KEY INFORMATION GUIDELINES FOR POWER GENERATION RISK ENGINEERING SURVEY REPORTS

This document has been produced by the Engineering Sub-Group of the LMA/IUA Joint Power Generation Committee and is based on the Key Information Guidelines for Oil, Gas & Petrochemical Risk Engineering Survey Reports (OG&P IGRES 2015/001) which was developed by Ron Jarvis (Swiss Re, London) and Andy Goddard (Talbot Syndicate, London) with contributions from London market engineers within the LMA Onshore Energy Business Panel Risk Engineers Sub-Group

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SECTION A: INTRODUCTION TO THIS DOCUMENT

1. Purpose

The purpose of this document is to outline the **key** information requirements for power generation risk engineering survey reports ('market reports') and to provide guidance to risk engineers responsible for producing such market reports.

2. Scope

This document identifies the key items of interest to (Re)Insurers rather than providing an exhaustive and definitive list of all possible information. It is recognised that, depending on the type of survey being undertaken, it may not always be possible to obtain all the information requested.

This document does not stipulate a specific format for market reports (section titles, order etc.) Ensuring that the information (Re)Insurers find most useful is present somewhere within a market report is far more important than the report format itself.

This document is intended to outline information which would typically be available from a standard single site survey. With particular reference to business interruption, it is intended to outline information which should be available at the site level.

This document has been developed for power generation assets.

This document has been developed by the Lloyd's Market Association (LMA) and hence is principally for market reports produced for the London market, although this guidance could be adopted in other global markets.

3. General Principles

The following points are intended as general principles applicable to market reports.

Primary customer

The primary purpose of market reports is to allow (Re)Insurers to understand the exposures and loss control features of a particular site, such that the underwriter can make an informed decision about the transfer of risk. (Re)Insurers would therefore consider themselves as the primary (but not the only) customer for market reports.

Report length

There is a growing tendency for market reports to expand. It is considered that a more succinct market report, containing the information needed by (Re)Insurers, is achievable through better report writing and greater use of bullet points, tables, charts and diagrams. Certain pitfalls should be avoided:

- Avoiding lengthy narrative and ensuring that text is relevant to risk quality assessment and the insurance cover being provided. Lengthy descriptions of the physical asset including the process should generally be avoided.
- Avoiding repetition.
- Avoiding report 'creep' by not simply adding more information to an existing market report following each survey, unless that information is considered to materially improve the report content. It is also to ensure that historical information left in a report does not become obsolete. Where reports for a particular site become lengthy

following re-surveys, it is important to highlight any changes in the Executive Summary.

- Removing generic text from the main body of the report. Examples of generic text include standardised sections which appear in every report from the same engineering provider (e.g. the description of the loss estimating methodology). Such generic text could be provided within an appendix or even as a standalone document.

Evidence based opinion

The risk engineer's opinion of the quality of individual risk control elements should only be provided along with supporting evidence. Reference should be made to the review of relevant documentation where applicable. Comments benchmarking against recognised good industry practice should also be provided where possible.

Implementation and compliance

A description of the features of a risk control element is normally provided in market reports, however commentary and evidence, to support the *actual* implementation of an apparently sound system, is often missing. Failures in implementation and non-compliance with established systems of work and procedures are a significant contributor to major losses making this is an important aspect to address within the report.

Performance data

Wherever possible, relevant performance data such as RAM (Reliability, Availability and Maintainability) data and other Key Performance Indicators (KPIs) should be provided and can be used as evidence to support opinion and effective implementation (as above) (e.g. availability %, forced outage % and scheduled outage %). Where possible, it is also important to comment upon trends and any exceptions to ensure the data is meaningful to the reader.

Information not provided

Within the constraints of the survey process, it is recognised that not all of the information outlined in this document can be provided or revalidated at every survey. If information was not available or was not assessed then this should be stated within the market report.

Electronic format

All text, attachments and embedded files (appendices, drawings, photos etc.) should be inserted such that they can be extracted and clearly read.

SECTION B: KEY INFORMATION REQUIREMENTS

EXECUTIVE SUMMARY

4. Executive Summary

4.1. **Introduction**

4.1.1. Purpose of the site visit.

4.1.2. Date and duration of site survey, and scope of survey activity.

4.1.3. History of any previous survey activities.

4.1.4. Details of the key survey participants.

4.2. **Overview**

Ideally no more than one or two pages, this should be a précis and *not a cut and paste from the main body of the report,* covering:

4.2.1. Site location, and significant natural hazards.

4.2.2. Brief description of the plant (MW and $/MW), type of plant and machinery (including gas turbines, steam turbines, boilers, transformers and generators as well as model numbers and country of manufacture where available), total generating capacity, number of units.

