<b>Period</b>	5-7 or 7-10 years	3-5 years	5-7 years	3-5 years	More than 7 years	7-10 years	3-5 years
Actual/Recommended change	<b>Decision Basis</b>	Not applicable	Not applicable			Not applicable	Not applicable	Prior mtce experience
<b>2. Inspect slot insert migration</b>								
Recommended	<b>Basis</b>	Time, service hours or cycles	Time		Time	Service hrs or Condition based	Service hours	Service hours & operation cycles
	<b>Period</b>	5-7 or 7-10 years	3-5 years		3-5 years	40K - 60K hrs	40K to 60K hours	20K to 40K hours
	<b>Source</b>	Mfr or Company standard	Mfr or Company standard		Manufacturer	Manufacturer	Manufacturer	Manufacturer
Actual	<b>Outage type</b>	Major - rotor out	Major - rotor out	Major - rotor out	Major - rotor out	Major - rotor out	Major - rotor out	Any
	<b>Period</b>	5-7 or 7-10 years	3-5 years	5-7 years	3-5 years	More than 7 years	40K to 60K hours	3-5 years
Actual/Recommended change	<b>Decision Basis</b>	Not applicable	Not applicable			Not applicable	Not applicable	Prior mtce experience
<b>3. General inspection, clean, and paint as required.</b>								
Recommended	<b>Basis</b>	Condition based	Time		Time	Service hrs or Condition based	Service hours	Service hours & operation cycles
	<b>Period</b>		3-5 years		3-5 years	40K - 60K hrs	40K to 60K hours	20K to 40K hours
	<b>Source</b>	Mfr or Company standard	Manufacturer		Manufacturer	Manufacturer	Manufacturer	Manufacturer
Actual	<b>Outage type</b>	Major - rotor in or out	Major - rotor out	Major - rotor out	Major - rotor out	Major - rotor out	Major - rotor out	Any
	<b>Period</b>	5-7 or 7-10 years	3-5 years	5-7 years	3-5 years	7 - 10 years	40K to 60K hours	Annual or 3-5 years
Actual/Recommended change	<b>Decision Basis</b>	Not applicable	Not applicable			Not applicable	Prior mtce experience	Prior mtce experience
<b>4. Electrical tests: IR; PI; winding resistance; DLA / DDF/ tan δ.</b>								
Recommended	<b>Basis</b>	Time, service or condition	Time		Time	Service hours	Time	Service hours & operation cycles
	<b>Period</b>	3-5 years	Annual & 3 - 5 years		7-10 years	10K - 20K hrs	3-5 years	20K to 40K hours
	<b>Source</b>	Company standard	Mfr or Company standard		Company standard	Manufacturer	Manufacturer	Manufacturer
Actual	<b>Outage type</b>	Major - rotor in or out	Any	Major - rotor in or out	Major - rotor out	Any	Major - rotor in	Any
	<b>Period</b>	3-5 years	Annual & 3 - 5 years	5-7 years	7-10 years	Annual or 2 years	3-5 years	Annual or 3-5 years
Actual/Recommended change	<b>Decision Basis</b>	Not applicable	Not applicable			Experience or cost saving	Not applicable	Prior mtce experience
<b>5. HV withstand</b>								
Recommended	<b>Basis</b>	Time or Condition based	Time		Not recommended	Condition based	Time	Service hours & operation cycles
	<b>Period</b>	5-7 or 7-10 years	3-5 years				7-10 years	20K - 40K hrs 40K - 60K hrs
	<b>Source</b>	Company standard	Mfr or Company standard				Manufacturer	Manufacturer
Actual	<b>Outage type</b>	Major - rotor out	Major - rotor in or out	Major - rotor in or out	Task not done	Major - rotor out	Major - rotor out	Major - rotor out
	<b>Period</b>	5-7 or 7-10 years	3-5 years	Condition based		7 - 10 years	7-10 years	3 - 5 years, or 7 - 10 years
Actual/Recommended change	<b>Decision Basis</b>	Not applicable	Not applicable				Not applicable	Maintenance cost saving

		Australia 1	Australia 2	Australia 3	Serbia - Montenegro	Italy - Base Load	Italy - Mid Load	Brazil
<b>Stator winding – end windings</b>								
<b>1. Test for water leaks, and repair</b>								
Recommended	Basis	Time	Time	Time	Not recommended	Service hours	Service hours & operation cycles	Condition based
	Period	3-5 years	2 years	2 years		60K to 90K hours	40K to 60K hours	< 10K hours
	Source	Manufacturer	Manufacturer	Manufacturer		Company standard	Company standard	Company standard
Actual	Outage type	Major - rotor in or out	Major - rotor in or out	Any	Minor	Major - rotor out	Minor	Major - rotor in
	Period	3-5 years	4 years	2 years	Annual	60K to 90K hours	40K to 60K hours	< 10K hours
Actual/Recommended change	Decision Basis	Prior mtce experience	Prior mtce experience	Prior mtce experience	Prior mtce experience	Not applicable	Not applicable	Market needs
<b>2 years. Test for water leaks – no repair</b>								
Recommended	Basis	Time	Time	Time	Not recommended	Service hours	Service hours & operation cycles	Service hours
	Period	3-5 years	2 years	2 years		60K to 90K hours	40K to 60K hours	> 90K hours
	Source	Manufacturer	Manufacturer	Manufacturer		Company standard	Company standard	Manufacturer
Actual	Outage type	Major - rotor in	Major - rotor in or out	Any	Minor	Major - rotor out	Minor	Major - rotor in
	Period	7-10 years	4 years	2 years	Annual	60K to 90K hours	40K to 60K hours	> 90K hours
Actual/Recommended change	Decision Basis	Prior mtce experience	Prior mtce experience	Prior mtce experience	Prior mtce experience	Not applicable	Not applicable	Not applicable
<b>3. Inspect end windings, including supports, spacers and phase</b>								
Recommended	Basis	Time	Time	Time	Time	Service hours	Service hours & operation cycles	Service hours
	Period	3-5 years	4 years	2 years	5-7 years	60K to 90K hours	40K to 60K hours	> 90K hours
	Source	Manufacturer	Manufacturer	Manufacturer	Manufacturer, or National std.	Company standard	Company standard	Manufacturer
Actual	Outage type	Major - rotor in or out	Major - rotor in or out	Any	Major - rotor out	Major - rotor out	Minor	Major - rotor in
	Period	3-5 years	4 years	2 years	5-7 years	60K to 90K hours	40K to 60K hours	> 90K hours
Actual/Recommended change	Decision Basis	Prior mtce experience	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
<b>4. Inspect/test/repair temperature sensors</b>								
Recommended	Basis	Time	Time	Time	Time	Service hours	Service hours & operation cycles	Condition based
	Period	3-5 years	4 years	2 years	5-7 years	60K to 90K hours	60K to 90K hours	< 10K hours
	Source	Manufacturer	Manufacturer	Manufacturer	Manufacturer, or National std.	Company standard	Company standard	Company standard
Actual	Outage type	Major - rotor out	Major - rotor in or out	Any	Major - rotor out	Major - rotor out	Major - rotor out	Major - rotor in
	Period	7-10 years	4 years	2 years	5-7 years	60K to 90K hours	60K to 90K hours	< 10K hours
Actual/Recommended change	Decision Basis	Prior mtce experience	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Market needs
<b>5. General inspection for contamination and insulation state;</b>								
Recommended	Basis	Time	Time	Time	Time	Service hours	Service hours & operation cycles	Condition based
	Period	3-5 years	4 years	2 years	5-7 years	60K to 90K hours	40K to 60K hours	< 10K hours
	Source	Manufacturer	Manufacturer	Manufacturer	Manufacturer, or National std.	Company standard	Company standard	Company standard
Actual	Outage type	Major - rotor in	Major - rotor in or out	Any	Major - rotor out	Major - rotor out	Minor	Major - rotor out
	Period	3-5 years	4 years	2 years	5-7 years	60K to 90K hours	40K to 60K hours	> 90K hours
Actual/Recommended change	Decision Basis	Prior mtce experience	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Market needs

<b>Stator winding – end windings</b>		Australia 1	Australia 2	Australia 3	Serbia - Montenegro	Italy - Base Load	Italy - Mid Load	Brazil
<b>6. Capacitance mapping</b>								
Recommended	<b>Basis</b>	Time	Time		Not recommended			Service hours
	<b>Period</b>	3-5 years	2 years					> 90K hours
	<b>Source</b>	Manufacturer	Manufacturer					Manufacturer
Actual	<b>Outage type</b>	Major - rotor out	Major - rotor out	Task not done				Major - rotor in
	<b>Period</b>	7-10 years	15 years					> 90K hours
Actual/Recommended change	<b>Decision Basis</b>	Prior mtce experience	Prior mtce experience			On condition	On condition	Not applicable
<b>7. Tracer gas leak test</b>								
Recommended	<b>Basis</b>	Time	Time	Condition Based	Not recommended			Condition based
	<b>Period</b>	3-5 years	2 years					< 10K hours
	<b>Source</b>	Manufacturer	Manufacturer	Manufacturer				Company standard
Actual	<b>Outage type</b>	Major - rotor out	Major - rotor in or out	Any	Minor			Major - rotor in
	<b>Period</b>	7-10 years	15 years		Only if necessary			< 10K hours
Actual/Recommended change	<b>Decision Basis</b>	Prior mtce experience	Prior mtce experience	Prior mtce experience	Prior mtce experience	On condition	On condition	Market needs
<b>8. Modal response</b>								
Recommended	<b>Basis</b>	Time	Not recommended		Not recommended			Service hours
	<b>Period</b>	3-5 years						> 90K hours
	<b>Source</b>	Manufacturer						Manufacturer
Actual	<b>Outage type</b>	Major - rotor out	Task not done	Task not done	Minor			Major - rotor in or out
	<b>Period</b>	7-10 years			Only if necessary			> 90K hours
Actual/Recommended change	<b>Decision Basis</b>	Prior mtce experience			Prior mtce experience	On condition	On condition	Not applicable

		Finland	Russia	USA	Japan	France	Croatia	Switzerland
<b>Stator winding – end windings</b>								
<b>1. Test for water leaks, and repair</b>								
Recommended	Basis	Condition based	Time		Time	Service hrs or Condition based	Service hours	Condition based
	Period		3-5 years		Two years	10K - 20K hrs	40K to 60K hours	20K to 40K hours
	Source		Mfr or Company standard		Manufacturer	Manufacturer	Manufacturer	Manufacturer
Actual	Outage type	Major - rotor in or out	Major - rotor in or out	Major - rotor in or out	Major - rotor in or out		Major - rotor out	Task not done
	Period		3-5 years	Condition based	Two years		40K to 60K hours	Annual
Actual/Recommended change	Decision Basis		Not applicable			Not applicable	Not applicable	Market needs
<b>2. Test for water leaks – no repair</b>								
Recommended	Basis	Time, service hours or cycles	Condition based		Not recommended	Service hours	Service hours	Service hours & operation cycles
	Period	2 - 5 years				10K - 20K hrs	40K to 60K hours	20K to 40K hours
	Source	Manufacturer & Company std	Manufacturer			Manufacturer	Manufacturer	Manufacturer
Actual	Outage type	Major - rotor in or out			Not recommended	Major - rotor out	Major - rotor out	Task not done
	Period	Annual				7 - 10 years	40K to 60K hours	Annual
Actual/Recommended change	Decision Basis	Risk assessment	Not applicable				Not applicable	Market needs
<b>3. Inspect end windings, including supports, spacers and phase</b>								
Recommended	Basis	Time, service hours or cycles	Time		Time	Service hours	Service hours	Service hours & operation cycles
	Period	3 - 7 years	3-5 years		Two years	10K - 20K hrs	20K to 40K hours	20K to 40K hours
	Source	Manufacturer & Company std	Mfr or Company standard		Company standard	Manufacturer	Manufacturer	Manufacturer
Actual	Outage type	Minor, or Major - rotor out	Major - rotor out	Major - rotor in or out	Major - rotor in or out	Major - rotor in or out	Major - rotor in	
	Period	Annual	3-5 years	5-7 years	Two years	3 - 5 years	20K to 40K hours	Annual or 3-5 years
Actual/Recommended change	Decision Basis	Risk assessment	Not applicable			Prior mtce experience	Not applicable	Prior mtce experience
<b>4. Inspect/test/repair temperature sensors</b>								
Recommended	Basis	Time	Time		Time	Service hrs or Condition based	Service hours	Service hours & operation cycles
	Period	2 - 5 years	Annual or 3-5 years		Two years	40K - 60K hrs	40K to 60K hours	20K to 40K hours
	Source	Manufacturer & Company std	Manufacturer		Company standard	Manufacturer	Manufacturer	Manufacturer
Actual	Outage type	Any	Minor	Major - rotor out	Major - rotor in or out	Major - rotor out	Major - rotor out	Any or none
	Period	Annual	Annual or 3-5 years	Condition based	Two years	7 - 10 years	40K to 60K hours	Annual
Actual/Recommended change	Decision Basis	Risk assessment	Not applicable			Not applicable	Not applicable	Market needs
<b>5. General inspection for contamination and insulation state;</b>								
Recommended	Basis	Time, service hours or cycles	Time		Time	Service hrs or Condition based	Service hours	Service hours & operation cycles
	Period	2 - 5 years	3-5 years		Two years	40K - 60K hrs	40K to 60K hours	20K to 40K hours
	Source	Manufacturer	Manufacturer		Company standard	Manufacturer	Manufacturer	Manufacturer
Actual	Outage type	Major - rotor out	Major - rotor out	Minor	Major - rotor in or out	Major - rotor out	Major - rotor out	Any
	Period	2 - 5 years	3-5 years	5-7 years	Two years	7 - 10 years	40K to 60K hours	Annual or 3-5 years
Actual/Recommended change	Decision Basis		Not applicable			Prior mtce experience	Not applicable	Market needs

<b>Stator winding – end windings</b>		Finland	Russia	USA	Japan	France	Croatia	Switzerland
<b>6. Capacitance mapping</b>								
Recommended	<b>Basis</b>	Time or Condition based	Not recommended		Time	Service hrs or Condition based	Service hours	Service hours & operation cycles
	<b>Period</b>	7-10 years			3-5 years	10K - 20K hrs or 40K - 60K hrs	20K to 40K hours	40K to 60K hours
	<b>Source</b>	Company standard			Manufacturer	Manufacturer	Manufacturer	
Actual	<b>Outage type</b>	Major - rotor out	Task not done	Major - rotor out	Major - rotor out		Major - rotor in	Not recommended
	<b>Period</b>	7-10 years		Condition based	3-5 years		20K to 40K hours	
Actual/Recommended change	<b>Decision Basis</b>		Not applicable			Not applicable	Not applicable	Risk assessment
<b>7. Tracer gas leak test</b>								
Recommended	<b>Basis</b>	Time, service hours or cycles	Time		Condition based	Service hours	Condition based	Condition based
	<b>Period</b>	Two years	3-5 years			40K - 60K hrs	20K to 40K hours	20K to 40K hours
	<b>Source</b>	Company standard	Mfr or Company standard		Manufacturer	Manufacturer	Manufacturer	
Actual	<b>Outage type</b>	Major - rotor in or out	Major - rotor out	Major - rotor in or out	Major - rotor out	Major - rotor out	Major - rotor in	
	<b>Period</b>	Two years	3-5 years	Condition based		7 - 10 years	20K to 40K hours	
Actual/Recommended change	<b>Decision Basis</b>		Not applicable			Prior mtce experience	Other	Market needs
<b>8. Modal response</b>								
Recommended	<b>Basis</b>	Time, service hours or cycles			Not recommended	Service hours		Condition based
	<b>Period</b>	5-7 or 7-10 years				40K - 60K hrs		20K to 40K hours
	<b>Source</b>	Company standard				Manufacturer		
Actual	<b>Outage type</b>	Major - rotor out			Task not done	Major - rotor out		
	<b>Period</b>	7-10 years		Condition based		7 - 10 years		
Actual/Recommended change	<b>Decision Basis</b>					Prior mtce experience		Market needs

