Design Standard for Gas Turbine Exhaust System and Waste Heat Recovery Unit

Waste heat recovery is a subject that, although not new, has gained a lot of attention over the last few years. A better utilisation of the heat produced from the combustion of fuel in Gas Turbines (GT), can be directly translated into better overall efficiencies and economical savings for the operators.

Waste heat recovery units (WHRUs) are heat exchangers utilised to recover heat from a hot gas stream. In the case of GT cycles, these units are used for two main purposes:

- In the power generation industry, to produce steam which can be used to drive a steam turbine or for other type of processes.

- In the oil and gas industry, for heating medium applications, typically glycol solutions, hot oil or water.

In order to enjoy the benefits of using gas turbine cycles that make use of a waste heat recovery unit, operators rely on the optimum performance of the WHRU itself and the exhaust system. However, experience has shown that the performance of these two elements is not entirely satisfactory. **The equipment requires maintenance after only a few years of operation, which causes unscheduled shutdowns and loss of oil or gas production.** Hence, not fulfilling the criteria stipulated in the API Standard 616, section 4.1:

> "The equipment (including auxiliaries) covered by this standard shall be designed and constructed for a minimum service life of 20 years and at least 3 years of uninterrupted operation." [1]

The Norwegian oil company StatoilHydro has recognised this problem and brought it forward to the European Turbine Network's (ETN) table in order to address it. Being a user orientated association, ETN has studied the feasibility of this subject and has decided to develop this document in order to capture the reasoning to initiate a project on this matter.

Objective

It is important to mention that the overall objective of this project is to **develop an ETN standard for the design of gas turbine exhaust systems and waste heat recovery units.**

In order to build up a standard of high quality, ETN is looking for the participation of different stakeholders involved in the research, design, manufacture, maintenance and operation of WHRUs and exhaust systems.

Roadmap

To achieve the main objective of this project, the following steps have been proposed:

Step I. Collection of experience data from gas turbine operators

Gas turbine operators face different problems and failures (issues) in the GT exhaust and WHRU's. It is proposed that these issues are to be prioritised. Therefore, a number of them have been listed. However, it is important to underline that this list is not exhaustive.

To carry out the prioritisation of the different issues, a ranking system has been proposed:

- 1 if the user is **very interested** in addressing the issue.
- 2 if the user is **interested** in addressing the issue.
- 3 if the user is **not interested** in addressing the issue.

The proposed issues, together with a format to prioritise them are shown below:

Company Name		
Issue Number	**Issue**	**Mark**
1	Cracks in the exhaust channel	
2	Loss of insulation in the exhaust channel	
3	Power loss due to turbulent flow	
4	Leaks in expansion bellows	
5	Leaks in flanged joints	
6	Leaks in weather gasket	
7	High vibrations on the WHRU	
8	Poor silencer performance	
9	Problem with bypass control of the WHRU	
10	Others (Please specify)	

It is envisaged, that with the results of this prioritisation, the particular objectives of the project can be established. Furthermore, this would be a powerful tool to subdivide the work load between the interested stakeholders.

Once the prioritisation and the determination of particular objectives have been concluded, the collection of data from the gas turbine operators can be carried out either by a postgraduate student or a member of the ETN staff.

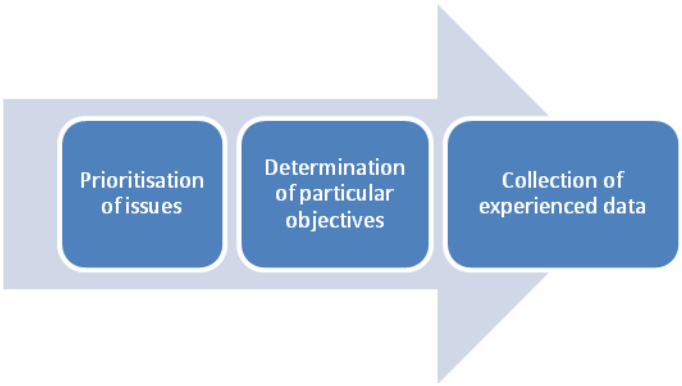
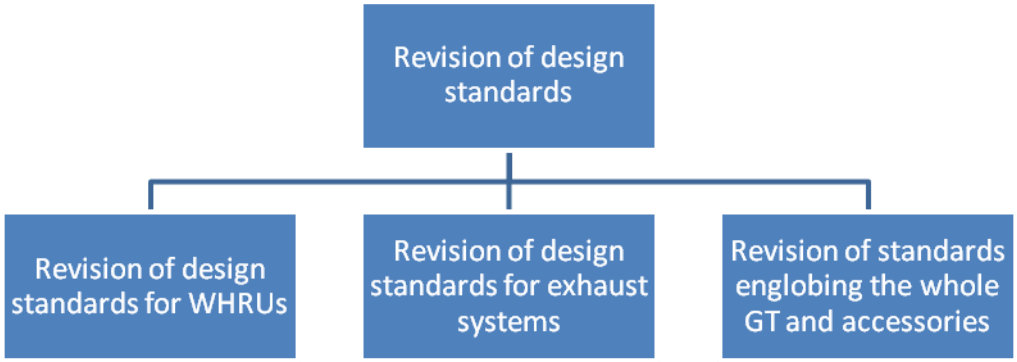
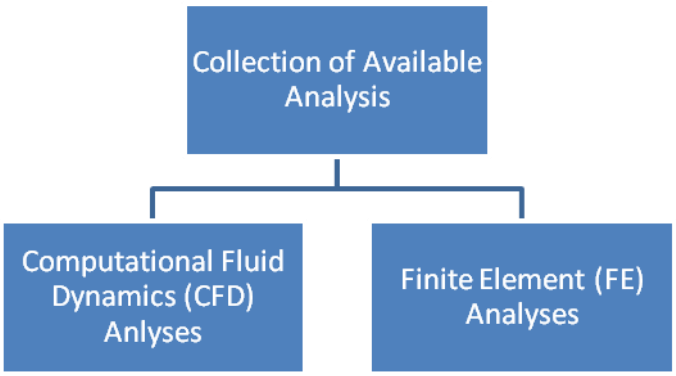


