# Challenges Managing the Subfab

Looking ahead,
going beyond expectations

Ahead > Beyond

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EBARA CORPORATION

# Abstract

The subfab is crucial to the fab's operations. Ensuring the subfab ecosystem operates smoothly takes considerable effort and coordination between the Device Manufacturers and Suppliers.

Major challenges include the PAC, (pumps, abatement, chillers) keeping the equipment operational, maintained and supported by qualified personnel. Additional regulations and sustainability initiatives are pushing mature technologies to their limits to meet corporate goals.

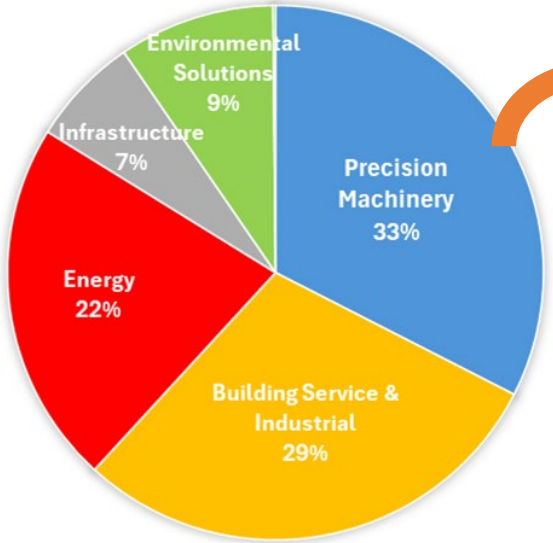
This webinar focuses on methods and solutions to overcome some of these challenges.

# Ebara Corporate / Precision Machinery Company

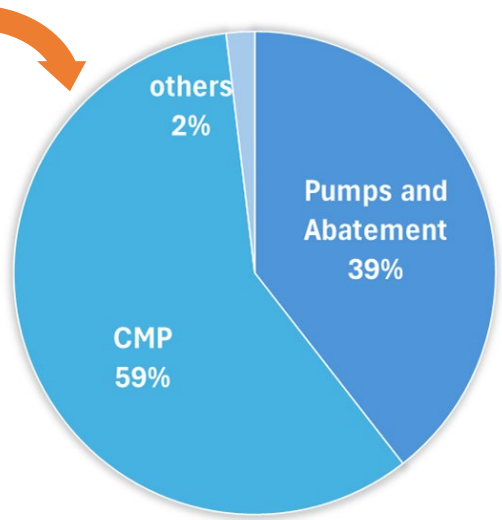
## Main End-User Markets

### Leading Supplier of Semiconductor Manufacturing Equipment

EBARA CORPORATION FY'23
REVENUE 759 BILLION YEN ($5.77 B)




PRECISION MACHINERY FY'23
REVENUE 247 BILLION YEN ($1.88 B)




## Main Products & Services

### Dry Vacuum Pump

Creates vacuum environment necessary for the semiconductor manufacturing process.

### Gas Abatement System

Harmful gases generated in the manufacturing process are rendered harmless.

### CMP System

Polishes wafers which make the base of IC chips to flatness down to Nanometer precision.

### Plating Machine

Surface-processes the electrodes of the top surface of IC chips. The work is done in a clean room as extremely delicate process is required.

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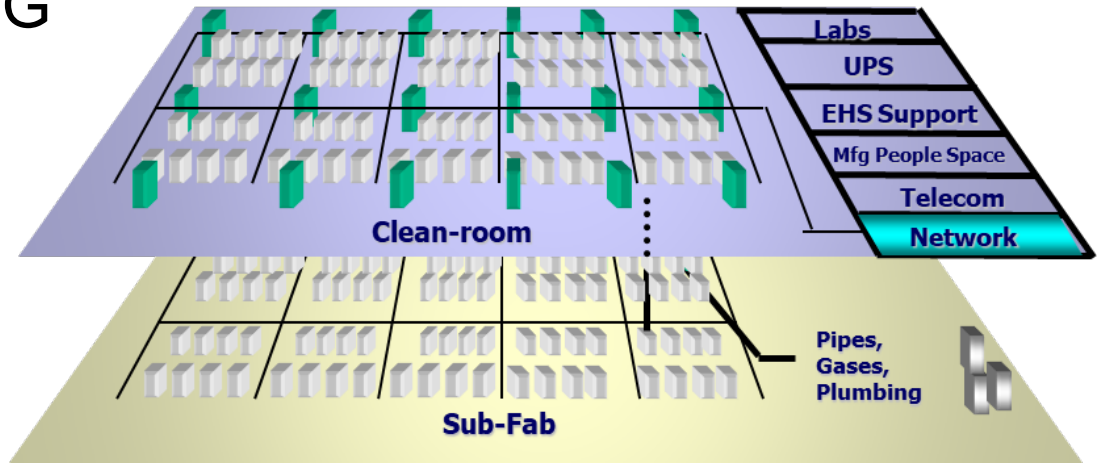
# Challenges Managing the Subfab