		Australia 1	Australia 2	Australia 3	Serbia - Montenegro	Italy - Base Load	Italy - Mid Load	Brazil
<b>Stator winding - terminal box.</b>								
<b>1. General inspection and clean; including support insulators, flexibles</b>								
Recommended	<b>Basis</b>	Time	Time	Time	Time	Service hours	Service hours & operation cycles	Condition based
	<b>Period</b>	3-5 years	4 years	2 years	5-7 years	20K to 40K hours	20K to 40K hours	20K to 40K hours
	<b>Source</b>	Manufacturer	Manufacturer	Manufacturer or other	Mfr or National standard	Company standard	Company standard	Company standard
Actual	<b>Outage type</b>	Major - rotor in or out	Major - rotor in or out	Major - rotor in or out	Major - rotor out	Minor	Minor	Major - rotor in
	<b>Period</b>	3-5 years	4 years	2 years	5-7 years	20K to 40K hours	20K to 40K hours	40K to 60K hours
Actual/Recommended change	<b>Decision Basis</b>	Prior mtce experience	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Prior mtce experience
<b>2. Disconnect flexibles; inspect; replace as required; reconnect.</b>								
Recommended	<b>Basis</b>	Time	Not recommended	Time	Time	Service hours	Service hours & operation cycles	Condition based
	<b>Period</b>	> 10 years		3 - 5 years	5-7 years	20K to 40K hours	20K to 40K hours	20K to 40K hours
	<b>Source</b>	Manufacturer		Manufacturer	Mfr or National standard	Company standard	Company standard	Company standard
Actual	<b>Outage type</b>	Major - rotor in or out	Task not done	Major - rotor in or out	Major - rotor out	Minor	Minor	Major - rotor in
	<b>Period</b>	> 10 years		3 - 5 years	5-7 years	20K to 40K hours	20K to 40K hours	40K to 60K hours
Actual/Recommended change	<b>Decision Basis</b>	Other		Not applicable	Not applicable	Not applicable	Not applicable	Prior mtce experience
<b>3. CT electrical and ratio tests etc.</b>								
Recommended	<b>Basis</b>		Not recommended	Condition Based	Time			Condition based
	<b>Period</b>				5-7 years			20K to 40K hours
	<b>Source</b>				Mfr or National standard			Company standard
Actual	<b>Outage type</b>		Task not done		Major - rotor out			Major - rotor in
	<b>Period</b>				5-7 years			40K to 60K hours
Actual/Recommended change	<b>Decision Basis</b>				Not applicable			Prior mtce experience

		Finland	Russia	USA	Japan	France	Croatia	Switzerland
<b>Stator winding - terminal box.</b>								
<b>1. General inspection and clean; including support insulators, flexibles</b>								
Recommended	<b>Basis</b>	Time	Time		Time	Service hours	Service hours	Service hours & operation cycles
	<b>Period</b>	Annual	3-5 years		Two years	10K - 20K hrs	40K to 60K hours	20K to 40K hours
	<b>Source</b>	Company standard	Manufacturer		Manufacturer	Manufacturer	Manufacturer	Manufacturer
Actual	<b>Outage type</b>	Minor	Major - rotor in or out	Major - rotor out	Major - rotor in or out	Major - rotor in or out	Major - rotor out	Any
	<b>Period</b>	Annual	3-5 years	5-7 years	Two years	3-5 or 7-10 years	40K to 60K hours	Annual or 3-5 years
Actual/Recommended change	<b>Decision Basis</b>		Not applicable			Prior mtce experience	Not applicable	Market needs
<b>2. Disconnect flexibles; inspect; replace as required; reconnect.</b>								
Recommended	<b>Basis</b>	Time, service hours or cycles	Time		Time	Service hrs or Condition based	Service hours	Condition based
	<b>Period</b>	5-7 or 7-10 years	3-5 years		7-10 years	10K - 20K hrs	20K to 40K hours	20K to 40K hours
	<b>Source</b>	Company standard	Manufacturer		Company standard	Manufacturer	Manufacturer	
Actual	<b>Outage type</b>	Major - rotor in or out	Major - rotor in or out		Major - rotor out	Major - rotor in	Major - rotor in	
	<b>Period</b>	5-7 or 7-10 years	3-5 years	Condition based	7-10 years	3 - 5 years	20K to 40K hours	
Actual/Recommended change	<b>Decision Basis</b>		Not applicable			Not applicable	Not applicable	Prior mtce experience
<b>3. CT electrical and ratio tests etc.</b>								
Recommended	<b>Basis</b>	Time	Condition based		Time	Not recommended	Service hours	Service hours & operation cycles
	<b>Period</b>	5-7 or 7-10 years	Annual or 3-5 years		7-10 years		40K to 60K hours	40K to 60K hours
	<b>Source</b>	Company standard	Company standard		Company standard		Manufacturer	
Actual	<b>Outage type</b>	Major - rotor in or out	No outage required		Major - rotor out	Major - rotor in or out	Major - rotor out	
	<b>Period</b>	5-7 or 7-10 years		Condition based	7-10 years		40K to 60K hours	
Actual/Recommended change	<b>Decision Basis</b>		Not applicable				Not applicable	Prior mtce experience

		Australia 1	Australia 2	Australia 3	Serbia - Montenegro	Italy - Base Load	Italy - Mid Load	Brazil
<b>Bushings.</b>								
<b>1. Inspection &amp; clean, external.</b>								
Recommended	<b>Basis</b>	Time	Time	Time	Not recommended	Service hours	Service hours & operation cycles	Service hours
	<b>Period</b>	Annual	4 years	7- 10 years		20K to 40K hours	20K to 40K hours	20K to 40K hours
	<b>Source</b>	Manufacturer	Manufacturer	Manufacturer		Company standard	Company standard	Company standard
Actual	<b>Outage type</b>	Major - rotor in or out	Major - rotor in or out	Major - rotor in or out	Major - rotor out	Minor	Minor	Major - rotor in
	<b>Period</b>	3-5 years	4 years	3 - 5 years	5-7 years	20K to 40K hours	20K to 40K hours	40K to 60K hours
Actual/Recommended change	<b>Decision Basis</b>	Prior mtce experience	Not applicable		Prior mtce experience	Not applicable	Not applicable	Prior mtce experience
<b>2. Internal inspection – gas cooled bushings</b>								
Recommended	<b>Basis</b>	Time	Time	Time		Service hours	Service hours & operation cycles	Service hours
	<b>Period</b>	> 10 years	4 years	7- 10 years		20K to 40K hours	20K to 40K hours	20K to 40K hours
	<b>Source</b>	Manufacturer	Manufacturer	Manufacturer		Company standard	Company standard	Company standard
Actual	<b>Outage type</b>	Major - rotor in or out	Major - rotor in or out	Major - rotor out		Minor	Minor	Major - rotor out
	<b>Period</b>	> 10 years	4 years	7- 10 years		20K to 40K hours	20K to 40K hours	> 90K hours
Actual/Recommended change	<b>Decision Basis</b>	Risk assessment	Not applicable	Not applicable		Not applicable	Not applicable	Prior mtce experience
<b>3. Leakage test - replace gaskets and seals if required.</b>								
Recommended	<b>Basis</b>	Time	Time	Time	Not recommended			Service hours
	<b>Period</b>	3-5 years	10 years	7- 10 years				20K to 40K hours
	<b>Source</b>	Manufacturer	Manufacturer	Manufacturer				Company standard
Actual	<b>Outage type</b>	No outage required	Major - rotor in or out	Major - rotor out	Major - rotor out			Major - rotor in
	<b>Period</b>	Two years	20	7- 10 years	5-7 years			40K to 60K hours
Actual/Recommended change	<b>Decision Basis</b>	Prior mtce experience	Prior mtce experience	Not applicable	Prior mtce experience	On condition	On condition	Prior mtce experience
<b>4. Leakage test - replace bushings if required.</b>								
Recommended	<b>Basis</b>	Time	Not recommended	Time	Not recommended			Service hours
	<b>Period</b>	> 10 years		7- 10 years				20K to 40K hours
	<b>Source</b>	Manufacturer		Manufacturer				Company standard
Actual	<b>Outage type</b>	Major - rotor in or out	Task not done	Major - rotor out	Minor			Major - rotor in or out
	<b>Period</b>	> 10 years		7- 10 years	Only if necessary			> 90K hours
Actual/Recommended change	<b>Decision Basis</b>	Prior mtce experience		Not applicable	Prior mtce experience	On condition	On condition	Prior mtce experience

		Finland	Russia	USA	Japan	France	Croatia	Switzerland
<b>Bushings.</b>								
<b>1. Inspection &amp; clean, external.</b>								
Recommended	<b>Basis</b>	Time	Time		Time	Service hours	Time	Service hours & operation cycles
	<b>Period</b>	Annual	3-5 years		Two years	10K - 20K hrs	3-5 years	20K to 40K hours
	<b>Source</b>	Company standard	Mfr or Company standard		Manufacturer	Manufacturer	Manufacturer	Manufacturer
Actual	<b>Outage type</b>	Minor	Major - rotor in or out	Minor	Major - rotor in or out	Major - rotor out	Major - rotor in	Any
	<b>Period</b>	Annual	3-5 years	5-7 years	Two years	7 - 10 years	3-5 years	3-5 years
Actual/Recommended change	<b>Decision Basis</b>		Not applicable			Prior mtce experience	Prior mtce experience	Market needs
<b>2. Internal inspection – gas cooled bushings</b>								
Recommended	<b>Basis</b>	Time	Time		Time	Not recommended	Time	Service hours & operation cycles
	<b>Period</b>	5-7 or 7-10 years	3-5 years		3-5 years		3-5 years	20K to 40K hours
	<b>Source</b>	Manufacturer	Mfr or Company standard		Manufacturer		Manufacturer	Manufacturer
Actual	<b>Outage type</b>	Major - rotor in or out	Major - rotor in or out		Major - rotor out		Major - rotor in	
	<b>Period</b>	5-7 or 7-10 years	3-5 years	Condition based	3-5 years		3-5 years	3-5 years
Actual/Recommended change	<b>Decision Basis</b>		Not applicable			Rec being followed	Prior mtce experience	Market needs
<b>3. Leakage test - replace gaskets and seals if required.</b>								
Recommended	<b>Basis</b>	Time	Time		Time	Service hours	Time	Service hours & operation cycles
	<b>Period</b>	> 7 years	3-5 years		Two years	> 90K hours	5-7 years	40K to 60K hours
	<b>Source</b>	Manufacturer	Mfr or Company standard		Manufacturer	Manufacturer	Manufacturer	Manufacturer
Actual	<b>Outage type</b>	Major - rotor in or out	Major - rotor in or out		Major - rotor in or out		Major - rotor out	Any
	<b>Period</b>	> 7 years	3-5 years	Condition based	Two years		5-7 years	Annual or 3-5 years
Actual/Recommended change	<b>Decision Basis</b>		Not applicable				Prior mtce experience	Market needs
<b>4. Leakage test - replace bushings if required.</b>								
Recommended	<b>Basis</b>	Time	Time		Condition based	Condition based	Time	Service hours & operation cycles
	<b>Period</b>	> 7 years	3-5 years				5-7 years	40K to 60K hours
	<b>Source</b>	Manufacturer	Mfr or Company standard		Manufacturer		Manufacturer	Manufacturer
Actual	<b>Outage type</b>	Major - rotor in or out	Major - rotor in or out		Major - rotor out		Major - rotor out	
	<b>Period</b>	> 7 years	3-5 years	Condition based			5-7 years	Annual
Actual/Recommended change	<b>Decision Basis</b>		Not applicable				Prior mtce experience	Market needs

		Australia 1	Australia 2	Australia 3	Serbia - Montenegro	Italy - Base Load	Italy - Mid Load	Brazil
<b>Core &amp; frame</b>								
<b>1. Visual inspection &amp; clean.</b>								
Recommended	<b>Basis</b>	Time	Time	Time	Time	Service hours	Service hours & operation cycles	Not recommended
	<b>Period</b>	3-5 years	4 years	7- 10 years	5-7 years	60K to 90K hours	60K to 90K hours	
	<b>Source</b>	Manufacturer	Manufacturer	Manufacturer	Mfr or National standard	Company standard	Company standard	
Actual	<b>Outage type</b>	Major - rotor in or out	Major - rotor in or out	Major - rotor out	Major - rotor out	Major - rotor out	Major - rotor out	
	<b>Period</b>	3-5 years	4 years	3 - 5 years	5-7 years	60K to 90K hours	60K to 90K hours	
Actual/Recommended change	<b>Decision Basis</b>	Prior mtce experience	Not applicable		Not applicable	Not applicable	Not applicable	
<b>2. Frame cracking NDT &amp; repair.</b>								
Recommended	<b>Basis</b>	Time	Not recommended	Time	Not recommended			Not recommended
	<b>Period</b>	3-5 years		7- 10 years				
	<b>Source</b>	Manufacturer						
Actual	<b>Outage type</b>	Major - rotor out	Task not done	Major - rotor out	Minor			
	<b>Period</b>	> 10 years		7- 10 years	Only if necessary			
Actual/Recommended change	<b>Decision Basis</b>	Prior mtce experience		Not applicable	Not applicable	On condition	On condition	
<b>3. Check liquid level detectors</b>								
Recommended	<b>Basis</b>		Time	Time	Time	Service hours	Service hours & operation cycles	
	<b>Period</b>		Daily	3 - 5 years	Annual	20K to 40K hours	20K to 40K hours	
	<b>Source</b>		Manufacturer	Manufacturer	Manufacturer	Company standard	Company standard	
Actual	<b>Outage type</b>			Major - rotor in or out	Minor	Minor	Minor	
	<b>Period</b>		Daily	3 - 5 years	Annual	20K to 40K hours	20K to 40K hours	
Actual/Recommended change	<b>Decision Basis</b>		Not applicable		Not applicable	Not applicable	Not applicable	
<b>4. Check longitudinal core tightening screws.</b>								
Recommended	<b>Basis</b>	Time	Time	Time	Time	Service hours	Service hours & operation cycles	Not recommended
	<b>Period</b>	3-5 years	4 years	7- 10 years	5-7 years	60K to 90K hours	60K to 90K hours	
	<b>Source</b>	Manufacturer	Manufacturer	Manufacturer	Mfr or National standard	Company standard	Company standard	
Actual	<b>Outage type</b>	Major - rotor out	Major - rotor in or out	Major - rotor out	Major - rotor out	Major - rotor out	Major - rotor out	
	<b>Period</b>	> 10 years	4 years	7- 10 years	5-7 years	60K to 90K hours	60K to 90K hours	
Actual/Recommended change	<b>Decision Basis</b>	Prior mtce experience	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	
<b>5. Check gas flow control rings, baffles etc.</b>								
Recommended	<b>Basis</b>	Time	Time	Time	Time	Service hours	Service hours & operation cycles	
	<b>Period</b>	3-5 years	4 years	7- 10 years	Annual	20K to 40K hours	20K to 40K hours	
	<b>Source</b>	Manufacturer		Manufacturer	Manufacturer	Company standard	Company standard	
Actual	<b>Outage type</b>	Major - rotor out	Major - rotor out	Major - rotor out	Minor	Minor	Minor	
	<b>Period</b>	7-10 years	15 years	7- 10 years	Annual	20K to 40K hours	20K to 40K hours	
Actual/Recommended change	<b>Decision Basis</b>	Prior mtce experience	Prior mtce experience	Not applicable	Not applicable	Not applicable	Not applicable	

Core & frame		Australia 1	Australia 2	Australia 3	Serbia - Montenegro	Italy - Base Load	Italy - Mid Load	Brazil
<b>6. Inspect end shields.</b>								
Recommended	<b>Basis</b>	Time	Not recommended	Time	Time			
	<b>Period</b>	3-5 years		3 - 5 years	5-7 years			
	<b>Source</b>	Manufacturer		Manufacturer	Mfr or National standard			
Actual	<b>Outage type</b>	Major - rotor out	Task not done	Major - rotor in or out	Major - rotor out			
	<b>Period</b>	7-10 years		3 - 5 years	5-7 years			
Actual/Recommended change	<b>Decision Basis</b>	Prior mtce experience		Not applicable	Not applicable			
<b>7. EI-Cid test</b>								
Recommended	<b>Basis</b>	Time	Condition based	Condition Based	Not recommended	Service hours	Service hours & operation cycles	Not recommended
	<b>Period</b>	3-5 years				60K to 90K hours	60K to 90K hours	
	<b>Source</b>	Other				Company standard	Company standard	
Actual	<b>Outage type</b>	Major - rotor out			Major - rotor out	Major - rotor out	Major - rotor out	
	<b>Period</b>	> 10 years			5-7 years	60K to 90K hours	60K to 90K hours	
Actual/Recommended change	<b>Decision Basis</b>	Prior mtce experience	Prior mtce experience		Market needs	Not applicable	Not applicable	
<b>8. Ring flux test</b>								
Recommended	<b>Basis</b>	Elcro recommended		Condition Based	Time			
	<b>Period</b>				5-7 years			
	<b>Source</b>				National standard			
Actual	<b>Outage type</b>				Major - rotor out			
	<b>Period</b>				5-7 years			
Actual/Recommended change	<b>Decision Basis</b>				Not applicable	On condition	On condition	

