

Officine Mario Dorin S.p.A.

***The Compressor Role
in the Roadmap to Viable
CO₂ Refrigeration Equipment***

ATMOSHPERE – 2010

CONTENTS SUMMARY

1. **Officine Mario Dorin: general overview**
2. **Compressor impact on refrigeration equipment:**
 - 2.1 **Capital Cost**
 - 2.2 **Running Cost**
3. **Conclusions**

1. Officine Mario Dorin: general overview

- Company founded in 1918
- First open type compressor for CFC: 1932
- First Semi-hermetic compressor for CFC: 1952
- First Trans-critical CO₂ compressor: 1999

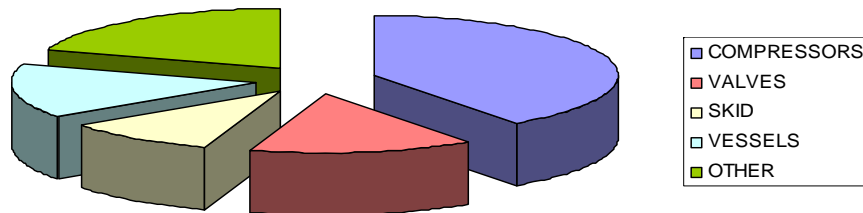
- n° 3 facilities in Firenze – Italia
- n° 150 employees
- to date: more than 12.000 CO₂ compressors
already commissioned
- year 2008:
 - 75.000 manufactured compressors
 - 1.200 Trans-critical CO₂ compressors
 - 300 Cascade CO₂ compressors
- year 2010 (YTD):
 - 2.000 Trans-critical CO₂ compressors
 - 1500 Cascade CO₂ compressors



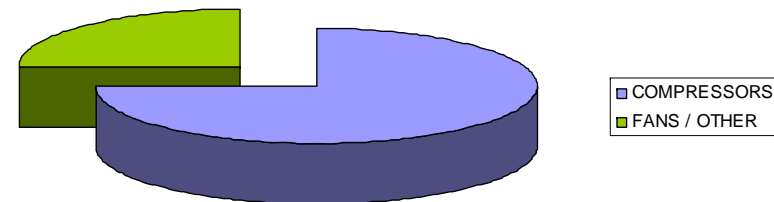
2. Compressor impact on RAC equipment capital cost

- CO₂ systems are becoming an extremely good OPTION for many RAC applications, as alternatives to high GWP refrigerants
- OEMs have two main ways to improve this situation further:
 - Reduce system capital cost
 - Reduce system running cost
- Compressor plays a key role in refrigeration equipment capital and running cost:

