document # 234 rev 1

Custom Designed to Meet Your Requirements

- Pilot
- Small Scale
- Sterile or Non Sterile
- Bulk (to 320 sq ft)
- Stoppering (to 240 sq ft)
- API Manufacturing

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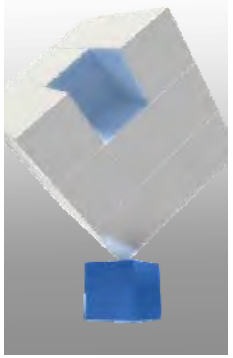
SP Scientific Benchmark Lyophilizers – Shelf Area & Clearance

Model		1000	2000	3000	3500	4000	4500	5000	5500	6000	6500
Shelf Size	mm	410 x 610	510 x 760	610 x 915	610x 1220	610x 915	610x 1220	915 x 1220	1220x 1220	915x 1220	1220x 1220
	Inches	16 x 24	20 x 30	24 x 36	24 x 48	24 x 36	24 x 48	36 x 48	48 x 48	36 x 48	48 x 48
2	Area m^2 (ft2)	0.43 (5.3)	0.77 (8.33)								
	Clearance (mm)	169	215								
3	Area m^2 (ft2)	0.74 (8.0)	1.16 (12.0)	1.67 (18.0)							
	Clearance (mm)	108	139	167							
4	Area m^2 (ft2)	0.99 (10.47)	1.55 (16.67)	2.23 (24.0)	2.97 (32.0)	2.28 (24.0)	2.97 (32.0)	4.46 (48.0)	5.94 (64.0)		
	Clearance (mm)	78	101	122	122	225	225	270	270		
5	Area m^2 (ft2)	1.24 (13.33)	1.93 (20.8)	2.79 (30.0)	3.71 (40.0)	2.79 (30.0)	3.71 (40.0)	5.61 (60.0)	7.43 (80.0)		
	Clearance (mm)	60	78	95	95	175	175	210	210		
6	Area m^2 (ft2)	1.5 (16.0)	2.32 (25.0)	3.34 (36.0)	4.46 (48.0)	3.34 (36.0)	4.46 (48.0)	6.72 (72.0)	8.91 (36.0)	6.72 (72.0)	8.91 (96.0)
	Clearance (mm)	48	63	77	77	145	145	170	170	255	255
7	Area m^2 (ft2)		2.7 (29.17)	3.9 (42.0)	5.2 (56.0)	3.9 (42.0)	5.2 (56.0)	7.85 (84.0)	10.4 (112.0)	7..85 (84.0)	10.4 (112.0)
	Clearance (mm)		52	64	64	120	120	145	145	215	215
8	Area m^2 (ft2)			4.46 (48.0)	5.94 (64.0)	4.46 (48.0)	5.94 (64.0)	8.97 (96.0)	11.89 (128.0)	8.97 (96.0)	11.89 (128.0)
	Clearance (mm)			54	54	105	105	125	125	185	1.85
9	Area m^2 (ft2)					5.05 (54.0)	6.68 (72.0)	10.09 (108.0)	13.37 (144.0)	10.09 (108.0)	13.37 (144.0)
	Clearance (mm)					92	92	110	110	163	163
10	Area m^2 (ft2)					5.61 (60.0)	7.43 (80.0)	11.21 (120.0)	14.86 (160.0)	11.21 (120.0)	14.86 (160.0)
	Clearance (mm)					82	82	3.8 95	95	145	145
11	Area m^2 (ft2)					6.17 (66.0)	8.17 (88.0)	12.34 (132.0)	16.35 (176.0)	12.34 (132.0)	16.35 (176.0)
	Clearance (mm)					72	72	85	85	130	130
12	Area m^2 (ft2)					6.72 (72.0)	8.91 (96.0)	13.45 (144.0)	17.83 (192.0)	13.45 (144.0)	17.83 (192.0)
	Clearance (mm)					65	65	75	75	115	115
13	Area m^2 (ft2)					7.28 (78.0)	9.6 (104.0)	14.58 (156.0)	19.32 (208.0)	14.58 (156.0)	19.32 (208.0)
	Clearance (mm)					60	60	70	70	105	105
14	Area m^2 (ft2)							15.7 (168.0)	20.81 (224.0)	15.7 (168.0)	20.81 (224.0)
	Clearance (mm)							63	63	100	100
15	Area m^2 (ft2)									16.82 (180.0)	22.29 (240.0)
	Clearance (mm)									90	90



		6000	6500
		915x 1220	1220x 1220
		36 x 48	48 x 48
15	Area m^2 (ft2)	16.82 (180.0)	22.29 (240.0)
	Clearance (mm)	90	90
16	Area m^2 (ft2)	17.94 (192.0)	23.78 (256.0)
	Clearance (mm)	85	85
17	Area m^2 (ft2)	19.06 (204.0)	25.26 (272.0)
	Clearance (mm)	75	75
18	Area m^2 (ft2)	20.18 (216.0)	26.75 (288.0)
	Clearance (mm)	2.8 72	72
19	Area m^2 (ft2)	21.3 (228.0)	28.24 (304.0)
	Clearance (mm)	65	65
20	Area m^2 (ft2)	22.42 (240.0)	29.72 (320.0)
	Clearance (mm)	63	63

Benchmark with SIP

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Benchmark 5000

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Benchmark 3000 with CIP

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Benchmark 5000

Convenient "service side" layout
of clean room installation.
Designed for easy accessibility to
major components and maintenance points.

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Benchmark 5000

alternate view of "service side"

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Benchmark Design Flexibility System Installed in Isolator

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Isolator Interface

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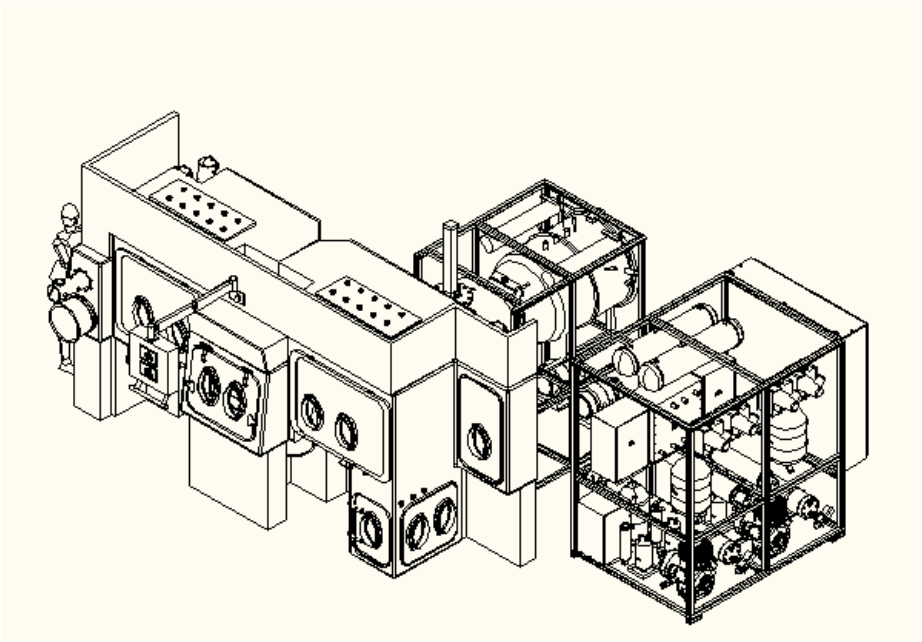

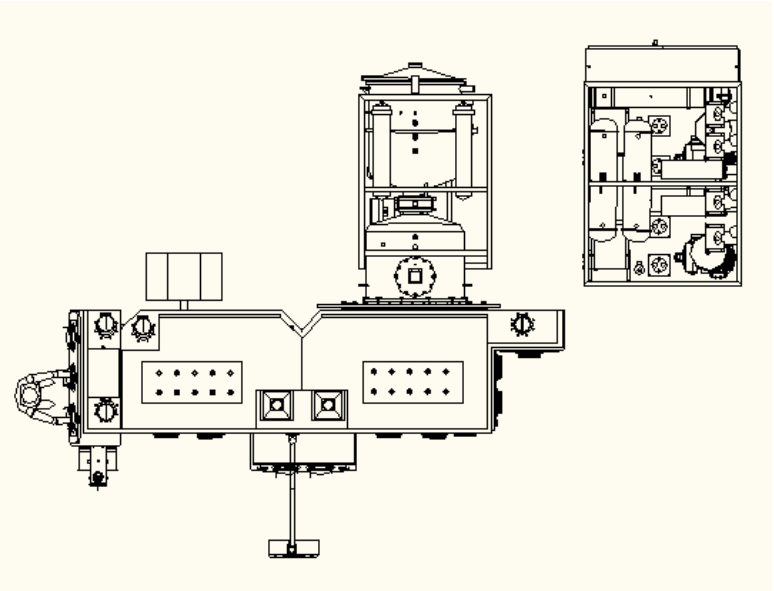

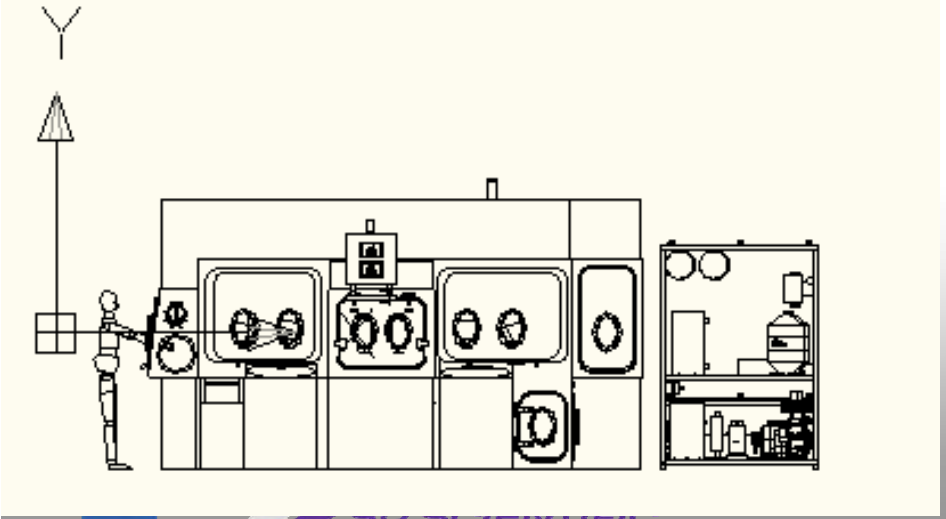

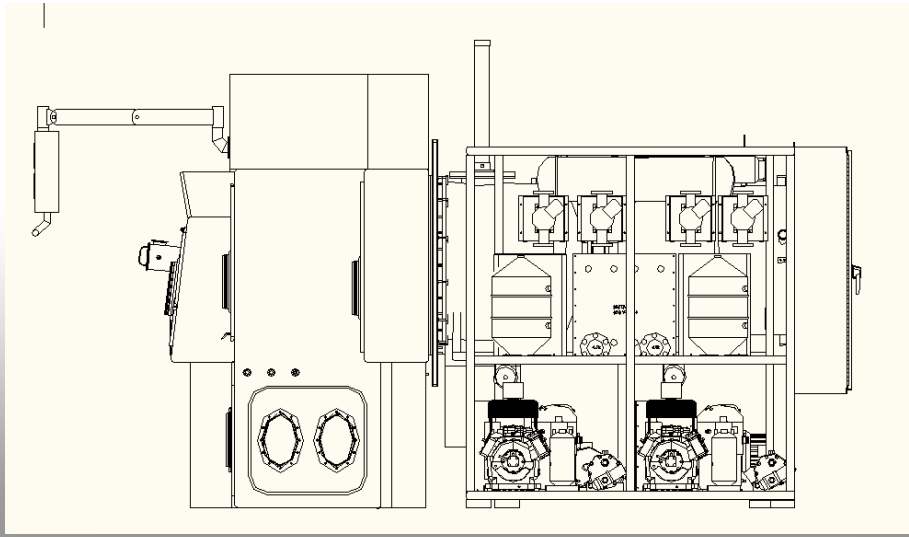

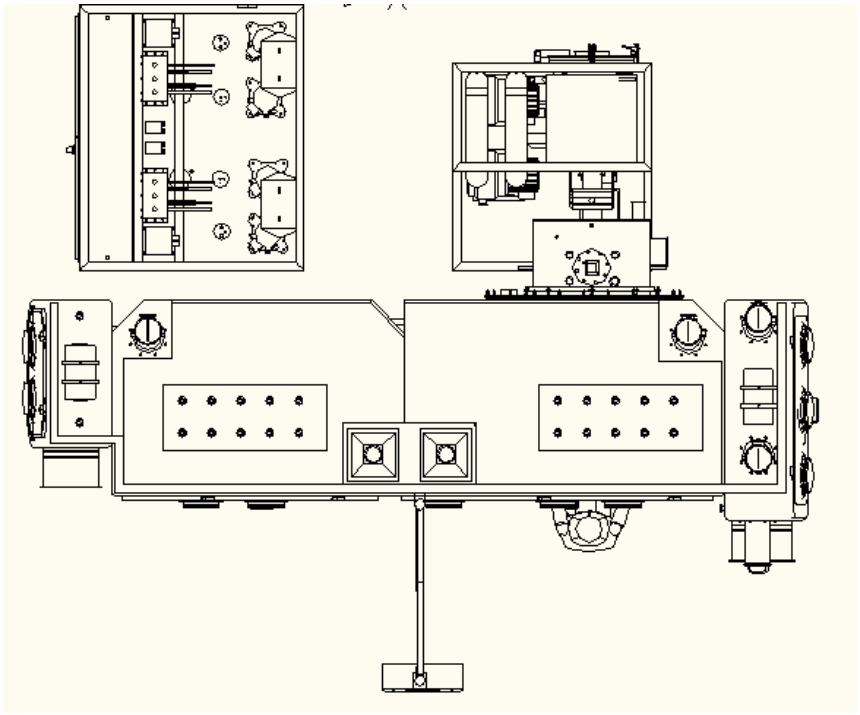

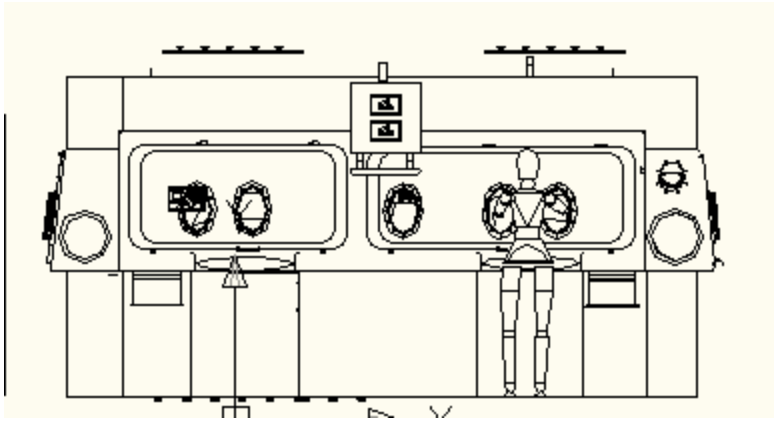

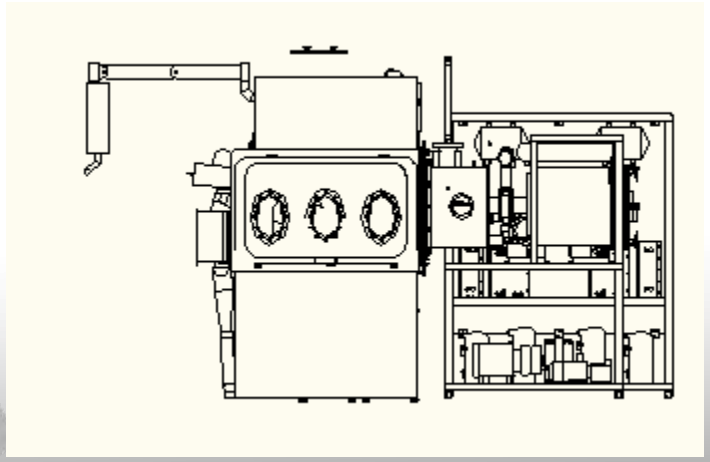

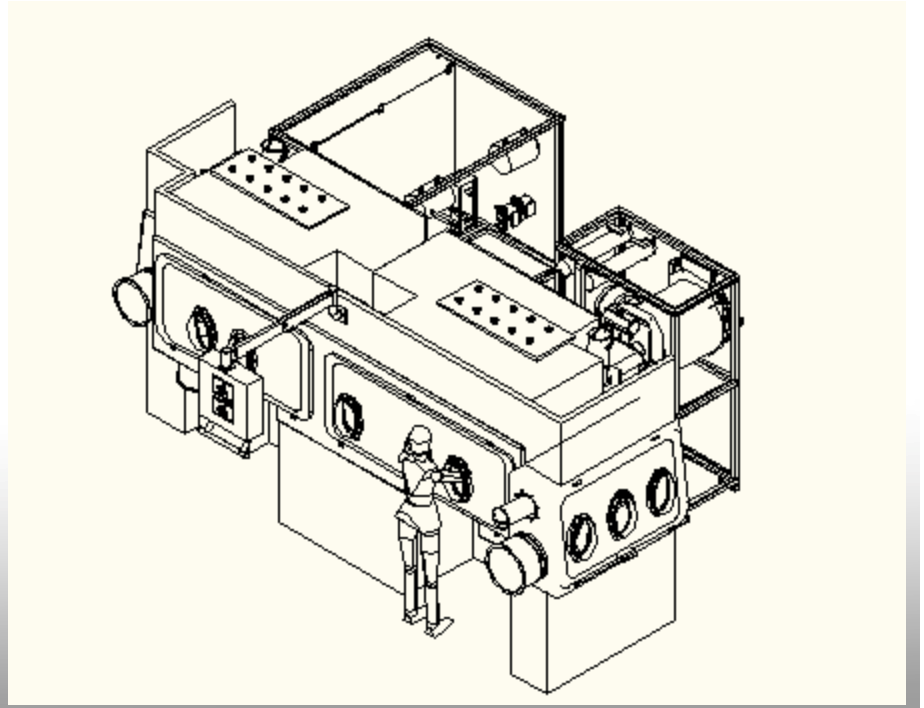

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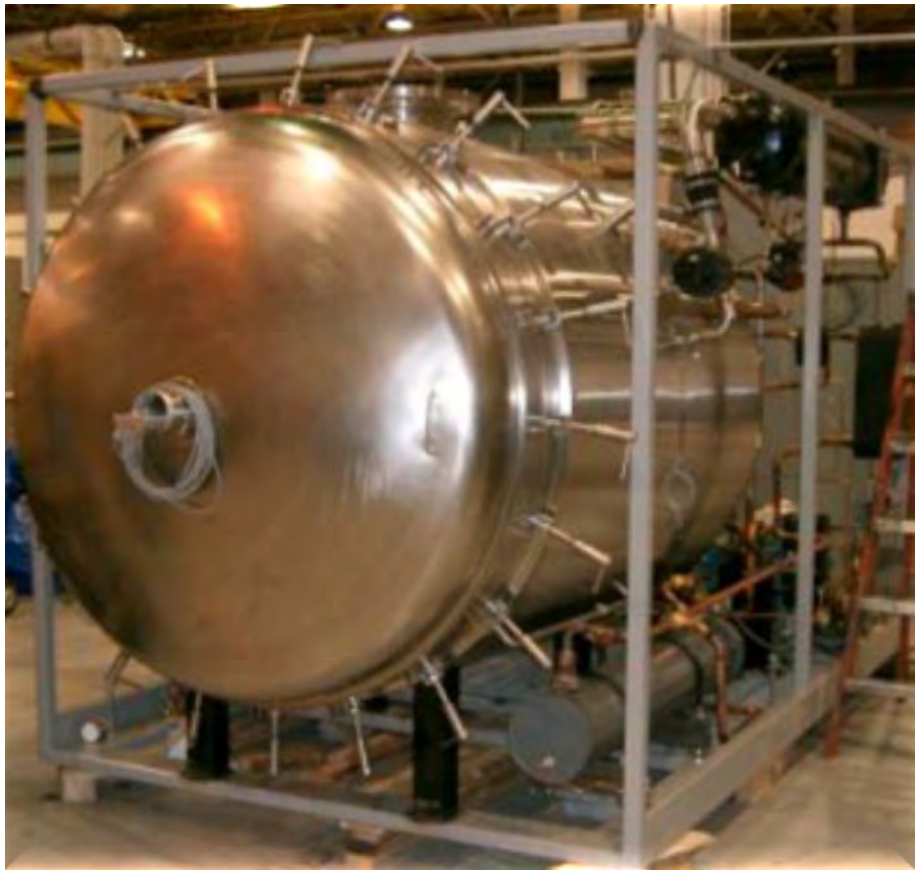

Benchmark 5000 Internal Condenser

When space saving is paramount and chamber isolation is not required

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Benchmark 5000
in Factory Acceptance Testing

Factory supplied FAT documentation helps shorten commission time and validates system performance

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Benchmarks Design Flexibilty to Meet any Need

- External & Internal Condensers.
- Steam sterilizable (SIP) option
- Clean-in-place (CIP) options

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Shelf Array Performance

Shelf to shelf +/-1.0°C at common measuring points under steady state conditions.