		Finland	Russia	USA	Japan	France	Croatia	Switzerland
<b>Core &amp; frame</b>								
<b>1. Visual inspection &amp; clean.</b>								
Recommended	Basis	Time	Time		Time	Service hours	Time	Service hours & operation cycles
	Period	5-7 years	3-5 years		3-5 years	40K - 60K hrs	5-7 years	20K to 40K hours
	Source	Manufacturer & Company std	Manufacturer		Manufacturer	Manufacturer	Manufacturer	Manufacturer
Actual	Outage type	Major - rotor in or out	Major - rotor out	Major - rotor out	Major - rotor out	Major - rotor out	Major - rotor out	Any
	Period	5-7 or 7-10 years	3-5 years	5-7 years	3-5 years	7 - 10 years	5-7 years	Annual or 3-5 years
Actual/Recommended change	Decision Basis		Not applicable			Prior mtce experience	Not applicable	Prior mtce experience
<b>2. Frame cracking NDT &amp; repair.</b>								
Recommended	Basis	Condition based	Condition based		Not recommended	Condition based	Time	Condition based
	Period						5-7 years	40K to 60K hours
	Source						Manufacturer	Manufacturer
Actual	Outage type	Major - rotor out			Task not done		Major - rotor out	
	Period			Condition based			5-7 years	3-5 years
Actual/Recommended change	Decision Basis					Not applicable	Not applicable	Prior mtce experience
<b>3. Check liquid level detectors</b>								
Recommended	Basis	Time	Time		Time	Condition based	Time	Service hours & operation cycles
	Period	Annual	Annual		Two years		Annual	20K to 40K hours
	Source	Manufacturer & Company std	Other		Company standard		Manufacturer	Manufacturer
Actual	Outage type	Minor	Major - rotor in or out	No outage required	Major - rotor in or out	Major - rotor in or out	No outage required	Any
	Period	Annual	Annual		Two years	7 - 10 years	Annual	Annual or 3-5 years
Actual/Recommended change	Decision Basis		Not applicable				National Standard	Market needs
<b>4. Check longitudinal core tightening screws.</b>								
Recommended	Basis	Time, service hours or cycles	Time		Time	Not recommended	Time	Not recommended
	Period	2 - 5 years	3-5 years		3-5 years		5-7 years	
	Source	Manufacturer & Company std	Manufacturer		Manufacturer		Manufacturer	
Actual	Outage type	Major - rotor in or out	Major - rotor out	Major - rotor in or out	Major - rotor out		Major - rotor out	Task not done
	Period	2 - 5 years	3-5 years	7-10 years	3-5 years		5-7 years	
Actual/Recommended change	Decision Basis		Not applicable			Not applicable	Not applicable	Prior mtce experience
<b>5. Check gas flow control rings, baffles etc.</b>								
Recommended	Basis	Time, service hours or cycles	Condition based		Time	Service hours	Time	Service hours & operation cycles
	Period	5-7 or 7-10 years			3-5 years	40K - 60K hrs	5-7 years	20K to 40K hours
	Source	Manufacturer & Company std			Manufacturer	Manufacturer	Manufacturer	Manufacturer
Actual	Outage type	Major - rotor in or out			Major - rotor out	Major - rotor in or out	Major - rotor out	Any
	Period	5-7 or 7-10 years		Condition based	3-5 years		5-7 years	Annual
Actual/Recommended change	Decision Basis		Rec being followed				Not applicable	Prior mtce experience

Core & frame		Finland	Russia	USA	Japan	France	Croatia	Switzerland
<b>6. Inspect end shields.</b>								
Recommended	<b>Basis</b>	Time, service hours or cycles	Time		Time	Service hours	Time	Service hours & operation cycles
	<b>Period</b>	5-7 or 7-10 years	3-5 years		3-5 years	40K - 60K hrs	5-7 years	40K to 60K hours
	<b>Source</b>	Company standard	Manufacturer		Manufacturer	Manufacturer	Manufacturer	Manufacturer
Actual	<b>Outage type</b>	Major - rotor in or out	Major - rotor out	Major - rotor in or out	Major - rotor out	Major - rotor out	Major - rotor out	Major - rotor out
	<b>Period</b>	5-7 or 7-10 years	3-5 years	5-7 years	3-5 years	7 - 10 years	5-7 years	3-5 or 7-10 years
Actual/Recommended change	<b>Decision Basis</b>		Not applicable			Prior mtce experience	Not applicable	Prior mtce experience
<b>7. EI-Cid test</b>								
Recommended	<b>Basis</b>	Time, service hours or cycles	Time		Not recommended	Service hours	Service hours	Service hours & operation cycles
	<b>Period</b>	5-7 or 7-10 years	3-5 years			40K - 60K hrs	40K to 60K hours	20K to 40K hours
	<b>Source</b>	Company standard	Other			Manufacturer	Manufacturer	Manufacturer
Actual	<b>Outage type</b>	Major - rotor out	Major - rotor out	Major - rotor out	Task not done	Major - rotor out	Major - rotor out	Any
	<b>Period</b>	7-10 years	3-5 years	Condition based		7 - 10 years	40K to 60K hours	3-5 years
Actual/Recommended change	<b>Decision Basis</b>		Not applicable			Not applicable	Not applicable	Market needs
<b>8. Ring flux test</b>								
Recommended	<b>Basis</b>	Condition based	Time		Not recommended	Condition based		Condition based
	<b>Period</b>		3-5 years					20K to 40K hours
	<b>Source</b>	Company standard	Mfr or Company standard					
Actual	<b>Outage type</b>	Major - rotor out	Major - rotor out	Major - rotor out	Task not done			
	<b>Period</b>	> 10 years	3-5 years	Condition based				
Actual/Recommended change	<b>Decision Basis</b>		Not applicable			Not applicable		Risk assessment

		Australia 1	Australia 2	Australia 3	Serbia - Montenegro	Italy - Base Load	Italy - Mid Load	Brazil
<b>Stator cooling water system</b>								
<b>1. Inspect heat exchangers</b>								
Recommended	<b>Basis</b>	Time	Time	Time	Time	Service hours	Service hours & operation cycles	Not recommended
	<b>Period</b>	3-5 years	4 years	7- 10 years	Annual	60K to 90K hours	60K to 90K hours	
	<b>Source</b>	Manufacturer	Manufacturer	Manufacturer	Manufacturer	Company standard	Company standard	
Actual	<b>Outage type</b>	Major - rotor in or out	Major - rotor out	Major - rotor out	Minor	Major - rotor out	Major - rotor out	
	<b>Period</b>	7-10 years	4 years	3 - 5 years	Annual	60K to 90K hours	60K to 90K hours	
Actual/Recommended change	<b>Decision Basis</b>	Prior mtce experience	Not applicable		Not applicable	Not applicable	Not applicable	
<b>2. Mechanical maintenance of pumps, valves etc.</b>								
Recommended	<b>Basis</b>	Time	Time	Time	Time	Service hours	Service hours & operation cycles	Not recommended
	<b>Period</b>	Annual	4 years	7- 10 years	Annual	60K to 90K hours	60K to 90K hours	
	<b>Source</b>	Manufacturer	Manufacturer		Manufacturer	Company standard	Company standard	
Actual	<b>Outage type</b>	Major - rotor in or out	Major - rotor out	Major - rotor out	Minor	Major - rotor out	Major - rotor out	
	<b>Period</b>		4 years	7- 10 years	Annual	60K to 90K hours	60K to 90K hours	
Actual/Recommended change	<b>Decision Basis</b>		Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	
<b>3. Pressure test</b>								
Recommended	<b>Basis</b>	Time	Not recommended	Time	Time	Service hours	Service hours & operation cycles	Not recommended
	<b>Period</b>	3-5 years		3 - 5 years	Annual	60K to 90K hours	60K to 90K hours	
	<b>Source</b>	Manufacturer		Manufacturer	Manufacturer	Company standard	Company standard	
Actual	<b>Outage type</b>	Major - rotor in or out	Task not done	Major - rotor in or out	Minor	Major - rotor out	Major - rotor out	
	<b>Period</b>	3-5 years		3 - 5 years	Annual	60K to 90K hours	60K to 90K hours	
Actual/Recommended change	<b>Decision Basis</b>	Prior mtce experience			Not applicable	Not applicable	Not applicable	
<b>4. Vacuum test</b>								
Recommended	<b>Basis</b>	Condition based	Not recommended	Time	Not recommended	Service hours	Service hours & operation cycles	Not recommended
	<b>Period</b>			7- 10 years		60K to 90K hours	60K to 90K hours	
	<b>Source</b>			Manufacturer		Company standard	Company standard	
Actual	<b>Outage type</b>	Major - rotor in or out	Task not done	Major - rotor out		Major - rotor out	Major - rotor out	
	<b>Period</b>	7-10 years		7- 10 years		60K to 90K hours	60K to 90K hours	
Actual/Recommended change	<b>Decision Basis</b>	Prior mtce experience		Not applicable		Not applicable	Not applicable	

		Finland	Russia	USA	Japan	France	Croatia	Switzerland
<b>Stator cooling water system</b>								
<b>1. Inspect heat exchangers</b>								
Recommended	<b>Basis</b>	Time	Time		Time	Service hours	Time	Service hours & operation cycles
	<b>Period</b>	Annual	1 - 2 years		3-5 years	> 90K hours	3-5 years	20K to 40K hours
	<b>Source</b>	Manufacturer & Company std	Mfr or Company standard		Manufacturer	Manufacturer	Manufacturer	Manufacturer
Actual	<b>Outage type</b>	Minor	Major - rotor in or out	Minor	Major - rotor out	Major - rotor in	Major - rotor in	Any
	<b>Period</b>	Annual	1 - 2 years	5-7 years	3-5 years	3 - 5 years	3-5 years	7-10 years
Actual/Recommended change	<b>Decision Basis</b>		Not applicable				Not applicable	Market needs
<b>2. Mechanical maintenance of pumps, valves etc.</b>								
Recommended	<b>Basis</b>	Time	Time		Time	Service hours	Time	Service hours & operation cycles
	<b>Period</b>	Annual	3-5 years		3-5 years	40K - 60K hrs	Annual	20K to 40K hours
	<b>Source</b>	Company standard	Mfr or Company standard		Manufacturer	Manufacturer	Manufacturer	Manufacturer
Actual	<b>Outage type</b>	Minor	Major - rotor in or out	Minor	Major - rotor out		No outage required	Any
	<b>Period</b>	Annual	3-5 years	5-7 years	3-5 years		Annual	3-5 years
Actual/Recommended change	<b>Decision Basis</b>		Not applicable				Not applicable	Market needs
<b>3. Pressure test</b>								
Recommended	<b>Basis</b>	Time	Time		Time	Condition based	Service hours	Service hours & operation cycles
	<b>Period</b>	3 - 10 years	3-5 years		3-5 years		40K to 60K hours	40K to 60K hours
	<b>Source</b>	Company standard	Mfr or Company standard		Manufacturer	Manufacturer	Manufacturer	
Actual	<b>Outage type</b>	Major - rotor in or out	Major - rotor in or out		Major - rotor out		Major - rotor out	
	<b>Period</b>	5-7 or 7-10 years	3-5 years	Condition based	3-5 years		40K to 60K hours	
Actual/Recommended change	<b>Decision Basis</b>		Not applicable				Not applicable	Prior mtce experience
<b>4. Vacuum test</b>								
Recommended	<b>Basis</b>	Time	Time		Time	Service hours	Service hours	Condition based
	<b>Period</b>	3 - 10 years	1 - 2 years		3-5 years	10K - 20K hrs	40K to 60K hours	20K to 40K hours
	<b>Source</b>	Company standard	Manufacturer		Manufacturer	Manufacturer	Manufacturer	
Actual	<b>Outage type</b>	Major - rotor in or out	Major - rotor in or out		Major - rotor out		Major - rotor out	
	<b>Period</b>	5-7 or 7-10 years	1 - 2 years	Condition based	3-5 years		40K to 60K hours	
Actual/Recommended change	<b>Decision Basis</b>		Not applicable				Not applicable	Prior mtce experience

		Australia 1	Australia 2	Australia 3	Serbia - Montenegro	Italy - Base Load	Italy - Mid Load	Brazil
<b>Stator water treatment</b>								
<b>1. Replace resin</b>								
Recommended	<b>Basis</b>		Time	Condition Based	Technical diagnostic	Time	Time	Not recommended
	<b>Period</b>		20months			Annual	Annual	
	<b>Source</b>		Manufacturer	Manufacturer	Manufacturer	Company standard	Company standard	
Actual	<b>Outage type</b>		No outage required			No outage required	No outage required	
	<b>Period</b>		As required			Annual	Annual	
Actual/Recommended change	<b>Decision Basis</b>		Prior mtce experience		Not applicable	Not applicable	Not applicable	
<b>2. Component inspection &amp; repair</b>								
Recommended	<b>Basis</b>		Time	Condition Based	Time	Service hours	Service hours & operation cycles	Not recommended
	<b>Period</b>		2 years		Annual	60K to 90K hours	60K to 90K hours	
	<b>Source</b>		Manufacturer		Manufacturer	Company standard	Company standard	
Actual	<b>Outage type</b>		Not recommended		Minor	Major - rotor out	Major - rotor out	
	<b>Period</b>				Annual	60K to 90K hours	60K to 90K hours	
Actual/Recommended change	<b>Decision Basis</b>				Not applicable	Not applicable	Not applicable	
<b>3. Calibrate conductivity instruments.</b>								
Recommended	<b>Basis</b>	Time	Not recommended	Time	Time	Service hours	Service hours & operation cycles	Not recommended
	<b>Period</b>	Annual			5-7 years	60K to 90K hours	60K to 90K hours	
	<b>Source</b>	Manufacturer			Manufacturer	Company standard	Company standard	
Actual	<b>Outage type</b>	Major - rotor in or out	No outage required	Major - rotor in or out	Major - rotor in or out	Major - rotor out	Major - rotor out	
	<b>Period</b>	3-5 years	4 years	2 years	5-7 years	60K to 90K hours	60K to 90K hours	
Actual/Recommended change	<b>Decision Basis</b>	Prior mtce experience			Not applicable	Not applicable	Not applicable	

		Finland	Russia	USA	Japan	France	Croatia	Switzerland
<b>Stator water treatment</b>								
<b>1. Replace resin</b>								
Recommended	<b>Basis</b>	Time or Condition based	Condition based		Condition based	Service hours	Time	Condition based
	<b>Period</b>	1 - 2 years				2 years	Two years	20K to 40K hours
	<b>Source</b>	Manufacturer & Company std	Manufacturer		Company standard	Manufacturer	Manufacturer	Manufacturer
Actual	<b>Outage type</b>	Minor	No outage required	Minor	No outage required	No outage required	No outage required	Any
	<b>Period</b>	1 - 2 years				Annual or 2 years	Two years	5-7 years
Actual/Recommended change	<b>Decision Basis</b>		Rec being followed			Prior mtce experience	Not applicable	Market needs
<b>2. Component inspection &amp; repair</b>								
Recommended	<b>Basis</b>	Time	Time & operation cycles		Time	Service hours	Time	Condition based
	<b>Period</b>	Annual	3-5 years		Two years	40K - 60K hrs	Annual	20K to 40K hours
	<b>Source</b>	Manufacturer & Company std	Other		Manufacturer	Manufacturer	Manufacturer	Manufacturer
Actual	<b>Outage type</b>	Minor	Major - rotor in or out	Major - rotor in or out	Major - rotor in or out		No outage required	Any
	<b>Period</b>	Annual	3-5 years		Two years		Annual	Annual
Actual/Recommended change	<b>Decision Basis</b>		Not applicable				Not applicable	Market needs
<b>3. Calibrate conductivity instruments.</b>								
Recommended	<b>Basis</b>	Time	Time		Time	Service hours	Time	Service hours & operation cycles
	<b>Period</b>	1 - 2 years	3-5 years		Annual	40K - 60K hrs	Annual	20K to 40K hours
	<b>Source</b>	Company standard	Other		Manufacturer	Manufacturer	Manufacturer	Manufacturer
Actual	<b>Outage type</b>	Major - rotor in or out	Major - rotor in or out	Major - rotor in or out	No outage required	Manufacturer	No outage required	Any
	<b>Period</b>	1 - 2 years	3-5 years		Annual	3 - 5 years	Annual	Annual
Actual/Recommended change	<b>Decision Basis</b>		Not applicable				Not applicable	Prior mtce experience