4.2.3. Ownership and management.

4.2.4. Brief history, year built, main contractor(s), and commercial operation dates.

4.2.5. Brief details of any future development projects, or upgrades.

4.3. **Comments and conclusions**

This section should give the Engineers opinion of the risk, including:

4.3.1. Strengths and areas for improvement of the plant.

4.3.2. Highlight any engineering issues, equipment hardware anomalies which could affect the risk.

4.3.3. Management systems, attitude to risk management and progress in clearing loss prevention recommendations.

4.3.4. Brief overview of incidents over the last 5 years.

PLANT STATUS

5. Site Description

5.1. Provide a map showing the site location, including the geo-coordinates for the site, latitude and longitude (to 3 decimal places).

5.2. Description of site location, topography, ground conditions if known, proximity to sea/river.

5.3. Provide an aerial view of the site.

5.4. Identify any third party exposures, particularly industrial facilities, gas pipelines and/or OH cables.

5.5. Specify the total site area (hectares) and comment if congested.

6. Plant Description

6.1. Brief description of site history: ownership, main contractors, dates when construction started and when units entered commercial operation. Details of any major upgrades or refurbishment.

6.2. An overall plant layout drawing to scale should be provided in electronic form either as a separate document or in the appendix of the report.

6.3. A scale drawing of the power house showing the orientation and spatial separation of the turbine generators should be provided either as a separate pdf or in the appendix of the report.

6.4. Provide approximate spatial separation and segregation between:

6.4.1. Fuel handling and storage facilities and main power plant equipment.

6.4.2. Main buildings/areas, switchyard, control and electrical buildings and power house.

6.4.3. Between neighbouring boilers or HRSGs.

6.4.4. Between turbine generators (clear spatial separation or centreline separation, and orientation axially inline or parallel.

6.5. Transformers spatial separation or blast wall separation as NFPA 850?

6.6. Identify the location and containment/drainage provided for the main flammable substances in the power house such as:

6.6.1. Turbine generator lubricating oil tanks.

6.6.2. Generator seal oil skids.

6.6.3. Turbine control oil skids.

6.6.4. Hydrogen for generator cooling.

6.7. Comment on segregation/unitisation of electrical and control rooms. Are there any locations where an incident could affect multiple units?

6.8. Cable tunnels.

6.9. Cable spread rooms.

6.10. Statement of controls (control room design and location). Control systems hardware installed, age, availability of spares and obsolescence if applicable. Shutdown and emergency control systems. Boiler burner management and flame monitoring systems. Who was the overall design architect? Turnkey or bit part/interfaces.

6.11. Provision of any advanced monitoring systems such as; turbine generator online vibration monitoring systems, transformer online Dissolved Gas Analysers, generator online Partial Discharge monitoring, CDM, BHM, EHM, etc.

6.12. Fuel storage and Handling Facilities

6.13. Describe the bunding arrangement for the main fuel oil tanks.

6.14. Construction. Details of foundations. Brief description of construction of main buildings (a table format may be appropriate), highlight the use of any flammable materials such as PUR or PIR insulated panels.

6.15. Major equipment, Boilers, Heat Recovery Steam Generators (HRSGs), Gas Turbines, Steam Turbine, Generators, Transformers. Provide nameplate details of the major equipment, details of Original Equipment Manufacturer (OEM), year manufactured, country of manufacture and ISO ratings. A table format (an example of which is included in the Appendix) is appropriate for this information. Comment on any upgrades or modifications.

6.16. Balance of Plant (BOP). Brief details of BOP systems, comment on built in redundancy (e.g. 2 x 100%/3 x 50%) and major spares.

7. Loss and Incident History

7.1. Provide details (including date, amount of loss (where applicable) and a description of the loss/incident) of losses (including losses below the deductible) and incidents going back 5 years.

7.2. Consequences and root causes for each of the losses and incidents and the changes made to prevent future losses and incidents.

EXPOSURE ASSESSMENT

8. Exposures

8.1. Identify and comment on any unusual fire and explosion exposures.

8.2. Identify and comment upon technology risks such as novel or unproven processes and pioneering design (e.g. design capacity).

