Manufacturing of Large UHV Vessel

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1° GEOMETRICAL SHAPE AND MAIN CHARACTERISTICS

2° ASSUMPTION AND CALCULATION RESULTS
   - Calculation method by means of finite element analysis such as ANSYS

3° MATERIAL AND SURFACE PREPARATION

4° CONSTRUCTION METHOD
   - Shop manufacture and site works

5° PERFORMANCES TO BE EXPECTED
   - Expected outgassing rate

6° MAGNETIC PERMEABILITY

7° SIZE OPTIMISATION AND PRECAUTION

8° WELDING CONSIDERATIONS IN RESPECT WITH UHV CONDITIONS
International Workshop on

**EXTREME HIGH VACUUM - APPLICATION AND TECHNOLOGY (X-VAT)**

April 23-25, 2003
Burg Liebenzell
Bad Liebenzell, Black Forest, Germany
International Workshop on Extrem High Vacuum - Application and Technology (X-VAT)
Manufacturing of large UHV vessels
Plan

- SDMS presentation
- General informations
- Achievements (ALCATEL, VIRGO)
- Tritium-β spectrometer
A few figures

- Founded in 1962
- Located near Grenoble (France)
- Issued capital 1 114 000 Euros
- Turnover 2002 : 13 000 000 Euros (50% export)
- Workforce : 100
SDMS
(19000 m²)
Workshop J

(20 tons & controlled atm.)
Workshop C
(50 tons)
Workshop H
(clean room)
Quality Assurance

ISO 9001 since 2001 by BVQI

ISO 9002 from 1992 to 2001 by AFAQ

Certified AD - HP0 by the TÜV Saarland (German standards)
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Process Cleanliness

- Not for an attractive appearance: to fulfil the requirements
- Cleanliness during procurement and manufacturing
- Qualified machining process (oils)
- Materials cleaning (tests and experience)
  - degreasing / rinsing / alkaline solution / rinsing / Drying / Bake-out
- Cleanliness during the assembly - clean rooms - handling with gloves - tools - straps...
- Shipment
- At each stage (contamination, scratch…)

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Materials and surfaces

- Use of stainless steel X2CrNi 18-9 (1.4307- 304L) or X2CrNiMo 17-12-2 (1.4404- 316L) or 1.4429 (X2CrNiMoN 17-13-3) or 1.4406 (X2CrNiMoN 17-11-2)
- Mechanical polishing of plates in order to obtain a surface roughness value about 0.6 - 0.8 µ (beginning)
- Electropolishing of plates in order to obtain a final surface roughness value about 0.2 µ à 0.4 µ
- Cleaning (cleaning workshop)
- Baking at 400°C during 7 to 10 days
Performances

- Leak rate ($< 10^{-12}$ mbar l / s with RGA)
- Outgassing
  - see SDMS booklet « Outgassing - Results and Economic Consequences - SDMS »
  - Materials / Roughness
- Magnetic permeability
- Dimensional requirements
Plan

- SDMS presentation
- General informations

Achievements
(ALCATEL, VI RGO)

- Tritium-β spectrometer
SDMS achievements

- VIRGO UHV chambers (UHV / Outgassing rate)
- ALCATEL SPACE INDUSTRIES simulation chamber (dimensions)
  - Manufacturing process (quality plan)
  - Dimensional requirements (flanges)
  - Gaskets (HELICOFLEX)
  - Outgassing (oven, procedure)
  - Helium tests, RGA
  - Pumping system
LAPP

- VIRGO (18 tons)
- Date: 05/98
- 10 chambers 20m³
- Gravitational waves measurements
- UNS S30400 (304) UNS S30403 (304L)
LAPP (idem)

- $10^{-10}$ mbar
- Mechanical and inner electropolishing
LAPP (idem)

- HT 400°C (200 h)
- Outgassing rate
  - $10^{-14}$ mbar l / s . Cm²
- On site:
  - Bake-out 150°C
Alcatel Space Industries

- 130m³ Simulation chamber
- 5m in diameter
- HELIOS 1
- Ra 0.8µm
Alcatel Space Industries

- Chamber 450 m³
- Date: 12/97
- UNS S30403 / 304L / 1.4307
- Internal diameter: 6m
- Total Length: 16m
- Thickness: 15mm
- HELIOS2 tests (launched by ARIANE5)
- Clean room class 100
Alcatel Space
(1/10th scale model)
Flange (lower)
Wall plates on jig protected by plastic layer (class 100)
Lower part (class 100 inside)
Upper and middle parts
Handling

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Cranes
Shipment
Plan

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Tritium-β spectrometer

- **Geometrical Shape and Main Characteristics**
- **Assumption and Calculation Results**
  - Calculation method by means of finite element analysis such as ANSYS
- **Material and Surface Preparation**
- **Construction Method**
  - Shop manufacture and site works
- **Performances to be Expected**
  - Expected outgassing rate
- **Magnetic Permeability**
- **Size Optimisation and Precaution**
- **Welding Considerations in Respect with Ultra-Vacuum Conditions**
General drawing
Updated Details
Lower part
Upper part
Support
Assembly
Results

- CODAP / Working temperature at 400°C
- SHELL Ø7000 / 20 mm
- STIFFENING RINGS / 200 x 40
- CONICAL SHELL / 20 mm
- STIFFENING RINGS / 200 x 40
- HEMI-HEAD / 15 mm
- SHELL Ø1000 / 10 mm
Manufacturing process

- Hot rolled plates (thickness >6mm)
- Mechanical polishing (+ plastic layer)
- Cutting / Forming
- Assembly using a specific jig (the protective plastic layer is kept during manufacturing operations)
- Nozzles DN1500, DN1000 and others
- Manufacture of a specific tool for site assembly works
- Transportation and assembly on site, tests and adjustments
  - Welding
  - Electropolishing
  - Final cleaning
Conclusions

- Outgassing rate: $10^{-13}$ mbar.l.s$^{-1}$.cm$^{-2}$ after several baking treatments at the temperature of 400°C
- Leak rate $< 10^{-12}$ mbar l / s
- Magnetic permeability:
  - 1.4429 X2CrNiMoN 17-13-3 or 1.4406 X2CrNiMoN 17-11-2
  - 1.4307 or 1.4404

Acknowledgements:
- SDMS staff
- VIRGO staff (Mr MUGNIER)
Thank you for your attention