Presentation

- Introduction
- Capability overview
- Company profile
- Reference projects
- Technical presentation
- Case study on Retrofits
- General discussion
Aarding Thermal Acoustics
Introduction & Capabilities
• Well established company (started in 1960)

• Offices in Netherlands, Singapore, USA, Canada, Brazil, China, India

• Active in the Power-Energy and Petrochemical market

• Part of CECO Environmental Group (Traded on NASDAQ, CECE, Annual Sales ~$250M)

• Strong global presence

• $50M annual sales worldwide
• Supply of custom designed turnkey systems
  – Baseload systems
  – Start Stop systems

• Service and Maintenance for existing Power Plants
  – Both on mature as well as on advanced Advanced type systems
Capabilities

- Exhaust Diffuser / Exhaust Plenum
- Exhaust Duct
- Exhaust Bypass System
- Silencer
- Exhaust / HRSG Inlet Duct
- HRSG Internal Insulation
- Vent Silencer
- Stack
- Expansion Joint
- Diverter Damper
- Stack Damper
- Guillotine Damper

Lloyd's certified
ISO-9001:2008

www.aarding.com
Strong Global Presence

- World-wide installed references
- Global fabrication experience
- Multi-language staff (over 9 languages)
<table>
<thead>
<tr>
<th>Reference</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>F9FA Bypass Stack</td>
<td>GE-SADESSA</td>
</tr>
<tr>
<td>F9F-05 Teststand Mobile Exhaust</td>
<td>GE-Greenville</td>
</tr>
<tr>
<td>F7FA PP13 PP14 12 Bypass Diverter Systems</td>
<td>SCECO SAUDI</td>
</tr>
<tr>
<td>TVA Paradise</td>
<td>USA</td>
</tr>
<tr>
<td>Shaybah</td>
<td>M-East</td>
</tr>
<tr>
<td>Los Guindos</td>
<td>Latin America</td>
</tr>
<tr>
<td>Energia Del Valle</td>
<td>Latin America</td>
</tr>
<tr>
<td>BLNG II</td>
<td>Asia</td>
</tr>
<tr>
<td>Jazan</td>
<td>M-East</td>
</tr>
<tr>
<td>Nuevo Pemex 3rd Train</td>
<td>Latin America</td>
</tr>
<tr>
<td>Shuqaiq</td>
<td>M-East</td>
</tr>
<tr>
<td>Bandirma II</td>
<td>Asia</td>
</tr>
<tr>
<td>Syncrude</td>
<td>USA</td>
</tr>
<tr>
<td>San Gabriel</td>
<td>Latin America</td>
</tr>
<tr>
<td>Wildcat</td>
<td>USA</td>
</tr>
</tbody>
</table>

Over 300 BYPASS Diverter systems installed (small to the largest)
General References - Retrofits

- Retrofits of ducts and section repairs  
- F9E Corby UK Plenum, ducts and silencers  
- F9E Inlet Duct upgrades & revamps  
- Retrofit of Exhaust system Silencer duct section  
- F9E Retrofit of Exhaust section including Diverter  
- Retrofit of Exhaust Plenum System  
- Retrofit of Exhaust Duct & Plenum Section  
- Retrofit of GT Testcel KLMAIRFRANCE  
- Retrofit of refinery based Exhaust LM2500  
- Retrofit of Complete Exhaust System  
- Retrofit of Exhaust Plenum System  
- Retrofit of Exhaust Plenum System  
- Retrofit of Exhaust & Silencer System  
- V94.2 Retrofit of Exhaust & Silencer System  
- Large number of Vent silencers  

- BLNG BRUNEI  
- EON ESBI UK  
- AES Europe  
- PCS Singapore  
- TNB Gelugor  
- SESB Labuan  
- SUEZ Rayong  
- KLM Schiphol  
- BP Lingen  
- CEB Mauritius  
- Tampere Finland  
- Shell Moerdijk  
- PTT Ratchaburi  
- POWERTEK Bangladesh  

- mainly US, EU and Asia
Focus on Exhaust & Acoustical systems

In-House Engineering Capabilities

– Experienced engineers
  • Industry related expertise
  • Full range of reference projects

– Advanced Engineering Techniques
  • Thermal Analysis
  • CFD analysis
  • Acoustic modelling
  • Metallurgical testing
  • HI CAD 3D design
Project driven Engineering Solutions

• In House Design & Engineering
  – All systems designed to order

• Worldwide Manufacturing
  – Production facilities in Europe, North America, Middle East & Asia

• Site / installation supervision
World-Wide supplier to

- EPC contractors,
- OEM: Turbine & HRSG suppliers
- Maintenance companies
- End Users
World-Wide supplier to EPC contractors, turbine & HRSG suppliers and Engineering companies.