AISI type 316L stainless steel.

Ra25 standard Chamber and RA 32 condenser interior finish; an Ra 12 mirror finish is available as an options as well as electro-polishing.

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Shelves

Shelf stack temperature uniformity - heat transfer fluid circuit designed in *parallel* (rather than in sequence)

Stainless braided Teflon hoses transport the fluid in and out of the shelves.

A compensating radiant shelf is included ensuring all product is under the same conditions

Full shelf compression is achieved in all Benchmark stoppering models.

If room height is a problem we can reduce height of cylinder, and the shelves will have "daylight" between them at full stroke

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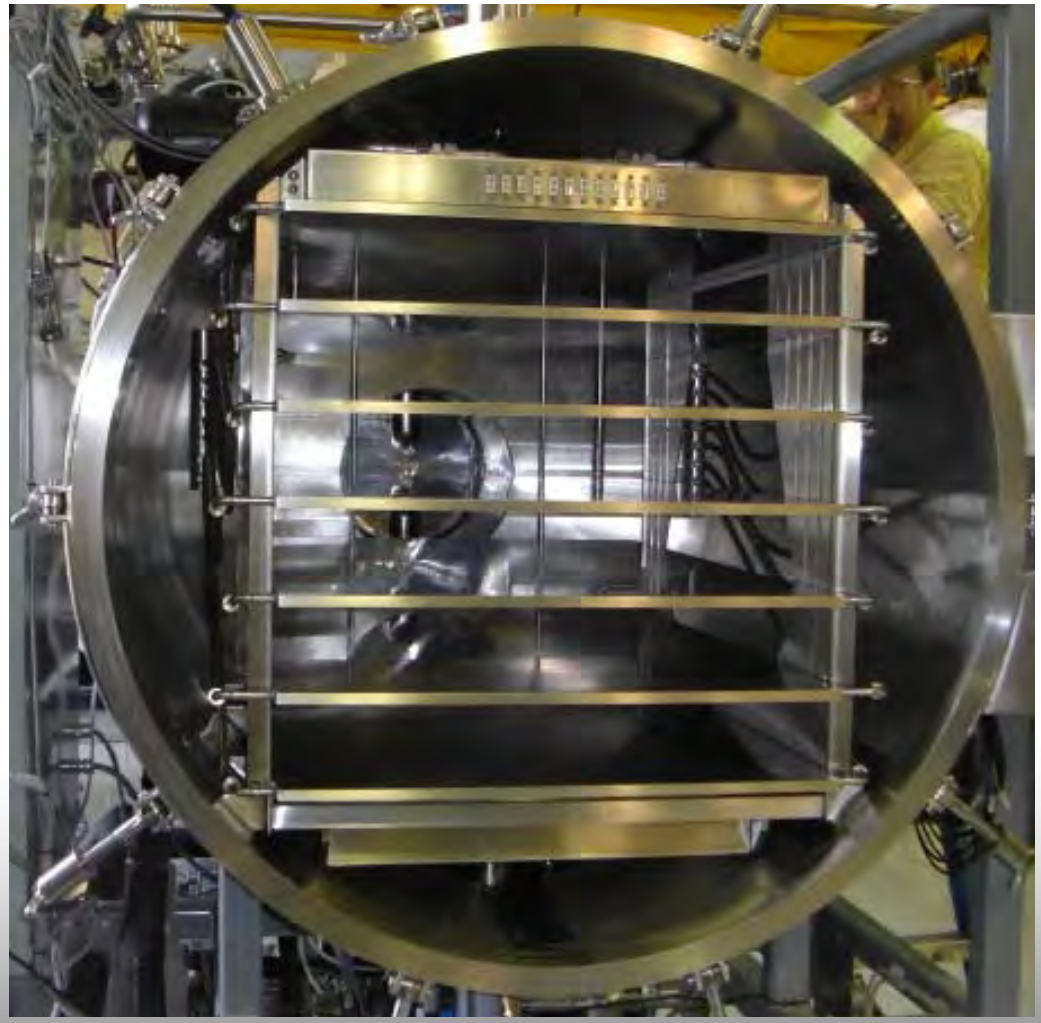
Bottom Up Stoppering



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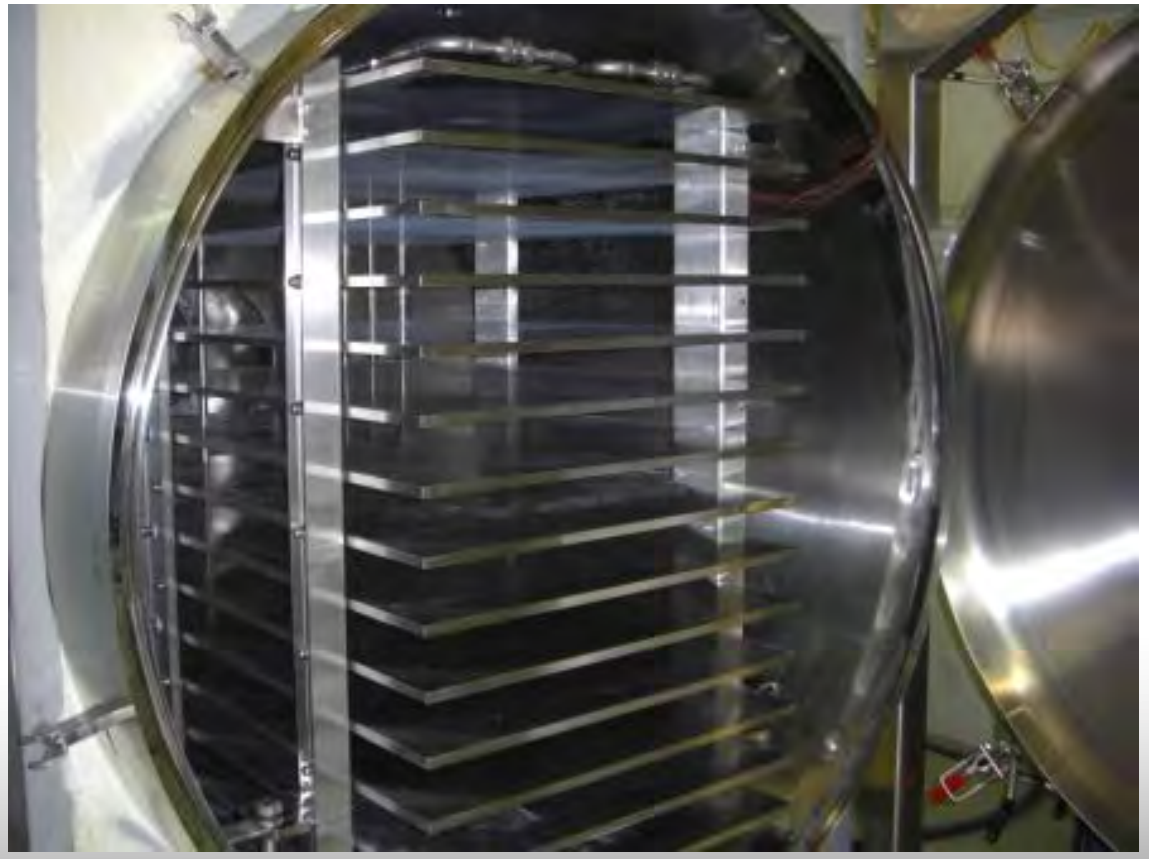
Bulk Fixed Shelf Stack
(watch the load height)



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ControLyo™ Nucleation On-Demand Technology

- Load vials onto shelf of Lyophilzer at 4ºC and equilibrate
- Pressurize system with inert gas (Nitrogen or Argon)
- Ramp temperature down to -4ºC and begin equilibration for 45'
- Depressurize to induce nucleation

All Steps are Programmed Into the Software

- Continue to ramp down to -45ºC to complete freezing step

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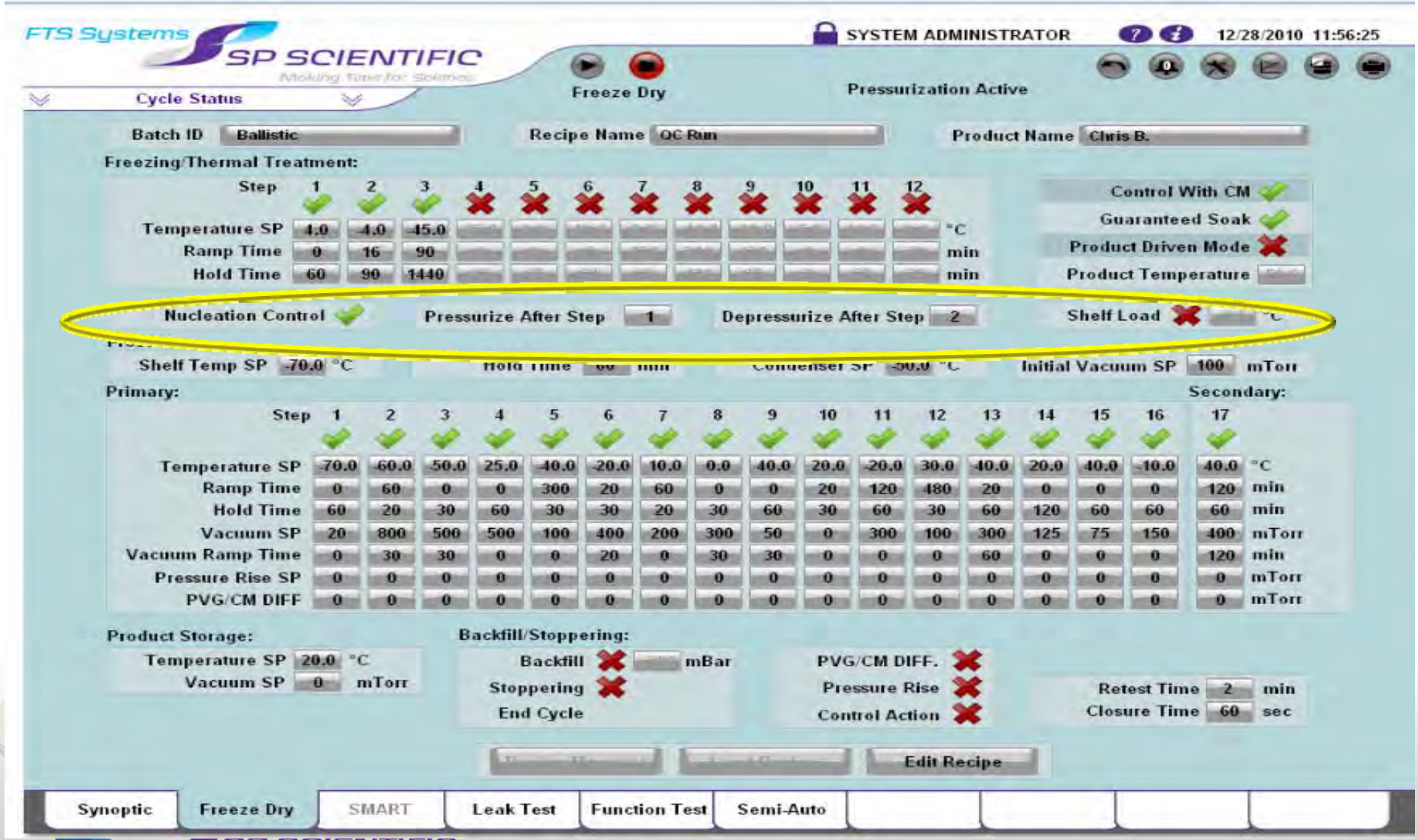
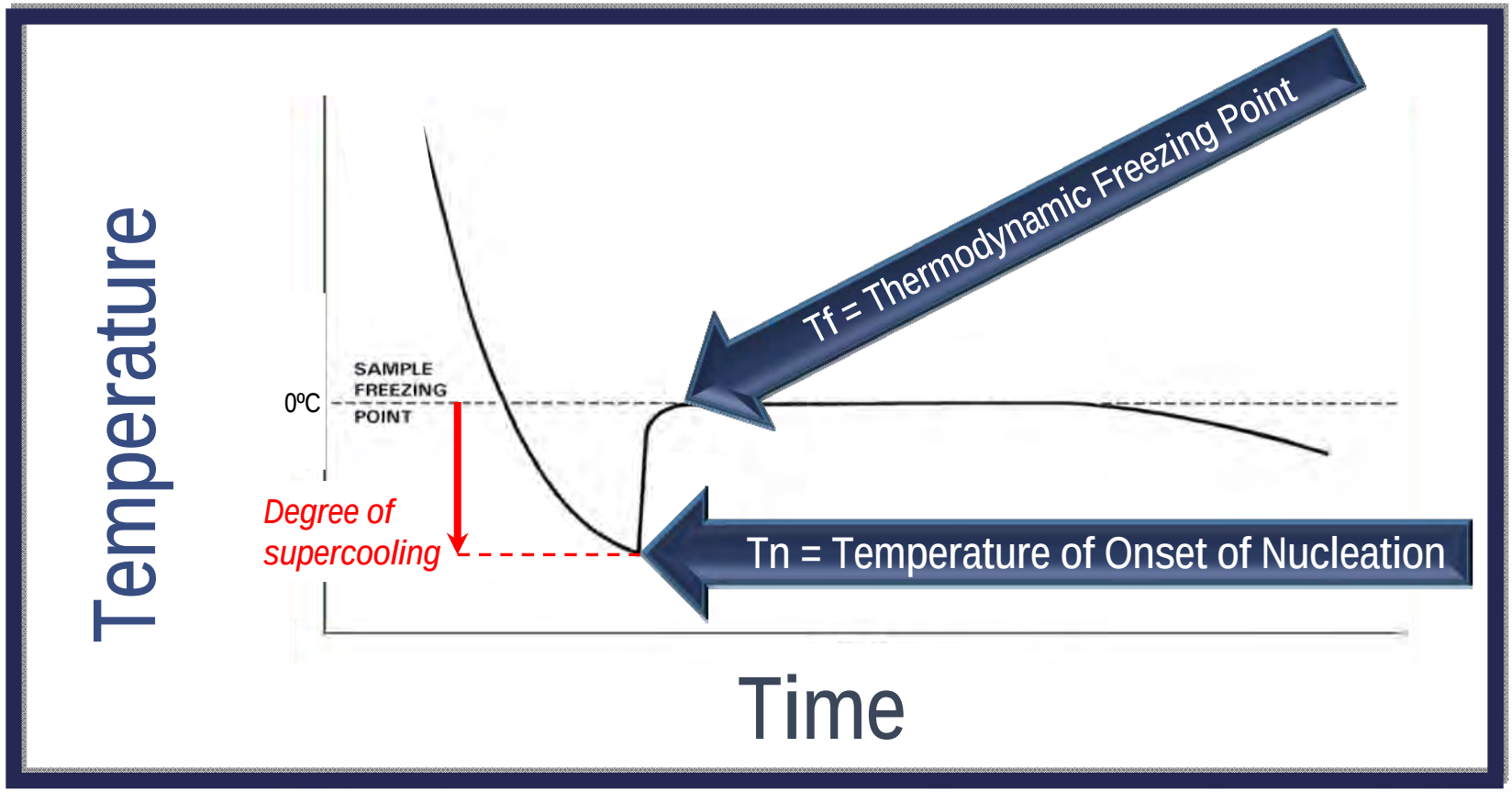
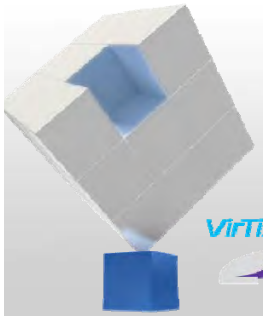
Lyos Software with *ControLyo™* Nucleation On-Demand Technology