8.3. Identify the key natural peril exposures along with the associated controls, both physical (e.g. design standards, flood defences etc.) and procedural (e.g. hurricane preparedness procedures). Provide details of any natural catastrophe exposure assessments and emergency response plans in the event of a natural catastrophe (including any relevant third party and/or government and/or local authority studies, e.g. in respect of flood defences).

8.4. If the plant is in a flood zone comment on historical flooding in the area. Comment on the susceptibility of the plant to flooding; elevation of major equipment, underground basements, value of equipment likely to be affected etc.

8.5. Identify any onsite or offsite third party operations and comment upon the proximity and possibility of property damage accumulation.

9. Values

9.1. **Property Damage (PD)**

9.1.1. The date of the last valuation and who provided it.

9.1.2. Whether the values are based on historical book values or current replacement values.

9.1.3. Comment on whether the values appear reasonable compared with industry benchmarks.

9.1.4. Provide a breakdown of values with separate values given for major equipment.

9.1.5. The basis for the values used in the Estimated Maximum Loss (EML)/Maximum Possible Loss (MPL) calculations (e.g. if declared values or engineers' estimates have been used).

9.2. **Business Interruption (BI)**

9.2.1. The basis for BI sums insured (e.g. gross margin).

9.2.2. Are there any take or pay agreements with the fuel supply.

9.2.3. Is there a strong seasonal bias in the BI exposure? Provide an income and dispatch profile by month.

10. Loss Estimates

Estimated Maximum Loss (EML)/Maximum Possible Loss (MPL)

These terms are for a catastrophic loss scenario. The term used should be defined.

The EML/MPL is based upon a catastrophic loss caused by a credible worst case event. The event is based upon historical evidence for the type of plant in question. It is assumed that active systems (firefighting systems etc.) are non-operational.

If an earthquake EML/MPL is quoted then the rationale for this compared with a normal EML/MPL should be stated.

10.1. **Property Damage (PD)**

10.1.1. For the Property Damage (PD) EML/MPL the following should be stated:

10.1.1.1. The scenario (fire, internal explosion, etc.)

10.1.1.2. The affected unit and/or equipment.

10.1.1.3. The estimated PD value and time to repair.

10.2. **Business Interruption**

10.2.1. The BI rationale and calculation should be kept clear and simple.

10.2.2. Is there any take-or-pay arrangement with the fuel supply

11. Business Interruption

11.1. Utility redundancy; emergency power supplies and UPS systems, fuel supplies, water supplies etc. Identify redundancy, buffer supplies, alternate supplies and comment on adequacy.

11.2. Process flexibility, number of units, can units operate in open cycle, is there any critical equipment (e.g. STG in a multi-shaft 2 into 1 CCGT).

11.3. Service agreements; such as agreements with OEMs which would provide access to fleet spares.

11.4. Spare parts holdings, particularly major strategic spares holdings; large transformers, turbine/generator rotors, etc.

11.5. Accessibility. How easy is it to get people/parts to the plant in an emergency, consider infrastructure, potential weather constraints, geo-political events.

11.6. Workshop facilities, onsite facilities, in country facilities, regional facilities. Consider where the nearest workshops are which could carry out repairs to turbines, generators, transformers etc.

11.7. Does the plant supply power or steam directly to some customers and are there any penalties associated with inability to supply.

11.8. Describe the plant's Business Continuity Planning, including threat assessment and mitigation(s), emergency response, crisis management and business recovery.

11.9. If applicable, where on the market merit order does this plant fall?

11.10. Some discussion as to the electricity market this plant is operating in (influence of hydros, shifting regulation, relative fuel costs etc.)

11.11. Any fines and penalties for non-availability? Any 'buffer' applicable to mitigate losses (e.g. no BI loss for first 5% FOR in any one year).

11.12. Fuel availably and level of fuel reserves (days).

11.13. List the critical customers and suppliers and the contingent BI sums insured.

11.14. Any regulatory/emissions constraints preventing alternative running options?

LOSS PREVENTION

12. Management & Organisation

12.1. A copy of the (Re)Insured's management organigram (high level positions) is required. The following comments are important:

12.1.1. Any recent or proposed changes in organisation. The risk assessment conducted and the effect these may have on the risk.