Average compressors weight in pack
total cost: 40%*



Average compressors weight in pack
power consumption: 75%*



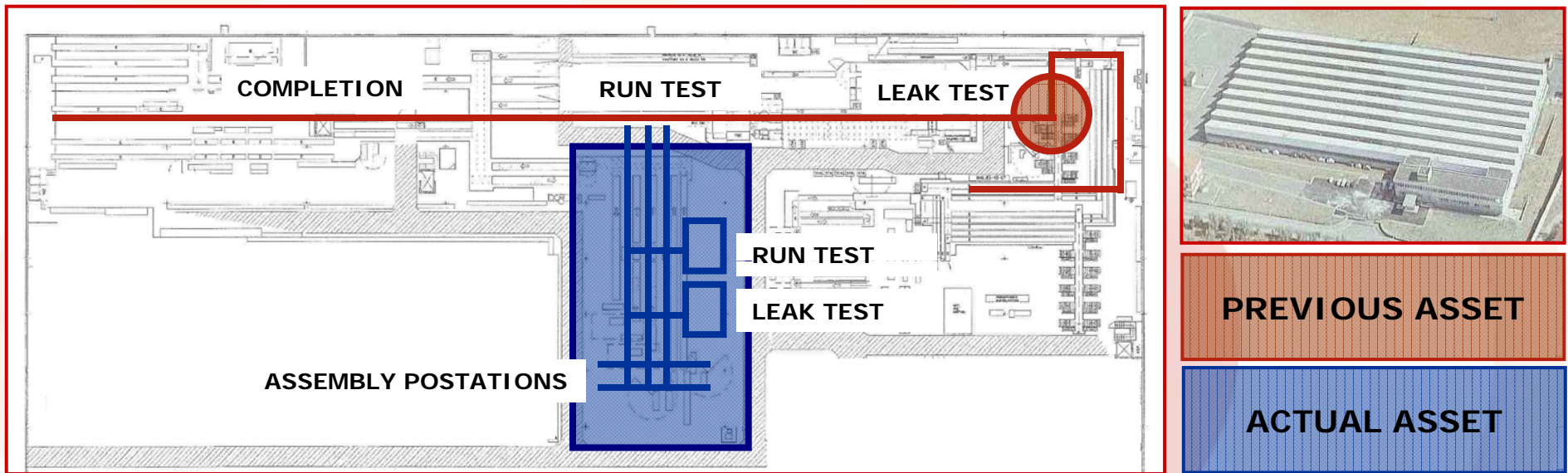
* figures relating to typical booster configuration for medium size supermarket

2. Compressor impact on RAC equipment capital cost

- OEMs have two main ways to improve this situation further:
 - Reduce system capital cost
 - Reduce system running cost
- DORIN worked on both aspects thanks to:
 - Investments in an industrial scale manufacturing line for CO₂ compressors
 - Launch of new compressor ranges featuring:
 - Highest industrialization level
 - Energy efficiency increase
- **MONTHLY PRODUCTION CAPABILITY BOOST: TRANS-CRITICAL CO₂ COMPRESSORS**
 - **FEBRUARY 2010: 100 COMPRESSORS PER MONTH**
 - **JUNE 2010: 400 COMPRESSORS PER MONTH**
- Compressors for cascade / booster systems already manufactured in highly automated structure (room for 30.000 units per year)

2. Compressor impact on RAC equipment capital cost

→ Investments in an industrial scale manufacturing line for CO₂ compressors



→ MONTHLY PRODUCTION CAPABILITY BOOST: TRANS-CRITICAL CO₂ COMPRESSORS

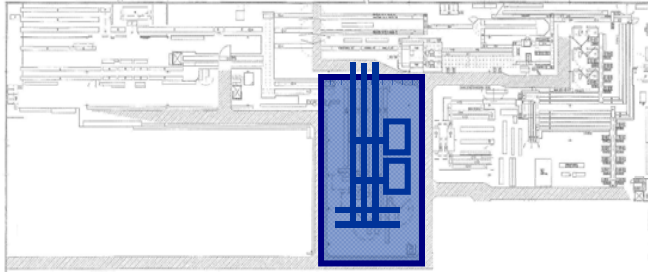
→ DECEMBER 2009: 100 COMPRESSORS PER MONTH