Ref. i.e.:

- GE
- Alstom
- Siemens / Westinghouse
- Nooter Erikson
- Shell-BLNG
- Suez-Glow Energy
- NEM
- CMI
- MHI
- Doosan
- Thosiba
- Deltak
- Cerrey
- Metka
- Vogt
- Marubeni
- Toyo /IKPT
- Sedae
- BP
- PTT Thai
Gas Turbine Exhaust Systems

Gas Turbine Simple Cycle System

Gas Turbine Combined Cycle System
Capabilities

1. Exhaust Diffuser / Exhaust Plenum
2. Exhaust Duct
3. Exhaust Bypass System
4. Silencer
5. Exhaust / HRSG Inlet Duct
6. HRSG Internal Insulation
7. Vent Silencer
8. Stack
9. Expansion Joint
10. Diverter Damper
11. Stack Damper
12. Guillotine Damper

Lloyd’s certified
ISO-9001:2008

www.aarding.com
Capabilities include:

- Diverter Dampers (Toggle, Pivot, Louver)
- Guillotine Dampers/Blanking Plates
- Stack Dampers / Louver Dampers
- Turbine and Exhaust Expansion Joints
- Installation and commissioning supervision
- Turnkey projects including erection
- Service, maintenance and retrofit for existing power plants
Capabilities
Bypass Stack – Simple Cycle
Capabilities
Bypass Stack – Combined Cycle
Capabilities
Bypass Stack – Combined Cycle
### Diverter Damper Functional Groups

<table>
<thead>
<tr>
<th>Feature</th>
<th>SGT5-2000 (SGT6-4000) 7FA.04 (7FA.05)</th>
<th>SGT5-4000 9FA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inlet Dia</td>
<td>5,6 m</td>
<td>6,5 m</td>
</tr>
<tr>
<td>Outlet</td>
<td>5,6 x 5,6 m (5,9x5,9m)</td>
<td>6,5 x 6,5 m</td>
</tr>
<tr>
<td>Gas Vol. Flow</td>
<td>1250 m³/sec (1350 m³/s)</td>
<td>1730 m³/sec</td>
</tr>
<tr>
<td>Gas Temp.600</td>
<td>620 °C (650°C)</td>
<td>620 °C (620°C)</td>
</tr>
<tr>
<td>Weight Blade</td>
<td>10 t</td>
<td>15 t</td>
</tr>
<tr>
<td>Weight</td>
<td>90 t</td>
<td>110 t</td>
</tr>
</tbody>
</table>
Capabilities
Bypass Retrofit in Malaysia
Plenum, Ducting & Diverter System
Internally Insulated Ductwork
Capabilities
Internal Insulation
Capabilities (COLD CASING)

Internal Insulation System

The internal insulation system consisting of:

- Outer casing of carbon steel (stiffened)
- Sheeting + flat washers AISI 409/321 materials
- Studs + Nuts AISI 409/321,
- Bio Soluble insulation wool 64/128 kg/m³ in 50 mm layers
Capabilities – Inlet Ducts
Experience / Quality

- More than 50 years of experience of proven design
- ISO 9001:2008
- American Welding Society (AWS)
- European welding codes EN
- Full project documentation and history dockets
CERTIFICATE OF APPROVAL

This is to certify that the Quality Management System of:

Aarding Thermal Acoustics B.V.
Industrieweg 59
8070 AB Nunspeet
The Netherlands

has been approved by Lloyd’s Register Quality Assurance to the following Quality Management System Standard:

ISO 9001 : 2008

The Quality Management System is applicable to:

Design and production of vent silencers, flue gas silencers, thermal insulation, boiler internals, hush houses and exhaust gas systems.

This certificate is valid only in association with the certificate schedule bearing the same number on which the locations applicable to this approval are listed.

