IGEM
Institution of
Gas Engineers & Managers

Technical Report Synopsis

For Chartered Membership

To The Institution of Gas Engineers and Managers

Example

DEVELOPMENT OF RISK CONTROL MEASURES FOR GAS TURBINES USED IN GAS TRANSMISSION

November 2007

15/11/07

PM84 Synopsis

Declaration.

It is my belief that the specific contents and scope of this work are unique to this type of project. The decisions I have made are based on my own experience, understanding of the systems involved, by applying engineering principals and my operational experience to select the best solution. By taking cognizance of industry wide recommendations for associated power generation within company policy and current national guidance documents, this project will communicate lessons learned and apply best practice.

The information contained in this Synopsis may be considered company and commercially sensitive information. I will therefore present any written work and reports for National Grid approval prior to submission to the Institution of Gas Engineers and Managers. I will apply the Harvard reference system for citing references based on British Standards BS 5605:1990 for the Technical Report.

Signed..... .....

Summary Background

National Grid has gained a lot of experience and a good working knowledge of operating gas turbines over a thirty-five year period. With this knowledge and experience comes a good safety record. At the start of 2002 the predicted increase in gas demands called for larger industrial Gas Generators bringing hotter running temperatures, leading to hotter component surfaces.

The Moffat Compressor Station ventilation system operated by airflow passing through the cab and being extracted through outlet vents as a negative pressure system, resulting in potential hot spot areas out-with the mechanically ventilated airflow paths, and also extended fan operation with higher associated maintenance and running costs. This project will bring Moffat Compressor Station into compliance.

Project Regulation.

The UK Dangerous Substances and Explosive Regulations 2002 (DSEAR)[6] The Equipment and Protective Systems for use in Potentially Explosive Atmospheres Regulations (EPS), provide a United Kingdom legislative framework for the implementation of the ATEX Directives ATEX-100A and ATEX 137A [2]. The majority of Units within National Grid cannot comply directly with the regulations made to implement the ATEX Directives [2] due to the requirement to exclude hot surfaces from known hazardous areas. Ventilation was initially installed in acoustic enclosures mainly to assist the cooling of the gas turbines; it gave a secondary effect of diluting potential small gas leaks where hot surface areas exist.

The Health and Safety Executive have published guidance information that confirms that the provision of dilution ventilation will enable gas turbines operating within an enclosure to be regarded as ATEX [5] compliant by preventing an explosion.

National Grid currently operates twenty-four gas turbine powered compressor stations in the United Kingdom, all designed to compress and transport natural gas through the National Grid Transmission system. The compressor trains are housed within ventilated acoustically attenuated cabs; by design some newer cabs have increased natural ventilated flow rates. Some of the existing operational units within the fleet experience hotter running temperatures; all the compressor stations require individual measurement and assessment due to unique differences in design and have varying running temperatures and air flow characteristics.

PM84 Project Management

My main role and responsibility as Project Manager was to provide a solution to bring the conditions within the recommendations without affecting the existing safety and emergency shut down systems, my objective was to develop a programme to measure existing operation and set out a strategy for remedial enhancement, including design assessments and approval for normal running to safety critical shut-down. I also introduced some additional maintenance design features that delivered energy savings and reduced the need to work at heights for maintenance and inspection.

An independent safety review was undertaken to verify that existing safety systems remain operationally the same [8]; it was my responsibility to ensure that the best available ventilation solution was offered to this Project. The review included commissioning specialist engineers and developing their findings and recommendations. A literature review was also undertaken to include relevant technical references.

All fire and gas alarm, trip levels, cause and effect conditions were maintained and independently assessed under the National Grid design appraisal and approval scheme [12]. All individual modified elements, mechanical, electrical, control; software and instrumentation were also independently assessed under this process. A safety risk assessment was also undertaken to review the overall principal of safe operation.

Conclusions

The new design installation changed the airflow direction by modification resulting in a positive ventilation system; this reduced the surface temperatures by increasing the forced ventilation and by re-directing the airflow path over known hot spots. This ventilation is not only used to disperse the heat generated by the gas turbines, but also to ensure that any natural gas leaks could not accumulate within the enclosure to pose a significant explosion hazard.

This project met all its objectives with key lessons learned.

Future fleet assessments will be considered based on measured improvements made at Moffat Compressor Station and by calculation to assess ventilation performance against the dilution of potential small leaks [15]. This Project also reclaims electrical operational costs with improved airflows against optimum fan usage, and posed questions on the manner in which we apply and assess PM84 as a guidance document.

Bibliography of Technical References

1] Area classification code Petroleum installations IP15

2] ATEX Directives 100A and ATEX 137A

3] BS6739 gas detection equipment (now incorporated in PM84),

4] Control of safety risk at gas turbines used for power generation HSE - PM84 2000

5] Control of safety risk at gas turbines used for power generation HSE - PM84 2003

6] Dangerous Substances and explosive atmospheres Regulations - DSEAR 2002

7] European Standards for Gas supply systems Compressor Stations

8] Functional Requirements prEN 12583

9] Hazardous Area Classification Natural Gas installations SR25

10] IGE Risk Assessment SR24

11] IGE/SR 15 safety related system (how to design and modify plant)

12] IGEGL5/Transco G17/ National Grid G19 design appraisal and approval.

13] Moorhouse, J. (1979), Moffat vent system report

14] SIL level document IEC61508

15] Ivings, M & Lea, C Outstanding safety questions concerning the use of gas turbines for power generation.

APPENDIX A

The basic principals involved in the ventilation assessment

1) Visual inspection of the existing ventilation operation.
2) Measurements of airflow velocity in Cabs.
3) Thermographic measurement under operational conditions.
4) Assess ventilation system against PM84 recommendations.
5) Assessing the number of volume changes per hour (VCH)

$$VCH = \frac{\text{Volume Flowrate x3600}}{\text{Gross Volume of Cab}}$$

6) Assessment of dilution ventilation of small leaks.
7) The Auto Ignition of natural gas is in the range of 482DegC to 632 DegC.
8) The highest internal Cab surface temperatures were found to be 483 DegC, and 496DegC.

APPENDIX B

Moffat PM84 Project - Key considerations.

- A safety review was undertaken.
- Project development to measure existing fleet compliance.
- Strategy set out for remedial enhancement.
- Design assessments and approval.
- Fail safe and safety critical shut-down.
- Enhanced working at height and maintenance design features,
- Strategy for national fleet assessments.
- A safety risk assessment on the overall principal of operation.

APPENDIX C – IGEM Guidance criterion

Part 1: Project Statement: - I will demonstrate my knowledge and understanding of the engineering principles for this project by the application of my own experience and understanding of the systems involved. This is based on using my operational experience to select the best solution within company policy and the current national guidance documents, taking cognisance of industry wide recommendations for associated power generation.

Part 2: Personal Role Statement: -

I describe my personal role and responsibilities in this project at the grade of CEng, to provide a solution to bring the conditions within the recommendations without affecting the existing safety and emergency shut down systems. It was also responsibility to develop a programme of measurement on the existing operational conditions, and set out a strategy for remedial enhancement. This included design assessments and approval for normal running to safety critical shut-down.

Part 3: Academic Level Statement: -

I will demonstrate my knowledge and understanding of this project for CEng level by demonstration of sufficient science and engineer knowledge in the following areas:-

- Material Emissivisity
- Minor leaks methodology.
- Assessment of dead spaces and non ventilated areas.
- Explosion tests and measurements
- Combined system knowledge and application.

Contents Page number