→ JUNE 2010: 400 COMPRESSORS PER MONTH

2. Compressor impact on RAC equipment capital cost

➔ Investments in an industrial scale manufacturing line for CO₂ compressors

ASSEMBLY POSTATIONS

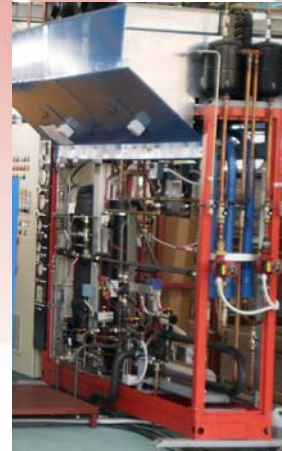


LEAK TEST: 100% production

180 bar: HP side - 130 bar: LP side

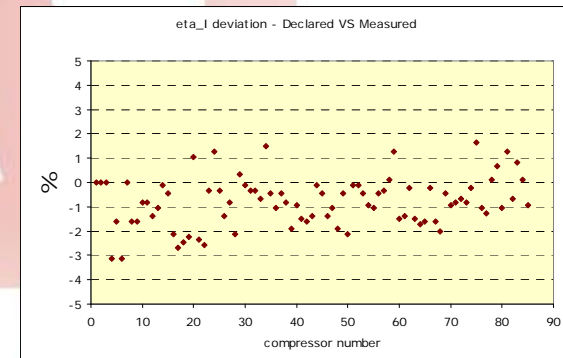
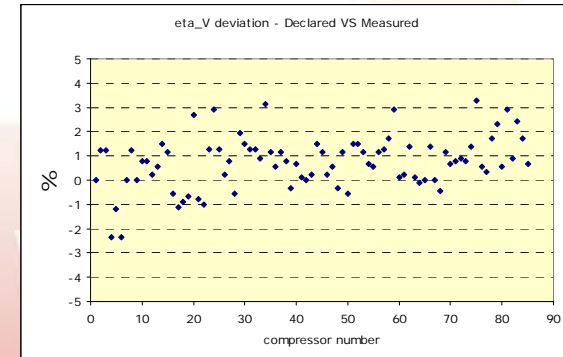
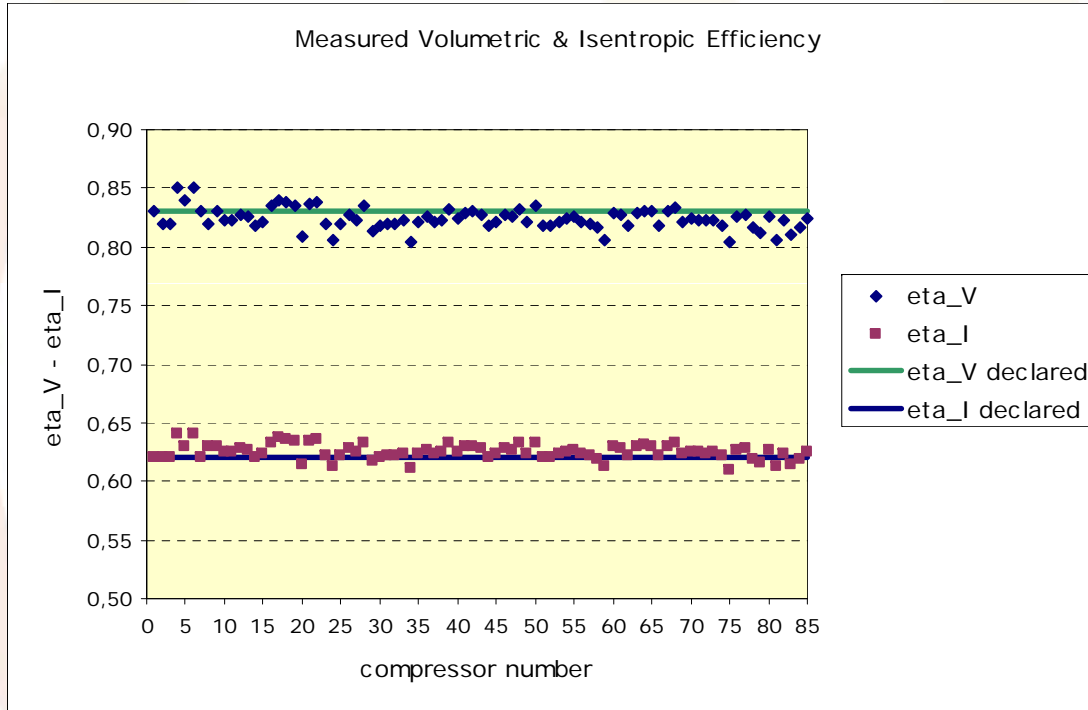
RUN TEST: 100% production

