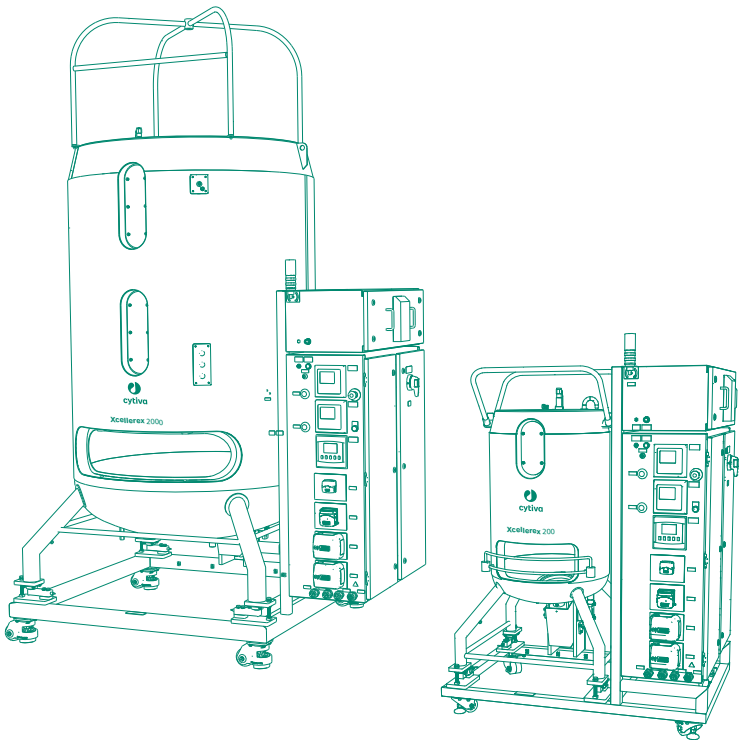
Xcellerex™ XDR-50 to 2000 Bioreactor Systems

Operating Instructions

Original instructions



cytiva.com

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1 Introduction

About this chapter

This chapter contains important user information and regulatory information about Xcellerex™ XDR-50 to 2000 Bioreactor Systems that use the automation AVEVA software.

In this chapter

Section		See page
1.1	Important user info	8
1.2	About this manual	9
1.3	Abbreviations	10

1.1 Important user info

Introduction

This section contains important information regarding XDR-50 to 2000 Bioreactor Systems that use AVEVA software. This section gives important information about this manual.

Read this before operating the product



All users must read the entire *Operating Instructions* before installation, operation, or maintenance.

Always keep the *Operating Instructions* at hand when operating the product.

Do not install, operate, or perform maintenance in any other way than described in the user documentation. Improper use can result in exposure to hazards that can lead to personal injury and can cause damage to the equipment.

Intended use of XDR-50 to 2000 Bioreactor Systems

XDR-50 to 2000 Bioreactor Systems are stirred-tank bioreactors intended for cell culture and microbial fermentation processes used in researching, developing or manufacturing biologics or drugs.

XDR-50 to 2000 Bioreactor Systems are not medical devices and shall not be used in any clinical procedures or for diagnostic purposes.

Prerequisites

In order to operate XDR-50 to 2000 Bioreactor Systems in a safe way and according to their intended use, the following prerequisites must be fulfilled:

- You should be acquainted with the use of general laboratory equipment and with the handling of biological materials.
- You should be acquainted with the automated bioreactor operation using software.
- You must read and understand the *Safety instructions* chapter in this manual (*Chapter 2 Safety Instructions, on page 12*).
- All users who log on to the system must be familiar with basic operations in Microsoft Windows operating system.

It is recommended that the system is installed by a Cytiva representative.

1.2 About this manual

Introduction

This section contains information about the purpose and scope of this manual, notes and tips, and typographical conventions.

Purpose of this manual

This manual provides instructions needed to install, operate and maintain XDR-50 to 2000 Bioreactor Systems in a safe way.

Scope of this manual

This manual is valid for all standard variants of XDR-50 to 2000 Bioreactor Systems. Your system is either CE-classified or UL-classified. The system configuration for your system is described in the General Specification and on the nameplate.

This manual describes the operation of XDR-50 to 2000 Bioreactor Systems hardware using the AVEVA software.

XDR-50 to 2000 Bioreactor Systems are referred to as "the product" in this manual. The manual covers multiple releases of the product and some manual sections apply only for certain releases. These sections are clearly defined as not applicable for certain releases, or as describing optional components.

System options

The information in this manual is applicable for all standard systems. The functionalities described as "optional" need to be purchased by the customer.

Notes and tips

Note: *A note is used to indicate information that is important for trouble-free and optimal use of the product.*

Tip: *A tip contains useful information that can improve or optimize your procedures.*

Typographical conventions

The text on a graphical user interface is identified in this manual by ***bold italic*** text.

The text on the label of a hardware item is identified in this manual by **bold** text.

Text that the user must either type exactly as shown in the manual, or that the software displays as a response (not a regular part of the graphic user interface), is shown by a monospaced typeface (for example, `Recipe Information`).

Tip: *The text can include clickable hyperlinks to reference information.*

1.3 Abbreviations

List of Abbreviations

The following terms and abbreviations are used in the user documentation for XDR-50 to 2000 Bioreactor Systems:

Term/Abbreviation	Definition	Translation
ACD	aseptic connection device	aseptic connection device
cP	unit of dynamic viscosity	unit of dynamic viscosity
CV	controlled variable The output from the PID controller, or a manually set value that controls the process variable.	controlled variable The output from the PID controller, or a manually set value that controls the process variable.
CVHL	controlled variable high limit	controlled variable high limit
CVLL	controlled variable low limit	controlled variable low limit
DB	deadband The deadband is a defined range of process variable, where the PID controller does not change the corresponding controlled variable.	deadband The deadband is a defined range of process variable, where the PID controller does not change the corresponding controlled variable.
DO	dissolved oxygen	dissolved oxygen
I/O Cabinet	Input/Output Cabinet	Input/Output Cabinet
MFC	mass flow controller	mass flow controller
OUR	oxygen uptake rate	oxygen uptake rate
PID	proportional integral derivative A PID controller tries to minimize the difference between a measured PV and a defined SP. The PID controller calculates the control signal that controls the process toward the SP.	proportional integral derivative A PID controller tries to minimize the difference between a measured PV and a defined SP. The PID controller calculates the control signal that controls the process toward the SP.
PLC	programmable logic controller	programmable logic controller
PV	process variable The actual measured value of the parameter.	process variable The actual measured value of the parameter.
RTD	resistance temperature detector	resistance temperature detector
SCADA	supervisory control and data acquisition	supervisory control and data acquisition

Term/Abbreviation	Definition	Translation
SLPM	standard liters per minute	standard liters per minute
SP	setpoint The process target value defined by a user or the system, that the PID controller tries to reach by adjusting the process control outputs.	setpoint The process target value defined by a user or the system, that the PID controller tries to reach by adjusting the process control outputs.
SPHL	setpoint high limit	setpoint high limit
SPLL	setpoint low limit	setpoint low limit
TCU	temperature control unit	temperature control unit
ToP	Product Documentation package (Turnover Package, ToP)	Product Documentation package (Turnover Package)
UPS	uninterruptible power supply	uninterruptible power supply

2 Safety Instructions

About this chapter

This chapter describes safety precautions and emergency shutdown procedures for XDR-50 to 2000 Bioreactor Systems. The labels on the system, information regarding recycling and security access levels are also described.

All users must read this chapter before using XDR-50 to 2000 Bioreactor Systems, and observe the safety instructions at all times during use.

In this chapter

Section		See page
2.1	Safety precautions	13
2.2	Labels and symbols	18
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Important



WARNING

All users must read and understand the entire contents of this general safety chapter, and the specific safety precautions information in each subsequent chapter of this manual to become aware of the hazards involved.

2.1 Safety precautions

Introduction

XDR-50 to 2000 Bioreactor Systems are powered by mains voltage and handles materials that can be hazardous. Before installing, operating or maintaining the system, you must be aware of the hazards described in this manual.

Follow the instructions to avoid injury to the operator or other personnel, damage to samples or other substances handled by the equipment, to the product, or to other equipment in the area.

Definitions

This user documentation contains safety notices (WARNING, CAUTION, and NOTICE) concerning the safe use of the product. See definitions below.



WARNING

WARNING indicates a hazardous situation which, if not avoided, could result in death or serious injury. It is important not to proceed until all stated conditions are met and clearly understood.



CAUTION

CAUTION indicates a hazardous situation which, if not avoided, could result in minor or moderate injury. It is important not to proceed until all stated conditions are met and clearly understood.



NOTICE

NOTICE indicates instructions that must be followed to avoid damage to the product or other equipment.

General precautions



WARNING

All users must read and understand the entire contents of this chapter to become aware of the hazards involved.

Failure to do this can cause human injury or death, or damage to the equipment.



WARNING

Do not operate the product in any other way than as described in the user documentation.



WARNING

All installation, maintenance, operation, and inspection must be carried out according to local regulations by adequately trained personnel.



WARNING

Do not use the product if it is not working properly, or if it has suffered any damage including:

- damage to the mains cable or its plug
- damage caused by dropping the product
- damage caused by splashing liquid onto the product



WARNING

Hazardous voltage. Only personnel authorized by Cytiva may open the I/O Cabinet doors. There is hazardous voltage inside the cabinet that can cause human injury or death.



CAUTION

Use caution. Use caution close to moving parts, stored energy, pressurization, and electrical sources.



CAUTION

Moving parts. To avoid damage to the equipment and personal injury, keep fingers and other objects clear of valves, rotating pumps, fans or other moving parts.

Personal protection



WARNING

Slipping hazard. Remove any spillage on the floor immediately to minimize the risk for slipping accidents.



WARNING

Hazardous substances. When using hazardous chemical and biological agents, take all suitable protective measures, such as wearing protective clothing, glasses, and gloves resistant to the substances used. Follow local and national regulations for safe operation and maintenance of the system.



WARNING

Spread of biological agents. The operator has to take all necessary actions to avoid spreading hazardous biological agents in the vicinity of the system. The facility should comply with the national code of practice for biosafety.



WARNING

Personal protective equipment. For personal safety during the transportation, installation, operation and maintenance of the system, always use protective glasses and other personal protective equipment appropriate for the current application. The following personal protective equipment should always be available:

- Protective glasses
- Working gloves to protect against sharp edges
- Protective footwear, preferably with steel toe-cap
- Disposable gloves

Always use clean disposable gloves when manually handling parts.



WARNING

Personal Protective Equipment (PPE). When packing, unpacking, transporting or moving the product, wear the following:

- Protective footwear, preferably with steel toe caps.
- Working gloves, protecting against sharp edges.
- Protective glasses.



WARNING

Strong magnets. Magnets may interfere with functioning of pacemakers or implanted heart defibrillators and cause DEATH or SERIOUS INJURY. Magnets are located on the bottom of the product, and in the impeller assembly of the bag assembly.

- OBSERVE and follow instructions for installation, operation, and maintenance of the product.
- KEEP a safe distance of 25 cm or more from the magnets to avoid exposure to magnetic field greater than 0.5 mT (5 G).
- WARN other people who wear pacemakers or implanted heart defibrillators from getting too close to the magnets.

Flammable liquids and explosive environment



WARNING

Fire and explosion hazard. Follow the instructions below to avoid a fire or explosion when using oxygen:

- Monitor oxygen flow rates displayed on the user interface.
- Check for leaks, poor connections, or damages to the equipment prior to use.
- Use proper ventilation when operating the bioreactor using oxygen.
- Do not expel oxygen into an enclosed space.



WARNING

Do not work in an explosive atmosphere. The product is not designed to handle liquids under flammable conditions. The product is not approved for work in a potentially explosive atmosphere, in areas classified as Zone 0 to Zone 2 according to IEC 60079-10 2002.



WARNING

Gas pressure. The gas supply pressure must not be higher than 303 kPa (3.03 bar, 44 psig).



WARNING

Use correct tubing. Use only gas tubing specified by Cytiva. Using other gas tubing may result in a gas leak.



WARNING

Gas shut-off valves. Gas shut-off valves that can be physically locked out for servicing must be installed on the facility gas supplies.



WARNING

Gas leakage hazard. Make sure that the gas connections are tight in order to avoid gas leakage.



WARNING

Gas lines. Before connecting or disconnecting the gas lines, turn off the instrument and follow the Lock-Out / Tag-Out (LOTO) procedure to avoid a gas explosion risk.



WARNING

Gas leakage hazard. To prevent any gas leakage, always switch off all gas supplies when the system is not in use.

2.2 Labels and symbols

Introduction

This section describes the nameplate, labels, and other safety and regulatory information attached to XDR-50 to 2000 Bioreactor Systems.

Labels on the instrument

There are two nameplates and two regulatory labels on XDR-50 to 2000 Bioreactor Systems.

The following illustration shows the location of the nameplate on the back of the X-station.



The following illustration shows the location of the nameplate on the back of the I/O Cabinet.



Nameplate

The nameplate identifies the equipment and shows electrical data, regulatory compliance, and warning symbols.

The following text may be present on the nameplate:

Label text	Description
Serial No	Serial number of the system.
Year of Mfg.	The year the system was built.
Volt/Phase/ Frequency	Electrical power requirements in Volts (V)/Phase/ Frequency (Hz).
Full load Amps	Maximum current used by the system (A).
Largest Motor	Horsepower rating of the motor (hp).
Max Power	Maximum power required by the system (kVA).
SCCR	Short circuit current rating (A).
Pneumatic Supply	Gas input pressure (kPa, bar, or psi).
Protection Class	Cabinets ingress protection.

Label text	Description
Enclosure Type	Electrical cabinet type.
Diagram	Electrical schematic.

Regulatory label

A regulatory label is located below the nameplate on the XDR-50 to 2000 Bioreactor Systems.

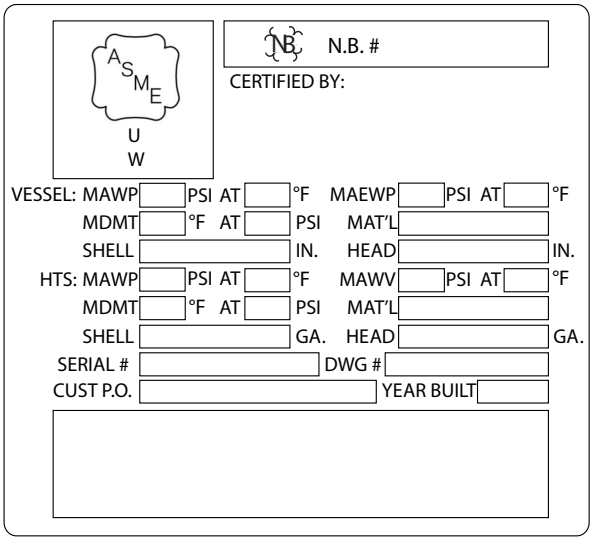
The following symbols may be present on the regulatory label:

Label image	Description
	**Warning!** Do not use the system before reading the *Operating Instructions*. Do not open any covers or replace parts unless specifically stated in the user documentation.
	This symbol indicates that electrical and electronic equipment must not be disposed of as unsorted municipal waste and must be collected separately. Contact an authorized representative of the manufacturer for information concerning the decommissioning of equipment.

For information regarding shelf life contact your local Cytiva representative.

ASME label

The label shown below is an example. Actual data printed on the label is specific for each individual system and may vary from system to system.



The ASME label information is explained below.

Label text/ symbol	Meaning	Translation
	Symbol of the National Board of Boiler and Pressure Vessel Inspectors.	Symbol of the National Board of Boiler and Pressure Vessel Inspectors.
N.B.#	Registration number identifying the ASME BPVI inspection stamp.	Registration number identifying the ASME BPVI inspection stamp.
	American Society of Mechanical Engineers Boiler and Pressure Vessels Code stamp symbol.	American Society of Mechanical Engineers Boiler and Pressure Vessels Code stamp symbol.
U **W**	The welded (W) product is manufactured according to ASME BPVC Division 1 (U).	The welded (W) product is manufactured according to ASME BPVC Division 1 (U).
CERTIFIED BY:	Information stating the name of the ASME BPVI inspection company.	Information stating the name of the ASME BPVI inspection company.

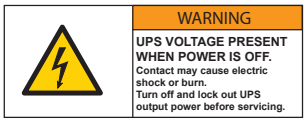
Label text/ symbol	Meaning	Translation
VESSEL:	Information valid for the pressure vessel.	Information valid for the pressure vessel.
MAWP	Maximum allowed working pressure for the vessel (in psi, at specified temperature in °F).	Maximum allowed working pressure for the vessel (in psi, at specified temperature in °F).
MAEWP	Maximum allowed external working pressure (in psi, at specified temperature in °F).	Maximum allowed external working pressure (in psi, at specified temperature in °F).
MDMT	Minimum design metal temperature for the vessel (in °F, at specified pressure in psi).	Minimum design metal temperature for the vessel (in °F, at specified pressure in psi).
MAT'L	Vessel material.	Vessel material.
SHELL	Thickness of the cylindrical part of the vessel inner wall (in inches).	Thickness of the cylindrical part of the vessel inner wall (in inches).
HEAD	Thickness of the bottom elliptic part of the vessel inner wall (in inches).	Thickness of the bottom elliptic part of the vessel inner wall (in inches).
HTS:	Information valid for the heat transfer system (vessel jacket).	Information valid for the heat transfer system (vessel jacket).
MAWP	Maximum allowed working pressure for the heat transfer system (in psi, at specified temperature in °F).	Maximum allowed working pressure for the heat transfer system (in psi, at specified temperature in °F).
MAWV	Maximum allowed working vacuum for the heat transfer system (in psi, at specified temperature in °F).	Maximum allowed working vacuum for the heat transfer system (in psi, at specified temperature in °F).
MDMT	Minimum design metal temperature for the heat transfer system (in °F, at specified pressure in psi).	Minimum design metal temperature for the heat transfer system (in °F, at specified pressure in psi).
MAT'L	Material for the heat transfer system.	Material for the heat transfer system.
SHELL	Thickness of the cylindrical part of the heat transfer system (in gauges).	Thickness of the cylindrical part of the heat transfer system (in gauges).
HEAD	Thickness of the bottom elliptic part of the heat transfer system (in gauges).	Thickness of the bottom elliptic part of the heat transfer system (in gauges).
SERIAL #	Identification number of the specific instrument (serial number).	Identification number of the specific instrument (serial number).

Label text/ symbol	Meaning	Translation
DWG #	Manufacturer's drawing number used to assemble the vessel.	Manufacturer's drawing number used to assemble the vessel.
CUST P.O.	Purchase order for the pressure vessel.	Purchase order for the pressure vessel.
YEAR BUILT	Year the equipment was produced.	Year the equipment was produced.

Safety labels

The table below describes the various safety labels that are located on parts of the XDR-50 to 2000 Bioreactor Systems.

Safety label	Description
	**Warning! Burn Hazard/Hot Surface.** The heaters are hot during operation. Do not touch the heaters when in use. Allow the heaters to cool before servicing. The agitator motor may become hot during operation. Do not touch the motor or any parts near it during operation. Allow the motor to cool before servicing.
	**Warning! Rotating Parts/Cutting of Fingers.** Motor magnetic shaft must be completely stopped prior to servicing instrument.
	**Warning! High Pressure.** The gases operate under high pressure. Do not open gas lines. Servicing gas lines is reserved for authorized service engineers. Wear protective glasses and read service manual prior to servicing gas lines. Maximal allowed pressure 303 kPa (3.03 bar, 44 psig).
	**Warning! Hand Crush Hazard.** Contact may result in serious injury. Use caution when operating X-lift and G-lift.
	**Warning! Hazardous voltage.** Disconnect power before servicing. Authorized personnel only.
	**Warning! Hazardous voltage.** Disconnect power before servicing. Authorized personnel only.

Safety label	Description
	**Warning! STRONG magnets.** Magnets may interfere with functioning of pacemakers or implanted heart defibrillators and cause DEATH or SERIOUS INJURY. Magnets are located on the bottom of the XDR-50 to 2000 Bioreactor Systems, and in the impeller assembly of the bags. • OBSERVE and follow instructions for installation, operation, and maintenance of XDR-50 to 2000 Bioreactor Systems. • KEEP a safety distance of 25 cm or more from the magnets to avoid exposure to magnetic field greater than 0.5 mT (5 G). • WARN other people who wear pacemakers or implanted heart defibrillators from getting too close to the magnets.
	**Warning! Hazardous voltage.** Disconnect power before servicing. Authorized personnel only.
	**Warning! High leakage current.** A grounded earth connection is essential before connecting the mains power supply. Follow the instructions and guidelines described in *Section 5.2 Site requirements, on page 140*. ***Note:*** *This safety label is valid for systems with an input power supply rating of 220 V AC ± 10%.*

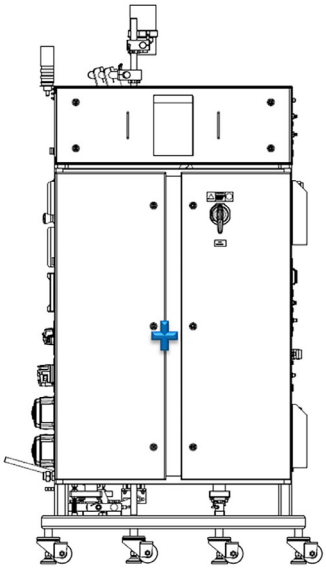
2.3 Center of gravity

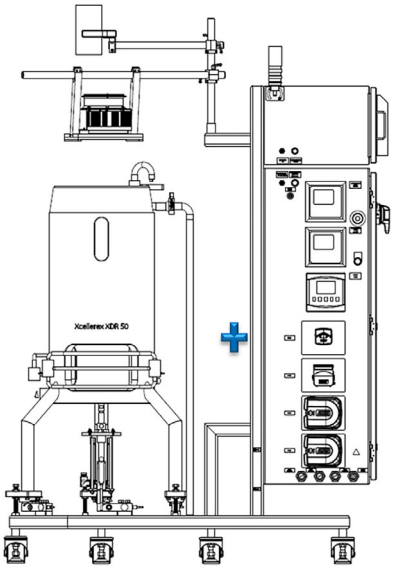
Illustration of center of gravity

The following illustrations show the location of the center of gravity for different sizes of XDR-50 to 2000 Bioreactor Systems. Two variants are shown for the 50 L XDR vessel:

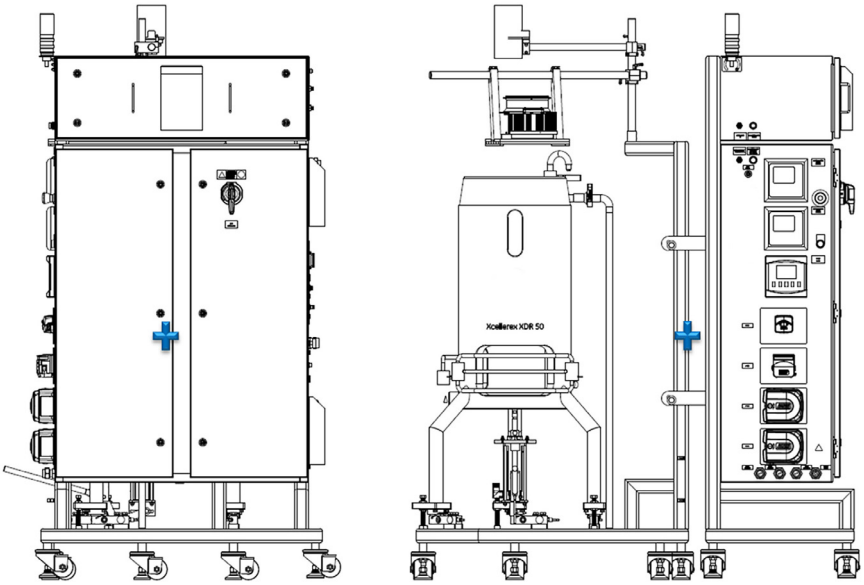
- Standard (single frame) design
- Split frame design

50 L XDR bioreactor (standard design)

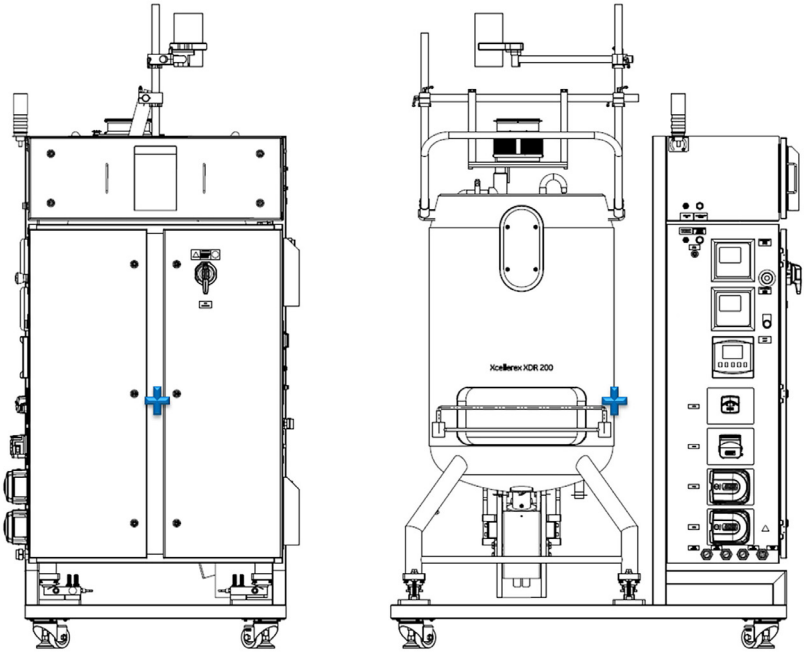




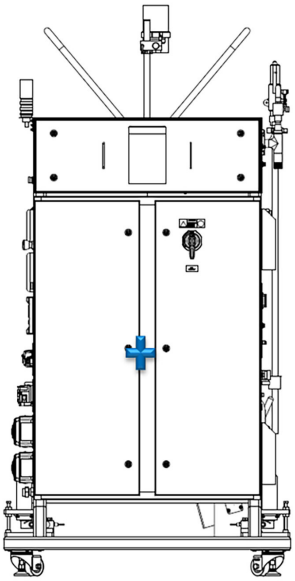
50 L XDR bioreactor (split frame design)

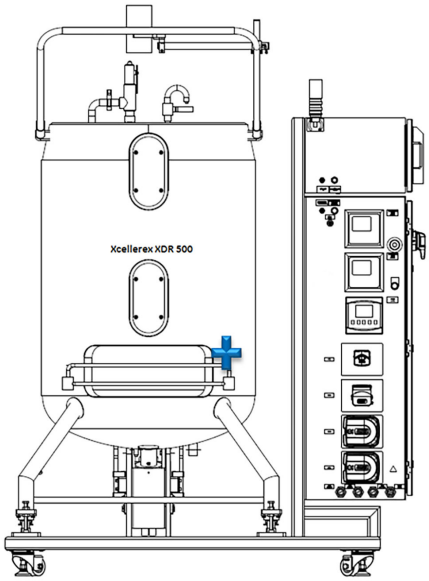


200 L XDR bioreactor

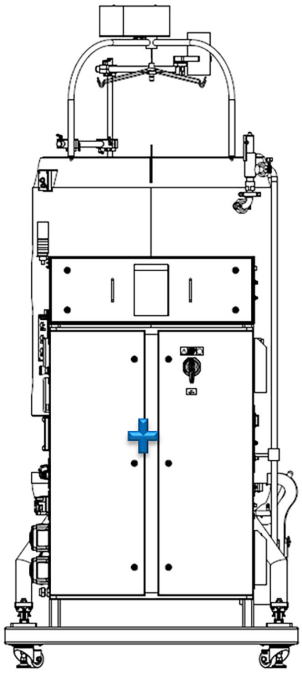


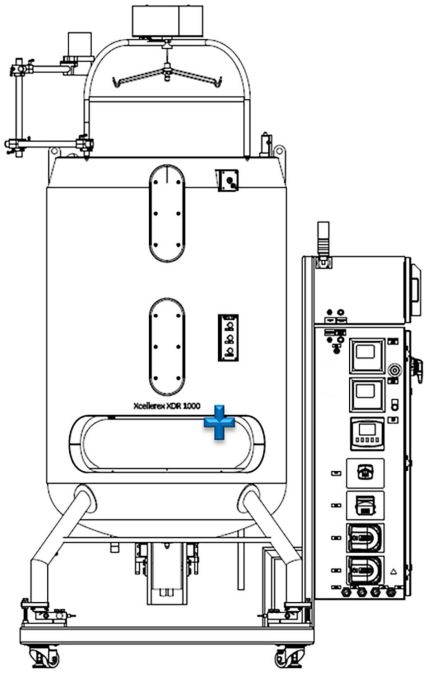
500 L XDR bioreactor



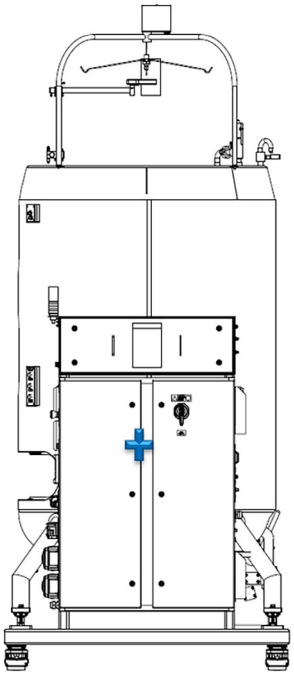


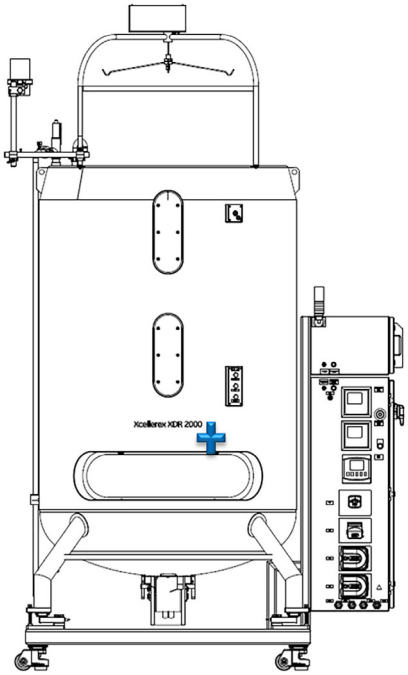
1000 L XDR bioreactor





2000 L XDR bioreactor





2.4 Emergency procedures

Introduction

This section describes how to shut down XDR-50 to 2000 Bioreactor Systems in an emergency situation, what happens as the result of power interruption, and the procedure for restarting XDR-50 to 2000 Bioreactor Systems.

In this section

Section		See page
2.4.1	MAIN DISCONNECT switch and Emergency Stop button	31
2.4.2	Emergency shutdown	34
2.4.3	Restart after emergency shutdown	36
2.4.4	Power interruption	38

2.4.1 MAIN DISCONNECT switch and Emergency Stop button

MAIN DISCONNECT switch

The system power switch **MAIN DISCONNECT** is located on the side of the I/O Cabinet. The following illustration shows an example of the location of the **MAIN DISCONNECT** switch.



The system power switch positions are described in the following illustrations.

Illustration	Description
	The system power switch in the **O OFF** position: • Power is disconnected from the XDR-50 to 2000 Bioreactor Systems.
	The system power switch in the **ON I** position: • Power is connected to the XDR-50 to 2000 Bioreactor Systems.

Emergency Stop button

The **EMERGENCY STOP** button is located on the front of the I/O Cabinet. The following illustration shows an example of the location of the **EMERGENCY STOP** button.



The **EMERGENCY STOP** button is engaged by being pushed.

The **EMERGENCY STOP** button is disengaged by turning the button clockwise.

2.4.2 Emergency shutdown

Emergency shutdown procedure

Follow the steps below to shut down the system in an emergency situation.

Step	Action
1	Press the **EMERGENCY STOP** button.





Result:

- The power is instantly removed from the pumps and the pumps are placed in a safe state.
- All MFCs, filter heaters, condenser, agitator motor and TCU are turned off.
- All control loops are forced into manual mode with the CVs set to factory defaults.
- ***E-Stop Active*** is displayed on the ***Reactor Display*** screen.



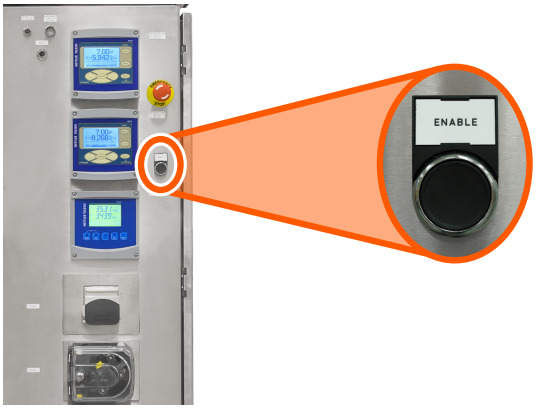
- The ***Reactor State Engine*** is shown in ***Interlocked*** state with ***Errors***.
- Data logging continues.

Step	Action
2	If required: • switch off the mains power supply using the system power switch,   • disconnect the mains cable or • switch off the main circuit breaker. ***Note:*** *The external circuit breaker is provided by the user. The location of the circuit breaker depends on the facility.* *Result:* All power is removed from the I/O Cabinet.

2.4.3 Restart after emergency shutdown

Restart bioreactor

Follow the instructions below to restart XDR-50 to 2000 Bioreactor Systems after emergency shutdown.

Step	Action
1	Make sure that the condition that caused the emergency shutdown is corrected.
2	Disengage the **EMERGENCY STOP** by turning it clockwise.  *Result:* The **EMERGENCY STOP** button pops out.
3	Press the **ENABLE** button that is located near the **EMERGENCY STOP** button.  *Result:* ***E-stop Active*** is no longer shown on the ***Reactor Display*** screen. Control and data logging restart.

The following table describes agitator state after clearance of the emergency stop.

Before emergency stop	After emergency stop
Batch not running. Agitator in ***Auto/ Local*** mode.	Agitator is enabled but not running.
Batch not running. Agitator in ***Manual/ Local*** mode.	Agitator is disabled and not running.
Batch is running and agitator is part of a batch recipe.	Agitator is enabled and running.

The system is designed to recover to its previous state after an emergency stop condition is reset; however, after power restoration the user should verify the status of all PID control loops and setpoints.

Note: *Server class computers can take up to 10 minutes or more to completely boot. The Ethernet switches are switched on and return to active state automatically without user intervention.*

2.4.4 Power interruption

Process control

The process control stops if one of the following conditions happens, whichever occurs first:

- The I/O Cabinet loses power.
- The X-Station UPS is exhausted.

Backup power capabilities

Equipment	Backup power supply
X-Station	The X-Station has a built-in UPS that provides 20 to 25 minutes power supply, if fully charged.
I/O Cabinet	The I/O Cabinet does not have a built-in UPS. It is recommended to connect the I/O Cabinet into the site emergency power system.

NOTICE

If the I/O Cabinet is connected to the site emergency power system, the X-Station should also be connected to the same emergency power system. This connection would make sure that the X-Station does not lose power before the I/O Cabinet does.

See *Power interruption to X-Station, on page 39* for more information.

Power interruption to X-Station

Event	Result
Power interruption occurs	• The server computer and programmable logic controller (PLC) continue to run on the UPS backup battery. Data collection continues until the backup power is exhausted. • Data collection stops when X-Station backup power is exhausted. • A running batch continues to run until the UPS has been exhausted. • When the UPS reaches a critical low level, the server shuts down and the PLC turns off shortly thereafter. ***Note:*** *Historical data are not lost due to a power loss. The data are stored on the server hard drives. Data are not collected when the power is off.*
Power returns	If the UPS backup power is not exhausted: • The system continues to operate as prior to the power interruption. If the UPS backup power is exhausted: • The system goes into a safe state with all control loops turned off.

Power interruption to I/O Cabinet, *Batch Manager* in *Run* state

Event	Result
Power interruption occurs	The bioreactor shuts down immediately, if the I/O Cabinet is not connected to a backup power source. • The PLC goes to the ***Held*** state. • All control loops are set to the safe state. • Data collection stops. If a batch is running when power to the I/O Cabinet is lost, but the X-Station is still running, the following info is displayed: • ***Reactor Display*** screen shows that the ***Batch Manager*** is in the ***Held*** state. • An ***E-stop Active*** status is flashing on the ***Reactor Display*** screen. • Alarm messages are shown in the alarm summary pane on the ***Reactor Display*** screen. Depending on the TCU model: • The TCU goes into standby mode. A standby message is shown on the TCU display. • The TCU shuts down immediately.
Power returns	• If the X-Station UPS is not exhausted, PLC returns to the ***Run*** state. • If the agitator is part of a batch recipe, and the agitator was running prior to power loss, the agitator is enabled and running when power returns. • All control loops return to normal operation. • If the TCU was in ***Remote*** mode, the TCU restarts automatically. • If the TCU was not in ***Remote*** mode, the TCU must be restarted. Refer to the TCU manufacturer's manual for instructions.

Power interruption to I/O Cabinet, *Batch Manager* not in *Run* state

Event	Result
Power interruption occurs	The bioreactor shuts down immediately, if the I/O Cabinet is not connected to a backup power source. • All control loops are set to their default condition. On the X-Station: • An ***E-stop Active*** status is flashing on the ***Reactor Display*** screen. • Alarm messages are shown in the alarm summary pane on the ***Reactor Display*** screen. Depending on the TCU model: • The TCU goes into standby mode. A standby message is shown on the TCU display. • The TCU shuts down immediately.
Power returns	• If the agitator was in ***Auto/Local*** mode when the power interruption occurred, the agitator is enabled and running when power returns. • The control loops stay in the safe state. • If the TCU was in ***Remote*** mode, the TCU restarts automatically. • If the TCU was not in ***Remote*** mode, the TCU must be restarted. Refer to the TCU manufacturer's manual for instructions.

Power interruption to temperature control unit (TCU)

Event	Result
Power interruption occurs	• The TCU shuts down immediately. • The bioreactor stays in the same mode as before power interruption. • No alarm is displayed on the ***Reactor Display*** screen. ***Note:*** *No alarm is shown on the **Reactor Display** screen when the TCU fails. Temperature deviation alarms inform the operator when the bioreactor temperature falls outside the set limits.*
Power returns	Depending on the TCU model: • The TCU restarts automatically or • The TCU must be restarted. Refer to the TCU manufacturer's manual for instructions.

2.5 Interlocks

Introduction

This section describes the interlocks functionality for the XDR bioreactor.

In this section

Section		See page
2.5.1	Interlock conditions	44
2.5.2	Interlock limits	49
2.5.3	Interlock illustrations	51

2.5.1 Interlock conditions

General interlocks

The following table describes the general interlocks for XDR-50 to 2000 Bioreactor Systems. See also for detailed information for specific XDR vessel sizes.

Weight interlock limits, on page 49

Condition	Result
The XDR vessel weight is equal to or lower than the ***LoLo*** weight interlock limit.	• Interlocks stop the agitator. The agitator remains interlocked until the agitator setpoint exceeds 10 rpm, if these PID control loops are in ***Auto*** mode. • The agitator resumes operation when the XDR vessel weight is higher than the ***LoLo*** weight interlock limit.
The XDR vessel weight is equal to or lower than the ***Lo*** weight interlock limit.	• Interlocks stop DO control, pH control, vessel temperature control, and exhaust filter heater control, if these PID control loops are in ***Auto*** mode. • The agitator remains interlocked until the agitator setpoint exceeds 10 rpm. • The vessel temperature CV is set to the current SP. • The exhaust filter heater temperature CV is set to zero. • When the XDR vessel weight is higher than the ***Lo*** weight interlock limit, and the agitator setpoint exceeds 10 rpm, the XDR bioreactor system resumes control of the specified PID control loops, and the agitator resumes operation.

Condition	Result
The XDR vessel weight is equal to or higher than the ***HiHi*** weight interlock limit.	• Interlocks stop DO control and pH control, if these PID control loops are in ***Auto*** mode. • Auxiliary input 1 and 2 control stops. • Interlocks turn off pumps. • When the XDR vessel weight is lower than the ***HiHi*** weight interlock limit, the XDR bioreactor system resumes DO control, pH control, auxiliary input 1 and 2 control, and mass flow controllers and pumps are restarted.
The agitator ***PV*** is equal to or lower than 10 rpm.	• Interlocks stop DO control, pH control, vessel temperature control, and exhaust filter heater control, if these PID control loops are in ***Auto*** mode. • The vessel temperature CV is set to the current SP. • The exhaust filter heater temperature CV is set to zero. • When the agitator ***PV*** exceeds 10 rpm, the XDR bioreactor system resumes control of the specified PID control loops, adjusts the vessel temperature CV to the setpoint, and adjusts the exhaust filter heater temperature CV to the specified temperature.

Condition	Result
Bag pressure is higher than 4.83 kPa (48.26 millibar, 0.7 psig).	• Interlocks stop DO control and pH control, if these PID control loops are in ***Auto*** mode. • Auxiliary input 1 and 2 control stops. • Exhaust filter heater temperature control stops. • Interlocks shut off mass flow controllers and pumps. • When the bag pressure is lower than the specified threshold, the XDR bioreactor system resumes DO control, pH control, auxiliary input 1 and 2 control, exhaust filter heater temperature control, and mass flow controllers and pumps are restarted.
The designated total gas flow rate exceeds the gas flow limit defined for the selected bag type. See *Exhaust gas flow limits, on page 49* for the detailed data. The total gas flow rate is defined as the sum of CVHL values for all mass flow controllers.	• Interlocks shut off all mass flow controllers. • Exhaust filter heater temperature control stops. The temperature CV is set to zero. • When the total gas flow rate does not exceed the gas flow limit defined for the selected bag type, the XDR bioreactor system restarts the mass flow controllers, and resumes exhaust filter heater temperature control.

Condition	Result
Exhaust filter heater temperature is more than 5°C off the setpoint.	• The temperature increase rate must be at least 2°C per 7 min until the temperature reaches the interval of ±5°C from the setpoint. • If the temperature increase rate is lower than the specified range, the interlock alarm is activated and the exhaust filter heater is set to ***Manual/Local*** mode. The temperature CV is set to zero. • The interlock is not active within a 5°C interval from the setpoint. • When the exhaust filter heater temperature is within 5°C off the setpoint, and the temperature increase rate is within the specified range, the XDR bioreactor system resumes normal operation. • If the temperature increase rate is lower than the specified range, the interlock alarm is activated, and corrective actions need to be taken until the temperature increase rate is within the specified range.
The pH transmitter communication alarm is active.	• Interlocks stop pH control. • When the pH transmitter communication alarm is not active, the XDR bioreactor system resumes pH control.
The MFCs are not operational.	The temperature control of the exhaust filter heaters 1 and 2 stops.

Interlocks, Liquid Management (optional function)

The following table describes additional interlocks, that are specific for the Liquid Management function. These interlocks are only available if the system is configured with the Liquid Management function.

Condition	Result
One feed pump is active in sequential feed mode.	The second feed pump cannot start. Only one pump can be active at a time in sequential feed mode.
The weight on a feed scale is lower than the ***Switchover SP*** value.	The feed pump assigned to this feed scale does not start.
The pump is stopped manually at the pump (stop button), when the system is in ***Auto/Local*** or in ***Auto/Remote*** control mode.	The pump shuts off. The control mode changes to ***Manual/Local*** and the CV is set to 0. The pump remains shut off when the user presses **Enter** on the pump hardware.

2.5.2 Interlock limits

Weight interlock limits

The following table shows the weight interlock limits for different sizes of the bioreactor.

	Interlock type		
XDR vessel size	***HiHi***	***Lo***	***LoLo***
50 L	55 kg	25 kg	2 kg
200 L	220 kg	38 kg	9 kg
500 L	525 kg	85 kg	12 kg
1000 L	1050 kg	175 kg	33 kg
2000 L	2100 kg	348 kg	63 kg

Exhaust gas flow limits

The following table shows the exhaust gas flow limits for different disposable bags.

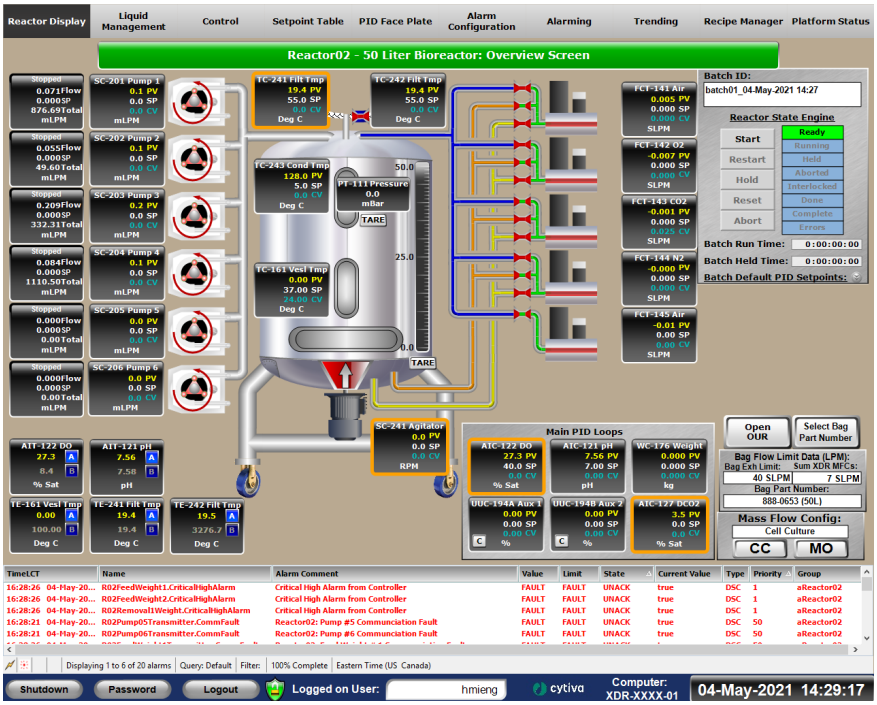
XDR vessel size	Bag ID	Exhaust gas flow limit (SLPM)
50 L	888-0086	40
50 L	888-0235	100
50 L	888-0356	40
50 L	888-0652	40
50 L	888-0653	40
50 L	888-0769	100
50 L	888-2-0086	40
50 L	888-2-0235	100
50 L	888-2-0356	40
50 L	29713149	40
50 L	29713151	40
50 L	29713153	40
50 L	29713155	100
50 L	29713157	40
200 L	888-0067	40
200 L	888-0151	40
200 L	888-0388	200
200 L	888-0559	200

XDR vessel size	Bag ID	Exhaust gas flow limit (SLPM)
200 L	888-0784	40
200 L	888-2-0067	40
200 L	888-2-0151	40
200 L	29712046	40
200 L	29712048	40
200 L	29712054	40
200 L	29712055	200
200 L	29712057	40
500 L	888-0070	80
500 L	888-2-0070	80
500 L	29712669	80
500 L	29713201	80
1000 L	888-0071	135
1000 L	888-0660	135
1000 L	888-2-0071	135
1000 L	29713203	135
1000 L	29713205	135
2000 L	888-0081	135
2000 L	888-2-0081	135
2000 L	29710570	135
2000 L	29710571	135
2000 L	29721436	135
2000 L	29721438	135
2000 L (XDR-2000 Pro Max™ bag)	29724937	270

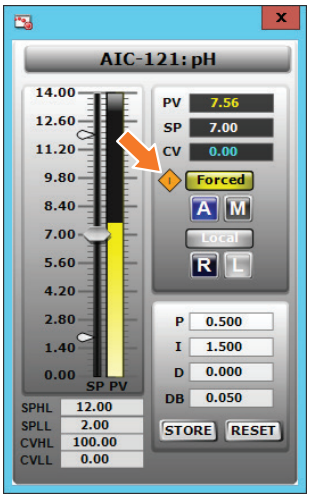
2.5.3 Interlock illustrations

Illustration of the interlocks

The panels for stopped PID control loops are marked with orange frames on the ***Reactor Display*** screen. The illustration below shows the ***Reactor Display*** screen for an interlocked XDR bioreactor.



An interlock icon  is shown on the PID faceplates of the stopped PID control loops.


AIC-121: pH
14.00
12.60
11.20
9.80
8.40
7.00
5.60
4.20
2.80
1.40
0.00
SP PV
PV 7.56
SP 7.00
CV 0.00
Forced
A M
Local
R L
P 0.500
I 1.500
D 0.000
DB 0.050
STORE RESET
SPHL 12.00
SPLL 2.00
CVHL 100.00
CVLL 0.00

2.6 Security access levels

Introduction

This section contains important information regarding XDR-50 to 2000 Bioreactor Systems software modes and security access levels. The security setup depends on the software version installed on the system. Refer to the section applicable for your system.

In this section

Section		See page
2.6.1	General information	54
2.6.2	Security access levels	55

2.6.1 General information

Overview

The XDR-50 to 2000 Bioreactor Systems software has two modes:

- View only
- Operation

The default mode is view only. All users can access the view only mode without logging on.

The operation mode has four security access levels:

- HMI Operator
- HMI Supervisor
- HMI Engineer
- Windows Administrator

User role assignment

The XDR-50 to 2000 Bioreactor Systems control system uses Microsoft Windows authentication. Unique user names and passwords are assigned to each user to make sure that the user has appropriate access to the XDR bioreactor control system. The access level for each user (HMI Operator, HMI Supervisor, or HMI Engineer) is defined by the customer.

View only mode

The default mode is view only, and is available to all users without logging on. All users can open and view the operation screens using the InTouch HMI WindowViewer software.