## Equipment Challenges (PAC)

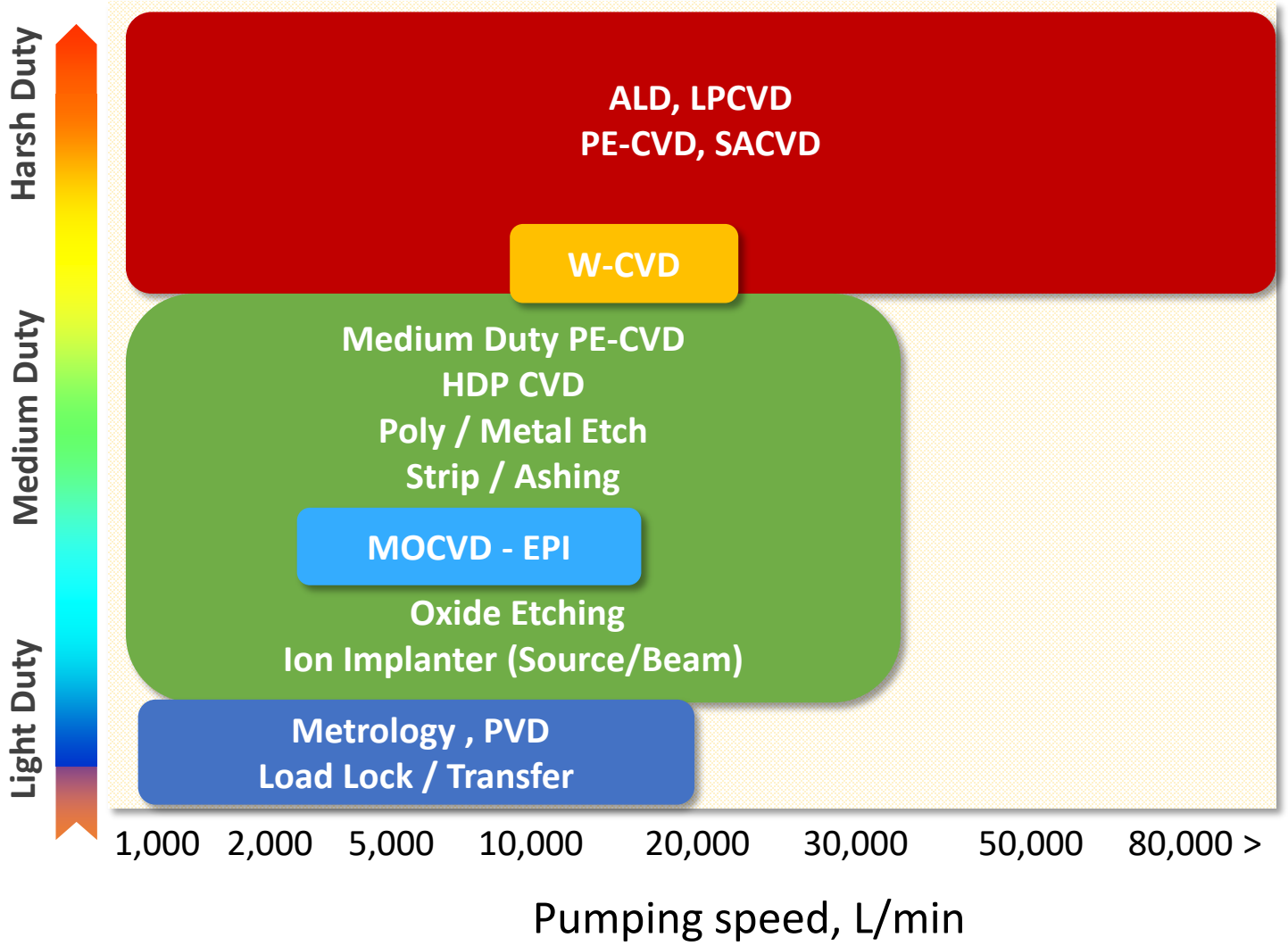
- Vacuum Pumps – Applications, End of Life (EoL)
- Abatement - Updated Regulations for GHG
- Chillers – GWPs & PFAS Regulations
- Reducing OpEX, Sustainability



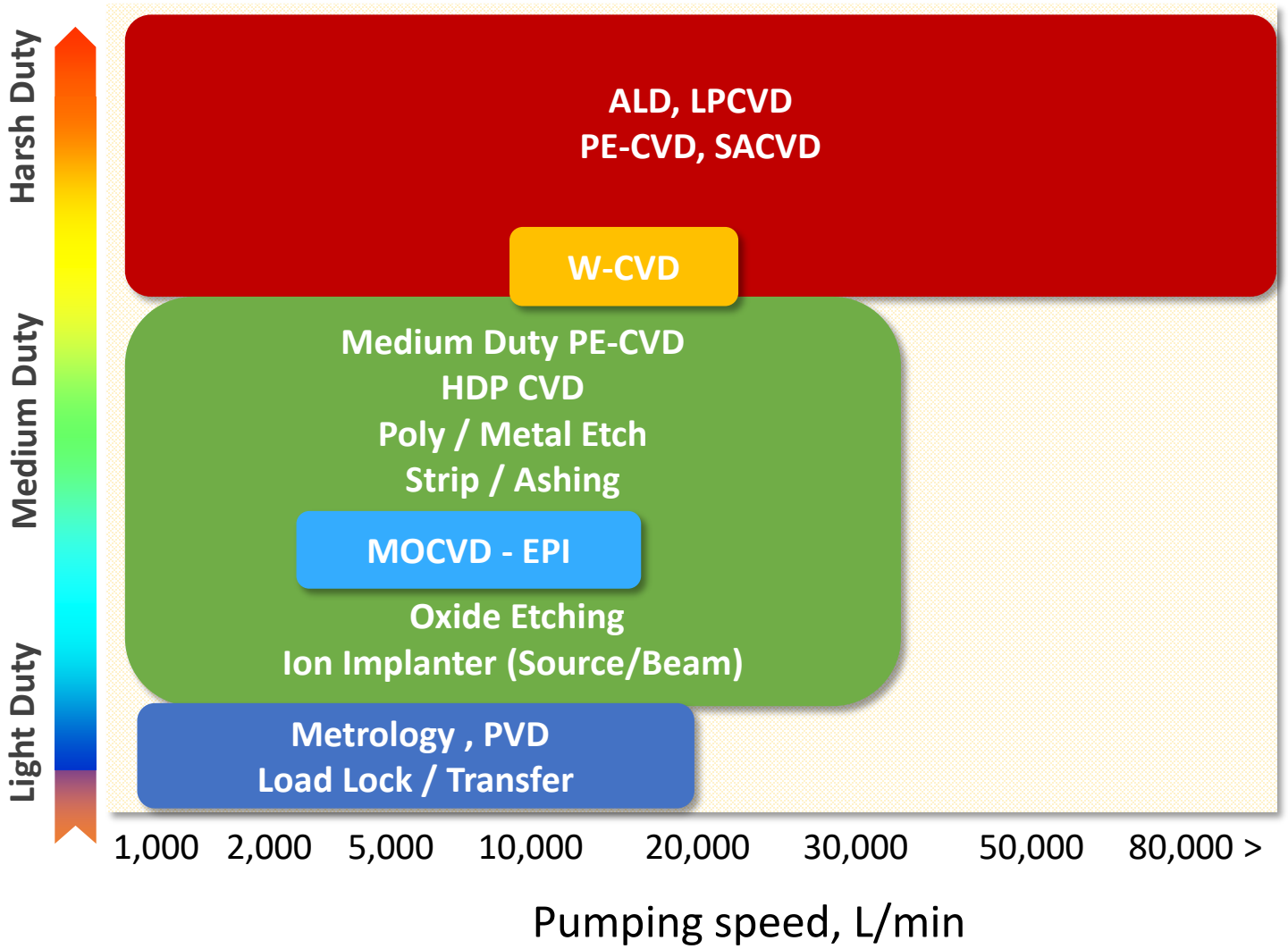

## Operational Challenges

- Qualified Personnel – Training
- Logistics – Inventory, Spares Management
- Communications – Supplier Relations