		Australia 1	Australia 2	Australia 3	Serbia - Montenegro	Italy - Base Load	Italy - Mid Load	Brazil
<b>Rotor</b>								
<b>1. Remove rotor for inspection - inspect accessible rotor components, including fan; NDT of rotor bore.</b>								
Recommended	<b>Basis</b>	Time	Time	Time	Time	Service hours	Service hours & operation cycles	Service hours
	<b>Period</b>	3-5 years	10 years	7- 10 years	5-7 years	60K to 90K hours	60K to 90K hours	> 90K hours
	<b>Source</b>	Manufacturer	Manufacturer	Manufacturer	Manufacturer	Company standard	Company standard	Manufacturer
Actual	<b>Outage type</b>	Major - rotor out	Major - rotor out	Major - rotor out	Major - rotor out	Major - rotor out	Major - rotor out	Major - rotor out
	<b>Period</b>	7-10 years	15 years	7- 10 years	5-7 years	60K to 90K hours	20K to 40K hours	> 90K hours
Actual/Recommended change	<b>Decision Basis</b>	Prior mtce experience	Prior mtce experience	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
<b>2. Remove retaining rings – inspect &amp; NDT rings, wedges &amp; slots.</b>								
Recommended	<b>Basis</b>	Time	Time	Time	Time			Service hours
	<b>Period</b>	3-5 years	10 years	7- 10 years	>7 years			> 90K hours
	<b>Source</b>	Other	Manufacturer	Manufacturer	Manufacturer			Manufacturer
Actual	<b>Outage type</b>	Major - rotor out	Major - rotor out	Major - rotor out	Major - rotor out			Major - rotor out
	<b>Period</b>	> 10 years	25 years	7 - 10 years	>7 years			> 90K hours
Actual/Recommended change	<b>Decision Basis</b>	Maintenance cost saving	Prior mtce experience	Not applicable	Not applicable	On condition	On condition	Not applicable
<b>3. Electrical tests: IR; PI; RSO; winding resistance</b>								
Recommended	<b>Basis</b>	Time	Time	Time	Time	Service hours	Service hours & operation cycles	Service hours
	<b>Period</b>	3-5 years	10 years	3 - 5 years	5-7 years	20K to 40K hours	20K to 40K hours	> 90K hours
	<b>Source</b>	Manufacturer	Manufacturer	International standard	Mfr or National standard	Company standard	Company standard	Manufacturer
Actual	<b>Outage type</b>	Major - rotor out	Major - rotor in or out	Any	Major - rotor out	Major - rotor out	Minor	Major - rotor in or out
	<b>Period</b>	7-10 years	4 years	3 - 5 years	5-7 years	20K to 40K hours	20K to 40K hours	> 90K hours
Actual/Recommended change	<b>Decision Basis</b>	Prior mtce experience	Prior mtce experience	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
<b>4. Time of flight diffraction</b>								
Recommended	<b>Basis</b>	Time	Not recommended		Time			Not recommended
	<b>Period</b>	3-5 years			5-7 years			
	<b>Source</b>	Manufacturer			Other			
Actual	<b>Outage type</b>	Major - rotor out	Major - rotor out		Major - rotor in or out			
	<b>Period</b>	7-10 years	15 years		5-7 years			
Actual/Recommended change	<b>Decision Basis</b>	Prior mtce experience	Prior mtce experience		Prior mtce experience			

		Finland	Russia	USA	Japan	France	Croatia	Switzerland
<b>Rotor</b>								
<b>1. Remove rotor for inspection - inspect accessible rotor components, including fan; NDT of rotor bore.</b>								
Recommended	Basis	Time, service hours or cycles	Time		Time	Service hours	Service hours	Service hours & operation cycles
	Period	5-7 or 7-10 years	3-5 years		3-5 years	40K - 60K hrs	40K to 60K hours	40K to 60K hours
	Source	Manufacturer & Company std	Mfr or Company standard		Manufacturer	Manufacturer	Manufacturer	Manufacturer
Actual	Outage type	Major - rotor out	Major - rotor out	Major - rotor out	Major - rotor out	Major - rotor out	Major - rotor out	Major - rotor out
	Period	5-7 or 7-10 years	3-5 years	5-7 years	3-5 years	7 - 10 years	40K to 60K hours	2-5 years OR 7-10 years
Actual/Recommended change	Decision Basis		Not applicable			Prior mtce experience	Not applicable	Prior mtce experience
<b>2. Remove retaining rings – inspect &amp; NDT rings, wedges &amp; slots.</b>								
Recommended	Basis	Time, service hours or cycles	Time		Time	Service hours	Service hours	Service hours & operation cycles
	Period	5-7 or 7-10 years	3-5 or >10 yrs		>10 yrs	40K - 60K hrs	40K to 60K hours	60K to 90K hours
	Source	Company standard	Mfr or Company standard		Manufacturer	Manufacturer	Manufacturer	Manufacturer
Actual	Outage type	Major - rotor out	Major - rotor out		Major - rotor out		Major - rotor out	Major - rotor out
	Period	5-7 or >10 years	3-5 or >10 yrs	Condition based	>10 yrs		40K to 60K hours	>7 years
Actual/Recommended change	Decision Basis		Not applicable				Not applicable	Prior mtce experience
<b>3. Electrical tests: IR; PI; RSO; winding resistance</b>								
Recommended	Basis	Time or Condition based	Time		Time	Service hours	Time	Service hours & operation cycles
	Period	Annual	Annual or 3-5 years		3-5 years	10K - 20K hrs	3-5 years	20K to 40K hours
	Source	Manufacturer & Company std	Mfr or Company standard		Manufacturer	Manufacturer	Manufacturer	Manufacturer
Actual	Outage type	Minor	Major - rotor in or out	Major - rotor out	Major - rotor out	Any	Major - rotor in	Any
	Period	Annual	3-5 years	5-7 years	3-5 years	2 years	3-5 years	Annual or 3-5 years
Actual/Recommended change	Decision Basis		Not applicable			Prior mtce experience	Not applicable	Market needs
<b>4. Time of flight diffraction</b>								
Recommended	Basis		Not recommended		Time	Not recommended	Time	Not recommended
	Period				7-10 years		Two years	
	Source				Manufacturer		Other	
Actual	Outage type				Major - rotor out		No outage required	
	Period			Condition based	7-10 years		Two years	
Actual/Recommended change	Decision Basis						Prior mtce experience	

		Australia 1	Australia 2	Australia 3	Serbia - Montenegro	Italy - Base Load	Italy - Mid Load	Brazil
<b>Hydrogen cooling system</b>								
<b>1. Remove, inspect &amp; repair hydrogen coolers.</b>								
Recommended	<b>Basis</b>	Time	Time	Time	Time	Service hours	Service hours & operation cycles	Condition based
	<b>Period</b>	3-5 years	4 years	3 - 5 years	Annual	60K to 90K hours	60K to 90K hours	> 90K hours
	<b>Source</b>	Manufacturer	Manufacturer	Manufacturer	Manufacturer	Company standard	Company standard	Company standard
Actual	<b>Outage type</b>	Major - rotor in or out	Major - rotor in or out	Major - rotor in or out	Minor	Major - rotor out	Major - rotor out	Major - rotor out
	<b>Period</b>	7-10 years	4 years	3 - 5 years	Annual	60K to 90K hours	60K to 90K hours	> 90K hours
Actual/Recommended change	<b>Decision Basis</b>	Prior mtce experience	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Maintenance cost saving
<b>2. Pressure test cooling water piping.</b>								
Recommended	<b>Basis</b>	Time	Not recommended	Condition based	Time	Service hours	Service hours & operation cycles	Service hours
	<b>Period</b>	3-5 years		3 - 5 years	Annual	60K to 90K hours	60K to 90K hours	< 10K hours
	<b>Source</b>	Manufacturer		Manufacturer	Manufacturer	Company standard	Company standard	Company standard
Actual	<b>Outage type</b>	Major - rotor in or out	Task not done	Major - rotor in or out	Minor	Major - rotor out	Major - rotor out	Minor
	<b>Period</b>	7-10 years		3 - 5 years	Annual	60K to 90K hours	60K to 90K hours	< 10K hours
Actual/Recommended change	<b>Decision Basis</b>	Prior mtce experience		Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
<b>3. Calibrate dewpoint instrumentation</b>								
Recommended	<b>Basis</b>	Time	Not recommended	Time	Time	Service hours	Service hours & operation cycles	Service hours
	<b>Period</b>	Two years		3 - 5 years	Annual	60K to 90K hours	60K to 90K hours	< 10K hours
	<b>Source</b>	Manufacturer			Manufacturer	Company standard	Company standard	Company standard
Actual	<b>Outage type</b>	Major - rotor in or out	No outage required	Major - rotor in or out	M	Major - rotor out	Major - rotor out	Minor
	<b>Period</b>	7-10 years	Monthly	3 - 5 years	Annual	60K to 90K hours	60K to 90K hours	< 10K hours
Actual/Recommended change	<b>Decision Basis</b>	Prior mtce experience	Prior mtce experience	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
<b>Hydrogen seals</b>								
<b>1. Inspect, including NDT</b>								
Recommended	<b>Basis</b>	Time	Time	Time	Time	Service hours	Service hours & operation cycles	Service hours
	<b>Period</b>	3-5 years	4 years	3 - 5 years	Annual	20K to 40K hours	20K to 40K hours	< 10K hours
	<b>Source</b>	Manufacturer	Manufacturer	Manufacturer	Manufacturer	Company standard	Company standard	Company standard
Actual	<b>Outage type</b>	Major - rotor in or out	Major - rotor out	Major - rotor in or out	Minor	Minor	Minor	Minor
	<b>Period</b>	3-5 years	15 years	3 - 5 years	Annual	20K to 40K hours	20K to 40K hours	< 10K hours
Actual/Recommended change	<b>Decision Basis</b>	Not applicable	Prior mtce experience	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
<b>2. IR testing</b>								
Recommended	<b>Basis</b>	Time	Time	Time	Time	Service hours	Service hours & operation cycles	Service hours
	<b>Period</b>	3-5 years	4 years	3 - 5 years	Annual	20K to 40K hours	20K to 40K hours	< 10K hours
	<b>Source</b>	Manufacturer	Manufacturer	Manufacturer	Manufacturer	Company standard	Company standard	Company standard
Actual	<b>Outage type</b>	Major - rotor in or out	Major - rotor out	Major - rotor in or out	Minor	Minor	Minor	Minor
	<b>Period</b>	3-5 years	15 years	3 - 5 years	Annual	20K to 40K hours	20K to 40K hours	< 10K hours
Actual/Recommended change	<b>Decision Basis</b>	Not applicable	Prior mtce experience	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable

		Finland	Russia	USA	Japan	France	Croatia	Switzerland
<b>Hydrogen cooling system</b>								
<b>1. Remove, inspect &amp; repair hydrogen coolers.</b>								
Recommended	Basis	Time, service hours or cycles	Time		Time	Service hrs or Condition based	Service hours	Service hours & operation cycles
	Period	2 years or 5-7 years	2 or 3-5 years		3-5 years	40K - 60K hrs	40K to 60K hours	20K-40K or 60K-90K hours
	Source	Manufacturer & Company std	Mfr or Company standard		Manufacturer	Manufacturer	Manufacturer	Manufacturer
Actual	Outage type	Major - rotor in or out	Major - rotor in or out	Major - rotor in or out	Major - rotor out	Manufacturer	Major - rotor out	Any
	Period	3 - 7 years	2 or 3-5 years	Condition based	3-5 years	5 - 7 years	40K to 60K hours	Annual or 7-10 years
Actual/Recommended change	Decision Basis		Not applicable				Not applicable	Prior mtce experience
<b>2. Pressure test cooling water piping.</b>								
Recommended	Basis	Time	Time		Time	Not recommended	Service hours	Service hours & operation cycles
	Period	5-7 years	3-5 years		3-5 years		40K to 60K hours	40K to 60K hours
	Source	Company standard	Mfr or Company standard		Manufacturer		Manufacturer	
Actual	Outage type	Major - rotor in or out	Major - rotor in or out		Major - rotor out	Major - rotor out	Major - rotor out	
	Period	5-7 or 7-10 years	3-5 years	Condition based	3-5 years	7 - 10 years	40K to 60K hours	
Actual/Recommended change	Decision Basis		Not applicable				Not applicable	Market needs
<b>3. Calibrate dewpoint instrumentation</b>								
Recommended	Basis	Time	Time		Not recommended	Service hours		Service hours & operation cycles
	Period	2 - 5 years	3-5 years			40K - 60K hrs		20K to 40K hours
	Source	Company standard	Other			Manufacturer		Manufacturer
Actual	Outage type	No outage required	Major - rotor in or out		Task not done	Major - rotor out		Any
	Period	3-5 years	3-5 years	Condition based		7 - 10 years		Annual
Actual/Recommended change	Decision Basis		Not applicable					Market needs
<b>Hydrogen seals</b>								
<b>1. Inspect, including NDT</b>								
Recommended	Basis	Time, service hours or cycles	Time		Time	Service hours	Service hours	Service hours & operation cycles
	Period	3 - 7 years	2 or 3-5 years		3-5 years	40K - 60K hrs	20K to 40K hours	40K to 60K hours
	Source	Manufacturer & Company std	Mfr or Company standard		Manufacturer	Manufacturer	Manufacturer	Manufacturer
Actual	Outage type	Major - rotor in or out	Major - rotor in or out	Major - rotor in or out	Major - rotor out	Major - rotor out	Major - rotor in	
	Period	3 - 7 years	2 or 3-5 years	5-7 years	3-5 years	7 - 10 years	20K to 40K hours	3-5 years
Actual/Recommended change	Decision Basis		Not applicable				Not applicable	Maintenance cost saving
<b>2. IR testing</b>								
Recommended	Basis	Time	Time		Time	Service hours	Time	Service hours & operation cycles
	Period	Annual	2 or 3-5 years		Two years	10K - 20K hrs	Annual	40K to 60K hours
	Source	Manufacturer & Company std	Mfr or Company standard		Manufacturer	Manufacturer	Manufacturer	Manufacturer
Actual	Outage type	Minor	Major - rotor in or out	Major - rotor in or out	Major - rotor in or out	Major - rotor in or out	No outage required	
	Period	Annual	2 or 3-5 years	5-7 years	Two years	3 - 5 years	Annual	3-5 years
Actual/Recommended change	Decision Basis		Not applicable			Prior mtce experience	Not applicable	Maintenance cost saving

		Australia 1	Australia 2	Australia 3	Serbia - Montenegro	Italy - Base Load	Italy - Mid Load	Brazil
<b>Bearings</b>								
<b>1. Inspection including NDT</b>								
Recommended	<b>Basis</b>	Time	Time	Time	Time	Service hours	Service hours & operation cycles	Service hours
	<b>Period</b>	3-5 years	4 years	3 - 5 years	Annual	20K to 40K hours	20K to 40K hours	20K to 40K hours
	<b>Source</b>	Manufacturer	Manufacturer	Manufacturer	Manufacturer	Company standard	Company standard	Company standard
Actual	<b>Outage type</b>	Major - rotor out	Major - rotor out	Major - rotor in or out	Minor	Minor	Minor	Major - rotor in
	<b>Period</b>	3-5 years	15 years	3 - 5 years	Annual	20K to 40K hours	20K to 40K hours	20K to 40K hours
Actual/Recommended change	<b>Decision Basis</b>	Not applicable	Prior mtce experience	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
<b>2. IR testing</b>								
Recommended	<b>Basis</b>	Time	Time	Time	Time	Service hours	Service hours & operation cycles	Service hours
	<b>Period</b>	Two years	4 years	3 - 5 years	Annual	20K to 40K hours	20K to 40K hours	< 10K hours
	<b>Source</b>	Manufacturer	Manufacturer	Manufacturer	Manufacturer	Company standard	Company standard	Company standard
Actual	<b>Outage type</b>	Major - rotor out	Major - rotor out	Major - rotor in or out	Minor	Minor	Minor	Minor
	<b>Period</b>	3-5 years	15 years	3 - 5 years	Annual	20K to 40K hours	20K to 40K hours	< 10K hours
Actual/Recommended change	<b>Decision Basis</b>	Prior mtce experience	Prior mtce experience	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
<b>3. Shaft earthing system inspect &amp; repair</b>								
Recommended	<b>Basis</b>	Time	Time	Time		Service hours	Service hours & operation cycles	Service hours
	<b>Period</b>	Two years	Weekly	< 10K hours		20K to 40K hours	20K to 40K hours	< 10K hours
	<b>Source</b>	Manufacturer	Manufacturer			Company standard	Company standard	Company standard
Actual	<b>Outage type</b>	Major - rotor in or out	No outage required	No outage required		Minor	Minor	Minor
	<b>Period</b>	Annual	2 week	< 10K hours		20K to 40K hours	20K to 40K hours	< 10K hours
Actual/Recommended change	<b>Decision Basis</b>	Prior mtce experience	Prior mtce experience	Not applicable		Not applicable	Not applicable	Not applicable
<b>Seal oil system</b>								
<b>1. Mechanical maintenance of pumps, strainers etc.</b>								
Recommended	<b>Basis</b>	Time	Time	Time	Time	Service hours	Service hours & operation cycles	Condition based
	<b>Period</b>	Two years	4 years	2 years	Annual	60K to 90K hours	60K to 90K hours	< 10K hours
	<b>Source</b>	Manufacturer	Manufacturer	Manufacturer	Manufacturer	Company standard	Company standard	Company standard
Actual	<b>Outage type</b>	Major - rotor in or out	Major - rotor in or out	Minor	Minor	Major - rotor out	Major - rotor out	Minor
	<b>Period</b>	3-5 years	4 years	2 years	Annual	60K to 90K hours	60K to 90K hours	< 10K hours
Actual/Recommended change	<b>Decision Basis</b>	Prior mtce experience	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable

		Finland	Russia	USA	Japan	France	Croatia	Switzerland
<b>Bearings</b>								
<b>1. Inspection including NDT</b>								
Recommended	<b>Basis</b>	Time, service hours or cycles	Time & operation cycles		Time	Service hours	Service hours	Service hours & operation cycles
	<b>Period</b>	2 - 5 years	3-5 years		3-5 years	40K - 60K hrs	20K to 40K hours	20K to 40K hours
	<b>Source</b>	Manufacturer & Company std	Manufacturer		Manufacturer	Manufacturer	Manufacturer	Manufacturer
Actual	<b>Outage type</b>	Major - rotor in or out	Major - rotor in or out	Major - rotor in or out	Major - rotor out	Major - rotor out	Major - rotor in	Any
	<b>Period</b>	2 - 5 years	3-5 years	5-7 years	3-5 years	7 - 10 years	20K to 40K hours	3-5 years
Actual/Recommended change	<b>Decision Basis</b>		Not applicable			Not applicable	Not applicable	Prior mtce experience
<b>2. IR testing</b>								
Recommended	<b>Basis</b>	Time	Time & operation cycles		Time	Service hours	Time	Service hours & operation cycles
	<b>Period</b>	Annual	3-5 years		Two years	10K - 20K hrs	Annual	20K to 40K hours
	<b>Source</b>	Manufacturer & Company std	Mfr or Company standard		Manufacturer	Manufacturer	Manufacturer	Manufacturer
Actual	<b>Outage type</b>	Minor	Major - rotor in or out	Major - rotor in or out	Major - rotor in or out	Major - rotor in or out	No outage required	Any
	<b>Period</b>	Annual	Annual	5-7 years	Two years	3 - 5 years	Annual	3-5 years
Actual/Recommended change	<b>Decision Basis</b>		Not applicable			Prior mtce experience	Not applicable	Prior mtce experience
<b>3. Shaft earthing system inspect &amp; repair</b>								
Recommended	<b>Basis</b>	Time	Condition based		Time	Service hours	Time	Service hours & operation cycles
	<b>Period</b>	Annual			Two years	10K - 20K hrs	Annual	20K to 40K hours
	<b>Source</b>	Manufacturer & Company std	Mfr or Company standard		Manufacturer	Manufacturer	Manufacturer	Manufacturer
Actual	<b>Outage type</b>	Minor	No outage required	Minor	Major - rotor in or out		No outage required	Any
	<b>Period</b>	Annual	Annual & 3 - 5 years		Two years		Annual	1 or 2 years
Actual/Recommended change	<b>Decision Basis</b>		Not applicable				Not applicable	Market needs
<b>Seal oil system</b>								
<b>1. Mechanical maintenance of pumps, strainers etc.</b>								
Recommended	<b>Basis</b>	Time, service hours or cycles	Time		Time	Service hours	Time	Condition based
	<b>Period</b>	2 - 5 years	2 or 3-5 years		3-5 years	10K - 20K hrs	Annual	20K to 40K hours
	<b>Source</b>	Manufacturer & Company std	Mfr or Company standard		Manufacturer	Manufacturer	Manufacturer	Manufacturer
Actual	<b>Outage type</b>	Minor	Major - rotor in or out	Major - rotor in or out	Major - rotor out	Major - rotor out	No outage required	Any
	<b>Period</b>	2 - 5 years	2 or 3-5 years	5-7 years	3-5 years	7 - 10 years	Annual	3-5 years
Actual/Recommended change	<b>Decision Basis</b>		Not applicable				Not applicable	Maintenance cost saving

		Australia 1	Australia 2	Australia 3	Serbia - Montenegro	Italy - Base Load	Italy - Mid Load	Brazil
<b>Slip rings &amp; brush gear (or diodes)</b>								
<b>1. Inspection, including brush wear</b>								
Recommended	Basis	Time	Time	Time	Time	Service hours	Service hours & operation cycles	Service hours
	Period	Annual	Weekly	< 10K hours	Annual	20K to 40K hours	20K to 40K hours	< 10K hours
	Source	Manufacturer	Manufacturer	Manufacturer	Manufacturer	Company standard	Company standard	Company standard
Actual	Outage type	No outage required	No outage required	No outage required	Minor	Minor	Minor	Minor
	Period	Annual	2 week	< 10K hours	Annual	20K to 40K hours	20K to 40K hours	< 10K hours
Actual/Recommended change	Decision Basis	Prior mtce experience	Prior mtce experience	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
<b>2. Cleaning, including clean/replace filters</b>								
Recommended	Basis	Time	Time	Time	Time	Service hours	Service hours & operation cycles	Service hours
	Period	Two years	Weekly	2 years	Annual	20K to 40K hours	20K to 40K hours	< 10K hours
	Source	Manufacturer	Manufacturer	Manufacturer	Manufacturer	Company standard	Company standard	Company standard
Actual	Outage type	Major - rotor in or out	No outage required	Minor	Minor	Minor	Minor	Minor
	Period	Two years	2 week	2 years	Annual	20K to 40K hours	20K to 40K hours	< 10K hours
Actual/Recommended change	Decision Basis	Prior mtce experience	Prior mtce experience	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
<b>3. Slipring grinding</b>								
Recommended	Basis	Condition based	Condition based	Time	Time			Service hours
	Period	> 10 years		2 years	5-7 years			< 10K hours
	Source	Manufacturer		Manufacturer	Manufacturer			Company standard
Actual	Outage type	Major - rotor in or out	Major - rotor in or out	Any	Major - rotor in or out			Minor
	Period	> 10 years	20 years	2 years	Only if necessary			< 10K hours
Actual/Recommended change	Decision Basis	Prior mtce experience	Not applicable	Not applicable	Prior mtce experience	On condition	On condition	Not applicable
<b>4. IR testing</b>								
Recommended	Basis	Time	Time	Time	Time	Service hours	Service hours & operation cycles	Service hours
	Period	3-5 years	4 years	2 years	Annual	20K to 40K hours	20K to 40K hours	< 10K hours
	Source	Manufacturer	Manufacturer	Manufacturer	Manufacturer	Company standard	Company standard	Company standard
Actual	Outage type	Major - rotor in or out	Major - rotor in or out	Major - rotor in or out	Minor	Minor	Minor	Minor
	Period	3-5 years	4 years	2 years	Annual	20K to 40K hours	20K to 40K hours	< 10K hours
Actual/Recommended change	Decision Basis	Prior mtce experience	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
<b>Instrumentation</b>								
<b>1. Calibration &amp; circuit checks</b>								
Recommended	Basis	Time		Time	Time	Service hours	Service hours & operation cycles	
	Period	Two years	4 years	3 - 5 years	Annual	60K to 90K hours	60K to 90K hours	
	Source	Manufacturer	Manufacturer	Manufacturer	Manufacturer	Company standard	Company standard	
Actual	Outage type	Major - rotor in or out	Major - rotor in or out	Major - rotor in or out	Minor	Major - rotor out	Major - rotor out	
	Period	3-5 years	4 years	3 - 5 years	Annual	60K to 90K hours	60K to 90K hours	
Actual/Recommended change	Decision Basis	Prior mtce experience	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	

		Finland	Russia	USA	Japan	France	Croatia	Switzerland
<b>Slip rings &amp; brush gear (or diodes)</b>								
<b>1. Inspection, including brush wear</b>								
Recommended	Basis	Time, service hours or cycles	Time & operation cycles		Time	Service hours	Service hours	Service hours & operation cycles
	Period	Annual	Annual		Two years	10K - 20K hrs	20K to 40K hours	20K to 40K hours
	Source	Manufacturer & Company std	Manufacturer or other source		Company standard	Manufacturer	Manufacturer	Manufacturer
Actual	Outage type	Minor	No outage required	Minor	Major - rotor in or out	Manufacturer	Major - rotor in	Any
	Period	Annual	< 10K hours		Two years	Annual or 2 years	20K to 40K hours	Annual
Actual/Recommended change	Decision Basis		Prior mtce experience				Not applicable	Maintenance cost saving
<b>2. Cleaning, including clean/replace filters</b>								
Recommended	Basis	Time	Time		Time	Service hours	Time	Service hours & operation cycles
	Period	Annual	Annual		Two years	10K - 20K hrs	Annual	20K to 40K hours
	Source	Manufacturer & Company std	Other		Company standard	Manufacturer	Manufacturer	Manufacturer
Actual	Outage type	Minor	Minor	Minor	Major - rotor in or out	Manufacturer	No outage required	Any
	Period	Annual	Annual		Two years	Annual or 2 years	Annual	Annual
Actual/Recommended change	Decision Basis		Not applicable				Not applicable	Maintenance cost saving
<b>3. Slipring grinding</b>								
Recommended	Basis	Condition based	Time		Condition based	Service hrs or Condition based	Service hours	Condition based
	Period		2 or 3-5 years			40K - 60K hrs	20K to 40K hours	20K to 40K hours
	Source	Manufacturer & Company std	Other		Company standard	Manufacturer	Manufacturer	
Actual	Outage type	Minor	Any		Major - rotor in or out		Major - rotor in	
	Period	2 - 5 years	2 or 3-5 years	Condition based		>10 years	20K to 40K hours	
Actual/Recommended change	Decision Basis		Not applicable			Other	Not applicable	Maintenance cost saving
<b>4. IR testing</b>								
Recommended	Basis	Time or Condition based	Time		Time	Service hours	Time	Service hours & operation cycles
	Period	Annual	Annual		Two years	10K - 20K hrs	Annual	20K to 40K hours
	Source	Company standard	Other		Company standard	Manufacturer	Manufacturer	Manufacturer
Actual	Outage type	Minor	Minor		Major - rotor in or out	Any	No outage required	Major - rotor out
	Period	Annual	Annual	Condition based	Two years	2 years	Annual	Annual or 7-10 years
Actual/Recommended change	Decision Basis		Not applicable				Not applicable	Maintenance cost saving
<b>Instrumentation</b>								
<b>1. Calibration &amp; circuit checks</b>								
Recommended	Basis	Time	Condition based		Time	Service hours	Time	Service hours & operation cycles
	Period	3-5 years			Two years	40K - 60K hrs	Annual	20K to 40K hours
	Source	Manufacturer & Company std	Other		Company standard	Manufacturer	Manufacturer	Manufacturer
Actual	Outage type	Minor	No outage required	Minor	Major - rotor in or out		No outage required	Any
	Period	2 - 5 years		Condition based	Two years		Annual	Annual
Actual/Recommended change	Decision Basis		Not applicable				Not applicable	Market needs

		Australia 1	Australia 2	Australia 3	Serbia - Montenegro	Italy - Base Load	Italy - Mid Load	Brazil
<b>Neutral point grounding system</b>								
<b>1. Inspection &amp; cleaning</b>								
Recommended	Basis	Time		Time	Time	Service hours	Service hours & operation cycles	Service hours
	Period	Two years		3 - 5 years	Annual	20K to 40K hours	20K to 40K hours	20K to 40K hours
	Source	Manufacturer		Manufacturer	Manufacturer	Company standard	Company standard	Company standard
Actual	Outage type	Major - rotor in or out		Major - rotor in or out	Major - rotor in or out	Minor	Minor	Minor
	Period	3-5 years		3 - 5 years	Annual	20K to 40K hours	20K to 40K hours	40K to 60K hours
Actual/Recommended change	Decision Basis	Prior mtce experience		Not applicable	Not applicable	Not applicable	Not applicable	Prior mtce experience
<b>2. Resistance or impedance measurement</b>								
Recommended	Basis	Time		Time	Time	Service hours	Service hours & operation cycles	Service hours
	Period	Two years		3 - 5 years	Annual	20K to 40K hours	20K to 40K hours	20K to 40K hours
	Source	Manufacturer		Company standard	Manufacturer	Company standard	Company standard	Company standard
Actual	Outage type	Major - rotor in or out		Major - rotor in or out	Major - rotor in or out	Minor	Minor	Minor
	Period	3-5 years		3 - 5 years	Annual	20K to 40K hours	20K to 40K hours	40K to 60K hours
Actual/Recommended change	Decision Basis	Prior mtce experience		Not applicable	Not applicable	Not applicable	Not applicable	Prior mtce experience
<b>Excitation system checks</b>								
<b>1. AVR characteristic checks</b>								
Recommended	Basis	Time		Time	Time	Time	Time	Service hours
	Period	3-5 years			Annual	3-5 years	3-5 years	> 90K hours
	Source	Manufacturer		Government	Manufacturer	Company standard	Company standard	Manufacturer
Actual	Outage type	Major - rotor in or out			Minor	No outage required	No outage required	Major - rotor in or out
	Period	3-5 years			Annual	3-5 years	3-5 years	> 90K hours
Actual/Recommended change	Decision Basis	Prior mtce experience			Not applicable	Not applicable	Not applicable	Not applicable
<b>2. AVR limit checks</b>								
Recommended	Basis	Time		Time	Time	Time	Time	Service hours
	Period	3-5 years			Annual	3-5 years	3-5 years	> 90K hours
	Source	Manufacturer		Government	Manufacturer	Company standard	Company standard	Manufacturer
Actual	Outage type	Major - rotor in or out			Minor	No outage required	No outage required	Major - rotor in or out
	Period	3-5 years			Annual	3-5 years	3-5 years	> 90K hours
Actual/Recommended change	Decision Basis	Prior mtce experience			Not applicable	Not applicable	Not applicable	Not applicable
<b>3. Demagnetisation checks</b>								
Recommended	Basis	Condition based		Time	Time	Time	Time	Service hours
	Period				Annual	3-5 years	3-5 years	> 90K hours
	Source			Manufacturer	Manufacturer	Company standard	Company standard	Manufacturer
Actual	Outage type			Major - rotor out	Minor	No outage required	No outage required	Major - rotor in or out
	Period			7- 10 years	Annual	3-5 years	3-5 years	> 90K hours
Actual/Recommended change	Decision Basis				Not applicable	Not applicable	Not applicable	Not applicable

		Finland	Russia	USA	Japan	France	Croatia	Switzerland
<b>Neutral point grounding system</b>								
<b>1. Inspection &amp; cleaning</b>								
Recommended	Basis	Condition based	Time		Time	Service hours	Time	Service hours & operation cycles
	Period		3-5 years		3-5 years	40K - 60K hrs	Annual	40K to 60K hours
	Source	Company standard	Mfr or Company standard		Company standard	Manufacturer	Manufacturer	Manufacturer
Actual	Outage type	Minor	Major - rotor out		Major - rotor out	Manufacturer	No outage required	Any
	Period	Annual	3-5 years	Condition based	3-5 years	Annual or 2 years	Annual	Annual
Actual/Recommended change	Decision Basis		Not applicable				Not applicable	Market needs
<b>2. Resistance or impedance measurement</b>								
Recommended	Basis	Time	Time		Time	Not recommended	Time	Service hours & operation cycles
	Period	2 - 5 years	3-5 years		Two years		Annual	40K to 60K hours
	Source	Company standard	Mfr or Company standard		Company standard		Manufacturer	
Actual	Outage type	Major - rotor in or out	Major - rotor out		Major - rotor in or out		No outage required	
	Period	2 - 5 years	3-5 years	Condition based	Two years		Annual	
Actual/Recommended change	Decision Basis		Not applicable			Not applicable	Not applicable	Market needs
<b>Excitation system checks</b>								
<b>1. AVR characteristic checks</b>								
Recommended	Basis	Time	Time		Time	Service hours	Time	Service hours & operation cycles
	Period	3-5 years	3-5 years		Two years	> 90K hours	Annual	20K to 40K hours
	Source	Company standard	Mfr or Company standard		Company standard	Manufacturer	Company standard	Manufacturer
Actual	Outage type	Minor	Major - rotor in or out		Major - rotor in or out		No outage required	Any
	Period	3-5 years	3-5 years	3-5 years	Two years		Annual	3-5 years
Actual/Recommended change	Decision Basis		Not applicable			Other	Not applicable	Maintenance cost saving
<b>2. AVR limit checks</b>								
Recommended	Basis	Time	Time		Time	Service hours	Time	Service hours & operation cycles
	Period	3-5 years	3-5 years		Two years	> 90K hours	5-7 years	20K to 40K hours
	Source	Company standard	Mfr or Company standard		Company standard	Manufacturer	Company standard	Manufacturer
Actual	Outage type	Minor	Major - rotor in or out		Major - rotor in or out		No outage required	Any
	Period	3-5 years	3-5 years	3-5 years	Two years		5-7 years	3-5 years
Actual/Recommended change	Decision Basis		Not applicable			Other	Not applicable	Market needs
<b>3. Demagnetisation checks</b>								
Recommended	Basis	Time	Time		Not recommended	Condition based	Time	Time
	Period	3-5 years	3-5 years				Annual	Annual
	Source	Company standard	Mfr or Company standard			Manufacturer	Company standard	Company standard
Actual	Outage type	Minor	Major - rotor in or out		Task not done		No outage required	No outage required
	Period	3-5 years	3-5 years	Condition based			Annual	Annual
Actual/Recommended change	Decision Basis		Not applicable			Other	Not applicable	Not applicable