12.1.2. Adequacy of staffing in critical positions (including management turnover).

12.1.3. Engineer's opinion of the attitude of the senior management towards safety and loss prevention (it is accepted that some diplomacy may be required).

12.1.4. Staff training and background.

12.2. Describe Management of Change (MoC) procedures.

12.3. Describe document management procedures.

13. Operations

13.1. **Organisation**

13.1.1. Operations shift manning level

13.1.2. Vacancies and turnover of personnel with trends (provide data and/or KPIs).

13.1.3. Average experience levels (provide data and/or KPIs).

13.1.4. The age profile of the staff.

13.1.5. Comment upon use of additional manning and technical support; Station Chemist, Performance Engineer, Operations Support, etc.

13.1.6. Comment upon the approach to ISO accreditations (e.g. ISO 9001, ISO 14001, ISO 55000, OSHAS 18001 etc.) at the plant.

13.2. **Shift Handover Procedures**

13.2.1. Describe the main elements of shift handover procedure. Comment and provide opinion upon the adequacy of the procedure and provide evidence of its implementation.

13.3. **Standard & Emergency Operating Procedures (SOPs & EOPs)**

13.3.1. Comment on availability of SOPs and drawings for the Operations Personnel.

13.3.2. Comment upon the quality of the SOPs based on review of sample documentation.

13.3.3. Comment upon the use of signed and itemised checklists for critical operations; such as return to service following an outage.

13.3.4. Comment upon the adequacy of the routine review process for SOPs and provide data and/or KPIs on compliance with the process.

13.4. **Training & Competence Assurance**

13.4.1. Describe the main elements of the training and certification process for new operators.

13.4.2. Describe the main elements of the operator competence definition and assessment process.

13.4.3. Describe the main elements of the critical SOP refresher training programmes.

13.5. **Permit To Work (PTW)**

13.5.1. Describe the main elements of the PTW system and highlight any deficiencies versus industry best practice.

13.5.2. Provide evidence of compliance with the PTW system based on review of sample documentation (both at the permit issuing location and in the plant) and verification on the plant.

13.5.3. Comment upon housekeeping, including caps and blanks on open ends, bolting standards of pipework and junction boxes, condition of surface coatings, condition of lagging etc.

13.5.4. Describe the main elements of the PTW audit process and provide data and/or KPIs for PTW compliance.

13.6. **Equipment Isolation**

13.6.1. Describe the main elements of the equipment isolation procedures and highlight any deficiencies versus industry best practice.

13.6.2. Provide evidence of compliance with the equipment isolation procedures based on review of sample documentation and verification on the plant.

13.7. **Safety Instrumented System (SIS) Override Management**

13.7.1. Describe the main elements of the SIS override procedure and highlight any deficiencies versus industry best practice.

13.7.2. Provide evidence of compliance with the SIS override procedure based on review of sample documentation and verification in the control room.

13.7.3. Provide data and/or KPIs associated with the implementation of the SIS override procedure (e.g. number of SIS in override, duration of SIS in override, SIS availability etc.)

13.8. **Operational Testing Routines**

13.8.1. Provide details of routine operational testing including frequency of testing; Turbine over-speed trips, DC emergency oil pumps, turbine valve freedom of movement checks, turbine NRV checks, emergency generators (loaded/unloaded).

14. Maintenance

14.1. **Organisation**

14.1.1. Provide a basic and brief outline of the maintenance organisation including employee numbers and sub-department numbers.

14.1.2. Comment on vacancies and turnover of personnel.

14.1.3. Comment on experience levels.

14.1.4. Describe the extent of the use of contractor workforce and the level of in-house supervision. Third-party QA.

14.1.5. Details of any Long Term Maintenance Agreements or Parts Supply Agreements, such as performance guarantees, penalties, spares pricing, guaranteed response times, and the equipment which is covered.

14.1.6. Maintenance Training.

14.2. **Planning, Prioritisation & Performance**

14.2.1. Maintenance Planning and use of Computerised Maintenance Management System

14.2.2. Provide details of the overall major overhaul plan (schedule, frequency etc.), any interim planned shutdowns.

14.3. **Boilers HRSGs and Pressure Parts**

14.3.1. Provide details of major and minor outages, planned frequency, scope of work, and actual dates of the last outage.

14.3.2. It is essential that the last major overhaul report(s) are reviewed to assess the quality of the work, identify whether there were any findings, and whether these were resolved.