Approval Certificate No.: RQA656680

Original Approval: 3 December 1991
Current Certificate: 1 August 2014
Certificate Expiry: 31 July 2017

Issued by: Lloyd’s Register Netherlands B.V. for and on behalf of Lloyd’s Register Quality Assurance Limited

INTERNATIONAL INSTITUTE OF WELDING

Having satisfied the requirements of the IIW Manufacturer Certification Scheme for the Management of Quality in Welding

The Unit: Aarding Thermal Acoustics
Located in: Nunspeet, Netherlands
Company: Aarding Thermal Acoustics B.V.

is certified in accordance with

ISO 3834 Part 2 – Doc. IAB - 340

for the product(s): Design and production of vent silencers, flue gas silencers, thermal insulation, boiler internals, hush houses and exhaust gas systems.

with the scope of work stated in the attached Schedule

Certificate number and revision status: IIW EN-ISO 3834/040 - Rev. 00
First issue date: 15 July 2011
Current issue date: 15 July 2011
Date of expiry: 15 July 2016

ANBCC Governing Board Representation: H. Zandvlei

M.W.M. van Teylingen

This Certificate is subject to the rules established by IIW for the certification of Companies

www.aarding.com
Capabilities – HRSG

Insulation Systems
- Top and Bottom Sections
- Sidewall Sections

Internals
Large Diameter Stack Dampers

www.aarding.com
Large turbine expansion joints
Capabilities
Flue Gas Silencers

• Noise reduction after a gas turbine.
• Installed in Stacks or ductwork
• Proven Acoustical Design – EU Patented
Capabilities

Lloyd's certified
ISO-9001:2008

1. Exhaust Diffuser / Exhaust Plenum
2. Exhaust Duct
3. Exhaust Bypass System
4. Silencer
5. Exhaust / HRSG Inlet Duct
6. HRSG Internal Insulation
7. Vent Silencer
8. Stack
9. Expansion Joint
10. Diverter Damper
11. Stack Damper
12. Guillotine Damper

www.aarding.com
Capabilities
Fluegas Silencers

European Patented Design Silencer Assemblies
Flue Gas Silencers
Flue Gas Silencers
Capabilities
Flue Gas Silencers / Baffles
Noise reduction in steam and gas applications
Proven Acoustical Design
Compact Design
  – Reduced weight
  – Limited installation space required
Capabilities
Vent Silencers
Vent Silencers

- General
- Silencer type
- Diffusers
- Connections
- Additional Features
Vent Silencers – Silencer type

Inline Silencers  Vent Silencers
Vent Silencers - General

Design acc.:
• ASME B31.1/3
• PED (European projects, if required)

Production Vent Silencers in:
– Malaysia
– The Netherlands
– Romania
– Russia
– USA
Commissioning Silencers

- Noise reduction during a commissioning / steam blow-down type application
- Designed for a rugged type service
- Inlet components designed to withstand pressure loading, debris impact and free water impact.
- Rental Silencer
Commissioning Silencers
Commissioning Silencers
Gas Turbine Exhaust Systems
Ageing & Upgrades
Ageing

Operational Damages
Gas Turbine Exhaust Ducts
Major Drivers of Operational Damages

• **Ageing**
  – Wear & Tear of Exhaust & Silencer Systems
  – Multiple repair area’s weakening the Exhaust Structure
  – Alloy Degradation

• **Safety requirements**
  – Ageing systems showing excessive temperatures
  – unplanned maintenance events (casing cracks/ruptures etc)

• **Change in Power Plant Operation**
  – Market Driven two-shifting / Start Stops increase
  – Higher Temperatures & flue gas velocities in the GT exhaust ducting.
  – Minor defects in the external / internal insulation of exhaust ducts system rapidly leading to widespread damage (potential for significant loss of plant availability).
Operational damages
GE Gas Turbine Exhaust Plenum

Un-reliable and Un-Safe operation

Severe damage to the casing
Hot spots
Consequential Damages as a result of elevated temperatures on Bellows and transition / silencer ducts

Operational damages
GE Gas Turbine Ducts & Bellows
Operational damages
GE Gas Turbine Units

Deferred maintenance resulting in severe exhaust system damages as well as GT damage
Fire hazards as a result of overheated turbine compartments
Operational damages
GE Gas Turbine Ducts – Insulation system