		Australia 1	Australia 2	Australia 3	Serbia - Montenegro	Italy - Base Load	Italy - Mid Load	Brazil
<b>Generator electrical protection system</b>								
<b>1. Protection trip checks</b>								
Recommended	<b>Basis</b>	Time		Time	Time	Time	Time	Time
	<b>Period</b>	3-5 years		3 - 5 years	Annual	3-5 years	3-5 years	20K to 40K hours
	<b>Source</b>	Other		Company standard	Manufacturer	Company standard	Company standard	Company standard
Actual	<b>Outage type</b>	Minor		Major - rotor in or out	Minor	No outage required	No outage required	Minor
	<b>Period</b>	3-5 years		3 - 5 years	Annual	3-5 years	3-5 years	40K to 60K hours
Actual/Recommended change	<b>Decision Basis</b>	Risk assessment		Not applicable	Not applicable	Not applicable	Not applicable	Prior mtce experience
<b>2. Relay injection</b>								
Recommended	<b>Basis</b>	Time		Time	Time	Time	Time	Time
	<b>Period</b>	3-5 years		3 - 5 years	Annual	3-5 years	3-5 years	20K to 40K hours
	<b>Source</b>	Other		Company standard	Manufacturer	Company standard	Company standard	Company standard
Actual	<b>Outage type</b>	Minor		Major - rotor in or out	Minor	No outage required	No outage required	Minor
	<b>Period</b>	3-5 years		3 - 5 years	Annual	3-5 years	3-5 years	40K to 60K hours
Actual/Recommended change	<b>Decision Basis</b>	Risk assessment		Not applicable	Not applicable	Not applicable	Not applicable	Prior mtce experience
<b>3. Circuit checks</b>								
Recommended	<b>Basis</b>			Time	Time	Time	Time	Time
	<b>Period</b>			3 - 5 years	Annual	3-5 years	3-5 years	20K to 40K hours
	<b>Source</b>			Company standard	Manufacturer	Company standard	Company standard	Company standard
Actual	<b>Outage type</b>			Major - rotor in or out	Minor	No outage required	No outage required	Minor
	<b>Period</b>			3 - 5 years	Annual	3-5 years	3-5 years	40K to 60K hours
Actual/Recommended change	<b>Decision Basis</b>			Not applicable	Not applicable	Not applicable	Not applicable	Prior mtce experience
<b>4. CT IR and continuity</b>								
Recommended	<b>Basis</b>			Condition Based	Time	Not recommended	Not recommended	Time
	<b>Period</b>				5-7 years			20K to 40K hours
	<b>Source</b>				Manufacturer			Company standard
Actual	<b>Outage type</b>				Minor			Minor
	<b>Period</b>				5-7 years			40K to 60K hours
Actual/Recommended change	<b>Decision Basis</b>				Not applicable	On condition	On condition	Prior mtce experience

		Finland	Russia	USA	Japan	France	Croatia	Switzerland
<b>Generator electrical protection system</b>								
<b>1. Protection trip checks</b>								
Recommended	<b>Basis</b>	Time	Time		Time	Service hours	Time	Service hours & operation cycles
	<b>Period</b>	3-5 years	7-10 years		Two years	> 90K hours	Annual	20K to 40K hours
	<b>Source</b>	Company standard	Mfr or Company standard		Company standard	Manufacturer	National Standard	Manufacturer
Actual	<b>Outage type</b>	Minor	Major - rotor in or out	Minor	Major - rotor in or out	Manufacturer	No outage required	Any
	<b>Period</b>	3-5 years	7-10 years	3-5 years	Two years	Annual or 2 years	Annual	Annual or 3-5 years
Actual/Recommended change	<b>Decision Basis</b>		Not applicable				Not applicable	Maintenance cost saving
<b>2. Relay injection</b>								
Recommended	<b>Basis</b>	Time	Time & operation cycles		Time	Service hours	Time	Service hours & operation cycles
	<b>Period</b>	3-5 years	> 90K hours		Two years	> 90K hours	Annual	20K to 40K hours
	<b>Source</b>	Company standard	Mfr or Company standard		Company standard	Manufacturer	National Standard	Manufacturer
Actual	<b>Outage type</b>	Minor	Major - rotor in or out	Minor	Major - rotor in or out	Manufacturer	No outage required	Any
	<b>Period</b>	3-5 years	> 90K hours	3-5 years	Two years	Annual or 2 years	Annual	Annual or 3-5 years
Actual/Recommended change	<b>Decision Basis</b>		Not applicable				Not applicable	Maintenance cost saving
<b>3. Circuit checks</b>								
Recommended	<b>Basis</b>	Time	Time		Time	Service hours	Time	Service hours & operation cycles
	<b>Period</b>	3-5 years	7-10 years		Two years	> 90K hours	Annual	20K to 40K hours
	<b>Source</b>	Company standard	Mfr or Company standard		Company standard	Manufacturer	National Standard	Manufacturer
Actual	<b>Outage type</b>	Minor	Major - rotor in or out	Minor	Major - rotor in or out	Manufacturer	No outage required	Any
	<b>Period</b>	3-5 years	7-10 years	3-5 years	Two years	Annual or 2 years	Annual	Annual or 3-5 years
Actual/Recommended change	<b>Decision Basis</b>		Not applicable				Not applicable	Maintenance cost saving
<b>4. CT IR and continuity</b>								
Recommended	<b>Basis</b>	Time	Time		Time	Service hours	Time	Service hours & operation cycles
	<b>Period</b>	3-5 years	7-10 years		Two years	> 90K hours	Annual	20K to 40K hours
	<b>Source</b>	Company standard	Mfr or Company standard		Company standard	Manufacturer	National Standard	
Actual	<b>Outage type</b>	Minor	Major - rotor in or out	Minor	Major - rotor in or out	Manufacturer	No outage required	
	<b>Period</b>	3-5 years	7-10 years	Condition based	Two years	Annual or 2 years	Annual	
Actual/Recommended change	<b>Decision Basis</b>		Not applicable				Not applicable	Maintenance cost saving

**9. APPENDIX 2 - Appendix to Chapter 5**

**Planned maintenance tasks for generator components – Manufacturers  
(pp 57 to 66)**

		Japan Manufacturer	Italy Manufacturer	USA 1 Manufacturer	USA 2 Manufacturer	France Manufacturer
<b>Stator winding – slot content</b>						
<b>1. Inspect wedges and repair or replace</b>						
Recommended	<b>Basis</b>	Time	Service hours & operation cycles	Condition based	Time	Service hours or Condition based
	<b>Period</b>	3-5 years	40K to 60K hours	5-7 years	5-7 years	40K to 60K hours
Actual/Recommended change	<b>Decision Basis</b>	Market needs				
<b>2. Inspect slot insert migration</b>						
Recommended	<b>Basis</b>	Time	Service hours & operation cycles	Time & operation cycles	Condition based	Service hours or Condition based
	<b>Period</b>	3-5 years	40K to 60K hours	3-5 years		40K to 60K hours
Actual/Recommended change	<b>Decision Basis</b>	Market needs		Prior mtce experience		
<b>3. General inspection, clean, and paint as required.</b>						
Recommended	<b>Basis</b>	Time	Service hours & operation cycles	Time	Time	Service hours or Condition based
	<b>Period</b>	3-5 years	40K to 60K hours	3-5 years	5-7 years	40K to 60K hours
Actual/Recommended change	<b>Decision Basis</b>	Market needs		Other		
<b>4. Electrical tests: IR; PI; winding resistance; DLA / DDF/ tan δ.</b>						
Recommended	<b>Basis</b>	Time	Service hours & operation cycles	Time	Time	Service hours
	<b>Period</b>	3-5 years	20K to 40K hours	3-5 years	3-5 years	10K to 20K hours
Actual/Recommended change	<b>Decision Basis</b>	Risk assessment				
<b>5. HV withstand</b>						
Recommended	<b>Basis</b>	Not recommended	Service hours & operation cycles	Time	Condition based	Condition based
	<b>Period</b>		40K to 60K hours	3-5 years		
Actual/Recommended change	<b>Decision Basis</b>			Other		
<b>Stator winding – end windings</b>						
<b>1. Test for water leaks, and repair</b>						
Recommended	<b>Basis</b>	Time	Condition based	Condition based	Time	Service hours or Condition based
	<b>Period</b>	Two years			5-7 years	10K to 20K hours
Actual/Recommended change	<b>Decision Basis</b>	Market needs				
<b>2. Test for water leaks – no repair</b>						
Recommended	<b>Basis</b>	Not recommended	Service hours & operation cycles	Condition based	Not recommended	Service hours
	<b>Period</b>		40K to 60K hours			10K to 20K hours
Actual/Recommended change	<b>Decision Basis</b>		Risk assessment			
<b>3. Inspect end windings, including supports, spacers and phase connection rings</b>						
Recommended	<b>Basis</b>	Time	Service hours & operation cycles	Time	Time	Service hours
	<b>Period</b>	3-5 years	40K to 60K hours	3-5 years	5-7 years	10K to 20K hours
Actual/Recommended change	<b>Decision Basis</b>	Market needs	Risk assessment			

		Japan Manufacturer	Italy Manufacturer	USA 1 Manufacturer	USA 2 Manufacturer	France Manufacturer
<b>4. Inspect/test/repair temperature sensors</b>						
Recommended	Basis	Not recommended	Service hours & operation cycles	Condition based	Condition based	Service hours or Condition based
	Period		40K to 60K hours	3-5 years	Not recommended	40K to 60K hours
Actual/Recommended change	Decision Basis					
<b>5. General inspection for contamination and insulation state;</b>						
Recommended	Basis	Time	Service hours & operation cycles	Time	Time	Service hours or Condition based
	Period	3-5 years	40K to 60K hours	3-5 years	3-5 years	40K to 60K hours
Actual/Recommended change	Decision Basis	Market needs				
<b>6. Capacitance mapping</b>						
Recommended	Basis	Time	Condition based	Not recommended	Time	Service hours or Condition based
	Period	3-5 years			5-7 years	10K to 20K hrs 40K to 60K hrs
Actual/Recommended change	Decision Basis	Risk assessment				
<b>7. Tracer gas leak test</b>						
Recommended	Basis	Condition based	Condition based	Condition based	Condition based	Service hours
	Period					40K to 60K hours
Actual/Recommended change	Decision Basis					
<b>8. Modal response</b>						
Recommended	Basis	Not recommended	Condition based	Service hours & operation cycles	Condition based	Service hours
	Period			5-7 years	Not recommended	40K to 60K hours
Actual/Recommended change	Decision Basis			Maintenance cost saving		
<b>Stator winding - terminal box.</b>						
<b>1. General inspection and clean; including support insulators, flexibles &amp; CT stack.</b>						
Recommended	Basis	Time	Service hours & operation cycles	Time	Condition based	Service hours
	Period	3-5 years	20K to 40K hours	3-5 years		10K to 20K hours
Actual/Recommended change	Decision Basis	Market needs		Maintenance cost saving		
<b>2. Disconnect flexibles; inspect; replace as required; reconnect.</b>						
Recommended	Basis	Not recommended	Service hours & operation cycles	Condition based	Condition based	Service hours or Condition based
	Period		20K to 40K hours			10K to 20K hours
Actual/Recommended change	Decision Basis			Maintenance cost saving		
<b>3. CT electrical and ratio tests etc.</b>						
Recommended	Basis	Time	Service hours & operation cycles	Condition based	Condition based	Not recommended
	Period	3-5 years	40K to 60K hours			
Actual/Recommended change	Decision Basis	Market needs		Other		

		Japan Manufacturer	Italy Manufacturer	USA 1 Manufacturer	USA 2 Manufacturer	France Manufacturer
<b>Bushings.</b>						
<b>1. Inspection &amp; clean, external.</b>						
Recommended	<b>Basis</b>	Not recommended	Service hours & operation cycles	Time	Condition based	Service hours
	<b>Period</b>		20K to 40K hours	3-5 years		10K to 20K hours
Actual/Recommended change	<b>Decision Basis</b>			Risk assessment		
<b>2. Internal inspection – gas cooled bushings</b>						
Recommended	<b>Basis</b>	Time	Service hours & operation cycles	Condition based	Condition based	Not recommended
	<b>Period</b>	Two years	20K to 40K hours			
Actual/Recommended change	<b>Decision Basis</b>	Market needs		Risk assessment		
<b>3. Leakage test - replace gaskets and seals if required.</b>						
Recommended	<b>Basis</b>	Time	Condition based	Condition based	Condition based	Service hours
	<b>Period</b>	7-10 years				> 90K hours
Actual/Recommended change	<b>Decision Basis</b>	Market needs		Risk assessment		
<b>4. Leakage test - replace bushings if required.</b>						
Recommended	<b>Basis</b>	Not recommended	Condition based	Condition based	Condition based	Condition based
	<b>Period</b>					
Actual/Recommended change	<b>Decision Basis</b>			Risk assessment		
<b>Core &amp; frame</b>						
<b>1. Visual inspection &amp; clean.</b>						
Recommended	<b>Basis</b>	Time	Service hours & operation cycles	Time	Time	Service hours
	<b>Period</b>	3-5 years	40K to 60K hours	3-5 years	5-7 years	40K to 60K hours
Actual/Recommended change	<b>Decision Basis</b>	Market needs				
<b>2. Frame cracking NDT &amp; repair.</b>						
Recommended	<b>Basis</b>	Not recommended	Service hours & operation cycles	Condition based	Condition based	Condition based
	<b>Period</b>		40K to 60K hours			
Actual/Recommended change	<b>Decision Basis</b>			Risk assessment	rare	
<b>3. Check liquid level detectors</b>						
Recommended	<b>Basis</b>	Not recommended	Service hours & operation cycles	Condition based	Condition based	Condition based
	<b>Period</b>		20K to 40K hours			
Actual/Recommended change	<b>Decision Basis</b>					

		Japan Manufacturer	Italy Manufacturer	USA 1 Manufacturer	USA 2 Manufacturer	France Manufacturer
<b>4. Check longitudinal core tightening screws.</b>						
Recommended	<b>Basis</b>	Not recommended	Service hours & operation cycles	Time	Time	Not recommended
	<b>Period</b>		40K to 60K hours	3-5 years	5-7 years	
Actual/Recommended change	<b>Decision Basis</b>					
<b>5. Check gas flow control rings, baffles etc.</b>						
Recommended	<b>Basis</b>	Time	Service hours & operation cycles	Time	Time	Service hours
	<b>Period</b>	3-5 years	20K to 40K hours	5-7 years	5-7 years	40K to 60K hours
Actual/Recommended change	<b>Decision Basis</b>	Market needs				
<b>6. Inspect end shields.</b>						
Recommended	<b>Basis</b>	Not recommended	Service hours & operation cycles	Time	Time	Service hours
	<b>Period</b>		20K to 40K hours	5-7 years	5-7 years	40K to 60K hours
Actual/Recommended change	<b>Decision Basis</b>					
<b>7. El-Cid test</b>						
Recommended	<b>Basis</b>	Not recommended	Service hours & operation cycles	Condition based or Time	Condition based or Time	Service hours
	<b>Period</b>		40K to 60K hours	5-7 years	7-10 years	40K to 60K hours
Actual/Recommended change	<b>Decision Basis</b>					
<b>8. Ring flux test</b>						
Recommended	<b>Basis</b>	Not recommended	Condition based	Condition based	Condition based	Condition based
	<b>Period</b>					
Actual/Recommended change	<b>Decision Basis</b>			Risk assessment		