35 bar: LP side - 90 bar: HP side



2. Compressor impact on RAC equipment capital cost

- ➔ Investments in an industrial scale manufacturing line for CO₂ compressors
 RUN TEST: 100% production – DECLARED DATA CROSS CHECK

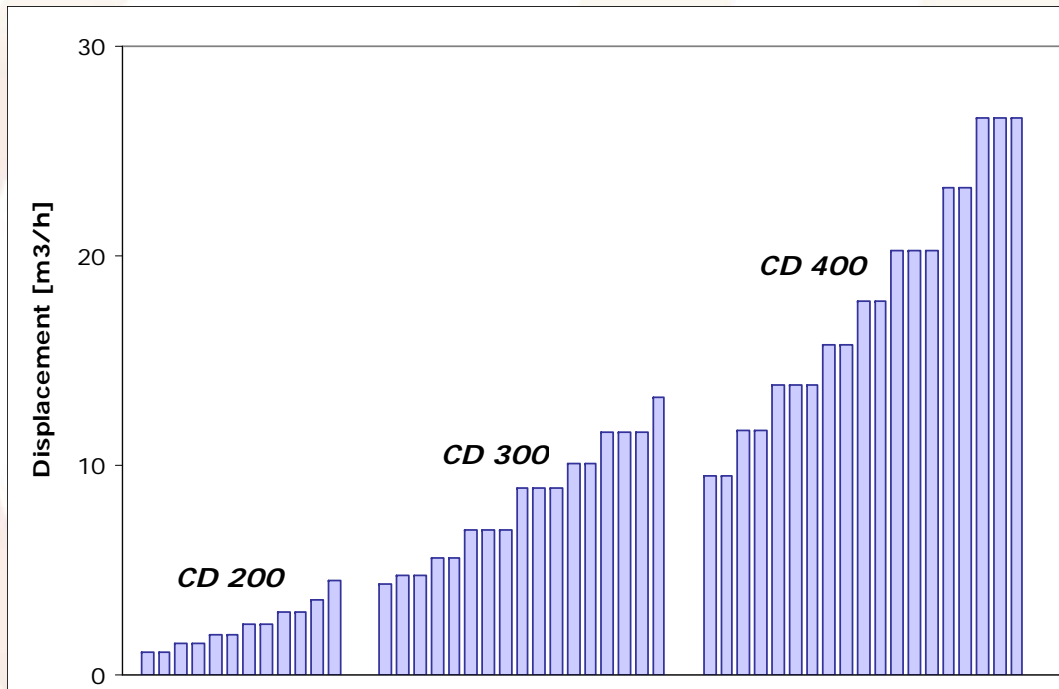


- ➔ Tests conducted at 35 bar_g suction, 10K SH, 90 bar_g discharge
- ➔ eta_V – max deviation = 3.26 %
- ➔ eta_I – max deviation = 1.62 %