# Dry Pump Application Range



# Dry Pump Application Range




## EBARA's Models

Model EV-M

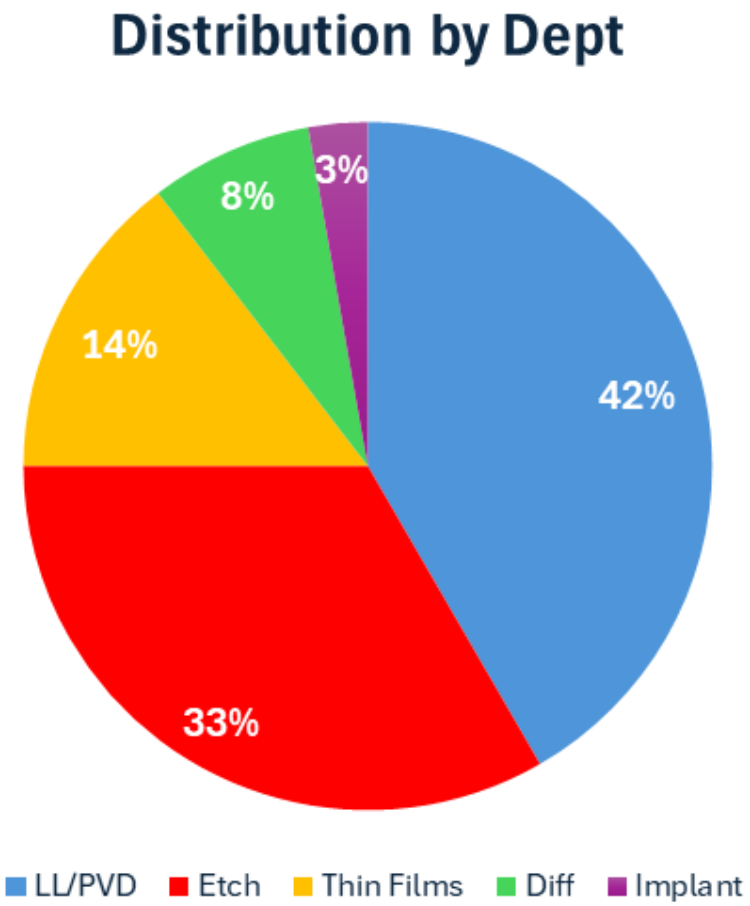
Model EV-X

Model ES-A

Model EV-S

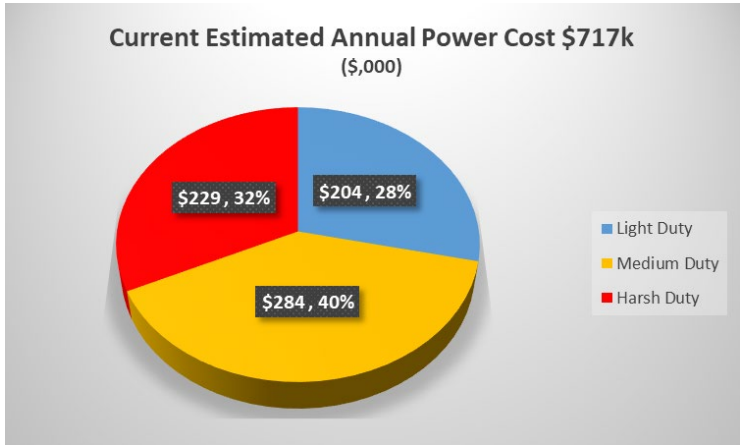
Model 000 is our model code

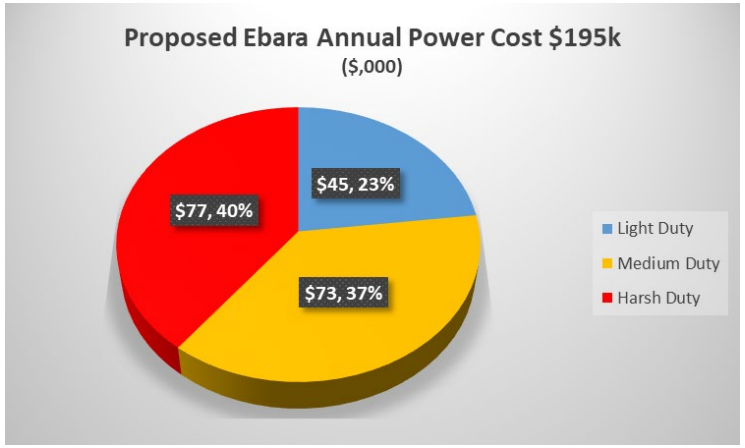
# Example of an Audit of a Current Pump Fleet in 200mm Fab



# Reduce the Fab's OpEx

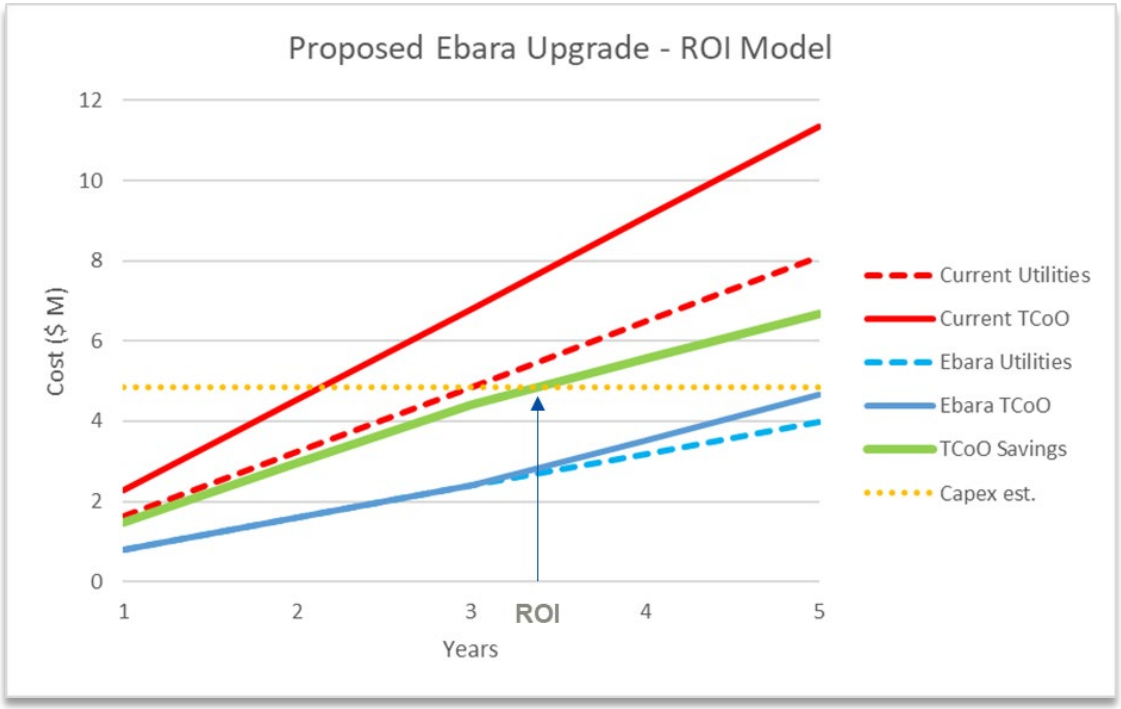
## Example: Upgrade of (250) EOL Pumps with new efficient Ebara Models