Windows administration

Users having Windows Administrator access level can create, delete and manage user accounts. See *Section 8.8.2 Add and remove users, on page 483* for more information.

Operating system

XDR-50 to 2000 Bioreactor Systems run with Microsoft Windows Server 2019 (Desktop Experience).

2.6.2 Security access levels

User access

The following table describes the user access to system functions. The system functions can be configured independently for all connected bioreactors (maximally four systems).

See *Appendix B User interface description, on page 549* for a more detailed description of the system functions.

✓ Access allowed

✗ Access not allowed

System functions	Access level			
	View only (no logon)	Operator	Supervisor	Engineer
Acknowledge alarms	✗	✓	✓	✓
Adjust alarm settings	✗	✗	✓	✓
Adjust offsets for: • DO probe • Exhaust filter heater temperature • pH probe • Vessel temperature	✗	✗	✓	✓
Adjust tuning parameters for main PID control loops: • Auxiliary inputs • Dissolved CO_2 • Dissolved oxygen • pH • Vessel weight	✗	✗	✗	✓
Adjust tuning parameters for PID control loops: • Agitator • Exhaust filter heater • MFCs • Pumps • Temperature	✗	✗	✗	✗

System functions	Access level			
	View only (no logon)	Operator	Super-visor	Engineer
Adjust PID control loop tuning parameters (P, I, D, DB) for feed control (Liquid Management)	✗	✗	✗	✓
Adjust controlled variables (CV)	✗	✓	✓	✓
Adjust setpoints (SP)	✗	✓	✓	✓
Adjust setpoint control limits (SPHL, SPLL, CVHL, CVLL):	✗	✗	✗	✓
Advance step (***Setpoint Table***)	✗	✗	✓	✓
Assign pumps (Liquid Management)	✗	✗	✓	✓
Calibrate pump	✗	✗	✓	✓
Change PID loop control modes: ***Auto/Manual*** ***Remote/Local***	✗	✓	✓	✓
Change user password	✗	✓	✓	✓
Control ***Setpoint Tables***	✗	✓	✓	✓
Configure ***Setpoint Tables***	✗	✗	✓	✓
Edit gas flow paths	✗	✗	✓	✓
Enable and disable agitator	✗	✓	✓	✓
Enable and disable alarms	✗	✗	✓	✓
Enable and disable mapping functions	✗	✗	✓	✓
Enable and disable ***Setpoint Tables***	✗	✓	✓	✓
Exit software	✗	✗	✓	✓
Map and unmap PID control loops	✗	✗	✓	✓
Measure oxygen uptake rate	✗	✗	✓	✓
Operate ***Batch Manager***	✗	✓	✓	✓
Operate dual feed mode (Liquid Management)	✗	✗	✓	✓
Operate flow totalizer (Liquid Management)	✗	✓	✓	✓

System functions	Access level			
	View only (no logon)	Operator	Super-visor	Engineer
Operate totalizers: • MFC • Pump	✗	✓	✓	✓
Select auxiliary input configuration options	✗	✗	✗	✓
Select bag type	✗	✓	✓	✓
Add or delete bag	✗	✗	✓	✓
Select functionality: single purpose or dual purpose	✗	✗	✓	✓
Select probe channel (A/B)	✗	✓	✓	✓
Select pump direction	✗	✗	✓	✓
Select scales (Liquid Management)	✗	✗	✓	✓
Set default PID setpoints	✗	✓	✓	✓
Switch pump assignment: • Control mapping or • Liquid Management	✗	✗	✓	✓
Tare bag pressure	✗	✓	✓	✓
Tare vessel weight	✗	✓	✓	✓
View and select auxiliary input configuration options	✗	✗	✗	✓

3 System description

About this chapter

This chapter provides a description of XDR-50 to 2000 Bioreactor Systems and an overview of system components.

In this chapter

Section		See page
3.1	System overview	59
3.2	XDR vessel components	64
3.3	Agitator assembly	88
3.4	Supply hardware	95
3.5	Safety system	112
3.6	X-Station	114
3.7	Temperature control unit (TCU)	116
3.8	Disposable components	117

3.1 System overview

Introduction

This section provides the overview of XDR-50 to 2000 Bioreactor Systems hardware and information about the bioreactor connectivity to other systems.

In this section

Section		See page
3.1.1	System hardware	60
3.1.2	System connectivity	62

3.1.1 System hardware

Description

XDR-50 to 2000 Bioreactor Systems are modular systems, designed for cell cultivation and microbial fermentation processes.

XDR-50 to 2000 Bioreactor Systems consist of the following parts:

- XDR vessel
- I/O Cabinet
- Gas supply cabinet
- Condenser assembly (optional)
- X-Station
- Temperature control unit (TCU)

The cell cultivation process is managed using a free-standing control unit called X-Station.

A separate temperature control unit is necessary for vessel jacket temperature regulation. The TCU can be purchased from Cytiva or supplied by the customer.

Functionality

XDR-50 to 2000 Bioreactor Systems provide the possibility to monitor and control pH, temperature, dissolved oxygen, weight, liquid addition and removal, and dissolved CO_2 (optional function). The systems provide different gas flow and gas mixing possibilities.

The 50 L and 200 L bioreactors are available in two different variants:

- Single purpose: for cell culture only
- Dual purpose: for cell culture or microbial fermentation

Operating principle

The cell cultivation process is done in a disposable bag, which is installed inside the XDR vessel. Media and cells are added into the disposable bag. The growth environment in the disposable bag is monitored and controlled by the bioreactor control system.

The liquids are introduced using tubing that can be connected using weldings or aseptic integral fittings, if available. Mixing of the disposable bag contents is done with an agitator motor which is magnetically coupled to an impeller assembly, that is an integral part of the disposable bag.

The exhaust gases exit the disposable bag through exhaust filters. The temperature of the exhaust filters is maintained by the exhaust filter heaters.

An optional condenser assembly is available to prevent excessive water loss from certain cell cultures (typical for microbial cell cultures). The condenser assembly is set between the disposable cell culture bag and the exhaust filters. The exhaust gases from the cell culture bag pass through the condenser assembly. The condensed water vapor is redirected into the disposable bag.

The product is collected through the harvest lines at the bottom of the disposable bag.

Illustration of the system



Part	Description
1	Temperature control unit (TCU)
2	XDR bioreactor
3	X-Station

Accessories

Accessories are available for XDR-50 to 2000 Bioreactor Systems. Accessories may be applicable to process hardware, measurement and control, interconnectivity, and more. For more information about specific accessories and their operating instructions refer to user documentation for each respective accessory.

3.1.2 System connectivity

Connection to X-Station

The I/O Cabinet of XDR-50 to 2000 Bioreactor Systems is connected to the X-Station using a PROFIBUS network. Industry standard connectors and cables are used for these connections.

When several bioreactors are connected to a single X-Station, a daisy chain scheme is used. The communication to each bioreactor is independent of the presence of other bioreactors and is not interrupted if one of the bioreactors is turned off. Each connected bioreactor operates independently from the others. All connected bioreactors may be operated simultaneously.

Connection to external systems (optional)

XDR-50 to 2000 Bioreactor Systems can be connected to an external system using the X-Station. The connection is done using the external Ethernet port on the back of the X-Station, correct connection credentials must be used. The Ethernet port is protected from unauthorized access with a physical lock. Only an authorized key holder can unlock the port.

The illustration below shows the location of the Ethernet port.



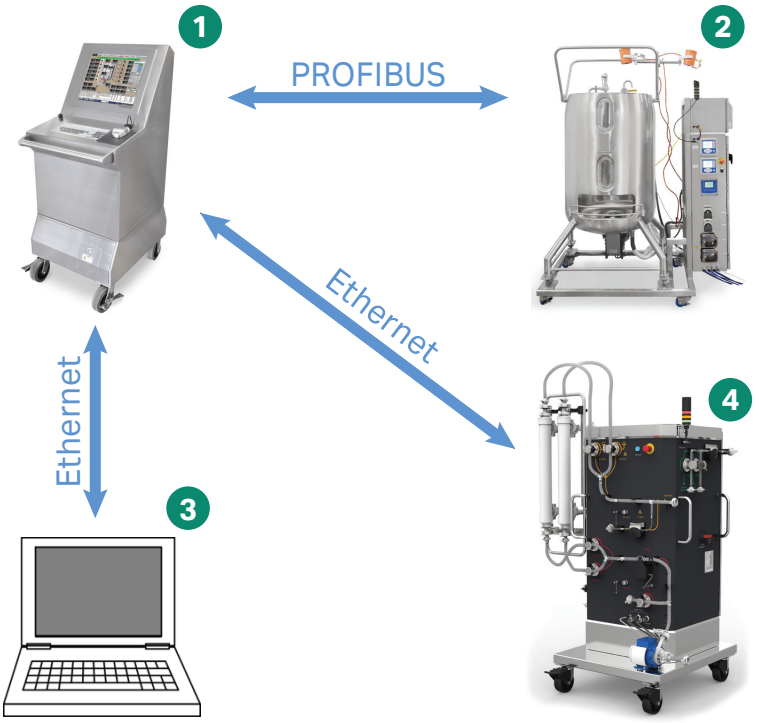
Contact your Cytiva representative for additional information.

Connection to an external system is not required for connection of a bioreactor to the X-Station.

Connection to logical software

It is possible to integrate XDR-50 to 2000 Bioreactor Systems with MRP/ERP (Manufacturing Resource Planning / Enterprise Resource Planning) software. Contact your Cytiva representative for additional information.

Illustration of system connectivity



Part	Description
1	X-Station
2	Bioreactor
3	External computer for OPC data use (optional)[1]
4	Xcellerex APS (Automated Perfusion System) (optional) ***Note:*** *Contact your Cytiva representative for available options.*

[1] Computer supplied by the customer.

3.2 XDR vessel components

Introduction

This section provides information about the various components of the XDR vessel.

In this section

Section		See page
3.2.1	XDR vessel	65
3.2.2	Front openings and detachable door	70
3.2.3	Load cells	74
3.2.4	Exhaust filter and filter heater assembly	77
3.2.5	Bag hoist	81
3.2.6	Condenser assembly (optional)	84
3.2.7	Alarm stack (optional)	86

3.2.1 XDR vessel

Description

The XDR vessel is a stainless steel cylindrically shaped container. The vessel has the capacity to hold 22 to 2000 L culture medium, depending on the system.

A disposable bag is installed inside the vessel. Media and cells are added to the bag. The contents of the bag are stirred using an impeller. Flexible tubing is used to transfer materials (liquids and gases) in and out of the disposable bag. Tubing support at the top of the XDR vessel supports the tubing connected to the disposable bag.

The growth environment in the disposable bag is monitored and controlled by the bioreactor control system.

50 L XDR vessel

The 50 L XDR vessel is available in two different variants: standard (single frame) design and split frame design. The split frame design is built on two separate frames:

- I/O Cabinet and gas supply cabinet
- XDR vessel

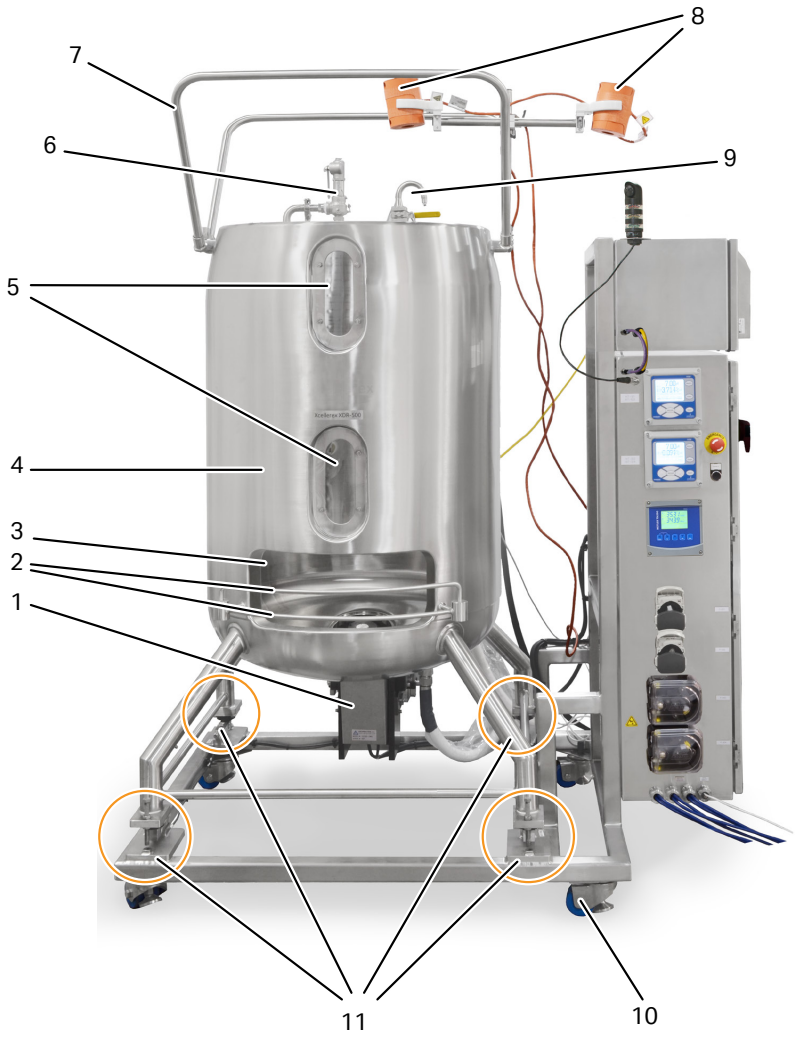
1000 and 2000 L XDR vessels

The tubing support on 1000 and 2000 L XDR vessels is integrated with a bag hoist. The bag hoist helps the operator to lift and lower the disposable bag through the XDR vessel during the installation and removal of the bag.

The 1000 and 2000 L XDR vessels have a rectangular opening at the front for installation and removal of the disposable bag. A detachable door covers the opening and supports the disposable bag after installation.

Illustration of the 50, 200, and 500 L XDR vessels

The following illustration shows an example of 50, 200, and 500 L XDR vessels.



Part	Description
1	Agitator motor
2	Probe support bar
3	Probe window
4	Stainless steel vessel

Part	Description
5	Viewing window (2)
6	Pressure relief valve for vessel jacket[1]
7	Tubing support
8	Exhaust filter heater (2)[2, 3]
9	Air vent for vessel jacket
10	Caster (4)[4]
11	Load cell (4)[5]

[1] Only for 200 and 500 L XDR vessels. 50 L XDR vessel has a burst disc.
[2] One exhaust filter heater is supplied as standard.
[3] XDR-2000 Pro Max bag requires two exhaust filter heaters.
[4] The split frame design of 50 L XDR vessel has 9 casters.
[5] 50 L XDR vessel has 3 load cells.

Illustration of the 1000 and 2000 L XDR vessels

The following illustration shows an example of the 1000 and 2000 L XDR vessels.



Part	Description
1	Agitator motor
2	Probe support bar[1]
3	Detachable door with probe window

Part	Description
4	Viewing window (2)
5	Tubing support
6	Bag hoist
7	Exhaust filter heater (2)[2, 3]
8	Bag hoist power connector
9	Stainless steel vessel
10	Bag hoist operating panel
11	Casters (4)
12	Load cells (4)

[1] The probe support bar is an integrated part of the detachable door.
[2] One exhaust filter heater is supplied as standard.
[3] XDR-2000 Pro Max bag requires two exhaust filter heaters.

Bottom openings

The XDR vessel has two openings at the bottom of the vessel.

The large opening is used for connecting the impeller baseplate to the agitator motor. When the disposable bag is installed inside the XDR vessel, the motor assembly is lifted up to enable the connection to the impeller baseplate.

The second (smaller) opening at the bottom of the XDR vessel is used for harvesting the cell culture after a completed run. The harvest line is inserted into this opening during the installation of the disposable bag.

50 L XDR vessel has only one opening at the bottom of the vessel.

Additional components

The following additional units are attached to the XDR vessel frame:

- I/O Cabinet
- Gas supply cabinet

An optional condenser assembly is available and can be attached to the XDR vessel. The condenser is used to prevent excessive water loss through the exhaust gases. The condenser assembly is optional and is applicable for microbial fermentation processes.

XDR vessel independent parts are described in more detail in the following sections of this manual.

3.2.2 Front openings and detachable door

Description

Different sizes of XDR vessels have different front openings for access to the disposable bag assembly.

For 50, 200 and 500 L XDR vessels, the disposable bag is installed through the top of the XDR vessel. The vessel front opening (probe window) is used for probe installation and access.

For 1000 and 2000 L XDR vessels, the front opening of the vessel is used for the disposable bag installation. After the installation of the bag the front opening is covered with a detachable door, that supports the weight of the liquid contents of the disposable bag. The door can be made of polymer or stainless steel and is held in closed position by cam locks. The door has an opening for installation and access of the probes.

Viewing windows

XDR vessel has a vertical viewing window on the vessel front. The viewing window gives a possibility for visual monitoring of the disposable bag contents. The viewing window is covered with transparent polymer.

1000 L and 2000 L XDR vessels have two viewing windows.

Probe window

The probe window is the opening at the bottom of the XDR vessel front (50, 200 and 500 L XDR vessels), or the opening in the detachable door (1000 and 2000 L XDR vessels).

The probe window provides access to the probes that are installed in the disposable bag. The reinforcement sheet of the disposable bag surrounds the probes and is aligned with the probe window. The reinforcement sheet supports the lower part of the bag and helps with the correct orientation of the probes in the probe window.

The probe window has metal bars to support the installed probes. The probe support of the 50, 200 and 500 L XDR vessels is detachable. For 1000 and 2000 L XDR vessels, the probe support is an integrated part of the detachable door that covers the front opening of the XDR vessel.

Illustration of the probe window

The following illustration shows an example of the probe window with probe support for 50, 200 and 500 L XDR vessels.



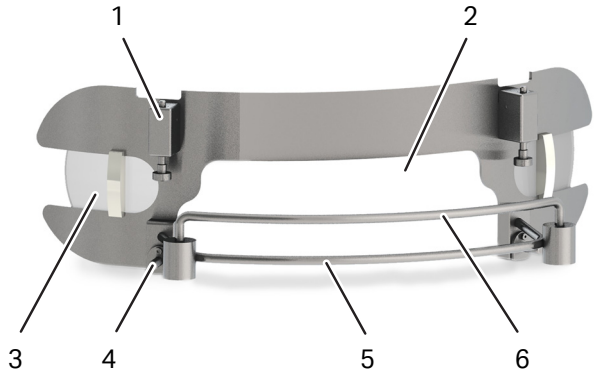
Illustration of the front opening with a door

The following illustration shows the vessel opening of 1000 and 2000 L XDR vessels, covered with a detachable polymer door with probe window and probe support bar. The probe support bar is an integrated part of the detachable door.

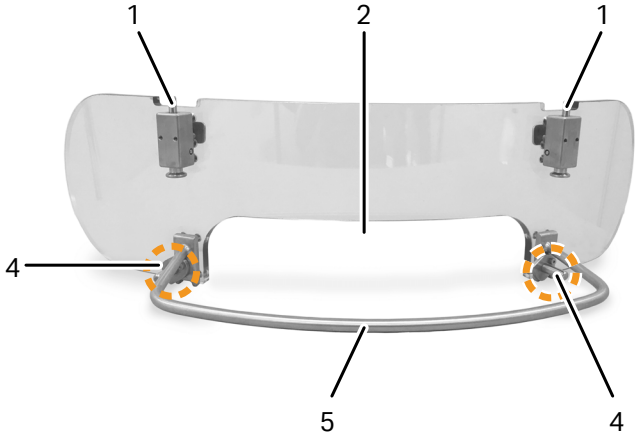


Illustration of 1000 and 2000 L XDR vessel door

The following illustration shows an example of a stainless steel door.



The following illustration shows an example of a polymer door.



Part	Description
1	Retention pin
2	Probe window
3	Perfusion tubing slot with cover plate ***Note:*** *The cover plate must be removed to connect the perfusion tubing to the disposable bag.*
4	Cam lock

Part	Description
5	Probe and probe cable support bar (lower)[1] Support for standard probes (pH, DO, CO_2), sample tubing, and temperature probe.
6	Probe and probe cable support bar (upper)[2] Support for single-use DO probes, and spare tubing.

[1] The lower probe support bar is an integrated part of the detachable door.
[2] The upper probe support bar is removable.

3.2.3 Load cells

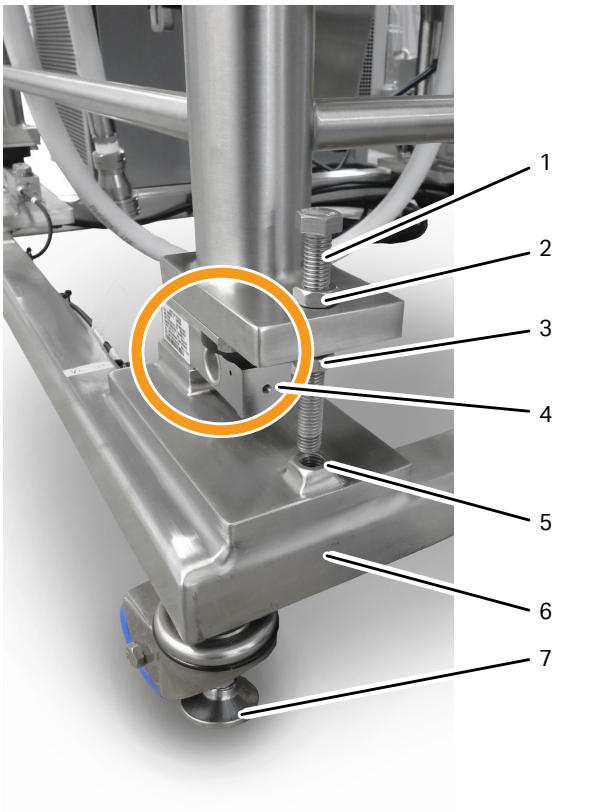
Description

Load cells measure the weight of the bioreactor. Load cells are not a structural element.

Load cells must be secured by jacking bolts when the bioreactor is moved. The jacking bolts lift the bioreactor body up, secure it and take the load off from the load cells, thereby preventing the damage to the load cells. Load cells should be recalibrated after moving the XDR vessel.

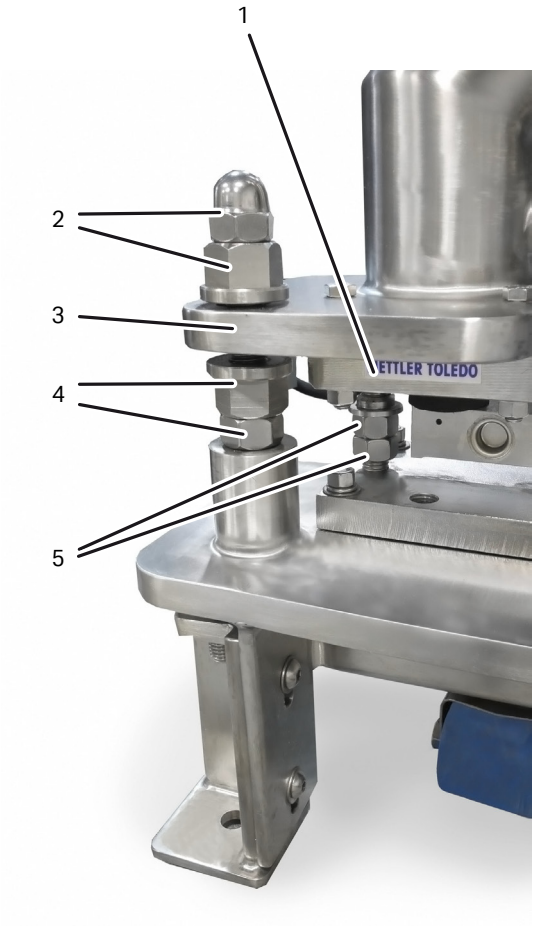
For the seismic XDR vessels, the jacking bolts are also designed to provide a resistance during earthquakes. The seismic jacking bolts are an optional component.

Illustration of non-seismic load cells



Part	Description
1	Jacking bolt
2	Top nut
3	Bottom nut
4	Load cell
5	Acceptor nut
6	Vessel frame
7	Leveling foot

Illustration of seismic load cells



Part	Description
1	Load cell
2	Large jacking bolt, top nuts
3	Vessel supporting frame
4	Large jacking bolt, bottom nuts
5	Small jacking bolt with top and bottom nut

3.2.4 Exhaust filter and filter heater assembly

Description

XDR-50 to 2000 Bioreactor Systems are provided with one exhaust filter heater. The second exhaust filter heater is optional. The filter preserves the aseptic cell culture and prevents microorganisms from escaping from the disposable bag into the environment with the exhaust gas flow.

Several different sizes of filters are available. The required filter size is directly proportional to the expected flow rate of gases through the bioreactor.

Exhaust filter heater assembly

An exhaust filter heater is attached to the tubing support at the top of the XDR vessel. The filter heater maintains the temperature of the exhaust filter.

The exhaust filter heater is wrapped around the exhaust filter and closed with the clasps. The exhaust filter heater is connected to the I/O Cabinet with a cable. The cable provides electrical power to the heater element inside the exhaust filter heater, and transmits temperature information back to the I/O Cabinet.

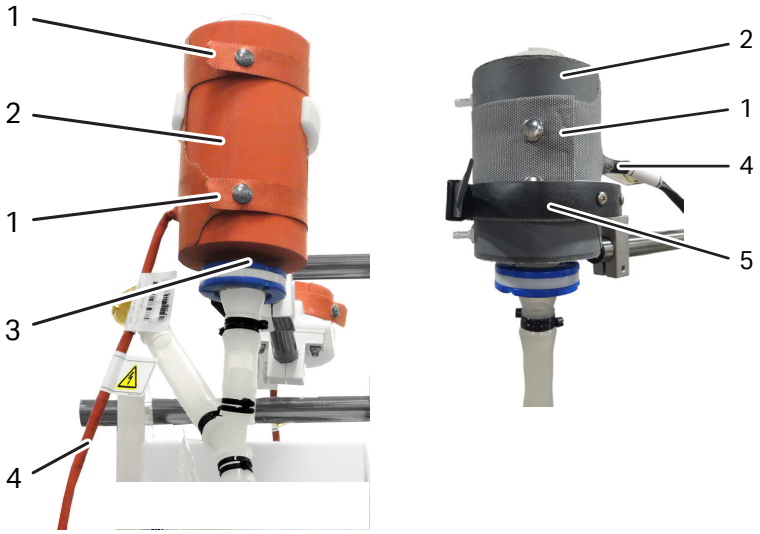
Operating principle

The exhaust gases contain moisture that is retained by the exhaust filter. A filter that contains condensed moisture develops a higher resistance to gas flow. The accumulating pressure in the disposable bag may lead to excessive bag pressure and rupture of the bag. The exhaust filter heater maintains the temperature of the exhaust filter, thereby decreasing the vapor condensation and keeping the exhaust filter as dry as possible.

Illustration of large filter heater assembly

The following illustration shows an example of a large exhaust filter heater.

Note: *Exhaust filter heater color can vary. The images are for illustrative purposes only.*

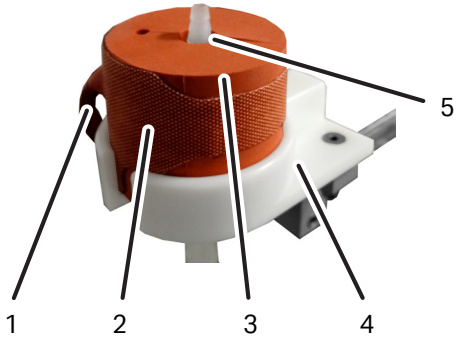


Part	Description
1	Filter heater strap
2	Filter heater body
3	Inlet for exhaust filter
4	Mains cable
5	Filter heater holder strap

Illustration of small filter heater assembly

The following illustration shows an example of a small exhaust filter heater.

Note: *Exhaust filter heater color can vary. The images are for illustrative purposes only.*



Part	Description
1	Mains cable
2	Strap
3	Filter heater body
4	Filter heater holder
5	Exhaust filter outlet

Optional exhaust filter heaters

The XDR-50 to 2000 Bioreactor Systems for standard cell culture have one standard exhaust filter heater. All XDR-50 to 2000 Bioreactor Systems include a connector for an optional second exhaust filter heater.

The XDR-2000 Bioreactor System for the XDR-2000 Pro Max bag requires two exhaust filter heaters.

Optional exhaust filter and pinch valve

Optional secondary exhaust filters can be added to the disposable bag, together with the corresponding exhaust filter heaters. The secondary exhaust filter can be used in parallel to the primary filter to increase the exhaust gas flow capacity. Alternatively, the secondary filter can be used as a backup filter for the primary exhaust filter.

When used as a backup filter, the optional exhaust filter is connected to a pinch valve (optional component). If the primary exhaust filter is clogged and the bag pressure exceeds the defined limit, the pinch valve opens and the exhaust gas flow is directed to the secondary exhaust filter (backup filter).

The following illustration shows an example of a pinch valve.



3.2.5 Bag hoist

Description

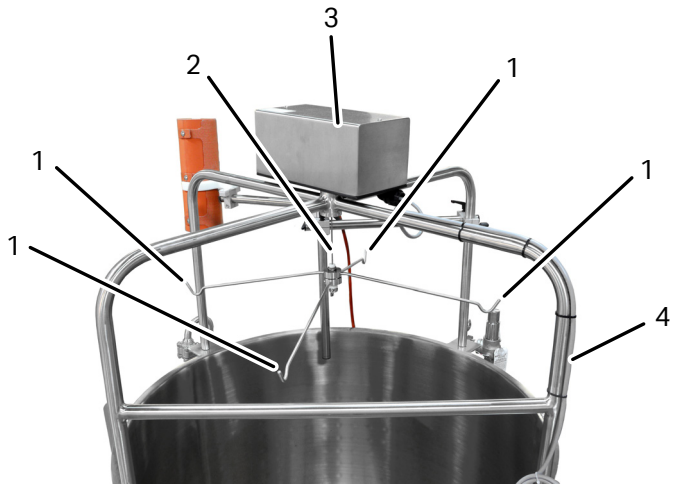
1000 and 2000 L XDR vessels have a bag hoist, located at the top of the XDR vessel and integrated with the tubing support.

The bag hoist is a system for lifting and lowering of the disposable bag during bag installation and removal. The bag hoist consists of a motor, a cable and a set of hooks. The motor lifts or lowers the bag which is attached to the cable using the hooks.

The motor is operated via a button panel located on the front of the XDR vessel. The operator must manually align and correct the disposable bag position while the hoist is lifting or lowering the bag through the bag loading window.

Illustration of the bag hoist

The illustration below shows the bag hoist system.



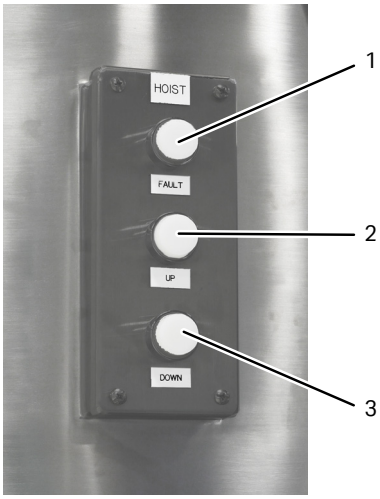
Part	Description
1	Bag hooks
2	Hoist cable
3	Hoist mechanism
4	Power and control cable

Illustration of the bag hoist operating panel

The following illustration shows the location of the bag hoist operating panel.



The following illustration shows the bag hoist operating panel.



Part	Name	Description
1	**FAULT** button	The button is lit if a fault is present. Pressing the button for 3 seconds clears the fault.
2	**UP** button[1]	Lifts the hoist. The hoist is moving while the button is pressed.
3	**DOWN** button[1]	Lowers the hoist. The hoist is moving while the button is pressed.

[1] The button is lit while pressed.

3.2.6 Condenser assembly (optional)

Description

The condenser assembly contains a solid state electrical cooler and two cooling plates. The condenser assembly is attached to the top of the vessel frame. A condenser bag is installed between the cooling plates.

The condenser bag is a separate smaller plastic bag connected to the main disposable bag by plastic tubing. The exhaust gases move through the condenser bag when they exit the fermentation bag. The condenser bag contains a grid type material to improve the contact between the cooling plates and the condenser bag, while distorting and prolonging the route taken by the exhaust gases. The condensed water vapor is directed back into the cell culture bag.

The condenser bag is attached to the disposable bag assembly at the time of manufacturing.

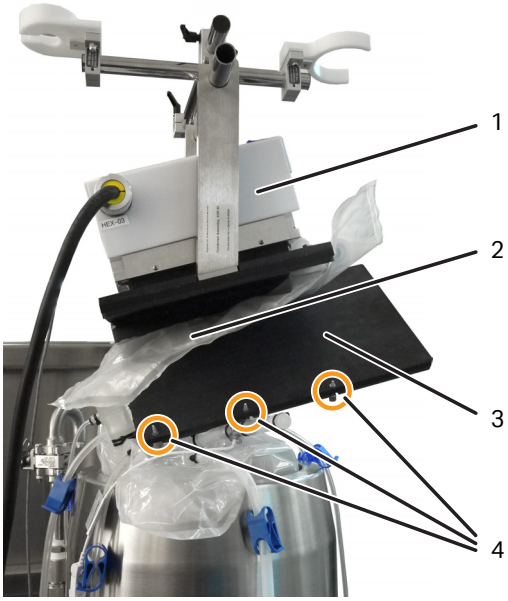
The condenser assembly is optional and is used in microbial fermentation processes.

Operating principle

The condenser is used to prevent excessive water loss in applications such as fermentation. Microbial cell cultures require high gas flow rates. The escape of water vapor carried by the gases may cause excessive water loss from the cell culture and change batch characteristics. The condenser is used to minimize this water loss. Less humid exhaust gases also help to keep the exhaust filter dry and thereby prevent filter clogging.

After passing through the condenser assembly the exhaust gases are directed to the exhaust filters.

Illustration of the condenser assembly



Part	Description
1	Solid state electrical cooler
2	Condenser bag
3	Cooling plate
4	Thumbscrews

3.2.7 Alarm stack (optional)

Description

The XDR-50 to 2000 Bioreactor Systems may have an optional alarm system. The alarm system, the audible-visible "alarm stack" (referred to in this manual as alarm stack gives the users visual and audible signals about the current state of the system and the ongoing process.

The alarm stack is an optional component.

Alarm stack location

The alarm stack is attached to the gas supply cabinet front. The alarm stack is connected to the **LIGHT STACK** connector on the I/O Cabinet with a cable.

The following illustration shows the location of the alarm stack.



Alarm stack colors

The following light and sound signals are given:

Light	Quality	Sound	Description
	Constant		**EMERGENCY STOP** is engaged.
	Flashing		An interlock is active.
	Constant		Acknowledged alarms are present.
	Flashing		Unacknowledged alarms or unacknowledged return alarms are present. ***Note:*** *Sound signal is given only when the system is in **Running** state.*
	Constant		The system is in ***Running*** state.
	Flashing		The system is in ***Held*** or ***Aborted*** state.

3.3 Agitator assembly

Introduction

This section provides information about the agitator system of the XDR-50 to 2000 Bioreactor Systems.

In this section

Section		See page
3.3.1	Agitator	89
3.3.2	Agitator motor	90
3.3.3	Agitator motor lifting system	92

3.3.1 Agitator

Description

The cell culture inside the disposable bag is stirred by an impeller. The agitation is provided by a servo drive and motor. The motor and the impeller assembly are magnetically coupled.

The impeller baseplate is part of the disposable bag, located at the bottom of the bag. There are no openings in the disposable bag wall for agitation access.

Agitator operating principle

The agitator drive head is connected to the impeller baseplate via magnetic coupling. The magnetic field keeps the agitator drive head connected to the impeller baseplate and transfers the rotational energy from the motor to the impeller baseplate, and further to the impeller inside the disposable bag.

A sparger is located under the impeller. The sparger is used to supply the cell culture media with gases for cell growth.

3.3.2 Agitator motor

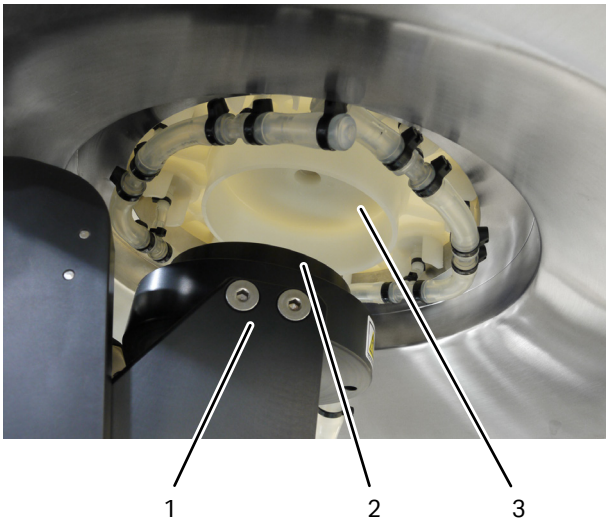
Description

The impeller is set into rotation by the agitator motor. The agitator motor is located under the XDR vessel. An opening at the bottom of the XDR vessel allows the contact between the impeller baseplate and the agitator motor.

After the disposable bag has been inserted into the XDR vessel and the impeller baseplate has been centered in the bottom opening of the XDR vessel, the agitator motor is lifted to make the connection between the motor and the impeller baseplate. The agitator motor and the impeller are magnetically coupled when connected. The operator uses a handle to lift and lower the agitator motor.

When the agitator motor is engaged with the impeller, the motor lifting device must be locked in the engaged position.

Illustration of the agitator system



Part	Description
1	Agitator motor
2	Magnetic drive head
3	Impeller baseplate (part of the disposable bag)

Agitation speed

The maximum agitation speed depends on the size of the XDR vessel. The following table shows the agitator speed for each vessel size.

XDR vessel size	Maximum agitation speed (rpm)
50 L	360
200 L	360
500 L	250
1000 L	140
2000 L	115[1], 120[2]

[1] 115 rpm is the maximum agitation speed for counterclockwise agitation using standard disposable bag assemblies. Certain applications running clockwise agitation with liquid volume up to 1500 L require reduced maximum speed (105 rpm).

[2] 120 rpm is the maximum agitation speed for XDR-2000 Pro Max disposable bag assemblies. The maximum agitation speed varies with viscosity.

If your application requires faster operation than the standard disposable bag assemblies shown above, contact your Cytiva representative.

Using the agitator in viscous solutions may lead to decoupling of the impeller core from the magnetic drive head. Decreasing agitator speed helps to avoid the decoupling.

3.3.3 Agitator motor lifting system

Description

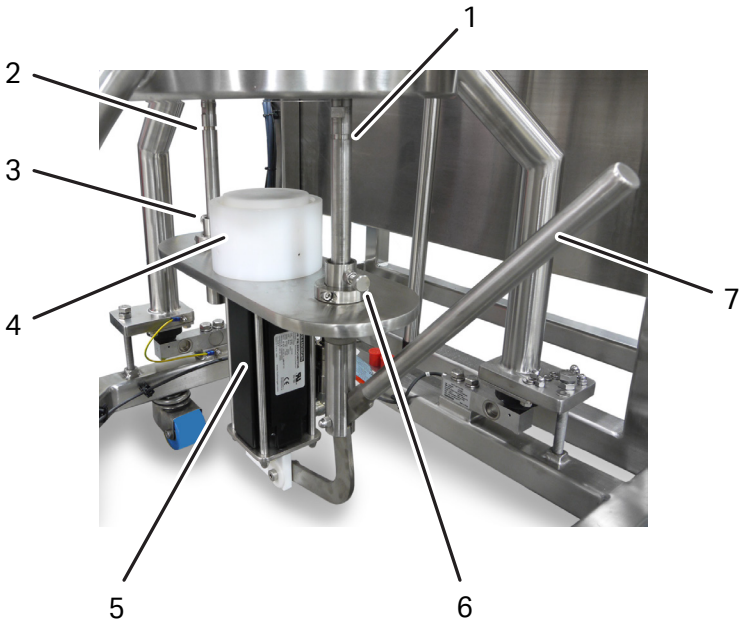
XDR-50 to 2000 Bioreactor Systems have a manually operated lifting system that engages and disengages the agitator motor and the impeller baseplate of the disposable bag assembly. The lifting system is used during installation and removal of the disposable bag.

The agitator motor is mounted inside an X-lift or a G-lift assembly. The 50 L XDR vessel has a G-lift. The 200, 500, 1000 and 2000 L XDR vessels have an X-lift.

During the disposable bag installation, the operator uses the front opening to reach inside the XDR vessel and arrange the agitator baseplate correctly in the vessel bottom opening. The operator then uses a lift handle to lift the agitator motor. The G-lift is engaged by pushing the handle downwards. The X-lift is engaged by pulling the handle upwards.

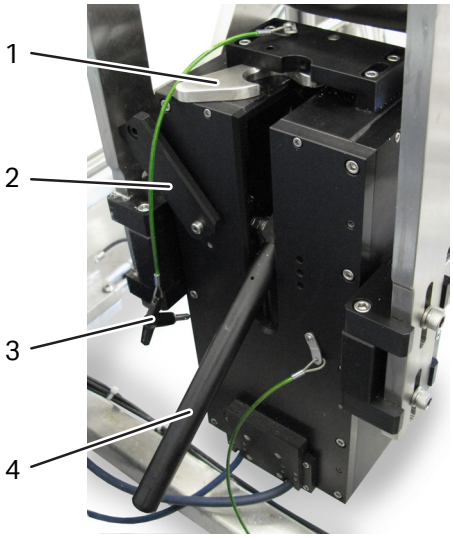
Both lifts must be locked in their engaged and disengaged positions.

Illustration of G-lift



Part	Description
1	Front groove
2	Rear groove
3	Rear locking pin
4	Agitator drive head
5	Motor
6	Front locking pin
7	Handle

Illustration of X-lift



Part	Description
1	Handle lock
2	Locking bar
3	Locking pin
4	Lift handle

3.4 Supply hardware

Introduction

This section provides information about separate units that supply XDR-50 to 2000 Bioreactor Systems with electrical power, gases, and liquids.

In this section

Section		See page
3.4.1	I/O Cabinet	96
3.4.2	Gas supply cabinet	100
3.4.3	Pumps	103
3.4.4	Auxiliary inputs	109

3.4.1 I/O Cabinet

Description

The I/O Cabinet physically and logically connects the XDR vessel to the control system inside the X-Station. The I/O Cabinet controls the instrumentation for supplying the disposable bag with liquid contents, and for the measurement and control of process parameters. The I/O Cabinet is constructed of stainless steel and is compatible with its installation environment.

The pumps that supply the disposable bag with liquid contents are attached to the I/O Cabinet.

The I/O Cabinet has connection points for the following equipment:

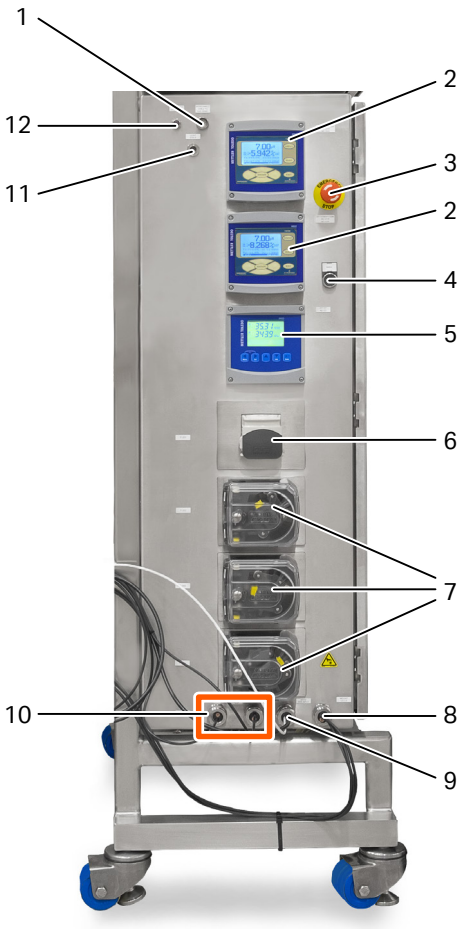
- Agitator motor
- Auxiliary inputs
- Bag pressure measurement
- Bag hoist (1000 and 2000 L XDR vessels)
- Condenser control (optional)
- Dissolved CO_2 measurement (optional)
- Exhaust filter heater control
- pH/DO measurement
- Pumps
- PROFIBUS ports
- Scales
- TCU control
- Temperature measurement

The connection to the control system is made using a PROFIBUS network. Optional systems can be connected via the auxiliary inputs.

The I/O Cabinet is located at the side of the XDR vessel and is attached to the XDR vessel frame.

Illustration of the I/O Cabinet front

The following illustration shows an example of an I/O Cabinet front.

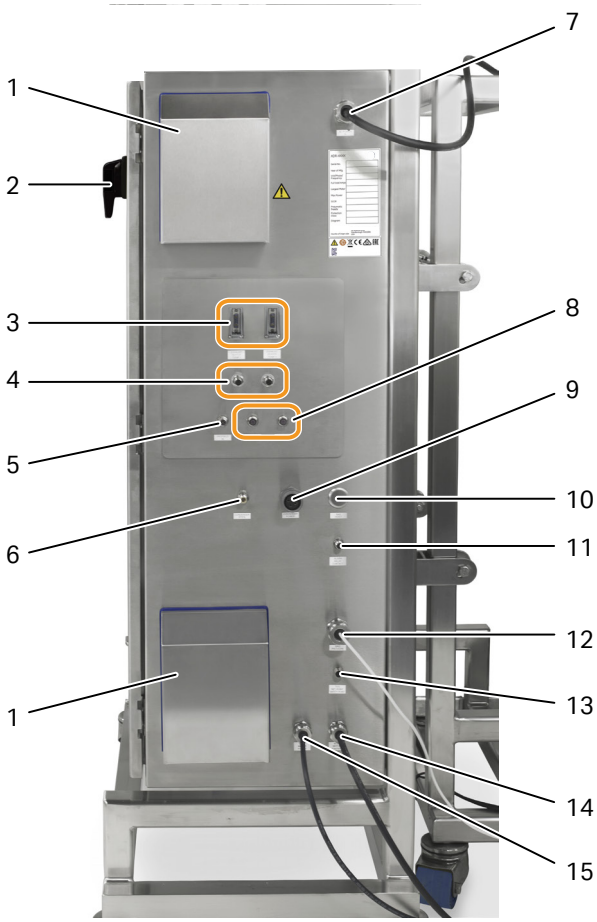


Part	Description
1	Electrical interconnect connection port
2	pH/DO transmitter display (2)
3	**EMERGENCY STOP** button
4	**ENABLE** button
5	Dissolved CO_2 transmitter display (optional)
6	Pump, model 313
7	Pump, model 520
8	Connection port for load cell cables

Part	Description
9	Connection port for dissolved CO_2 probe cable and temperature probe cable
10	pH/DO probe cable connection port (2)
11	Alarm stack connection port
12	**PROFIBUS OUT** connection port

Illustration of the I/O Cabinet back

The following illustration shows an example of an I/O Cabinet back. Your system may differ from the configuration illustrated below.



Part	Description
1	Ventilation hood (2)
2	System power switch
3	Exhaust filter heater connection ports
4	Auxiliary input connection ports
5	X-Station connection port (**PROFIBUS IN**)
6	Condenser temperature feedback connection port
7	Mains cable
8	PROFIBUS connection ports for external devices
9	Condenser power connection port
10	Bag hoist power connection port (1000 and 2000 L XDR vessels)
11	Alarm relay connection port
12	Bag pressure sensor cable
13	TCU connection port
14	Agitator motor control cable
15	Agitator motor power cable

3.4.2 Gas supply cabinet

Description

The gas supply cabinet contains mass flow controllers (MFCs), which provide gases for the cell cultivation process in the disposable bag. The mass flow controllers supply the cell culture with air, oxygen (O_2), carbon dioxide (CO_2), and optionally nitrogen (N_2).

The gas supply cabinet is located at the side of the XDR vessel above the I/O Cabinet, and is attached to the XDR vessel frame.

3-way valve

200 L dual purpose bioreactor has a 3-way solenoid valve for changing the gas flow path to either sparger 2 or headspace. The 3-way valve is a high flow rate valve and is connected to MFC5 (air mass flow controller) at the time of manufacturing. The following table describes the work principle of the 3-way valve.

Process mode	Flow rate (SLPM)	Gas flow target
Cell culture (***CC***)	0 to 10	Headspace outlet
Microbial fermentation (***MO***)	0 to 100[1]	Sparger 2 outlet

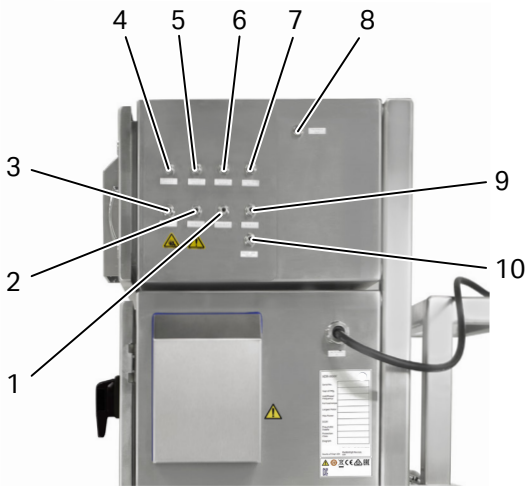
[1] The XDR-2000 Pro Max bag supports flow rates of up to120 SLPM.