14.3.3. Statutory inspection requirements, WSE, competent authority.

14.3.4. Use of Third Party Inspectors.

14.3.5. NDT routines, tube thickness checks, UT/DPI/MPI/PMI etc.

14.3.6. Creep Life Assessment (particularly for older plants).

14.3.7. FAC (Flow Accelerated Corrosion) targeted inspection (particularly for HRSGs).

14.3.8. Describe the testing and overhaul regime for pressure relief valves.

14.3.9. Describe the inspection regime for pressure vessels.

14.3.10. Describe the inspection regime for piping systems.

14.3.11. Describe the inspection regime for pipe hangars and supports

14.3.12. What controls are in place to ensure that only qualified welders and procedures are used for repairs and alterations?

14.3.13. What controls are in place to ensure that only materials conforming to appropriate pressure equipment codes are used for repairs and alterations?

14.4. **Gas Turbines**

14.4.1. Provide details of inspection regimes, planned frequency of; Borescope Inspections (BSI), Combustion Inspections (CI), Hot Gas Path Inspections (HGPI) and Major Inspections (MI).

14.4.2. Specify the actual dates of the last inspection outage and the number of Fired Hours (FH) or Equivalent Operating Hours (EOH) and starts since the last MI.

14.4.3. It is essential that the last overhaul report(s) are reviewed to assess the quality of the work, identify whether there were any findings, and whether these were resolved. Who reads reports, black copies?

14.4.4. Use of OEMs or Specialist Contractors; who carries out the work and who provides Technical Supervision?

14.4.5. Long Term Service Agreements, scope of agreement, planned and breakdown maintenance, parts supply, provision of on-site personnel, provision of remote monitoring, penalty and bonus arrangements, waiver of subrogation.

14.4.6. Who supplies replacement/refurbished parts? What is the cycle, SX, DS turbine parts?

14.4.7. Application and follow up of OEM Technical Advice (Technical Information Letters, Technical Information Service Letters, Service Bulletins, etc.). How are these received, assessed, implemented and tracked? Are there any outstanding critical issues?

14.4.8. Comment on any upgrades or modifications.

14.4.9. Over-speed testing frequency.

14.5. **Steam Turbines**

14.5.1. Provide details of maintenance regime, planned frequency of minor (valves/bearings, BSI, LSB inspection, etc.) and major overhauls (open casing with rotor pulled) and scope of work.

14.5.2. Scope of NDT.

14.5.3. Specify the actual dates of the last major overhaul and the number of operating hours and starts since the last major overhaul.

14.5.4. It is essential that the last overhaul report(s) are reviewed to assess the quality of the work, identify whether there were any findings, and whether these were resolved.

14.5.5. Use of OEMs or Specialist Contractors; who carries out the work and who provides Technical Supervision?

14.5.6. Comment on any current or historic issues.

14.5.7. Over-speed testing frequency.

14.6. **Generators**

14.6.1. Provide details of inspection regime, planned frequency of minor and major overhauls (rotor pulled) and scope of work. First year camera inspection.

14.6.2. Use of air gap inspection crawler robots.

14.6.3. Specify the actual dates of the last major overhaul and the number of operating hours since the last major overhaul.

14.6.4. It is essential that the last overhaul report(s) are reviewed to assess the quality of the work, identify whether there were any findings, and whether these were resolved.

14.6.5. Use of OEMs or Specialist Contractors.

14.6.6. Scope of electrical testing; what electrical tests are carried out and how frequently, review the last set of test results and comment on them.

14.6.7. Comment on any current or historic issues.

14.7. **Transformers (including bushings and tap changers)**

14.7.1. Provide details of the insulation oil analysis routines; frequency of DGA analysis, screen tests (physical and chemical properties) and which laboratory carries out the analysis.

14.7.2. Furans analysis and inferred Degree of Polymerisation (DP)/life expectancy.

14.7.3. Corrosive sulphur analysis.

14.7.4. It is essential that the last set of insulation oil analysis results are reviewed to ensure that the results are satisfactory, and to confirm the testing frequency.

14.7.5. Electrical testing, scope of testing (IR/PI/Tan Delta/Turns Ratio/SFRA) and frequency. The last electrical testing report should be reviewed.