Typical Freezing Curve of Water





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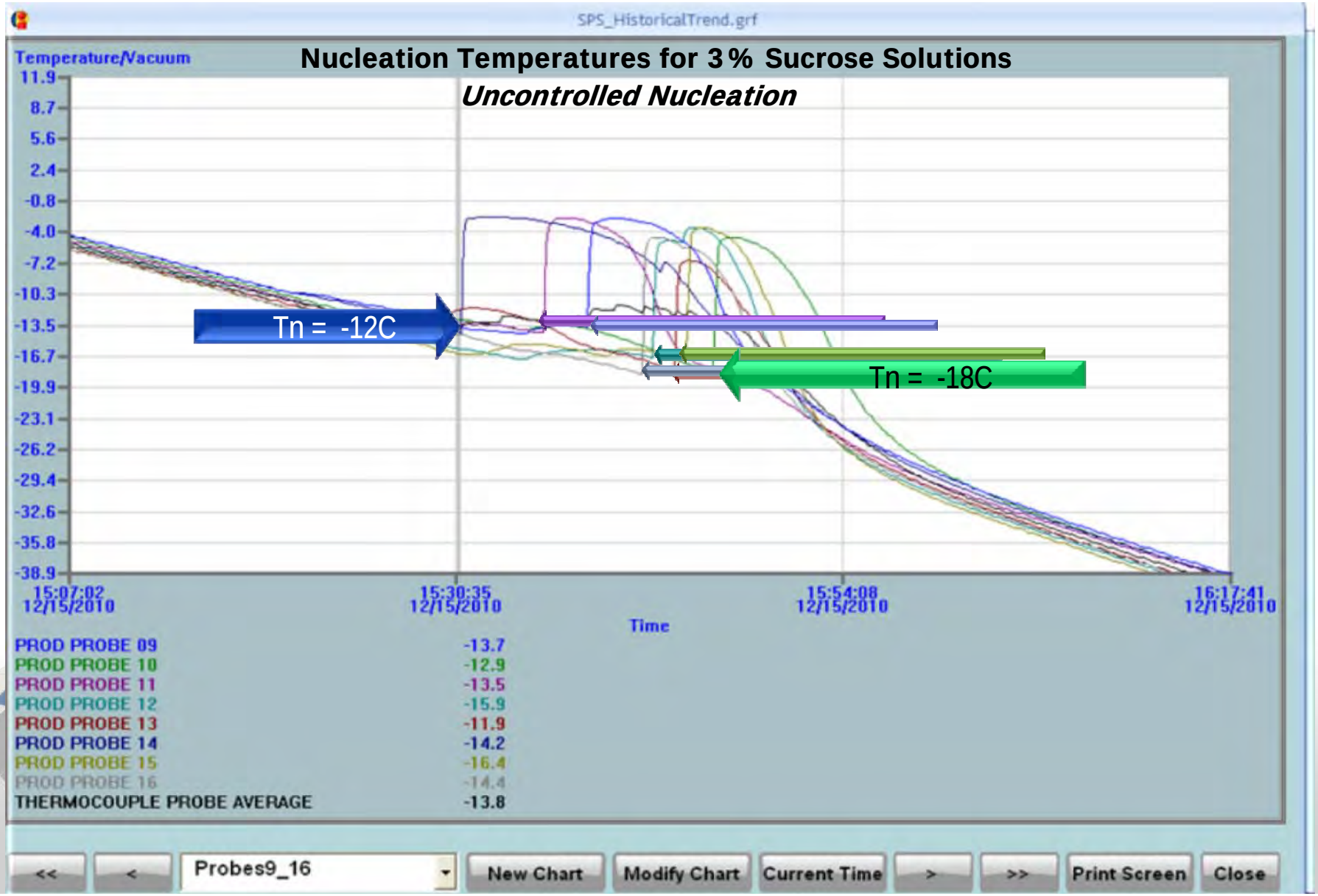
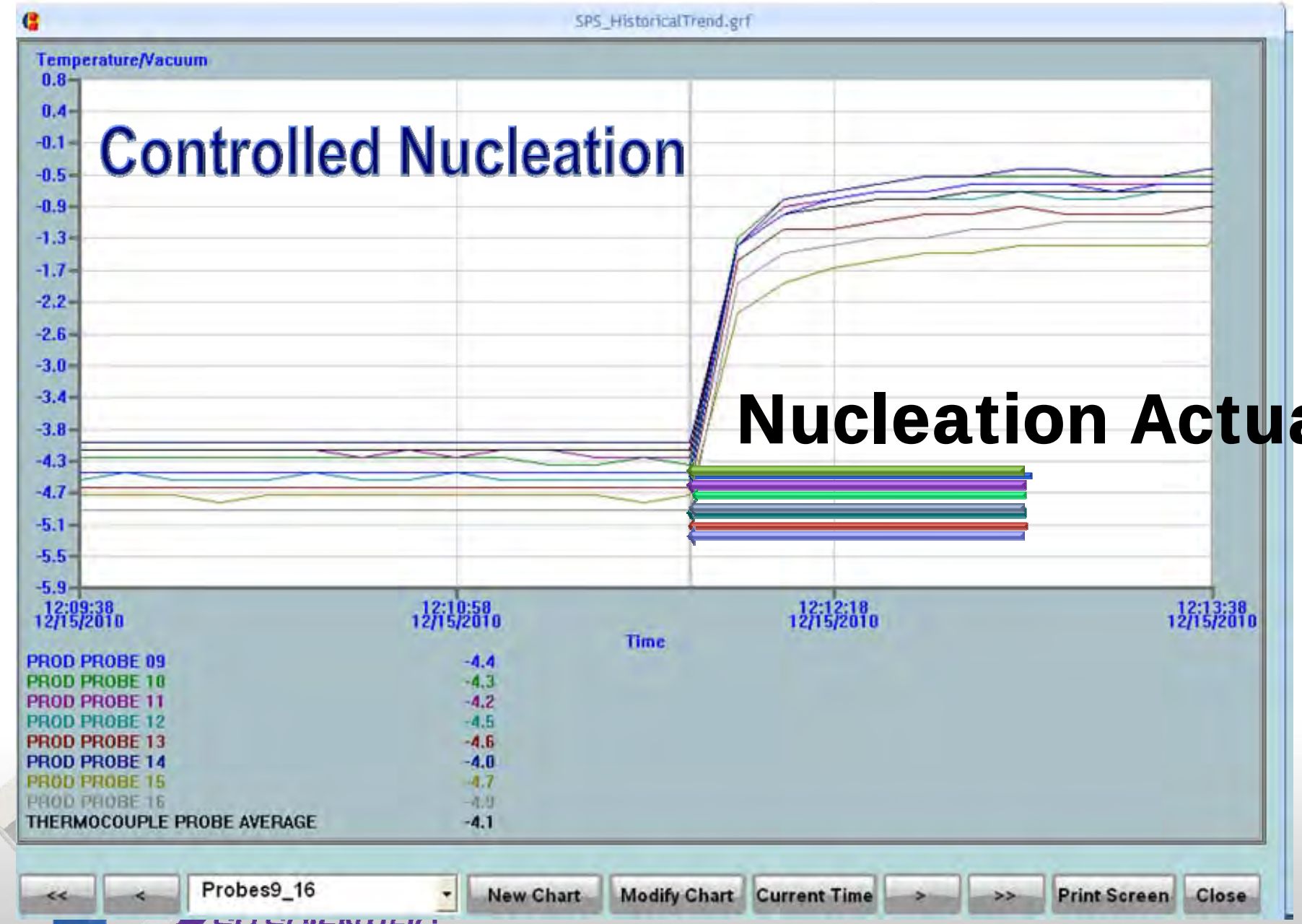
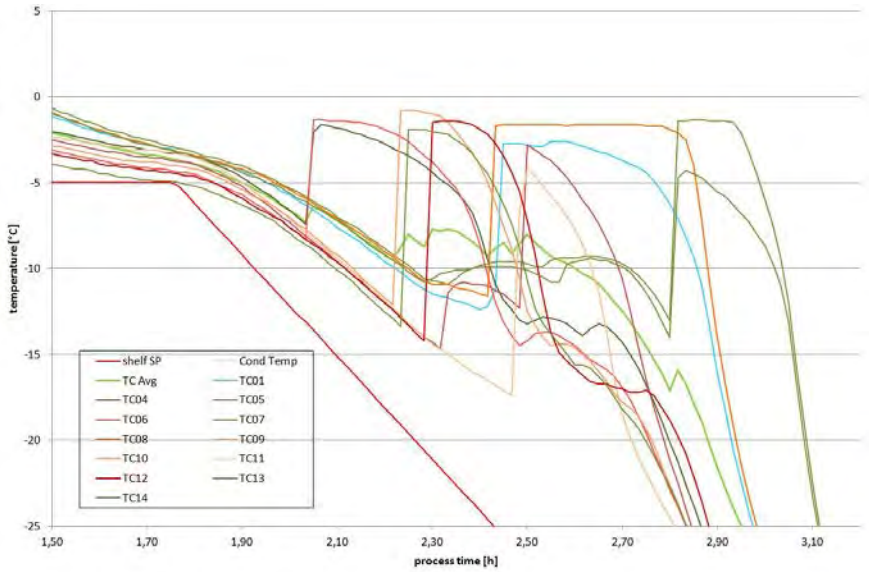
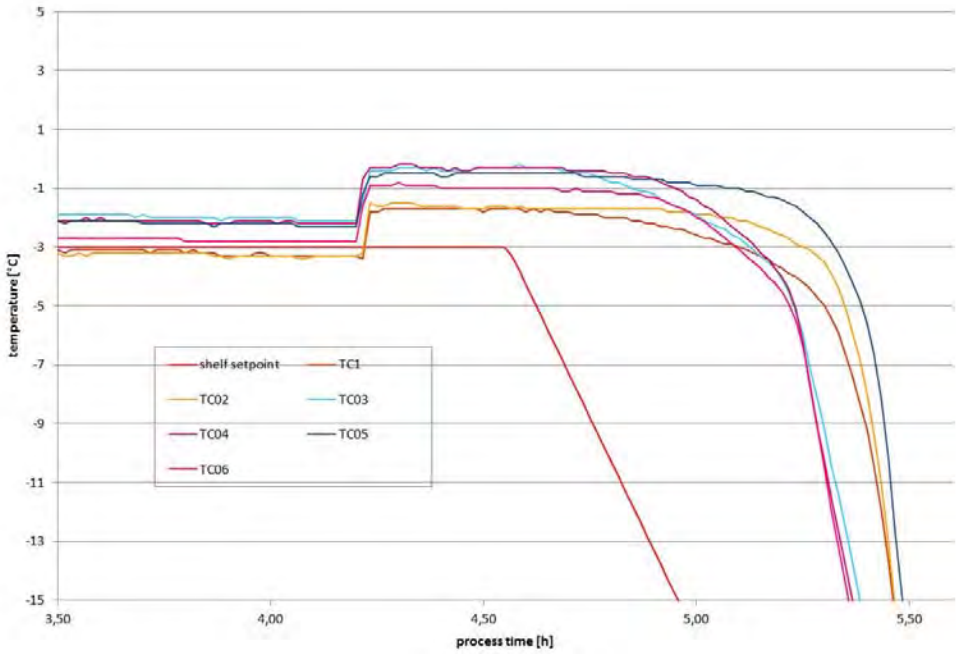
Uncontrolled Nucleation

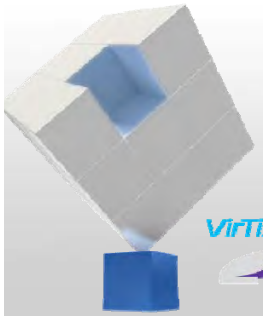



SPS_HistoricalTrend.grf
Temperature/Vacuum
0.8
0.4
-0.1
-0.5
-0.9
-1.3
-1.7
-2.2
-2.6
-3.0
-3.4
-3.8
-4.3
-4.7
-5.1
-5.5
-5.9
Controlled Nucleation
Nucleation Actuat
12:09:38 12/15/2010
12:10:58 12/15/2010
12:12:18 12/15/2010
12:13:38 12/15/2010
Time
PROD PROBE 09 -4.4
PROD PROBE 10 -4.3
PROD PROBE 11 -4.2
PROD PROBE 12 -4.5
PROD PROBE 13 -4.6
PROD PROBE 14 -4.0
PROD PROBE 15 -4.7
PROD PROBE 16 -4.9
THERMOCOUPLE PROBE AVERAGE -4.1
<<
<
Probes9_16
New Chart
Modify Chart
Current Time
>
>>
Print Screen
Close



Improved Uniformity





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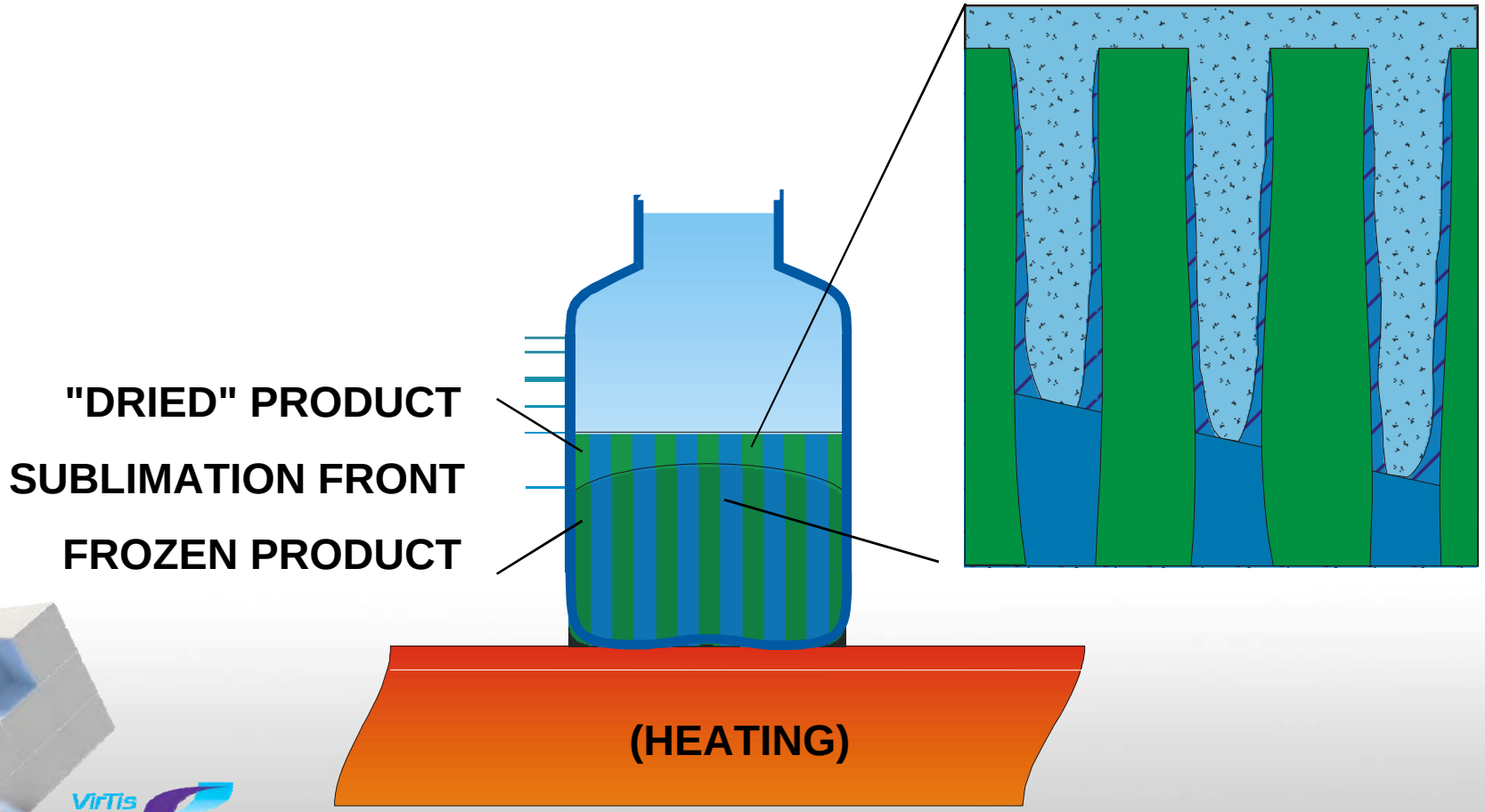
Primary Drying: Sublimation Front



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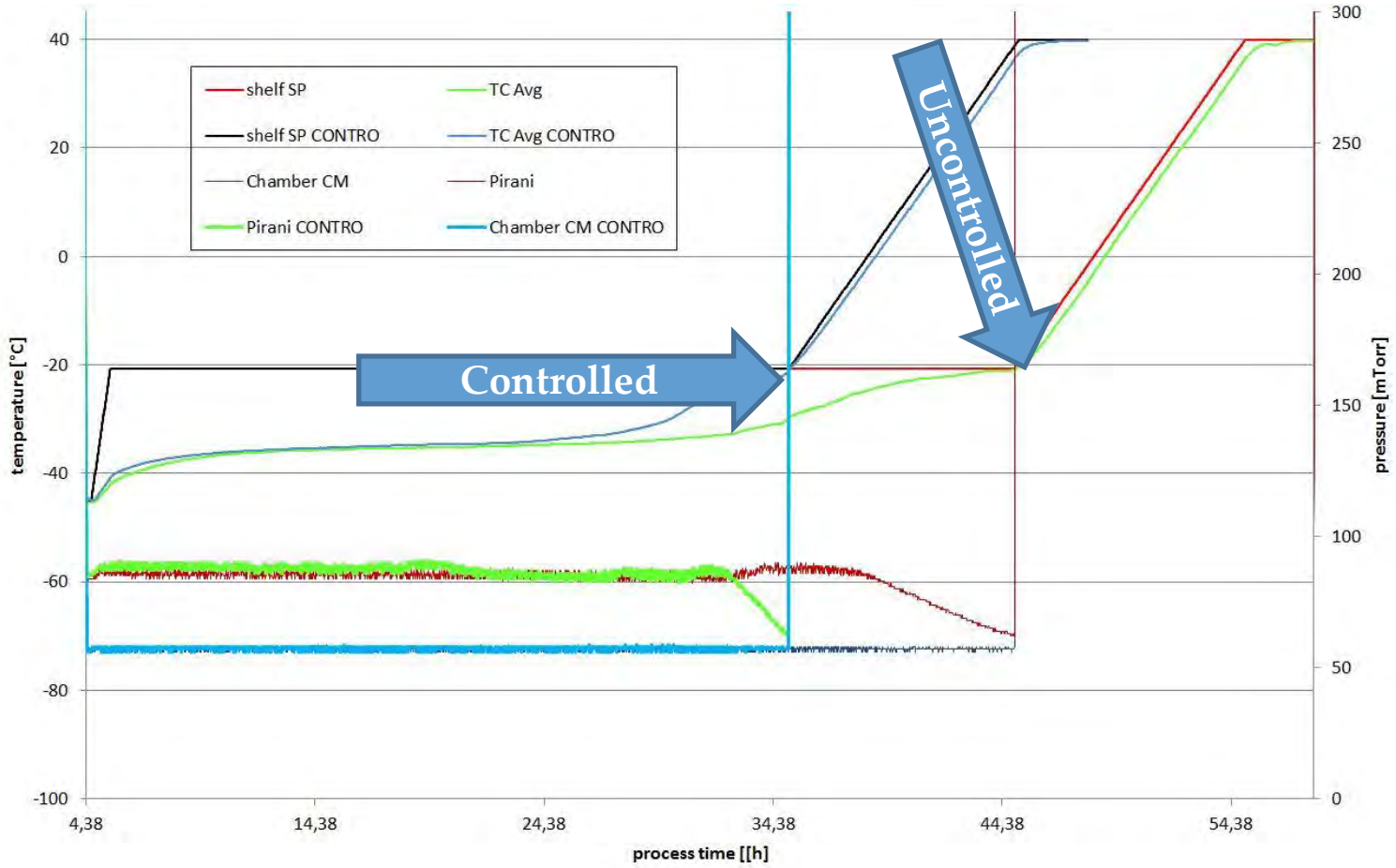
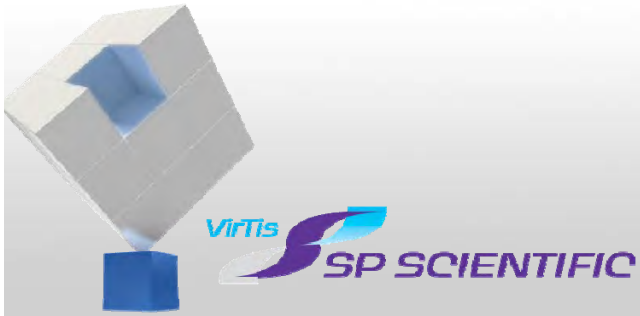

shelf SP
shelf SP CONTRO
Chamber CM
Pirani CONTRO
TC Avg
TC Avg CONTRO
Pirani
Chamber CM CONTRO
Controlled
Uncontrolled
temperature [°C]
pressure [mTorr]
process time [[h]
40
20
0
-20
-40
-60
-80
-100
300
250
200
150
100
50
0
4,38
14,38
24,38
34,38
44,38
54,38


VirTis
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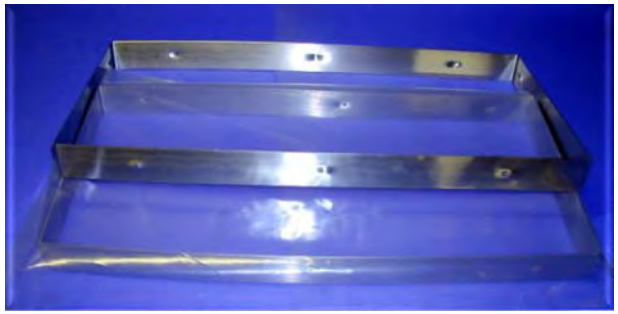
Experimental Demonstration of Benefits of Controlled Nucleation

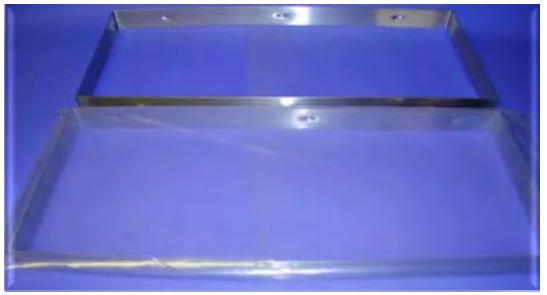
- Increase in pore size and reduction in dry layer resistance
- Faster primary drying
- Reduced freezing stress on biologicals
- Reduced reconstitution times
- Drying time optimization
- Improved cake appearance
- Reduced protein aggregation

Sever, R. 2010. Controlled Nucleation in Lyophilization. Effects on Process and Products. CPPR Freeze Drying Pharmaceuticals and Biologicals Conference. Oct. 1, 2010. Garmisch, Germany.