Illustration of the gas supply cabinet front



Part	Function
1	**PROFIBUS IN** connection port
2	Electrical interconnect connection port

Illustration of the gas supply cabinet back



Part	Function
1	CO_2 inlet
2	O_2 inlet
3	Air inlet
4	Sparger 1 outlet
5	Sparger 2 outlet
6	Headspace outlet
7	Pinch valve air outlet (**PINCH VALVE PILOT**)[1]
8	**PROFIBUS OUT** connection port
9	N_2 inlet
10	Air inlet for pinch valve activation (**PILOT AIR INLET**)[1]

[1] Pinch valve is an optional component.

3.4.3 Pumps

Description

The pumps are mounted on the I/O Cabinet. The pumps can perform the following functions:

- Fill the disposable bag with media.
- Introduce acids and bases for pH control.
- Add nutrients to cell culture.
- Control the weight of the XDR vessel.

Illustration of the location of the pumps



Pump models

Watson-Marlow peristaltic pumps models 114, 313, and 520 are used. Standard configuration of the system includes four pumps.

Two optional external pumps can be added, using PROFIBUS ports on the back of the I/O Cabinet.

For the characteristics of available pumps see *Section 10.4 Pump characteristics, on page 525*.

All pump options described in this manual are subject to change. Contact your Cytiva representative for latest options.

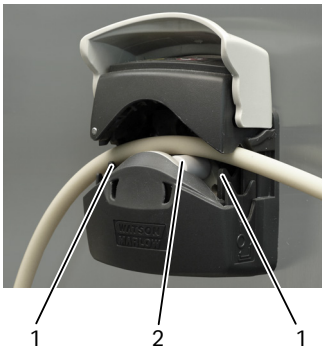
Operating principle

Watson-Marlow pumps model 114 are on/off pumps that operate at a fixed speed. Changing the controlled variable (CV) changes the time length which the pumps run (0% to 100% of the run time). The pumps switch on and off to achieve control.

Watson-Marlow pumps models 313 and 520 operate at variable speeds. Changing the CV between 0% and 100% increases the speed linearly over the range.

Illustration of a model 114 pump





Part	Description
1	Gripping elements
2	Roller

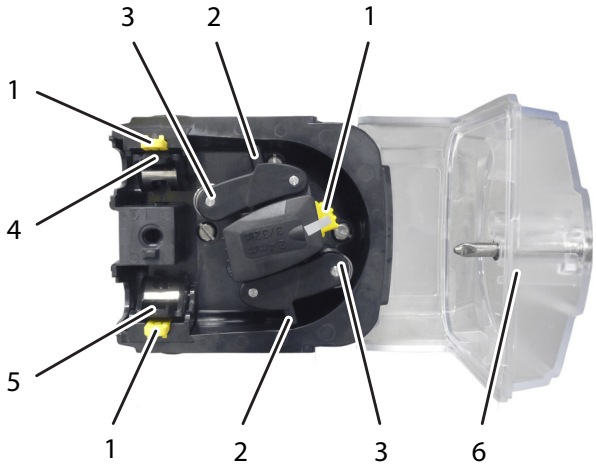
Illustration of a model 313 pump





Part	Description
1	Adjustment wheel for gripping elements
2	Roller

Illustration of a model 520 pump



Part	Description
1	Tube clamp
2	Retention pin
3	Roller
4	Tube guide roller
5	Follower roller
6	Cover

Illustrations of external pumps

The following illustrations show the available types of external pumps.

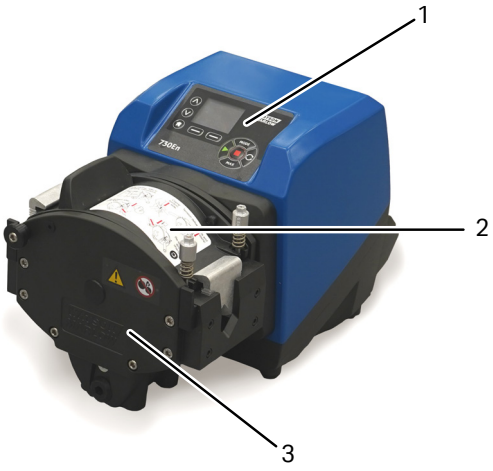
Model 530



Model 630



Model 730



Part	Description
1	Display and keypad
2	Pump head
3	Pump head cover

3.4.4 Auxiliary inputs

Description

XDR-50 to 2000 Bioreactor Systems have two auxiliary inputs.

The auxiliary inputs provide connectivity to defined accessories and user supplied instrumentation. The auxiliary inputs can be used for any measuring equipment with a 4 to 20 mA analog output. The auxiliary inputs can be configured in the software for use with various measurement and control applications. Examples of auxiliary inputs use:

- Cell density monitors
- CO_2 sensors
- Exhaust gas sensors

Refer to the system electrical drawing for connection details.

Note: *Some options may require customized cables, bags, and other accessories. Contact your local Cytiva representative for assistance.*

Auxiliary inputs location

Auxiliary inputs are located on the back of the I/O Cabinet. The inputs are labeled **AUX IN 1 4-20mA** and **AUX IN 2 4-20mA**.

The following illustration shows the auxiliary input location.



Illustration of the auxiliary inputs

The auxiliary input socket and plug are shown in the following illustrations.

Socket (on the I/O Cabinet)



Plug (on the external equipment)



Optional connectors

In addition to the 4 to 20 mA auxiliary input, connectors are available to provide 24 V DC control power to external devices if required.

The auxiliary inputs accept an industry standard 8-pin connector.

Refer to the electrical drawings in the Product Documentation package (ToP) for wiring details and additional information.

3.5 Safety system

Introduction

XDR-50 to 2000 Bioreactor Systems have several safety systems to maintain the safety of personnel, equipment, and the contents of the disposable bag.

Emergency stop

The system is equipped with an emergency stop functionality. The purpose of the emergency stop is to stop the system in an emergency situation, such as an accident or a sudden unexpected release of the cell culture from the disposable bag. The emergency stop button is located on the front of the I/O Cabinet of the bioreactor, and is labeled **EMERGENCY STOP**.



The **EMERGENCY STOP** is engaged by being pushed. See *Section 2.4.2 Emergency shutdown, on page 34* for more detailed description.

System labeling

The system is labeled to make operators aware of the hazards associated with system operation. These labels show important information that must be available to the user at all times during operation. All labels used on the system are described in this manual, see *Section 2.2 Labels and symbols, on page 18* for detailed information.

Alarm relay

The alarm relay is intended to connect the bioreactor to a separate building management system or other remote monitoring appliance. The alarm relay is a relay contact with an external connector located on the back of the I/O Cabinet. The relay changes state whenever an alarm is active on the system.

Burst disc and pressure relief valve

The 50 L XDR vessel is equipped with a burst disc that is designed to rupture when the XDR vessel jacket pressure is approaching the accepted test pressure. This prevents catastrophic failure of the vessel jacket.

The 200, 500, 1000 and 2000 L XDR vessels are equipped with a pressure relief valve to prevent damage to the heating/cooling jacket. The pressure relief valve opens if the pressure within the jacket exceeds the relief pressure, preventing catastrophic failure of the vessel jacket.

Any leaking or dripping from the XDR vessel jacket should immediately be reported to your Cytiva representative to get support.

Breakers and fuses

Specific subcomponents in the bioreactor are individually fused. This design protects the system from being completely disabled by a short circuit in a subcomponent. The fuses installed in the system are specified based on the expected quantity of electrical current consumed by each subcomponent, and by the type of load.

Seismic anchoring (optional)

In earthquake-prone areas, the bioreactors are specified to have seismic anchoring. These anchors tie the instrument to the building via the floor. Additionally, brackets are connected to captive pins to prevent damage in case of a load cell failure.

If needed, the seismic anchoring option must be included in the design of the instrument and is built into the system at the time of manufacturing.

3.6 X-Station

Description

X-Station contains the control system for XDR-50 to 2000 Bioreactor Systems. The X-Station includes the following components:

- Programmable logic controller (PLC)
- Server computer
- Ethernet switch
- Uninterruptible power supply (UPS)
- Touchscreen
- Keyboard
- Mouse

Programmable logic controller (PLC)

The PLC provides continuous monitoring and control of process instrumentation. The PLC also communicates with the computer system located in the X-Station.

Server computer

The server computer is built into the X-Station and is fully protected from the outside environment.

The server computer performs the following tasks:

- Communicates with PLC
- Performs data analysis
- Executes process control
- Displays data
- Stores history data
- Manages user credentials

The operator interface is based on AVEVA software running on a Microsoft Windows operating system. The AVEVA software also provides historical data collection.

Illustration of the X-Station



Part	Description
1	USB connection port with USB port lock and protective cover
2	Keyboard
3	Screen
4	Mouse
5	UPS access cover

3.7 Temperature control unit (TCU)

Description

A separate temperature control unit (TCU) is needed to keep the disposable bag contents at an appropriate temperature. The temperature controlling fluid circulates in the XDR vessel jacket. The TCU keeps the circulating fluid at the designated temperature.

The TCU provides heating only, or heating and cooling, depending on the purchased TCU model.

The TCU gets a remote input from the X-Station via a cable that connects the TCU to the **TCU SETPOINT** port on the I/O Cabinet. The temperature setpoint is provided by the PLC system.

Models of temperature control units

Two types of temperature control units can be used with XDR-50 to 2000 Bioreactor Systems:

- Heating only

  or

- Heating and cooling.

Use a heating only TCU	Use a heating and cooling TCU
Use this TCU if the cooling is provided by the facility where the system is installed (an in-house chilled water system is in use).	Use this TCU if the facility does not provide an in-house cooling system.

For more information about the TCU, refer to the manufacturer's manual.

3.8 Disposable components

Introduction

This section provides information about the disposable components that are needed for the cell culture process in XDR-50 to 2000 Bioreactor Systems.

In this section

Section		See page
3.8.1	Disposable bag assembly	118
3.8.2	Probe sheath assembly	122
3.8.3	Optical DO sensor (optional)	125

3.8.1 Disposable bag assembly

Description

The disposable bag assembly is a gamma-irradiated disposable cell culture bag, designed for either mammalian cell culture or microbial fermentation processes, depending on your purchase.

The disposable bag assembly is installed in the XDR vessel. The supply and the monitoring equipment are connected to the disposable bag. The process inside the disposable bag is monitored and controlled by the PLC.

The top of the disposable bag is supported by the tubing support (50, 200, and 500 L bags), or by the bag hoist (1000 and 2000 L bags). The bag stays in the upright position even if there is little or no flow through the mass flow controllers.

The contents of the bag are stirred with an agitator motor and an impeller. See *Section 3.3 Agitator assembly, on page 88* for description of these components.

Components

The disposable bag assembly comprises an agitator assembly, tubing sets, aseptic probe connectors, clamps, filters, sparger, and a thermowell. The tubing, the connectors, and the impeller baseplate on each bag size are designed to match the openings of the XDR vessel.

There are no openings in the disposable bag wall for agitation, the impeller baseplate is welded onto the bottom of the disposable bag.

Gases for cell growth are introduced into the cell culture media through a sparger, which is located under the impeller. Liquids (acid, base, and other liquids) are introduced into the disposable bag through the tubing at the top of the bag.

The product is collected through the harvest lines at the bottom of the disposable bag. 50 L disposable bag has several harvest lines, 200 to 2000 L bags have one harvest line.

The probe connectors (probe ports) are surrounded by a plastic reinforcement sheet that supports the lower part of the bag and helps with the correct orientation of the probes in the probe window.

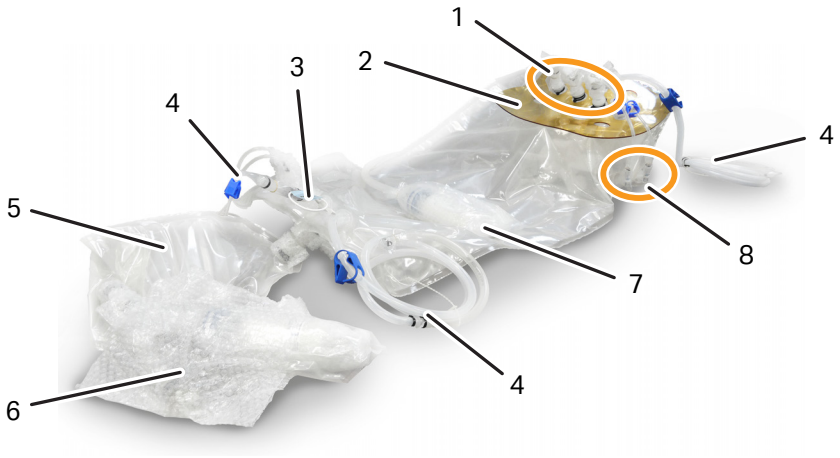
1000 and 2000 L disposable bags have bag support straps at the top of the bag to help with bag installation.

For the cell culture processes that use a condenser, the disposable bag must have a condenser bag. The condenser bag is attached to the disposable bag assembly at the time of manufacturing.

Customized disposable bags may have non-standard exhaust filters and other parts that are not shown in the following illustrations.

Overview of the disposable bag assembly

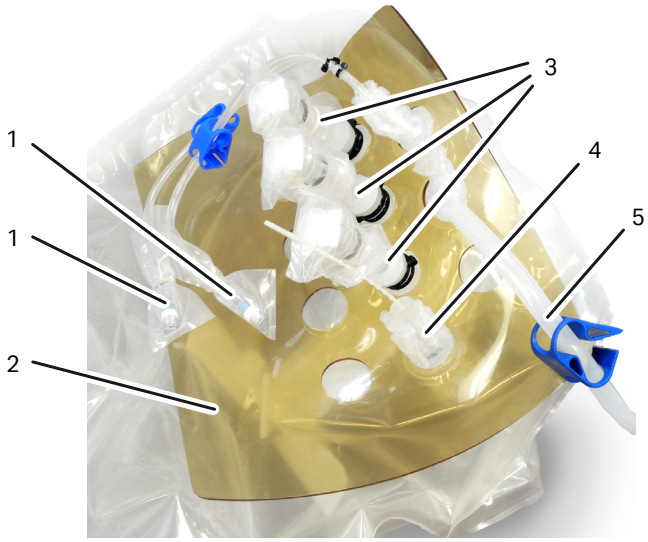
A microbial bag with an attached condenser bag is shown as an example of a disposable bag. The configuration of your bag may differ from the configuration shown below. The following illustration shows an overview of the bag. More detailed views of the disposable bag are presented later in this section.



Part	Description
1	Probe ports
2	Reinforcement sheet
3	Pressure sensor
4	Harvest line
5	Condenser bag
6	Exhaust filter
7	Sparge filter
8	Sample ports

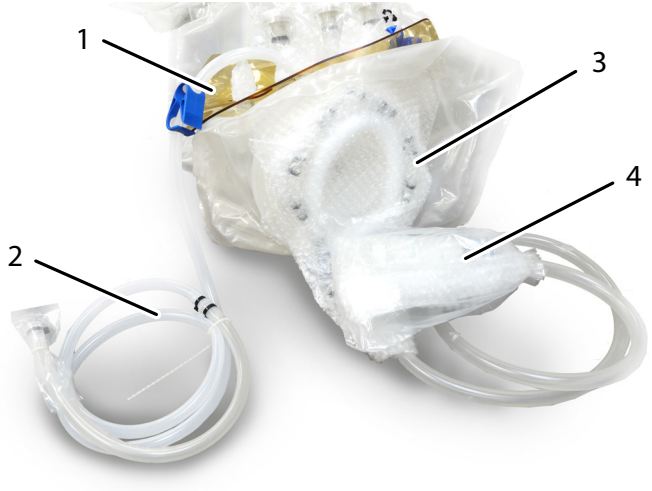
Disposable bag, detailed view

The following illustration shows a detailed view of the probe ports.



Part	Description
1	Sample ports
2	Reinforcement sheet
3	Probe ports with aseptic connectors
4	Thermowell
5	Spare tubing

The following illustration shows the bottom of the disposable bag.



Part	Description
1	Reinforcement sheet with probe ports
2	Harvest line
3	Impeller baseplate
4	Sparge (air inlet) tubing with filter

3.8.2 Probe sheath assembly

Description

The probe sheath is an accessory to the disposable bag. The probe sheath provides aseptic connection of a probe with the cell culture inside the disposable bag. The probe sheath with the inserted probe constitutes the probe sheath assembly (see *Illustrations of the probe sheath assembly, on page 124*).

The probe sheath is provided as a single unit and includes an aseptic connection device (ACD). The ACD is used to connect the probe sheath assembly to the disposable bag probe port. The aseptic membrane is then removed and the probe is inserted into the disposable bag.

Two probe sheath models are available: the bellows probe sheath and Xcellerex Click In probe sheath.

The probe sheath assembly must be autoclaved before connecting it to a probe port.

Compatible probes

The probes are connected to the probe sheath using a PG 13.5 threaded connector

The bellows probe sheath is compatible with the following 12 × 225 mm probes:

- Dissolved oxygen (DO) probe
- CO_2 probe
- pH probe

The Click In probe sheath is compatible with 12 × 225 mm probes.

Illustrations of probes

The following illustration shows a pH probe.



Part	Description
1	Threaded connector plug
2	O-ring
3	pH sensor

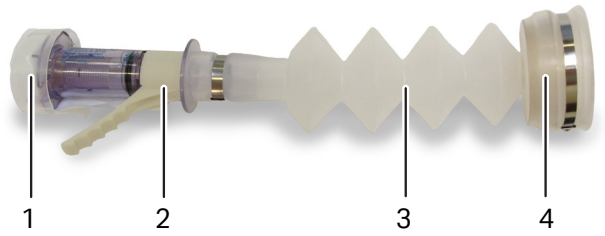
The following illustration shows a CO_2 probe.



Part	Description
1	Threaded connector plug
2	CO_2 sensor

Illustrations of the probe sheath

The following illustration shows the bellows probe sheath.



Part	Description
1	Aseptic connection device (male end)
2	Stop ring
3	Bellows
4	End plug

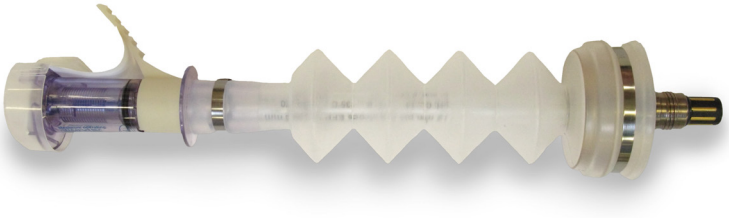
The following illustration shows the Click In probe sheath.



Part	Description
5	Aseptic connection device
6	Aseptic membrane
7	Cylinder
8	Plug
9	Stop tab

Illustrations of the probe sheath assembly

The following illustration shows the bellows probe sheath with the inserted probe.



The following illustration shows the Click In probe sheath with the inserted probe.



3.8.3 Optical DO sensor (optional)

Description

Dissolved oxygen (DO) can be monitored using a standard DO probe with the probe sheath (see *Section 3.8.2 Probe sheath assembly, on page 122* for more information), or using an optical DO sensor. The optical DO sensor is a single-use component. The optical DO sensor is attached to the disposable bag at the time of manufacturing and is sterilized together with the disposable bag.

When exposed to the light, the life span of the optical DO sensor is 30 days.

The optical DO sensor is an optional component.

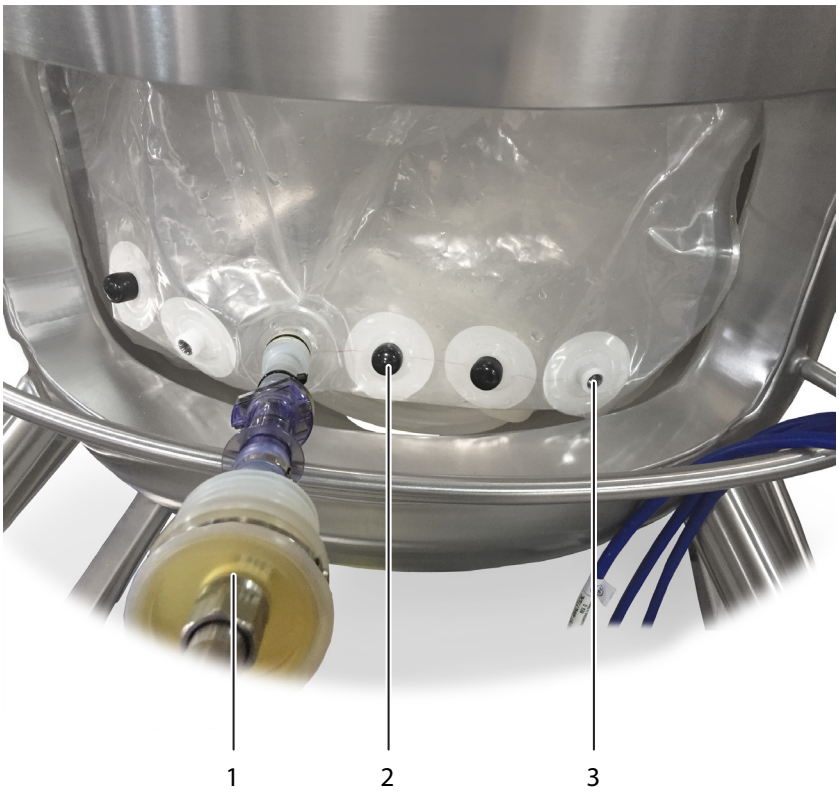
Components

The optical DO measurement system consists of the following components:

- Optical DO sensor window
- Sensor head
- VP8 cable
- Transmitter

Illustration of an optical DO sensor

The following illustration shows an example of a customized disposable bag inside the XDR vessel, with five optical DO sensors.



Part	Function
1	Standard probe
2	Optical DO sensor window (with protective cap)
3	Optical DO sensor window (without protective cap)

4 User interface overview

About this chapter

This chapter provides general information about XDR-50 to 2000 Bioreactor Systems software user interface. For more detailed information see *Appendix B User interface description, on page 549*.

In this chapter

Section		See page
4.1	Software structure	128
4.2	Overview screen	129
4.3	InTouch HMI WindowViewer screens	131
4.4	Process control and monitoring	133
4.5	Process modes (50 L and 200 L bioreactor)	134

4.1 Software structure

AVEVA software structure

XDR-50 to 2000 Bioreactor Systems are managed by using AVEVA software, running under Microsoft Windows operating system.

The user interacts with the instrument using a touchscreen and a keyboard.

Navigation

Tap the touchscreen or use the mouse to select buttons and objects.

Header toolbar

The header toolbar is located at the top of the screen and is available from all application interfaces. All screens are accessible from this toolbar.

The following illustration shows the header toolbar. This illustration is an example. Your screen layout may differ from the configuration shown below.



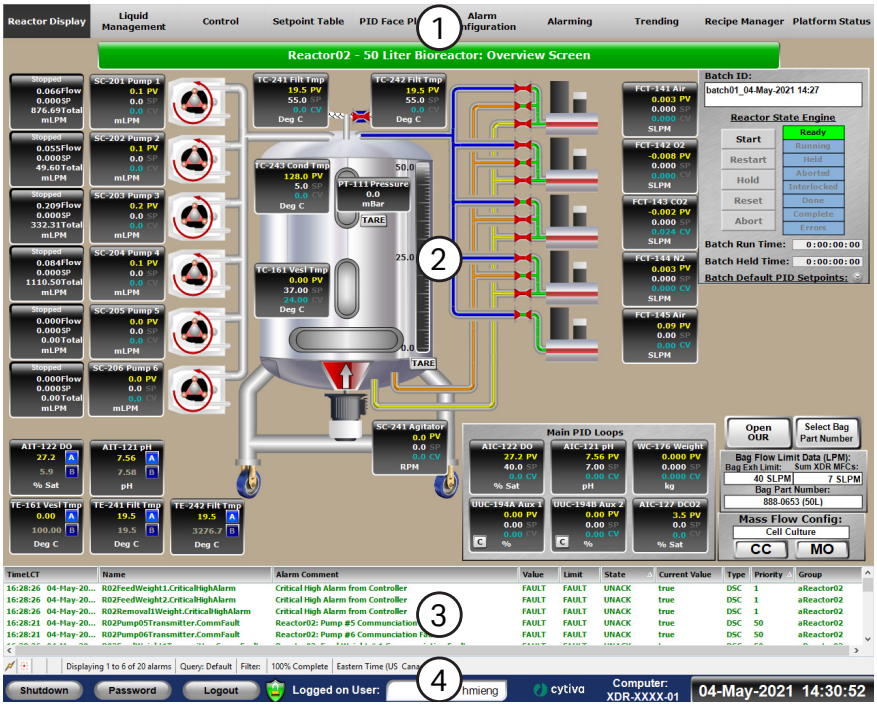
Clicking a button on the header toolbar opens the selected screen. If several options exist, a drop-down menu with additional choices is shown.

4.2 Overview screen

Introduction

Reactor Display is the default screen after logging on to the software. The ***Reactor Display*** screen shows a detailed graphic display of the selected system and allows the user to monitor and control the process.

Illustration of the *Reactor Display* screen



Part	Name	Description
1	Header toolbar	Provides access to all screens in AVEVA application.
2	Main pane	Contains graphic objects that display process data and give the user access to process control parameters.
3	Alarm summary pane	Presents the current alarms with a date and time stamp.
4	Footer toolbar	Displays the current user, allows shutdown of AVEVA application, changing user password, and changing the user.

4.3 InTouch HMI WindowViewer screens

Description of the screens

The user can access all software screens from the header toolbar.

Screen	Description
Reactor Display	Default screen at logon. Provides a detailed graphic display of the bioreactor system layout. Graphic objects give the user the access to process control parameters.
Liquid Management [1]	Displays a detailed graphical display of the hardware layout for this function. Provides access to the specific dialog boxes that are needed to set up the liquid management control.
Control	Displays input and output devices and intermediate control elements. Allows the user to configure the interaction of units that are part of the bioreactor control system.
Setpoint Table	Displays an overview of all individual PID control loop setpoint tables. Provides access to each individual setpoint table. Allows the user to define automatic changes to PID control loop setpoints according to selectable criteria.
PID Face Plate [2]	Displays an overview of all individual PID control loop faceplates. Each faceplate provides access to a PID control loop and allows the user to adjust PID control loop tuning parameters.
Alarm Configuration[2]	Displays an overview of alarm configuration dialog boxes for all available process variables. Each dialog box allows the user to activate the alarms and define the limits for deviation of a variable from a setpoint.
Alarm Summary [3]	Displays all currently active alarms and shows detailed information about each alarm. The user can select and acknowledge individual alarms.
Alarm History[3]	Displays all alarms (both active alarms and acknowledged alarms), and events. All information contained on this screen is saved in the database.
Trending	Selecting this option from the header toolbar opens an embedded AVEVA application. The ***Trending*** screen displays historical and real-time data as graphs. ***Trending*** application records all process parameters while the computer is on and connected to the I/O Cabinet.
Recipe Manager	Selecting this option from the header toolbar opens an integrated AVEVA Recipe Management application. The user can execute the existing recipes. Refer to *Xcellerex XDR bioreactor Recipe Manual (29698395)* for more information on the application.

1 Optional function.
2 This screen may be displayed in two or more pages.
3 These screens are accessible from ***Alarming*** button on the toolbar.

Screen	Description
Platform Status	Displays information about the status of the bioreactor automation control system.

4.4 Process control and monitoring

Introduction

The control system for XDR-50 to 2000 Bioreactor Systems provides continuous control and monitoring of the process. All process parameters can be accessed through InTouch HMI WindowViewer screens for viewing or modification.

Access to parameters

The InTouch HMI WindowViewer screens contain two types of panels:

- Display panels, which do not allow modification of the displayed values.
- Active panels, which open a dialog box when clicked, and let the user to access and modify the state of the process.

The automated process control is achieved by connecting the input signal from a transmitter unit to a final control element. This process of setting up the connections between units is called control loop mapping.

For detailed information on WindowViewer screens, screen elements, and control loop mapping see *Appendix B User interface description, on page 549*.

Use recipes

If Recipe Management is installed on your system, recipes can be used to define the default PID setpoints that are shown in ***Batch Manager*** (see *Default PID Setpoints, on page 593* for more information on the default PID setpoints).

Refer to *Xcellerex XDR bioreactor Recipe Manual (29698395)* for more information about how to use the Recipe Management application.

4.5 Process modes (50 L and 200 L bioreactor)

Description

The 50 L and 200 L bioreactors can be used for cell culture or microbial fermentation processes.

Two modes are available in the software for a dual purpose bioreactor:

- Cell culture mode (***CC***)
- Microbial fermentation mode (***MO***)

In the cell culture mode, 5 mass flow controllers are available (***FCT-141*** to ***FCT-145***). Both sparger inlet and headspace inlet to the disposable bag can be used for ***FCT-141*** to ***FCT-144***. Only headspace inlet is available for ***FCT-145***.

In the microbial fermentation mode, 2 mass flow controllers are available (***FCT-145*** and ***FCT-146***). Only the sparger inlet can be used for directing the gases into the disposable bag. Higher gas flow rates can be used in the fermentation mode than in the cell culture mode.

See *3-way valve, on page 100* for more information about the gas flow path in the cell culture mode and the microbial fermentation mode.

The process mode must be selected before a process run is started. The selection is done on the ***Reactor Display*** screen in the InTouch HMI WindowViewer software.

Illustration of cell culture mode

The following illustration is an example of the ***Reactor Display*** screen in cell culture mode (***CC***). Your screen layout may differ from the configuration shown below.

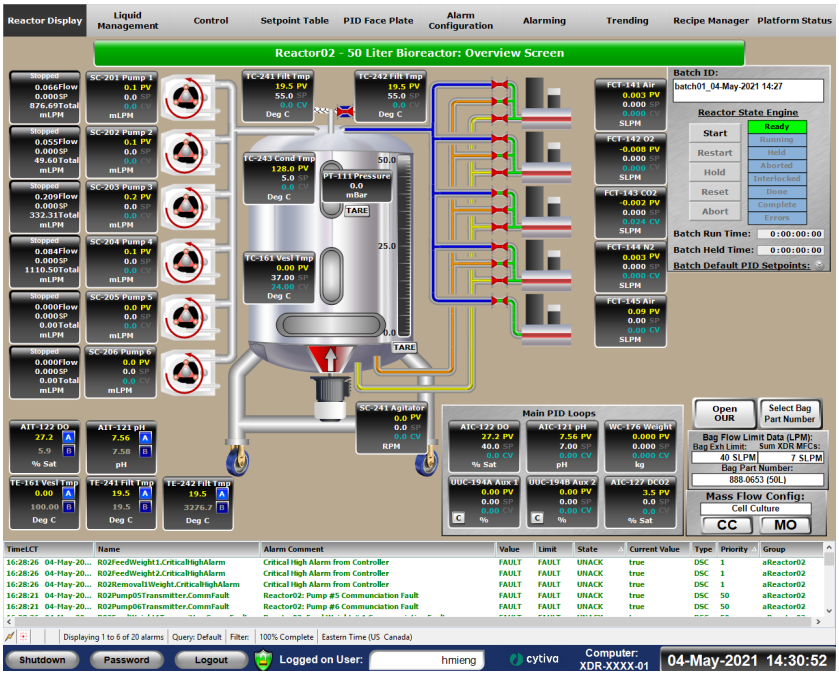
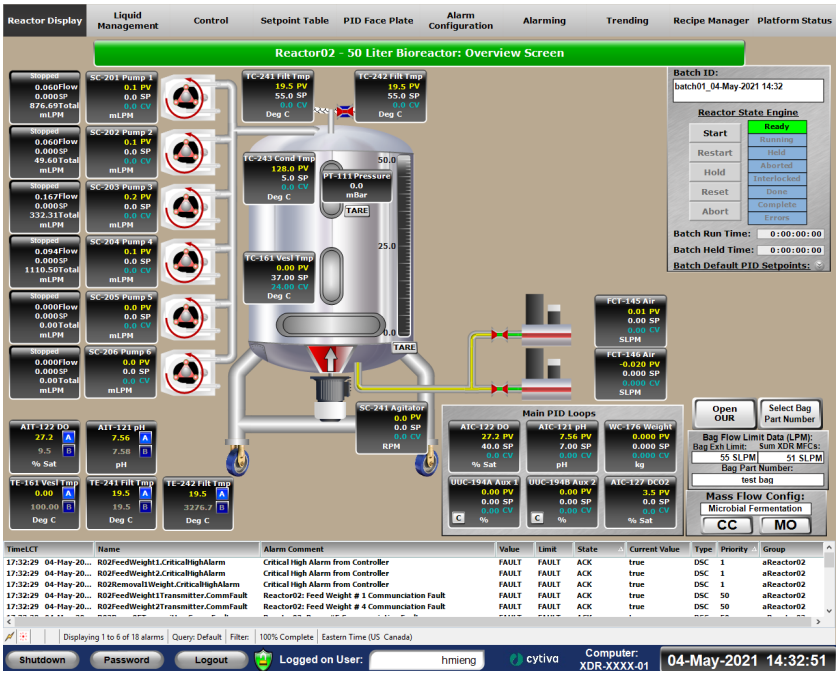


Illustration of microbial fermentation mode

The following illustration is an example of the ***Reactor Display*** screen in microbial fermentation mode (***MO***). Your screen layout may differ from the configuration shown below.



5 Installation

About this chapter

This chapter describes site requirements and pre-installation tasks for XDR-50 to 2000 Bioreactor Systems that the customer can complete without Cytiva support.

About the installation

Components not described in this manual must not be installed by the customer.

For unpacking instructions, refer to *Xcellerex XDR-50 to 2000 Bioreactor Systems Unpacking Instructions (29269631)*.

In this chapter

Section		See page
5.1	Safety precautions	138
5.2	Site requirements	140
5.3	50 L XDR vessel	146
5.4	Connect external equipment	147

5.1 Safety precautions



WARNING

Squeezing or crushing injuries. Because of the significant weight of the instrument, great care must be taken not to cause squeezing or crushing injuries during movement. At least two, but preferably three or more, persons are recommended when moving the unit.



WARNING

Tipping hazard. Pay extra attention when moving the system to make sure that the system does not tip.



WARNING

Hazardous voltage. It is essential for the safety of personnel working in or around electrically powered equipment to follow a company policy and procedure for Lock-Out / Tag-Out (LOTO).



WARNING

Hazardous voltage. The product must always be connected to a grounded power outlet.



WARNING

Access to power switch and power cord. The power switch must always be easy to access. The power cord must always be easy to disconnect.



WARNING

Access to mains cable. Do not block access to the mains cable. The mains cable must always be easily accessible for disconnection purposes.



WARNING

Access to power supply circuit breaker. The facility circuit breaker, controlling the power supply to the instrument, must always be easy to access.



WARNING

Earth leakage current. The earth leakage current exceeds 10 mA on the product with an input power supply rating of 220 V AC ± 10%.

The following warning is valid for systems with an input power supply rating of 220 V AC ± 10%.



WARNING

Secure Mains Power Supply Plug. Connect the system IEC 60309-compliant mains power supply plug to the facility IEC 60309 socket and secure the connection.



WARNING

All electrical installations must be performed by authorized personnel only.



CAUTION

Gas leakage hazard. Accidental N_2 gas leaks may lead to suffocation. The system must always be set up in an appropriately ventilated area.



CAUTION

Make sure that all tubing, hoses and cables are placed so that the risk of tripping accidents is minimized.



CAUTION

The product is designed for indoor use only.

5.2 Site requirements

Introduction

This section describes the requirements for space and supplies in the building where XDR-50 to 2000 Bioreactor Systems are going to be installed.

Space and floor

See *Section 10.1 System specifications, on page 521* for dimensions and weights of XDR-50 to 2000 Bioreactor Systems.

Minimum ceiling height and minimum door aperture requirements for respective systems are specified in the following table.

XDR vessel size	Minimum floor to ceiling height[1]	Minimum door height[2]	Minimum door width[2]
50 L (single frame design)	275 cm (108″)	200 cm (78½″)	121 cm (47½″)
50 L (split frame design)	275 cm (108″)	200 cm (78½″)	88 cm (34½″)
200 L	297 cm (117″)	200 cm (78½″)	120 cm (47″)
500 L	287 cm (113″)	200 cm (78½″)	129 cm (50½″)
1000 L	361 cm (142″)	242 cm (95″)	145 cm (57″)
2000 L	410 cm (161¼″)	277 cm (109″)	162 cm (63½″)

[1] Including 63.5 cm (25″) clearance between the instrument and the ceiling.
[2] Including 13 cm (5″) clearance.

The following illustration shows the dimensions of the X-Station.



NOTICE

The floor must be level and without irregularities to allow equal distribution of the system weight over all wheels.

NOTICE

At least 100 cm (40 in) free working space is needed around each unit during installation.

NOTICE

For convenient working conditions during the use, sufficient space should be provided on all sides of the system when installed at the intended production location.

Environmental conditions

The following general requirements must be fulfilled:

- The room must have exhaust ventilation.
- The instrument should not be exposed to corrosive gases.
- The instrument should not be exposed to sources of heat, such as direct sunlight.
- Dust in the atmosphere should be kept to a minimum.
- Strong magnetic or electric fields should be avoided.
- The instrument should not be exposed to vibrations.

Grounding and protective earth

- The protective earth wire must be connected to system ground.
- Ground impedance must conform to the requirements of national and local industrial safety regulations and/or electrical codes.
- Because the earth leakage current exceeds 10 mA on XDR-50 to 2000 Bioreactor Systems with supply voltage rating of 220 V AC ± 10%, these systems are provided with a pin and sleeve-type of plug meeting IEC 60309 standard.
- The integrity of all ground connections must be periodically checked.

Mains cable

The customer must install a mains disconnect switch on the wall, to allow immediate disconnection of all power from the system. For systems with a supply voltage rating of 220 V AC ± 10% the customer must also install an IEC 60309 socket connection.

Note: *If the customer replaces the plug supplied with the system, and uses a non-IEC 60309 plug instead, the compliance rating of the system is no longer valid.*

The mains cable is supplied by Cytiva. If the customer replaces the mains cable, the replacement cable must meet the mains cable specifications as shown in the following table.

The customer must install an electrical plug on the mains cable of Xcellerex bioreactor (applicable to 110 V AC instruments only), and follow the wire color code shown in the Cytiva electrical drawing. The electrical plug must comply with local regulations, and the installation must be performed in accordance with local codes.

The mains power supply cable wires are color or number coded. They must be connected to the corresponding terminals in a connector compatible with IEC 60309.

Number of conductors	AWG[1]	Cable outer diameter	Maximum operating voltage	Length
3	12	12.7 to 15.9 mm	600 V RMS	5 m

[1] AWG: American wire gauge

The cable must be installed according to national regulations.

Mains power plug installation check

To make sure that the mains power plug is installed properly, the site electrical engineer must perform the following checks:

Step	Action
1	Confirm that the L, N, and PE of the mains power plug properly align with the L, N, and PE of the outlet.
2	Inspect the mains power plug to make sure that the cable clamp is tightly fastened to the power cable outer jacket, and not on the wires. Make sure that there are no visible cuts in the exposed power cable outer jacket.
3	Measure the resistance between the system chassis and the ground pin on the mains power plug. The resistance reading should be less than 0.2 ohms.
4	Verify that the resistance reading remains stable while bending the power cable near the mains power plug, to make sure that the ground wire is properly terminated within the plug. If the resistance is not stable, the plug should be opened to verify all wiring terminations. Repeat this test until a stable resistance reading is achieved.

Electrical power

The following table specifies the power requirements for XDR-50 to 2000 Bioreactor Systems.

Parameter	Requirement
Supply voltage, XDR-50 to 2000 Bioreactor Systems	• 110 V AC ± 10%, 1 phase, 50/60 Hz, 14 A • 220 V AC ± 10%, 1 phase, 50/60 Hz, 6 A
Supply voltage, X-Station	• 110 V AC ± 10%, 1 phase and protective earth, 50/60 Hz, 2.9 A • 220 V AC ± 10%, 1 phase and protective earth, 50/60 Hz, 1.5 A
Number of electrical outlets	Three outlets for the following units[1]: • X-Station • Bioreactor • TCU
Recommended backup power supply	Uninterruptible power supply (UPS)

[1] Additional outlets are required, if optional equipment (for example external pumps) is purchased with the system.

Wiring diagrams for the system, voltage, power and fuse requirements are available in the Product Documentation package (ToP).

Gas supply



WARNING

Use correct tubing. Use only gas tubing specified by Cytiva. Using other gas tubing may result in a gas leak.



WARNING

Gas shut-off valves. Gas shut-off valves that can be physically locked out for servicing must be installed on the facility gas supplies.



WARNING

Gas leakage hazard. Make sure that the gas connections are tight in order to avoid gas leakage.

The customer must supply semi-rigid polyethylene, flexible polyvinyl chloride, or flexible polypropylene tubing from the room gas outlet to quick disconnect fittings of the gas supply cabinet. Nitrogen is not required for many processes but is recommended for dissolved oxygen (DO) calibration.

The table below describes the requirements regarding gas supply. The requirements depend on the disposable bag design.

Parameter	Requirement
Gas pressure and capacity	• Compressed air: 303 kPa (3.03 bar, 44 psig), 0–120 SLPM[1, 2] • Oxygen: 303 kPa (3.03 bar, 44 psig), 0–120 SLPM[1, 2] • Carbon dioxide: 303 kPa (3.03 bar, 44 psig), 0–20 SLPM • Nitrogen: 303 kPa (3.03 bar, 44 psig), 0–25 SLPM
Gas inlet dimensions	• **AIR INLET**, o.d. ½″ or ¼″ • **O_2 INLET**, o.d. ½″ or ¼″ • **CO_2 INLET**, o.d. ¼″ • **N_2 INLET**, o.d. ¼″ • **PILOT AIR INLET**, o.d. ¼″ ***Note:*** *Unused gas inlets should be plugged.*

Parameter	Requirement
Gas supply tubing	Semi-rigid polyethylene tubing, pressure rated 1000 kPa (10 bar, 150 psig) • Compressed air: o.d. ½″ or ¼″ • Oxygen: o.d. ½″ or ¼″ • Carbon dioxide: o.d. ¼″ • Nitrogen: o.d. ¼″
Gas outlet dimensions	• **SPARGER 1 OUTLET**, o.d. ½″ or ¼″ • **SPARGER 2 OUTLET**, o.d. ½″ or ¼″ • **HEADSPACE OUTLET**, o.d. ½″ or ¼″ • **PINCH VALVE PILOT**, o.d. ¼″ ***Note:*** *If the external valve is not used, the* **PINCH VALVE PILOT** *should be plugged.*

[1] Standard disposable bag assemblies support flow rates up to 100 SLPM. The XDR-2000 Pro Max bag supports flow rates up to 120 SLPM.
[2] XDR-2000 Pro Max disposable bag assemblies have the capacity to run at a higher aeration rate than standard disposable bag assemblies. If your application requires a higher aeration rate, contact your Cytiva representative.

Temperature regulation

A temperature control unit (TCU) is required to control the temperature of the bioreactor. Refer to the manufacturer´s manual for the electrical power requirements.



NOTICE

The temperature control unit needs to be disconnected before moving the equipment.

Computer

XDR-50 to 2000 Bioreactor Systems are provided with an industrial computer, which is included in the X-Station.

If the system is purchased without an X-Station, it may be connected to an existing X-Station using proper software and hardware.

Alternatively, the customer may provide their own computer-based automation system. Contact your Cytiva representative to verify the compatibility.

Connection to controlling system

A PROFIBUS cable must be installed between the I/O Cabinet and the X-Station.

5.3 50 L XDR vessel

Delivery

The 50 L XDR vessel is available in two different variants: standard (single frame) design and split frame design.



CAUTION

Split frame assembly. The split frame of the XDR vessel may be assembled and disassembled by a Cytiva service engineer or properly trained personnel.



NOTICE

The split frame of 50 L XDR vessel must always be assembled when in use.

If the split frame needs to be disassembled, for example when moving the system through narrow doors, contact your Cytiva representative for help.

5.4 Connect external equipment

Connect TCU

Follow the instructions below to connect the TCU to the bioreactor.

Step	Action
1	Verify that power voltage and frequency match the TCU requirements.
2	Verify that the adequate current is available.
3	Connect the TCU to the power supply using an appropriate cable.
4	Connect the connection cable to the applicable port on the TCU.
5	Connect the connection cable to **TCU SETPOINT** port on the back of the I/O Cabinet.



Step	Action
6	Connect the TCU outlet tubing to coolant inlet (**SUPPLY**) of the XDR vessel jacket at the back of the XDR vessel. ***Note:*** *Details on your system may differ from the following illustrations.*



Step	Action
7	Connect the TCU inlet tubing to coolant outlet (**RETURN**) of the XDR vessel jacket at the back of the XDR vessel.



8	Remove the wrapping material from the TCU tubing before use.

Refer to the TCU manufacturer's documentation for more information.

Fill and empty the vessel jacket

Refer to the TCU manufacturer's documentation for instructions.

6 Preparation

About this chapter

This chapter provides required information to prepare XDR-50 to 2000 Bioreactor Systems for operation. It is assumed that the instrument has been installed properly.

In this chapter

Section		See page
6.1	Safety precautions	151
6.2	Stabilize the XDR vessel	153
6.3	Prepare the probes	172
6.4	Prepare the disposable bag	208
6.5	Install the condenser bag	235
6.6	Engage and disengage the agitator motor	239
6.7	Install the exhaust filter heater	256
6.8	Install probes	263
6.9	Set XDR vessel weight and pressure	287
6.10	Prepare the pumps	292

6.1 Safety precautions



WARNING

Personal Protective Equipment (PPE). When packing, unpacking, transporting or moving the product, wear the following:

- Protective footwear, preferably with steel toe caps.
- Working gloves, protecting against sharp edges.
- Protective glasses.



WARNING

Fire and explosion hazard. Follow the instructions below to avoid a fire or explosion when using oxygen:

- Monitor oxygen flow rates displayed on the user interface.
- Check for leaks, poor connections, or damages to the equipment prior to use.
- Use proper ventilation when operating the bioreactor using oxygen.
- Do not expel oxygen into an enclosed space.



WARNING

Risk of fall from height. To prevent falling accidents, take adequate safety precautions and follow local regulations.



WARNING

Hazardous voltage. It is essential for the safety of personnel working in or around electrically powered equipment to follow a company policy and procedure for Lock-Out / Tag-Out (LOTO).



WARNING

Gas leakage hazard. Make sure that the gas connections are tight in order to avoid gas leakage.



CAUTION

Do not use the product in a dusty atmosphere or close to spraying water.



CAUTION

Inspect cables. Cables need to be inspected for wear and damage. Replace damaged cables before connecting power to the system.



CAUTION

Pinch hazard. Do not operate the pumps without the covers in place.



CAUTION

Use caution. Use caution close to moving parts, stored energy, pressurization, and electrical sources.



CAUTION

Magnetic components. Use caution when handling magnetic components. There is a strong magnetic attraction between the impeller and the motor drive coupling.

6.2 Stabilize the XDR vessel

Introduction

This section provides information about how to make sure that XDR-50 to 2000 Bioreactor Systems are in stable position during preparation and operation.

In this section

Section		See page
6.2.1	Jacking bolts	154
6.2.2	Use jacking bolts, non-seismic vessels	155
6.2.3	Use jacking bolts, seismic vessels	161
6.2.4	Leveling feet	166
6.2.5	Use leveling feet, 50 to 1000 L vessels	167
6.2.6	Use leveling feet, 2000 L vessels	169

6.2.1 Jacking bolts

Safety precautions



WARNING

Secure jacking bolts. Do not move the instrument without engaging the jacking bolts. Always secure the instrument using the jacking bolts to prevent damage to the load cells, thereby avoiding damage to the equipment and injury to operators.



WARNING

Jacking bolts. Be careful to avoid squeezing or crushing injuries when engaging and disengaging jacking bolts using a wrench.



WARNING

Improper use of jacking bolts. Improper use of jacking bolts may cause the instrument to collapse on the operator.



NOTICE

Securing the jacking bolts in a way other than described in this manual may damage the load cells.

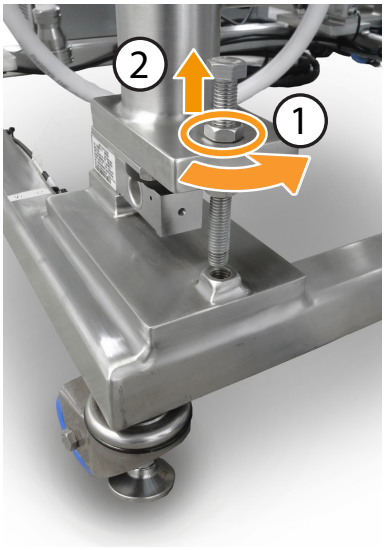
Use of jacking bolts

The jacking bolts lift the instrument body up, secure it and take the load off the load cells to prevent damage to the load cells. The jacking bolts must be disengaged during a batch run to enable the vessel weight to be monitored. The jacking bolts must be engaged during each move (including short moves, such as cleaning under the wheels of the instrument).