14.7.6. Engineering analysis of the overall health of the transformers (including bushings and tap changers).

14.8. **Balance of Plant**

14.8.1. Describe the inspection regime for storage tanks.

14.8.2. Describe the battery testing regime; how frequently are load tests carried out?

14.8.3. Testing of static grounding/bonding systems.

14.9. **Preventive Maintenance Routines**

14.9.1. Vibration monitoring; frequency, internal/external contractor, scope, review the last report.

14.9.2. Thermographic surveys; frequency, internal/external contractor, scope, review the last report.

14.9.3. Lubricating oil analysis for major equipment; frequency, by who, and scope of analysis.

14.10. **Equipment Deficiency Management**

14.10.1. Is any equipment approaching or operating beyond end-of-life?

14.10.2. Explain how inspection repair recommendations are issued, actioned and tracked to completion.

14.10.3. How are on-line leaks managed? How are temporary repairs controlled?

14.11. **Inspection Quality Assurance**

14.11.1. What controls are in place to ensure that work of contract inspection or repair organisations meet the required standard?

14.12. **Incoming material control**

14.12.1. What controls are in place to ensure that incoming materials meet the required standard?

LOSS MITIGATION

15. Fire Protection & Emergency Response

15.1. **Organisation**

15.1.1. Provide basic details of the emergency response organisation (onsite, offsite and any mutual aid schemes).

15.1.2. Provide basic details of the training programme with data and/or KPIs on compliance with the stated training programme.

15.1.3. Provide opinion of the adequacy of the on-site and/or local fire fighting force (manning, training, equipment, etc.)

15.1.4. Quality of the emergency plans and procedures and pre-fire plans.

15.1.5. Exercise frequency (review some of the recommendations made following these exercises).

16. Active Protection

16.1. **Fire water system**

16.1.1. Is there redundancy in the fire main/hydrant system?

16.1.2. Comment on the adequacy of fire water supply (volume of storage tank, volume dedicated to fire water, pump capacity, backup diesels for electric pumps, security/reliability of power supply).

16.1.3. Comment on the design of the fire water system (automatic/manual starting, jockey pumps, etc.)

16.1.4. Comment on the adequacy of the testing of fire water system performance including piping systems and pumps – weekly and annually.

16.1.5. Comment on the general condition of the system.

16.1.6. Testing and maintenance procedures, frequency, responsibility.

16.2. **Detection Systems**

16.2.1. Comment on the adequacy of fire, smoke and gas detection and alarm systems.

16.2.2. The operability of these systems (check they are functional).

16.2.3. Testing and maintenance procedures, frequency, responsibility.

16.3. **Fixed Fire Protection Systems**

16.3.1. Fixed fire protection should be provided in accordance with NFPA 850, a gap analysis should be carried out to identify any shortfalls. A simple table showing the major equipment and indicating the type of fixed protection provided or lack of will suffice.

16.3.2. Comment on any deficiencies.

17. Emergency Response

17.1. **Emergency Response Planning**

17.1.1. Provide basic details and comment on the adequacy and quality of the emergency response plan.

17.1.2. Provide basic details and comment upon the adequacy and quality of the fire pre-plans.

17.1.3. Provide details of any natural catastrophe exposure assessments and emergency response plans in the event of a natural catastrophe (including any relevant third party and/or government and/or local authority studies, e.g. in respect of flood defences).

17.2. **Emergency Response Exercises**

17.2.1. Provide basic details and comment upon the adequacy and quality of the emergency response exercises including follow-up reports and recommendations.

17.2.2. Provide data and/or KPIs on compliance with the stated exercise schedule.

17.2.3. Provide details of the process for handling recommendations with data and/or KPIs on recommendation tracking.

RISK IMPROVEMENT RECOMMENDATIONS

18. Risk Improvement Recommendations

18.1. Recommendations should be presented in two parts. The background to the issue should be explained in some detail and include references to standards or established best practice followed by the recommendation.

18.2. Where recommendations are in multiple parts each sub-recommendation should be individually identified with a separate letter (a, b, c etc.) or number (I, ii, iii, etc.). Bulleted lists should be avoided.

18.3. A report of outstanding recommendations should be provided in the market Report.

18.4. The response of the Insured to survey recommendations is a very important risk quality indicator. A status report of outstanding previous recommendations must be provided in the market Report. This status report should be based on a written response from the Insured and there should be a comment in the market Report regarding the intent of the client to address the recommendations. This could be made during the survey or before the market Report is published.