		Japan Manufacturer	Italy Manufacturer	USA 1 Manufacturer	USA 2 Manufacturer	France Manufacturer
<b>Stator cooling water system</b>						
<b>1. Inspect heat exchangers</b>						
Recommended	<b>Basis</b>	Time	Service hours & operation cycles	Time	Time	Service hours
	<b>Period</b>	Two years	40K to 60K hours	3-5 years	5-7 years	> 90K hours
Actual/Recommended change	<b>Decision Basis</b>	Market needs				
<b>2. Mechanical maintenance of pumps, valves etc.</b>						
Recommended	<b>Basis</b>	Time	Service hours & operation cycles	Time	Time	Service hours
	<b>Period</b>	Two years	40K to 60K hours	3-5 years	3-5 years	40K to 60K hours
Actual/Recommended change	<b>Decision Basis</b>	Market needs				
<b>3. Pressure test</b>						
Recommended	<b>Basis</b>	Not recommended	Service hours & operation cycles	Condition based	Condition based	Condition based
	<b>Period</b>		40K to 60K hours			
Actual/Recommended change	<b>Decision Basis</b>					
<b>4. Vacuum test</b>						
Recommended	<b>Basis</b>	Not recommended	Service hours & operation cycles	Condition based	Condition based	Service hours
	<b>Period</b>		40K to 60K hours			10K to 20K hours
Actual/Recommended change	<b>Decision Basis</b>					
<b>Stator water treatment</b>						
<b>1. Replace resin</b>						
Recommended	<b>Basis</b>	Time	Time	Condition based or Time	Condition based or Time	Service hours
	<b>Period</b>	Two years	Annual	Two years	Two years	Two years
Actual/Recommended change	<b>Decision Basis</b>	Market needs				
<b>2. Component inspection &amp; repair</b>						
Recommended	<b>Basis</b>	Time	Service hours & operation cycles	Condition based	Condition based	Service hours
	<b>Period</b>	Two years	40K to 60K hours			40K to 60K hours
Actual/Recommended change	<b>Decision Basis</b>	Market needs				
<b>3. Calibrate conductivity instruments.</b>						
Recommended	<b>Basis</b>	Time	Service hours & operation cycles	Time		Service hours
	<b>Period</b>	Two years	40K to 60K hours	3-5 years		40K to 60K hours
Actual/Recommended change	<b>Decision Basis</b>	Market needs				

		Japan Manufacturer	Italy Manufacturer	USA 1 Manufacturer	USA 2 Manufacturer	France Manufacturer
<b>Rotor</b>						
<b>1. Remove rotor for inspection - inspect accessible rotor components, including fan; NDT of rotor bore.</b>						
Recommended	<b>Basis</b>	Time	Service hours & operation cycles	Time	Time	Service hours
	<b>Period</b>	3-5 years	40K to 60K hours	T4/T5	5-7 years	40K to 60K hours
Actual/Recommended change	<b>Decision Basis</b>	Market needs		Market needs		
<b>2. Remove retaining rings – inspect &amp; NDT rings, wedges &amp; slots.</b>						
Recommended	<b>Basis</b>	Time		Condition based	Condition based	Service hours
	<b>Period</b>	> 10 years				40K to 60K hours
Actual/Recommended change	<b>Decision Basis</b>	Market needs		Other		
<b>3. Electrical tests: IR; PI; RSO; winding resistance</b>						
Recommended	<b>Basis</b>	Not recommended	Service hours & operation cycles	Time or Condition based	Time	Service hours
	<b>Period</b>		20K to 40K hours	3-5 years	5-7 years	10K to 20K hours
Actual/Recommended change	<b>Decision Basis</b>					
<b>4. Time of flight diffraction</b>						
Recommended	<b>Basis</b>	Not recommended		Not recommended		Not recommended
	<b>Period</b>					
Actual/Recommended change	<b>Decision Basis</b>					

		Japan Manufacturer	Italy Manufacturer	USA 1 Manufacturer	USA 2 Manufacturer	France Manufacturer
<b>Hydrogen cooling system</b>						
<b>1. Remove, inspect &amp; repair hydrogen coolers.</b>						
Recommended	<b>Basis</b>	Time	Service hours & operation cycles	Time	Time	Service hours or Condition based
	<b>Period</b>	Two years	40K to 60K hours	5 to 10 years	5-7 years	40K to 60K hours
Actual/Recommended change	<b>Decision Basis</b>	Market needs		Risk assessment		
<b>2. Pressure test cooling water piping.</b>						
Recommended	<b>Basis</b>	Time	Service hours & operation cycles	Condition based	Condition based	Not recommended
	<b>Period</b>	> 10 years	40K to 60K hours	Not recommended	Not recommended	
Actual/Recommended change	<b>Decision Basis</b>	Market needs				
<b>3. Calibrate dewpoint instrumentation</b>						
Recommended	<b>Basis</b>	Not recommended	Service hours & operation cycles	Time		Service hours
	<b>Period</b>		40K to 60K hours	3-5 years		40K to 60K hours
Actual/Recommended change	<b>Decision Basis</b>					
<b>Hydrogen seals</b>						
<b>1. Inspect, including NDT</b>						
Recommended	<b>Basis</b>	Time	Service hours & operation cycles	Time	Condition based or Time	Service hours
	<b>Period</b>	Two years	20K to 40K hours	3-5 years	5-7 years	40K to 60K hours
Actual/Recommended change	<b>Decision Basis</b>	Market needs				
<b>2. IR testing</b>						
Recommended	<b>Basis</b>	Time	Service hours & operation cycles	Time	Condition based	Service hours
	<b>Period</b>	3 or 6 mths	20K to 40K hours	3-5 years		10K to 20K hours
Actual/Recommended change	<b>Decision Basis</b>					

		Japan Manufacturer	Italy Manufacturer	USA 1 Manufacturer	USA 2 Manufacturer	France Manufacturer
<b>Bearings</b>						
<b>1. Inspection including NDT</b>						
Recommended	<b>Basis</b>	Time	Service hours & operation cycles	Condition based or Time	Condition based or Time	Service hours
	<b>Period</b>	Two years	20K to 40K hours	3-5 years	3-5 years	40K to 60K hours
Actual/Recommended change	<b>Decision Basis</b>	Market needs				
<b>2. IR testing</b>						
Recommended	<b>Basis</b>	Time	Service hours & operation cycles	Condition based or Time	Condition based	Service hours
	<b>Period</b>	3 or 6 mths	20K to 40K hours	3-5 years		10K to 20K hours
Actual/Recommended change	<b>Decision Basis</b>					
<b>3. Shaft earthing system inspect &amp; repair</b>						
Recommended	<b>Basis</b>	Time	Service hours & operation cycles	Condition based or Time	Condition based or Time	Service hours
	<b>Period</b>	Annual	20K to 40K hours	3-5 years	3-5 years	10K to 20K hours
Actual/Recommended change	<b>Decision Basis</b>	Market needs				
<b>Seal oil system</b>						
<b>1. Mechanical maintenance of pumps, strainers etc.</b>						
Recommended	<b>Basis</b>	Time	Service hours & operation cycles	Time	Time	Service hours
	<b>Period</b>	Annual	40K to 60K hours	3-5 years	3-5 years	10K to 20K hours
Actual/Recommended change	<b>Decision Basis</b>	Market needs				

		Japan Manufacturer	Italy Manufacturer	USA 1 Manufacturer	USA 2 Manufacturer	France Manufacturer
<b>Slip rings &amp; brush gear (or diodes)</b>						
<b>1. Inspection, including brush wear</b>						
Recommended	Basis	Time	Time	Time	Time	Service hours
	Period	Daily	Annual	Less than one year	Less than one year	10K to 20K hours
Actual/Recommended change	Decision Basis					
<b>2. Cleaning, including clean/replace filters</b>						
Recommended	Basis	Clean filters	Time	Time	Time	Service hours
	Period		Annual	Annual	Annual	10K to 20K hours
Actual/Recommended change	Decision Basis					
<b>3. Slipring grinding</b>						
Recommended	Basis	Condition based		Condition based	Condition based	Service hours or Condition based
	Period					40K to 60K hours
Actual/Recommended change	Decision Basis			Other		
<b>4. IR testing</b>						
Recommended	Basis	Not recommended	Service hours & operation cycles	Time		Service hours
	Period		20K to 40K hours			10K to 20K hours
Actual/Recommended change	Decision Basis					
<b>Instrumentation</b>						
<b>1. Calibration &amp; circuit checks</b>						
Recommended	Basis	Time	Service hours & operation cycles			Service hours
	Period	3 or 12 months	40K to 60K hours			40K to 60K hours
Actual/Recommended change	Decision Basis					
<b>Neutral point grounding system</b>						
<b>1. Inspection &amp; cleaning</b>						
Recommended	Basis	Not recommended	Service hours & operation cycles			Service hours
	Period		20K to 40K hours			40K to 60K hours
Actual/Recommended change	Decision Basis					
<b>2. Resistance or impedance measurement</b>						
Recommended	Basis	Not recommended	Service hours & operation cycles			Not recommended
	Period		20K to 40K hours			
Actual/Recommended change	Decision Basis					

		Japan Manufacturer	Italy Manufacturer	USA 1 Manufacturer	USA 2 Manufacturer	France Manufacturer
<b>Generator electrical protection system</b>						
<b>1. Protection trip checks</b>						
Recommended	<b>Basis</b>	Time	Time			Service hours
	<b>Period</b>	Two years	Annual			> 90K hours
Actual/Recommended change	<b>Decision Basis</b>	Market needs				
<b>2. Relay injection</b>						
Recommended	<b>Basis</b>	Time	Time			Service hours
	<b>Period</b>	Two years	Annual			> 90K hours
Actual/Recommended change	<b>Decision Basis</b>	Market needs				
<b>3. Circuit checks</b>						
Recommended	<b>Basis</b>	Time	Service hours & operation cycles			Service hours
	<b>Period</b>	Two years	20K to 40K hours			> 90K hours
Actual/Recommended change	<b>Decision Basis</b>	Market needs				
<b>4. CT IR and continuity</b>						
Recommended	<b>Basis</b>	Time	Service hours & operation cycles			Service hours
	<b>Period</b>	Two years	40K to 60K hours			> 90K hours
Actual/Recommended change	<b>Decision Basis</b>	Market needs				
<b>Excitation system checks</b>						
<b>1. AVR characteristic checks</b>						
Recommended	<b>Basis</b>	Time	Service hours & operation cycles	Time		Service hours
	<b>Period</b>	Two years	20K to 40K hours	3-5 years		> 90K hours
Actual/Recommended change	<b>Decision Basis</b>					
<b>2. AVR limit checks</b>						
Recommended	<b>Basis</b>	Time	Service hours & operation cycles	Time		Service hours
	<b>Period</b>	Two years	20K to 40K hours	3-5 years		> 90K hours
Actual/Recommended change	<b>Decision Basis</b>					
<b>3. Demagnetisation checks</b>						
Recommended	<b>Basis</b>	Not recommended	Service hours & operation cycles	Condition based		Condition based
	<b>Period</b>		20K to 40K hours			
Actual/Recommended change	<b>Decision Basis</b>					

**10. APPENDIX 3 - Appendix to Chapter 6**

**Generator in service diagnostic testing – Utilities & manufacturers (pp 68 to 78)**

## UTILITIES

	Australia 1	Australia 2	Australia 3	Serbia - Montenegro	Italy - Base Load	Italy - Mid Load	Brazil
<b>Stator winding – slot content</b>							
<b>1. Partial discharge monitoring – various types</b>							
<b>Usage</b>	Used now	Used now	Used now	Future use	Used now	Used now	Not used
<b>Mode &amp; frequency</b>		Intermittent - 6 month	Intermittent - 6 month	Intermittent - > 6 mths	Intermittent - > 6 mths	Intermittent - > 6 mths	
<b>Reason for use</b>	Other reason	Potential fault response	Company usual practice	Other reason	Company usual practice	Company usual practice	
<b>Stator winding – end windings</b>							
<b>1. Stator end winding vibration monitor</b>							
<b>Usage</b>	Not used	Not used	Not used	Used now	Not used	Not used	Future use
<b>Mode &amp; frequency</b>				On known condition			Intermittent - > 6 mths
<b>Reason for use</b>							Company usual practice
<b>Rotor</b>							
<b>1. Rotor shorted turns detection</b>							
<b>Usage</b>	Used now	Used now	Used now	Used now	Used now	Used now	Future use
<b>Mode &amp; frequency</b>	Intermittent - > 6 mths	Continuous use - regular data review	Intermittent - 6 month	On known condition	Intermittent - > 6 mths	Intermittent - > 6 mths	Intermittent - > 6 mths
<b>Reason for use</b>	Potential fault response	Potential fault response	Company usual practice	Other reason	Company usual practice	Company usual practice	Company usual practice
<b>2. Shaft torsional oscillation monitoring</b>							
<b>Usage</b>	Not used	Not used	Not used	Not used	Not used	Not used	Not used
<b>Mode &amp; frequency</b>							
<b>Reason for use</b>							

	Finland	Russia	USA	Japan	France	Croatia	Switzerland
<b>Stator winding – slot content</b>							
<b>1. Partial discharge monitoring – various types</b>							
<b>Usage</b>	Used now	Used now	Not used	Not used	Not used	Used now	Used now
<b>Mode &amp; frequency</b>	Intermittent - > 6 mths	Intermittent - > 6 mths				Intermittent - > 6 mths	Various
<b>Reason for use</b>	Company usual practice	Company usual practice				Mfrs recommendation	Mfrs rec or Company practice
<b>Stator winding – end windings</b>							
<b>1. Stator end winding vibration monitor</b>							
<b>Usage</b>	Used now	Used now	Not used	Not used	Used now	Used now	Used now
<b>Mode &amp; frequency</b>	Continuous OR Intermittent - > 6 mths	On known condition			Continuous	Intermittent - > 6 mths	Various
<b>Reason for use</b>	Company usual practice	Potential fault response			Any or all reasons	Mfrs recommendation	Mfrs rec or Company practice
<b>Rotor</b>							
<b>1. Rotor shorted turns detection</b>							
<b>Usage</b>	Future use	Not used	Used now	Not used	Future use	Used now	Used now
<b>Mode &amp; frequency</b>	On known condition	-	Intermittent - > 6 mths		Intermittent - monthly	Intermittent - > 6 mths	Various
<b>Reason for use</b>	Company usual practice	-	Company usual practice		Mfrs rec or potential fault	Mfrs recommendation	Any or all reasons
<b>2. Shaft torsional oscillation monitoring</b>							
<b>Usage</b>	Past use	Used now	Not used	Not used	Not used	Used now	
<b>Mode &amp; frequency</b>	On known condition	On known condition				Continuous use - regular data review	
<b>Reason for use</b>	Other reason	Other reason				Company usual practice	

	Australia 1	Australia 2	Australia 3	Serbia - Montenegro	Italy - Base Load	Italy - Mid Load	Brazil
<b>Core &amp; frame</b>							
<b>1. Stator core/frame vibration monitoring</b>							
<b>Usage</b>	Not used	Not used	Not used	Used now	Used now	Used now	Future use
<b>Mode &amp; frequency</b>				On known condition	On known condition	On known condition	Intermittent - > 6 mths
<b>Reason for use</b>				Other reason	Other reason	Other reason	Company usual practice
<b>2. Stator core lamination vibration – audio detector</b>							
<b>Usage</b>	Not used	Not used	Not used	Used now	Used now	Used now	Not used
<b>Mode &amp; frequency</b>				On known condition	On known condition	On known condition	
<b>Reason for use</b>				Other reason	Other reason	Other reason	
<b>Hydrogen cooling system</b>							
<b>1. Dew point monitoring</b>							
<b>Usage</b>	Used now	Used now	Used now	Not used	Used now	Used now	Not used
<b>Mode &amp; frequency</b>	Continuous use & monitoring	Continuous use - regular data review	Continuous use - regular data review		Continuous use & monitoring	Continuous use & monitoring	Other reason
<b>Reason for use</b>	Potential fault response	Mfrs recommendation	Mfrs recommendation		Company usual practice	Company usual practice	Other reason
<b>2. Hydrogen make up rate monitoring</b>							
<b>Usage</b>	Used now	Used now	Used now	Used now	Not used	Not used	Used now
<b>Mode &amp; frequency</b>	Continuous use & monitoring	Continuous use - regular data review	Continuous use & monitoring	Continuous use - regular data review			Intermittent - weekly testing
<b>Reason for use</b>	Potential fault response	Potential fault response	Company usual practice	Other reason			Company usual practice
<b>3. Hydrogen purity analysis</b>							
<b>Usage</b>	Used now	Used now	Used now	Used now	Used now	Used now	Used now
<b>Mode &amp; frequency</b>	Continuous use & monitoring	On known condition	Continuous use & monitoring	Continuous use - regular data review	Continuous use & monitoring	Continuous use & monitoring	Intermittent - 6 month
<b>Reason for use</b>	Potential fault response	Potential fault response	Mfrs recommendation	Other reason	Company usual practice	Company usual practice	Company usual practice