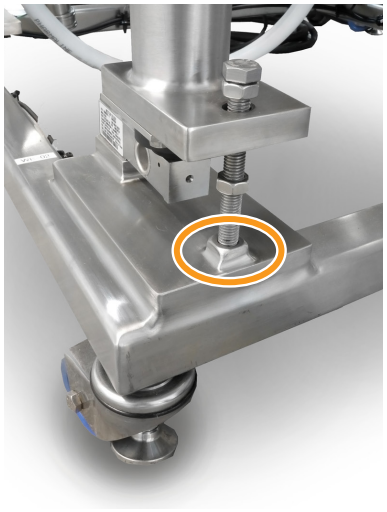
6.2.2 Use jacking bolts, non-seismic vessels

Engage jacking bolts for non-seismic vessels

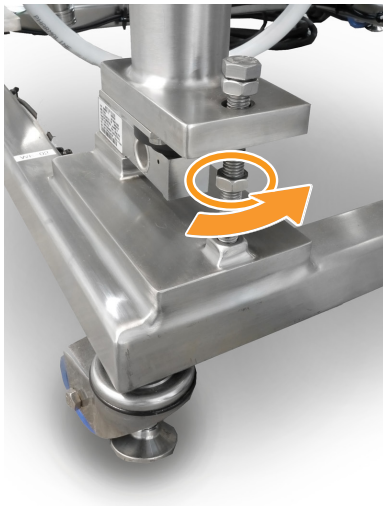
Follow the instructions below to engage the non-seismic jacking bolts.

Step	Action
1	Verify the following: • The instrument is clear of obstructions. • The ends of the jacking bolts do not touch the nut that is designed to accept them. • The jacking bolt threads are undamaged. • Each of the nuts turns freely using fingers alone.
2	Turn each of the top nuts (1) to the highest point on the threads (2) using your fingers. 

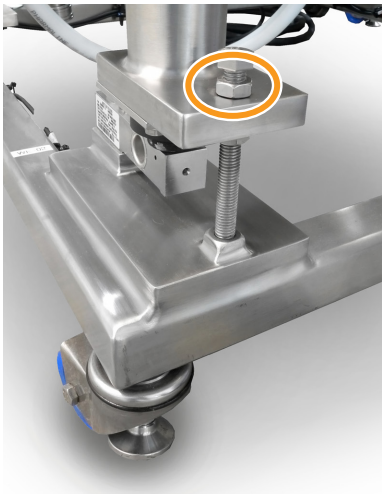
Step	Action
3	Thread the jacking bolts into the acceptor nuts on the bioreactor frame, using your fingers.



4	Turn each of the bottom nuts to the highest point on the threads using your fingers.

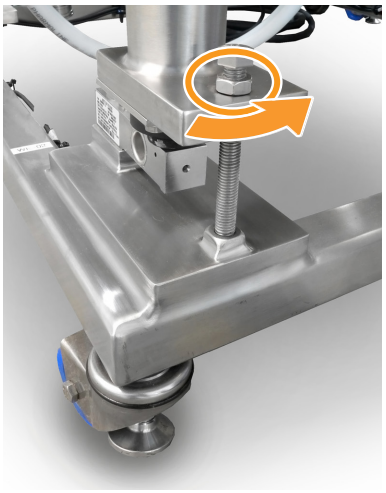


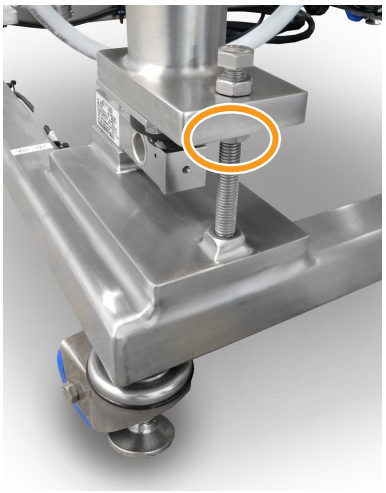
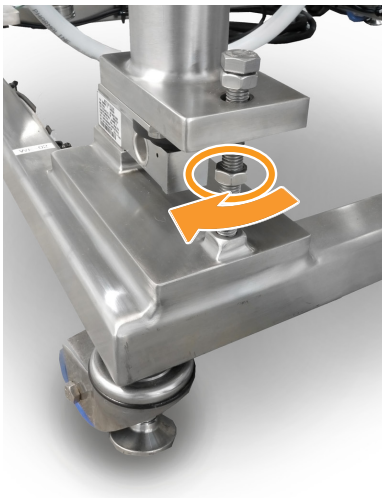
5	Tighten each bottom nut three additional turns, using a wrench.

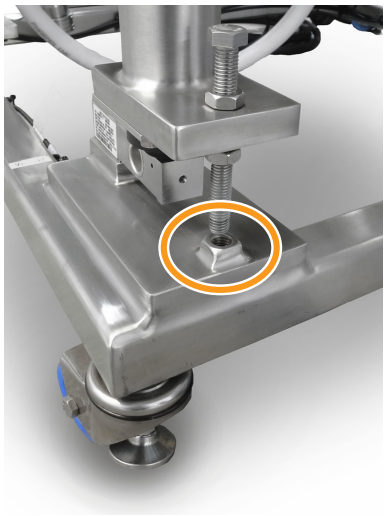
Step	Action
6	Use your fingers to turn each of the top nuts down until they reach the frame that supports the XDR vessel feet. 
7	Tighten the top nuts using the wrench. *Result:* The jacking bolts are engaged and the load cells are protected from possible damage caused by movement.

Disengage jacking bolts for non-seismic vessels

Follow the instructions below to disengage the non-seismic jacking bolts.

Step	Action
1	Loosen the top nuts using a wrench. 
2	Turn each of the top nuts up to the highest point on the threads, using your fingers. 

Step	Action
3	Loosen the bottom nuts using the wrench. 
4	Turn each of the bottom nuts downwards on the threads, using your fingers. 

Step	Action
5	Turn the jacking bolts up to remove the bolts from the acceptor nuts.  *Result:* The jacking bolts are disengaged.

NOTICE

Before starting batch operations, verify that the instrument is clear of obstructions.

Depending on site requirements, a functional check or load cell calibration might be required before starting a batch.

6.2.3 Use jacking bolts, seismic vessels

Engage jacking bolts for seismic vessels

Follow the instructions below to engage the seismic jacking bolts.

Step	Action
1	Verify the following: • The instrument is clear of obstructions. • The jacking bolt threads are undamaged. • Each of the nuts turns freely using fingers alone.
2	Turn each of the large top nuts to the highest point on the threads using your fingers.



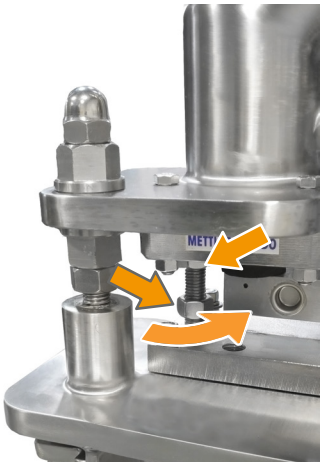
Step	Action
3	Use your fingers to turn each of the large bottom nuts up until they reach the frame that supports the XDR vessel feet.



4	Turn each of the large bottom nuts up to three additional turns, using a wrench.
5	Use your fingers to turn each of the large top nuts down until they reach the frame which supports the XDR vessel feet.

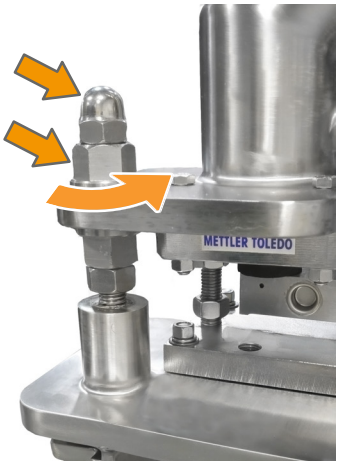


6	Tighten the large top nuts using the wrench.

Step	Action
7	Turn each of the small nuts up until they reach the frame that supports the XDR vessel feet. 
8	Tighten the small nuts using the wrench. *Result:* The jacking bolts are engaged and the load cells are protected from possible damage caused by movement.

Disengage jacking bolts for seismic vessels

Follow the instructions below to disengage the seismic jacking bolts.

Step	Action
1	Loosen the small nuts using a wrench. 
2	Turn the small nuts halfway down using your fingers.
3	Loosen the large top nuts using the wrench. 
4	Turn each of the large top nuts to the highest point on the threads, using your fingers.

Step	Action
5	Loosen the large bottom nuts using the wrench. 
6	Turn each of the large bottom nuts to the lowest point of the threads, using your fingers. *Result:* The jacking bolts are disengaged.

NOTICE

Before starting batch operations, verify that the instrument is clear of obstructions.

Depending on site requirements, a functional check or load cell calibration might be required before starting a batch.

6.2.4 Leveling feet

Use of leveling feet

The leveling feet lift the instrument body up and take the load off the casters. Lower the leveling feet and make sure that the full weight load is removed from the casters before filling the XDR vessel.



NOTICE

The casters may be damaged if the leveling feet are not set down.

6.2.5 Use leveling feet, 50 to 1000 L vessels

Leveling feet for 50 L vessel

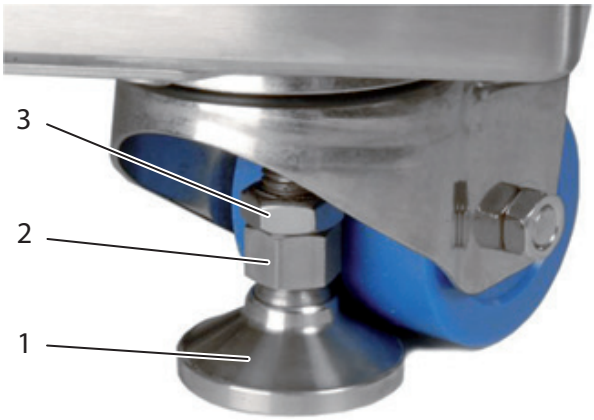
XDR-50 Bioreactor Systems are available in two alternative variants: standard (single frame) design and split frame design. The split frame design is built on two separate frames, each with its own set of casters and leveling feet. See *Section 3.2.1 XDR vessel, on page 65* for more information.

When working with the split frame design, always make sure that the leveling feet are lifted and lowered on both frames.

Lower the leveling feet

Follow the instructions below to lower the leveling feet.

Step	Action
1	Turn the adjustment nut (2) counterclockwise to move the leveling foot (1) downwards, until the leveling foot reaches the ground.

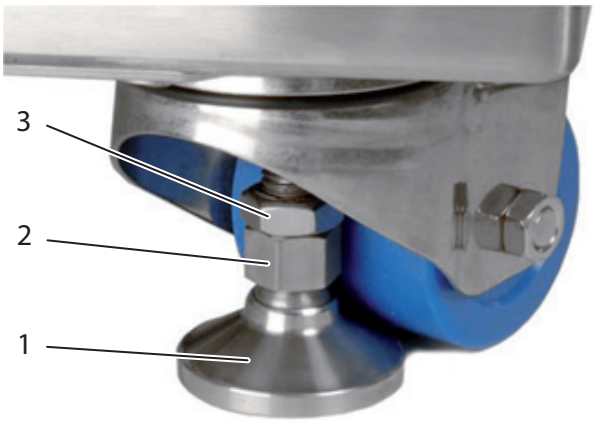


2	Continue to turn the adjustment nut (2) using an adjustable wrench until the caster is lifted from the ground and the leveling foot supports the weight of the XDR vessel.
3	Turn the locking nut (3) counterclockwise until it reaches the adjustment nut and locks the adjustment nut in place.

Lift the leveling feet

Follow the instructions below to lift the leveling feet.

Step	Action
1	Turn the locking nut (3) clockwise to the highest point on the threads.



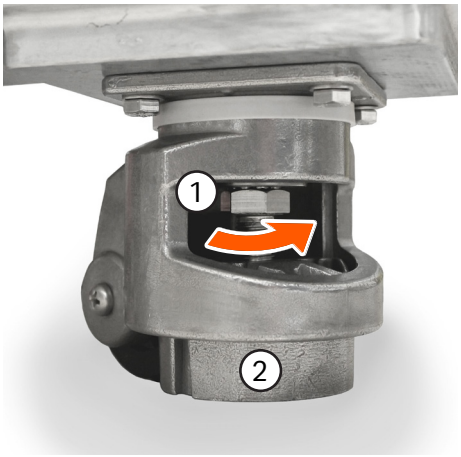
2	Turn the adjustment nut (2) clockwise to lift the leveling foot (1), using an adjustable wrench. Continue turning the nut until the caster reaches the ground and supports the weight of the XDR vessel.
3	Use your fingers and continue to turn the adjustment nut (2) clockwise until it reaches the locking nut.

6.2.6 Use leveling feet, 2000 L vessels

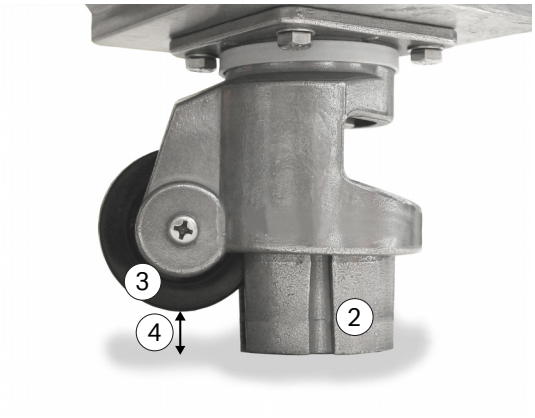
Lower the leveling feet

Follow the instructions below to lower the leveling feet.

Step	Action
1	Turn the nut (1) counterclockwise to move the leveling foot (2) downwards, until the leveling foot reaches the ground. Use your fingers to turn the nut.



Step	Action
2	Continue turning the nut using a wrench until the bottom of the wheel (3) is lifted at most 9 mm (4) from the ground, and the leveling foot (2) supports the weight of the XDR vessel.



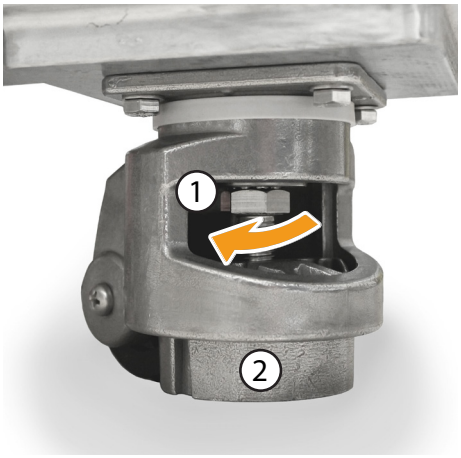
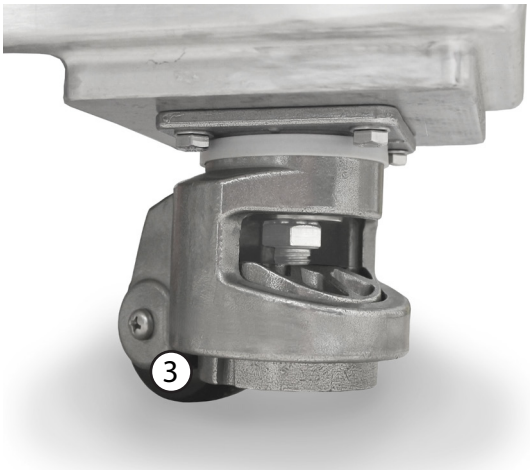
NOTICE

The bottom of the wheel must not be lifted more than 9 mm from the ground. Lifting the bottom of the wheel more than 9 mm from the ground can disengage the nut and damage the caster.

3	Verify that the vessel frame is level.

Lift the leveling feet

Follow the instructions below to lift the leveling feet.

Step	Action
1	Turn the nut (1) clockwise using a wrench, until the leveling foot (2) is lifted from the ground and the wheel starts to support the weight of the XDR vessel. 
2	Continue to turn the nut using your fingers, until the nut reaches the XDR vessel frame and the wheel (3) fully supports the vessel weight. 

6.3 Prepare the probes

Introduction

Xcellerex XDR bioreactors support the use of single-use probes and multi-use probes.

For information on preparing Mettler-Toledo **InSUS 310** single-use pH probes for reliable measurements, see *Section 6.3.1 Prepare single-use probes, on page 173*. For more information on using single-use probes, refer to the documentation provided by the manufacturer.

The remainder of this section describes how to prepare the multi-use probes. It also describes how to prepare the probe sheath and autoclave the probe sheath assembly.

In this section

Section		See page
6.3.1	Prepare single-use probes	173
6.3.2	Calibrate the pH probe	174
6.3.3	Calibrate the DO probe with N_2	183
6.3.4	Calibrate the dissolved CO_2 probe	195
6.3.5	Autoclave probe sheath assembly	202

6.3.1 Prepare single-use probes

Prepare InSUS 310 single-use pH probes for reliable measurements

Mettler-Toledo **InSUS 310** single-use pH probes are manufactured with a polyvinyl-pyrrolidone (PVP) coating that extends the shelf life of the probes. In order to obtain an accurate measurement, the PVP coating needs to be removed, often referred to as "wetting." Submerge the probe in liquid for 120 minutes before taking a measurement.



IMPORTANT
Submerging the probe in liquid for less than 120 minutes results in unreliable measurements.

For all other instructions regarding the use of single-use probes with Xcellerex XDR bioreactors, refer to the documentation provided by the manufacturer.

The remainder of this section describes how to prepare multi-use probes.

6.3.2 Calibrate the pH probe

Introduction

This section gives calibration instructions for the following models of the pH probe:

- Rosemount model 1056
- Rosemount model 56
- Mettler-Toledo model M800

Materials

Note: *If XDR-50 to 2000 Bioreactor Systems are used in a GMP regulated environment, the pH probe is a GMP critical component.*

The following materials are required:

- 30 mL pH standard solution of pH 4.
- 30 mL pH standard solution of pH 9.21 (for Mettler-Toledo model M800).
- 30 mL pH standard solution of pH 10.
- 500 mL deionized water.

Prepare for calibration

Prepare the pH probe as follows:

Step	Action
1	Take the pH probe out of the packaging.
2	Rinse the sensor end of the pH probe with deionized water.
3	Connect the pH probe with the probe cable so that no thread is visible on the probe.
	NOTICE Do not cross-thread the probe cable.
4	Tighten the connection properly. Carefully push the connector together when tightening it.

Calibrate the pH probe (Rosemount model 1056)

The following instruction describes the calibration procedure using the Rosemount model 1056 transmitter display.

Do the autocalibration of the pH probe as follows:

Step	Action
1	Find the pH/DO transmitter display on the I/O Cabinet. Press **MENU** (1).



Result:

A menu is displayed on the transmitter screen.

2 Use the navigation keys to make selections in the menu:



a. Select ***Calibrate*** and press ***ENTER*** (2).

b. Select ***Sensor 1*** and press ***ENTER***.

c. Select ***pH*** and press ***ENTER***.

d. Select ***Buffer Cal*** and press ***ENTER***.

e. Select ***Auto*** and press ***ENTER***.

Step	Action
	f. Select ***Start Auto Cal*** and press ***ENTER***.
	g. Rinse the pH probe with deionized water.
	h. Put the tip of the probe into the pH 4 buffer. Stir approximately ten times and make sure no air bubbles are present on the probe.
	i. Press ***ENTER*** to start the calibration. When the calibration reading is finished, the system displays a range of pH values.
	j. Select the closest value to pH 4 from the list with the navigation keys and press ***ENTER***.
3	The system displays ***Place the sensor in Buffer 2***.
4	Rinse the pH probe with deionized water.
5	Calibrate the probe at pH 10 as follows:
	a. Put the tip of the probe in the pH 10 buffer. Stir approximately ten times and make sure no air bubbles are present on the probe.
	b. Press ***ENTER*** to start the calibration. When the calibration reading is finished, the system displays a range of pH values.
	c. Select the closest value to pH 10 from the list with the navigation keys and press ***ENTER***.
	Result:
	The pH probe is autocalibrated to pH 4 and pH 10. The slope and offset values are displayed.
6	Make a note of the slope and offset values from the display.
	Tip: *Consult the probe manufacturer's manual for acceptable slope value range.*
7	Press ***EXIT*** repeatedly until you reach to the main screen.



Step	Action
8	Rinse the pH probe with deionized water.
9	Disconnect the probe cable from the pH probe.

If the calibration fails, find the cause of the failure using the transmitter and sensor user manuals.

Tip: *If duplicate probes are used, label the calibrated probe as pH-1. Then repeat the steps described above to calibrate the second pH probe and label it as pH-2. After sterilization the probes need to be connected to pH/DO transmitters* **AIT-121A/122A** *and* **AIT-121B/122B***, respectively.*

Standardize the probe (offset at reference pH) (Rosemount model 1056)

This procedure is valid for the Rosemount model 1056 transmitter.

For the greatest possible accuracy a standardization procedure must be performed. You need a sample of the contents of your current cell culture. Perform this procedure when the probes have been installed in the disposable bag.

Make sure that the following has been completed before pH probe standardization:

- The disposable bag has been filled with media.
- The media has equilibrated to the process temperature.
- The temperature probe has been calibrated. See *Section 8.7.4 Temperature probe calibration, on page 473* for instructions.

Follow the instructions below to perform the pH probe standardization.

Step	Action
1	Take an aseptic sample of the disposable bag contents as described in *Section 7.4.6 Take a sample, on page 375*.
2	Measure the pH of your sample using an external calibrated pH meter.
3	Perform the standardization as follows, using the pH/DO transmitter display on the I/O Cabinet:

Step	Action
4	Press ***MENU*** (1).



Result:

A menu is displayed on the transmitter screen.

5 Use the navigation keys to make selections in the menu:



a. Select ***Calibrate*** and press ***ENTER*** (2).

b. Select ***Sensor 1*** and press ***ENTER***.

c. Select ***pH*** and press ***ENTER***.

d. Select ***Standardize*** and press ***ENTER***.

e. Enter the externally measured pH value of your sample and press ***ENTER***.

Step	Action
	f. Press ***EXIT*** (3) repeatedly until you reach to the main screen.

Calibrate the pH probe (Rosemount model 56)

The following instruction describes the calibration procedure using the Rosemount model 56 transmitter display.

Do the autocalibration of the pH probe as follows:

Step	Action
1	Find the pH/DO transmitter display on the I/O Cabinet. Press ***ENTER/MENU***.



Result:

A menu is displayed on the transmitter screen.

2	Use the navigation keys to make selections in the menu:



Step	Action
3	Select ***S1 Measurement*** and press ***ENTER/MENU***.
4	Select ***Manual buffer*** and press ***ENTER/MENU***.
5	Rinse the pH probe with deionized water.
6	Put the tip of the probe into the pH 4 buffer. Stir approximately ten times and make sure no air bubbles are present on the probe.
7	Press ***ENTER/MENU***.
8	When the pH value on the display has stabilized, type the buffer pH value (4.00) into the text box, using the numeric keypad. Press ***ENTER/MENU***.
9	The system displays ***Place sensor in the second buffer***.
10	Rinse the pH probe with deionized water.
11	Put the tip of the probe into the pH 10 buffer. Stir approximately ten times and make sure no air bubbles are present on the probe.
12	Press ***ENTER/MENU***.
13	When the pH value on the display has stabilized, type the buffer pH value (10.00) into the text box. Press ***ENTER/MENU***. *Result:* The pH probe is autocalibrated to pH 4 and pH 10. The slope and offset values are displayed.
14	Make a note of the slope and offset values from the display. ***Tip:*** *Consult the probe manufacturer's manual for acceptable slope value range.*
15	Press **EXIT** repeatedly until you reach to the main screen.



16	Rinse the pH probe with deionized water.

Step	Action
17	Disconnect the probe cable from the pH probe.

If the calibration fails, find the cause of the failure using the transmitter and sensor user manuals.

Tip: *If duplicate probes are used, label the calibrated probe as pH-1. Then repeat the steps described above to calibrate the second pH probe and label it as pH-2. After sterilization the probes need to be connected to pH/DO transmitters* **AIT-121A/122A** *and* **AIT-121B/122B***, respectively.*

Calibrate the pH probe (Mettler-Toledo model M800)

The following instruction describes the calibration procedure using the Mettler-Toledo model M800 transmitter display.

Do the autocalibration of the pH probe as follows:

Step	Action
1	Find the pH/DO transmitter display on the I/O Cabinet.



2	Press the calibration button  to open the ***CAL*** screen.
3	Select ***Calibrate Sensor***.
4	In the ***Chan*** box, select ***CHAN_1***.
5	In the ***Method*** box, select ***2-Point***.
6	Rinse the pH probe with deionized water.
7	Put the tip of the probe into the pH 4 buffer. Stir approximately ten times and make sure no air bubbles are present on the probe.

Step	Action
8	Press the ***Cal*** button, and then press ***Next***.
9	Wait until the pH value on the display has stabilized and the screen shows the message ***Press 'Next' when sensor is in buffer 2***.
10	Rinse the pH probe with deionized water.
11	Put the tip of the probe into the pH 9.21 buffer. Stir approximately ten times and make sure no air bubbles are present on the probe.
12	Press ***Next***.
13	Wait until the pH value on the display has stabilized and the slope and offset values are displayed.
14	Press ***Adjust*** to save the calibration values. *Result:* The pH probe is autocalibrated to pH 4 and pH 9.21. The slope and offset values are displayed.
15	Press the return button  to return to the main screen.
16	Rinse the pH probe with deionized water.
17	Disconnect the probe cable from the pH probe.

If the calibration fails, find the cause of the failure using the transmitter and sensor user manuals.

Tip: *If duplicate probes are used, label the calibrated probe as pH-1. Then repeat the steps described above to calibrate the second pH probe and label it as pH-2. After sterilization the probes need to be connected to pH/DO transmitters* **AIT-121A/122A** *and* **AIT-121B/122B***, respectively.*

6.3.3 Calibrate the DO probe with N_2

Introduction

This section gives calibration instructions for the following models of the DO probe:

- Rosemount model 1056
- Rosemount model 56
- Mettler-Toledo model M800

Materials

The DO probe must be zero calibrated with nitrogen before installing the probe in the disposable bag.

Before calibration prepare the following:

- Nitrogen (N_2) gas supply
- A probe saturation chamber (50 mL conical tube or plastic bag)

Prepare for calibration

Prepare the DO probe as follows:

Step	Action
1	Take the DO probe out of the packaging.
2	Connect the DO probe with the probe cable so that no thread is visible on the probe.
	NOTICE Do not cross-thread the probe cable.
3	Tighten the connection properly. Carefully push the connector together when tightening it.

Calibrate the DO probe with nitrogen (Rosemount model 1056)

The following instruction describes the calibration procedure using the Rosemount model 1056 transmitter display.

Calibrate the DO probe as follows:

Step	Action
1	Prepare the probes for calibration as follows:

a. For a reusable probe:

i. Connect the probe saturation chamber to the N_2 gas flow.

ii. Place 5–7 cm of the DO probe into the saturation chamber and turn on the N_2 gas flow.



b. For a single-use DO sensor:

i. Screw the sensor head connector (A) onto the single-use DO sensor (B) to make the single-use probe.



Result:



ii. Connect the VP8 cable to the single-use probe.

iii. Place the single-use probe and the N_2 gas delivery tubing (1) in a plastic bag and loosely seal the bag.

Step	Action



iv. Turn on the N_2 gas flow.

2 Find the pH/DO transmitter display on the I/O Cabinet. Press **MENU** (1).



Result:

A menu is displayed on the transmitter screen.

Step	Action
3	Use the navigation keys to make selections in the menu:



a. Select ***Calibrate*** and press **ENTER** (2).

b. Select ***Sensor 2*** and press **ENTER**.

c. Select ***Oxygen*** and press **ENTER**.

d. Select ***Zero Cal***.

e. Wait until first decimal of the ***S2*** value is stable.

Note:
*If the **S2** value is not stable before the calibration start, the calibration result is incorrect.*

f. Press **ENTER**.

Result:

The calibration starts. ***Zeroing Wait*** message is displayed.

4 Wait until the ***S2*** value stabilizes and ***Sensor zero done*** message is displayed.

5 Verify that the ***S2*** calibration value is approximately ***0% sat***. If the ***S2*** value is larger than 0.05%, the calibration has failed. Repeat steps c to f above to recalibrate the DO probe.

Result:

The DO probe is calibrated at 0% saturation level.

Step	Action
6	Press **EXIT** repeatedly until you reach to the main screen.



7	Disconnect the probe cable from the DO probe.

If the calibration fails, find the cause of the failure using the transmitter and sensor user manuals.

Tip: *If duplicate probes are used, label the calibrated probe as DO-1. Then repeat the steps described above to calibrate the second DO probe and label it as DO-2. After sterilization the probes need to be connected to pH/DO transmitters* **AIT-121A/122A** *and* **AIT-121B/122B**, *respectively.*

Calibrate the DO probe with nitrogen (Rosemount model 56)

The following instruction describes the calibration procedure using the Rosemount model 56 transmitter display.

Calibrate the DO probe as follows:

Step	Action
1	Find the pH/DO transmitter display on the I/O Cabinet. Press ***ENTER/MENU***.



Result:

A menu is displayed on the transmitter screen.

2 Use the navigation keys to make selections in the menu:



3 Select ***S2 Measurement*** and press ***ENTER/MENU***.

4 Prepare the probes for calibration as follows:

a. For a reusable probe:

i. Connect the probe saturation chamber to the N_2 gas flow.

ii. Place 5–7 cm of the DO probe into the saturation chamber and turn on the N_2 gas flow.

Step	Action



b. For a single-use DO sensor:

i. Screw the sensor head connector (A) onto the single-use DO sensor (B) to make the single-use probe.



Result:



ii. Connect the VP8 cable to the single-use probe.

iii. Place the single-use probe and the N_2 gas delivery tubing (1) in a plastic bag and loosely seal the bag.

Step	Action



iv. Turn on the N_2 gas flow.

5 On the transmitter screen, select ***Zero*** and press ***ENTER/MENU***.

Result:

Information is shown on the screen and the ***S2*** value starts to stabilize.

6 Wait until first decimal of the ***S2*** value is stable.

Note:
*If the **S2** value is not stable before the calibration start, the calibration result is incorrect.*

7 Press ***ENTER/MENU***.

Result:

The calibration starts. ***Zeroing sensor. Please wait.*** message is displayed.

8 Wait until the ***S2*** value stabilizes and ***Sensor Zero complete.*** message is displayed.

9 Verify that ***Zero current*** < 1.0 nA. If the ***Zero current*** value is higher than 2.0 nA, the calibration has failed. Repeat steps 3 to 9 above to recalibrate the DO probe.

10 Press ***ENTER/MENU*** to save the calibration values.

Step	Action
	Result: The DO probe is calibrated at 0% saturation level.
11	Press **EXIT** repeatedly until you reach to the main screen.



12	Disconnect the probe cable from the DO probe.

If the calibration fails, find the cause of the failure using the transmitter and sensor user manuals.

Tip: *If duplicate probes are used, label the calibrated probe as DO-1. Then repeat the steps described above to calibrate the second DO probe and label it as DO-2. After sterilization the probes need to be connected to pH/DO transmitters* **AIT-121A/122A** *and* **AIT-121B/122B***, respectively.*

Calibrate the DO probe with nitrogen (Mettler-Toledo model M800)

The following instruction describes the calibration procedure using the Mettler-Toledo model M800 transmitter display.

Calibrate the DO probe as follows:

Step	Action
1	Find the pH/DO transmitter display on the I/O Cabinet.



2	Press the calibration button to open the ***\CAL*** screen.
3	Select ***Calibrate Sensor***. *Result:* The ***\CAL\Calibrate Sensor*** screen opens.
4	On the ***Chan*** menu, select ***CHAN_2***.
5	On the ***Method*** menu, select ***1-Point***. Press ***Slope***.
6	Prepare the probes for calibration as follows: **a.** For a reusable probe: **i.** Connect the probe saturation chamber to the N_2 gas flow. **ii.** Place 5–7 cm of the DO probe into the saturation chamber and turn on the N_2 gas flow.



b. For a single-use DO sensor:

i. Screw the sensor head connector (A) onto the single-use DO sensor (B) to make the single-use probe.

Step	Action



Result:



ii. Connect the VP8 cable to the single-use probe.

iii. Place the single-use probe and the N_2 gas delivery tubing (1) in a plastic bag and loosely seal the bag.



iv. Turn on the N_2 gas flow.

7 Press ***Cal***.

8 Message ***Remove sensor from process, put sensor in air or cal gas*** is shown. Press ***Next***.

Step	Action
9	100% saturation level is shown by default. Type 0.00 into the text box to set the DO level to 0% saturation.
10	Wait until the value on the display has stabilized and the slope and offset values are displayed.
11	Press ***Adjust***.
12	Wait until the message ***Calibration Saved Successfully! Reinstall sensor.*** is shown, then press ***Done***. *Result:* The DO probe is calibrated at 0% saturation level.
13	Press the return button  to return to the main screen.
14	Disconnect the probe cable from the DO probe.

If the calibration fails, find the cause of the failure using the transmitter and sensor user manuals.

Tip: *If duplicate probes are used, label the calibrated probe as DO-1. Then repeat the steps described above to calibrate the second DO probe and label it as DO-2. After sterilization the probes need to be connected to pH/DO transmitters* **AIT-121A/122A** *and* **AIT-121B/122B***, respectively.*

6.3.4 Calibrate the dissolved CO_2 probe

Introduction

This section gives calibration and standardization instructions for the following models of the CO_2 probe:

- Mettler-Toledo model M400 G1
- Mettler-Toledo model M400 G2

Materials

The following materials are required:

- 30 mL pH standard solution of pH 7.
- 30 mL pH standard solution of pH 9.21.
- 500 mL deionized water.

Prepare for calibration

Prepare the CO_2 probe as follows:

Step	Action
1	Take a CO_2 probe out of the packaging.
2	Connect the CO_2 probe with the probe cable so that no thread is visible on the probe.
	NOTICE Do not cross-thread the probe cable.
3	Remove the protective cap from the probe.
4	Rinse the sensor end of the probe with deionized water.

Calibrate the probe (Mettler-Toledo model M400 G1)

The following instruction describes the calibration of the Mettler-Toledo model M400 G1 CO_2 probe. Follow the instructions below to calibrate the probe.

Step	Action
1	Find the transmitter display on the I/O Cabinet and verify that CO_2 concentration value is displayed. If "**---**" is displayed, make sure that the CO_2 probe is correctly connected to the probe cable. See *Prepare for calibration, on page 195* for instructions.
2	Press ***Cal*** (1) to open the calibration menu.



3	Use the navigation keys to make selections in the menu:



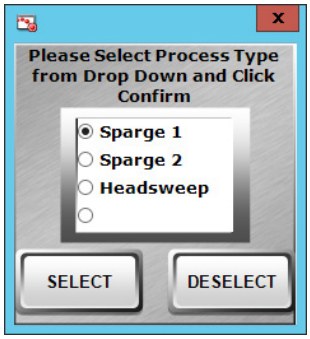
4	Select ***Channel A CO2***, and then press ***Enter*** (2).
5	Select ***Type = 2 point***, and then press ***Enter***.
6	Put the tip of the CO_2 probe into the pH 7 buffer. Stir approximately ten times and make sure no air bubbles are present on the probe.
7	Wait until the CO_2 value on the display has stabilized.
8	Press ***Enter*** and wait until the CO_2 value on the display has stabilized.

Step	Action
9	The system displays ***Press ENTER when Sensor is in Buffer 2***.
10	Rinse the CO_2 probe with deionized water.
11	Put the tip of the probe in the pH 9.21 buffer. Stir approximately ten times and make sure no air bubbles are present on the probe.
12	Wait until the CO_2 value on the display has stabilized.
13	Press ***Enter*** and wait until the CO_2 value on the display has stabilized. *Result:* The system displays the values for slope calibration factor ***S*** and the offset calibration factor ***Z***.
14	Select ***Adjust*** with the navigation keys, and then press ***Enter***. *Result:* The CO_2 probe is calibrated to pH 7 and pH 9.21. The calibration values are saved.
15	Press ***Menu*** and ***Cal*** simultaneously to return to the main screen.

Standardize the probe (Mettler-Toledo model M400 G1)

For the greatest possible accuracy a standardization procedure should be performed. The following instruction describes the standardization of the Mettler-Toledo model M400 G1 CO_2 probe. Follow the instructions below to perform CO_2 probe standardization at 50% CO_2 level.

Step	Action
1	Unscrew the probe cap.
2	Replace the electrolyte in the probe cap. Make sure that half of the cap is filled, and that the electrolyte does not get on the outside of the membrane.
3	Carefully align the thread of the probe cap with the thread of the probe. Screw the probe cap back on the probe. Make sure not to cross-thread the probe cap.
4	Tighten the probe cap firmly with your fingers, then tighten the cap for one quarter turn using the wrench supplied by the probe manufacturer. ***Note:*** *If the probe cap is not correctly tightened, squeezing or bending of the cap may cause signal disturbance.*
5	On the transmitter display on the I/O Cabinet, press ***Enter***.

Step	Action
6	Place 5–7 cm of the CO_2 probe into the saturation chamber (a plastic bag or container).
7	On the X-Station, open the CO_2 and N_2 gas flows to ***Sparge 1***. See *Change gas flow path, on page 357* for detailed instructions.
	
8	Make sure that the CO_2 and N_2 gas supply tubing is connected to the gas inlets on the gas supply cabinet back.
9	Connect a gas tubing to **SPARGER 1 OUTLET** on the gas supply cabinet back, and put the end of the tubing into the saturation chamber near to the CO_2 probe.
10	Start both CO_2 and N_2 gas flow at the equal flow rates, for example 2.5 SLPM. See *Start the gas flow, on page 354* for detailed instructions.
11	Wait until the CO_2 value on the transmitter display has stabilized.
12	On the display, press ***Cal*** to open the calibration menu.
13	Select ***Channel A CO2***, select ***Process***, and then press ***Enter***.
14	Press ***Cal***. Set the CO_2 value to 50% using the navigation keys, and then press ***Enter***.
15	Make a note of the S and Z values from the display.
16	Press ***Menu*** and ***Cal*** simultaneously to return to the main screen.

If needed, the CO_2 probe accuracy can be verified at 0% and at 100% CO_2 level. Follow the procedure described above, and use the following conditions:

- Set the probe into 100% N_2 to verify the zero level.
- Set the probe into 100% CO_2 to verify the high level.

Calibrate the probe (Mettler-Toledo model M400 G2)

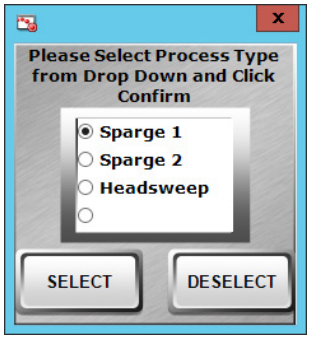
The following instruction describes the calibration of the Mettler-Toledo model M400 G2 CO_2 probe. Follow the instructions below to calibrate the probe.

Step	Action
1	Find the transmitter display on the I/O Cabinet. 
2	Press the calibration button  to open the ***CAL*** screen.
3	Select ***Calibrate Sensor***.
4	In the ***Unit*** box, select ***pH***.
5	In the ***Method*** box, select ***2-point***.
6	Rinse the CO_2 probe with deionized water.
7	Put the tip of the probe into the pH 7 buffer. Stir approximately ten times and make sure no air bubbles are present on the probe.
8	Press the ***Cal*** button. The display shows that the transmitter recognizes the buffer, and the measured value is shown.
9	Wait until the CO_2 value on the display has stabilized and the screen shows the message ***Press 'Next' when sensor is in buffer 2***.
10	Rinse the CO_2 probe with deionized water.
11	Put the tip of the probe into the pH 9.21 buffer. Stir approximately ten times and make sure no air bubbles are present on the probe.
12	Press ***Next***. The display shows that the transmitter recognizes the buffer, and the measured value is shown.
13	Wait until the pH value on the display has stabilized and the slope and offset values are displayed.
14	Press ***Adjust*** to save the calibration values. *Result:* The pH probe is autocalibrated to pH 7 and pH 9.21. The slope and offset values are displayed.

Step	Action
15	Press the return button  to return to the main screen.

Standardize the probe (Mettler-Toledo model M400 G2)

For the greatest possible accuracy a standardization procedure should be performed. The following instruction are for the Mettler-Toledo model M400 G2 CO_2 probe. Follow the instructions below to perform CO_2 probe standardization at 50% CO_2 level.

Step	Action
1	Unscrew the probe cap.
2	Replace the electrolyte in the probe cap. Make sure that half of the cap is filled, and that the electrolyte does not get on the outside of the membrane.
3	Carefully align the thread of the probe cap with the thread of the probe. Screw the probe cap back on the probe. Make sure not to cross-thread the probe cap.
4	Tighten the probe cap firmly with your fingers, then tighten the cap for one quarter turn using the wrench supplied by the probe manufacturer. ***Note:*** *If the probe cap is not correctly tightened, squeezing or bending of the cap may cause signal disturbance.*
5	Place 5–7 cm of the CO_2 probe into the saturation chamber (a plastic bag or container).
6	On the X-Station, open the CO_2 and N_2 gas flows to ***Sparge 1***. See *Change gas flow path, on page 357* for detailed instructions. 
7	Make sure that the CO_2 and N_2 gas supply tubing is connected to the gas inlets on the gas supply cabinet back.

Step	Action
8	Connect a gas tubing to **SPARGER 1 OUTLET** on the gas supply cabinet back, and put the end of the tubing into the saturation chamber near to the CO_2 probe.
9	Start both CO_2 and N_2 gas flow at the equal flow rates, for example 2.5 SLPM. See *Start the gas flow, on page 354* for detailed instructions.
10	Wait until the CO_2 value on the transmitter display has stabilized.
11	Press the calibration button  to open the ***CAL*** screen.
12	Select ***Calibrate Sensor***.
13	In the ***Unit*** box, select ***%CO2***.
14	In the ***Method*** box, select ***Process***.
15	Press the ***Cal*** button to start calibration, and then press the enter button  .
16	Press the calibration button  .
17	Set the CO_2 value to 50% using the on-screen keypad, and then press ***Next***.
18	Make a note of the slope and offset values.
19	Press ***Adjust*** to save the calibration values.
20	Press ***Done*** to complete the standardization process.
21	Press the return button  to return to the main screen.

If needed, the CO_2 probe accuracy can be verified at 0% and at 100% CO_2 level. Follow the procedure described above, and use the following conditions:

- Set the probe into 100% N_2 to verify the zero level.
- Set the probe into 100% CO_2 to verify the high level.

6.3.5 Autoclave probe sheath assembly

Introduction

This section gives information and instructions for the following tasks:

- *Autoclaving conditions, on page 202*
- *Prepare DO probe and dissolved CO2 probe, on page 202*
- *Prepare probe for autoclaving (bellows probe sheath), on page 203*
- *Prepare probe for autoclaving (Click In probe sheath), on page 205*

Autoclaving conditions

The probe sheath assembly with inserted probe must be autoclaved.

The recommended conditions for autoclaving are as follows:

Parameter	Bellows probe sheath	Click In probe sheath
Process temperature	> 121°C	> 126°C
Maximal allowed temperature	130°C	130°C
Minimum process time	30 min	45 min
Recommended process time	60 min	60 min
Cycle type	Liquid cycle	Liquid cycle

NOTICE

The autoclaving temperature must not exceed the maximum temperature recommended above.

NOTICE

Do not autoclave ratchet clamps.

Prepare DO probe and dissolved CO_2 probe

The electrolyte in the probe cap must be replaced with new solution before autoclaving (before each run). Half of the probe cap must be filled with electrolyte. If the electrolyte volume is not sufficient, the air inside the probe cap may move inside probe cap. This may cause large and sudden changes of the signal.

Follow the instructions below to prepare the DO probe and the dissolved CO_2 probe before autoclaving.

Step	Action
1	Unscrew the probe cap.
2	Replace the electrolyte in the probe cap. Make sure that half of the cap is filled, and that the electrolyte does not get on the outside of the membrane.
3	Carefully align the thread of the probe cap with the thread of the probe. Screw the probe cap back on the probe. Make sure not to cross-thread the probe cap.
4	Tighten the probe cap firmly with your fingers, then tighten the cap for one quarter turn using the wrench supplied by the probe manufacturer. ***Note:*** *If the probe cap is not correctly tightened, squeezing or bending of the cap may cause signal disturbance.*

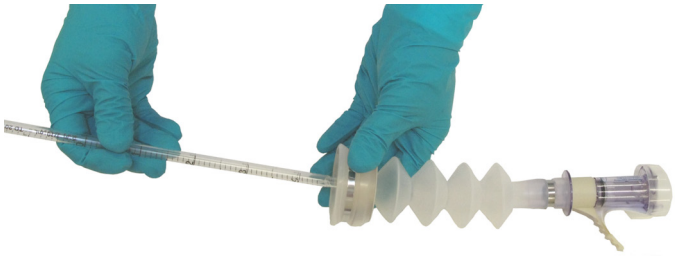
Prepare probe for autoclaving (bellows probe sheath)

Before autoclaving the probe sheath assembly, prepare the following:

- Disposable pipette
- Deionized water

Follow the instructions below to prepare the probe sheath for autoclaving.

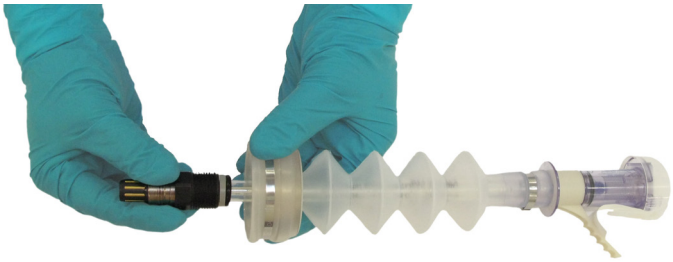
Step	Action
1	Verify that the probe cable is not connected to the probe.
2	Draw 1 to 2 mL deionized water into a disposable pipette.
3	Insert the pipette into the probe sheath assembly through the threaded hole in the probe sheath end plug.



Step	Action
4	Inject the water into the probe sheath, and then remove the pipette. ***Note:*** *The inserted water provides the steam inside the probe sheath assembly during autoclaving.*
5	Verify that the O-ring is in place on the probe.



6	Insert the probe into the probe sheath through the threaded hole in the end plug.



7	Turn the probe clockwise to tighten the probe in the probe sheath end plug.



Step	Action
8	Verify that the probe sheath assembly bellows are extended enough so that the sensory tip of the probe is not pressing hard against the paper membrane at the end of the ACD connector (1).



9	Place the probe sheath assembly into the autoclave. The connector end of the probe sheath assembly (1) should be lower than the plug end of the assembly. ***Tip:*** *Use a probe sheath assembly holder (optional accessory) to position the probe sheath assembly correctly during autoclaving. Contact your Cytiva representative for more information.*
10	Start the autoclave. See *Autoclaving conditions, on page 202* for sterilization conditions.

Prepare probe for autoclaving (Click In probe sheath)

Before autoclaving the probe sheath assembly, prepare the following:

- Disposable pipette
- Deionized water

Follow the instructions below to prepare the probe sheath for autoclaving.

Step	Action
1	Verify that the probe cable is not connected to the probe.
2	Draw 1 to 2 mL deionized water into a disposable pipette.

Step	Action
3	Insert the pipette into the probe sheath assembly through the threaded hole in the probe sheath end plug.



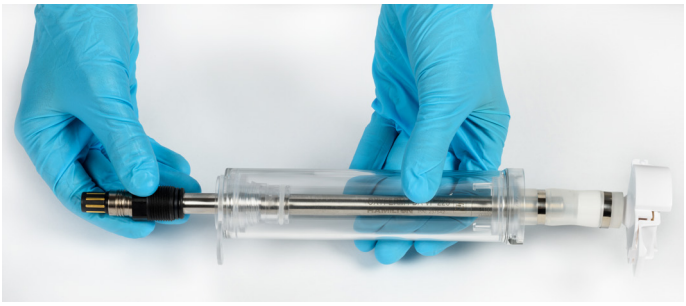
4	Inject the water into the probe sheath, and then remove the pipette.

Note:
The inserted water provides the steam inside the probe sheath assembly during autoclaving.

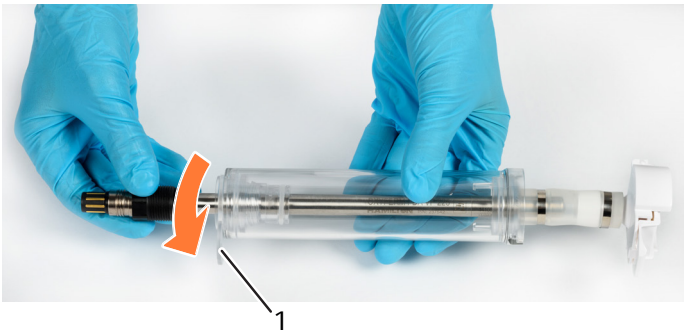
5	Verify that the O-ring is in place on the probe.



6	Insert the probe into the probe sheath through the threaded hole in the plug. Use the probe injector or a wrench to tighten the probe into the probe sheath.



Step	Action
7	Turn the probe clockwise to tighten the probe in the plug. Hold the stop tab (1) to prevent the plug from rotating.



8	Place the probe sheath assembly into the autoclave. The connector end of the probe sheath assembly should be lower than the plug end of the assembly.



Tip:
Use a probe assembly holder (optional accessory) to position the probe sheath assembly correctly during autoclaving. Contact your Cytiva representative for more information.

9	Start the autoclave. See *Autoclaving conditions, on page 202* for sterilization conditions.

6.4 Prepare the disposable bag

Introduction

This section provides instructions for unpacking and installing the disposable bag assembly.

In this section

Section		See page
6.4.1	Unpack the disposable bag assembly	209
6.4.2	Install the disposable bag, 50 to 500 L bioreactors	213
6.4.3	Install the disposable bag, 1000 and 2000 L bioreactors	218
6.4.4	Select disposable bag	229
6.4.5	Connect cables and tubing	233

6.4.1 Unpack the disposable bag assembly

Safety precautions



WARNING

Strong magnets. Magnets may interfere with functioning of pacemakers or implanted heart defibrillators and cause DEATH or SERIOUS INJURY. Magnets are located on the bottom of the product, and in the impeller assembly of the bag assembly.