Severe damage to the sheeting and insulation.
Operational damages
GE Gas Turbine Ducts

Thermal Shock
Severe cracking and degradation of original duct sections
Operational damages
GE Gas Turbine Ducts – Patch repairs

Repair by welding
Or
Section replacement

Does not offer a Lasting solution
On Ageing and older design Type Exhaust Systems
Operational damages
GE Gas Turbine Ducts  Flue Gas Silencers

Silencer Support failures
Sections damaged
Upgrades; Objectives

• Reduction of annual costs
  – Lower annual maintenance costs
  – Increased Unit availability

• Thermal improvement
  – Different options to reduce temperature levels and required ventilation

• Safety
  – Lower (duct surface/bellow) temperatures
  – Lower Load chamber temperatures / better accessibility
Upgrades to current industry standards

• Definition of system Requirements, Inspection & Analysis

• Upgrade of silencer systems
  – Supporting Cyclic Power Plant Operation or Life extension
  – Elimination of thermal shock for the silencer supports

• Upgrade of ducting systems
  – utilising only internal insulation (current status “cold casing design”)
  – Improved alloy structures adapted to higher EGT & gasflow
  – long term internal insulation integrity
  – safer operating regime
  – significantly reduced maintenance down time.

• Upgrade of transition areas such as bellow systems
  – Temperature reductions in critical access area’s (E.G. Load Chamber)
Thermographic periodical inspections

<table>
<thead>
<tr>
<th>Location</th>
<th>Measured Temperature</th>
<th>Difference in Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>108.3°C</td>
<td>68.3°C</td>
</tr>
<tr>
<td>A2</td>
<td>76.2°C</td>
<td>36.2°C</td>
</tr>
</tbody>
</table>
Upgrades: Defining Solutions

Examples of Analysis & Flow Modelling

Flow Modeling

Stress Calculations
Silencer Support

Stress Calculation Casing

Stress Calculations
Fluegas Silencers
Example of dedicated silencer support design
Upgrades: Defining Solutions

Example of upgraded Duct Design
Example of ATA upgraded flex plate insulation kit FIK HTXA™

temperature reduction at Plenum Duct Flex Plates

Bellow design installed
GE type Retrofit of Exhaust Duct, Silencer assembly & Plenum Duct

Case Study in Photographs

Report from a Recent Project
Retrofit
Plenum Duct – Existing

Plenum Duct

Old design
Box Type

Degraded
Flanges

Degraded &
Distorted Old
Design Plenum
Duct
Retrofit
Plenum Duct – Manufacturing

COLD Upgraded Design Duct

Sectional Design to accommodate fast installation during Overhaul

Half Moon Sections
Retrofit
Plenum Duct – Manufacturing

Sectional Design to accommodate fast installation during Overhaul
Retrofit
Plenum Duct – New

Inner (GT) Side
COLD Upgraded
Design Duct

Installation

Outer (GT) Side
COLD Upgraded
Design Duct
Retrofit Silencer Duct – New

Silencer duct
Including support structure
Retrofit
Silencer Duct – New

GA Drawing of a proven design system with removable duct section to accommodate hoisting of frames

Hoisting beam
Removable section
Sectional Bellow
Retrofit of Exhaust Duct, Silencer assembly & Plenum Duct

Exhaust Duct, Silencer Assy & Plenum Duct Custom Designed based upon

- GT Gasflow & EGT
- Duct Surface Temperature Requirements
- Noise Abatement Requirements
- Actual Plant Layout
- Overhaul time & planning
- Expected Exhaust System Life Extension
Retrofit
Exhaust Duct: Existing

- Degraded and damaged Carbon Steel Inner Duct
- Bulging duct casing
- Leaking Bellows
Retrofit
Exhaust Duct: Section Manufacturing
Retrofit
Exhaust Duct: New

COLD Upgraded Design Duct

New Bellow System

Custom Designed Access Door

www.aarding.com
Retrofit Silencer System - Existing

Detached Silencer units

Damaged Supports

Damaged perforated sheets & depleted Insulation
Retrofit Silencer System – Final Inspection

Patented Design accommodating Cold Casing structure
Retrofit Silencer System - New

Silencer Assembly installed in Upgraded Cold Design Duct

Upgraded Design Supports
If you need support for the upgrade of your Exhaust System please contact us at;
www.aarding.com