***Resulted in >70% Reduction***

***(>$500k Annual Savings)***




*For marketing demonstration purposes

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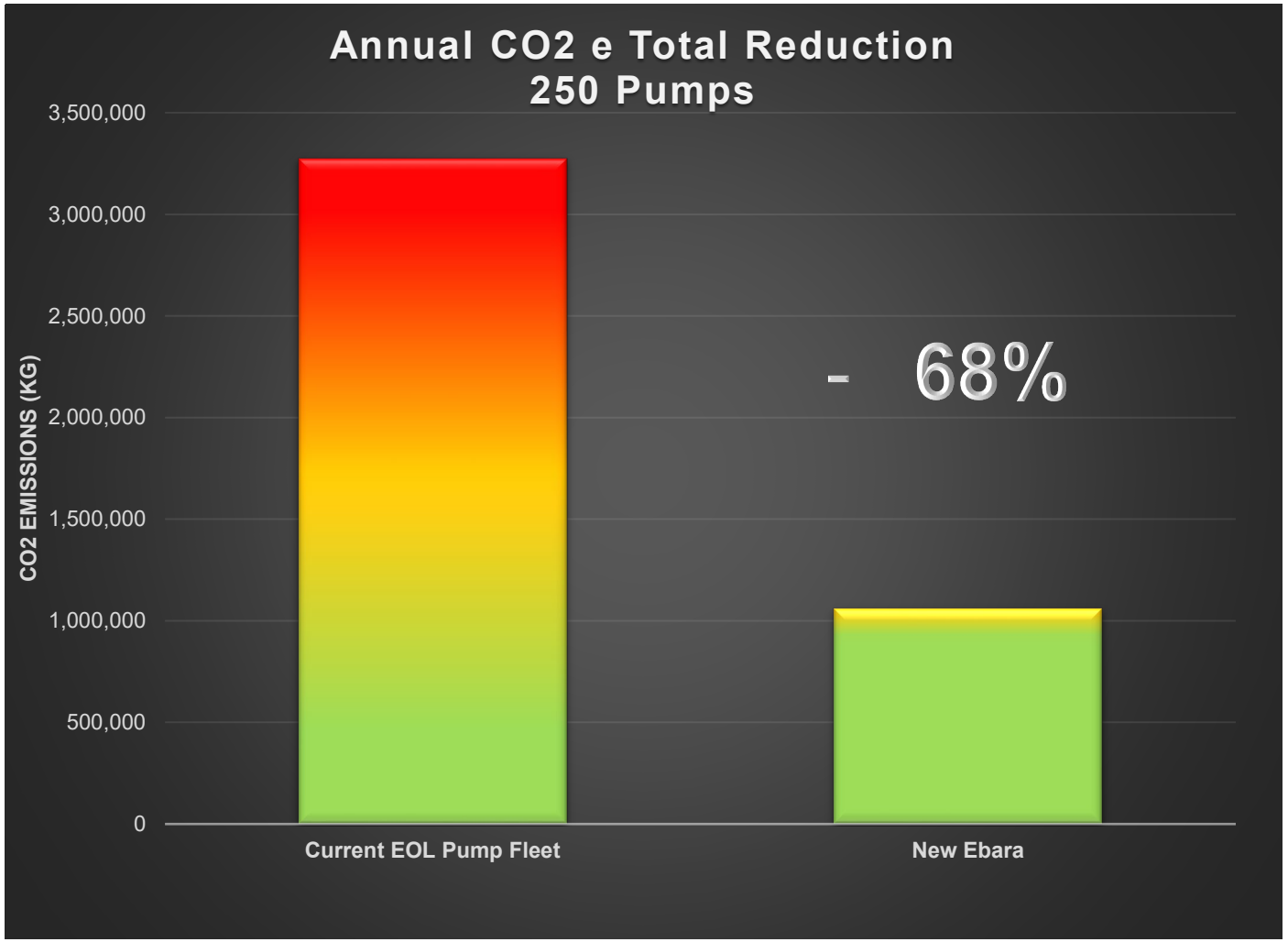
# Meeting Corporate Carbon Emissions Reductions




** based on average Intensity value of 400g CO2/kWh Ref: epa.gov

# EBARA Dry Pump Vacuum Family

## Model EV-S: Energy Saving roots design for light to medium duty

| Model | EV-S20 | EV-S50 | EV-S100 | EV-S200 |
|---|---|---|---|---|
| Pumping Speed (CFM) | 59 | 177 | 353 | 706 |

## Model EV-X: Energy Saving roots design medium duty, higher temperature pump

| Model | EV-X100 | EV-X200 | EV-X300 |
|---|---|---|---|
| Pumping Speed (CFM) | 353 | 636 | 636 |

## Model EV-M: Energy Saving roots design ideal for medium to harsh duty

| Model | EV-M20N | EV-M102N | EV-M202N | EV-M302N | EV-M502N | EV-M802N | EV-M1205 |
|---|---|---|---|---|---|---|---|
| Pumping Speed (CFM) | 64 | 353 | 707 | 954 | 1,767 | 2,827 | 3,887 |

## Model EST: Screw pump design for harsh duty applications with powders

| Model | EST25N | EST100WN | EST200WN | EST300WN | EST500WN | EST800WN |
|---|---|---|---|---|---|---|
| Pumping Speed (CFM) | 88 | 353 | 706 | 1,060 | 1,767 | 2,264 |

Model 000 is our model code

# EBARA Dry Pump Vacuum Family

Model ESA: Light gas pumping and fast pump down of large load-lock chambers

| Model | ESA25 | ESA70W | ESA200W | ESA300W | ESA500W |
|---|---|---|---|---|---|
| Pumping Speed (CFM) | 105 | 300 | 706 | 1,060 | 1,767 |

Model EV-A: Air-cooled vacuum pumps for N2 and clean applications

| Model | EV-A03 | EV-A06 | EV-A10 |
|---|---|---|---|
| Pumping Speed (CFM) | 9 | 22 | 36 |

Model EV-PA: Air-cooled vacuum pump for analytical applications

| Model | EV-PA50 | EV-PA250 | EV-PA500 |
|---|---|---|---|
| Pumping Speed (CFM) | 1.75 | 9 | 18 |

Model 000 is our model code

# Abatement -Updated Regulations for Greenhouse Gases

- As of 1/1/25 EPA  will revise the EPA GHG reporting rule which will have impacts on the selection of new and operations of existing POU abatement devices
- Global Warming Potentials of key gases are being updated
- Reporting required for companies emitting >25 $tCO_2e$
- GHG Reporting rule will affect companies by
  - What GHGs will need to be reported
  - Calculating emissions factors for gas utilization and byproduct formations
  - Testing, monitoring, reporting and record keeping