- OBSERVE and follow instructions for installation, operation, and maintenance of the product.
- KEEP a safe distance of 25 cm or more from the magnets to avoid exposure to magnetic field greater than 0.5 mT (5 G).
- WARN other people who wear pacemakers or implanted heart defibrillators from getting too close to the magnets.



NOTICE

Before opening the box, clear the inspection area of sharp objects. All personnel who handle the disposable bag assembly must remove watches, rings, and any items with sharp edges or points that could damage the disposable bag.

Prepare for unpacking

Inspect the box for damage before starting the unpacking. Record and photograph any damage to the box prior to unpacking. Inform your Cytiva representative about the damage.

Before unpacking the disposable bag assembly, prepare a stainless steel table with wheels with the following dimensions:

System	Minimum dimensions of the table
50–500 L bioreactors	75 × 130 cm (29″ × 51″)
1000–2000 L bioreactors	75 × 205 cm (29″ × 80″)

Unpack the disposable bag assembly

Follow the instructions below to unpack the disposable bag assembly.

Step	Action
1	Remove the disposable bag assembly from the box and from the protective bubble wrap.



2	Put the bag assembly on an inspection table.
3	Open the outer protective bag at the impeller end of the bag and pull out the bag assembly onto the table.
4	Carefully remove the bag assembly from the inner aseptic bag.
5	Remove the bubble wrap from the bag assembly.

NOTICE

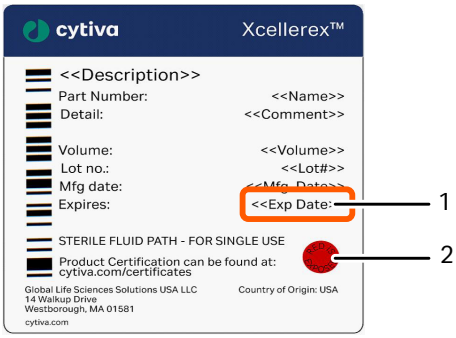
Do not remove bubble wrap from the tubing ports, tubing connectors, and filters. These items need protection during bag installation. The bubble wrap can be removed after the bag has been installed.

6	Unfold the disposable bag assembly and inspect the bag. Verify that the disposable bag has no tears, rips or cuts.

Note:

Light scratches and creases may be present on the bag due to handling. These and similar imperfections do not indicate a failed bag integrity.

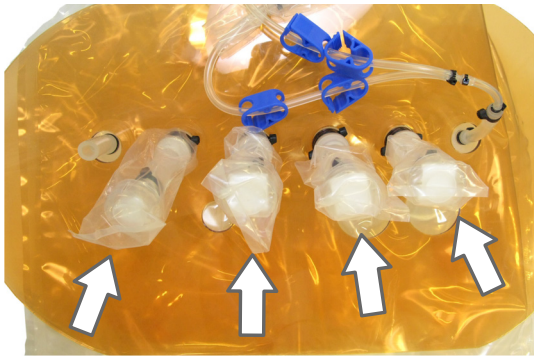
Step	Action
7	Verify that the expiry date (1) has not passed.



8	Verify that the gamma irradiation dot (2) on the bag label is red, indicating successful sterilization.
9	Remove the bubble wrap from around the probe ports.

NOTICE

Do not remove the plastic bags covering the probe port aseptic connectors. Unprotected connectors may be damaged during bag installation.



Step	Action
10	Immediately close all tubing clamps after removing the wrap from each component. 
11	Verify that the clamps on all tubing lines are closed, except on the headspace line, which is used to fill the disposable bag with air.
12	Carefully, turn over the bag assembly and remove the bubble wrap and protective foam from the impeller baseplate.
13	Remove any additional wrapping at the top of the disposable bag.

NOTICE

Do not remove bubble wrap from the tubing ports, tubing connectors, and filters. These items need protection during bag installation. The bubble wrap can be removed after the bag has been installed.

14	Make sure that the threaded pneumatic tubing adapters on the overlay tubing and sparge tubing are tightened onto the threaded hose barb tubing connector.  *Result:* The disposable bag assembly is ready to be installed into the XDR vessel.

6.4.2 Install the disposable bag, 50 to 500 L bioreactors

Safety precautions



WARNING

Strong magnets. Magnets may interfere with functioning of pacemakers or implanted heart defibrillators and cause DEATH or SERIOUS INJURY. Magnets are located on the bottom of the product, and in the impeller assembly of the bag assembly.

- OBSERVE and follow instructions for installation, operation, and maintenance of the product.
- KEEP a safe distance of 25 cm or more from the magnets to avoid exposure to magnetic field greater than 0.5 mT (5 G).
- WARN other people who wear pacemakers or implanted heart defibrillators from getting too close to the magnets.



CAUTION

Lift locked. Make sure that the agitator lift is in low position before starting bag installation.



NOTICE

Make sure that the inside of the XDR vessel is free of debris and sharp edges, and completely dry. Water on the vessel wall might be mistaken for bag leakage.



NOTICE

Make sure that the acrylic viewing windows are safely in place.

Start bag installation

50 to 500 L bioreactors require top loading bag installation.

If your system has a condenser, move the condenser unit out of the way while you are installing the disposable bag.

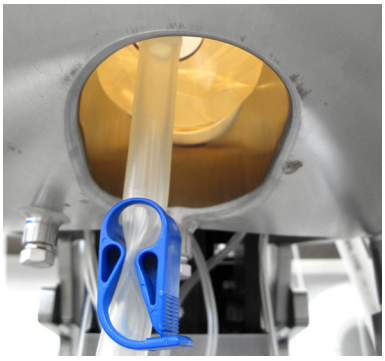
Start the disposable bag installation as described below.

Step	Action
1	Remove the probe support bar from the probe window.



2	Move the filter heater holder to the side.
3	Carefully move the disposable bag to the XDR vessel and lower the bag bottom into the vessel with the probe ports facing forward.



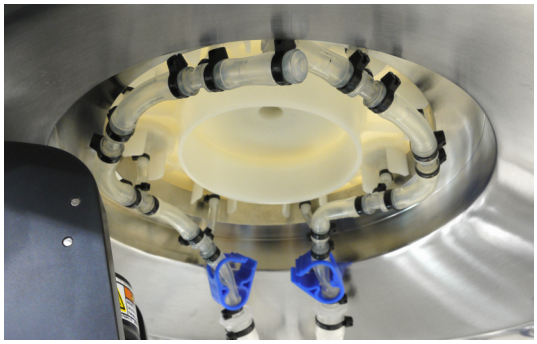
Step	Action
4	Hang the bag assembly over the rim at the front of the XDR vessel so that the bottom tubing and the bottom of the bag are inside the vessel.
5	Carefully pull the sparge tubing through the agitator port at the rear bottom of the XDR vessel. 
6	Lower the disposable bag into the XDR vessel. If your bag assembly has a condenser bag, hang the condenser bag over the back rim of the vessel. ***Note:*** *See Install the condenser bag, on page 235 about how to install the condenser bag.*

Finalize bag installation

To complete the bag installation follow the instructions below.

Step	Action
1	Carefully pull the harvest line through the harvest opening at the bottom front of the XDR vessel. 

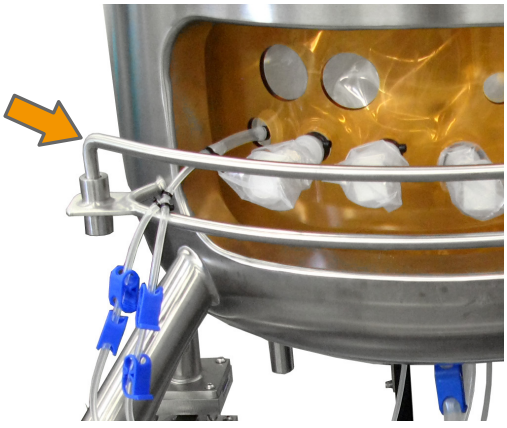
Step	Action
	Tip: *You can access the tubing more easily from the underside of the XDR vessel.*
2	Center the impeller baseplate in the bottom opening of the XDR vessel. Verify that the tubing is clear of the agitator motor before lifting the agitator motor to the impeller baseplate.



Note:

The impeller baseplate must be correctly arranged in the vessel agitator opening. If the impeller baseplate cannot be arranged as shown in the illustration above, lift the bag out of the XDR vessel and restart the installation as described in steps 3 to 6 in *Start bag installation, on page 213**.*

3	Align the probe aseptic connectors with the XDR vessel probe window.
4	Re-install the probe support bar at the probe window and arrange the tubing as appropriate.



5	Lift the sparge tubing with the air inlet filter up and hang the tubing over one of the tubing support bars at the top of the XDR vessel. Let the filter hang at the side of the XDR vessel.

Step	Action
6	Let the headsweep filter hang at the side of the XDR vessel (1).



7	Arrange the tubing on the tubing support (2).
8	Verify that jacking bolts are disengaged. See *Section 6.2 Stabilize the XDR vessel, on page 153* about how to disengage the jacking bolts.

Correct impeller baseplate position

If the impeller baseplate is not arranged as shown in step 2 in *Finalize bag installation, on page 215*, the agitation system cannot be correctly magnetically coupled. If the agitator emits a loud clicking noise during operation, the impeller baseplate is decoupled from the magnetic drive head. To correct the problem follow the instructions below.

Step	Action
1	Disengage the agitator motor as described in *Disengage agitator drive head using the G-lift, on page 244* or *Disengage agitator drive head using the X-lift, on page 251*.
2	Arrange the impeller baseplate correctly, as shown in step 2 in *Finalize bag installation, on page 215*.
3	Continue the bag installation as instructed in steps 3 to 8.

6.4.3 Install the disposable bag, 1000 and 2000 L bioreactors

Safety precautions



WARNING

Strong magnets. Magnets may interfere with functioning of pacemakers or implanted heart defibrillators and cause DEATH or SERIOUS INJURY. Magnets are located on the bottom of the product, and in the impeller assembly of the bag assembly.

- OBSERVE and follow instructions for installation, operation, and maintenance of the product.
- KEEP a safe distance of 25 cm or more from the magnets to avoid exposure to magnetic field greater than 0.5 mT (5 G).
- WARN other people who wear pacemakers or implanted heart defibrillators from getting too close to the magnets.



WARNING

Risk of fall from height. To prevent falling accidents, take adequate safety precautions and follow local regulations.



CAUTION

Lift locked. Make sure that the agitator lift is in low position before starting bag installation.



CAUTION

Hoist pinch hazard. Make sure that all personnel are clear of the bag hoist moving parts before operating the bag hoist.



CAUTION

Use safety ladder. Use a safety ladder to reach the top of the 1000 L and 2000 L XDR vessels, where the bag hoist, exhaust filter heater assembly, and the supporting frame are located.

NOTICE

Make sure that the inside of the XDR vessel is free of debris and sharp edges, and completely dry. Water on the vessel wall might be mistaken for bag leakage.

NOTICE

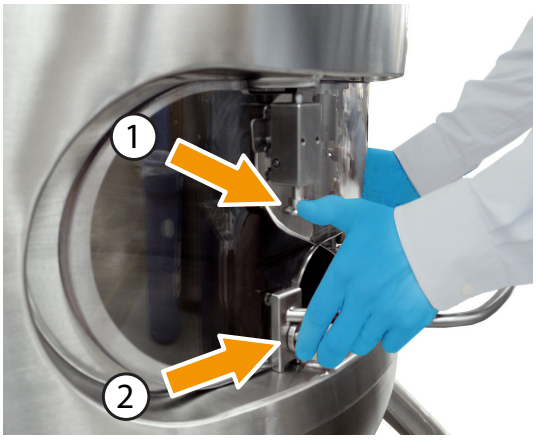
Make sure that the acrylic viewing windows are safely in place.

Start bag installation

1000 and 2000 L bioreactors require front loading bag installation, using a bag hoist. Two people are needed for front loading bag installation.

The 1000 L disposable bag may be available in different designs. Before starting the bag installation, verify if additional information is available for installation of your bag model.

Follow the instructions below to remove the XDR vessel door and insert the disposable bag assembly into the XDR vessel.

Step	Action
1	Simultaneously: • using your thumbs, push down the retention pins (1),  • using your index and middle finger, push the cam locks (2) toward each other.

Step	Action
2	Lift off the door. ***Tip:*** *Shake the door lightly to facilitate removal.*
3	Make sure the bag hoist power cable is connected to the power source. 
4	Move the inspection table with the disposable bag assembly to the XDR vessel.
5	Push and hold the **DOWN** button on the bag hoist operating panel to lower the hoist to the XDR vessel front opening. 

Step	Action
	Tip: *When the hoist reaches the end of its range (at the top or at the bottom), the hoist might come out of operational range. The hoist stops and the* **FAULT** *button is illuminated. Press the* **FAULT** *button for 3 seconds to reset the fault and allow the hoist to move again.*
6	Pull out the hoist through the opening. 
7	Find the pre-manufactured holes at the top of the disposable bag.
8	Insert the hoist hooks into the holes. 
9	Make sure that the bag is not twisted and that the bag front with probe ports points upwards.

Step	Action
10	Push and hold the **UP** button to lift the hoist, while slowly directing the disposable bag into the XDR vessel front opening, as the bag is lifted toward the top of the vessel. Release the **UP** button to pause the hoist and align the bag if needed.
11	Release the **UP** button to stop the bag when the impeller baseplate approaches the XDR vessel opening.
12	Carefully move the impeller part of the bag manually through the opening.

NOTICE

Free space between the impeller and XDR vessel opening is minimal. Make sure that the disposable bag is not damaged while the impeller is moved through the opening.

13	When the impeller part of the bag is inside the XDR vessel, continue to lift the bag with the hoist. *Result:* When the disposable bag is fully inserted and the bag hoist is at the top position, the hoist stops automatically.

Install filters and tubing

The following instructions describe the procedures to install the filters and organize tubing. The illustrations in this instruction are examples. The configuration of the disposable bag depend on your bag type.

Step	Action
1	Carefully pull the sparge tubing through the agitator opening. ***Tip:*** *The sparge tubing is connected to the sparger in the impeller baseplate.*

Step	Action
2	Carefully pull the harvest line through the harvest opening at the bottom front of the XDR vessel. Make sure that the plastic bag support that covers the opening has a few centimeters contact area with the XDR vessel all around the opening.



Tip:

You can access the tubing more easily from the underside of the XDR vessel.

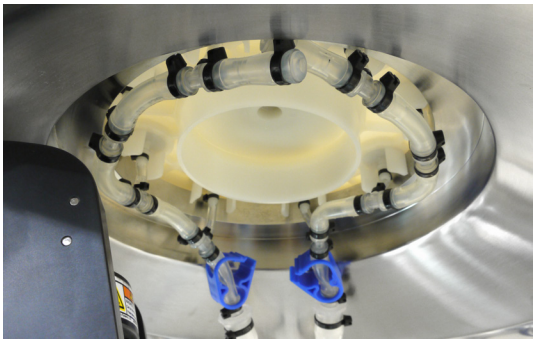
Step	Action
3	Lift the sparge tubing with the air inlet filter (1) up and hang the tubing over the bag hoist support bar (2). Let the filter hang at the side of the XDR vessel. This prevents the filter from being wetted.



NOTICE

A wetted filter may have a negative effect on batch sterility.

Step	Action
4	Center the impeller baseplate in the bottom opening of the XDR vessel. Verify that the tubing is clear of the agitator motor before lifting the agitator motor to the impeller baseplate.



Note:

Your system may differ from the configuration shown above. The image is for illustrative purposes only.

Tip:

If the impeller baseplate cannot be arranged as expected, lower the bag hoist approximately 10 cm to make the alignment easier.

5	Lift the sparge tubing with the air inlet filter up and hang the tubing over one of the bag hoist support bars at the top of the XDR vessel. Let the filter hang at the side of the XDR vessel.
6	Let the headsweep filter hang at the side of the XDR vessel.
7	Arrange the tubing on the tubing support.

Correct impeller baseplate position

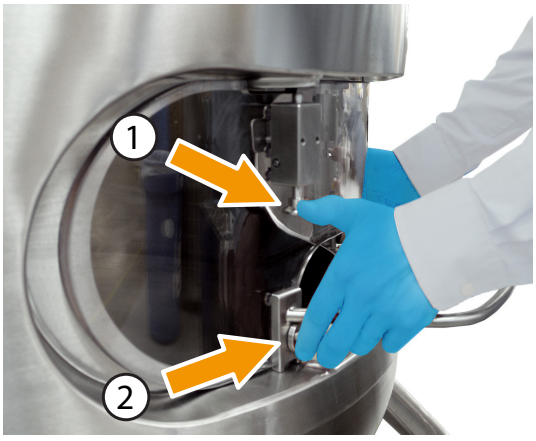
If the impeller baseplate is not correctly centered in the bottom opening of the XDR vessel during the disposable bag installation, the agitation system cannot be correctly magnetically coupled. If the agitator emits a loud clicking noise during operation, the impeller baseplate is decoupled from the magnetic drive head. To correct the problem follow the instructions below.

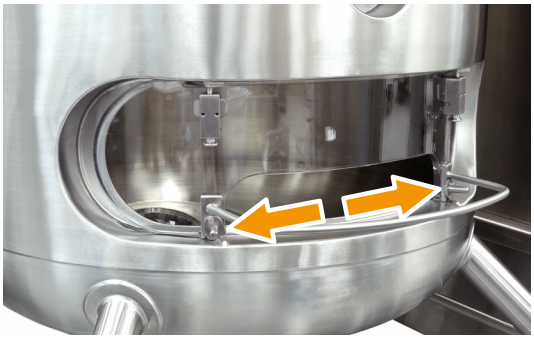
Step	Action
1	Disengage the agitator motor as described in *Disengage agitator drive head using the X-lift, on page 251*.
2	Arrange the impeller baseplate correctly, as shown in step 4 in the previous section.

Step	Action
3	Continue the bag installation as instructed in steps 5 to 7 in the previous section.

Finalize bag installation

Install the loading doors and continue the installation process as described below.

Step	Action
1	Simultaneously: • using your thumbs, push down the retention pins (1),  • using your index and middle finger, push the cam locks (2) toward each other.
2	Move the door to its proper location.
3	Align the retention pins with the holes in the XDR vessel jacket, and then release the retention pins.
4	Put the cam locks into their correct position.

Step	Action
5	Push the cam locks outwards to attach the door to the XDR vessel. 
6	Verify that the probe ports are centered in the opening of the door. If required, lift or lower the bag hoist to align the probe ports vertically.
7	Verify that jacking bolts are disengaged. See *Section 6.2 Stabilize the XDR vessel, on page 153* about how to disengage the jacking bolts.
8	Put the ladder in front of the bioreactor.

Step	Action
9	Connect the bag support straps to the top of the disposable bag.



Note:

The bag support straps prevent the disposable bag from collapsing onto the top of the media if there is little or no flow through the mass flow controllers.

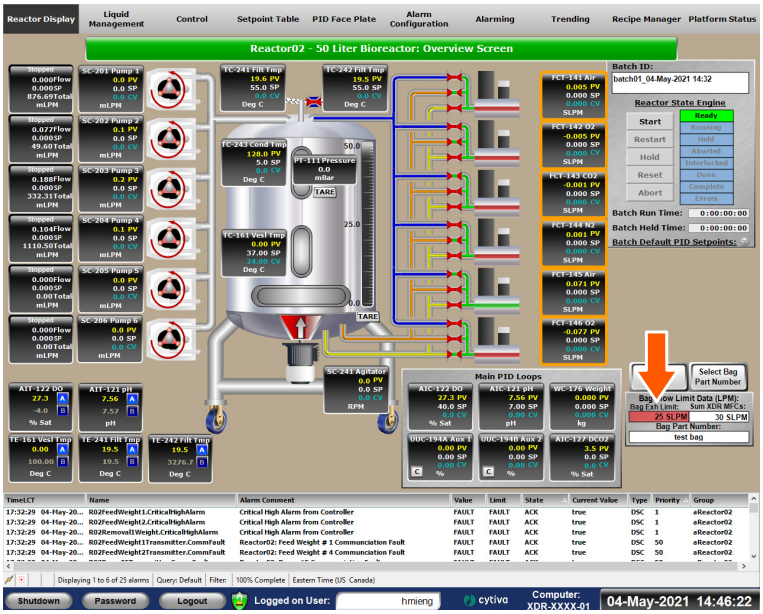
6.4.4 Select disposable bag

Description

The user must select the disposable bag part number before starting the cell culture process. Each disposable bag has a defined total exhaust gas flow limit. If the total MFC gas flow of the configured bioreactor is higher than the exhaust gas flow limit of the selected bag, the mass flow controllers do not operate.

Note: *The total MFC gas flow rate is defined as the sum of CVHL values for all mass flow controllers.*

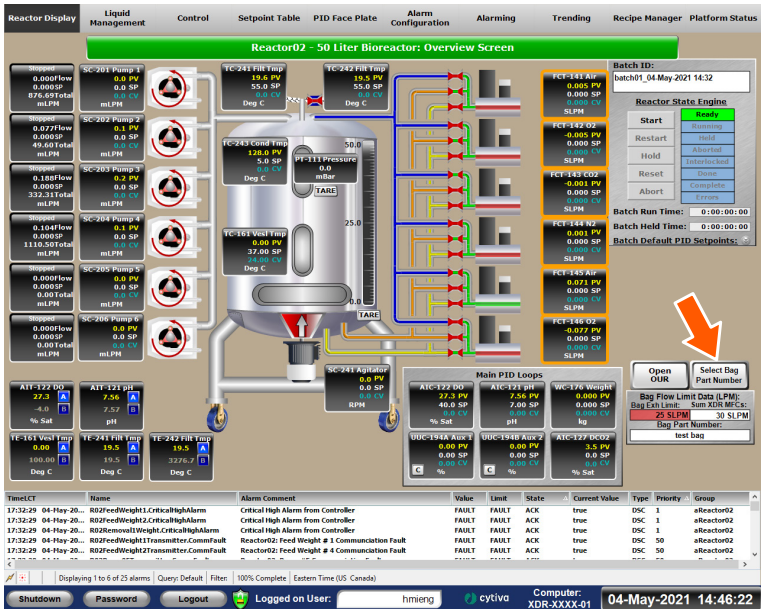
If the selected bag is not compatible with the total gas flow, the ***Bag Exh Limit*** data is shown in red on the ***Bag Flow Limit Data (LPM)*** display on the ***Reactor Display*** screen.



Select the disposable bag

Follow the instructions below to select the applicable disposable bag.

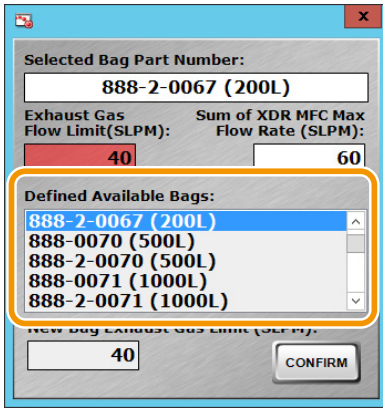
Step	Action
1	On the ***Reactor Display*** screen, click ***Select Bag Part Number***.



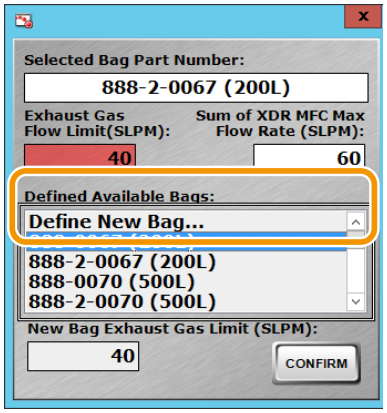
2	In the dialog box, select the part number of your disposable bag on the ***Defined Available Bags*** list. The bag list shows the Cytiva predefined bags. The bag part number is shown on the bag label.

Note:

To enable the use of the 2000 L (XDR-2000 Pro Max bag on your system and use an agitation up to 120 rpm, select ***29724937 (2000 L (XDR-2000 Pro Max bag))*** *from the drop-down menu.*



Step	Action
3	If the part number of your bag is not shown on the list, you can define a new customized bag. Select ***Define New Bag*** on the list.



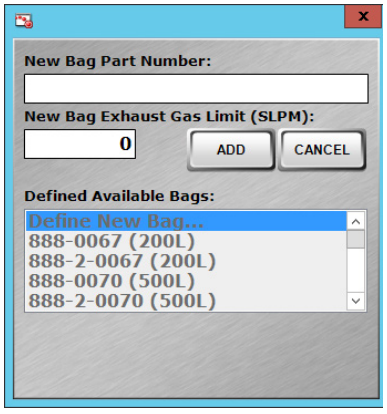
Result:

A dialog box opens for addition of a new bag.

4 Type a new part number for your bag in the ***New Bag Part Number*** text box, and type an applicable exhaust gas flow limit in the ***New Bag Exhaust Gas Limit (SLPM)*** text box.

Note:

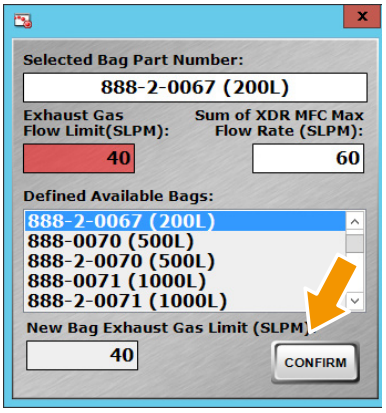
The new part number must be unique. Maximum 20 custom bag types are allowed.



5 Click ***ADD***, and then close the dialog box by clicking the close button .

6 Select the part number of your bag on the ***Defined Available Bags*** list.

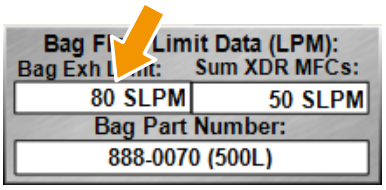
Step	Action
7	Click ***CONFIRM***.



8	Close the dialog box by clicking the close button  .

Result:

The disposable bag selected. If the total gas flow (***Sum XDR MFCs***) is within the limits of the selected bag, the ***Bag Exh Limit*** is shown in a white text box.



6.4.5 Connect cables and tubing

Connect the disposable bag tubing

Follow the instructions below to connect the disposable bag tubing.

Step	Action
1	Verify that the pump is calibrated. See *Section 6.10.2 Calibrate the pump, on page 299* for instructions. See also *Calibration schedule, on page 452* for information on calibration schedule.
2	Carefully pull the acid and base addition tubing into their respective containers. Install the tubing in the pumps as described in *Section 6.10.1 Install tubing, on page 293*.

Connect gas tubing

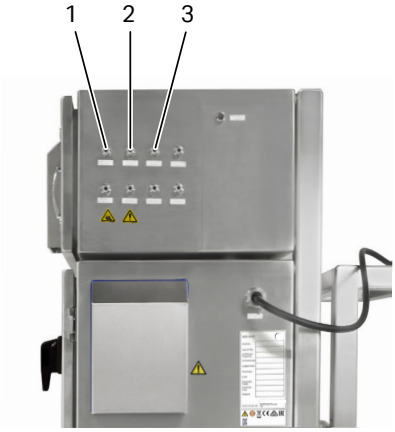
The gas tubing connectors are located on the back of the gas supply cabinet.

Connect the gas tubing as described below.

CAUTION

Quality of gases. The gases supplied to the system should be clean, filtered, and pharmaceutical quality. Failure to use pharmaceutical quality filtered gases could result in malfunction of flow control valves and gas supply solenoids.

Step	Action
1	Connect the pneumatic gas line from the **SPARGER 1 OUTLET** connector (1) to the sparge filter.



Step	Action
2	Connect the pneumatic gas line from the **HEADSPACE OUTLET** connector (3) to the headspace filter.
3	If applicable, connect the pneumatic gas line from the **SPARGER 2 OUTLET** connector (2) to the **SPARGER 2 OUTLET** (stripper) filter.
4	Verify that the clamps on all lines are closed, except on the headspace line, which is used to fill the disposable bag with air.
5	Connect the disposable bag pressure sensor connector to the **BAG PRESSURE SENSOR** cable from the I/O Cabinet. 

6.5 Install the condenser bag

Introduction

The condenser assembly is optional and is applicable for microbial fermentation processes. The condenser is used to prevent excessive water loss in applications such as fermentation.

Install the disposable bag assembly as described in *Section 6.4 Prepare the disposable bag, on page 208*. After finishing the disposable bag installation your system should look as shown in the following illustration, with the condenser bag hanging over the back rim of the XDR vessel.



Install the condenser bag

Follow the instructions below to install the condenser bag.

NOTICE

The thumbscrews which connect the cooling plate with the cooler have sharp threads and edges. Use caution while installing the condenser bag to prevent bag damage.

Step	Action
1	Unscrew the three thumbscrews that attach the cooling plate to the cooler.



Result:

The condenser bag holder opens as shown in the following illustration.



Step	Action
2	Turn the condenser and align it with the condenser bag. 
3	Carefully put the condenser bag onto the cooling plate and align the bag with the plate edges. 
4	Push up the cooling plate using one hand. Make sure that the screws do not come into contact with the bag. With your other hand, tighten the thumb-screws until light resistance is felt.

Step	Action
	Result: The condenser bag is correctly installed. 
5	Install the exhaust filter heater as instructed in *Appendix B User interface description, on page 549*. Make sure that the exhaust tubing is not pinched or blocked.

6.6 Engage and disengage the agitator motor

Introduction

This section gives information about how to raise and lower the agitator motor, which allows the user to engage and disengage the agitator drive mechanism.

In this section

Section		See page
6.6.1	Use of agitator motor lift	240
6.6.2	Use G-lift	242
6.6.3	Use X-lift	247

6.6.1 Use of agitator motor lift

Safety precautions



WARNING

Strong magnets. Magnets may interfere with functioning of pacemakers or implanted heart defibrillators and cause DEATH or SERIOUS INJURY. Magnets are located on the bottom of the product, and in the impeller assembly of the bag assembly.

- OBSERVE and follow instructions for installation, operation, and maintenance of the product.
- KEEP a safe distance of 25 cm or more from the magnets to avoid exposure to magnetic field greater than 0.5 mT (5 G).
- WARN other people who wear pacemakers or implanted heart defibrillators from getting too close to the magnets.



CAUTION

Lock agitator motor. Make sure that all personnel are clear of the agitator motor area before raising or lowering the motor. Failure to properly lock the agitator motor in place may result in injury to personnel.



CAUTION

Secure agitator motor handle. Do not release the agitator motor lift handle until the lock is engaged. Failure to do so may result in injury and equipment damage.



CAUTION

Clear magnetic drive area. With the bag assembly in position, the magnetic drive actuator is ready for engagement. All personnel must be clear of the magnetic drive actuator area under the vessel. Failure to do so may lead to bodily injury.

NOTICE

Move the agitator motor slowly to prevent tubing damage. The sparge tubing must be moved away from pinch points to prevent damage to the tubing.

Agitator motor lift

The agitator motor lifting system of 50 L bioreactor is called G-lift.

The agitator motor lifting system of 200 to 2000 L bioreactors is called X-lift.

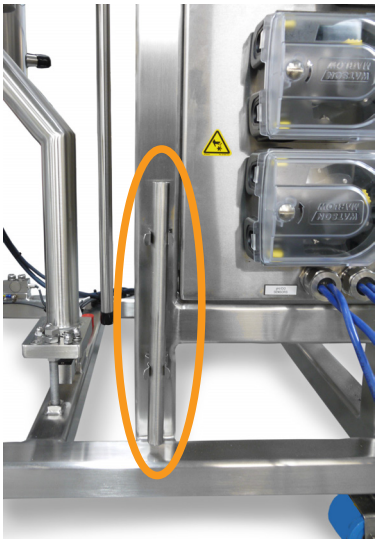
To install or remove a disposable bag assembly the agitator motor must be disengaged. The operator uses a handle to lift and lower the agitator motor. Both lifting systems must be locked in their engaged or disengaged positions.

6.6.2 Use G-lift

Engage agitator drive head using the G-lift

Follow the instructions below to engage the agitator drive head for the 50 L bioreactor.

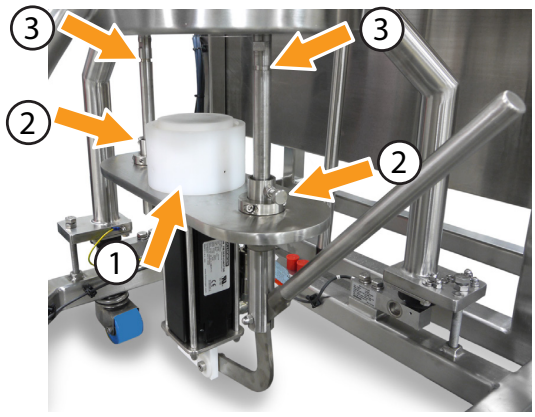
Step	Action
1	Find the G-lift handle on the XDR vessel frame, near the I/O Cabinet. The handle is stored in holding clips.



2	Slide the handle into the G-lift handle sleeve.



Step	Action
3	Push the handle slowly down to raise the G-lift until the agitator drive head (1) magnetically engages with the impeller baseplate.



Note:

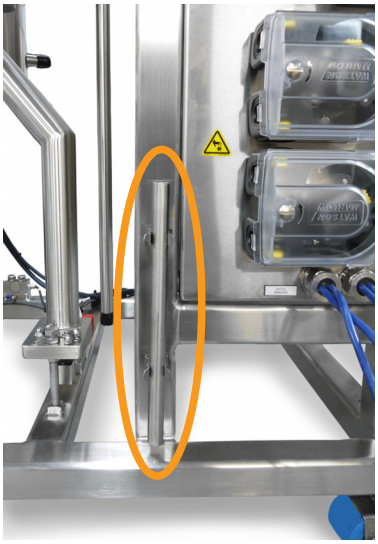
The locking pins (2) slide upwards and click into the grooves (3) to lock the agitator drive head in the engaged position.

4	Make sure that the front and rear locking pins (2) are securely locked in the grooves (3). Release the handle. *Result:* The agitator drive head is engaged with the impeller baseplate, as shown in the illustration below.

Step	Action
	
5	Remove the handle from the G-lift and put the handle back into the storage clips on the XDR vessel frame.

Disengage agitator drive head using the G-lift

Follow the instructions below to disengage the agitator drive head for the 50 L bioreactor.

Step	Action
1	Find the G-lift handle on the XDR vessel frame near the I/O Cabinet. The handle is stored in holding clips. 
2	Slide the handle into the G-lift handle sleeve. 

Step	Action
3	While pressing the handle upwards, pull the front (1) and rear locking pins out of the grooves to unlock the G-lift.



4	Pull the handle slowly upwards to lower the G-lift into the disengaged position. *Result:* The agitator drive head is disengaged from the impeller baseplate, as shown in the illustration below.



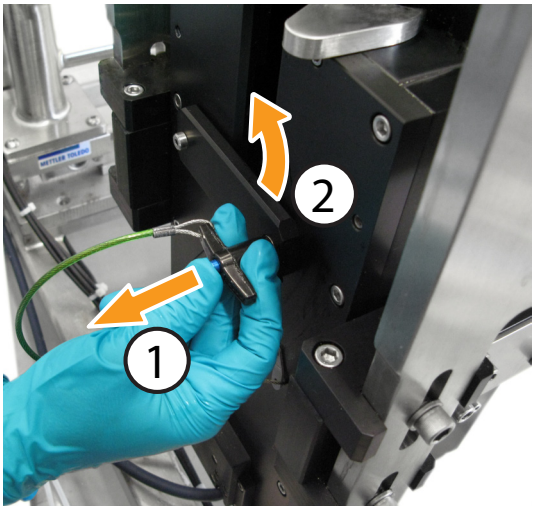
5	Remove the handle from the G-lift and put the handle back into the storage clips on the XDR vessel frame.

6.6.3 Use X-lift

Engage agitator drive head using the X-lift

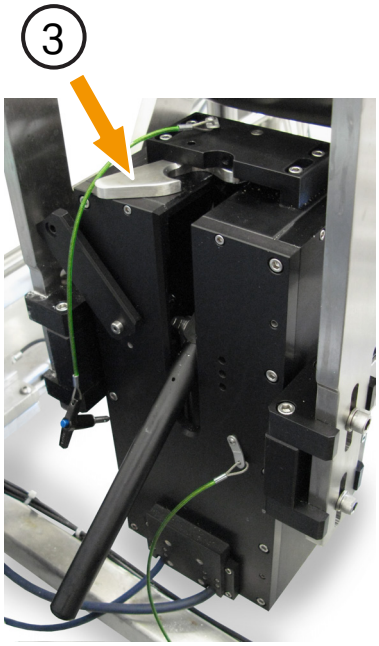
Follow the instructions below to engage the agitator drive head for 200 to 2000 L bioreactors.

Step	Action
1	Remove the locking pin from the locking bar by pressing the center button and pulling out the pin (1).



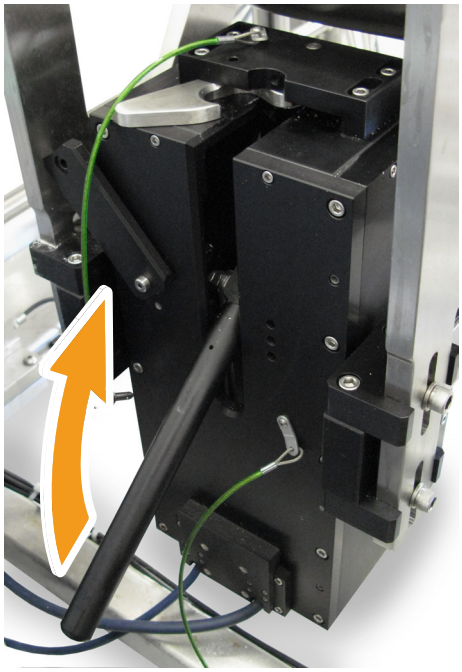
2	Turn the locking bar counterclockwise until it stops (2).

Step	Action
3	Remove the locking pin from the lift handle lock (3) by pressing the center button and pulling out the pin.



4	Turn the handle lock (3) counterclockwise until it stops.

Step	Action
5	Pull up the handle slowly to lift the agitator assembly from the housing. Continue lifting the agitator motor until it magnetically engages with the impeller baseplate.

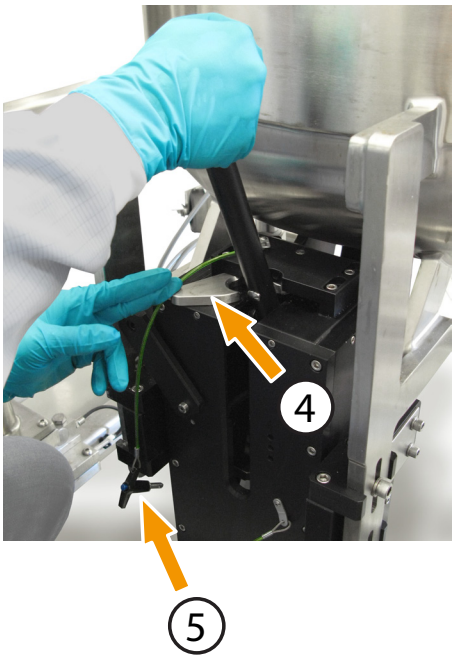


6	Push the lift handle up toward the XDR vessel and hold the handle in the up position.
7	Rotate the handle lock (4) to the right.

CAUTION

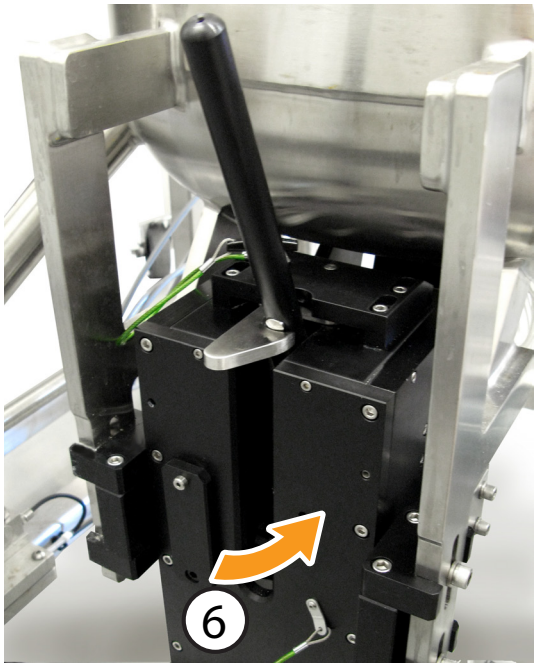
Secure agitator motor handle. Do not release the agitator motor lift handle until the lock is engaged. Failure to do so may result in injury and equipment damage.

Step	Action



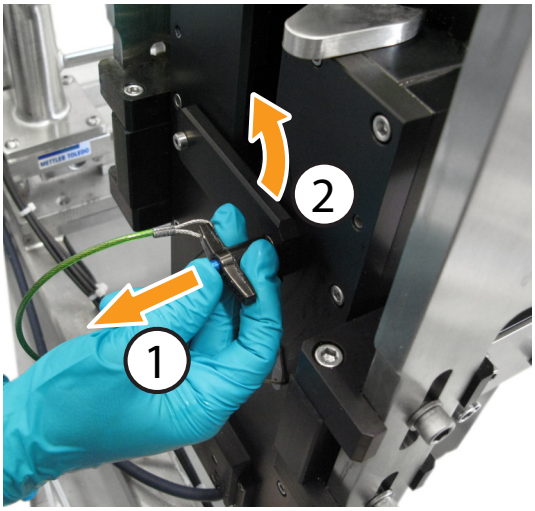
8 Install the locking pin (5) to lock the lift handle safely.

9 Release the lift handle.

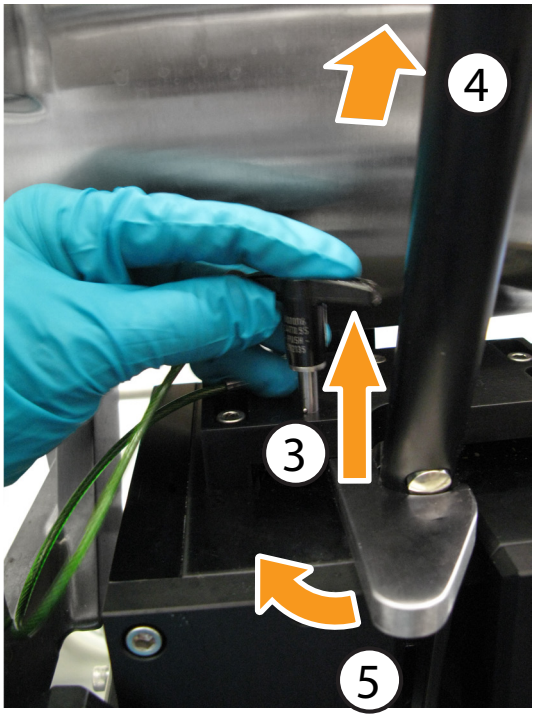
Step	Action
10	Rotate the lock bar until horizontal (6). 
11	Install the locking pin in the lock bar. *Result:* The agitator motor is engaged with the impeller baseplate and is in safe position.

Disengage agitator drive head using the X-lift

The lift is engaged when the lift handle is in the up position. Follow the instructions to disengage the X-lift for 200 to 2000 L bioreactors.

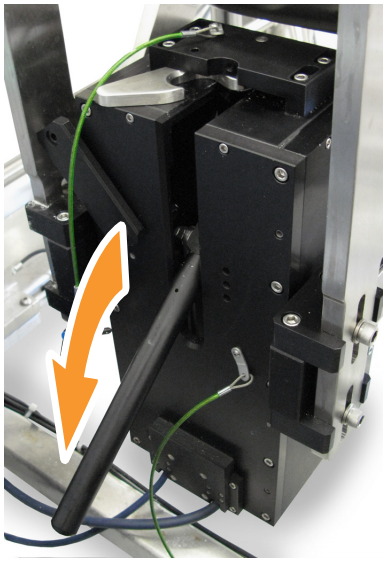
Step	Action
1	Remove the locking pin from the lock bar by pressing the center button and pulling out the pin (1). 
2	Turn the lock bar counterclockwise until it stops (2).

Step	Action
3	Remove the locking pin from the lift handle lock (3) by pressing the center button and pulling out the pin.



4	Push the lift handle up toward the XDR vessel (4) and hold the handle in the up position.
5	Rotate the lift handle lock to the left (5).

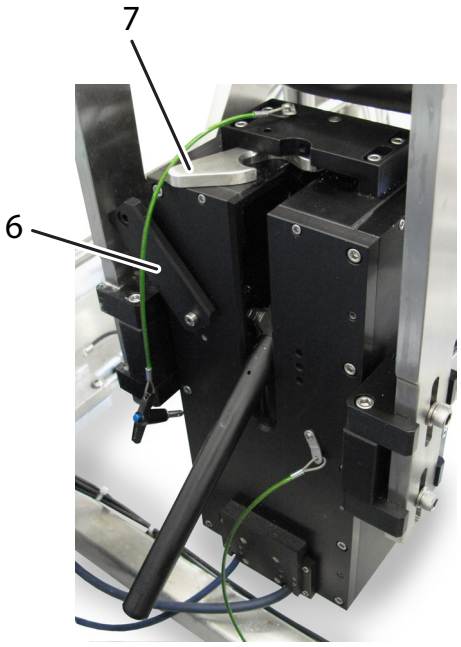
Step	Action
6	Lower the lift handle slowly. A light pull downwards may be required to disengage the agitator drive head.



Result:

The agitator drive head is disengaged and the drive mechanism retracted into the housing.

Step	Action
7	Rotate the lock bar (6) clockwise until horizontal and install the locking pin.



Result:

The handle is safely locked in the down position.

8	Rotate the handle lock (7) to the right and install the locking pin.

6.7 Install the exhaust filter heater

Introduction

This section describes how to install an exhaust filter heater on XDR-50 to 2000 Bioreactor Systems. One or two exhaust filter heaters may be installed, depending on the application.

NOTICE

A customized disposable bag assembly may have non-standard exhaust filters. Make sure that the exhaust filters on the disposable bag match the exhaust filter heaters on your instrument.

Install exhaust filter heater

Exhaust filter heater must be installed on the exhaust filter of the disposable bag when the bag assembly has been installed in the XDR vessel. See *Section 6.4.2 Install the disposable bag, 50 to 500 L bioreactors, on page 213* and *Section 6.4.3 Install the disposable bag, 1000 and 2000 L bioreactors, on page 218* for instructions on how to install the disposable bag.

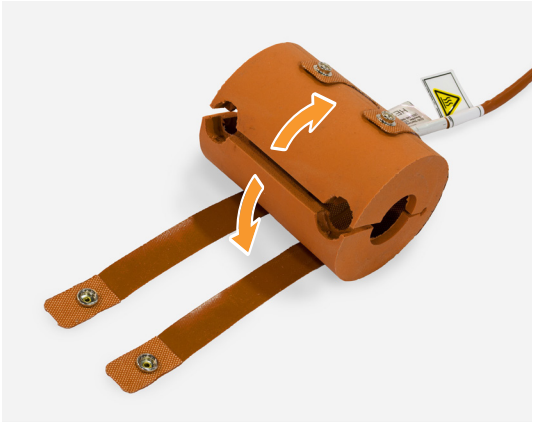
Both the large and the small exhaust filter heaters are installed according to the same procedure. Follow the instructions below to install an exhaust filter heater.

Note: *Exhaust filter heater color can vary. The images are for illustrative purposes only.*

Step	Action
1	Open the button locks of the snap straps of the exhaust filter heater.



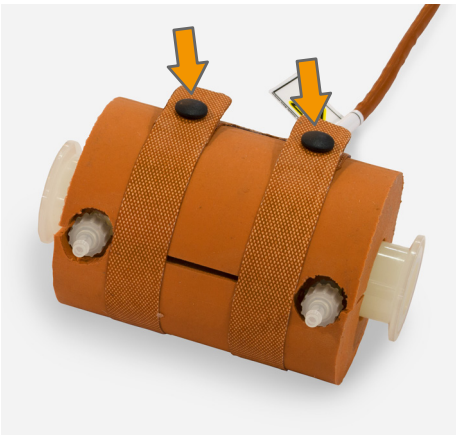
Step	Action
2	Using your hands pull apart the two sides of the exhaust filter heater at the slot.



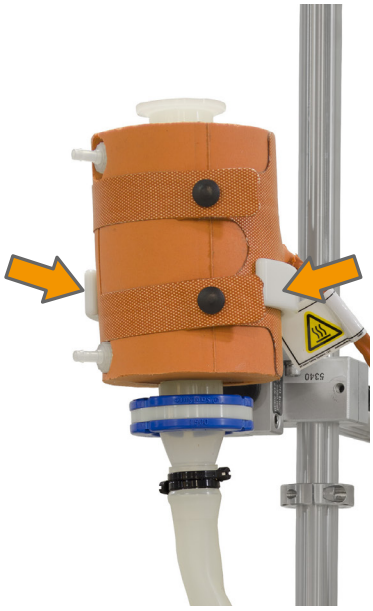
3	Insert the filter into the filter heater and align the filter vents with the openings in the filter heater.



Step	Action
4	Close the button locks.



5	Insert the filter heater into the exhaust filter heater holder at the top of the XDR vessel.



Step	Action
6	If your filter heater holder has a fastening strap, put the strap around the filter heater and close the buckle.