New Poly-Bottom Trays (Dissasembled)

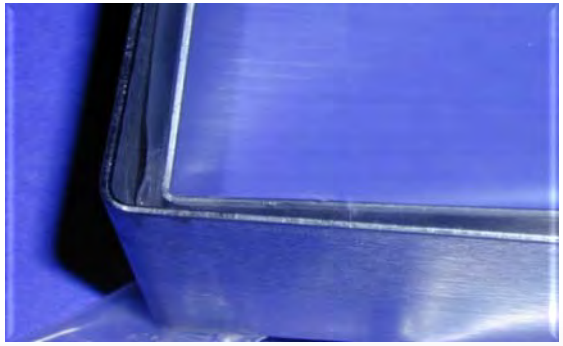


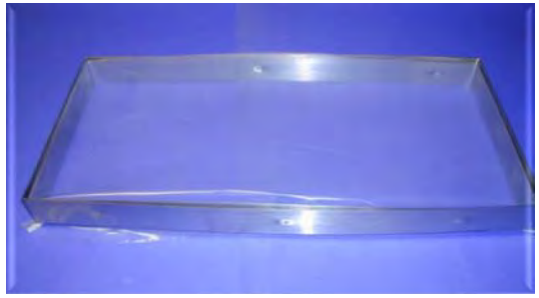
Poly bottom captured and upside down



Partially assembled with sheet ready to be captured between 'bands'

Detail showing poly between 'bands'





Fully assembled tray

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Optional Auto Locking Doors

Eliminates potential problems caused by manual latching

All latching occurs simultaneously and saves time with door closure

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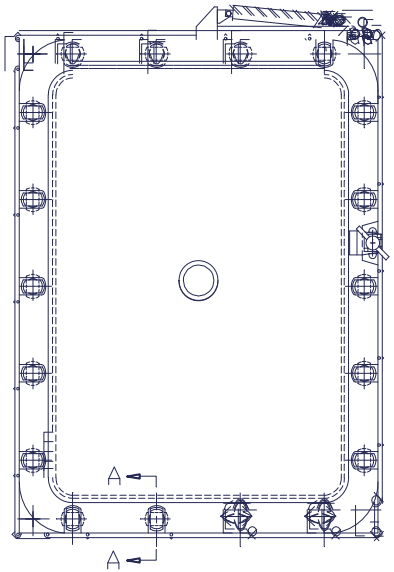
Auto locking door details



(FRONT VIEW)

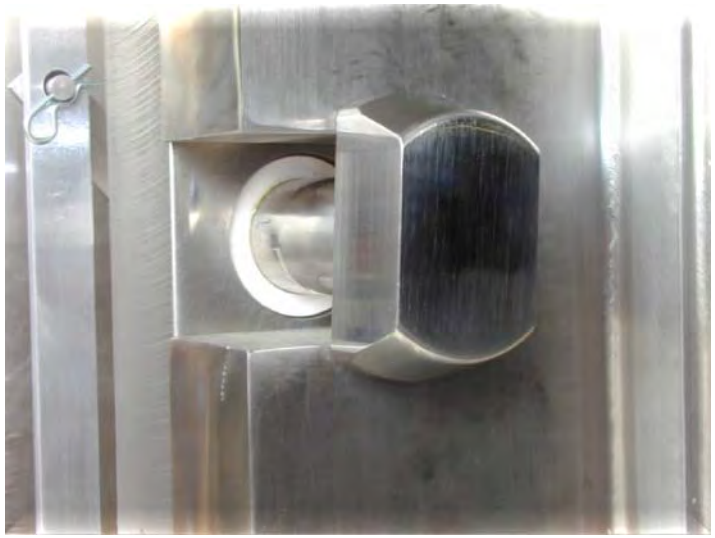
Automatic locking

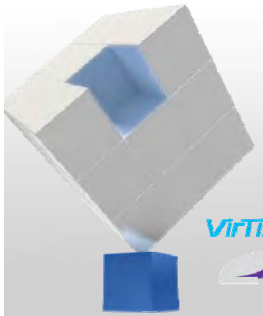
Separation between clean and mechanical spaces

Hydraulic and pneumatic versions

SIP ASME code compatible

Compatible with cylindrical or rectangular chambers





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"T" Handle Doors

Available as a cost saving for SIP units
Simplest technology

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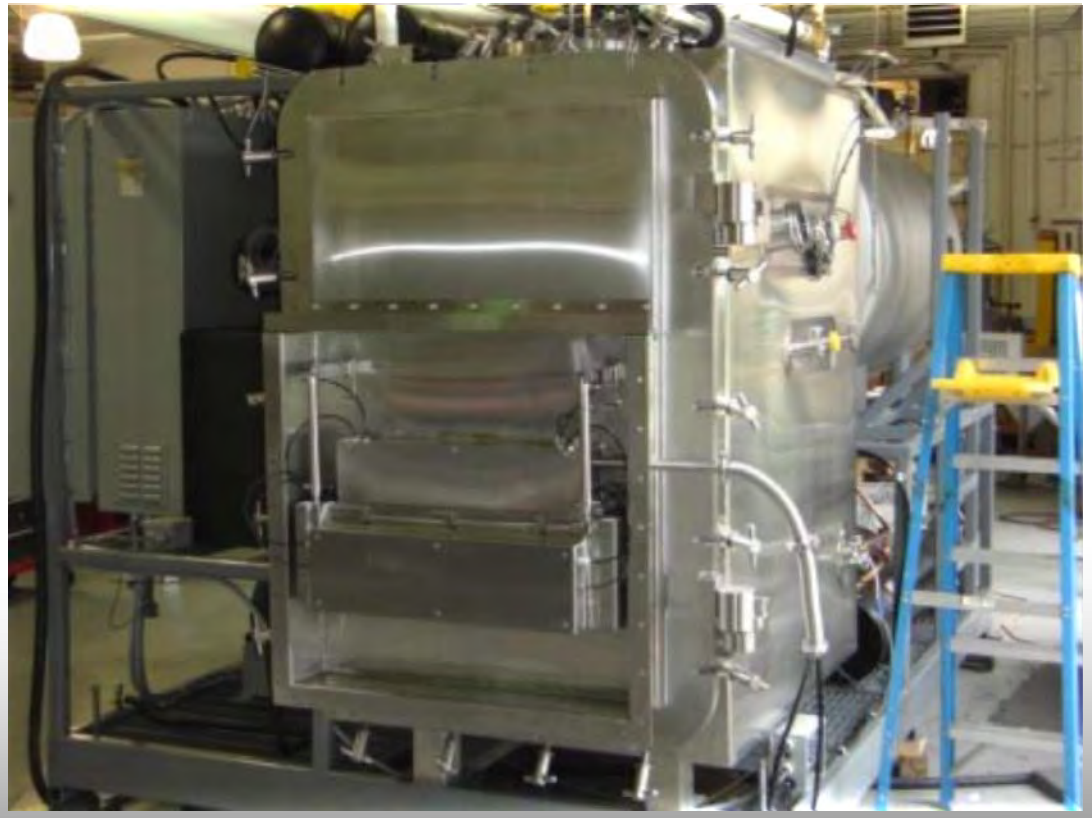
Auto-locking
Constant Level Loading Door



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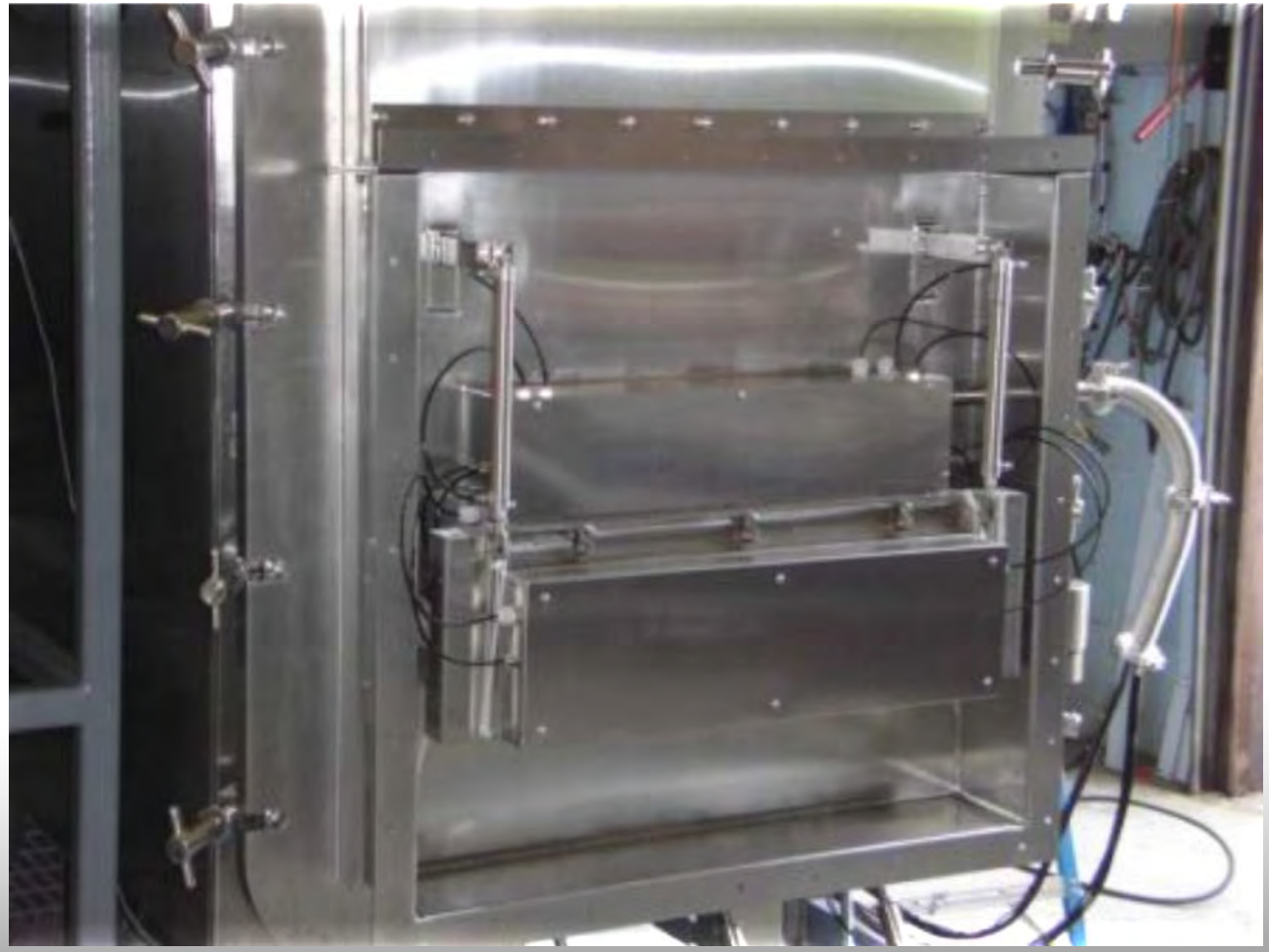
Door & Isolator Interface Detail



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Full Dress Panels

Dressed

Isolation Valve & Actuator
Valve Sized to Avoid Vapor Restriction

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Internal vs External Condensers

Internal Condenser

- **Cost efficiency**
- **Space saving**
- **Short vapor path**
- **Accessibility**

External Condenser

- Barometric control is possible (iso valve)
- Faster turn around
- Less chance of oil back-streaming
- Temperatures more uniform
- Higher ice capacities

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Condenser Load Testing at Factory with Customer Verification

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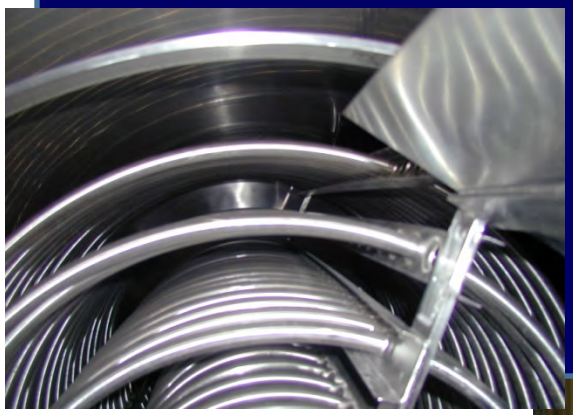
External Vertical Condenser



Top View

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Refrigeration Options

SL- Single compressor direct expansion
-60 C shelves –70C Condenser
EL – Cascade system direct expansion
-70 C Shelves –80C Condenser
LL - Dual compressors in parallel direct expansion
-60 C Shelves –75CCondenser
RSL –Redundant system fluid condenser
–60C shelf –65 C Condenser
Upgrades to Screw compressors

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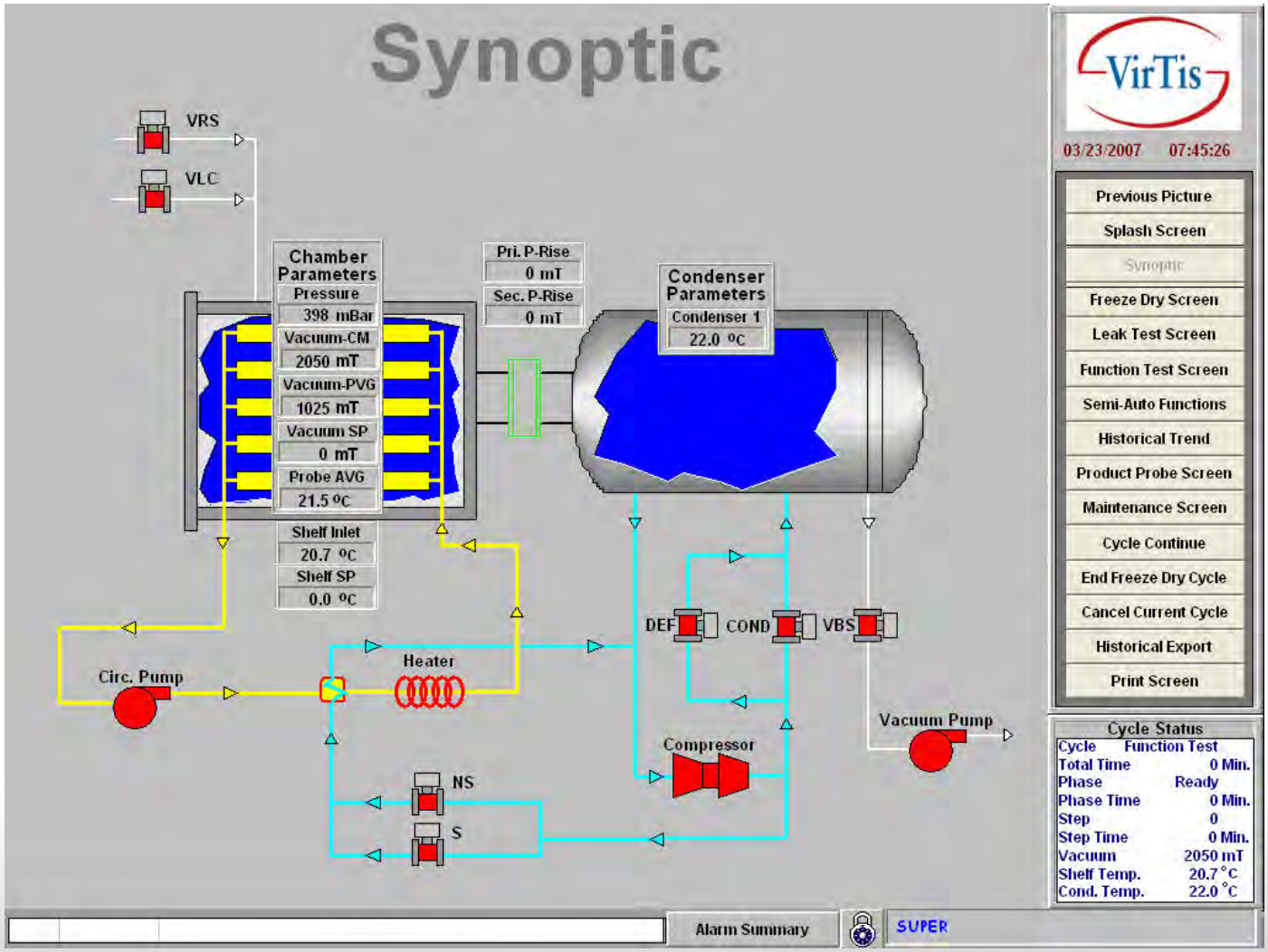
Typical SL Synoptic (External)

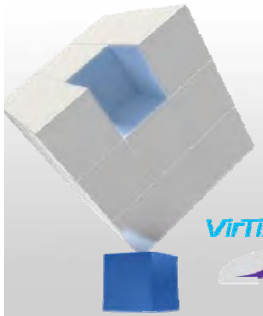
Basic Components:

White – Vacuum

Yellow – Heat Transfer

Blue – Refrigeration





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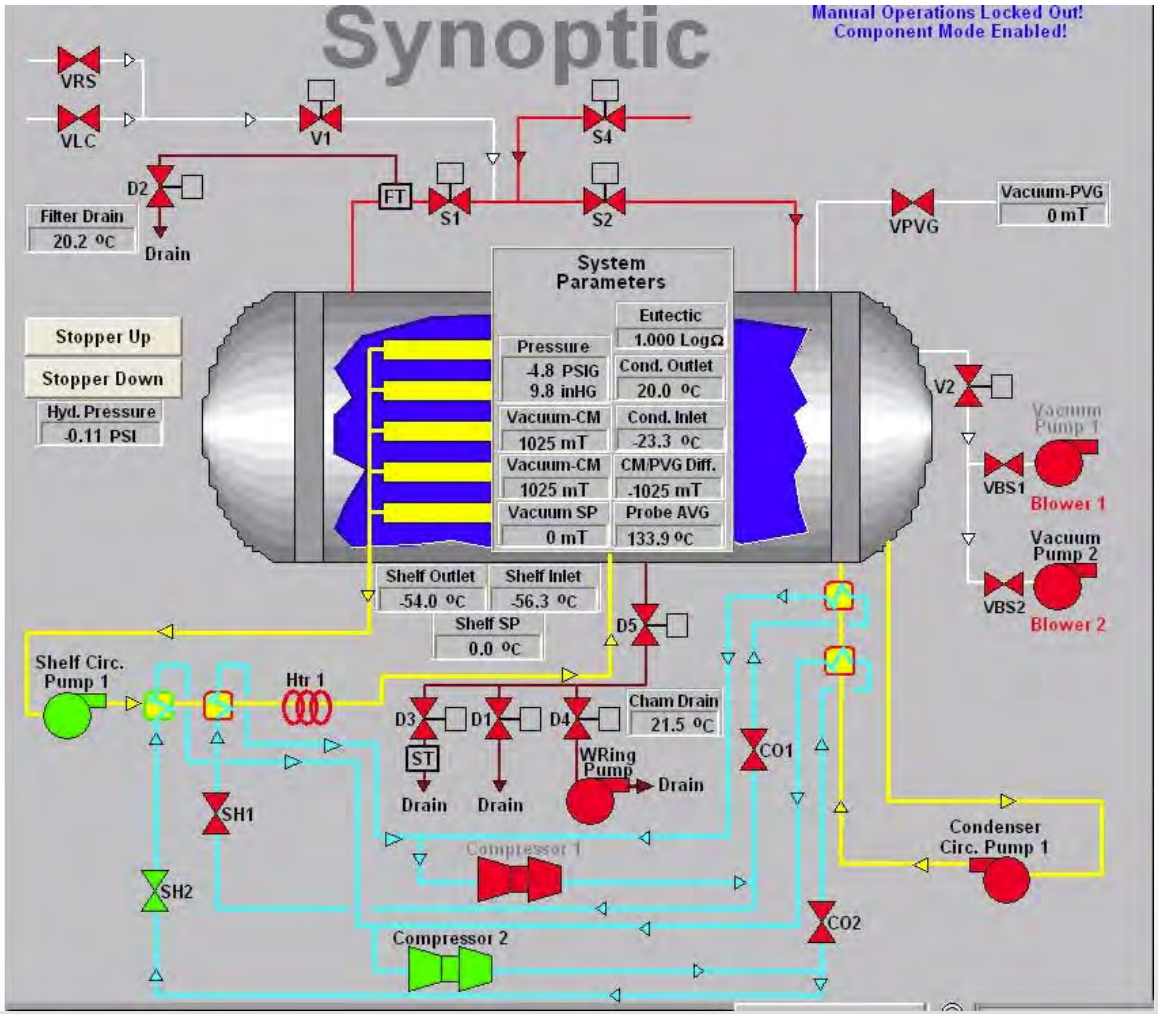
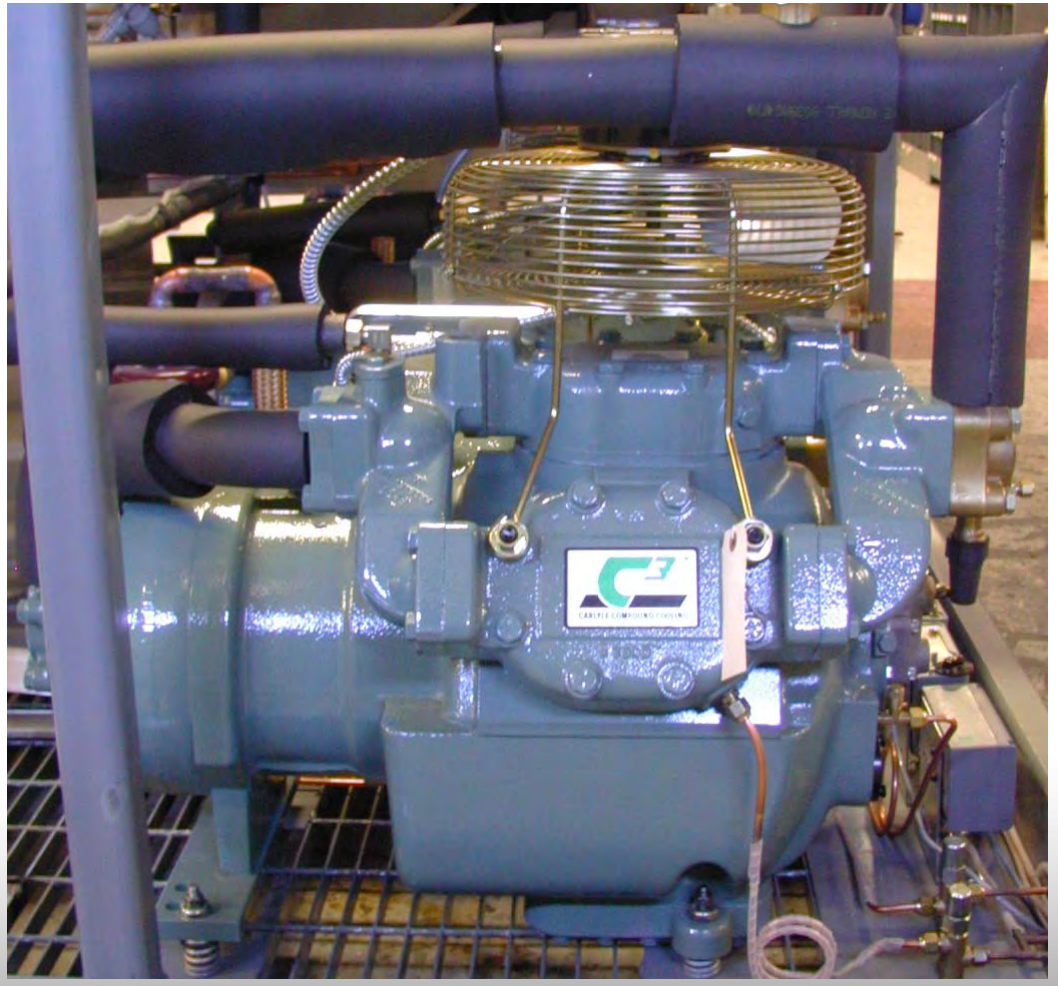
Redundant Compressors and Pumps (Internal & SIP)



VirTis SP SCIENTIFIC

Carlyle Reciprocating Compressors

- Worldwide availability
- Rugged & dependable
- Fiscally responsible



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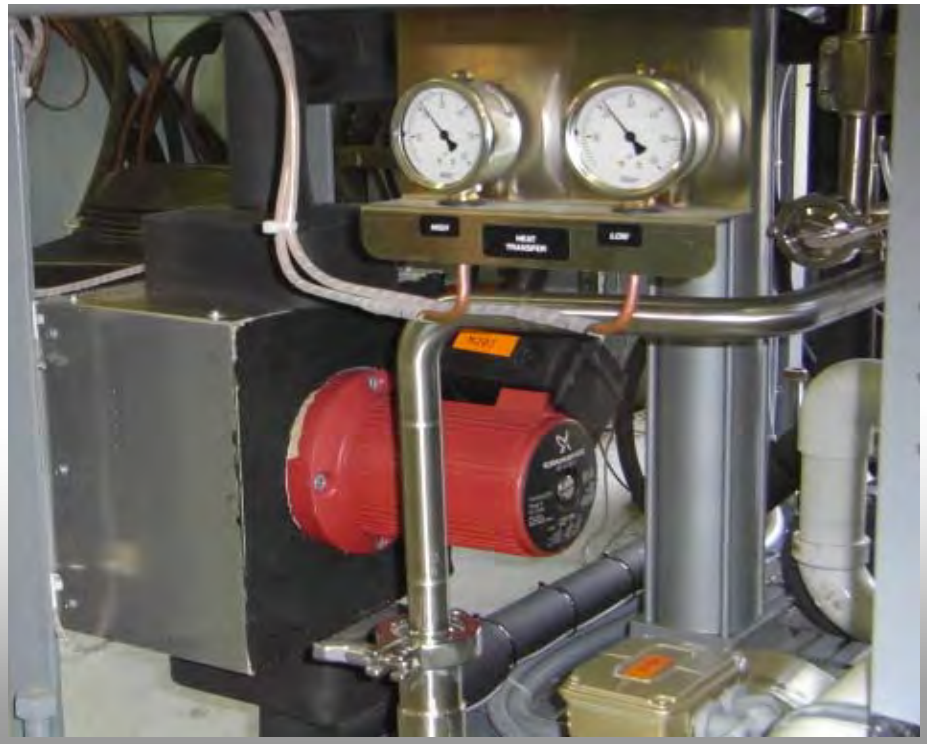
Refrigeration Gauges

Heat Transfer Pump



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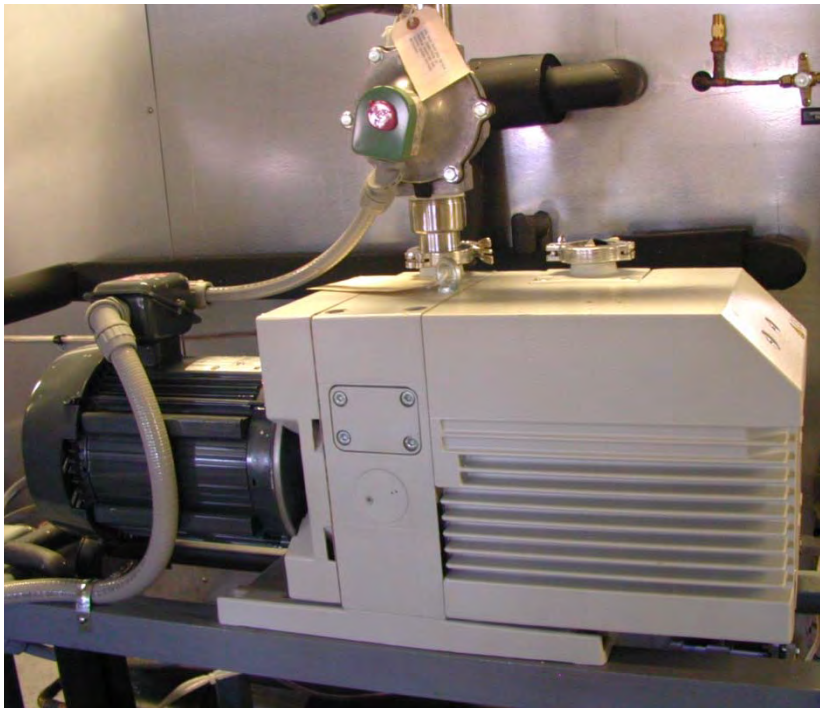
Leybold Vacuum Pumps



Vacuum Pumps with Roots Blowers

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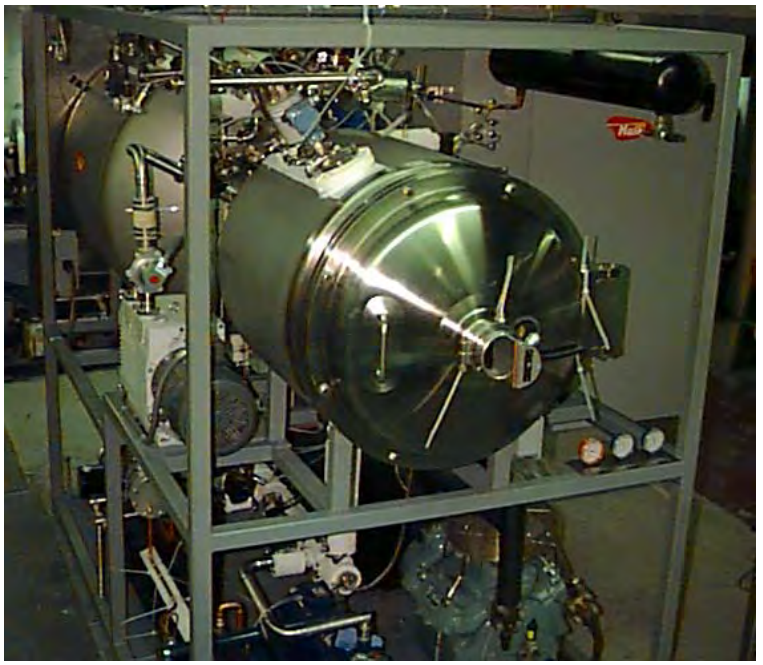
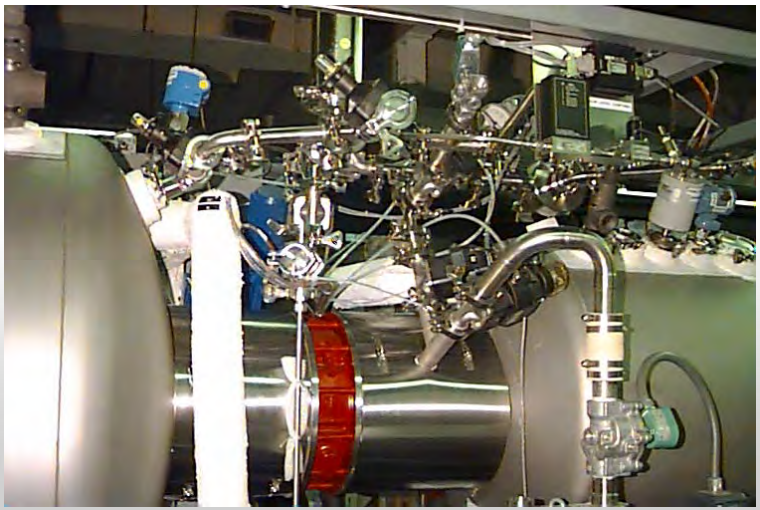
Steam in Place (SIP)

- Injectibles SIP
- Longer Lead Time
- ASME Pressure vessel
- Orbital Welding
- $Paperwork$





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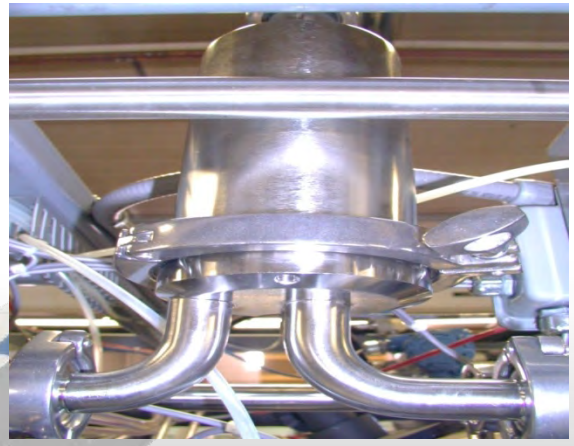
Pressure and Vacuum sensors mounted on Triclover connections

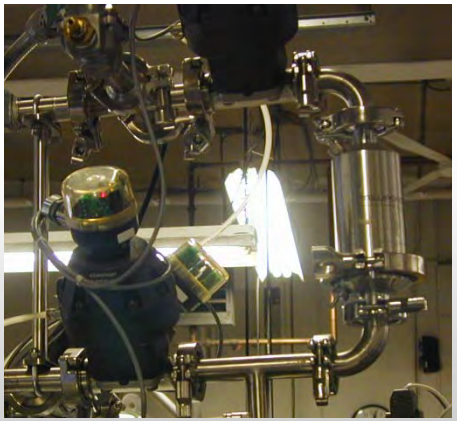
Heated Head Capacitance Manometer

Ceramic Thermocouple Jacks

0.2 Micron Hydrophobic N2 Filter



Clean Diaphragm Valves



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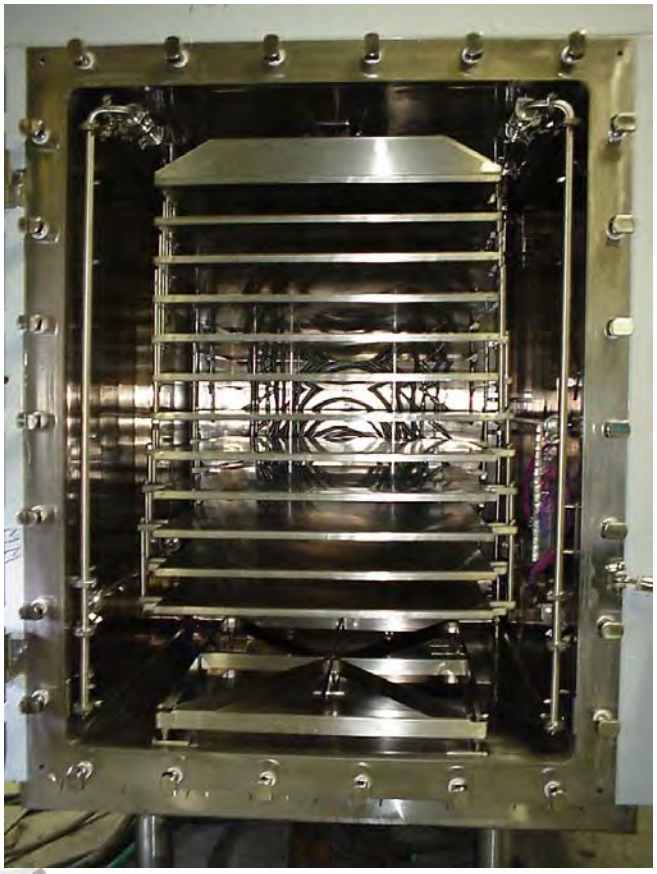
Clean-In-Place (CIP)



- Cleaning in place includes spray nozzles in the chamber and condenser
- Used to remove cyto-toxic products or insoluble residues

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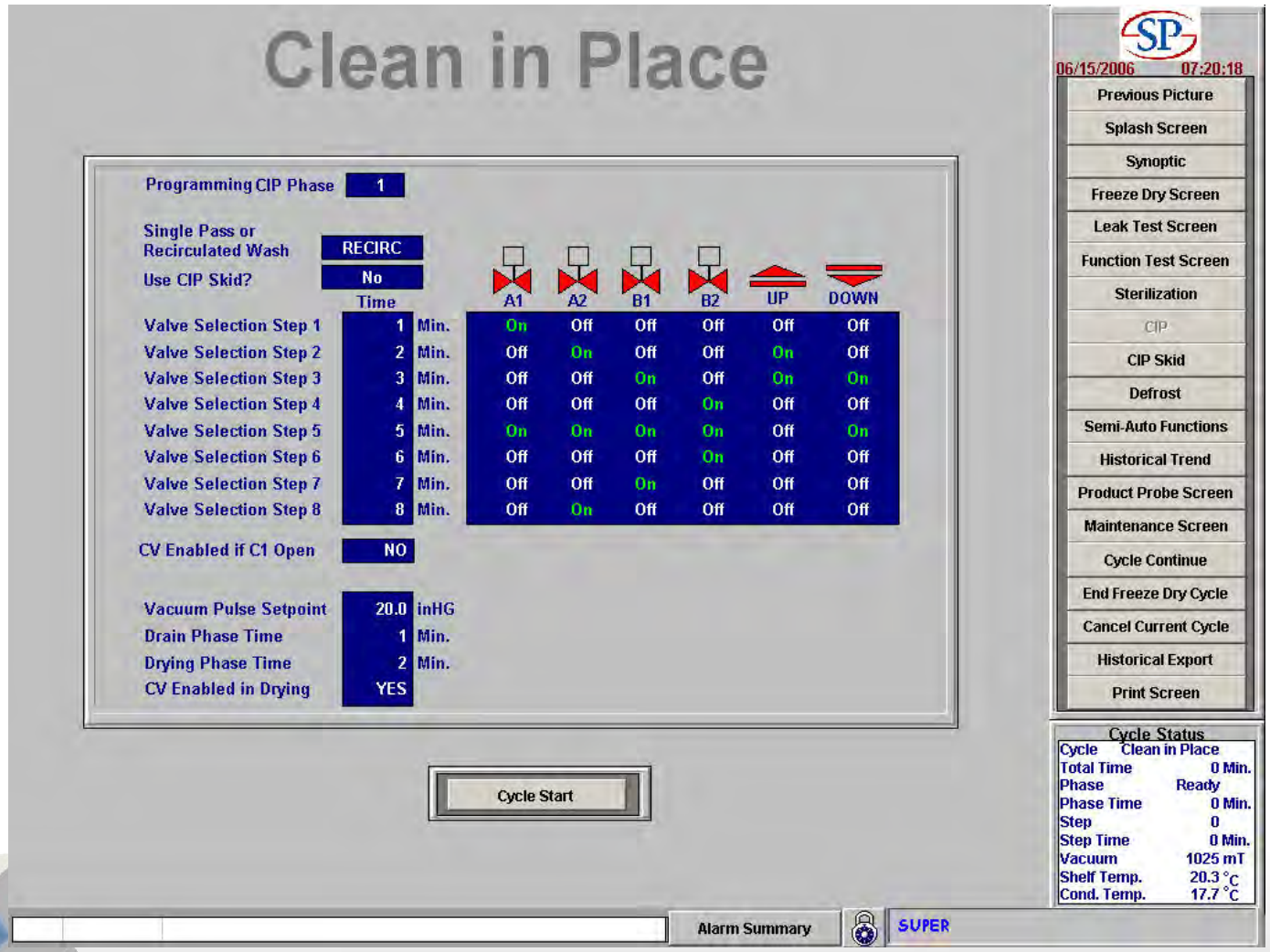

