CUSTODY TRANSFER METERING SYSTEM
for
NATURAL GAS REFINERY APPLICATION
NATURAL GAS INLET STATION PROJECT

Location:
- SARPOM Refinery Trecate – Italy

Project Target:
- New facilities to feed the Refinery with Natural Gas supplied by SNAM Rete Gas → Custody Transfer
Custody Transfer

Custody Transfer refers to the transactions involving transporting physical substance from one operator to another.

The International Organization of Legal Metrology (OIML) is an intergovernmental organization, established in 1955 in order to promote the global harmonization of legal metrology procedures.
Custody Transfer Europe

<table>
<thead>
<tr>
<th>MID</th>
<th>Measuring instruments</th>
</tr>
</thead>
<tbody>
<tr>
<td>MI-001</td>
<td>Water meters</td>
</tr>
<tr>
<td>MI-002</td>
<td>Gas meters and volume conversion devices</td>
</tr>
<tr>
<td>MI-003</td>
<td>Active electrical energy meters</td>
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<tr>
<td>MI-004</td>
<td>Heat meters</td>
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<tr>
<td>MI-005</td>
<td>Liquids other than water</td>
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<tr>
<td>MI-006</td>
<td>Automatic weighing instruments</td>
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<tr>
<td>MI-007</td>
<td>Taximeters</td>
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<tr>
<td>MI-008</td>
<td>Material measures</td>
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<tr>
<td>MI-009</td>
<td>Dimensional measuring instruments</td>
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<tr>
<td>MI-010</td>
<td>Exhaust gas analysers</td>
</tr>
</tbody>
</table>

Measuring instruments directive 2004/22/EC

- Defines limits for the Member States goals
- National Authorities can choose the way to achieve the goals
DESIGN

Design by ExxonMobil, verified and finalized for construction by ATEC

On the basis of:

- National and International codes (ASME, ANSI, UNI EN, IEC, etc.)
- Procedures & guidelines for REMI plants (Impianto di REgolazione e MIlsura) by SNAM Rete Gas
- Engineering Global Practices by ExxonMobil
CONCEPT DESIGN

Two 100% parallel trains to ensure reliability and on-line maintenance.

Each line can be conceptually divided into three sections:

- HIPPS → Safety system
- Filtering
- Metering

The same philosophy was maintained during construction, resulting in 3 separate skid units for easy transportation and installation, to be connected together on site.
ATEC Engineering team has gone through the following main steps:

- Design verification activities
- Engineering for construction (Calculations, Drawings & Specification)
  - Finite element model
- Definition and Procurement of Materials / Equipment, with specific attention to the items to be suitable for:
  - Custody transfer applications
  - Safety system with Safety integrity Level SIL 3
  - Installation in potentially explosive atmosphere according to ATEX directive
A FEM model has been developed for:

- Basement and support structure design
- Lifting elements design
- Thermal expansion evaluation, for field expansion loop design

On the basis of the finite element model output, a Stress analysis according to ASME B31.3 has been carried out for Piping mechanical verification.
FEM MODEL
# PROJECT DATA

<table>
<thead>
<tr>
<th>SIZE</th>
<th>DN 8” ANSI 600# &amp; 300#</th>
</tr>
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<tbody>
<tr>
<td>FLOW RATE (Q imp)</td>
<td>29.750 Sm³/h</td>
</tr>
<tr>
<td>PRESSURE</td>
<td>75 barg (HIPPS)</td>
</tr>
<tr>
<td></td>
<td>35 barg (Filt/Met)</td>
</tr>
<tr>
<td>TEMPERATURE</td>
<td>-12 °C to 95 °C</td>
</tr>
<tr>
<td>MAX FLOW RATE (Q ero)</td>
<td>23.800 Sm³/h</td>
</tr>
<tr>
<td>MIN FLOW RATE (Q min)</td>
<td>1.000 Sm³/h</td>
</tr>
<tr>
<td>MIN PRESSURE</td>
<td>13 barg</td>
</tr>
<tr>
<td>MAX PRESSURE</td>
<td>24 barg</td>
</tr>
<tr>
<td>TEMPERATURE</td>
<td>5 °C to 50 °C</td>
</tr>
</tbody>
</table>

**DESIGN CONDITIONS**

**OPERATING CONDITIONS**
HIPPS SKID – MAIN ITEMS

- **Nitrogen Tank** for valves actuators supply and filters purging
- **Ball Valve with Special Trim** for gradual opening in high DP applications
- **FB ball valves Pneumatically Actuated**
  - safety related
  - 2oo3 configuration solenoid valves
- **Pressure Transmitters** to the Logic Solver for system shut off
- **Ball valves with Mechanical Interlock** to avoid simultaneous opening
CE Marking according to:

PED 97/23/CE Pressure Equipment Directive

- Fluid Group I (natural gas)
- Assemblies in Category III
- Module G

According to UNI EN 764-7, in order to avoid the overcoming of the admissible values of safety parameters, it is possible to use a SRMCR (Safety Related Measurement Control and Regulation) system when a pressure limiting equipment is not feasible technically and/or economically.
In detail for this project, a **HIPPS** (High Integrity Pressure Protection System) has been designed and constructed.

The HIPPS (SRMCR) system has to be designed:

- in order to achieve a safety integrity level (**SIL**) equal to the one coming from the Risk Analysis

  
  \[
  \text{SIL} \rightarrow \text{PFD} \rightarrow \text{AT Availability Target}
  \]

- according to IEC 61508 and IEC 61511.

Common action of ATEC / EXXON / SUB-SUPPLIERS for final certification by Notified Body
FILTERING SKID – MAIN ITEMS

- **Natural Gas Filters** with particulate filtering element
- **Pressure Safety Valve** (the PSV function is covered in practice by HIPPS safety unit)
- **Spectacle blinds** for filters maintenance
- **Fixed points** for piping thermal expansion
METERING SKID – MAIN ITEMS

- Ultrasonic Flow Meters
  - For Custody Transfer
  - MID certified
- Gas Chromatograph
- Pressure Transmitters
- Temperature Transmitters

Signals to the Flow Computer
(for volume gas compensation)
The ultrasonic gas flowmeter operates according to the principle of measuring the transit time of an ultrasonic sound wave. A gas velocity is derived from the difference in transit time of a sound wave travelling in a direction with the flow direction and the sound wave travelling in the opposite direction.
Volume Gas Compensation

\[ Q_{vs} = Q_{vo} \cdot \frac{\rho_o}{\rho_s} \]

\( Q_{vo} \) and \( \rho_o \) are the flow rate and density at operating conditions
\( Q_{vs} \) and \( \rho_s \) are the flow rate and density at Standard conditions
(P=1 bar, T= 15 °C)

\[ \rho = \frac{P \cdot Mm}{(R \cdot T)} \times \frac{1}{Z} \]

ISO 6976 for Z calculation @Standard conditions
ISO 12213 for Z calculation @operating conditions
Single stream
Thank You!

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