7	Connect the exhaust filter heater cable to the **EXHAUST HEATER HE-241A/HE-241B** port on the back of the I/O Cabinet.

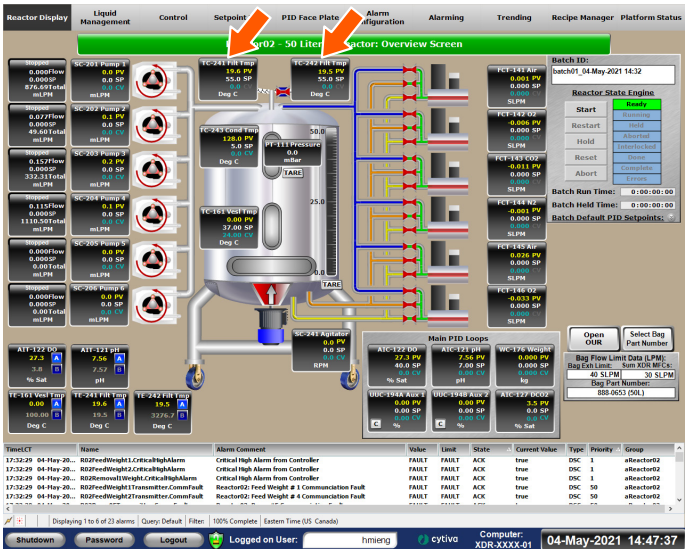
To install multiple exhaust filter heaters follow steps 1-6 above for each filter heater. Connect the filter heaters as specified by the batch record.

Heat up the exhaust filter heater

Follow the instructions below to heat up the filter heater.

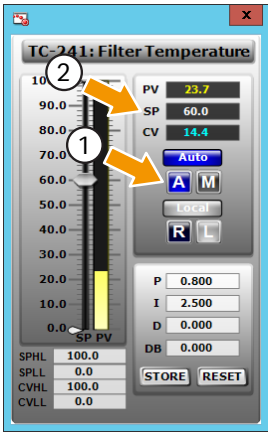
Step	Action
1	Log on to the software. See *Section 7.2.2 Log on / log off, on page 312* for instructions.

Step	Action
2	Click an applicable exhaust filter heater panel on the ***Reactor Display*** screen.



Result:

The ***Filter Temperature*** PID faceplate opens.

3	

In the ***Filter Temperature*** PID faceplate, click ***A*** (1) to set the the exhaust filter heater controller into ***Auto*** mode.

4	In the ***SP*** field (2), type temperature setpoint as 60°C.

Step	Action
	Result: The exhaust filter starts heating up.
5	Repeat steps 2 to 4 for the second exhaust filter heater, if applicable.
6	Wait until the exhaust filter heaters reach their operating temperatures. This could take 30 minutes to 1 hour.



CAUTION

Hot surface. Do not touch the exhaust filter heater while it is at the operating temperature. The heater is hot during normal use.



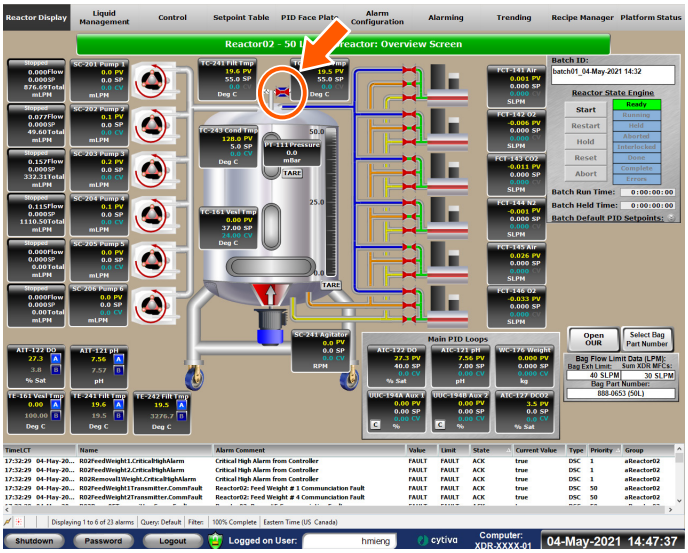
NOTICE

Failure to set up the exhaust filter heater properly may result in moisture accumulation and a clogged filter, which may lead to severe bag overpressure.

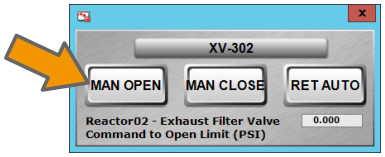
Operate pinch valve

Follow the instructions below to manually open and close the pinch valve.

Step	Action
1	Click the pinch valve icon to open the ***XV-302*** dialog box.



2	Open the valve by clicking ***MAN OPEN*** in the ***XV-302*** dialog box.



3	Close the valve by clicking ***MAN CLOSE*** in the ***XV-302*** dialog box.
4	Click ***RET AUTO*** to set the pinch valve in automatic mode.

6.8 Install probes

Introduction

This section provides instructions for installation of probes into the disposable bag. Instructions are given for installation of standard analytical probes using two models of probe sheath, and for connection of optical DO probe (optional component).

In this section

Section		See page
6.8.1	Install standard probes (bellows probe sheath)	264
6.8.2	Install standard probes (Click In probe sheath)	274
6.8.3	Prepare the thermowell and install the temperature probe	282
6.8.4	Connect cable to optical DO sensor window	286

6.8.1 Install standard probes (bellows probe sheath)

Prepare probe sheath assembly

All types of standard analytical probes are installed using the same procedure.

The probe sheath assembly must be autoclaved before installation. See *Section 6.3.5 Autoclave probe sheath assembly, on page 202* for instructions.

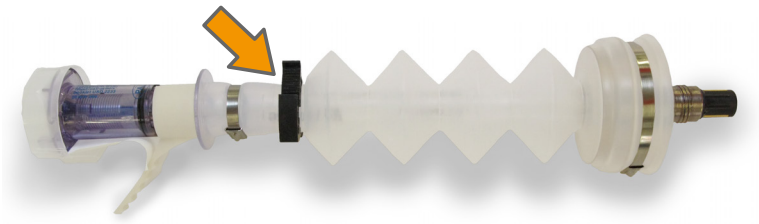
The instructions below involve handling of ratchet clamps. Carefully read through the notice below before starting to insert the probe sheath assembly into the disposable bag.

NOTICE

- Ratchet clamps might break if they are overtightened.
- A ratchet clamp can be released from its tightened state by sliding the interlocked clamp fingers sideways with respect to each other.
- If ratchet clamp fingers cannot be released, the ratchet clamp has to be cut open. Side cutters or pliers (similar to the ones used to remove a cable tie) can be used for the purpose.

Follow the instructions below to prepare for installation of the probe sheath assembly into the disposable bag.

Step	Action
1	Connect the probe to the appropriate probe cable from the I/O Cabinet.
2	Install one ratchet clamp at the section of the probe sheath assembly between the male ACD connector and the bellows section of the probe sheath assembly, as shown in the following illustration.



Step	Action
3	Using your fingers, loosely tighten the ratchet clamp until the teeth of the clamp are engaged enough to hold the clamp in position (2 to 3 teeth engaged).



NOTICE

Do not tighten the clamps too much, otherwise they may prevent the insertion of the probe into the disposable bag.

Install probe sheath assembly

Before starting the installation make sure that the clamp tightening pliers are available.

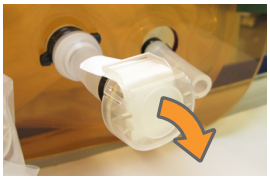


Tip: *Clamp tightening pliers for ratchet clamps are shipped with each bioreactor. You can also use a pair of medium sized multigrip pliers with parallel jaws to tighten the ratchet clamps.*

The disposable bag must be installed in the XDR vessel and the probe ports arranged on the probe support bar before starting the probe sheath installation.

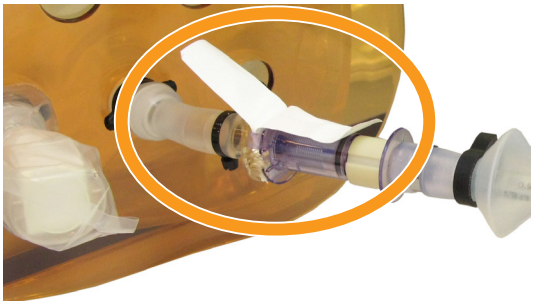
Follow the instructions below to install the probe sheath assembly. Before starting the installation make sure that the ACD connectors on the probe sheath and the disposable bag are compatible.

Step	Action
1	Remove the protective cap from the ACD connector on the probe port and from the ACD connector on the probe sheath.





2	Align the male ACD connector (on the probe sheath assembly) with the female connector (on the disposable bag), so that the white membrane strips face each other as they exit the flat sides of the connectors.



3	Press the connectors together to lock them until a double-click confirms that the connectors are engaged. Visually verify that the locking mechanism is fully engaged.

Step	Action
4	Support both connectors with one hand. Hold both the white membrane strips with the other hand and pull them (perpendicular to the connectors) simultaneously away from the connectors in one smooth continuous motion.



NOTICE

If only one membrane strip is removed or if a membrane strip breaks and only part of it is removed, the connection should not be considered aseptic.

Immediately clamp off this probe sheath assembly on the silicone tubing between the bag reinforcement sheet and the female ACD connector.



Step	Action
5	Pull off the stop ring that prevents unintentional insertion of the probe before the ACD connectors have been correctly connected.



6	Push the base of the male connector toward the base of the connector body until both connectors meet. *Result:* The male ACD connector makes a ratchet sound when pushed. The illustration below shows the current state of the connector.



7	Examine the connection to confirm that the sealing O-rings are in place and that they are not distorted.

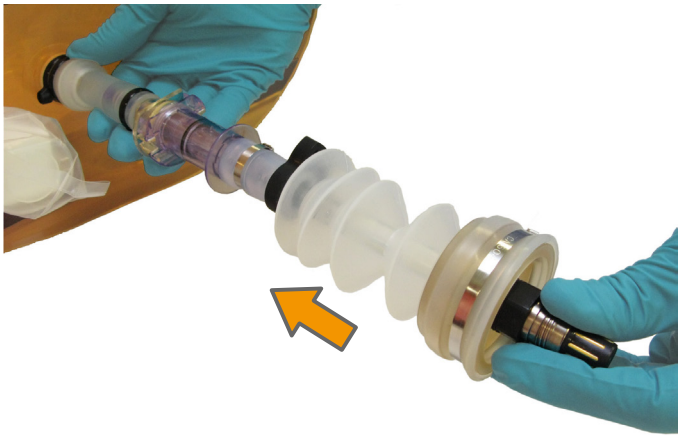
NOTICE

If there is any indication that the connection might not be aseptic, immediately clamp off this probe sheath assembly on the silicone tubing between the disposable bag and the female ACD connector.

Step	Action



8 Hold the engaged connectors with one hand and push the end plug of the probe sheath assembly toward the disposable bag, compressing the bellows of the probe sheath assembly.



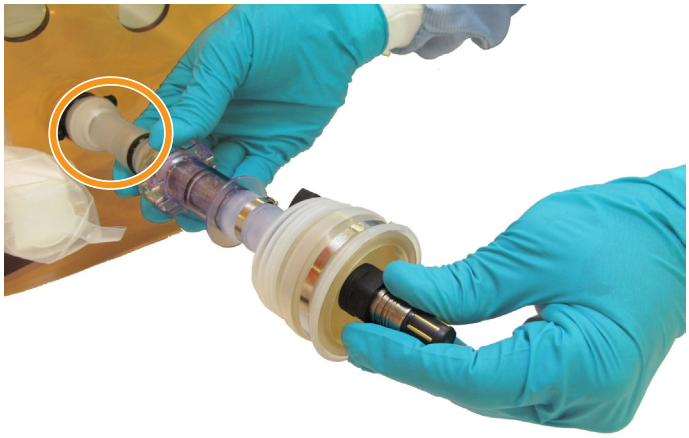
Result:

The bellows are fully compressed, as shown below. The probe tip is inserted into the disposable bag.

Step	Action



9 Install two ratchet clamps on the tubing between the bag reinforcement sheet and the mated connectors, at the location shown in the following illustration.



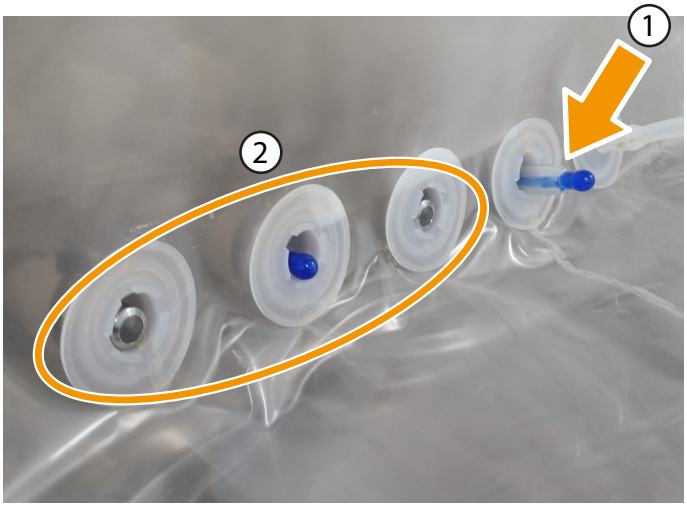
Step	Action
10	Hold the compressed probe sheath assembly in one hand and tighten all three ratchet clamps with the clamp tightening pliers, until 6–7 clamp teeth are engaged.



NOTICE

If the ratchet clamps are tightened too much, they can break. Previous experience has shown that if a ratchet clamp breaks, the probe itself would not be damaged, even if it is a pH probe with a glass body.

11	Verify that the probe is correctly installed in the disposable bag: the probe tip should extend fully from the probe port opening and be at least 8 mm away from the inside surface of the disposable bag. Use a flashlight for inspection, if needed. The following illustration shows a correctly installed probe (1) and incorrectly installed probes (2).



12	Install all probes as described in the steps above.

Step	Action
13	Clamp off any unused probe port connections. 

Correct arrangement

The illustration below shows a compressed probe sheath assembly in place.



When the primary and secondary seals are in place and properly tightened, the probe stays correctly in place, regardless of the internal pressure in the disposable bag. No additional measures are needed to prevent the probe from sliding out of the disposable bag.

Arrange the probes and the tubing on the probe support bar. Make sure that the pH and DO probes are slightly tilted (approximately 15 degrees): the probe end inside the disposable bag must be lower than the connector end of the probe sheath. This is necessary for correct functioning of the probes.

Tip: *If the probe is not tilted, air bubbles may assemble on the DO probe membrane and cause signal disturbance.*

6.8.2 Install standard probes (Click In probe sheath)

Prepare for installation

Most types of standard analytical probes can be installed using the same procedure. If the probe injector does not fit around the nut of the probe, use a wrench to tighten the nut of the probe.

The probe sheath assembly must be autoclaved before installation. See *Section 6.3.5 Autoclave probe sheath assembly, on page 202* for instructions.

The installation instructions involve handling of ratchet clamps. Carefully read through the notice below before starting to insert the probe sheath assembly into the disposable bag.

NOTICE

- Ratchet clamps might break if they are overtightened.
- A ratchet clamp can be released from its tightened state by sliding the interlocked clamp fingers sideways with respect to each other.
- If ratchet clamp fingers cannot be released, the ratchet clamp has to be cut open. Side cutters or pliers (similar to the ones used to remove a cable tie) can be used for the purpose.

The disposable bag must be installed in the XDR vessel and the probe ports arranged on the probe support bar before starting the probe sheath installation.

Install probe sheath assembly

Before inserting the probe sheath assembly into the disposable bag, make sure you have clamp tightening pliers (A) and the probe injector (B) accessible.

A



B



Tip: *Clamp tightening pliers for ratchet clamps are shipped with each bioreactor. You can also use a pair of medium sized multigrip pliers with parallel jaws to tighten the ratchet clamps.*

Note: *The probe injector is available for purchase at Cytiva ("Click In probe sheath plunger tool").*

Follow the instructions below to install the probe sheath assembly.

Step	Action
1	Lift up the protective cap on both ACD connectors.





2	Align the connector on the probe sheath assembly with the connector on the disposable bag, so that the white membrane strips face each other.



Step	Action
3	Press the connectors together to lock them.



Result:

A double-click confirms that the connectors are engaged.

4	Support both connectors with one hand. Hold both protective caps with the other hand and pull them (perpendicular to the connectors) up and away from the connectors.



Step	Action
5	Pull off the stop tab that prevents unintentional insertion of the probe before the ACD connectors have been correctly connected.



6	Place the probe injector to the end of the probe and push the probe through the probe sheath cylinder, until the plug reaches the stop (1).



Step	Action



Result:

A click confirms that the plug is engaged with the stop. The probe tip is inserted into the disposable bag.

7 Pull out the probe injector.

8 Install two ratchet clamps on the tubing between the bag reinforcement sheet and the ACD connector, at the location shown in the following illustration.



Step	Action
9	Hold the probe sheath assembly in one hand and tighten the ratchet clamps with the clamp tightening pliers, until 6–7 clamp teeth are engaged.



NOTICE

If the ratchet clamps are tightened too much, they can break. Previous experience has shown that if a ratchet clamp breaks, the probe itself would not be damaged, even if it is a pH probe with a glass body.

10	Hold the ACD connector with one hand. With the other hand turn the probe sheath cylinder counterclockwise a quarter turn, and then pull the cylinder away from the connector.



Result:

The cylinder disengages from the plug.

Step	Action



11 Connect the probe to the appropriate probe cable from the I/O Cabinet.

12 Install all probes as described in the steps above.

13 Clamp off any unused probe port connections.



Correct arrangement

The illustration below shows the probe sheath assembly in place.



When the primary and secondary seals are in place and properly tightened, the probe stays correctly in place, regardless of the internal pressure in the disposable bag. No additional measures are needed to prevent the probe from sliding out of the disposable bag.

Arrange the probes and the tubing on the probe support bar. Make sure that the pH and DO probes are slightly tilted (approximately 15 degrees): the probe end inside the disposable bag must be lower than the connector end of the probe sheath. This is necessary for correct functioning of the probes.

Tip: *If the probe is not tilted, air bubbles may assemble on the probe membrane and cause signal disturbance.*

6.8.3 Prepare the thermowell and install the temperature probe

Prepare the thermowell

The thermowell on the bioreactor bag is delivered with a tubing spacer. On 50 L bags, the tubing spacer consists of one piece: a tubing insert (1) that reaches into the thermowell. The tubing spacer delivered with the 50 L bags is shown below:



On 200, 500, 1000, and 2000 L bags, the tubing spacer consists of two attached pieces: a tubing insert (1) that reaches into the thermowell, and a plug (2) that is connected to the tip of the tubing insert. The tubing spacer delivered with the 200, 500, 1000, and 2000 L bags is shown below:



The tubing spacer must be removed from the thermowell before inserting the temperature probe into the thermowell. Commonly, the tubing spacer can be removed as one piece. Uncommonly, the plug becomes detached from the tubing insert during removal, and the tubing insert must be removed separately.

Follow the instructions below to remove the tubing spacer from the thermowell.

Step	Action
1	Slowly and carefully pull on the tubing spacer to remove the tubing spacer from the thermowell.

50 L bag:



200, 500, 1000, and 2000 L bags:

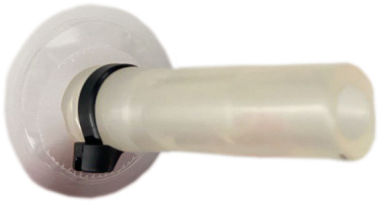


IMPORTANT

If the plug (2) is removed and the tubing insert (1) is still inside the thermowell, slowly and carefully remove the tubing insert from the thermowell.



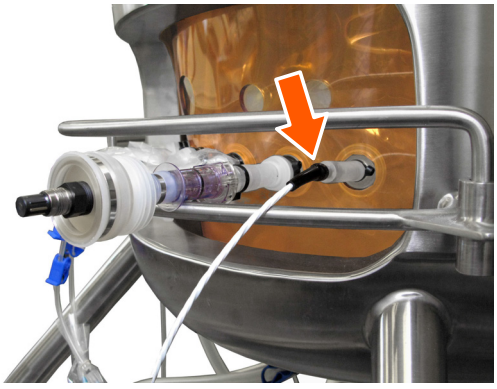
Step	Action
2	Inspect the thermowell to make sure that the tubing spacer is removed from the thermowell. The thermowell empty of the tubing spacer is shown in the image below:



Install the temperature probe

Follow the instructions below to install the temperature probe.

Step	Action
1	Spray a large quantity of 70% IPA solution onto the temperature probe in order to lubricate the temperature probe. This reduces the risk of damaging the bag.
2	Slowly twist the temperature probe while inserting the temperature probe into the thermowell. This reduces the risk of damaging the inner thermowell tubing.



Step	Action
3	Connect the temperature probe cable to the **RTD INPUT** connection port on the I/O Cabinet front.



6.8.4 Connect cable to optical DO sensor window

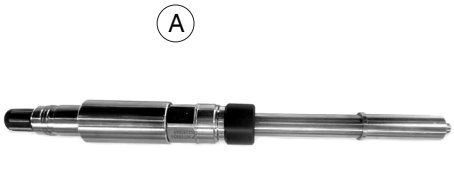
Optical DO sensor

The optical DO sensor (optional component) is a built-in component of the disposable bag. The sensor needs to be connected to the I/O Cabinet using the sensor head.

Connect the cable

Follow the instructions below to connect the optical DO sensor to the I/O Cabinet.

Step	Action
1	Connect the sensor head to an applicable VP8 cable.
2	Remove the protective cap from the optical DO sensor window.
3	Screw the sensor head connector (A) onto the DO sensor (B):



NOTICE

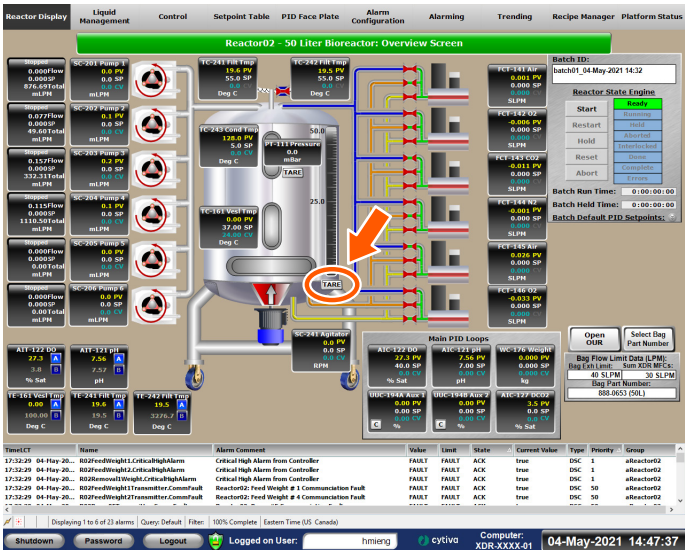
Do not cross-thread the connector cap. The base material is soft and may be damaged.

6.9 Set XDR vessel weight and pressure

Tare XDR vessel weight

Follow the instructions below to tare the XDR vessel weight.

Step	Action
1	Click ***TARE*** at the bottom of the reactor weight display on the ***Reactor Display*** screen.

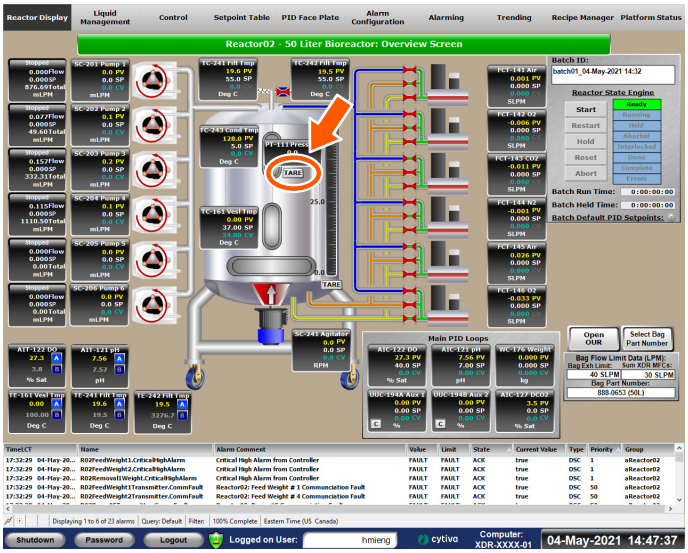


2	Confirm by clicking ***YES*** in the pop-up dialog box.
3	If the password is required, type your password.

Tare bag pressure

Follow the instructions below to tare the disposable bag pressure.

Step	Action
1	Click ***TARE*** below the bag pressure display on the ***Reactor Display*** screen.



2	Confirm by clicking ***YES*** in the pop-up dialog box.
3	Make sure that the bag pressure is shown as 0 kPa (0.00 mbar, 0.0 psig).

Fill the bag with air

CAUTION

Quality of gases. The gases supplied to the system should be clean, filtered, and pharmaceutical quality. Failure to use pharmaceutical quality filtered gases could result in malfunction of flow control valves and gas supply solenoids.

CAUTION

Sparge tubing unblocked. Make sure that the sparge tubing is not clamped or pinched between the air filter and the bioreactor bag. The blocked tubing may burst.

Fill the disposable bag with air before filling it with liquid. This allows the user to gently adjust the bag position and fit the bag inside the XDR vessel.

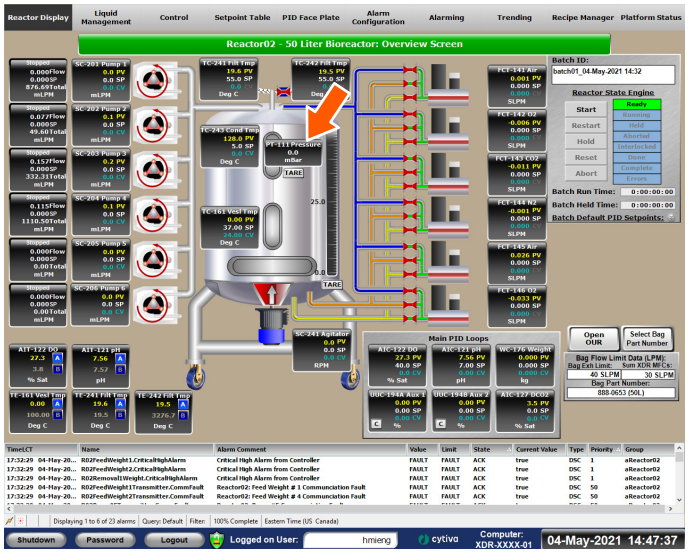
During the bag filling procedure, make sure that bag pressure data are shown as described in the instructions below. If the bag pressure readings are not as expected, the bag pressure sensor may have failed.

CAUTION

Failure of bag pressure sensor. Failure of bag pressure sensor may lead to bag overpressure, breakage of the bag, and a large leakage of bag contents.

Follow the instructions below to adjust the disposable bag inside the XDR vessel and fill the bag with air.

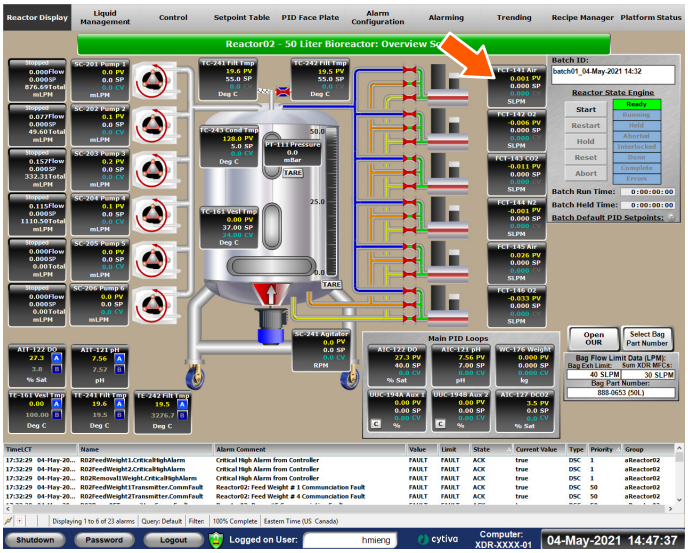
Step	Action
1	Close all tubing with clamps, including exhaust filter tubing. Keep the following tubing open: • sparge tubing • tubing that contains pressure sensor
2	Make sure that the bag pressure reading is 0 kPa (0.00 mbar, 0.0 psig).



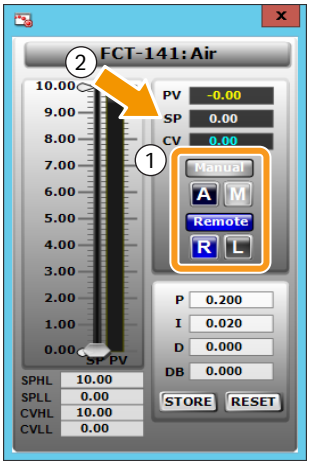
3	In the software, configure one MFC to use process air through the head-space tubing. Follow the instructions below.

Step	Action

a. Click the MFC1 panel (***FCT-141 →Air***) to open the MFC1 PID faceplate.



b. Click ***A*** and ***L*** (1) to put the MFC into ***Auto/Local*** mode.



c. Type a setpoint that is 25% of full scale into the ***SP*** text box (2).

Note:

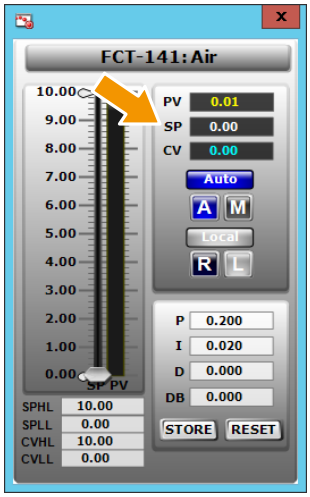
Full scale is based on the flow rate of the installed MFC.

4 When the flow is established, increase the ***SP*** value to increase the air flow rate if necessary.

Step	Action
5	Monitor the bag shape while filling the bag. Adjust the bag to correct the fit.
6	Make sure that proper alignment of the bag is maintained while the bag is filled with air: • Adjust the orientation of sample, pH, DO, and temperature probe connectors in the probe window at the front of the XDR vessel. • Verify that the impeller baseplate stays correctly engaged to the magnetic drive head.
7	Continue to fill the disposable bag until the bag shape fits the vessel shape and the bag is still soft to the touch.

NOTICE
Do not overfill the bag.

8	On the MFC1 PID faceplate (***FCT-141 →Air***), type 0 into the ***SP*** text box (0 SLPM).



Result:

The gas flow is turned off.

9	Check and arrange the disposable bag inside the XDR vessel as necessary to remove folds and wrinkles.

If your bag pressure readings are not shown as described above, the bag pressure sensor may have failed. Contact your Cytiva representative for help and service.

6.10 Prepare the pumps

Introduction

This section describes how to install tubing in pumps that are components of the XDR-50 to 2000 Bioreactor Systems. It also provides instructions for calibration of the pumps.

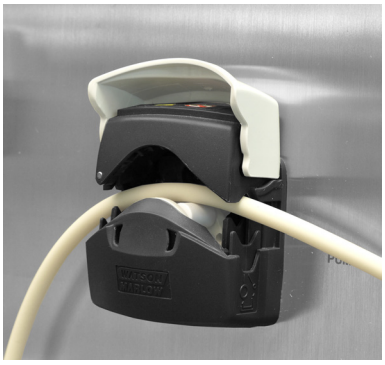
In this section

Section		See page
6.10.1	Install tubing	293
6.10.2	Calibrate the pump	299

6.10.1 Install tubing

Install tubing in pump model 114

To install the tubing in pump model 114 follow the steps below.

Step	Action
1	Open the pump head cover.
2	Insert the tubing through the pump. 
3	Close the pump head cover.

Install tubing in pump model 313

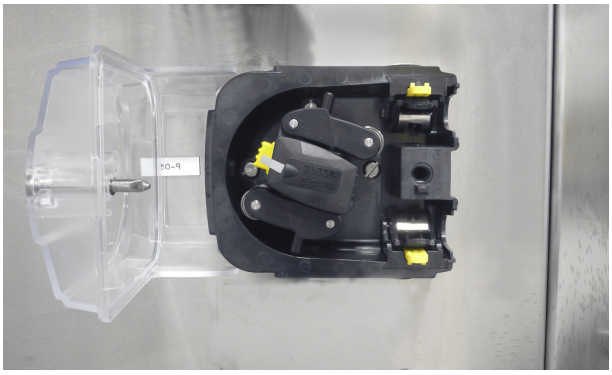
To install the tubing in pump model 313 follow the steps below.

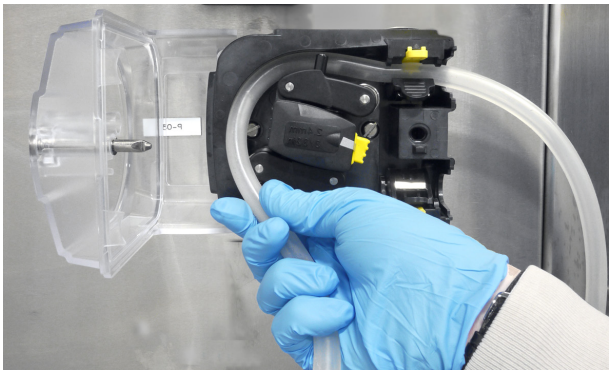
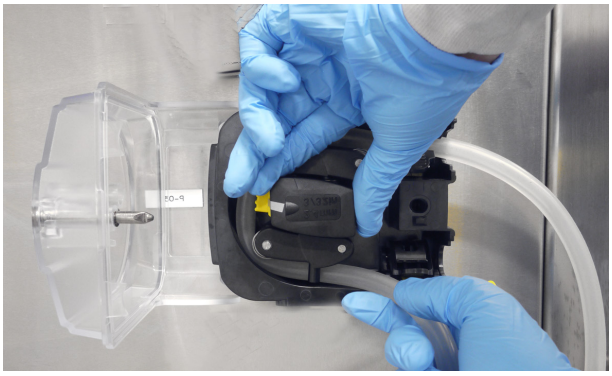
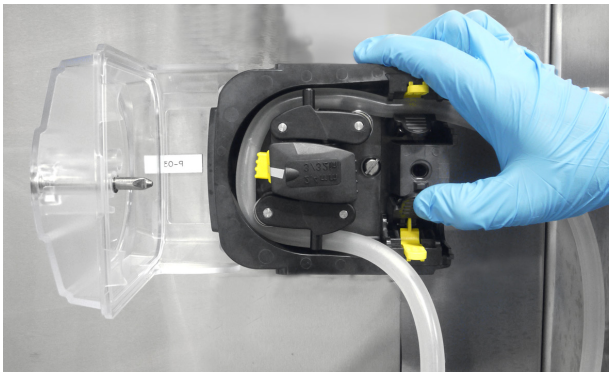
Step	Action
1	Open the pump head cover. 
2	Insert the tubing through the pump. 

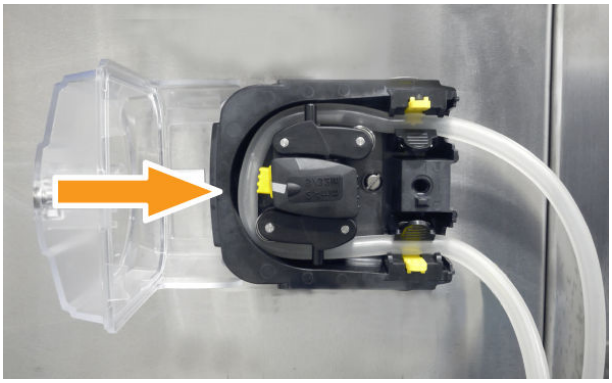
Step	Action
3	Close the pump head cover. 
4	If the tubing is moving in the pump head, tighten the adjustment wheel half a turn clockwise.  **CAUTION** **Do not overtighten.** Do not overtighten the adjustment wheel on the pumps. The flow through the tubing may be cut off.

Install tubing in pump model 520

To install the tubing in pump model 520 follow the steps below.

Step	Action
1	Unlock the pump head cover with a screwdriver. Open the cover. 
2	Press down the top lever with your thumb. 
3	Insert the tubing into the top retention clip. Verify that the tubing is firmly seated in the clip.
4	Align the roller assembly so that it is not blocked by the retention pin on the roller assembly.

Step	Action
5	Push the tubing into the space around the roller assembly. 
6	Turn the roller clockwise to move the insertion space forward all the way around the roller assembly. 
7	Press up the second lever with your thumb and firmly insert the tubing. 

Step	Action
8	Close the pump head and lock it using the screwdriver. 

6.10.2 Calibrate the pump

When to calibrate

The pumps are calibrated by the user. The pump must be calibrated each time a different tubing size is used in a particular pump. Pump calibration should be performed routinely to ensure operational accuracy over time. Contact your Cytiva representative for help and suggestions.

Note: *Remote (external) pumps are calibrated using the procedure defined by the manufacturer. Refer to the manufacturer's documentation for more information.*

Preparation

The pump calibration procedure determines the flow factor for the pump. The flow factor is used for calculation of the flow rate and the totalized flow.

The following equipment is needed for pump calibration:

- a water reservoir (minimum 2 L)
- tubing (identical to the tubing used during process)
- a collection container (volume minimum 2 L).

Note: *The collection container must enable the quantification of collected water. The container could be a graduated vessel or a tared container placed on a balance. Consider the accuracy required for your particular operation.*

To prepare for pump calibration follow the instructions below.



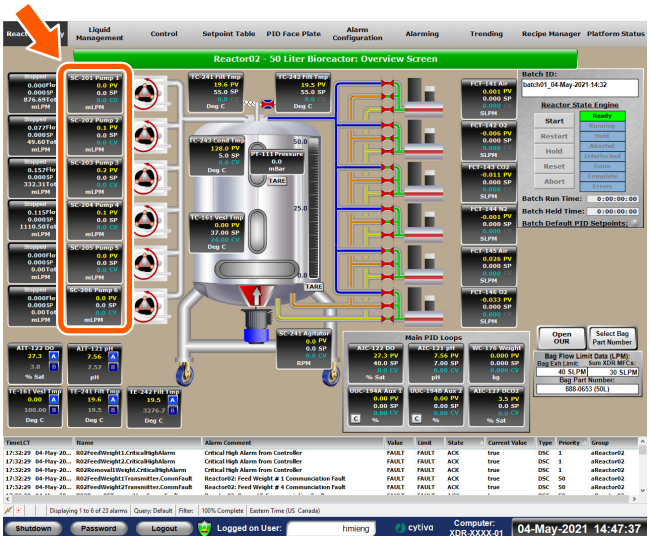
CAUTION

Pinch hazard. Do not operate the pumps without the covers in place.

Step	Action
1	Place the water reservoir at the same height as the process liquid.
2	Install the tubing into the pump. See *Section 6.10.1 Install tubing, on page 293* for instructions.
3	Put the inlet of the tubing into the water reservoir.
4	Put the outlet of the tubing into the collection container.
5	

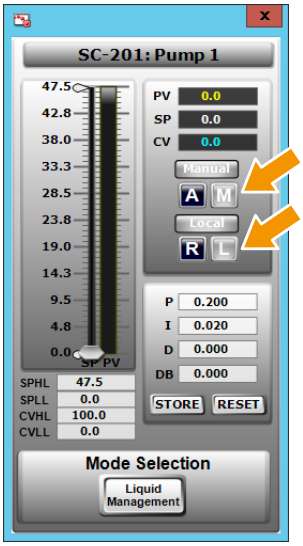
Step	Action

a. Click the relevant pump panel on the ***Reactor Display*** overview screen.



Result:
The pump PID faceplate opens.

b. In the pump PID faceplate, click ***M*** and ***L*** to set the pump in ***Manual***/ ***Local*** mode.



c. Run the pump until the tubing is filled with water.

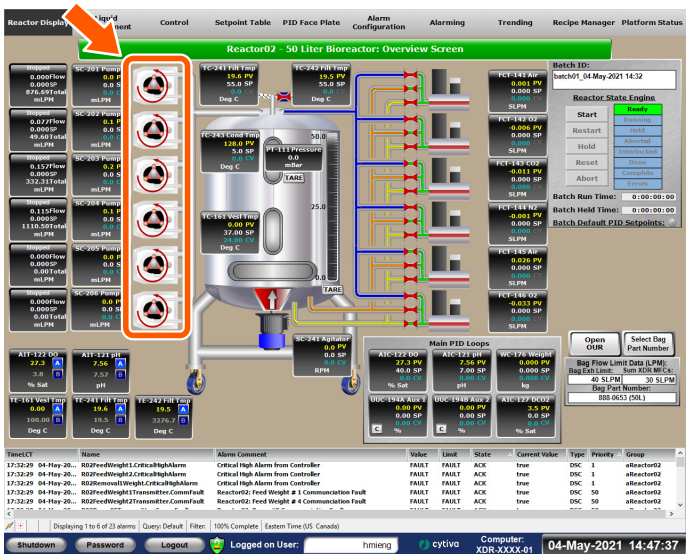
Step	Action
6	Discard the priming water.

Calibration

To start the pump calibration follow the instructions below.

Note: *Pump calibration is performed in rpm per volume of transferred liquid. When the pump is run in calibration mode, pump speed is displayed in rpm on the PID faceplate.*

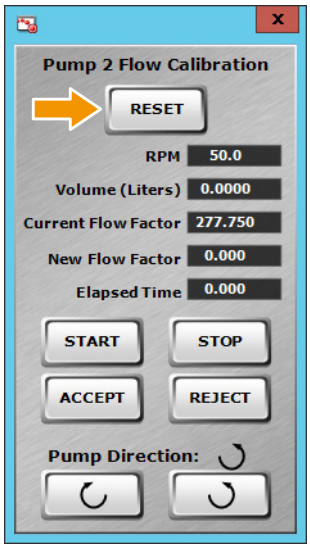
Step	Action
1	Empty and tare the collection container, if needed.
2	Click the relevant pump icon on the ***Reactor Display*** screen.



Result:

The ***Pump Flow Calibration*** dialog box opens.

Step	Action
3	Click ***Reset***.



Result:

The volume and the elapsed time values are set to zero.

4 Click ***Start***.

Result:

The pump starts to operate. The ***Elapsed Time*** counter starts. The volume shown in pump totalizer panel increases.

5 Run the pump for at least 5 minutes.

Tip:

The longer the pump runs, the more accurate the calibration.

6 Click ***Stop*** in the ***Pump Flow Calibration*** dialog box.

7 Measure the volume of the collected liquid.

8 Type the volume of the collected liquid into the ***Volume (Liters)*** text box.

Result:

A new flow factor is calculated and shown in the ***New Flow Factor*** text box.

9 Click ***Accept***.

Step	Action
	Result: The new flow factor is shown in the ***Current Flow Factor*** text box and is used for the pump flow.

7 Operation

About this chapter

This chapter gives instructions on how to operate XDR-50 to 2000 Bioreactor Systems in a safe way.

In this chapter

Section		See page
7.1	Safety precautions	305
7.2	Start the system and software	307
7.3	Configure control loops	319
7.4	Manage the disposable bag contents	346
7.5	Control the batch	389
7.6	Work with alarms	411
7.7	Configure trends	420
7.8	Complete a run	425

7.1 Safety precautions



WARNING

Hazardous substances. When using hazardous chemical and biological agents, take all suitable protective measures, such as wearing protective clothing, glasses, and gloves resistant to the substances used. Follow local and national regulations for safe operation and maintenance of the system.



WARNING

Slipping hazard. Remove any spillage on the floor immediately to minimize the risk for slipping accidents.



WARNING

Fire and explosion hazard. Follow the instructions below to avoid a fire or explosion when using oxygen:

- Monitor oxygen flow rates displayed on the user interface.
- Check for leaks, poor connections, or damages to the equipment prior to use.
- Use proper ventilation when operating the bioreactor using oxygen.
- Do not expel oxygen into an enclosed space.



WARNING

Gas leakage hazard. Make sure that the gas connections are tight in order to avoid gas leakage.



CAUTION

Quality of gases. The gases supplied to the system should be clean, filtered, and pharmaceutical quality. Failure to use pharmaceutical quality filtered gases could result in malfunction of flow control valves and gas supply solenoids.



CAUTION

Safe operation of software. To safely operate the bioreactor, knowledge of how to use system operating software is required.



CAUTION

Tuning PID control loops. Make sure that personnel tuning PID control loops are qualified to perform this task. Incorrectly tuned PID loops could cause injury to personnel and damage the instrument.



CAUTION

Changing split range setup. Only qualified personnel should change the split range percentage. Incorrectly set up split range could cause injury to personnel and damage the instrument.

7.2 Start the system and software

Introduction

This section gives information about how to start XDR-50 to 2000 Bioreactor Systems and how to log on to the software.

In this section

Section		See page
7.2.1	Start the system	308
7.2.2	Log on / log off	312
7.2.3	Set process mode (50 L and 200 L bioreactor)	316

7.2.1 Start the system

Start the instrument

Follow the instructions below to start the bioreactor.

Step	Action
1	Turn the system power switch (**MAIN DISCONNECT** , main disconnect) on the I/O Cabinet to **ON I** position.





Step	Action
2	Open the hatch on the bottom front panel to access the UPS on the X-Station.



WARNING

Hazardous voltage. The built-in UPS in the X-Station contains hazardous voltage when instrument power is switched off. Use caution when working around the UPS.

Step	Action
3	Press the power button on the front of the UPS to switch it on.



Result:

The computer starts.

4 Log on to Windows.

Result:
Windows software loads. ***Wait Before Start*** screen is displayed until all Windows services complete the start procedure.

5 Wait until the ***Wait Before Start*** screen closes.

NOTICE

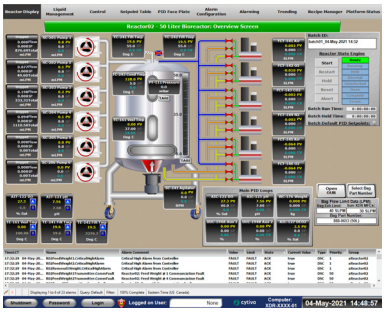
Do not start ***WindowViewer*** before the ***Wait Before Start screen*** closes. The Historian application for data recording must initiate correctly.

Result:

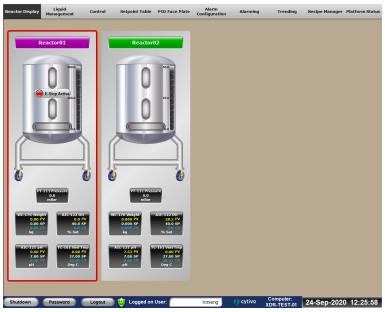
The ***WindowViewer*** application loads automatically. The ***Reactor Display*** screen (for single-vessel systems) or ***Multivessel Overview*** screen (for multi-vessel systems) opens.

Step	Action

Reactor Display screen



Multivessel Overview screen



Note:
After rebooting the computer, an error message may be shown stating that the licenses are not activated. The ***WindowViewer*** *application does not start. Click* ***RETRY*** *to start the application.*

6 When the ***Reactor Display*** screen is visible, press the **ENABLE** button that is located on the front of the I/O Cabinet, near to the **EMERGENCY STOP** button.



Result:

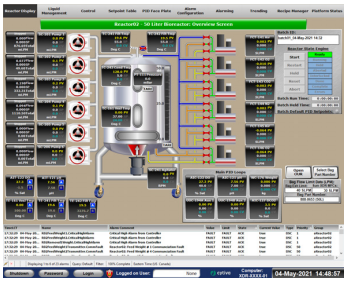
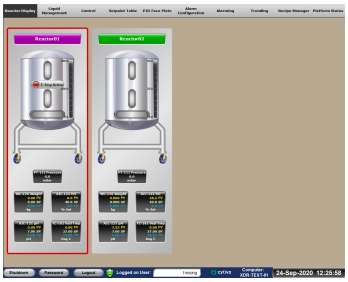
The control of the bioreactor is enabled.

7.2.2 Log on / log off

Log on to system

Follow the instructions below to log on to the InTouch HMI WindowViewer software.

Note: *The **WindowViewer** application starts automatically when the system is started. After rebooting the computer, an error message may be shown stating that the licenses are not activated, and the application does not start. Click **RETRY** to start **WindowViewer**.*

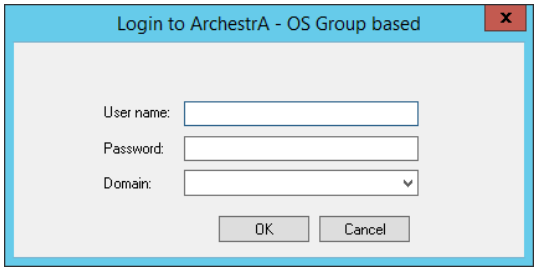
Step	Action
1	Open WindowViewer: • click the ***WindowViewer*** icon  on the desktop or on the taskbar or • select ***Start*** →***WindowViewer***. *Result:* The ***Reactor Display*** screen (for single-vessel systems) or ***Multivessel Overview*** screen (for multi-vessel systems) opens. ***Note:*** *The illustration below is an example. The details on the **Reactor Display** screen depend on your system configuration.* ***Reactor Display*** screen  ***Multivessel Overview*** screen 
2	If your system is configured for multiple bioreactors, click the applicable bioreactor image on the ***Multivessel Overview*** screen. *Result:* The ***Reactor Display*** screen for the selected bioreactor opens.

Step	Action
3	Click ***Login*** on the footer toolbar.



Result:

The ***Login to ArchestrA*** dialog box opens.

