

HVAC Systems – Achieve Acceptable Safety and Working Environment to Low Cost

a report by

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Introduction

Companies within the oil and gas industry strongly emphasise the importance of their employees by focus on safety and working environment. Statistics on unexpected incidences are frequently developed, and sick leave and occupational health and safety (OHS) reports are made to show company ambitions for health and safety. Without successful health and safety, no industrial project can be considered a true success.

Heating, ventilation and air-conditioning (HVAC) systems play a key role in achieving acceptable safety and working environment conditions for liquid natural gas (LNG) vessels, offshore installations or onshore plants. When proper indoor conditions are maintained, employees are better able to concentrate and make fewer mistakes, and company economy is improved through reduced sick leave and number of accidents. Also, naturally ventilated modules can improve the working environment by using weather louvers to reduce the exposure of wind, rain and snow to maintenance personnel.

As well as fulfilling safety and working environment conditions, an HVAC system must have high operational availability, simple balance/control functionality and be cost-, space- and weight-effective.

This article highlights three aspects of HVAC design; the comparison of low-velocity versus high-velocity systems, Safety Integrity Level (SIL) and the use of weather louvers/explosion relief panels for naturally ventilated areas. It is based on more than 40 years of experience gained by AC Marine AS (previously ABB AS and Norsk Viftfabrikk AS) as total system supplier of HVAC solutions to the marine and offshore market, and now also to onshore facilities such as LNG terminals.

Low-velocity Versus High-velocity HVAC System

The selected method of providing 'treated air' to internal spaces of a vessel or a platform will have a

significant impact on both the investment cost and operation costs. The following conclusions address these issues and highlight the key differences between the low-velocity system and the high-velocity system.

Low-velocity HVAC systems from 3m/s to 8m/s utilise large rectangular ducting that has the following disadvantages:

- requires a large amount of space for installation and is difficult to relocate for interference problem;
- all ducts penetrating A-rated decks and bulkheads must be provided with fire dampers due to the size of the duct;
- modifications of the duct system and relocation of in-line duct mounted equipment will have a big impact on other systems/equipment adjacent to the HVAC system;
- the system is significantly influenced by external wind/pressure conditions; and
- it is also common for low-velocity (also called low pressure) systems to have insufficient filtering of outside pollutants due to high pressure losses across filtering systems, resulting in high maintenance costs and degradation of components and ducts in a short period of time.

High-velocity HVAC systems from 8m/s to 18m/s offer standardised, off-the-shelf components (pre-insulated if required) and provide several advantages.

Equipment and installation costs for high-velocity HVAC systems are significantly less than the rectangular ducting of the low-pressure system due to the following key factors:

- less space requirement due to smaller duct sizes;
- more reliable pressure drop and sound calculations due to more predictable input data for the duct work;



- lighter and simpler join fittings and support/hangers;
- easier installation, less man-hours cost;
- balancing and fine-tuning of the high-velocity HVAC system is primarily made at room level, with cabin units allowing high throttling values at a low noise level. Low-pressure systems require additional effort at zone level to achieve the desired temperature in each room;
- reduced number of fire dampers based on Safety of Life at Sea (SOLAS) requirements for small diameter ducting increases the level of safety due to fewer potential failure sources;
- fewer and smaller duct components combined with less steel structure for supports and foundations due to more compact air heating units (AHUs) reduce the weight of the HVAC system considerably, providing a savings of at least 30%;
- reduced noise breakout from ductwork; and
- lower overall cost due to less material and standardised components.

It is important to note that high-velocity systems require higher fan power consumption. The increase in HVAC power consumption, however, is marginal compared with other electrical consumers on an oil and gas plant or on a large vessel. Increased noise levels from the fans are handled with proper calculations of the sound level throughout the system, and necessary attenuators must be added.

Estimated savings on the huge platforms Thunder Horse and Atlantis, where AC Marine supplied the complete system, are 35% by using high-velocity systems.

Safety Integrity Level

AC Marine supplied the complete HVAC system and performed for the first time a safety integrity level (SIL) analysis for Statoil's Kristin Platform in the North Sea. The purpose of this analysis was to consider the safety level for critical equipment and define an acceptable maintenance level.

On the Kristin project, each type of system was assigned a predefined value as a target for reliability. The Direct Expansion (DX) units and fire dampers were defined as critical safety equipment; fire dampers due to smoke/gas dispersion, and DX units because over-temperature in the Control Room

could shut down the platform. All hardware and software components in each system were analysed based on reliability data.

The biggest challenge was to get valid operation data for each component, which was accomplished through close co-operation between the different sub-suppliers and Statoil's operation staff. By conducting this process, the owner ensured a more predictable system with regards to safety level and to maintenance guidelines.

Weather Louvers/Explosion Relief Walls

For naturally ventilated areas, AC Marine has developed weather louvers/explosion relief walls to protect personnel in harsh climate conditions.

AC Marine's Louvered Walls

AC Marine's louvered walls are designed as a combination of weather cladding (solid) cassettes and pressure relief cassettes according to required ventilation or pressure relief.

Each louver cassette contains vertical vanes for water from air separation. The vanes in each panel extend out in opposite directions from the center of the panel, thus obtaining maximum intrusion of wind attacking at shallow angles, and straightening of air flow at louver exit.

The pressure drop coefficient of each louver cassette is optimized to 4.0 times the dynamic velocity of the air passing through the cassette. Pressure drop for a "wall system" will depend on area of louvers installed compared to the total wall area.

AC Marine's Explosion Relief Panels

AC Marine's explosion relief panels are specially designed to achieve shortest possible opening time, predictable opening pressures and are patented both in the UK and Norway. It is the first system of its kind to achieve a Lloyd's system assessment.

As the explosion relief panel must open extremely fast, it is essential to avoid any unnecessary friction forces. Opening time of less than 30 ms has been verified.

In order to predict the opening pressure for the panel, no bolts or rivets are used. The panel material is in elastic region, and finite element method are applied for design calculation purposes.

The system can also easily be integrated into other wall systems both on new and existing platforms.

The explosion panels have also been applied on onshore plants like Amersham's factory for pharmacy products on Lindesnes and Norsk Hydro's PVC plant on Herøya. ■

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