# Global Warming Potential Changes

| Greenhouse Gas (representative examples) | Current GWP (100 Year) | Revised GWP (100 Year) |
|---|---|---|
| Methane – $CH_4$* | 25 | 28 |
| Methyl Fluoride – $CHF_3$ | 92 | 116 |
| Nitrous Oxide – $N_2O$ | 298 | 265 |
| Carbon Tetrafluoride – $CF_4$ | 7,390 | 6,630 |
| Hexafluoroethane – $C_2F_6$ | 12,200 | 11,100 |
| Trifluoromethane – $CH_3F$ | 14,800 | 12,400 |
| Nitrogen Trifluoride – $NF_3$ | 17,200 | 16,100 |
| Sulfur Hexafluoride – $SF_6$ | 22,800 | 23,500 |

* Will have an impact of combustion gas $CO_2e$

# EPA Reporting Rule Updates to Emission Factors

Table I-16 to Subpart I of Part 98—Default Emission Destruction or Removal Efficiency (DRE) Factors for Electronics Manufacturing

| Manufacturing type/process type/gas | Default DRE % (Now) | Default DRE % (1/1/25) |
|---|---|---|
| MEMS, LCDs, and PV Manufacturing | 60 | 60 |
| Semiconductor Manufacturing | | |
| $CF_4$ | 75 | **87** |
| $CH_3F$ | 97 | **98** |
| $CHF_3$ | 97 | 97 |
| $CH_2F_2$ | 97 | **98** |
| $C_2F_6$ | 97 | **98** |
| $C_3F_8$ | 97 | **98** |
| $C_4F_6$ | 97 | **95** |
| $C_4F_8$ | 97 | **93** |
| $C_5F_8$ | 97 | 97 |
| $SF_6$ | 97 | **95** |
| $NF_3$ | 96 | 96 |
| All other carbon-based fluorinated GHG | 60 | 60 |
| $N_2O$ Processes: | | |
| CVD and all other $N_2O$-using processes | 60 | 60 |

# Requirements to Claim Default Destruction Rate Efficiencies

- Certify and document the abatement unit is designed for F-GHG and N2O
- Manufactures will need verified Destruction Rate Efficiencies, DRE, meet the default values tested at the worst-case flow conditions
- Will need to include existing and new systems >1/1/25
- Will be able to claim lower than default DREs with above bullets
- Keep records and document test methods

# EBARA Response

- Provide applications support to assist in development of the site abatement strategies
- Will provide certification letters of design for new and updated letters for existing installation for EBARA's abatement units per the updated regulations
- Will provide scheduled audits to existing installations to confirm units are installed and operating per manufacturing recommendations
- Assess site maintenance plans to ensure units operating and maintained properly

# EBARA Abatement Family for F-GHG

## Model G5 / G6 – Combustion-Wash

| Model | G5 -350 | G5-500 | G5-1200 | G6-E |
|---|---|---|---|---|
| Total Flow (SLM) | 350 | 500 | 1,200 | 400 |
| GHG Abatement | Y | Y | Y | Y |
| Inlets | 4 | 4 | 6 | 4 |

## Model TND – Combustion-Wash

| Model | TND SG | TND -DO | TND-DU | TND-SP+ |
|---|---|---|---|---|
| Total Flow (SLM) | 400 | 800 | 800 | 800 |
| GHG Abatement | Y | Y | Y | Y* |
| Inlets | 4 | 4/4 | 6/6 | 2-4 |

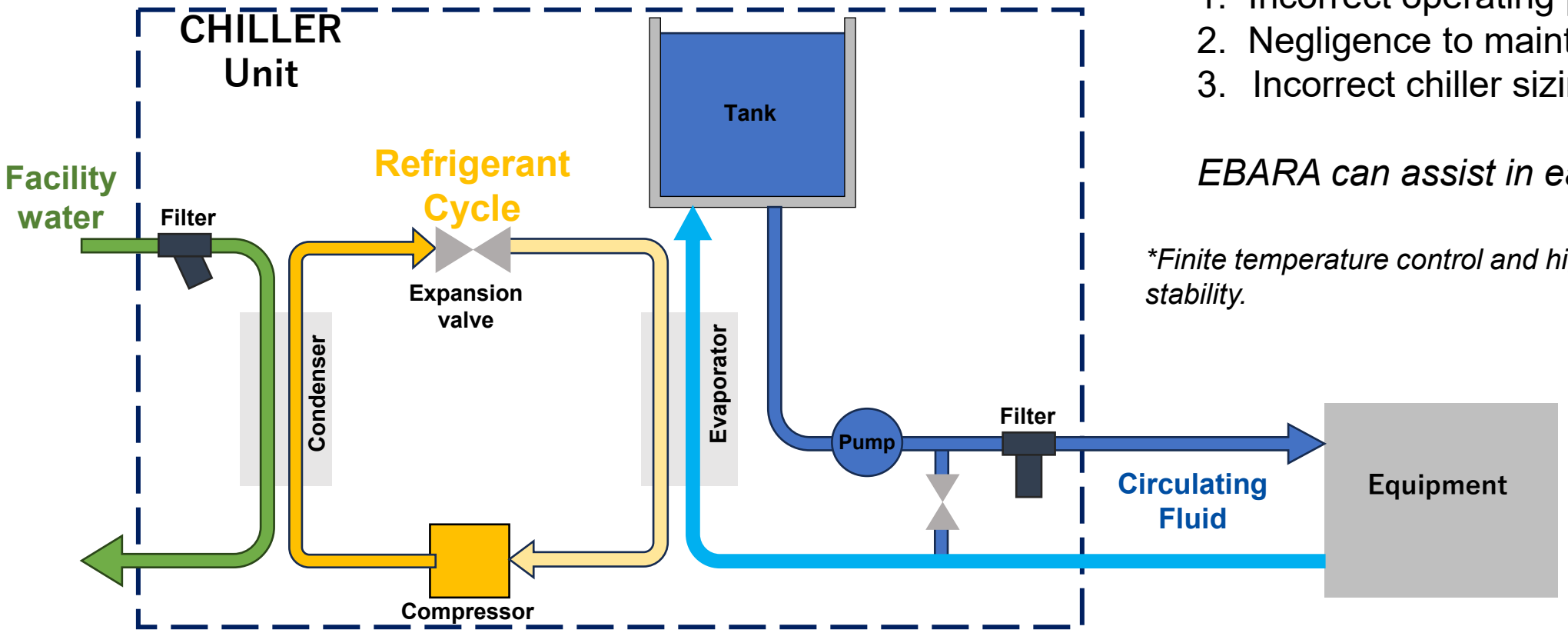
* Wet-Burn-Wet: GHG depends on type

## Model FDS – Thermal - Chemical Capture

| Model | FDS100 | FDS250 |
|---|---|---|
| Total Flow (SLM) | 100 | 250 |
| GHG Abatement | Y | Y |
| Inlets | 1 | 1 |