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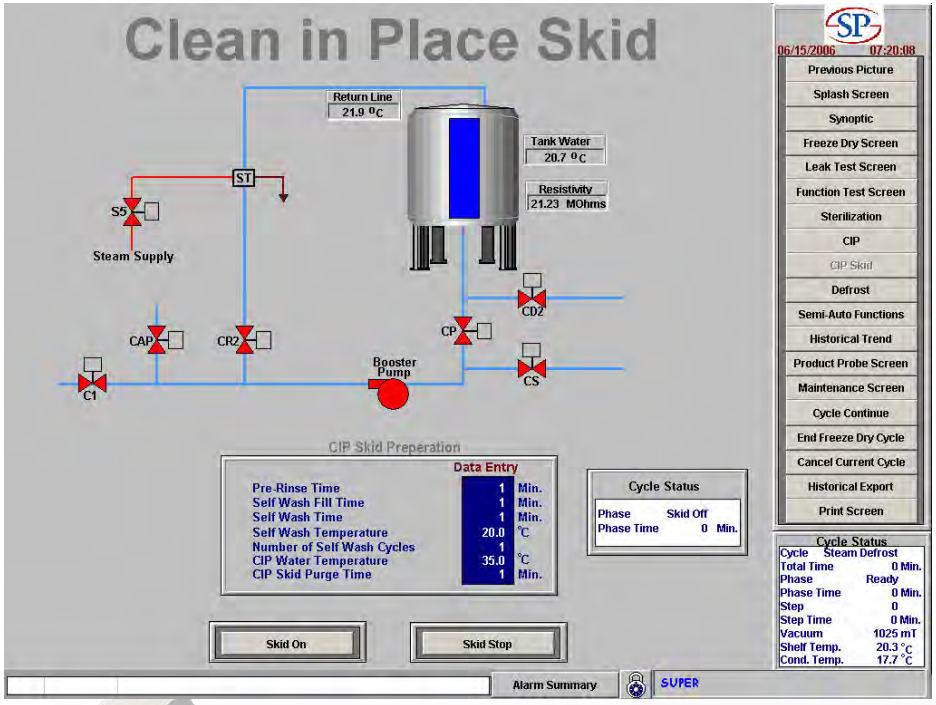
CIP Skid



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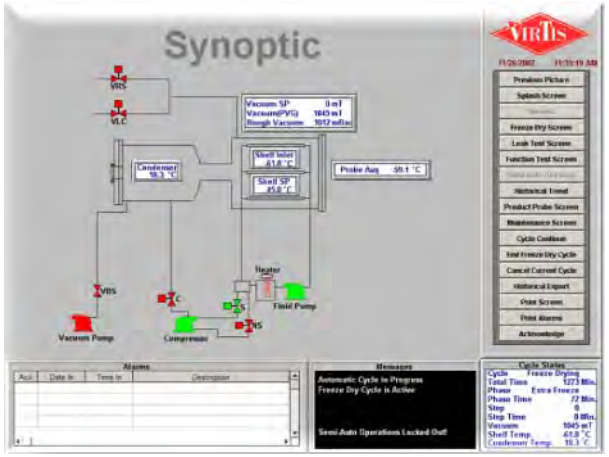
Benchmark Control Platforms

Encore

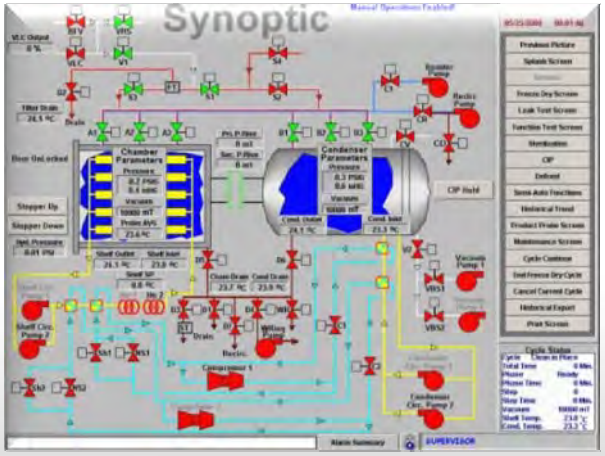
Allen Bradley Micrologix controller. Many of the features available on the more expensive Maestro but limited options to keep the cost down. BE, EC-1, CM, PRCM security historical data export all available

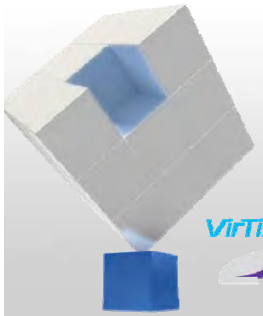
(Standard)



Maestro

SLC 5/03 AB controls offers world wide support for parts and service. The Maestro has additional options such as 21cfr11 compliant security and System Integration Testing, unlimited product probes, customized programming. Best choice for high tech R& D facilities or GMP production.





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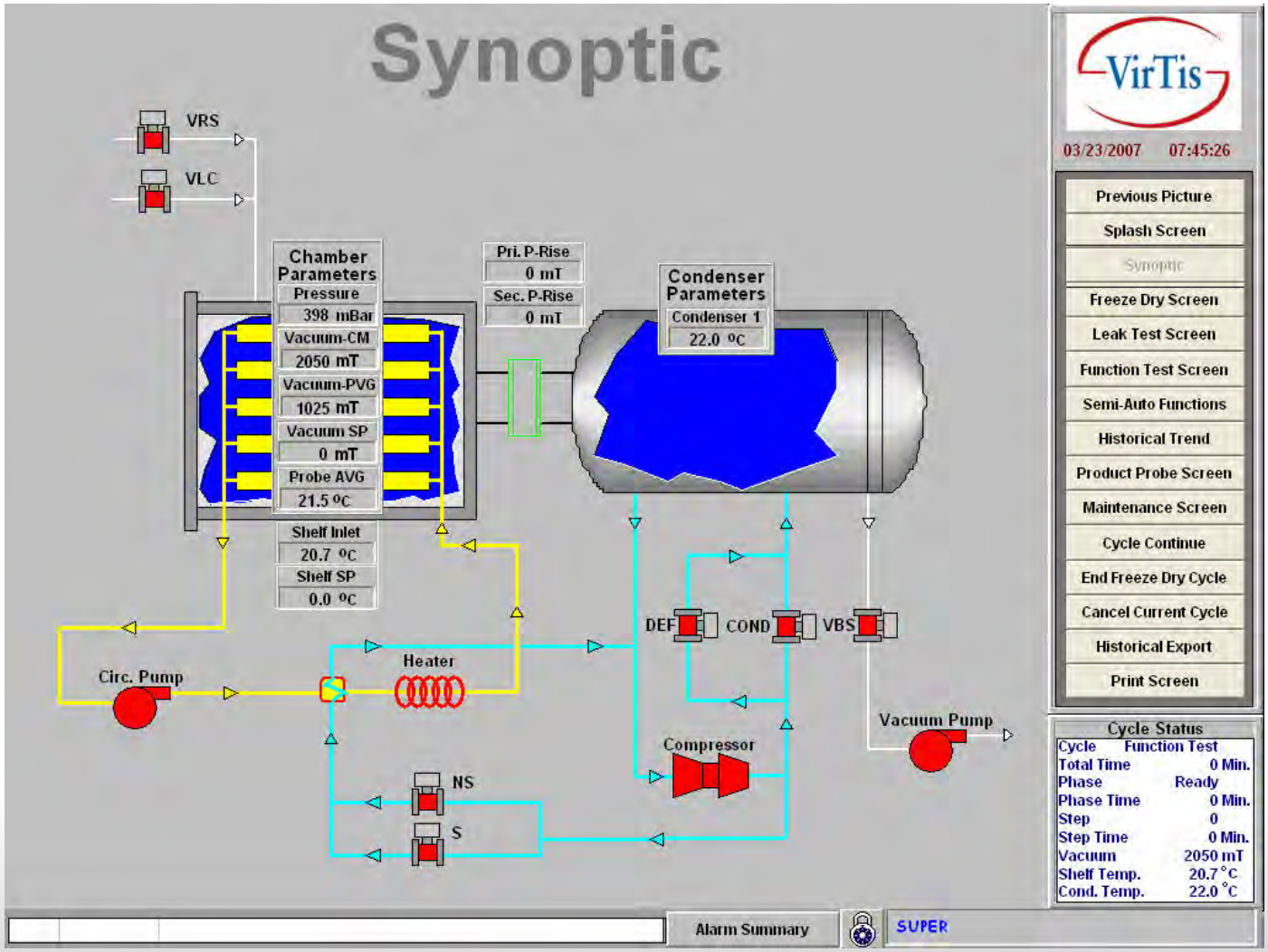
Controls

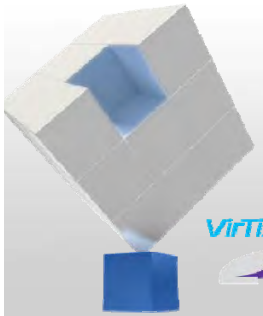
Basic Components:

White – Vacuum

Yellow – Heat Transfer

Blue – Refrigeration





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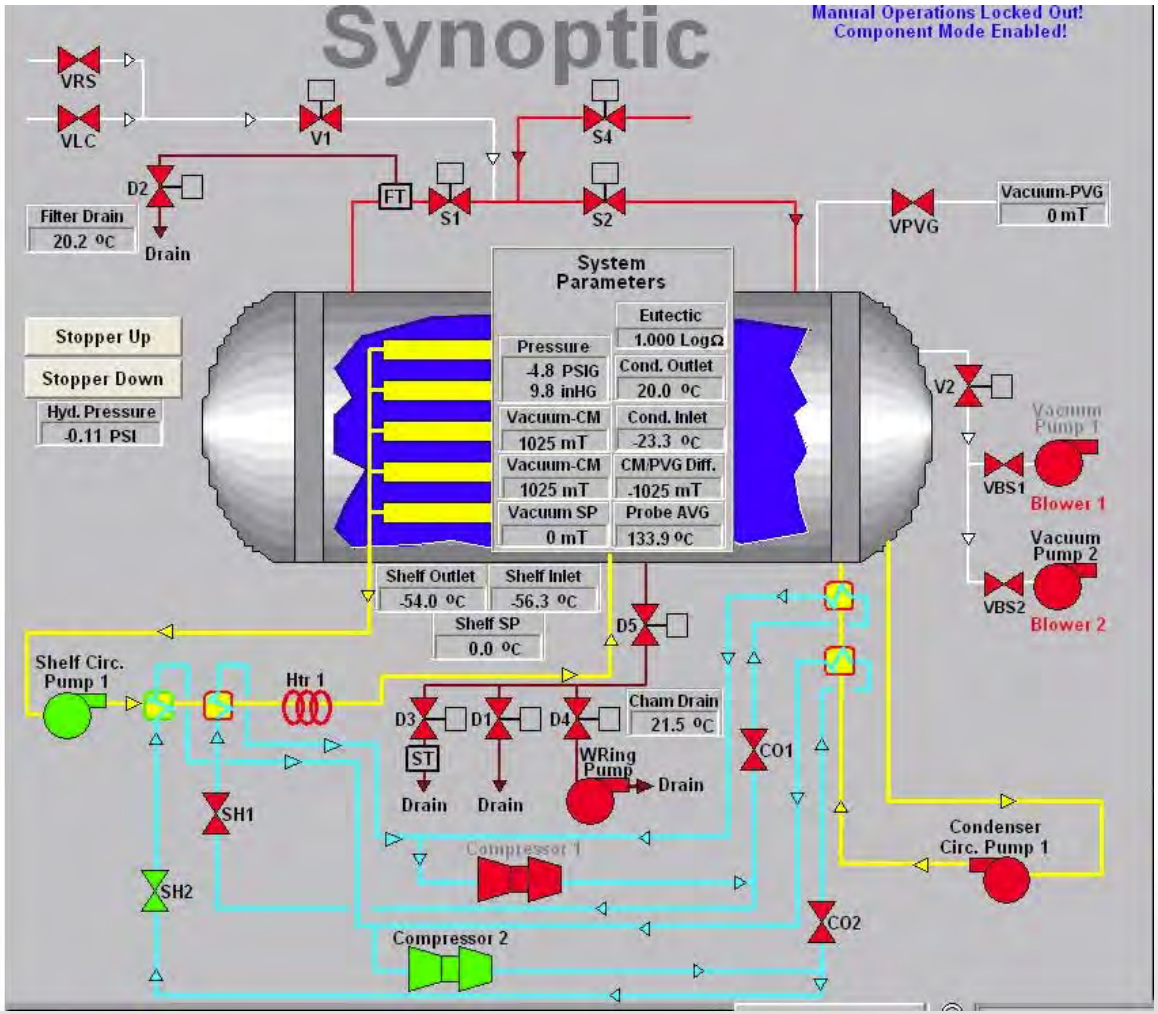
Redundant Compressors and pumps



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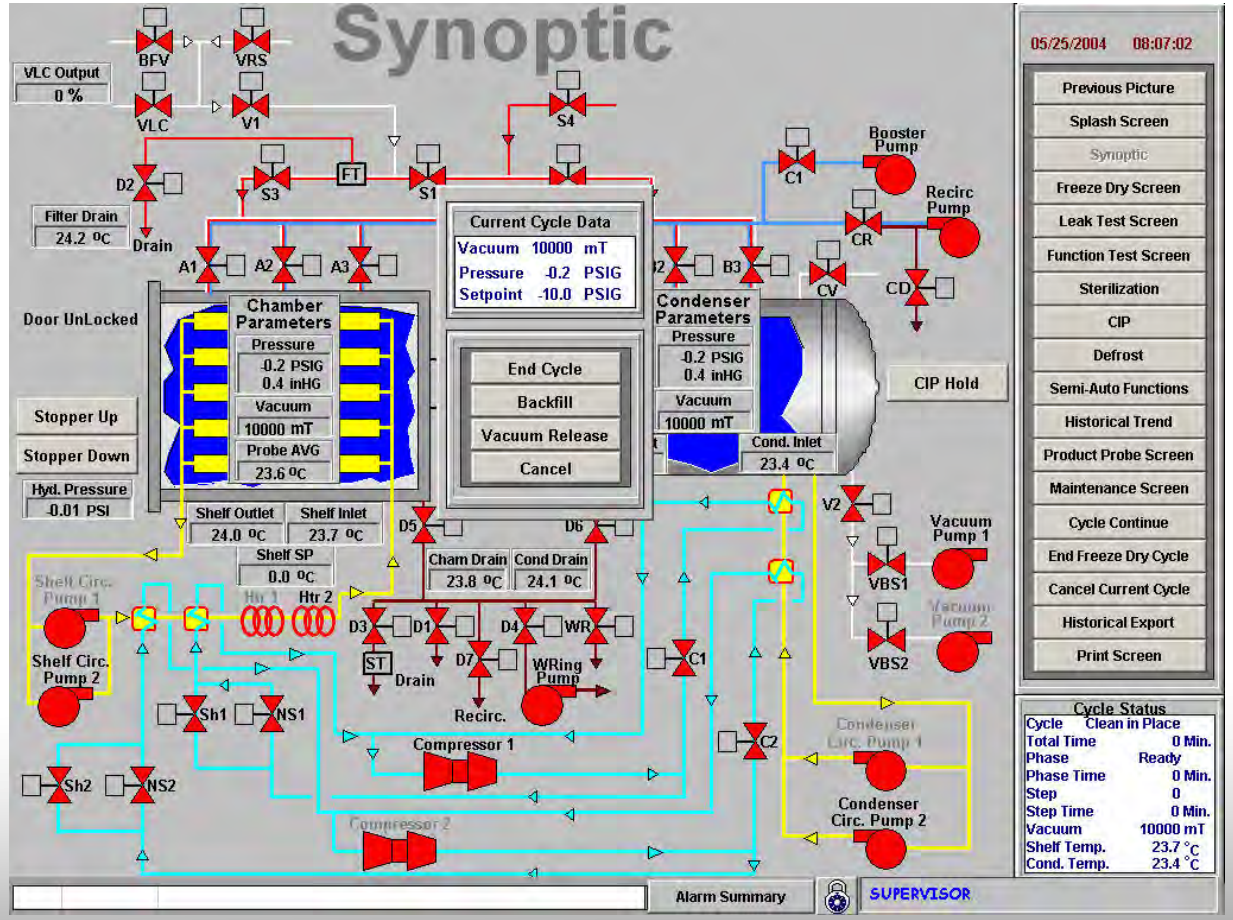
Full N + 1 Redundancy