18.5. The recommendations section should also include:

18.5.1. Implementation status verified by the surveyor. Note the status can only be established following an on-site visit or exceptionally if the client can provide compelling evidence.

18.5.2. The status flags can either be: No Plan; In Progress; No Progress; Under Review; Completed; Superseded; or Withdrawn.

18.5.3. These status flags are not sufficient without additional explanation and justification.

18.5.4. Where recommendations are being implemented in a phased manner, e.g. as a project, the recommendation should only be closed if the site has demonstrated a clear commitment to complete the work and, if necessary, there is a matching line item in future expenditure budgets.

SECTION C: APPENDIX TO THIS DOCUMENT

19. Example table format for major equipment details (6.15)

GAS TURBINE/GENERATOR – General Specifications	
Designation	***GT11,GT12,GT13, GT21,GT22,GT23***
GENERAL	
Service Status	Base load
Spacing	12m, (39ft) in-line, end to end.
TURBINE	
Designer	GE
Manufacturer / Year	GE, 2007
Model #	PG7121(EA) 7EA
Serial Nos#	298827+28,29,30,31,32
Rating (MW)	85.1 (ISO)
Fuels	Natural Gas only
Turbine Inlet Temp (°C)	1099 (base load at ISO)
Speed RPM	3600
GENERATOR	
Manufacturer/Year	GE VATech Hydro Austria 2007
Model #	7AC (TEWAC)
Serial #	
Rated voltage (kV)	13.8
Rated (MVA/MW)	99/80.35
Speed (RPM)	3600
Rotor cooling	Air
Stator cooling	Air
LUBRICATING OIL/SEAL OIL	
System/type	Forced w/main, shaft driven, AC and DC back-up pumps. 3 bearing configuration with centre bearing in GT enclosure. (Fire risk)
Piping	304L SS, double-walled.
Containment	Oily water sump catchment
Reservoir location	Auxiliary compartment
VIBRATION MONITORING	
Fixed/Portable	Fixed, Bentley Nevada
Alarms/Interlocks	Alarm/Trip levels

HEAT RECOVERY STEAM GENERATOR - General Specifications	
Designation	HRSG 11,12,13 21,22,23
Service Status	Base load
Spacing	35m
GENERAL	
Number of units	6
Designer	CSIC & 703 Research Inst. (China)
Manufacturer / Year	2009
Serial#	
Type	Horizontal gas flow.
Steam flow (kg/s) HP / LP	41.8/7.0 (332,000lbs/h/55,500lbs/h)
Steam pressure (bar) HP / LP	106/8.9 (1558/131 psi)
Steam temperature (°C) HP / LP	536/263 (997/505 F)
Gas flow to HRSG (kg/s)	0.27 (2143 lbs/h)
Gas temp to HRSG (°C) (Max)	26.7 (80F)
Boiler Fuels	Natural gas only to duct burners
N° of burners & type	2 off per HRSG, Dry Low NOx. gives + 5MW per HRSG, i.e. 30MW
Burner Interlocks & Controls	
Boiler interlocks (level, temp, press)	Per NFPA 85, IGEMA level controls
BOILER FEED PUMPS	
Driver & redundancy	Motor, 4 x 50%
MISCELLANEOUS	
Water Chemistry Testing/Controls	Sample system with auto feed control

STEAM TURBINE/GENERATOR - General Specifications	
Designation	***ST 10, ST 20***
Spacing	5m (16.5ft)
GENERAL	
Service Status	Base load & sliding pressure
Number of units	2
TURBINE	
Designer	GE
Type & N° of cylinders & reheat	Non-reheat, condensing, single casing, single flow, axial exhaust.
Manufacturer / Year	GE / 2007
Model #	GE SC5
Rating (MW)	152
Speed (RPM)	3600
GENERATOR	
Manufacturer/year	GE / USA/ 2007
Model #	7FH2
Serial #	270T785
Rated voltage (kV)	18
Rated MVA	180
Rotor cooling	Hydrogen (water coolers)
Stator cooling	Hydrogen (water coolers)
LUBRICATING OIL/SEAL OIL	
Type	Mineral oil, pressurised system, with back-up.
Piping	304L SS, double-walled.
Containment	Oily water sump catchment
Reservoir location	Auxiliary compartment
VIBRATION MONITORING	
Fixed/Portable	Fixed, Bentley Nevada
Alarms/Interlocks	Alarm/trip levels
HP STEAM	
Flow (kg/s)	125 (992,000 lbs/h)
Pressure (bar)	100 (1470 psi)
Temperature (°C)	531 (988F)
LP STEAM	
Flow (kg/s)	20.5 (162,700 lbs/h)
Pressure (bar)	8.1 (120psi)
Temperature (°C)	260 (500F)