Model 000 is our model code

# Chillers – Most Common Challenges




1. Incorrect operating practices.
2. Negligence to maintenance.
3. Incorrect chiller sizing.

*EBARA can assist in each area!*

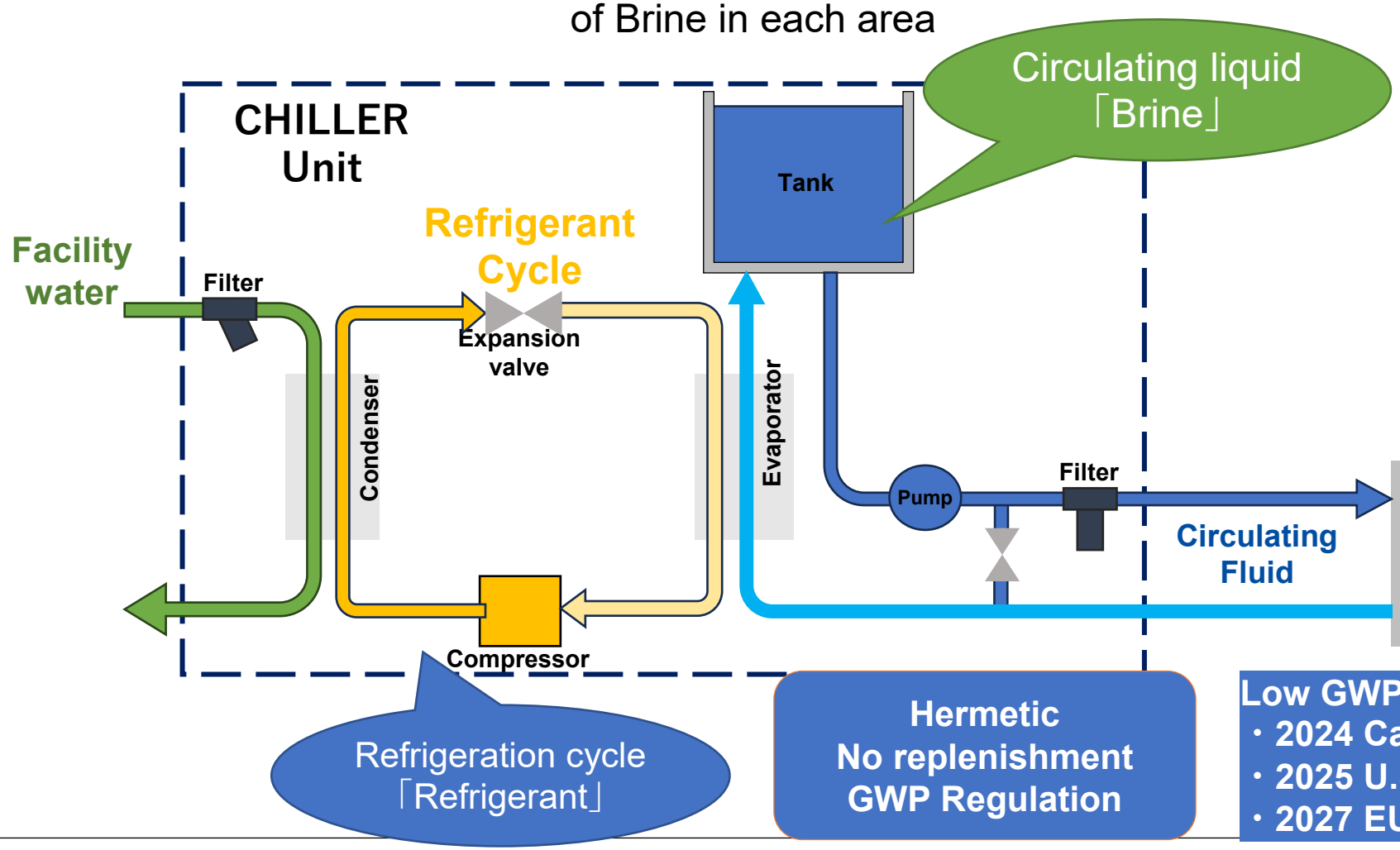
**Finite temperature control and highly accurate temperature stability.*

One of the biggest challenges for all chilling equipment suppliers – apart from meeting demand – *is reducing the huge amounts of heat-energy these chillers consume from the process chamber.*
EBARA's development of more compact and efficient chillers is a key differentiator!

# Chillers – Regulations for Reduction of GWP & PFAS

・Low GWP Regulation：Regulate Global Warming Potential of Refrigerant in each area
・PFAS Regulation　　：Regulate Organic fluorine compounds (most of existing circulating liquid ex.FC-3283) of Brine in each area




Non hermetic
Need Replenishment
GWP Not regulated

PFAS regulation in EU
・2025 Effective
・2027 Start

**Hermetic**
**No replenishment**
**GWP Regulation**

**Low GWP regulation**
**・2024 California GWP < 750**
**・2025 U.S GWP < 700**
**・2027 EU GWP < 150**

# Product / RJ-XA

| Model | RJ-XA-20 | RJ-XA-21 |
|---|---|---|
| CH | 1 | |
| Cooling capacity | 6.1 kW @ 20℃ | |
| Circulating Fluid | Deionized water, Ethylene glycol | |
| Temp. range | 5 ~ 40℃ | |
| Accuracy | ±0.1℃ | |
| HEX material (Brazing material) | SUS316 (Copper) | SUS316 **(Stainless)** |
| Dimensions(mm) | W375xD1050xH1200 | |
| Ref./ASHRAE Class | R513A/A1 | |
| GWP (global warming potential) | **629** ***IPCC ar6** | |
| Certification | SEMI S2&F47, NRTL, CE | |