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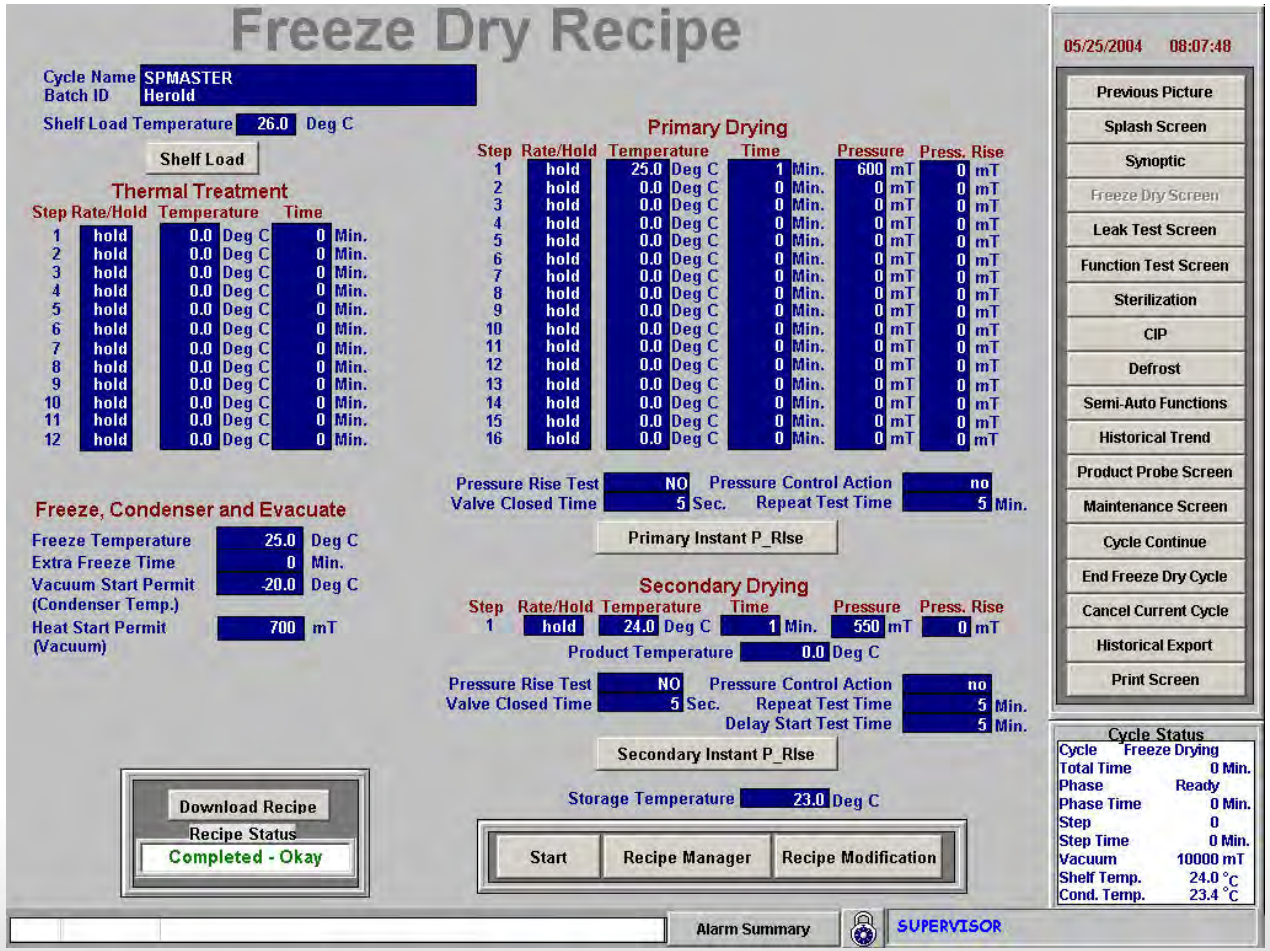
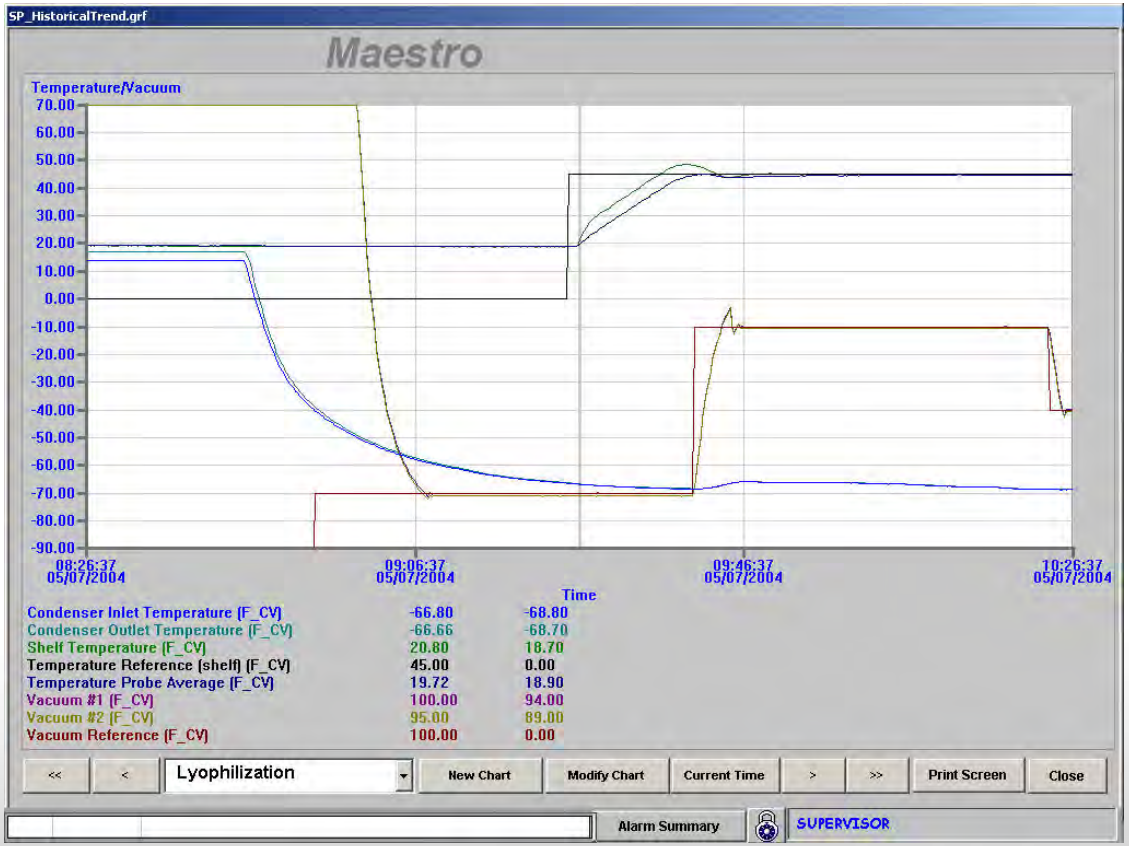
Intuitive Recipe Screen



VirTis SP SCIENTIFIC

Powerful Historical Trend Screen

Allows data to be viewed in any interval for any available recorded data.



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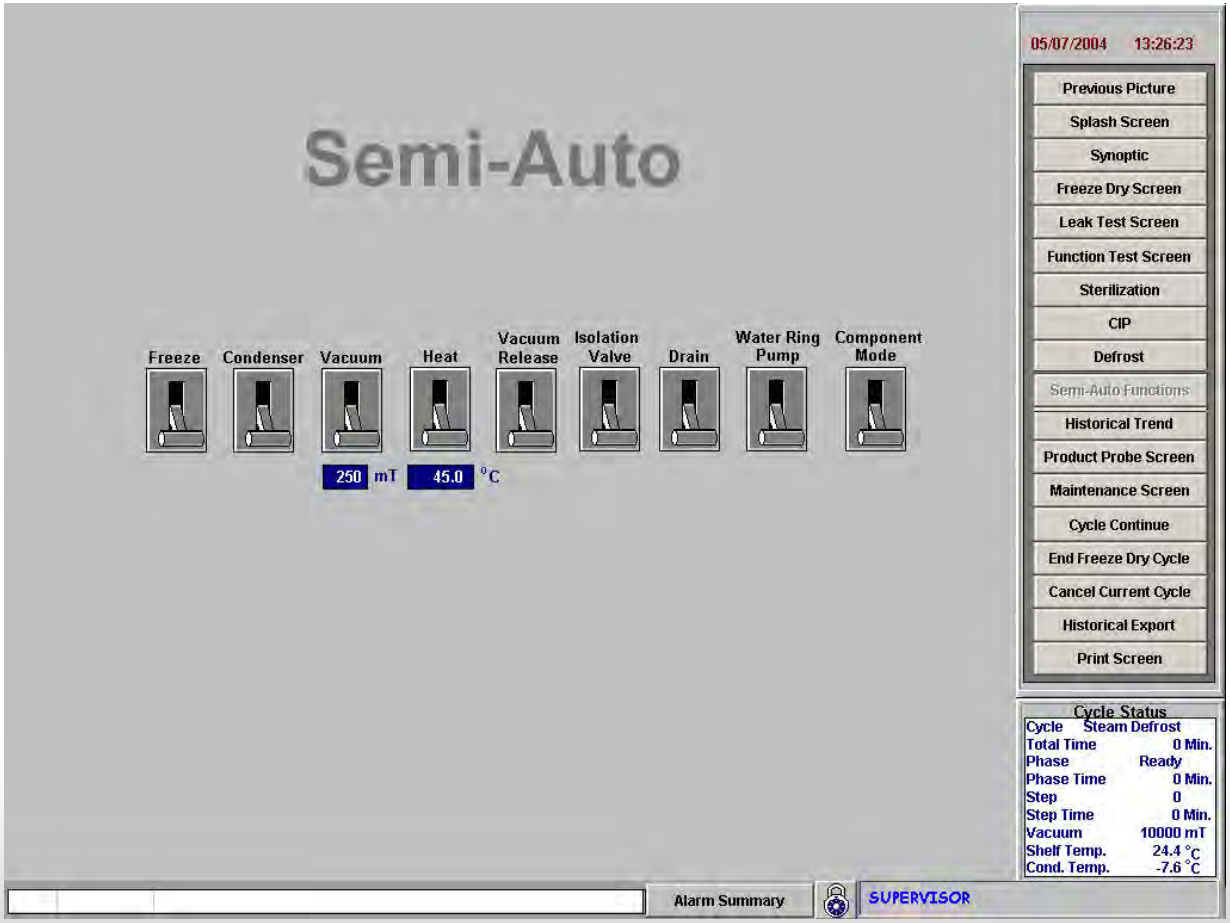
Manual Operation for Easy Troubleshooting



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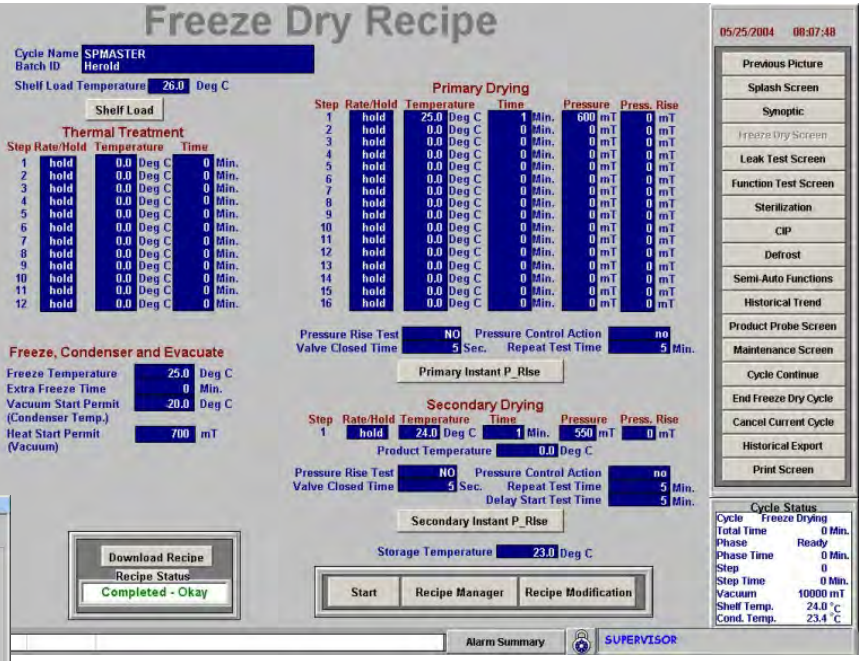
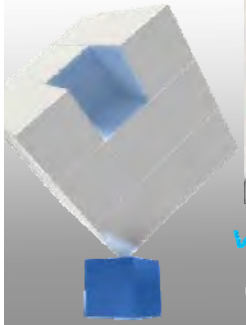
Controls Considerations

Recipe requirements?
How much time do you have to get it right?
Process development tools:
- Smart
- BE or PVG/CM (See Tech Briefs)

Automated Testing
Secure Data
21CFR11?



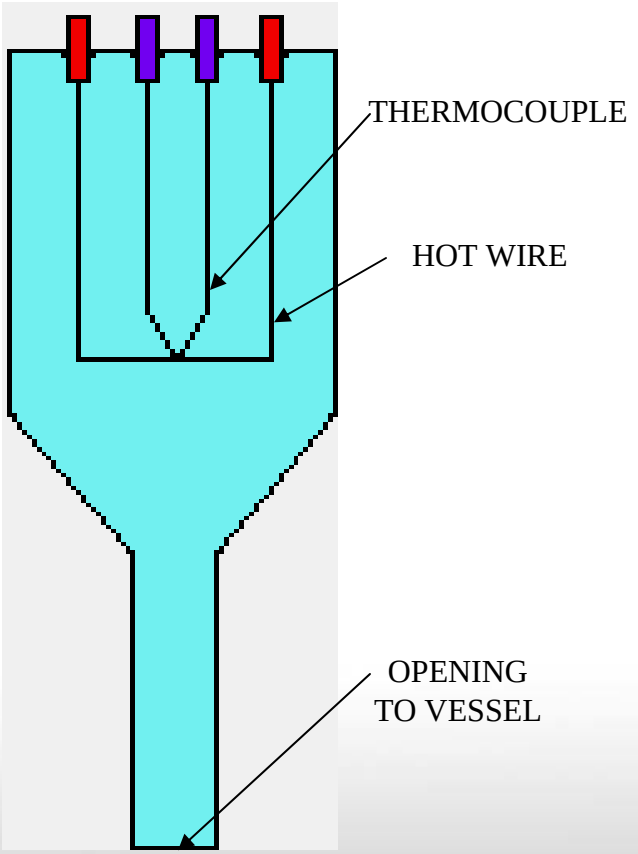
Recipe Screen

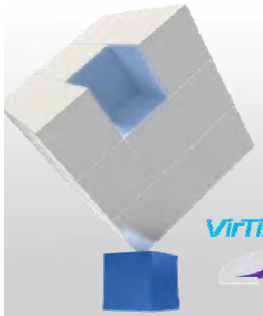


Historical Data

Pirani (T/C) Vacuum Gauge

- Wire heated by electric current
- Molecules of process gas impinge upon wire and cool it
- More molecules = cooler
- Less molecules = hotter
- Temperature correlates to Pressure
- Must be calibrated for specific process gas





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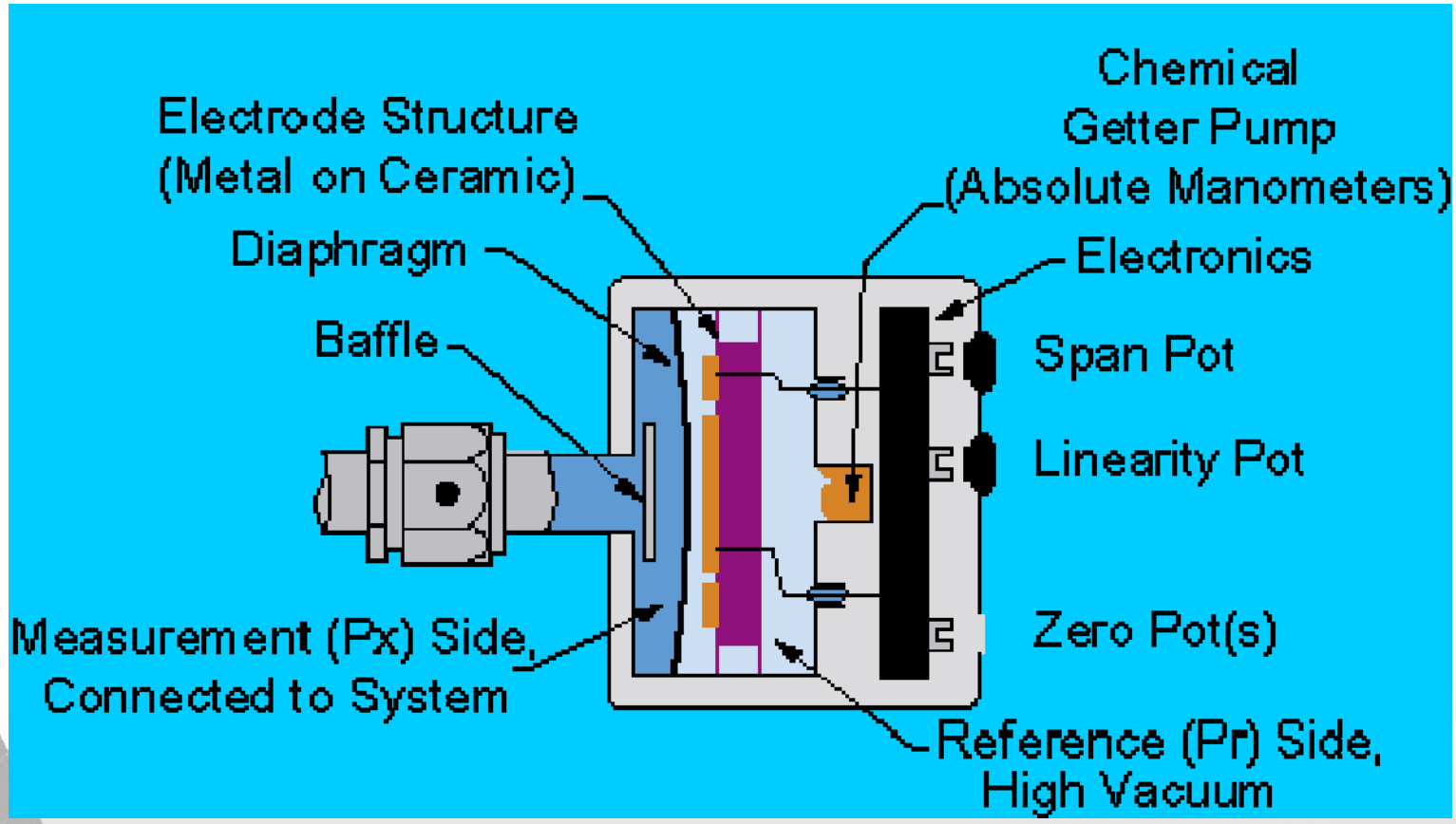
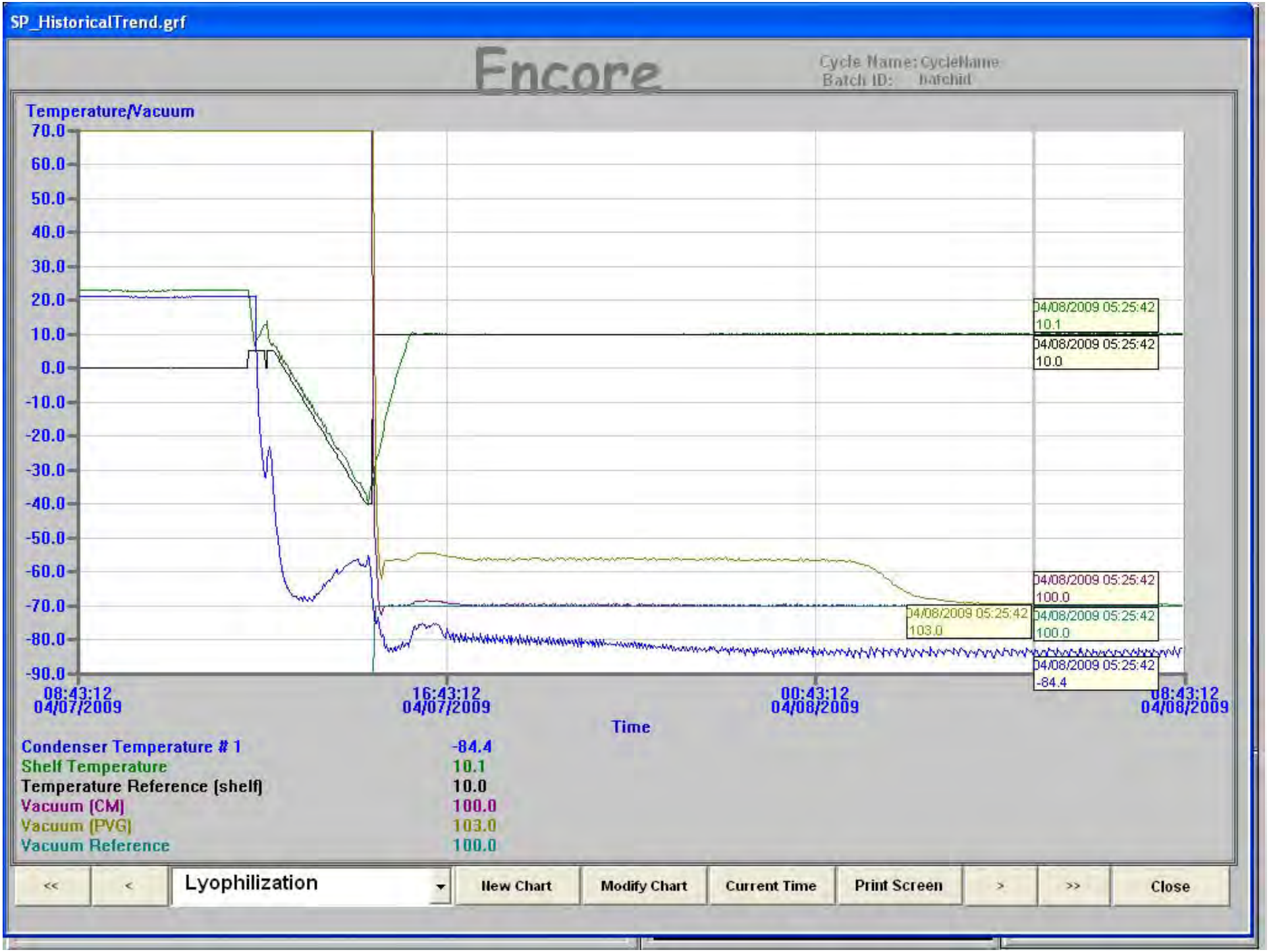
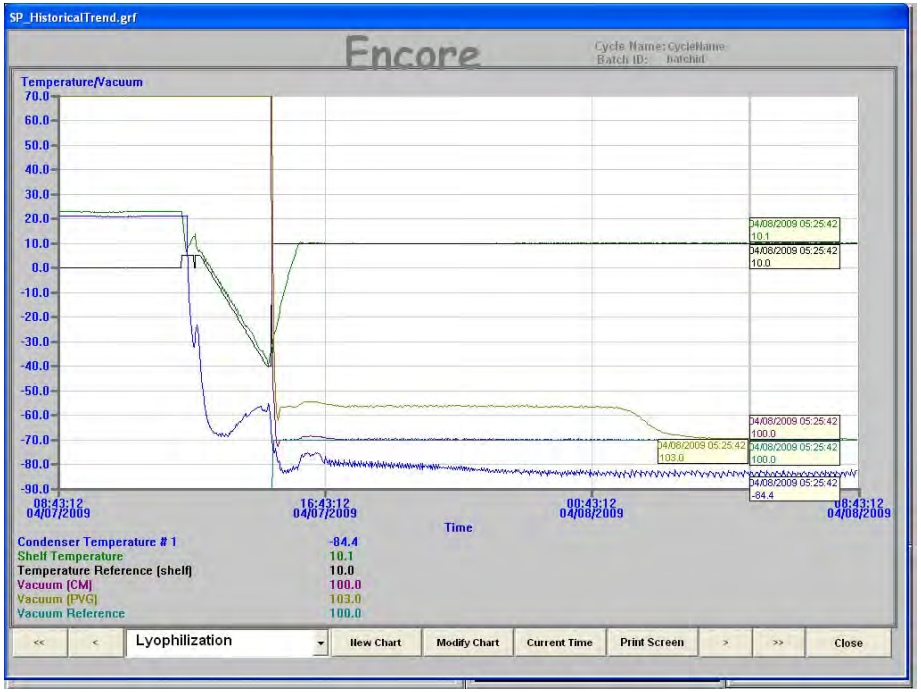
Capacitance Manometer