Figure 1 Evolution of Step I

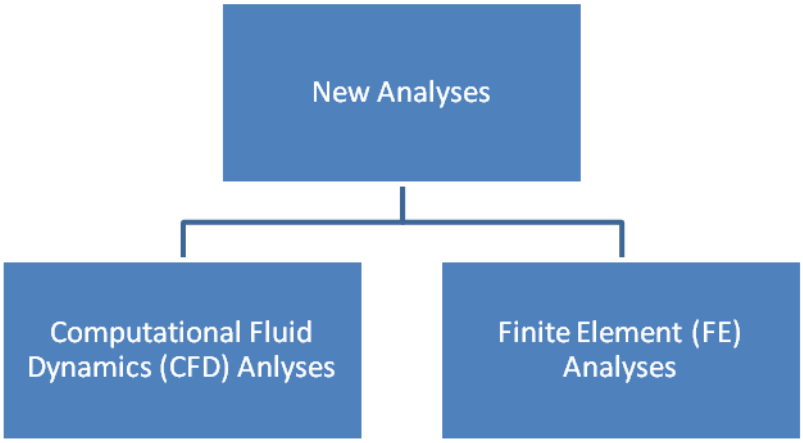
Step II. Revision of existing WHRU and Exhaust System design standards



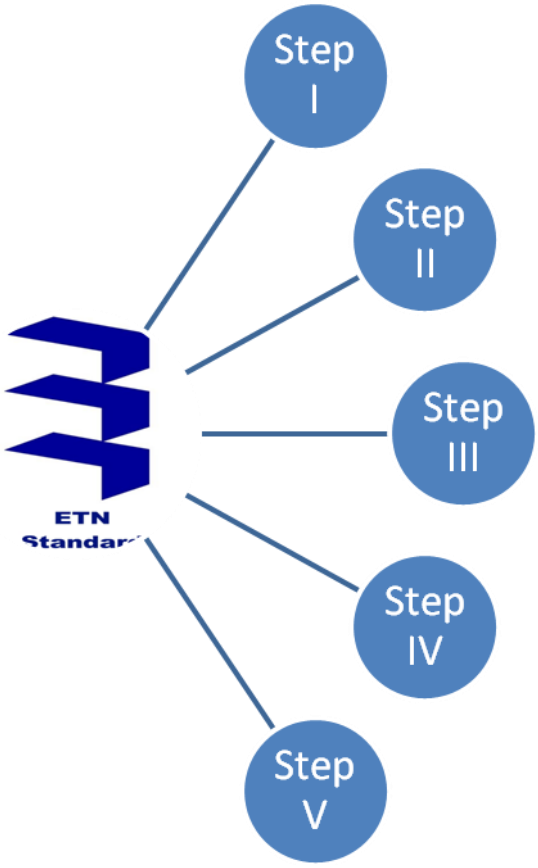
Step III. Collection of Available CFD and FE Analysis



Step IV. Execution of new CFD and FE analyses



Step V. Development of ETN Standard



References and Bibliography

1. - American Petroleum Institute. Gas Turbines for the Petroleum, Chemical and Gas Industry Services. API standard, 616. Washington, D.C.: American Petroleum Institute, 1998.

2. - Raju, K. Nagabhushan. Industrial Energy Conservation Techniques: (Concepts, Applications and Case Studies). New Delhi: Atlantic Publishers and Distributors, 2007.

3. – Skorping, Roald. Design standard for gas turbine exhaust system and waste heat recovery unit (WHRU). European Turbine Network, 2009.

4.- Boyce, Meherwan P. Gas Turbine Engineering Handbook. Gas Turbine Engineering Handbook. Boston [u.a.]: Gulf Professional Publ, 2006.