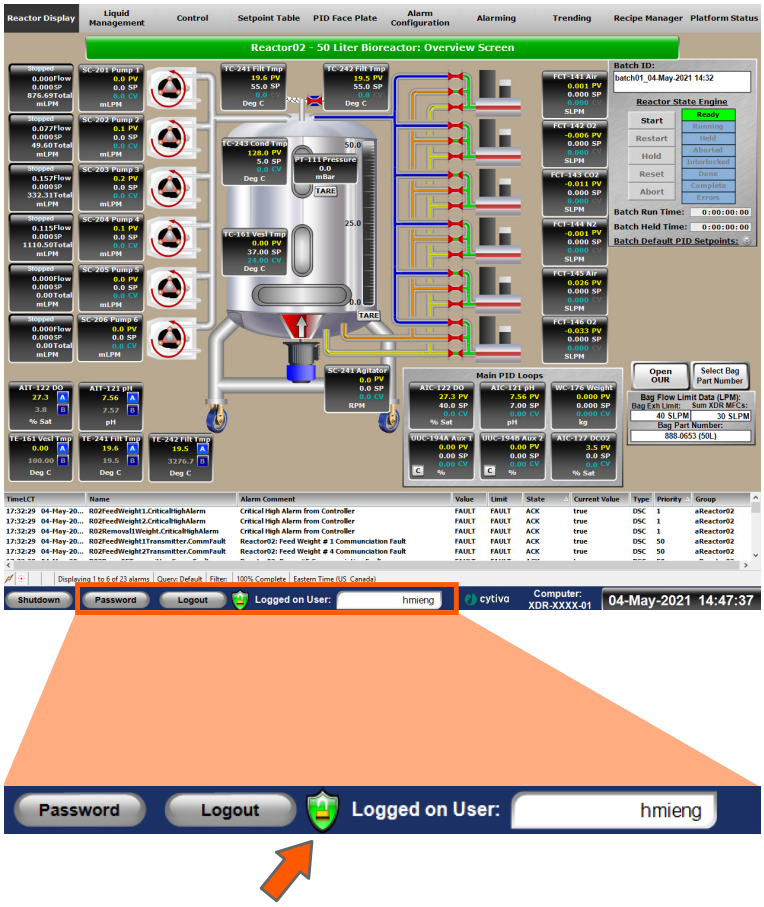


4	Type the user name in the ***User Name*** text box.
5	Type your password in the ***Password*** text box.
6	Leave the ***Domain*** text box blank.
7	Click ***OK***.

Step	Action

Result:

The ***Login*** button text changes to ***Logout***. The user name is shown in the text box on the screen footer and the security symbol turns green.



Log off

Click ***Logout*** on the screen footer to log off the InTouch HMI WindowViewer application.

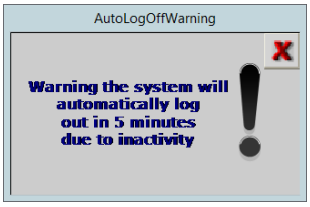
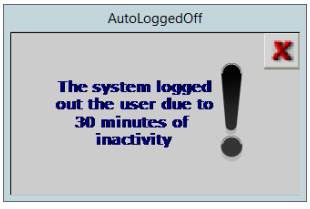


Result:

The user is logged off. The last active screen stays open. The security symbol turns red and the user name is shown as ***None***.

Auto log off

The system logs off the user after a period of inactivity.

Condition	Result
The user is inactive for more than 25 minutes.	An ***AutoLogOffWarning*** message is shown on the screen. 
The user is inactive for more than 30 minutes.	The user is automatically logged off. An ***AutoLoggedOff*** message is shown on the screen. The security symbol on the screen footer turns red and the user name is shown as ***None***. 

7.2.3 Set process mode (50 L and 200 L bioreactor)

Select process mode

If your 50 L or 200 L XDR bioreactor is a dual purpose system and can be used alternatively for cell culture or microbial fermentation, it can be run in two different modes. The process mode (cell culture mode, ***CC***, or microbial fermentation mode, ***MO***) must be selected before a process run is started.

Follow the instructions below to set the process mode.

Step	Action
1	If your system is configured for multiple bioreactors, select the applicable bioreactor as instructed in step 2 or step 3 below.
2	Click ***Reactor Display*** on the header toolbar.



Result:
The ***Multivessel Overview*** screen opens.

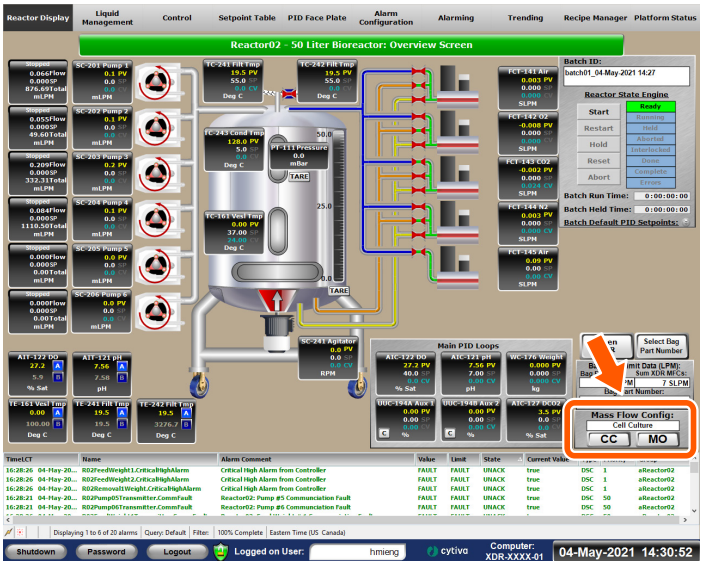
3	Click the applicable bioreactor image.



Result:

The ***Reactor Display*** screen opens.

Step	Action
4	Unmap all control loop configurations by following the steps described in *Section 7.3.3 Unmap control loops, on page 335*. ***Note:*** *Failing to perform this step can cause problems while reconfiguring the control loop for the new process mode that is selected in the following step below.*
5	On the ***Mass Flow Config*** panel, click the applicable button to select the process mode: • ***CC*** to select cell culture mode • ***MO*** to select fermentation mode



Step	Action
6	Confirm by clicking ***YES*** in the pop-up dialog box.



Step	Action
7	Close the dialog box by clicking the close button  .

7.3 Configure control loops

Introduction

This section gives instructions on how to map and unmap control loops for XDR-50 to 2000 Bioreactor Systems, and how to change the mapping.

For general information about planning the process control see *Appendix B.3 User interface: control functions, on page 595*.

For details of control mapping limits valid for specific PID control loops see *Control mapping limits, on page 597*.

Illustrations

The images in this chapter are for illustrative purposes only. Your screen layout may differ from the configuration shown in the illustrations.

In this section

Section		See page
7.3.1	Map a control loop using lookup tables	320
7.3.2	Map a control loop using split range	328
7.3.3	Unmap control loops	335
7.3.4	Change control loop mapping	344

7.3.1 Map a control loop using lookup tables

Introduction

The DO control loop is a typical primary control loop that is mapped using lookup tables. In the following example this loop is controlled by two lookup tables:

- Air MFC
- Oxygen MFC

See *Lookup table description, on page 604* for more mapping information.

Map the control loop to lookup tables

Follow the instructions below to connect the DO PID control loop to lookup tables.

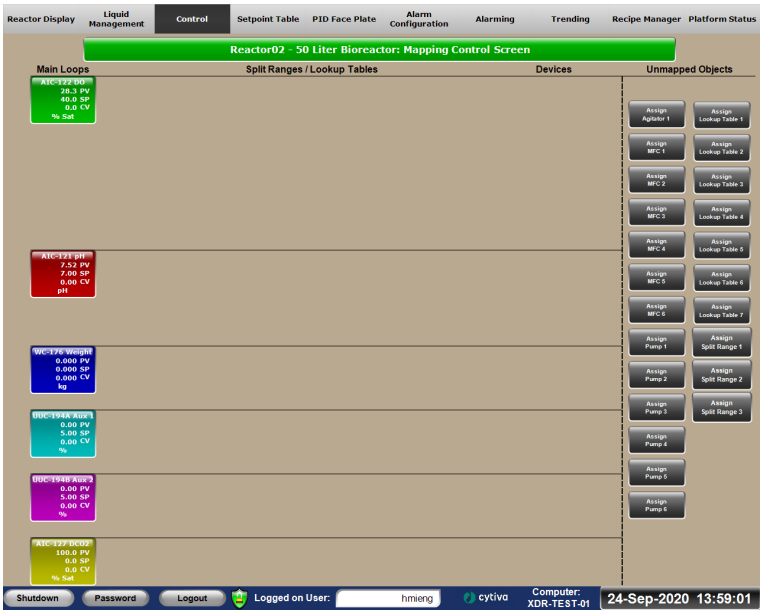
Step	Action
1	Click ***Control*** on the header toolbar.



Step	Action

Result:

The ***Control*** screen is shown. The illustration below shows an unmapped ***Control*** screen.

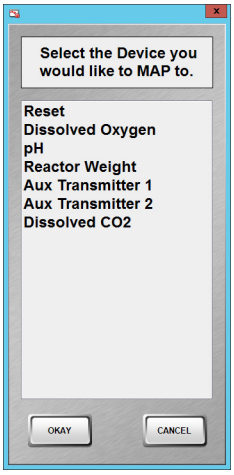


Step	Action
2	Click ***Assign Lookup Table 1***.



Result:

A dialog box opens, showing the available mapping options.

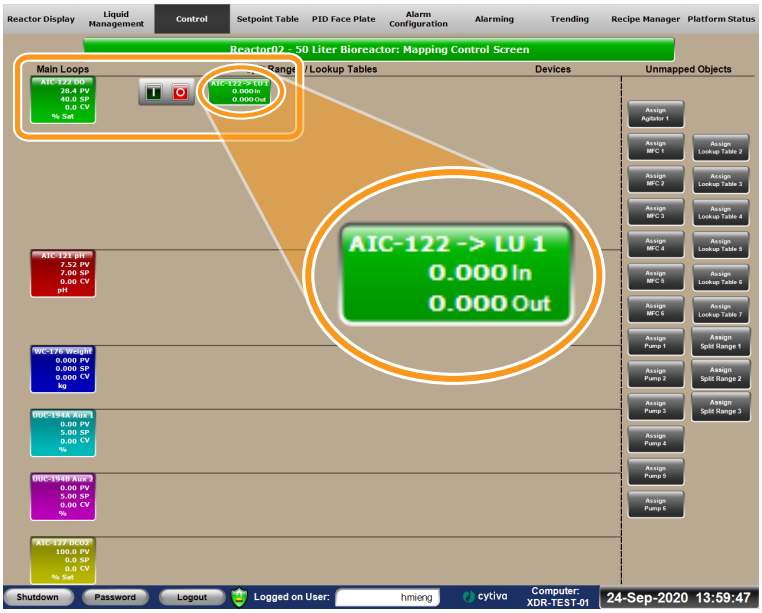


3	Select an applicable option, for the DO control loop select ***Dissolved Oxygen***. Click ***OKAY***.

Step	Action

Result:

The dialog box closes, the ***Assign Lookup Table 1*** panel turns green and moves to the middle of the screen, lining up with the DO control loop panel.



4 Click the dark green **I** button , and then click ***YES***.

Result:

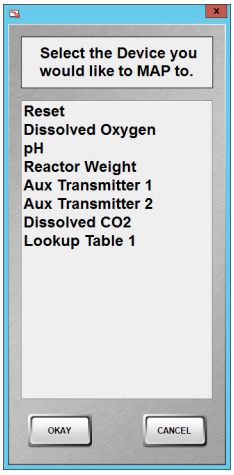
The button turns bright green, showing that lookup table 1 is active.

Step	Action
5	Click ***Assign MFC 1*** (air MFC).



Result:

A dialog box opens, showing the available device options.



6	Select ***Lookup Table 1*** and click ***OKAY***.

Step	Action

Result:

The dialog box closes, the ***Assign MFC1*** panel turns green and moves toward the center of the screen, lining up with the DO control loop panel and the lookup table 1 panel.



7 Click the dark green **I** button , and then click ***YES***.

Result:

The button turns bright green, showing that the air MFC (MFC1) is mapped to ***Lookup Table 1***.

8 To map the PID control loop to the second lookup table, repeat steps 2 to 7 above with the following options:

- In step 2, select ***Assign Lookup Table 2***.
- In step 3, select ***Dissolved Oxygen***.
- In step 5, click ***Assign MFC2*** (oxygen MFC).
- In step 6, select ***Lookup Table 2***.

Configure the lookup tables

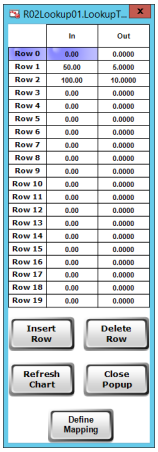
When both lookup tables have been mapped to the PID control loop, follow the instructions below to configure the lookup tables.

Step	Action
1	Click the ***Lookup Table 1*** panel.



Result:

Lookup Table 1 opens.



2	Type the applicable DO control parameters for air MFC (***FCT-141 →Air***) in ***Lookup Table 1***.
3	When all parameters have been defined, click ***Close Popup***.

Step	Action
4	To define the DO control parameters for oxygen MFC (***FCT-142*** →***Oxygen***) into ***Lookup Table 2***, click the ***Lookup Table 2*** panel and repeat steps 2 to 3 above.

Description of the mapped DO control loop

After completing the two mapping cycles and configuring the two lookup tables, the primary control loop (the DO control loop) is connected to two secondary control loops (***FCT-141*** and ***FCT-142***, that is, air MFC and oxygen MFC). The functionalities of the secondary control loops ***FCT-141*** and ***FCT-142*** are controlled by the CV of the DO PID control loop in a non-linear manner, according to the values defined in the lookup tables. The ***FCT-141*** and ***FCT-142*** PID faceplates show that the control loops are in ***Cascade*** mode.

The following illustration shows the ***Control*** screen with completed DO mapping using lookup tables.



Note: *It is recommended to use agitator as the primary device for DO control.*

7.3.2 Map a control loop using split range

Introduction

The pH control loop is a typical primary control loop that is mapped using split range. The following mapping example describes the mapping procedure.

The pH can be controlled by pumps or by an MFC:

- CO_2 MFC, or acid pump for the low pH range control,
- Base pump for the high pH range control.

See *Split range description, on page 602* for more mapping information.

Map the control loop using split range

Follow the instructions below to map a PID control loop to a split range.

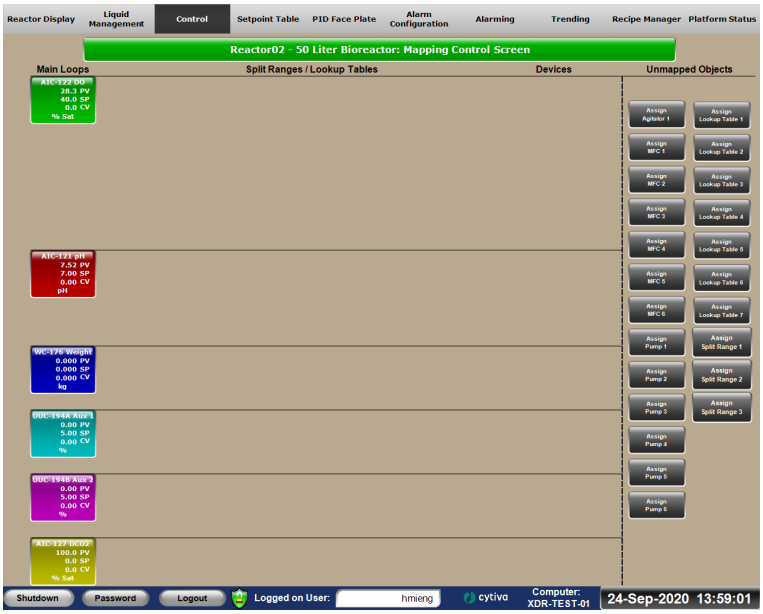
Step	Action
1	Click ***Control*** on the header toolbar.



Step	Action

Result:

The ***Control*** screen is shown. The illustration below shows an unmapped ***Control*** screen.

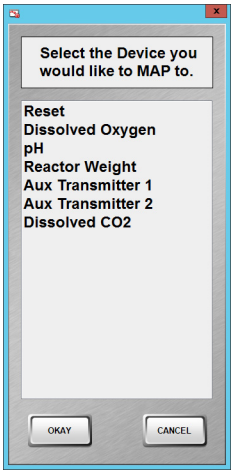


Step	Action
2	Click ***Assign Split Range 1***.



Result:

A dialog box opens, showing the available mapping options.

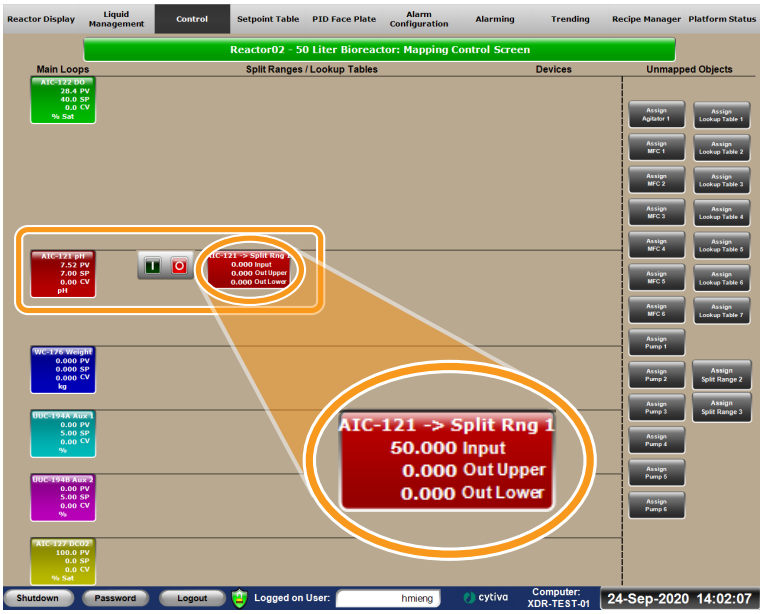


3	Select an applicable option, for pH control loop select ***pH***. Click ***OKAY***.

Step	Action

Result:

The dialog box closes. The ***Assign Split Range 1*** panel turns red and moves toward the center of the screen, lining up with the pH PID control loop panel.



4 Click the dark green **I** button , and then click ***YES***.

Result:

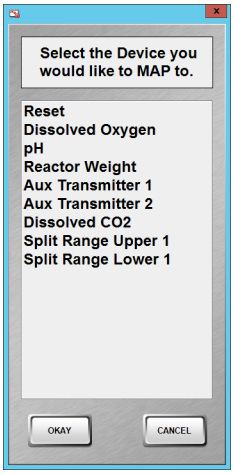
The button turns bright green, showing that ***Split Range 1*** is active.

Step	Action
5	Click ***Assign Pump 1*** (base pump, ***SC-201***).



Result:

A dialog box opens, showing the available device options.

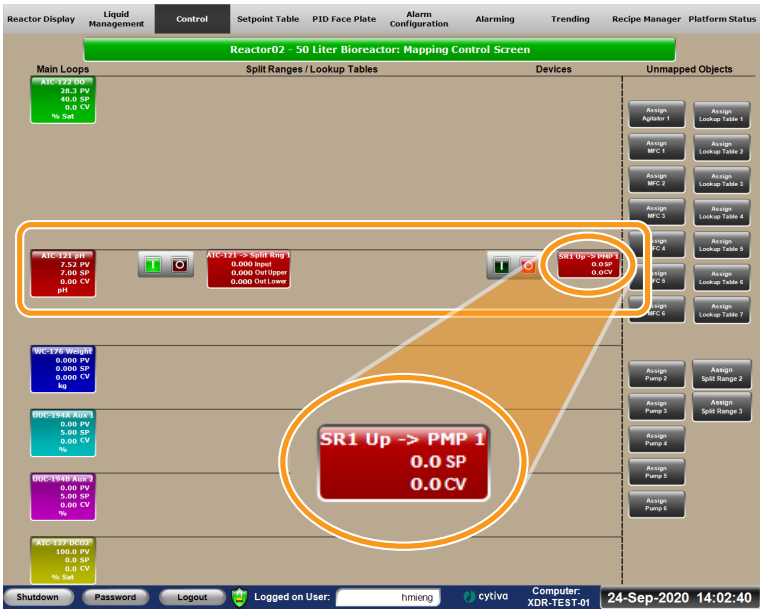


6	Select ***Split Range Upper 1*** and click ***OKAY***.

Step	Action

Result:

The dialog box closes. The ***Assign Pump 1*** panel turns red and moves toward the center of the screen, lining up with the ***pH PID Overview*** and the ***Split Range 1*** panels.



7 Click the dark green **I** button , and then click ***YES***.

Result:

The button turns bright green, showing that pump 1 (base pump, ***SC-201***) is mapped to ***Split Range Upper 1***.

8 To map the second device to the split range, repeat steps 5 to 7 above with the following options:

To map CO_2 MFC (*FCT-143*):	To map acid pump (pump 2, *SC-202*):
In step 5, click ***Assign MFC 3***.	In step 5, click ***Assign Pump 2***.
In step 6, select ***Split Range Lower 1***.	In step 6, select ***Split Range Lower 1***.

Description of the completed split range mapping

After completing the mapping of split range low and high ranges, the primary control loop (the pH control loop) is connected to two secondary control loops (base pump and acid pump, or base pump and CO_2 MFC). The functionality of the pumps (or the MFC) is controlled by the CV of the pH PID control loop in such way that only one device can run at any time. This setup avoids the conflict of raising and lowering the pH simultaneously.

The secondary PID control loop faceplates show that the control loops are in ***Cascade*** mode.

The following illustration shows the ***Control*** screen with completed pH mapping using split range.



7.3.3 Unmap control loops

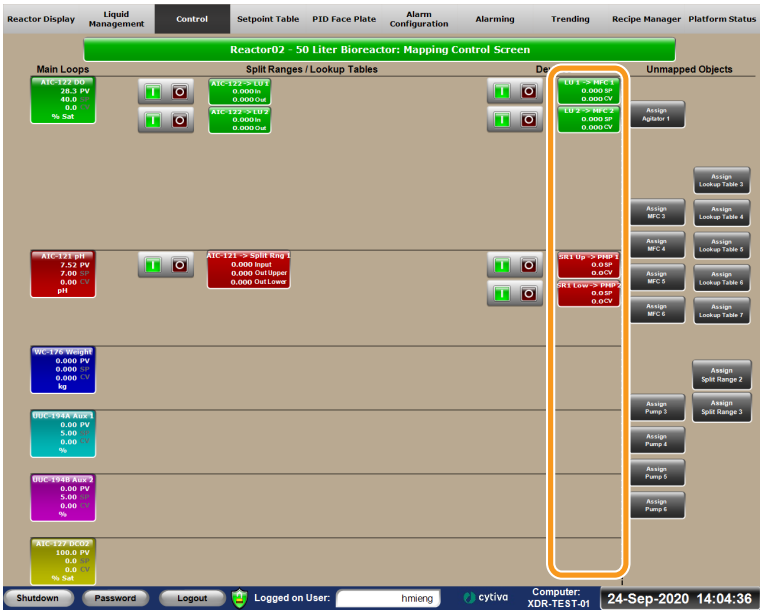
Unmap a device

Follow the instructions below to unmap a device.

Step	Action
1	Click ***Control*** on the header toolbar.



2	On the ***Control*** screen, find the panel for the device you want to unmap. The location of the available device panels is shown in the illustration below.



3	Click the dark red ***O*** button at the left of the panel.

Step	Action

Result:

A dialog box opens.



4 Click ***YES***.

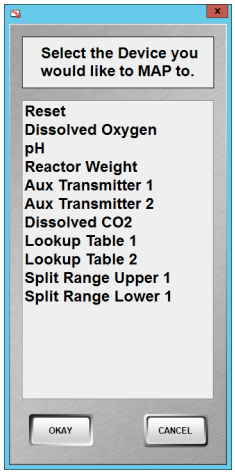
Result:

The bright green ***I*** button turns dark green , showing that the device is not active.

5 Click the device panel.

Result:

A mapping dialog box opens with the available device options.



6 Select ***Reset***, and then click ***OKAY***.

Step	Action
	Result: The dialog box closes. The panel turns gray and moves to the right side of the screen, lining up with all available device assignment buttons.



Repeat steps 1 to 6 above to unmap each device.

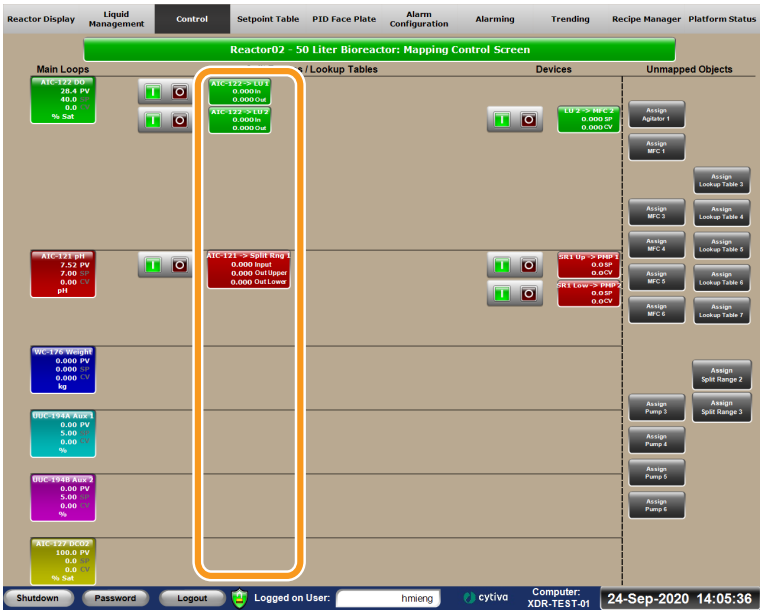
Unmap a lookup table

Follow the instructions below to unmap a lookup table.

Step	Action
1	Click ***Control*** on the header toolbar.



Step	Action
2	On the ***Control*** screen, find the lookup table panel you want to unmap. An example of the location of the available lookup table panels is shown in the illustration below.



3	Click the dark red ***O*** button ◘ at the left of the panel. *Result:* A dialog box opens.

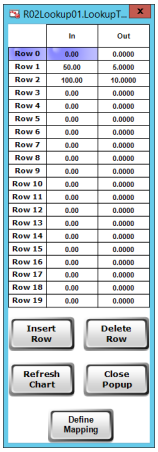


4	Click ***YES***. *Result:* The bright green ***I*** button turns dark green ▮, showing that the lookup table is not active.
5	Click the lookup table panel.

Step	Action

Result:

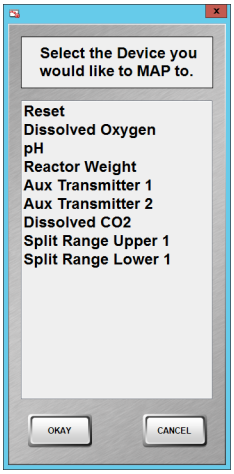
A lookup table opens.



6 Click ***Define Mapping***.

Result:

A mapping dialog box opens with the available device options.



7 Select ***Reset*** in the dialog box, and then click ***OKAY***.

8 Click the close button to close the dialog box.

Step	Action
	Result: The dialog box closes. The lookup table panel turns gray and moves to the right side of the screen, lining up with all available intermediate control element buttons.



Repeat steps 1 to 8 above to unmap each lookup table.

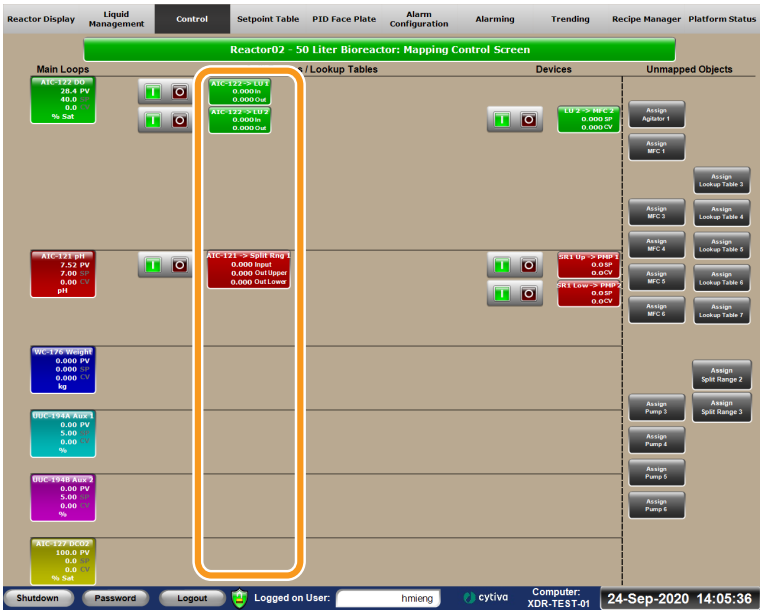
Unmap a split range

Follow the instructions below to unmap a split range.

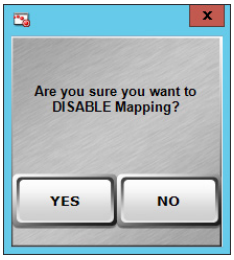
Step	Action
1	Click ***Control*** on the header toolbar.



Step	Action
2	On the ***Control*** screen, find the split range panel you want to unmap. An example of the panel location is shown in the illustration below.



3	Click the dark red ***O*** button at the left of the panel. *Result:* A dialog box opens.

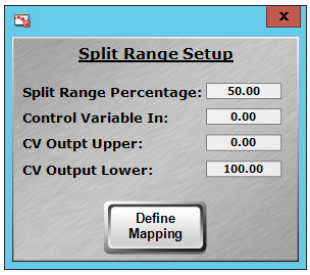


4	Click ***YES***. *Result:* The bright green ***I*** button turns dark green , showing that the split range is not active.
5	Click the split range panel.

Step	Action

Result:

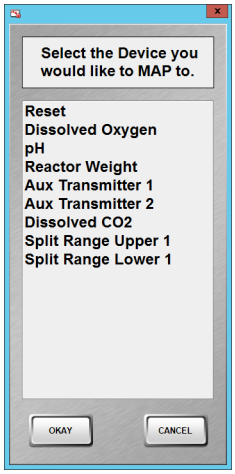
The ***Split Range Setup*** dialog box opens.



6 Click ***Define Mapping***.

Result:

A mapping dialog box opens with the available device options.



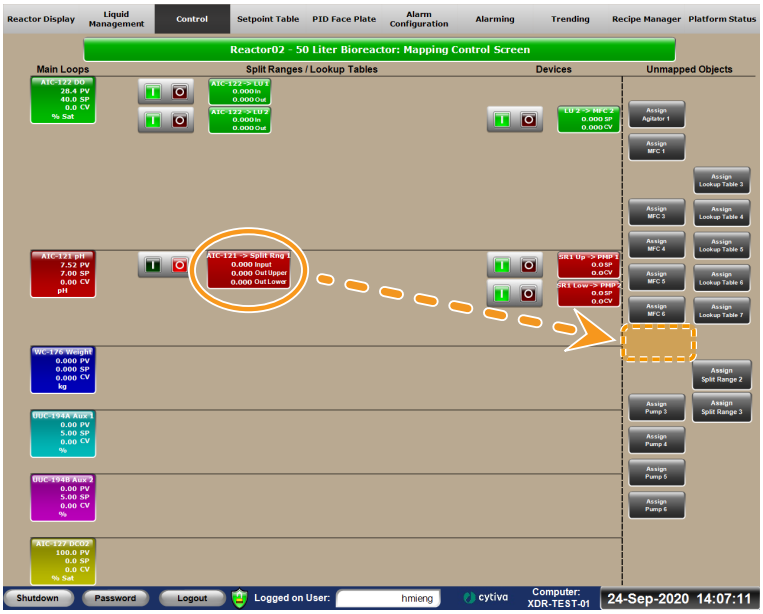
7 Select ***Reset*** in the dialog box, and then click ***OKAY***.

8 Click the close button to close the dialog box.

Step	Action

Result:

The dialog box closes. The split range panel turns gray and moves to the right side of the screen, lining up with all available intermediate control element buttons.



7.3.4 Change control loop mapping

Change PID control loop mapping

To change the mapping of a PID control loop follow the instructions below.

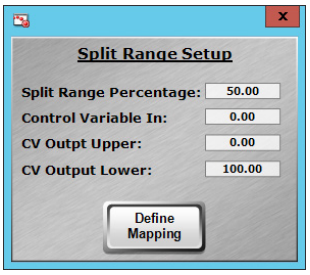
Step	Action
1	Unmap a lookup table or a split range. See *Unmap a lookup table, on page 337* or *Unmap a split range, on page 340* for instructions.
2	Repeat for a second lookup table or a second split range if applicable.
3	Map the applicable lookup table or split range to the PID control loop. See *Section 7.3.1 Map a control loop using lookup tables, on page 320* or *Section 7.3.2 Map a control loop using split range, on page 328* for instructions.

Change split range functions

The functions of a mapped split range can be changed. Follow the instructions below to change split range functions.

Step	Action
1	On the ***Control*** screen, click a split range panel.



Step	Action
	Result: The ***Split Range Setup*** dialog box opens. 
2	Type the applicable values in the text box.
3	Click the close button to close the dialog box.

Set an output device to work in reverse

An output device (for example, a pump) can be set to work in reverse; for example, to increase the process variable (PV) value when the control variable (CV) value decreases.

Follow the instructions below to set the pump to work in reverse.

Step	Action
1	Unmap the ***Split Range Upper 1*** and ***Split Range Lower 2*** pumps. See *Unmap a split range, on page 340* for instructions.
2	Follow steps 5 to 7 in *Section 7.3.2 Map a control loop using split range, on page 328*, make the following choices: • In step 5, click ***Assign Pump 1*** (base pump, ***SC-201***). • In step 6, select ***Split Range Upper 1***.
3	Repeat steps 5 to 7 making the following choices: • In step 5, click ***Assign Pump 2*** (acid pump, ***SC-202***). • In step 6, select ***Split Range Lower 1***. *Result:* The PID control loop is acting in reverse.

7.4 Manage the disposable bag contents

Introduction

This section provides information about how to fill the disposable bag with culture media and how to control liquid and gas flow.

In this section

Section		See page
7.4.1	Manage pump flow	347
7.4.2	Manage gas flow	354
7.4.3	Fill the disposable bag	359
7.4.4	Use the agitator	365
7.4.5	Probe selection and temperature control	372
7.4.6	Take a sample	375
7.4.7	Standardize pH probe	378
7.4.8	Calibrate the DO probe with O_2	379
7.4.9	Measure oxygen uptake rate (optional)	383

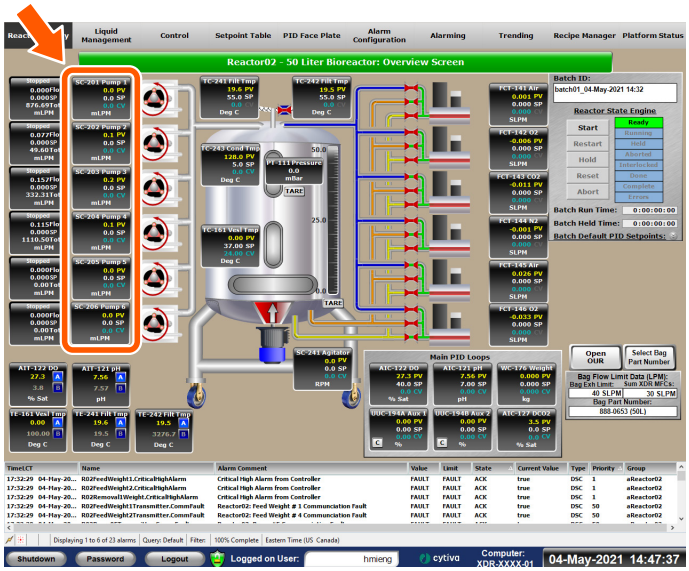
7.4.1 Manage pump flow

Start the pump

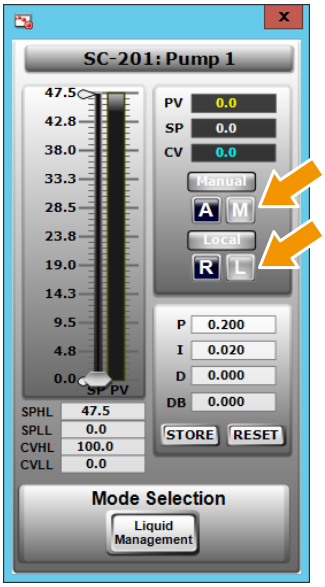
> **WARNING**
>
> **Clamps on pump tubing.** Make sure that the tubing between the pump and the bag assembly is not blocked or clamped.

To start the pump without pH control follow the instructions below.

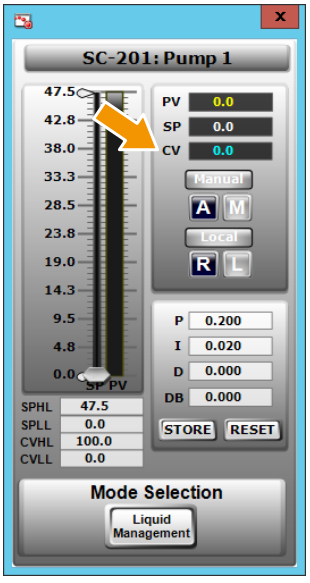
Step	Action
1	Verify that all clamps are open on the tubing that connects the disposable bag with the liquid reservoir.
2	Verify that the clamps on the exhaust gas tubing are open, to avoid over-pressure.
3	Click the applicable pump panel on the ***Reactor Display*** screen to open the pump PID faceplate.



Step	Action
4	On the pump PID faceplate, click ***M*** and ***L*** to set the pump in ***Manual***/***Local*** mode.



5	Type the applicable pump speed value into the ***CV*** text box on the pump PID faceplate.

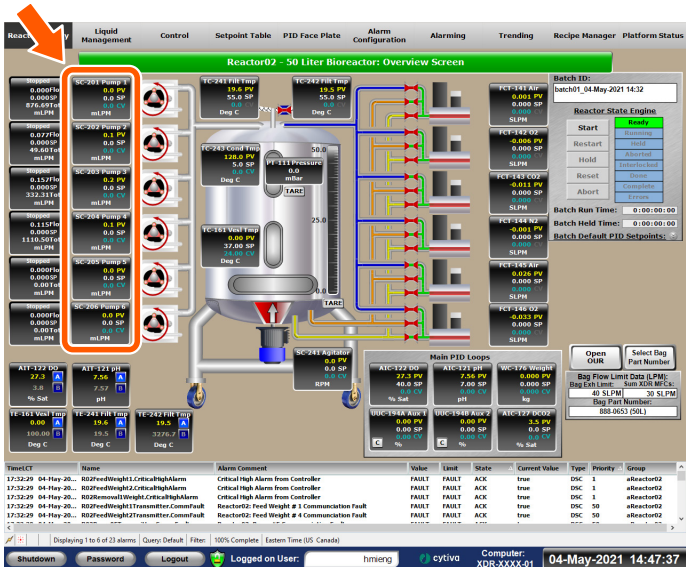


Step	Action
	Result: The pump starts.

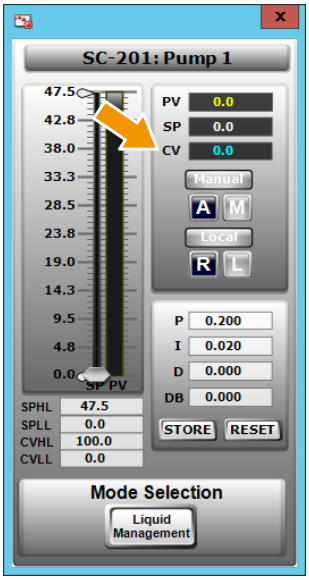
Stop the pump

Follow the instructions below to stop the pump.

Step	Action
1	Click the applicable pump panel on the ***Reactor Display*** screen to open the pump PID faceplate.



Step	Action
2	On the pump PID faceplate, type 0 into the ***CV*** text box.



Result:

The pump stops.

Change pump flow direction

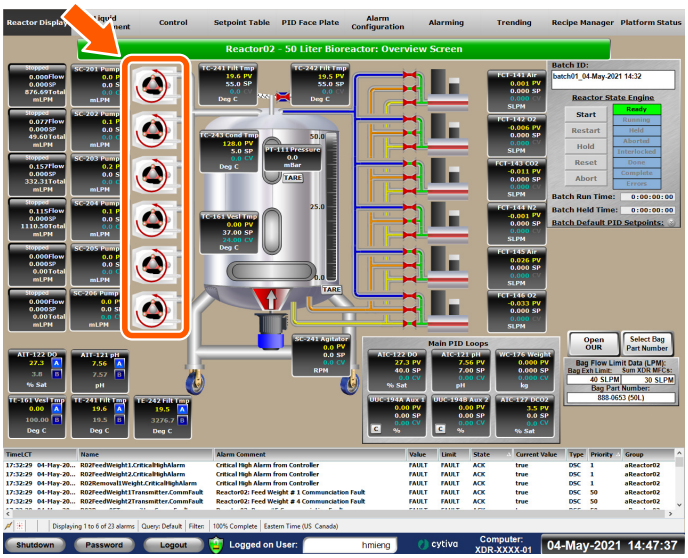
NOTICE

Do not change pump flow direction when the pump totalizer is running.

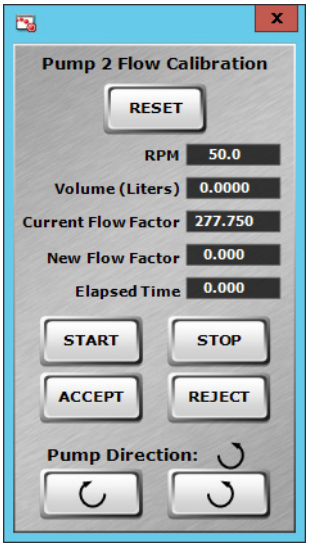
The same pump can be used to fill the XDR vessel and to harvest the contents. Change the pump flow direction if you want to switch from filling the XDR vessel to draining the vessel.

Follow the instructions below to change the pump flow direction.

Step	Action
1	Click the applicable pump icon on the ***Reactor Display*** screen to open the ***Pump Flow Calibration*** dialog box.



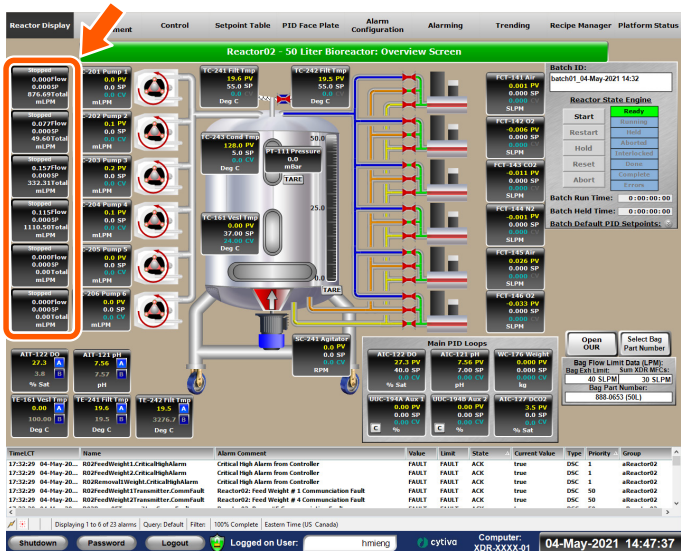
Step	Action
2	At the bottom of the dialog box, click the button showing the designated flow direction.



Step	Action
	Result: The flow direction changes. The pump icon on the ***Reactor Display*** screen shows the current flow direction. 

Measure the liquid flow

Follow the instructions below to measure the pump flow volume.

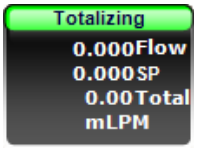
Step	Action
1	Click the applicable pump totalizer panel on the ***Reactor Display*** screen to open the pump ***Pump Totalizer*** dialog box. 

Step	Action
2	Click ***RESET***, then click ***START*** to start the pump totalizer.



3	*Result:* The measurement of the pumped volume starts. The gray ***START*** button changes to green ***RUNNING*** button. The red ***OFF*** button changes to gray ***STOP*** button. The recorded volume is continuously updated in the text box ***Milliliters***. On the ***Reactor Display*** screen, the pump totalizer panel shows a green ***Totalizing*** header.





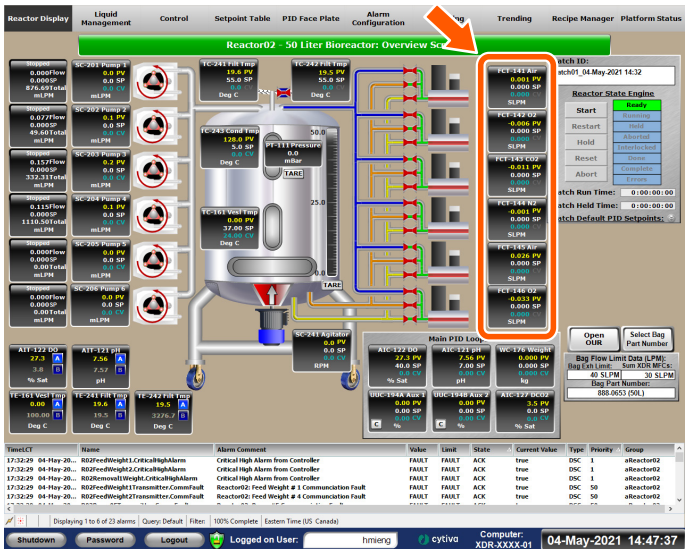
4	Click ***STOP*** to stop the pump totalizer when the process is completed.
5	Click ***RESET*** to reset the pump totalizer.

7.4.2 Manage gas flow

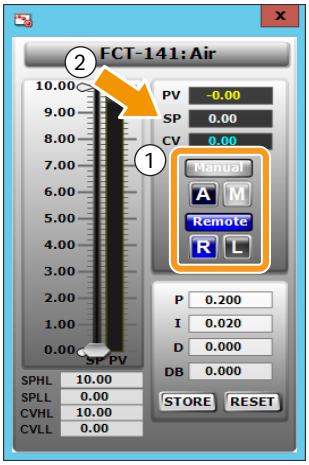
Start the gas flow

Follow the instructions below to start the gas flow and define the volume that passes through the mass flow controller.

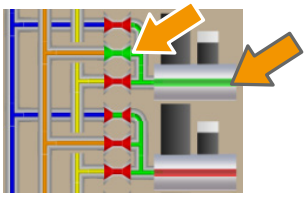
Step	Action
1	Click the relevant MFC control loop panel on the ***Reactor Display*** screen to open the MFC PID faceplate.



Step	Action
2	On the MFC PID faceplate, type the appropriate setpoint value into the ***SP*** text box (2).



3	Click ***A*** and ***L*** (1) to put the MFC into ***Auto***/***Local*** mode.
4	The solenoid valve icon and the gas flow path turn green to show active gas flow.

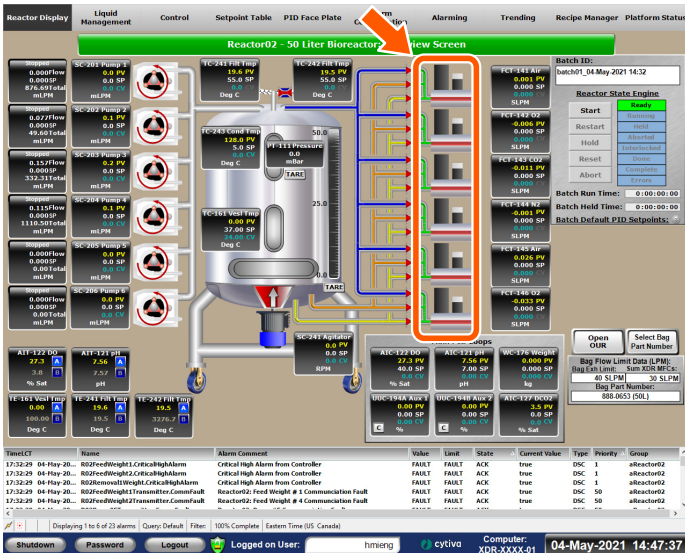


Measure the gas flow

Follow the instructions below to measure the gas volume that passes through the mass flow controller.

Note: *The MFC totalizer can be started when the MFC is running or stopped.*

Step	Action
1	Click the MFC icon on the ***Reactor Display*** screen to open the MFC ***Totalizer*** dialog box.



Step	Action
2	Click ***RESET***, and then click ***START*** to start the MFC totalizer.



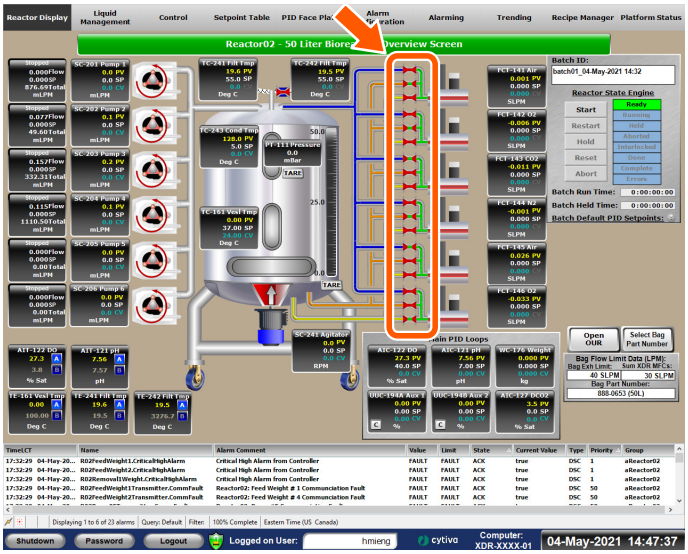
Step	Action
	Result: The measurement of the pumped gas volume starts. The gray ***START*** button is replaced by the green ***RUNNING*** button. The red ***OFF*** button is replaced by the gray ***STOP*** button. The recorded volume is continuously updated in the ***Liters*** text box. 
3	Click ***STOP*** to stop the MFC totalizer when the process is completed.
4	Click ***RESET*** to reset the MFC totalizer.