	Finland	Russia	USA	Japan	France	Croatia	Switzerland
<b>Core &amp; frame</b>							
<b>1. Stator core/frame vibration monitoring</b>							
<b>Usage</b>	Not used	Used now		Not used	Future use	Not used	Not used
<b>Mode &amp; frequency</b>		Continuous use & monitoring	On known condition		Continuous use - regular data review	On known condition	
<b>Reason for use</b>		Mfrs recommendation	Other reason		Other reason	Other reason	
<b>2. Stator core lamination vibration – audio detector</b>							
<b>Usage</b>	Not used	Past use	Other reason	Not used	Not used	Not used	Not used
<b>Mode &amp; frequency</b>			On known condition			On known condition	
<b>Reason for use</b>			Other reason			Other reason	
	Finland	Russia	USA	Japan	France	Croatia	Switzerland
<b>Hydrogen cooling system</b>							
<b>1. Dew point monitoring</b>							
<b>Usage</b>	Used now	Used now	Used now	Not used	Used now	Not used	Used now
<b>Mode &amp; frequency</b>	Continuous use & monitoring	Continuous use & monitoring	Intermittent - weekly testing		Intermittent - weekly testing	On known condition	Continuous
<b>Reason for use</b>	Company usual practice	Mfrs rec or Company practice	Company usual practice		Other reason	Other reason	Mfrs recommendation
<b>2. Hydrogen make up rate monitoring</b>							
<b>Usage</b>	Used now	Used now	Used now	Not used	Not used		Used now
<b>Mode &amp; frequency</b>	Continuous use & monitoring	Cont monitored or Int monthly test	Continuous use & monitoring				Cont monitored or Int monthly test
<b>Reason for use</b>	Mfrs rec or Company practice	Mfrs rec or Company practice	Company usual practice				Mfrs rec or Company practice
<b>3. Hydrogen purity analysis</b>							
<b>Usage</b>	Used now	Used now	Used now	Used now	Used now	Used now	Used now
<b>Mode &amp; frequency</b>	Continuous use & monitoring	Cont monitored or Int weekly test	Continuous use & monitoring	Continuous use & monitoring	Continuous use & monitoring	Continuous use - regular data review	Continuous use & monitoring
<b>Reason for use</b>	Mfrs rec or Company practice	Mfrs rec or Company practice	Company usual practice	Potential fault response	Mfrs recommendation	Mfrs recommendation	Mfrs recommendation

	Australia 1	Australia 2	Australia 3	Serbia - Montenegro	Italy - Base Load	Italy - Mid Load	Brazil
<b>Stator water treatment</b>							
<b>1. Stator cooling water conductivity</b>							
<b>Usage</b>	Used now	Used now	Used now	Used now	Used now	Used now	
<b>Mode &amp; frequency</b>	Continuous use & monitoring	Continuous use - regular data review	Continuous use & monitoring	Continuous use - regular data review	Continuous use & monitoring	Continuous use & monitoring	
<b>Reason for use</b>	Potential fault response	Potential fault response	Mfrs recommendation	Other reason	Company usual practice	Company usual practice	
<b>2. Hydrogen leakage into stator water</b>							
<b>Usage</b>	Used now	Used now	Used now	Used now	Used now	Used now	
<b>Mode &amp; frequency</b>	Continuous use & monitoring	Continuous use - regular data review	Continuous use - regular data review	Continuous use - regular data review	Continuous use & monitoring	Continuous use & monitoring	
<b>Reason for use</b>	Potential fault response	Potential fault response	Test equip supplier recommendation	Other reason	Company usual practice	Company usual practice	
<b>3. Oxygen concentration</b>							
<b>Usage</b>	Used now	Used now	Used now	Used now	Used now	Used now	
<b>Mode &amp; frequency</b>	Continuous use & monitoring	Continuous use - regular data review	Continuous use - regular data review	Continuous use - regular data review	Continuous use & monitoring	Continuous use & monitoring	
<b>Reason for use</b>	Potential fault response	Potential fault response	Test equip supplier recommendation	Other reason	Company usual practice	Company usual practice	
<b>4. Copper concentration</b>							
<b>Usage</b>	Used now	Used now	Used now	Not used	Used now	Used now	Used now
<b>Mode &amp; frequency</b>	Intermittent - 6 month	Continuous use - regular data review			Intermittent - monthly	Intermittent - monthly	Intermittent - > 6 mths
<b>Reason for use</b>	Potential fault response	Potential fault response			Company usual practice	Company usual practice	Other reason
<b>Bearings</b>							
<b>1. Bearing journal vibration – dual probe monitor</b>							
<b>Usage</b>	Used now	Used now	Used now	Used now	Used now	Used now	Used now
<b>Mode &amp; frequency</b>	Continuous use & monitoring	Continuous use - regular data review	Continuous use & monitoring	Continuous use & monitoring	Continuous use & monitoring	Continuous use & monitoring	Intermittent - > 6 mths
<b>Reason for use</b>	Potential fault response	Potential fault response	Mfrs recommendation	Other reason	Company usual practice	Company usual practice	Other reason
<b>2. Shaft grounding monitoring</b>							
<b>Usage</b>	Used now	Used now	Used now	Not used	Used now	Used now	Used now
<b>Mode &amp; frequency</b>	Intermittent - 6 month	Continuous use - regular data review	*		Intermittent - monthly	Intermittent - monthly	Intermittent - > 6 mths
<b>Reason for use</b>	Potential fault response	Potential fault response	Other reason		Company usual practice	Company usual practice	Other reason

	Finland	Russia	USA	Japan	France	Croatia	Switzerland
<b>Stator water treatment</b>							
<b>1. Stator cooling water conductivity</b>							
<b>Usage</b>	Used now	Used now	Used now	Used now	Used now	Used now	Used now
<b>Mode &amp; frequency</b>	Continuous use & monitoring	Continuous use & monitoring	Continuous use & monitoring	Continuous use & monitoring	Continuous	Continuous use - regular data review	Continuous
<b>Reason for use</b>	Mfrs rec or Company practice	Mfrs rec or Company practice	Company usual practice	Potential fault response	Mfrs rec or potential fault	Mfrs recommendation	Mfrs recommendation
<b>2. Hydrogen leakage into stator water</b>							
<b>Usage</b>	Used now	Used now	Used now	Not used	Used now	Not used	Used now
<b>Mode &amp; frequency</b>	Continuous use & monitoring	Cont monitored or Int weekly test	Intermittent - 6 month		Intermittent - weekly testing	On known condition	Continuous
<b>Reason for use</b>	Company usual practice	Mfrs rec or Company practice	Company usual practice		Mfrs recommendation	Other reason	Mfrs recommendation
<b>3. Oxygen concentration</b>							
<b>Usage</b>	Used now	Used now	Used now	Not used	Used now	Not used	Used by some
<b>Mode &amp; frequency</b>	On known condition	On known condition	Intermittent - 6 month		Intermittent - weekly or monthly	On known condition	Continuous use - regular data review
<b>Reason for use</b>	Company usual practice	Mfrs rec or Company practice	Company usual practice		Mfrs recommendation	Other reason	Mfrs recommendation
<b>4. Copper concentration</b>							
<b>Usage</b>	Used now	Used now	Used now	Not used	Used now	Used now	Used now
<b>Mode &amp; frequency</b>	Continuous use & monitoring	On known condition	Intermittent - weekly testing		Intermittent - weekly or monthly	Continuous use - regular data review	Continuous use & monitoring
<b>Reason for use</b>	Company usual practice	Company usual practice	Company usual practice		Mfrs recommendation	Other reason	Mfrs recommendation
<b>Bearings</b>							
<b>1. Bearing journal vibration – dual probe monitor.</b>							
<b>Usage</b>	Used now	Used now	Used now	Used now	Used now	Used now	Used now
<b>Mode &amp; frequency</b>	Continuous use & monitoring	Continuous use & monitoring	Continuous use & monitoring	Continuous use & monitoring	Continuous use & monitoring	Continuous use - regular data review	Continuous use & monitoring
<b>Reason for use</b>	Company usual practice	Mfrs rec or Company practice	Company usual practice	Potential fault response	Mfrs recommendation	Mfrs recommendation	Various
<b>2. Shaft grounding monitoring</b>							
<b>Usage</b>	Used now	Used now	Used now	Used now	Not used	Used now	Used now
<b>Mode &amp; frequency</b>	Continuous use & monitoring	On known condition	Intermittent - weekly testing	Continuous use & monitoring		Continuous use - regular data review	Continuous use & monitoring
<b>Reason for use</b>	Company usual practice	Company usual practice	Company usual practice	Mfrs recommendation		Other reason	Mfrs recommendation

	Australia 1	Australia 2	Australia 3	Serbia - Montenegro	Italy - Base Load	Italy - Mid Load	Brazil
<b>Slip rings &amp; brush gear (or diodes)</b>							
<b>1. Brush on-line condition monitor</b>							
<b>Usage</b>	Used now	Not used	Not used	Not used	Not used	Not used	Future use
<b>Mode &amp; frequency</b>	Continuous use & monitoring						Intermittent - monthly
<b>Reason for use</b>	Potential fault response						Company usual practice
<b>2. Diode breakdown detection</b>							
<b>Usage</b>	Not used	Not used	Not used	Not used	Not used	Not used	Not used
<b>Mode &amp; frequency</b>							
<b>Reason for use</b>							

	Finland	Russia	USA	Japan	France	Croatia	Switzerland
<b>Slip rings &amp; brush gear (or diodes)</b>							
<b>1. Brush on-line condition monitor</b>							
<b>Usage</b>	Past use	Used now	Not used	Not used	Not used	Used now	Not used
<b>Mode &amp; frequency</b>		Cont monitored or Int weekly test				Continuous use - regular data review	
<b>Reason for use</b>		Company usual practice				Mfrs recommendation	
<b>2. Diode breakdown detection</b>							
<b>Usage</b>	Used now	-	Not used	Used now	Used now		Used by some
<b>Mode &amp; frequency</b>	Continuous use & monitoring	-		Continuous use & monitoring	Continuous use & monitoring		Continuous use - regular data review
<b>Reason for use</b>	Mfrs rec or Company practice	-		Potential fault response	Mfrs recommendation		Mfrs recommendation

## MANUFACTURER RESPONSES

	M - Japan	M - Italy	M - France	USA - 1	USA - 2
<b>Stator winding – slot content</b>					
<b>1. Partial discharge monitoring – various types</b>					
Usage	Future use	Used now	Used now	Used now	Used now
Mode & frequency	Intermittent - > 6 mths	Cont stored or Inter > 6 mths	Continuous use & monitoring	Cont stored or Inter > 6 mths	Cont stored or Inter > 6 mths
Reason for use	Other reason	Mfrs recommendation	Mfrs rec or potential fault	Other reason	Potential fault response
<b>Stator winding – end windings</b>					
<b>1. Stator end winding vibration monitor</b>					
Usage	Past use	Future use	Used now	Used now	infrequently
Mode & frequency	Continuous use & monitoring	Cont stored or Inter > 6 mths	Continuous use & monitoring	Various	CM when used
Reason for use	Other reason	Potential fault response	Mfrs rec or potential fault	Company usual practice	Company usual practice
<b>Rotor</b>					
<b>1. Rotor shorted turns detection</b>					
Usage	Past use	Used now	Used now	Used now	Used now
Mode & frequency	On known condition	Intermittent - > 6 mths	Continuous use - regular data review	Cont monitored or Int monthly test	Continuous use & monitoring
Reason for use	Other reason	Mfrs recommendation	Mfrs rec or potential fault	Company usual practice	Mfrs recommendation
<b>2. Shaft torsional oscillation monitoring</b>					
Usage	Past use	Not used	Not used	Used now	Very rarely
Mode & frequency	Continuous use - regular data review			On known condition	CM when used
Reason for use	Other reason			Potential fault response	Response to system

	M - Japan	M - Italy	M - France	USA - 1	USA - 2
<b>Core &amp; frame</b>					
<b>1. Stator core/frame vibration monitoring</b>					
Usage	Not used	Not used	Future use	Used now	Very rare
Mode & frequency			Continuous use - regular data review	On known condition	CM when used
Reason for use			Other reason	Company usual practice	Company usual practice
<b>2. Stator core lamination vibration – audio detector</b>					
Usage	Not used	Not used	Not used	Not used	Not used
Mode & frequency					
Reason for use					
<b>Hydrogen cooling system</b>					
<b>1. Dew point monitoring</b>					
Usage	Not used	Used now	Used now	Used now	Used now
Mode & frequency		Continuous use & monitoring	Intermittent - weekly testing	Continuous use & monitoring	Continuous use & monitoring
Reason for use		Mfrs recommendation	Other reason	Mfrs recommendation	Company usual practice
<b>2. Hydrogen make up rate monitoring</b>					
Usage	Past use	Not used	Not used	Used now	Used now
Mode & frequency	Continuous use - regular data review			Continuous use - regular data review	Continuous use - regular data review
Reason for use	Other reason			Mfrs recommendation	Mfrs recommendation
<b>3. Hydrogen purity analysis</b>					
Usage	Used now	Used now	Used now	Used now	Used now
Mode & frequency	Continuous use & monitoring	Continuous use & monitoring	Continuous use & monitoring	Continuous use & monitoring	Continuous use & monitoring
Reason for use	Mfrs recommendation	Mfrs recommendation	Mfrs recommendation	Mfrs recommendation	Mfrs recommendation

	M - Japan	M - Italy	M - France	USA - 1	USA - 2
<b>Stator water treatment</b>					
<b>1. Stator cooling water conductivity</b>					
Usage	Used now	Used now	Used now	Used now	Used now
Mode & frequency	Continuous use & monitoring	Continuous use & monitoring	Continuous use & monitoring	Continuous use & monitoring	Continuous use & monitoring
Reason for use	Mfrs recommendation	Mfrs recommendation	Mfrs recommendation	Mfrs recommendation	Mfrs recommendation
<b>2. Hydrogen leakage into stator water</b>					
Usage	Past use	Used now	Used now	Used now	Sometimes
Mode & frequency	Continuous use - regular data review	Intermittent - 6 month	Intermittent - weekly testing	Continuous use & monitoring	Continuous use - regular data review
Reason for use	Other reason	Mfrs recommendation	Mfrs recommendation	Mfrs recommendation	Company usual practice
<b>3. Oxygen concentration</b>					
Usage	Not used	Used now	Used now	Used now	Rarely
Mode & frequency		Intermittent - 6 month	Intermittent - weekly or monthly	Continuous use & monitoring	
Reason for use		Mfrs recommendation	Mfrs recommendation	Mfrs recommendation	
<b>4. Copper concentration</b>					
Usage	Not used	Used now	Used now	Used now	Used now
Mode & frequency		Continuous use & monitoring	Continuous use & monitoring	Continuous use & monitoring	Continuous use & monitoring
Reason for use		Mfrs recommendation	Mfrs recommendation	Mfrs recommendation	Mfrs recommendation
<b>Bearings</b>					
<b>1. Bearing journal vibration – dual probe monitor.</b>					
Usage	Used now	Used now	Used now	Used now	Used now
Mode & frequency	Continuous use & monitoring	Continuous use & monitoring	Continuous use & monitoring	Continuous use & monitoring	Continuous use & monitoring
Reason for use	Mfrs recommendation	Mfrs recommendation	Mfrs recommendation	Mfrs recommendation	Mfrs recommendation
<b>2. Shaft grounding monitoring</b>					
Usage	Not used	Used now	Used now	Used now	Used now
Mode & frequency		Continuous use & monitoring	Continuous use & monitoring	Continuous use & monitoring	Continuous use & monitoring
Reason for use		Mfrs recommendation	Mfrs recommendation	Mfrs recommendation	Mfrs recommendation

	M - Japan	M - Italy	M - France	USA - 1	USA - 2
<b>Slip rings &amp; brush gear (or diodes)</b>					
<b>1. Brush on-line condition monitor</b>					
<b>Usage</b>	Past use	Not used	Not used	Used now	Y-occasionally
<b>Mode &amp; frequency</b>	Continuous use & monitoring			Continuous use & monitoring	Continuous use & monitoring
<b>Reason for use</b>	Other reason			Company usual practice	Company usual practice
<b>2. Diode breakdown detection</b>					
<b>Usage</b>	Used now	Not used	Used now	Used now	Used now
<b>Mode &amp; frequency</b>	Continuous use & monitoring		Continuous use & monitoring	Continuous use & monitoring	Continuous use & monitoring
<b>Reason for use</b>	Mfrs recommendation		Mfrs recommendation	Mfrs recommendation	Mfrs recommendation

**ISBN: 978-2-85873-073-5**