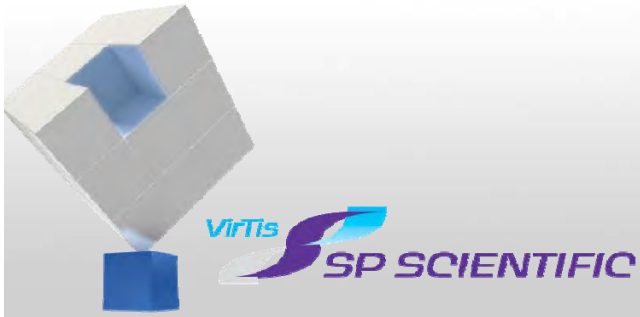


VirTis SP SCIENTIFIC

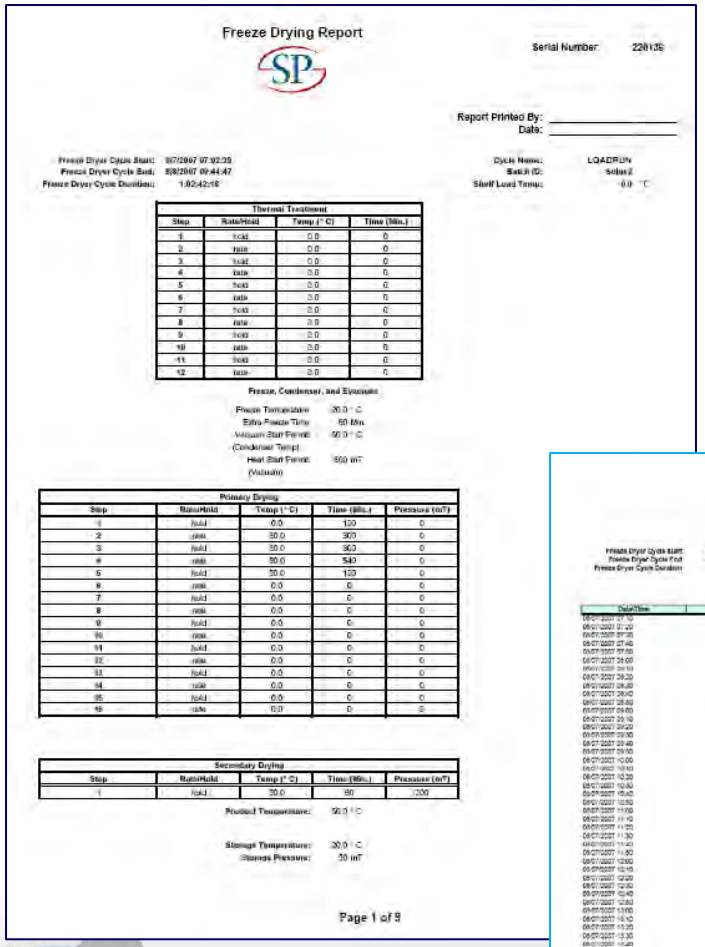

SP_HistoricalTrend.grf
Encore
Cycle Name: CycleName
Batch ID: batchid
Temperature/Vacuum
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
-80.0
-90.0
04/08/2009 05:25:42
10.1
04/08/2009 05:25:42
10.0
04/08/2009 05:25:42
100.0
04/08/2009 05:25:42
103.0
04/08/2009 05:25:42
100.0
04/08/2009 05:25:42
-84.4
08:43:12
04/07/2009
16:43:12
04/07/2009
00:43:12
04/08/2009
08:43:12
04/08/2009
Time
Condenser Temperature # 1 -84.4
Shelf Temperature 10.1
Temperature Reference (shelf) 10.0
Vacuum (CM) 100.0
Vacuum (PVG) 103.0
Vacuum Reference 100.0
<< < Lyophilization New Chart Modify Chart Current Time Print Screen > >> Close

Agreement with PVG/CM and Probes





Batch Records



Freeze Drying Report

Serial Number: 220139

Report Printed By: _____
Date: _____

Freeze Dryer Cycle Start: 8/7/2007 07:02:29
Freeze Dryer Cycle End: 8/8/2007 09:44:47
Freeze Dryer Cycle Duration: 1:02:42:18

Cycle Name: LOADRUN
Batch ID: Solus2
Shelf Load Temp: 0.0 °C

Thermal Treatment

Step	Ramp/Hold	Temp (° C)	Time (Min.)
1	hold	0.0	0
2	ramp	0.0	0
3	hold	0.0	0
4	ramp	0.0	0
5	hold	0.0	0
6	ramp	0.0	0
7	hold	0.0	0
8	ramp	0.0	0
9	hold	0.0	0
10	ramp	0.0	0
11	hold	0.0	0
12	ramp	0.0	0

Freeze, Condenser, and Evacuate

Freeze Temperature: -20.0 ° C
Extra Freeze Time: 60 Min.
Vacuum Start Femto: 50.0 ° C
(Condenser Temp)
Heat Start Femto: 500 mT
(Vacuum)

Primary Drying

Step	Ramp/Hold	Temp (° C)	Time (Min.)	Pressure (mT)
1	hold	0.0	120	0
2	ramp	50.0	900	0
3	hold	50.0	900	0
4	ramp	50.0	540	0
5	hold	50.0	120	0
6	ramp	0.0	0	0
7	hold	0.0	0	0
8	ramp	0.0	0	0
9	hold	0.0	0	0
10	ramp	0.0	0	0
11	hold	0.0	0	0
12	ramp	0.0	0	0
13	hold	0.0	0	0
14	ramp	0.0	0	0
15	hold	0.0	0	0
16	ramp	0.0	0	0

Secondary Drying

Step	Ramp/Hold	Temp (° C)	Time (Min.)	Pressure (mT)
1	hold	20.0	60	1200

Product Temperature: 50.0 ° C

Storage Temperature: 20.0 ° C
Storage Pressure: 50 mT

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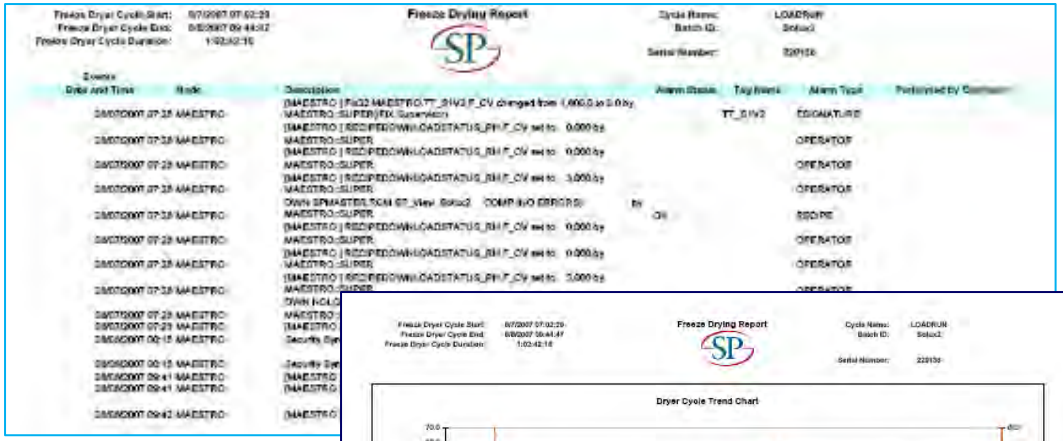

Freeze Drying Report

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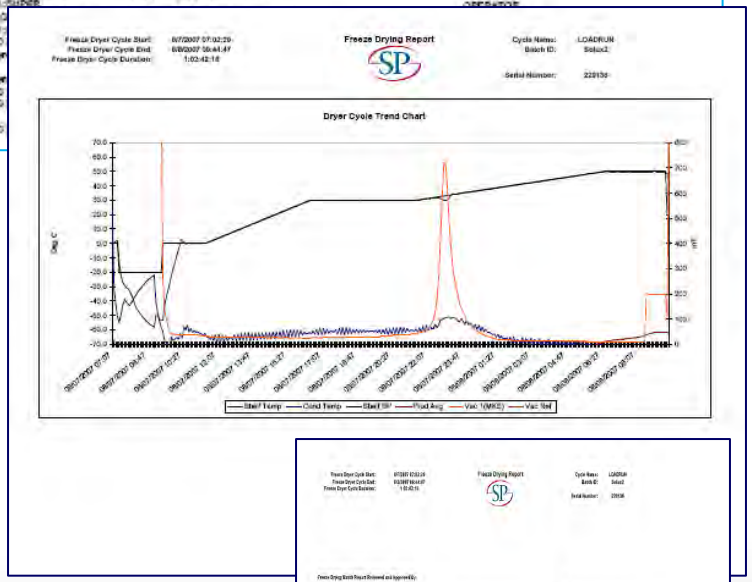
Freeze Dryer Cycle End: 8/8/2007 09:44:47
Freeze Dryer Cycle Duration: 1:02:42:18

Cycle Name: LOADRUN
Batch ID: Solus2
Serial Number: 220139

Events

Date and Time	Node	Description	Alarm Status	Tag Name	Alarm Type	Performed By Operator
08/07/2007 07:28	MAESTRO	[MAESTRO] Rx32 MAESTRO.TT_01V2.F_CV changed from 1,600.0 to 0.0 by MAESTRO::SUPER(FIX SuperAlert)		TT_01V2	EQUIPMAINT	
08/07/2007 07:28	MAESTRO	[MAESTRO] RECIPEDOWN.LOADSTATUS_RH.F_CV set to: 0.000 by MAESTRO::SUPER			OPERATOR	
08/07/2007 07:28	MAESTRO	[MAESTRO] RECIPEDOWN.LOADSTATUS_RH.F_CV set to: 0.000 by MAESTRO::SUPER			OPERATOR	
08/07/2007 07:28	MAESTRO	[MAESTRO] RECIPEDOWN.LOADSTATUS_RH.F_CV set to: 3.000 by MAESTRO::SUPER			OPERATOR	
08/07/2007 07:28	MAESTRO	OWN SPMASTER.SCM ST_View Solus2 COMP R/O ERROR 0	By			
08/07/2007 07:28	MAESTRO	MAESTRO::SUPER		CH	RECIPE	
08/07/2007 07:29	MAESTRO	[MAESTRO] RECIPEDOWN.LOADSTATUS_RH.F_CV set to: 0.000 by MAESTRO::SUPER			OPERATOR	
08/07/2007 07:29	MAESTRO	[MAESTRO] RECIPEDOWN.LOADSTATUS_RH.F_CV set to: 0.000 by MAESTRO::SUPER			OPERATOR	
08/07/2007 07:29	MAESTRO	[MAESTRO] RECIPEDOWN.LOADSTATUS_RH.F_CV set to: 3.000 by MAESTRO::SUPER			OPERATOR	
08/07/2007 07:29	MAESTRO	OWN SCALC				
08/07/2007 07:29	MAESTRO	MAESTRO				
08/07/2007 07:29	MAESTRO	[MAESTRO				
08/08/2007 00:15	MAESTRO	Security Syn				
08/08/2007 00:15	MAESTRO	Security Syn				
08/08/2007 09:41	MAESTRO	[MAESTRO				
08/08/2007 09:41	MAESTRO	[MAESTRO				
08/08/2007 09:42	MAESTRO	[MAESTRO				



Freeze Drying Report

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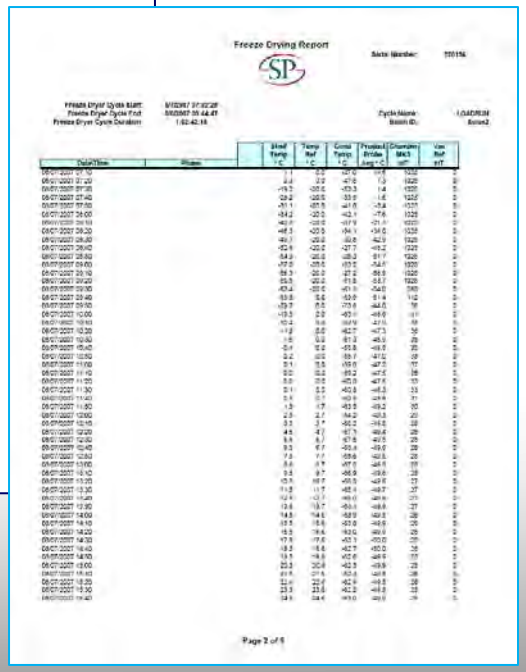
Freeze Dryer Cycle End: 8/8/2007 09:44:47
Freeze Dryer Cycle Duration: 1:02:42:18

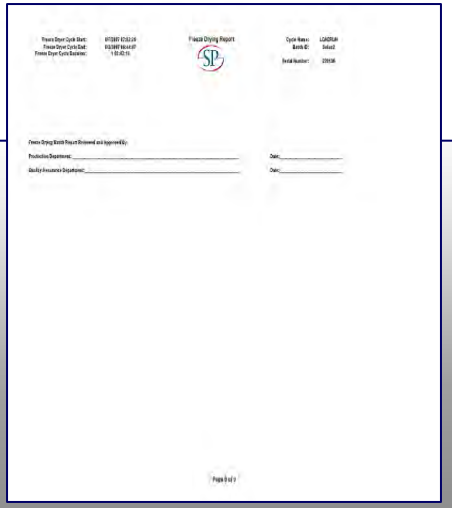
Cycle Name: LOADRUN
Batch ID: Solus2
Serial Number: 220139

Dryer Cycle Trend Chart



Freeze Drying Report

Page 2 of 9



Freeze Drying Report

Freeze Drying Batch Report Reviewed and Approved By:

Production Department: _____ Date: _____

Quality Assurance Department: _____ Date: _____

VirTis SP SCIENTIFIC

Electrical Cabinet

Skid Mounted UPS for PLC & Workstation

Documentation & Validation

Factory and Site Acceptance Testing (FAT/SAT)

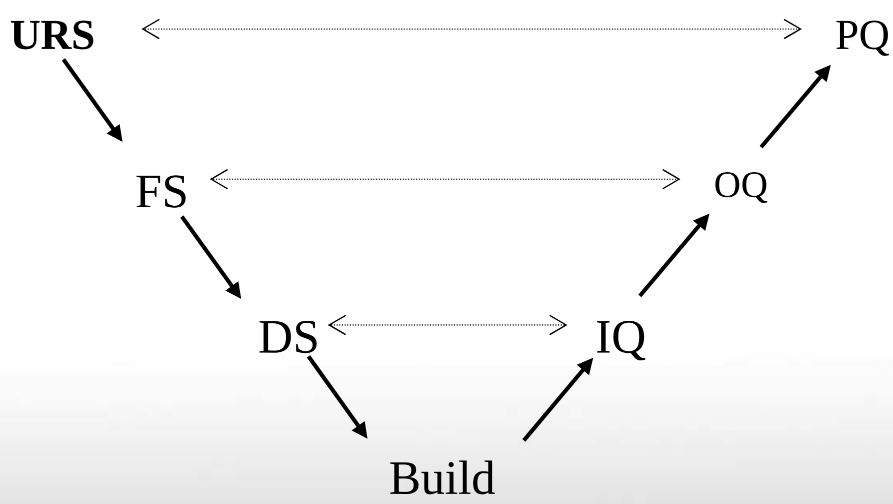
Customized Workbooks with Material and Welding Certifications

Control System Integration Testing

Inverted GAMP 4 Triangle

User Requirement Specs
Functional and Design Specs

Operational Qualification



Service & Support

Installation Supervision

Start-up Supervision

Maintenance, Operator or Lyophilization Training

PM Contracts

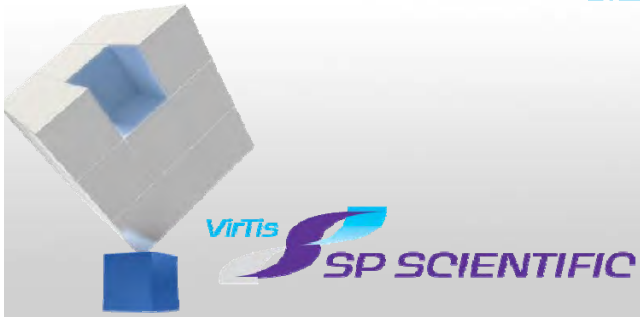
Extended Warrantee

Emergency Weekend Response

Time and Materials

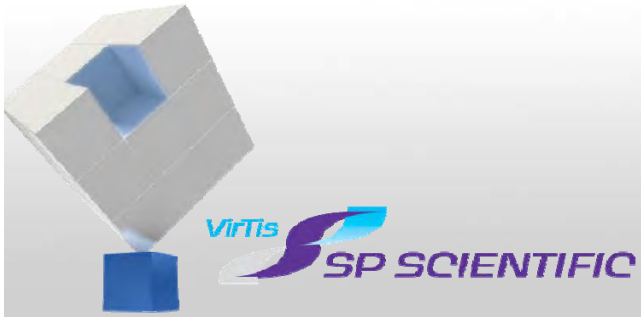
Maintenance Audit Programs

Calibration / Validation Assistance



Partnership Through Support …

… Together we can get the job done better!



Service and Support Mission

Our mission is Clear … to provide support and services of the highest quality, customer experience and greatest possible value to our customers, thereby gaining an holding their respect and loyalty.

In essence …. Partnership through Support

VirTis SP SCIENTIFIC