☞ **EXTREME REPEATABILITY**

2. Compressor impact on RAC equipment capital cost

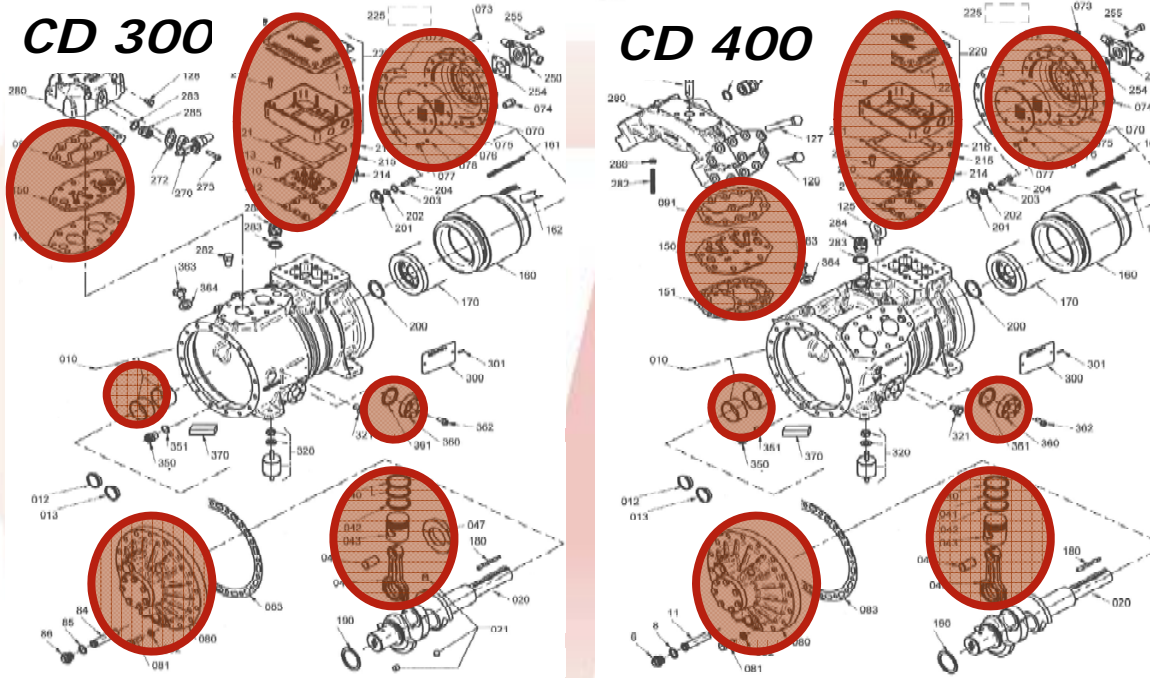
- Launch of new compressor ranges: CD 200 - CD 300 - CD 400
- The widest CO₂ compressor range available in the market



- Displacements ranging from 1.1 m³/h to 26.6 m³/h
- Motor power ranging from 1.5 hp to 40 hp

2. Compressor impact on RAC equipment capital cost

- Launch of new compressor ranges: CD 200 - CD 300 - CD 400
 - Supply chain optimization
 - Synergy between compressor ranges