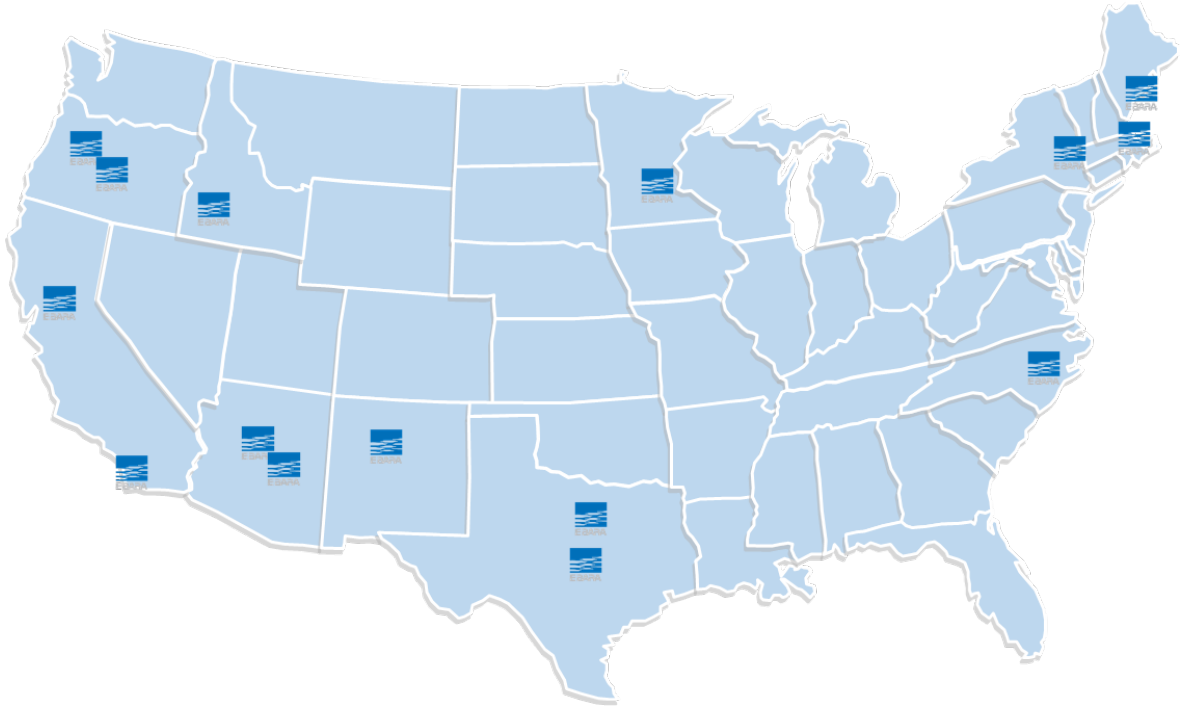

Model 00-0 is our model code

# Product / RJ-CA

| Model | RJ-CA |
|---|---|
| CH | 1 |
| Cooling capacity | 3.8 kW @ -10℃ |
| Circulating Fluid | 3M Fluorinert, Galden HT-200, SF10 |
| Temp. range | -20 ~ 70 ℃ |
| Accuracy | ±0.1℃ |
| HEX material<br>(Brazing material) | SUS316<br>(Copper) |
| Dimensions(mm) | W370xD950xH1100 |
| Ref./ASHRAE Class | **R744(CO2)**/A1 |
| GWP(global warming potential) | **1** |
| Certification | (SEMI S2&F47, NRTL, CE) |

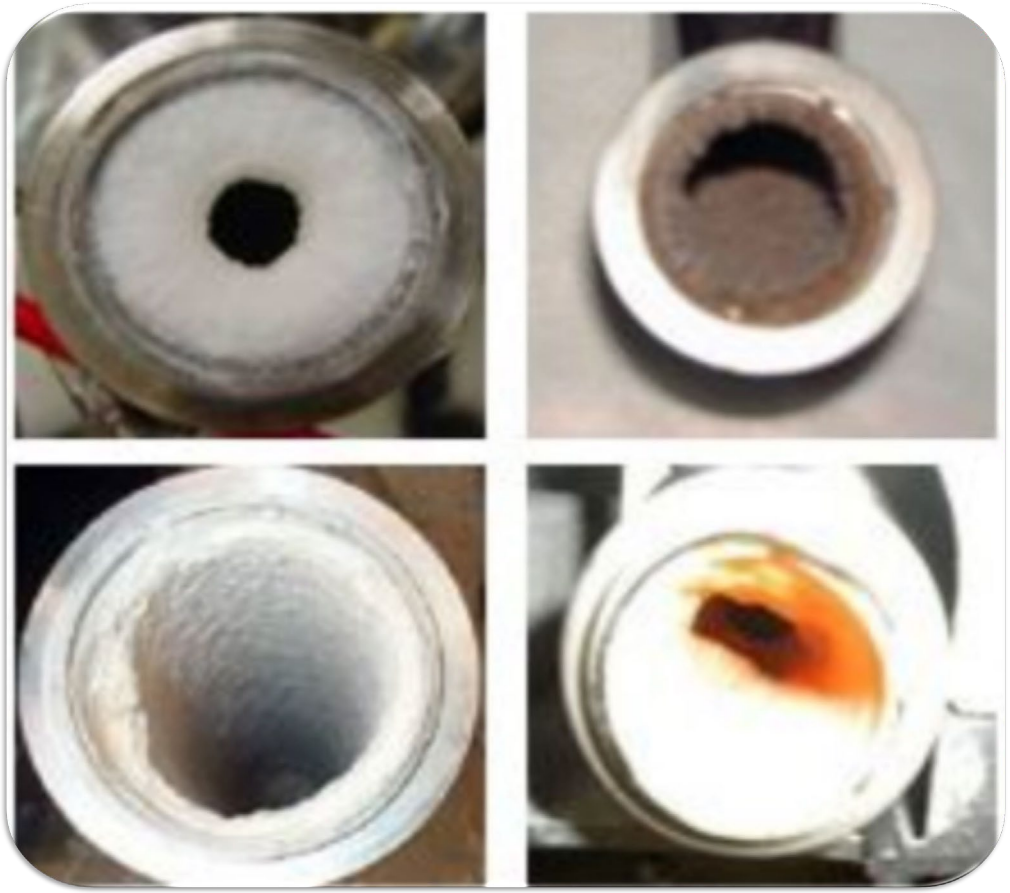

Model 00-0 is our model code

# North American Service and Support Locations



- ETI Headquarters and Service Center Sacramento
- Dry Pumps, Abatement & CMP Refurb.
- 155,000 sqft
- Rebuild Capacity 2,000+ annually
- TAT Target - 28 days

# Realities of a Subfab – We've All Seen This Movie!

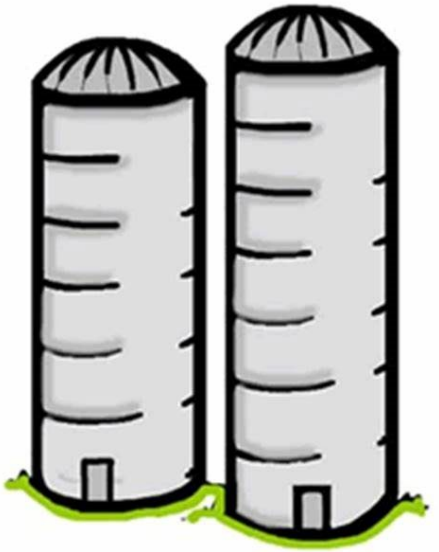


Not following best vacuum practices:
Employee safety, improperly trained technicians, wafer loss, productivity loss, excessive operation cost, environmental impact

# Service Personnel – Qualified Training

- To be a qualified technician working in a sub fab requires numerous skill sets and must have expertise in the following with a strong safety mindset:

  - Workforce development, electro-mechanical skills
  - Fundamental of semiconductor processes, vacuum and pneumatics
  - Specific expertise in fab process area / tool sets in sub fab
    - Vacuum Pump
    - Abatement
    - Chiller
    - Heaters
    - Job Hazard Analysis (JHA)