TRANSFORMERS & ELECTRICAL SYSTEMS			
TRANSFORMERS (>10 MVA) – General Specifications			
Designation	GT GSU	ST GSU	Unit Aux.
Number	GT 11,12,13 GT 21,22,23	ST 10, ST 20	12, 13, 21, 22, BBT 01
Service	GSU	GSU	Aux
Manufacturer	Toshiba/Brazil	Toshiba/Brazil	Toshiba
Year Manufactured	2009	2009	2009
Type	Core	Core	Core
Serial #	A08139/A08143	A08144-5	
Rating (MVA)	99	180	10/15
Serial Voltage (kV)	13.8-220	18-220	13.8/4.16
# Phases	3	3	3
Frequency (Hz)	60	60	60
Cooling	ONAN/ONAF	ONAN/ONAF	ONAN/ONAF
Oil type	Napthenic	Napthenic	Napthenic
Oil Capacity (kg)	27315	40890	5500
Total Weight (kg)	110,000	172,000	25,000
Drainage/Containment	Yes	Yes	Yes
Separation (transformers)	Firewall	Firewall	Firewall
Blast wall to NFPA 850	Yes	Yes	Yes
Barricades	Yes	Yes	Yes
Oil filled Condensor type Bushings	Yes	Yes	No
OLTC	No	No	Yes

EMERGENCY DIESEL and BLACK START GENERATORS x 2	
Supplier	Frerk Aggregatebau GmbH
Engine	Diesel
Rated Output (kW)	2500 kVA x 2
Speed (RPM)	1800

BATTERIES	
Type	Sealed Lead-Acid

Fire Pump	Electric	Diesel
Manufacturer	Patterson 6x5x11 SSCH	Patterson 8x6 MH
Rating	1250 gpm @ 150 psi	1250 gpm @ 347 ft head
Motor	150BHP, 3650 rpm	DFP 62012C10 at 2100rpm @ 205HP
FM Approved	Yes	Yes
Running hours.	No monitoring available	60.5hrs @ 7th Feb 2012, 72.5 @ 26th Feb 2013

FIXED FIRE DETECTION / FIRE PROTECTION SYSTEMS		
Equipment	**Gas / Fire Detection**	**Fixed Fire Protection**
Gas Turbine compartments	Y	Total flooding CO_2 system. 1 tank per GT.
Gas turbine lube oil tank	Y	Total flooding CO_2 system.
Gas turbine lube oil pipework	Y	Total flooding CO_2 system.
Gas turbine PCC's	Y	None
Boiler feed water pumps	Heat detection over drive motors	None
Steam turbine bearings	Smoke	Deluge
Steam turbine under-deck areas	N	None
Steam turbine combined lube oil and seal oil tank	Y	Deluge system
Steam turbine lube oil pipework	N	.
Steam turbine control oil skid	Y	Water sprinkler system
Gas turbine control oil skid	Combustible gas detectors	
HCO building		Sprinkler system
Generator bearings/enclosures	N	
Air Cooled Condenser	n/a	
Generator step-up transformers	Wet detection system	Water spray deluge system
Auxiliary transformers	Wet detection system	Water spray deluge system
LV auxiliary transformers	High temperature alarm and trip via dual embedded RTDs on each transformer core.	
Gas pressure reducing station	N	
Natural Gas AGI	Y	
Gas Heating Station	Y	
Emergency Diesel Generators	Y	CO_2 extinguishing system.
Electric Fire fighting pump house	Smoke detection	None
Fire fighting pump house	Smoke detection	Water sprinkler system
Central Control Room and common areas of building.	Y	Sprinkler system. Inergen Gas & self-extinguishing cable in underfloor.
Motor Control Centres (MCC's)	Smoke detection inc. underfloor.	Inergen Gas
Cable Galleries/Trenches	N/A	
Relay Room/DCS Room	Y	Inergen Gas
Battery Rooms	Gas detection	
Administrative building	Y	Water sprinkler system
Water treatment plant	Y	Water sprinkler system
Workshop and Stores	Y	Water sprinkler system