Bill of Materials: 85 items

CD 300 and CD 400 share 82 items

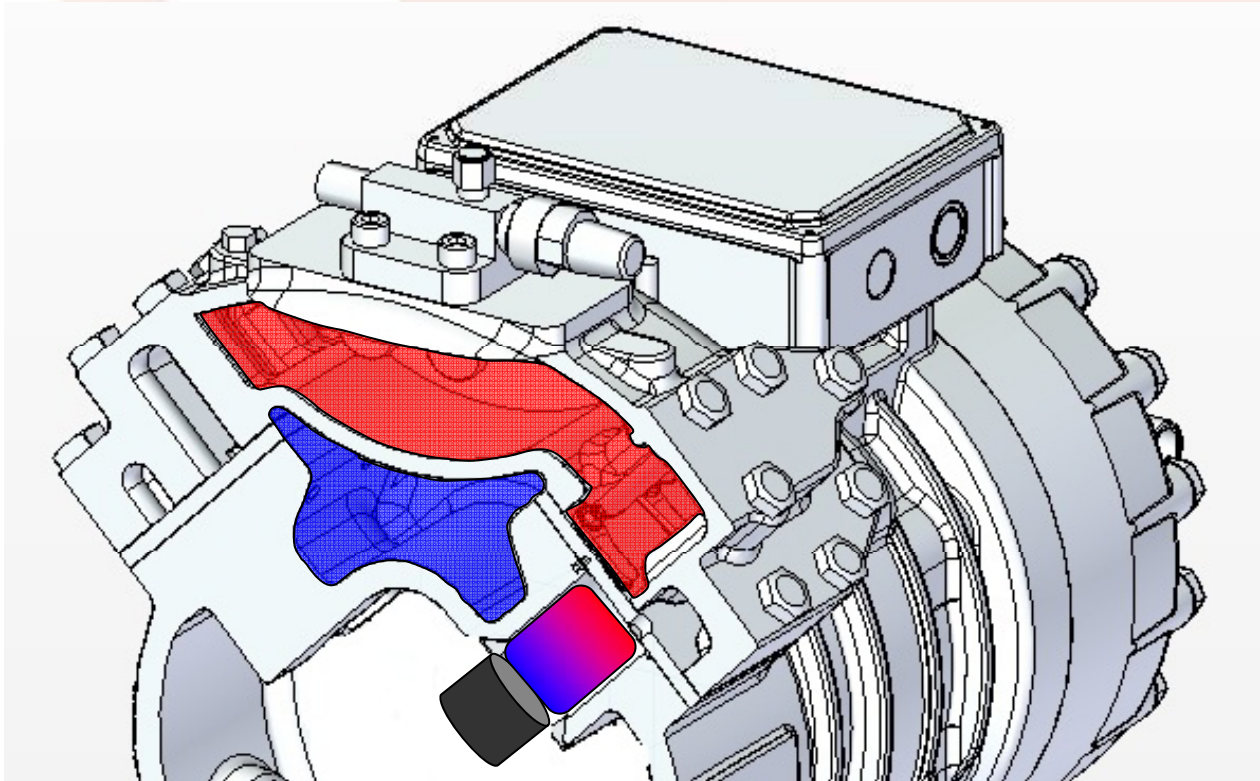
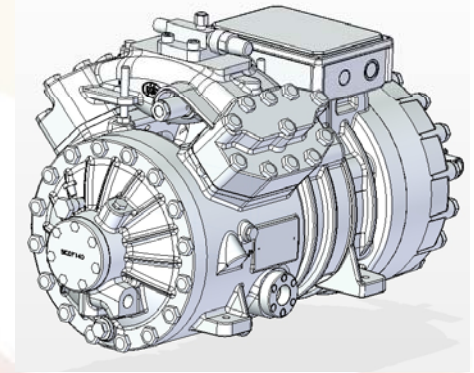
All parts are in common except:

- Crankcase
- Head
- Electric Motor

- Supply chain: standardized items & higher volumes
- Logistic: easier compressor assembly asset
- **HIGHEST INDUSTRIALIZATION LEVEL**

2. Compressor impact on RAC equipment running cost

- Launch of new compressor ranges: CD 200 - CD 300 - CD 400
 - Peculiar compressor design
 - Increase of compressor efficiency
 - Decrease of system running cost



- ✓ HP / LP thermal insulation
- ✓ Lower discharge temperature
- ✓ Better lubrication
- ✓ Isentropic efficiency increase
- **HIGHER RELIABILITY**
- **HIGHER EFFICIENCY**

3. Conclusions

- Carbon dioxide (R744 – CO₂) is nowadays considered one of the most viable alternatives to HFC refrigerants in the RAC industry
- Its use shall always be correctly assessed keeping in mind environmental and energy efficiency criteria
- Its use leads to important energy saving in several applications, but is actually limited by two main factors:
 - Poor component industrialization: **HIGHER CAPITAL COST**
 - Poor training of service engineers
- Situation could be improved thanks to:
 - Educational campaigns
 - Increased number of training centers – some already in operation
 - Equipment running cost decrease
 - Manufacturers shall work to increase their components efficiencies
 - Governmental incentives
 - Bigger volumes will be generated
 - Effective product industrialization will be reached
 - **SYSTEM CAPITAL COST WILL DECREASE**

3. Conclusions

→ DORIN ALREADY COMMITTED TO PROVIDE THE MARKET WITH COMPRESSORS REFLECTING:

→ EXTREME RELIABILITY LEVELS

→ HIGHEST INDUSTRIALIZATION LEVEL

→ UTMOST EFFICIENCY LEVEL



THANK YOU FOR YOUR KIND ATTENTION