# EBARA's Performance Based Training

- Ebara has established dedicated training and certification programs for its field service organization
  - Fundamentals of Semiconductor process*, Vacuum & Abatement
  - Vacuum pump operations – Level 1,2,3 & advanced modules
  - Abatement operations -Level 1,2,3 & advanced modules
  - Line Heaters – measure, install and troubleshoot
  - Mandatory Gap Training, refresh and recertification training

- *Customer specific programs available for Ebara's equipment for new and experienced technicians*
  - *Vacuum pump operations – Level 1,2,3*
  - *Abatement operations -Level 1,2,3*

# EBARA's Approach Factory Trained Service

## DRY Pumps

- Staging and commissioning
- Preventive maintenance
  - Oil, check-valve, exhaust line (not-limited to)
- Dry pump exchange (swap)
- Pack & ship, uncrating
- Inventory Management
  - spare dry pumps, consumables
- Reports & logistics
  - PM's complete, PM's past due, PM Forecast
  - Rebuilds performed, Rebuild spend, Rebuild Forecast
  - Trouble call report

# EBARA's Approach Factory Trained Service

## POU Abatement

- Staging and commissioning
  - Finger-print per process, set-up
- Preventive maintenance
- Parts Inventory Management
  - spare parts & consumables
- Reports & logistics
  - PM's complete, PM's past due, PM Forecast
  - Parts usage by tool ID, Trouble call report
- For all abatement technologies
  - Thermal, Combustion, Wet
  - Dry, Particle Management

 | 

# Vendor – Communications

- Quarterly Business Reviews (QBRs) addressing the following:
  - Inventory & Availability
  - TAT, WIP status, target return dates
  - Monthly parts usage report (on-site service)
- MTBF Goals
  - Monthly reports:  Pump exchanges by process group, length of service, RMA Log, monthly invoice amount
  - Forecast pump rebuilds
  - Metrics refined to extend pump life on problematic applications
- Preventing Product Loss (wafer rework or scrap)
  - Premature pump fails, Open escalations, Open CAR / CIR's
- Identified Risk
  - Pumps, abatement, chillers deemed at risk based on "Ebara Service approach"
  - Implementing CIPs and BKM to increase uptime

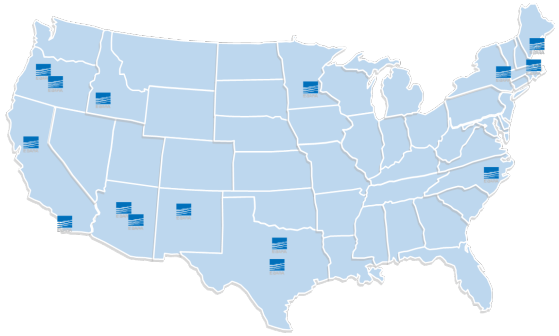
 

# Ebara's Total Comprehensive Service

## Managing Subfab operations

- Dedicated award-winning experience support teams
- Factory performance-based training technicians
- Spares and parts management

## Flexible Service Programs



| LOCATION | COVERAGE | WHAT SERVICE DO WE PROVIDE? |
|---|---|---|
| OR | 24-hrs/month | Ebara Dry pumps, abatement, line heaters. |
| WA | 1.5-days/qtr | Ebara GX Series abatement PM's. |
| CA | 40-hrs/bi-month | Ebara Dry pumps, abatement, line heaters; 3PP Pumps & Abatement. |
| OR | FST on-site | Ebara Dry pumps, abatement, line heaters; 3PP Pumps & Abatement. |
| ID | FST on-site | Ebara products: Dry pumps, abatement, line heaters. |
| CA | FST on-site | Ebara Dry pumps, abatement, line heaters; 3PP Pumps & Abatement. |
| CA | FST on-site | Ebara products: GX abatement PM's. |
| CA | FST on-site | Ebara EUV Systems. |
| AZ | 7x10 | Ebara Dry pumps |
| MA | 4-hrs/month | Ebara Dry pumps, abatement, line heaters; 3PP Pumps. |
| ME | 40-hrs/week | Ebara Dry pumps, abatement, line heaters; 3PP Abatement. |
| ME | 32-hrs/week | Ebara products only: Dry pumps, abatement, line heaters. |
| MA | 46-hrs/week | Ebara Dry pumps, abatement, line heaters; 3PP Abatement. |
| MA | 8-hrs/month | Ebara Dry pumps, abatement, line heaters; 3PP Pumps. |
| MA | 8-hrs/week | Ebara Dry pumps, abatement, line heaters; 3PP Pumps. |
| MA | 4-hrs/month | Ebara Dry pumps, abatement, line heaters; 3PP Pumps. |
| MA | 8-hrs/month | Ebara Dry pumps, abatement, line heaters; 3PP Pumps. |
| MA | 4-hrs/month | Ebara Dry pumps, abatement, line heaters; 3PP Pumps. |
| TX | 7x10 | Ebara Dry pumps, abatement, line heaters; 3PP Pumps & Abatement. |
| NY | 24-hrs/month | Ebara products: Dry pumps, abatement, line heaters. |
| NY | 24-hrs/month | Ebara products: Dry pumps, abatement, line heaters. |
| CT | Qtrly visit | Ebara products: Dry pumps, line heaters. |

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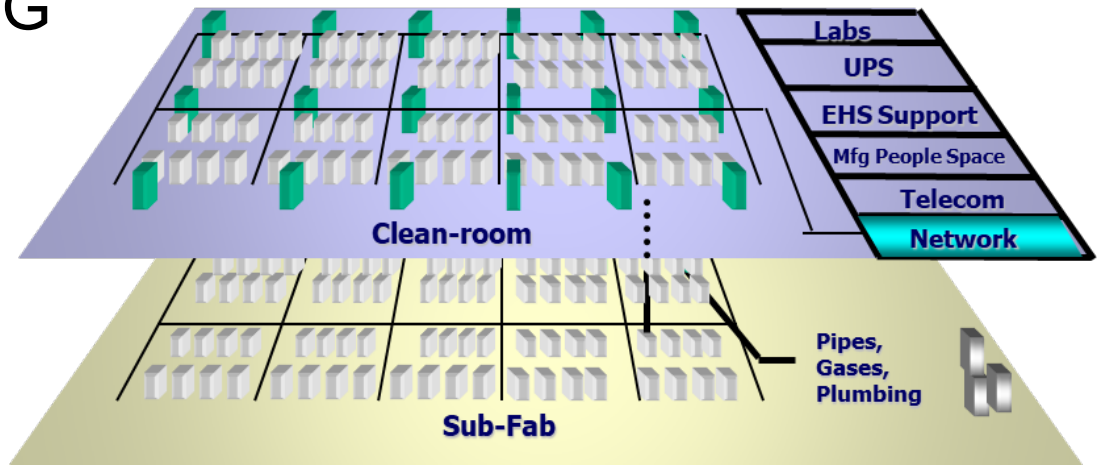


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- Qualified Personnel – Training
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- Communications – Supplier Relations

# Thank you!

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Ahead Beyond