Change gas flow path

A bank of solenoid valves, or alternatively the gas manifold inside the gas supply cabinet, allows the user to change the flow path of a specific gas and redirect the gas to the intended destination.

If you want to send one gas (for example, pure oxygen) through one set of spargers and a different gas through another set, follow the instructions below.

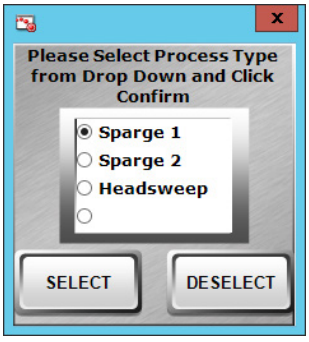
Step	Action
1	Click a relevant solenoid valve icon on the ***Reactor Display*** screen.



Result:

The dialog box for selection of gas flow path opens.

2	Click the applicable option button to open the gas flow to the designated destination (***Sparge 1***, ***Sparge 2***, or ***Headsweep***).



3	Click ***SELECT*** or ***DESELECT*** to confirm.
4	Click the close button to close the dialog box.
5	Repeat steps 1 to 4 to define the flow path for each gas.

7.4.3 Fill the disposable bag

Prepare for filling

NOTICE

Make sure that the disposable bag has been filled with air prior to filling the bag with media. Failure to first inflate the bag might result in incorrect fit and cause bag fracture during filling.

See *Fill the bag with air, on page 288* for instructions about how to fill the bag with air.

Tip: *It is recommended to use the largest available pump for filling and harvesting.*

Step	Action
1	Make sure that the leveling feet are set down and that the full weight load is removed from the casters before filling the XDR vessel.
2	Install the tubing for filling the disposable bag through the appropriate pump head on the pump cabinet front panel. See *Section 6.10.1 Install tubing, on page 293* for instructions.
3	Make sure that the pump has been calibrated using the correct tubing size. See *Section 6.10.2 Calibrate the pump, on page 299* for for instructions.
4	Weld or connect the media reservoir to the tubing.
5	Verify that all clamps are open on the tubing that connects the disposable bag with the media reservoir.
6	Verify that the XDR vessel is tared. See *Tare XDR vessel weight, on page 287* for instructions.

Fill the bag with culture media

Follow the instructions below to fill the disposable bag.

Step	Action
1	Click ***Control*** on the header toolbar.



Result:

The ***Control*** screen is displayed.

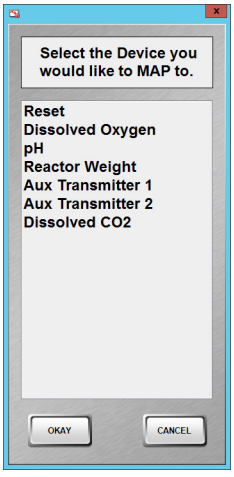
Step	Action
2	On the ***Control*** screen, click ***Assign Pump 4***.



Result:

A dialog box opens with the available device options.

3



Select ***Reactor Weight*** in the dialog box, and then click ***OKAY***.

Result:

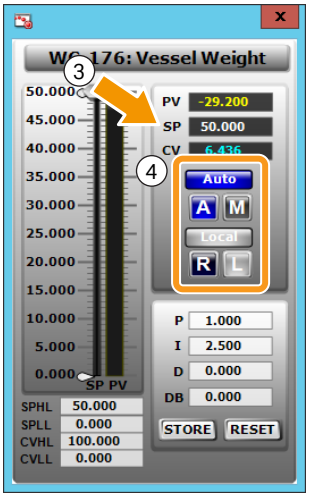
The dialog box closes, the ***Assign Pump 4*** panel turns blue and moves toward the center of the screen (1).

Step	Action



4 Click the ***Vessel Weight*** panel (2) to open the ***Vessel Weight*** PID faceplate.

5



Type the designated vessel weight value in the ***SP*** text box (3).

6 Click ***A*** and ***L*** (4) to set the vessel weight control to ***Auto/Local*** mode. Close the PID faceplate.

Step	Action
7	On the ***Control*** screen, click the dark green **I** button . Click ***OKAY*** in the confirmation dialog box.

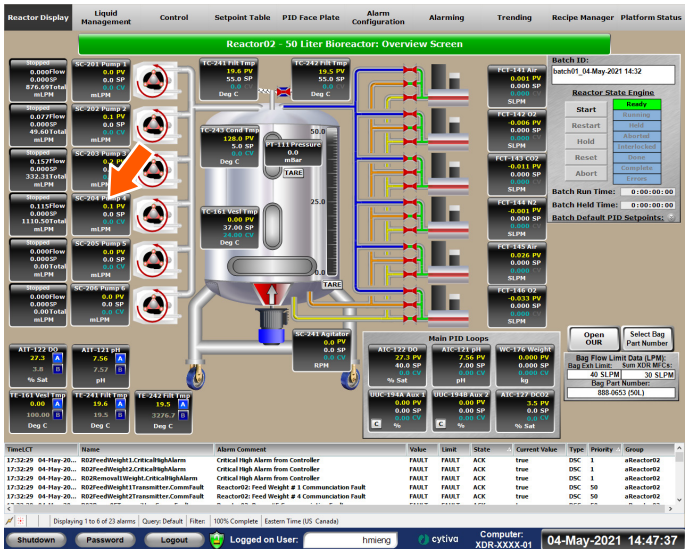


Result:

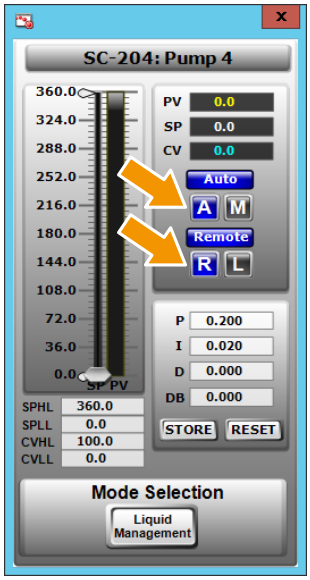
The button turns bright green, showing that the vessel weight is mapped to pump 4.

8	Click ***Reactor Display*** on the header toolbar to open the ***Reactor Display*** screen.

Step	Action
9	Click pump 4 panel to open the ***SC-204*** →***Pump 4*** PID faceplate.



10	Click ***A*** and ***R*** to set the pump to ***Auto/Remote*** mode. Close the PID faceplate.



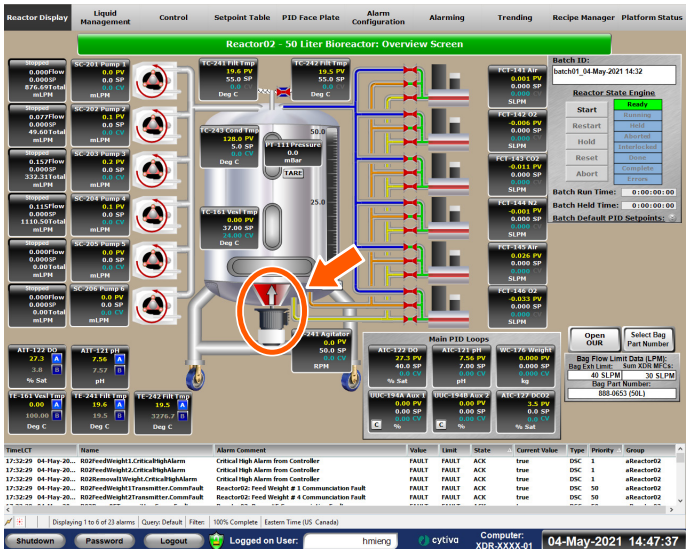
Step	Action
	Result: The pump starts to fill the disposable bag with the media. The filling continues until the XDR vessel weight reaches the defined setpoint (***SP***) value. The pump stops, when the vessel weight is equal to the setpoint.
11	When the media flow starts, open the clamps on the exhaust gas tubing to avoid overpressure.

7.4.4 Use the agitator

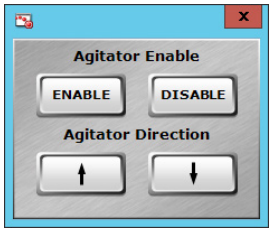
Start the agitator motor

Follow the instructions below to start and control the agitator motor.

Step	Action
1	Click the agitator icon on the ***Reactor Display*** screen to open the ***Agitator Enable*** dialog box.



2



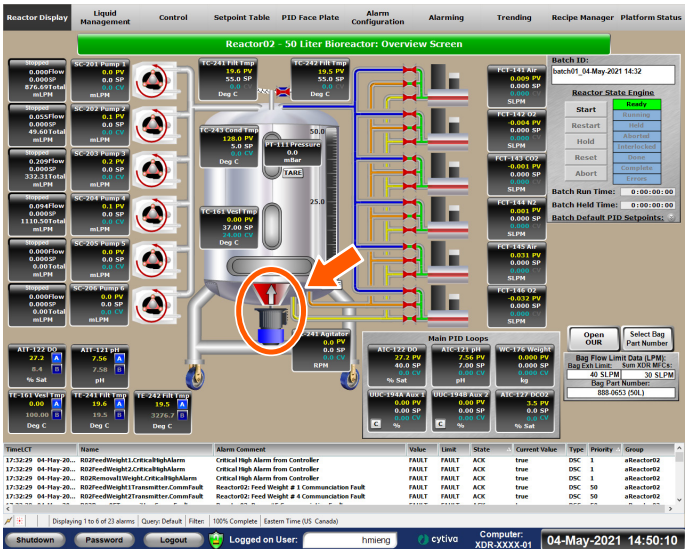
In the ***Agitator Enable*** dialog box, do the following:

- Click ***ENABLE*** to enable the agitator.
- Click the “up” arrow for pumping up or the “down” arrow for pumping down.

Step	Action

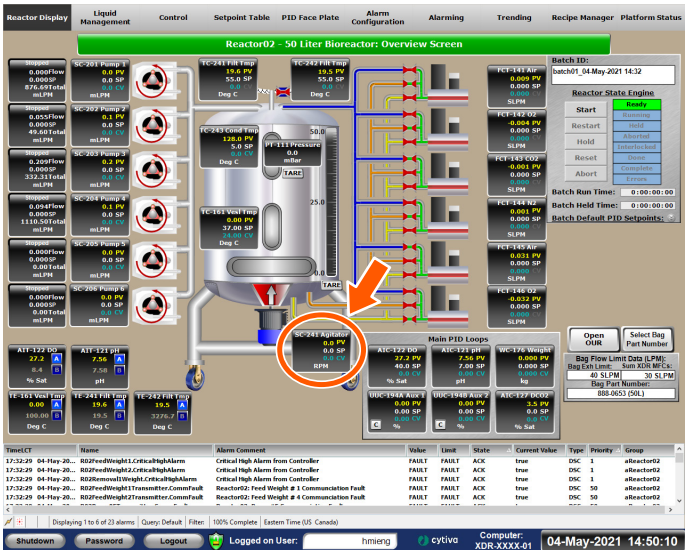
Result:

The agitator is enabled. The agitator block icon turns blue and the arrow points to the selected direction.

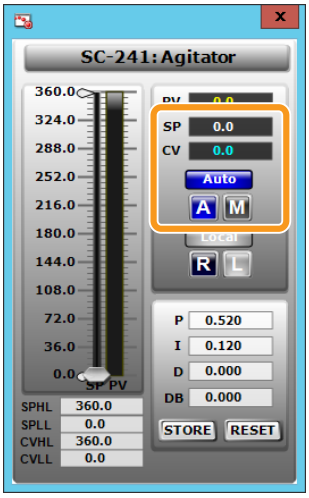


3 Click the close button to close the dialog box.

Step	Action
4	Click the agitator panel on the ***Reactor Display*** screen to open the ***Agitator*** PID faceplate.



5



- If the agitator is in ***Auto*** mode, type an applicable setpoint value into the ***SP*** text box.
- If the agitator is in ***Manual*** mode, type an applicable value into the ***CV*** text box.

Step	Action
	Result: The agitator starts to operate. The background for agitator direction arrow turns green.
6	Monitor the system to make sure that the agitation control is working as expected.

NOTICE

The agitator must not be operated in solutions with viscosity above 5 cP. Using the agitator in viscous solutions may lead to decoupling of the impeller baseplate from the magnetic drive head. The impeller assembly may shift from its stable position, damage the disposable bag and the process.

Correct impeller baseplate position

If the impeller baseplate is not correctly installed, the agitator system is not properly magnetically coupled and does not function correctly. During agitation the agitator emits a loud clicking noise and the agitator motor is detached from the impeller baseplate.

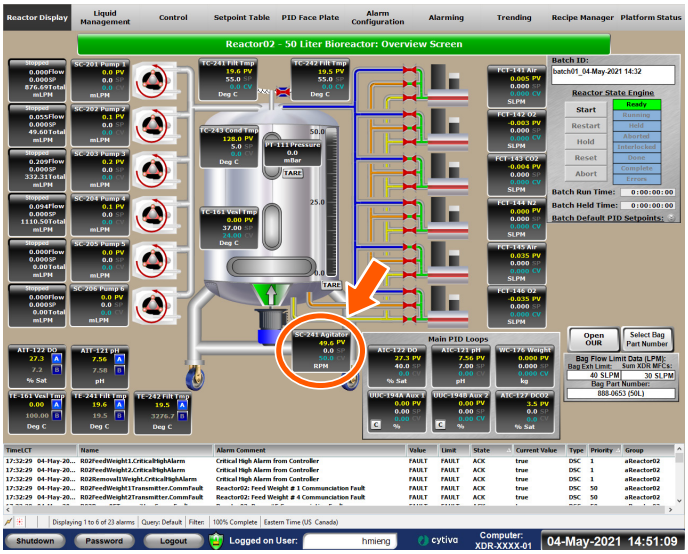
Follow the instructions below to correct the problem.

Step	Action
1	Stop the agitator motor as described in *Stop the agitator motor, on page 368*.
2	Disengage the agitator motor. See *Section 6.6 Engage and disengage the agitator motor, on page 239* for instructions.
3	Arrange the impeller baseplate correctly.
4	Engage the agitator motor.
5	Start the agitation as described in *Start the agitator motor, on page 365*.

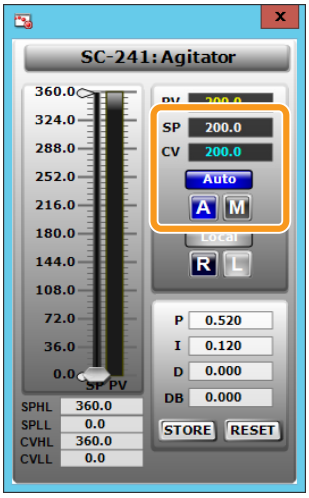
Stop the agitator motor

Follow the instructions below to stop the agitator motor.

Step	Action
1	Click the agitator panel on the ***Reactor Display*** screen to open the ***Agitator*** PID faceplate.



2

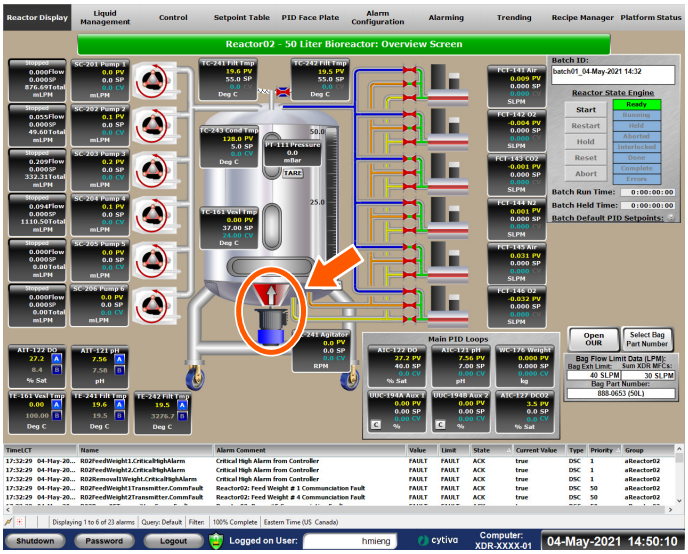


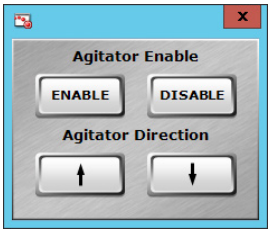
- If the agitator is in ***Auto*** mode, type 0 into the ***SP*** text box.
- If the agitator is in ***Manual*** mode, type 0 into the ***CV*** text box.

Result:

The agitator stops. The background for agitator direction arrow turns red.

Step	Action
3	Click the agitator icon on the ***Reactor Display*** screen to open the ***Agitator Enable*** dialog box.



4	

Click ***DISABLE*** to disable the agitator.

Result:

The agitator is disabled. The agitator block icon turns white.

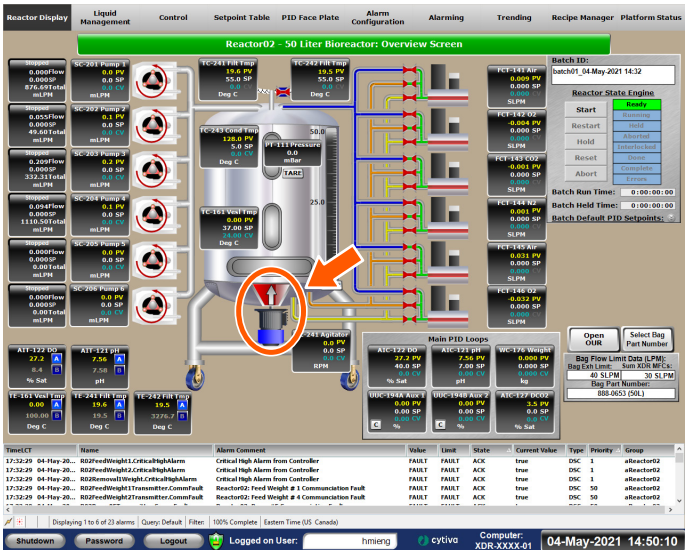
5	Click the close button to close the dialog box.

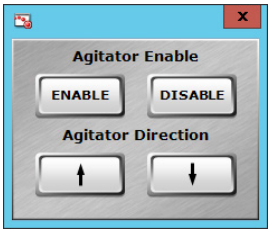
Change agitator direction

Follow the instructions below.

Step	Action
1	Stop the agitator motor as described in *Stop the agitator motor, on page 368*.

Step	Action
2	Click the agitator icon on the ***Reactor Display*** screen to open the ***Agitator Enable*** dialog box.



Step	Action
3	

Click the "up" arrow for pumping up or the "down" arrow for pumping down.

Result:

The agitation direction is set. The arrow on the agitator icon points to the selected direction.

Step	Action
4	Click the close button to close the dialog box.

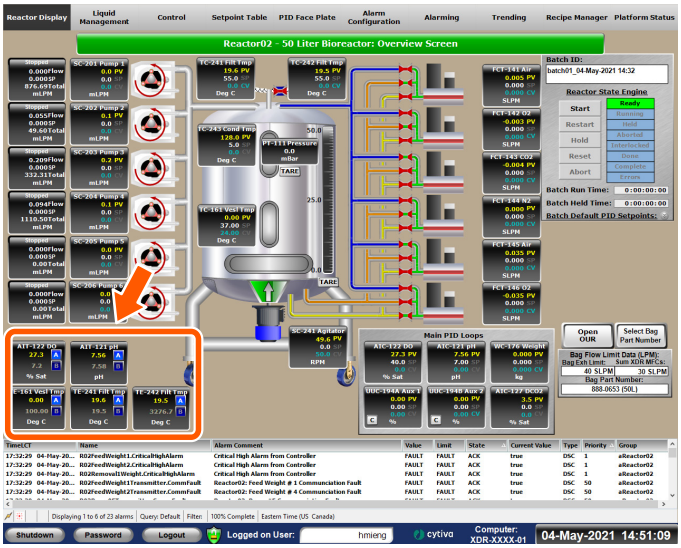
7.4.5 Probe selection and temperature control

Select probe

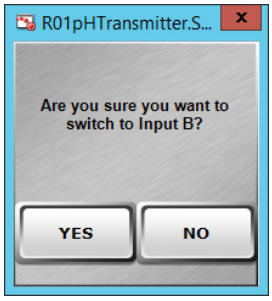
Duplicate probes can be installed for dissolved oxygen (DO), pH, exhaust filter heater temperature, or XDR vessel temperature. If duplicate probes of the same type are installed on the system, the user can switch between the alternative probes.

Follow the instructions below to select an alternative probe.

Step	Action
1	Find the applicable probe selection panel on the ***Reactor Display*** screen.



2	On the panel, click ***A*** or ***B*** to select the alternative probe.
3	Confirm by clicking ***YES***.

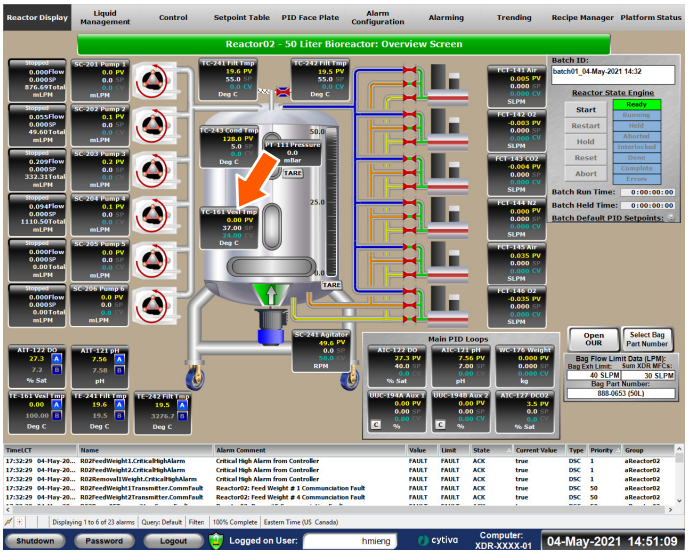


4	Close the dialog box by clicking the close button  .

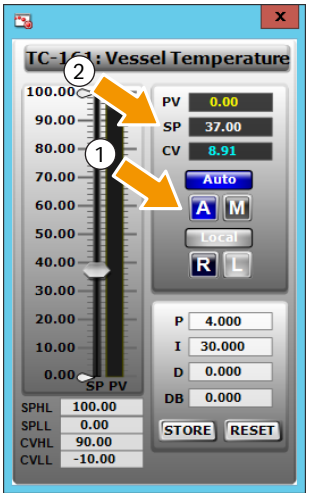
Temperature control

Follow the instructions below to set the temperature control of the XDR vessel.

Step	Action
1	On the ***Reactor Display*** screen, click the vessel temperature panel to open the ***Vessel Temperature*** faceplate.



2	Click ***A*** (1) to set the temperature in ***Auto*** mode.



3	Type the designated temperature setpoint in the ***SP*** text box (2).
4	Switch on the TCU.

Step	Action
5	Monitor the system to make sure that temperature control is working as expected.

DO control

Dissolved oxygen level can be controlled by changing the agitation speed. See *Start the agitator motor, on page 365* for instructions how to start the agitator motor and to set the agitation speed.

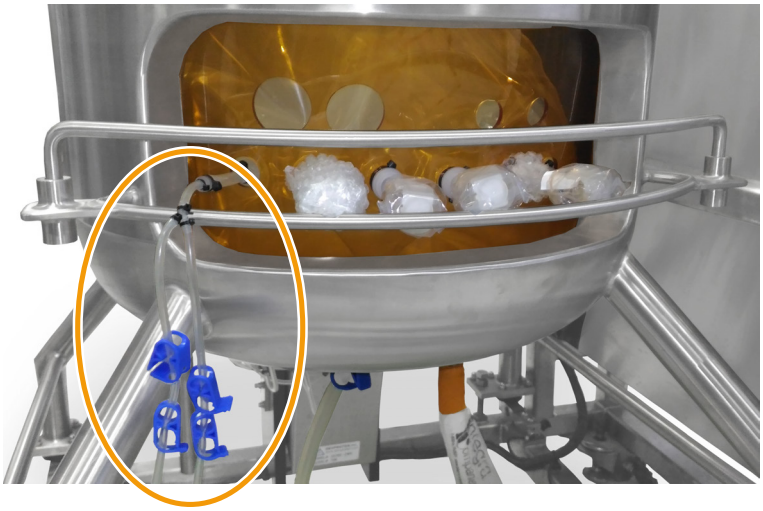
Dissolved oxygen level can also be controlled by mapping the agitator to the DO control loop. See *Section 7.3.1 Map a control loop using lookup tables, on page 320* for mapping instructions.

7.4.6 Take a sample

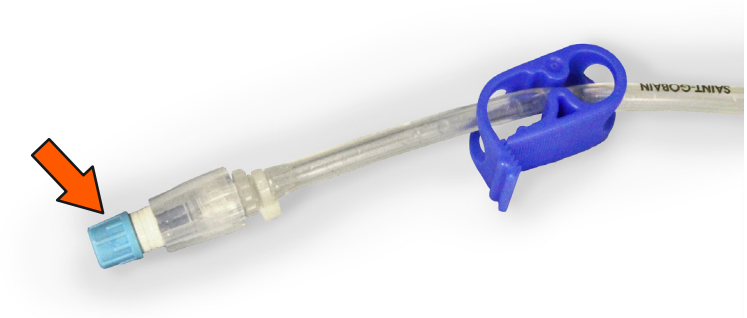
Take a sample of the disposable bag contents

Follow the instructions below to take a sample of the bag contents during the cell culture process.

Step	Action
1	Find the sample tubing in the probe window.



2	Disinfect the end of the sample tubing with 70% ethanol.
3	Remove the cap from the end of the sample tubing.



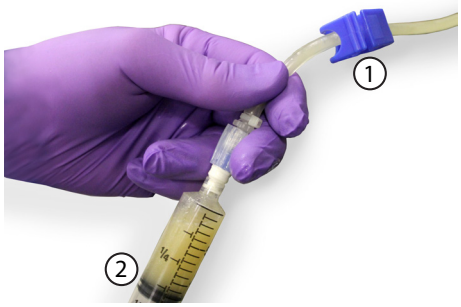
Step	Action
4	Disinfect the connector with 70% ethanol.



5	Connect an aseptic disposable syringe to the connector.



6	Open the clamp on the sample tubing (1).



7	Rinse the sample tubing by drawing approximately 5 mL of the cell culture into the syringe (2).
8	Disconnect the syringe. Discard the liquid and the syringe.
9	Disinfect the connector with 70% ethanol.

Step	Action
10	Connect a new aseptic disposable syringe to the connector.
11	Draw the necessary amount of the cell culture into the syringe.
12	Close the clamp on the sample tubing.
13	Disconnect the syringe and transfer the sample into a suitable receptacle.
14	Disinfect the connector on the sample tubing and replace the cap.

7.4.7 Standardize pH probe

Standardize the pH probe

You need to standardize the pH probe using a sample of your current cell culture. Perform this procedure when the probes have been installed in the disposable bag and the bag has been filled with the cell culture media.

See *Standardize the probe (offset at reference pH) (Rosemount model 1056), on page 177* for instructions.

7.4.8 Calibrate the DO probe with O_2

Preparation

Note: *If XDR-50 to 2000 Bioreactor Systems are used in a GMP regulated environment, the DO probe is a GMP critical component.*

Make sure that the following has been completed before DO probe calibration:

- The disposable bag has been filled with media.
- The media has equilibrated to the process temperature.
- The temperature probe has been calibrated. See *Section 8.7.4 Temperature probe calibration, on page 473* for instructions.
- The DO probe has been energized / polarized for a minimum of two hours from the time the cable was connected (polarographic sensors only). For polarization instructions, refer to the manufacturer's manual.

Perform the following calibration procedures on the DO probe, keeping the order shown below:

1. Temperature calibration.
2. Calibration at 0% saturation level.
3. Calibration at 100% saturation level.

These procedures are described later in this section.

Depending on the application, the 0% calibration for DO probe preparation (see *Section 6.3.3 Calibrate the DO probe with N2, on page 183*) may give sufficient accuracy at very low oxygen concentrations. If so, the in-bag 0% calibration with O_2 (*Calibrate the DO probe at 0 O2 saturation level, on page 380*) could be omitted.



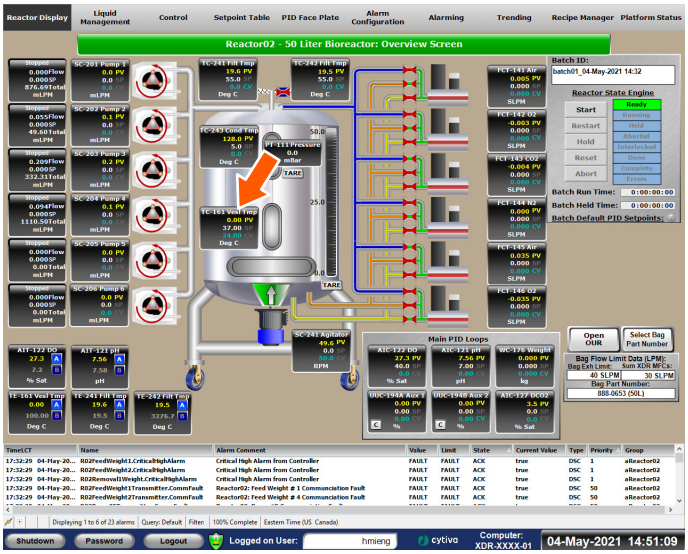
WARNING

Fire and explosion hazard. Follow the instructions below to avoid a fire or explosion when using oxygen:

- Monitor oxygen flow rates displayed on the user interface.
- Check for leaks, poor connections, or damages to the equipment prior to use.
- Use proper ventilation when operating the bioreactor using oxygen.
- Do not expel oxygen into an enclosed space.

Calibrate the DO probe temperature

Before performing the oxygen calibration, calibrate the DO probe temperature as described in the instructions below.

Step	Action
1	Verify that the agitator is running at full operational speed.
2	Do the following using pH/DO transmitter display on the I/O Cabinet: **a.** Press ***Menu***. **b.** Select ***Calibrate*** and press ***Enter***. **c.** Select ***Sensor 2*** and press ***Enter***. **d.** Select ***Temperature*** and press ***Enter***. **e.** Find out the current media temperature (PV). It is displayed on the vessel temperature panel on the ***Reactor Display*** screen.  **f.** Type the current media temperature into the text box in the DO calibration display on the I/O Cabinet. Press ***Enter***. **g.** Press ***Exit*** repeatedly to return to the home screen.

Calibrate the DO probe at 0% O_2 saturation level

Step	Action
1	Turn off gas inputs that contain oxygen.
2	Direct N_2 into the XDR vessel through the sparge tubing at a maximum flow rate.

Step	Action
3	Open the trend for the DO value (see *Section 7.7 Configure trends, on page 420*) and monitor the DO reading. Wait until the DO value stabilizes at minimum level.
4	Do the following using pH/DO transmitter display on the I/O Cabinet: **a.** Press **MENU**. **b.** Select ***Calibrate*** and press **ENTER**. **c.** Select ***Sensor 2*** and press **ENTER**. **d.** Select ***Oxygen*** and press **ENTER**. **e.** Select ***Zero Cal*** and press **ENTER**. *Result:* ***WAIT*** is displayed. **f.** Wait until ***Sensor Zero done*** is displayed. **g.** Press **EXIT** repeatedly to return to the home screen.

Calibrate the DO probe at 100% O_2 saturation level

Step	Action
1	Turn off all non-air gas inputs.
2	Direct air into the XDR vessel through the sparge tubing at the flow rate equal to 100% controlled variable (CV).
3	Open the trend for the DO value (see *Section 7.7 Configure trends, on page 420*) and monitor the DO reading. Wait until the DO value stabilizes at maximum level.
4	Do the following using pH/DO transmitter display on the I/O Cabinet: **a.** Press **MENU**. **b.** Select ***Calibrate*** and press **ENTER**. **c.** Select ***Sensor 2*** and press **ENTER**. **d.** Select ***Oxygen*** and press **ENTER**. **e.** Select ***Air Cal*** and press **ENTER**. **f.** Select ***Start Calibration***, press **ENTER**. **g.** Type the current atmospheric pressure into the text box, press **ENTER**.

Step	Action
	Result: ***WAIT*** is displayed.
	h. When the calibration is successfully completed, the screen returns to the calibration sub-menu.
	i. Press **EXIT** repeatedly to return to the home screen.

7.4.9 Measure oxygen uptake rate (optional)

Description

The oxygen uptake rate (OUR) is an objective measure of metabolic activity of the cells in a culture. The measured oxygen uptake rate can help to optimize growth affecting parameters during a cell culture process.

The OUR measurement is an optional function in the InTouch HMI WindowViewer application.

Operating principle

The OUR measurement process is described below.

Stage	Description
1	The OUR calculator schedules a request with the PLC to perform the test. ***Note:*** *If the dissolved oxygen level deviates from setpoint more than ± 2.5%, the request is denied. The system returns to normal operation.*
2	All MFCs are shut down.
3	The OUR calculator waits until the the degas time (defined by the operator) has passed. ***Note:*** *The degas time allows the gas bubbles to escape from the solution.*
4	The OUR calculator takes an initial DO measurement (***DOStart***, % saturation).
5	Measurement continues until the DO level is lower than or equal to the the minimal dissolved oxygen level (defined by the operator).
6	The OUR calculator takes a final DO measurement (***DOFinal***, % saturation).
7	The PLC calculates the amount of oxygen used by the cells during during the measurment and displays the result (mmol / (L × h)).

OUR calculation formula

The following information explains the formulas that are used by the OUR calculator.

$$\mathrm{OUR} = \frac{(\mathrm{DO_S} - \mathrm{DO_F}) \times \mathrm{P_{O_2}} \times \mathrm{H}}{\frac{\mathrm{t_f} - \mathrm{t_s}}{3600}}$$

OUR: oxygen uptake rate (mmol /(L × h))

DO_S: DO_{Start} recorded value (% converted to a fraction)

DO_F: DO_{Final} recorded value (% converted to a fraction)

P_{O_2}: standard mole fraction of O_2 in air at STP = 0.209 atm (STP: standard temperature and pressure)

H: oxygen solubility calculated according to Henry's law (mmol /(L × atm))

$(t_f - t_s)$: recorded measured time (min)

H (oxygen solubility) is calculated according to the following formula.

$$H = 1.26 - 0.23\left(\frac{T - 25}{40 - 25}\right)^{0.77}$$

T : cell culture temperature (°C)

Note: *This formula is only applicable for the temperature range 25°C to 40°C.*

Note: *If H is less than 0, then the value H = 0 is used for the OUR calculation.*

Verify before start

To be able to use the oxygen uptake rate calculator, make sure that the following conditions are met:

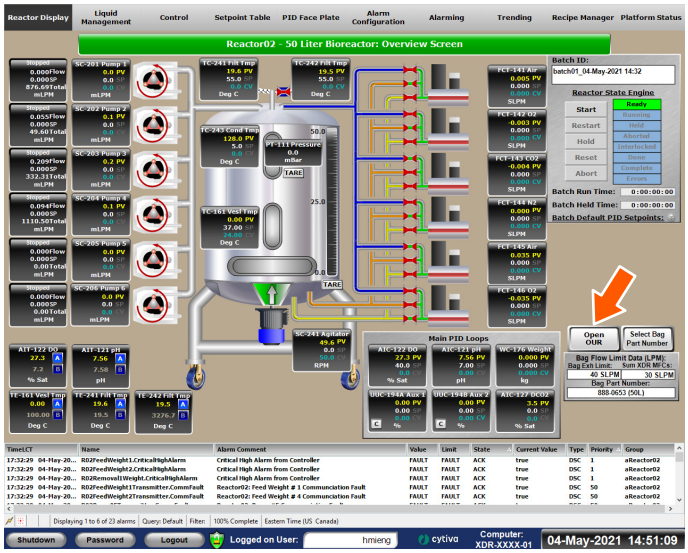
- Dissolved oxygen (DO) concentration must be within the range of ± 2.5% of setpoint.
- Minimal allowed level of dissolved oxygen (target level of dissolved oxygen) has been estimated.

  Note: ***DO minimal*** *should be high enough to avoid any damage to the cultured cells due to low level of oxygen during the measurement.*
- Agitation is switched on during the measurement to contribute to the accuracy of the result.

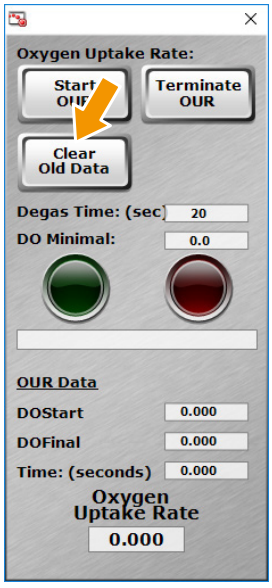
Measure oxygen uptake rate

Follow the instructions below to perform an oxygen uptake rate measurement.

Step	Action
1	On the ***Reactor Display*** screen, click ***Open OUR***.

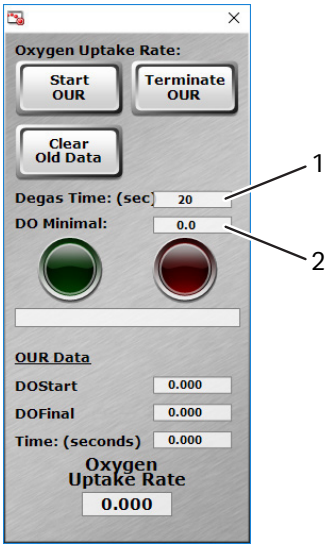


2	In the ***Oxygen Uptake Rate*** (OUR) dialog box, click ***Clear Old Data***.

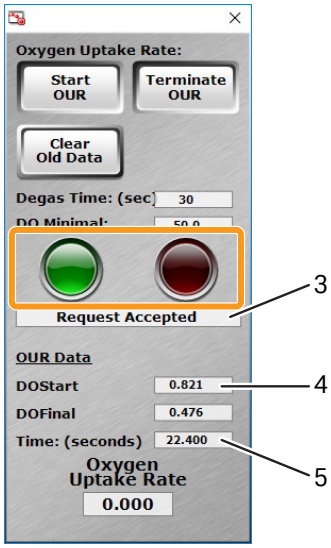


Result:

Previous measurement result is deleted.

Step	Action
3	Visually estimate the time needed for gas bubbles to disappear from the cell culture (degas time). Consider the following: • Too long estimated degas time reduces measurement accuracy, because the calculation time is shorter. • Too short estimated degas time reduces measurement accuracy, because oxygen transfer from gas phase to the culture media is still taking place.
4	Verify that the degas time is long enough to allow all gas bubbles to move from the sparger to the top of the cell culture and disappear.
5	Type the estimated degas time into the ***Degas Time: (sec)*** text box (1). 
6	Estimate the minimal theoretical allowed level of dissolved oxygen (% saturation). The allowed level of dissolved oxygen must be high enough not to cause damage to the cells.
7	Type the minimal allowed level of dissolved oxygen into the ***DO minimal*** text box (2). ***Note:*** ***DO minimal*** *is in saturation fraction units, where 0.00 is 0% and 1.00 is 100% saturation.*
8	Click ***Start OUR***.

Step	Action
	Result: If the request is accepted, the OUR measurement starts. A ***Request Accepted*** message is shown in the text box (3). The green indicator for process status is turned on. Data in the text boxes ***DOStart*** (4) and ***Time (seconds)*** (5) is updated.

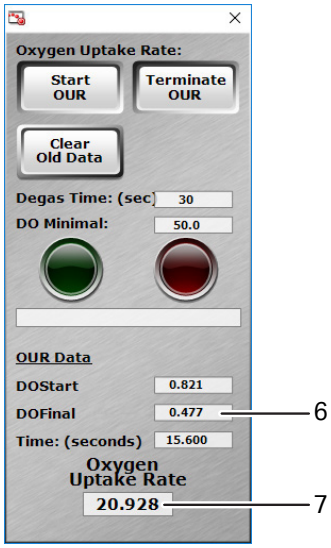


9	Click ***Terminate OUR*** if you want to stop the OUR measurement manually. *Result:* The OUR measurement is stopped. ***Request Rejected*** is shown in the text box (3).
10	Wait until the OUR measurement is finished.

Step	Action

Result:

The measurement result is shown in the ***DOFinal*** text box (6). The calculated oxygen uptake rate is shown in the ***Oxygen Uptake Rate*** text box (mmol / (L × h)) (7).



Note:

*The **Oxygen Uptake Rate** value is saved when the dialog box is closed.*

It is recommended to compare and verify the results of the OUR measurement using the methods established at your local facility.

7.5 Control the batch

Introduction

This section provides information about how to work with setpoint tables, batch control functions and recipe management.

In this section

Section		See page
7.5.1	Configure setpoint tables	390
7.5.2	Start, stop and hold a batch	406
7.5.3	Execute recipes	408

7.5.1 Configure setpoint tables

Setpoint Table description

The ***Setpoint Table*** gives the user the ability to assign different values to a control variable during a batch run. Up to twenty steps for each control loop can be programmed. The setpoint changes can be defined in two different ways:

- Keep the setpoint at a constant level for a specified time period.
- Change the setpoint from the ***Start SP*** to the ***End SP***.

When a setpoint change is configured, the user should take into account the maximal increase rate allowed by the hardware or control system for this parameter. The change should be configured within the limits of the equipment or PID control loop functionality. More information about the ranges of PID control loops can be found in the Product Documentation package (ToP).

The user can set a selected number of steps to repeat as a closed loop. When the last selected step ends, the process returns to the first selected step and repeats the defined sequence of gradient steps.

The setpoint table is designed to be used in connection with the ***Batch Manager***. If a setpoint table is enabled but not started, it is started automatically when ***Batch Manager*** is started.

See *Batch Manager display, on page 560* for description of ***Batch Manager*** display.

See *Section 7.5.2 Start, stop and hold a batch, on page 406* for more information on how to use the ***Batch Manager***.

Configure *Setpoint Table*

The user must have HMI Supervisor or HMI Engineer security access level to configure the ***Setpoint Table***.

Follow the instructions below to define the setpoint values in the ***Setpoint Table***. The agitator ***Setpoint Table*** is shown as an example.

Step	Action
1	Click ***Setpoint Table*** on the header toolbar.



Step	Action
2	On the ***Setpoint Table*** screen, locate the ***Setpoint Table*** for the applicable process parameter.



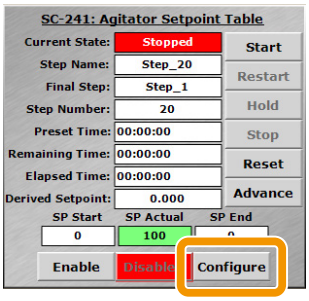
Note:

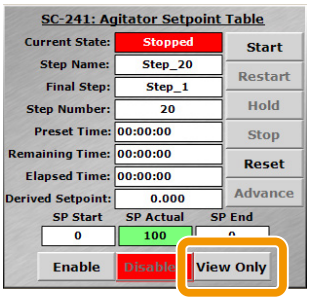
*The screen may be displayed in two or more pages. If the **Setpoint Table** for the process parameter is not shown, it may be located on the next page.*

3	Click ***Configure***.

Note:

*The button text is shown as **View Only** for the users with HMI Operator credentials. The operator can open the **Setpoint Table**, but no changes can be made.*



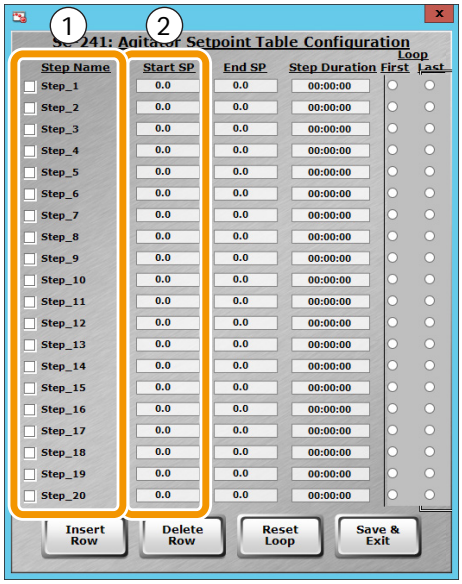


Step	Action

Result:

The ***Setpoint Table Configuration*** screen opens.

4 Select the check box in the ***Step Name*** column (1) for the step you want to configure.



Result:

The step is enabled and defines the setpoint during the process. The steps that are not selected are disabled.

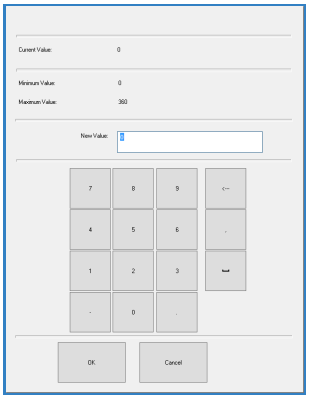
5 Define the setpoint value at the start of the step in the ***Start SP*** column:

a. Click the text box (2) to open the numeric keypad.

b. On the keypad (see below), use the keys to specify the applicable setpoint value.

Step	Action

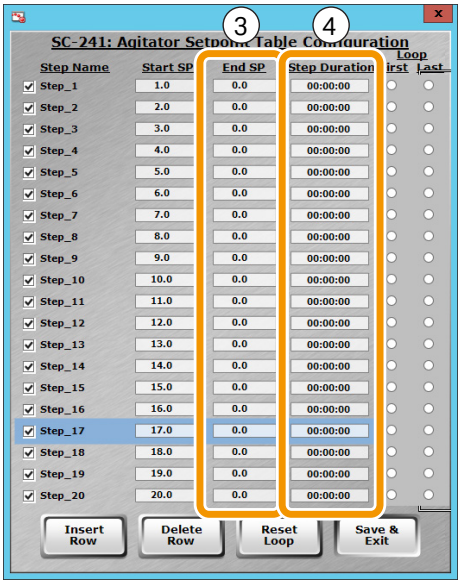
c. Click ***OK***.



Result:

The keypad closes. The specified setpoint value is shown in the ***Start SP*** column.

6 Define the setpoint value at the end of the step in the ***End SP*** column (3), as described in step 5 above.



Step	Action

Result:

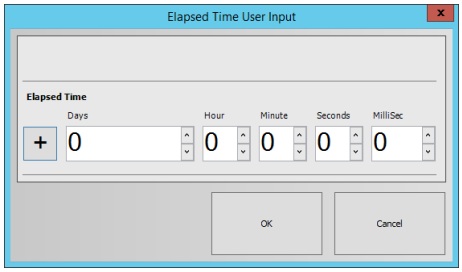
The specified setpoint value is shown in the ***End SP*** column.

7 Define the duration of the step in the ***Step Duration*** column:

a. Click the text box (4) to open the ***Elapsed Time User Input*** dialog box.

b. Specify the time parameters as applicable for your process.

c. Click ***OK***.



Result:

The dialog box closes. The specified time is shown in the ***Step Duration*** column.

8 Define all necessary setpoint value steps, as applicable for your process. Follow the instructions in steps 4 to 7.

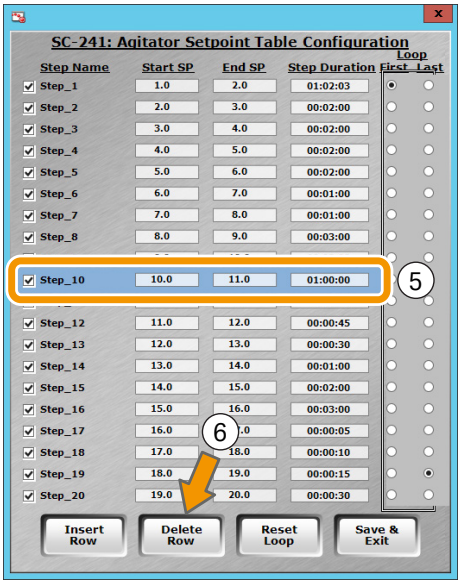
9 Delete rows if needed.

a. Click the step you want to delete.

Step	Action

Result:

The selected row is highlighted in blue (5).



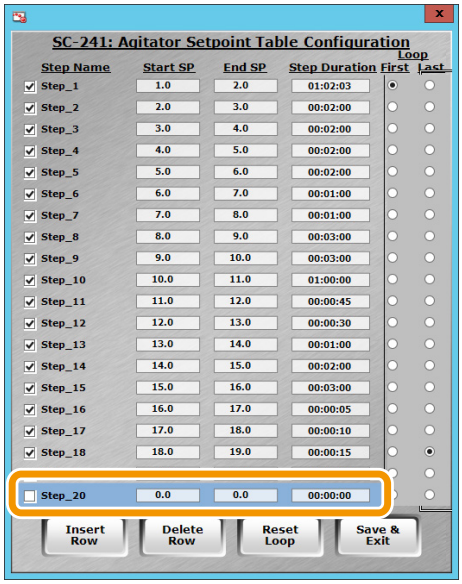
b. Click ***Delete Row*** (6) at the bottom of the ***Setpoint Table Configuration*** screen.

c. Click ***YES*** in the confirmation dialog box.

Step	Action

Result:

The highlighted row is deleted. A new step with a blank configuration is added at the bottom of the table (***Step_20***).



10 Add rows if needed. The row is inserted below the selected row.

Note:

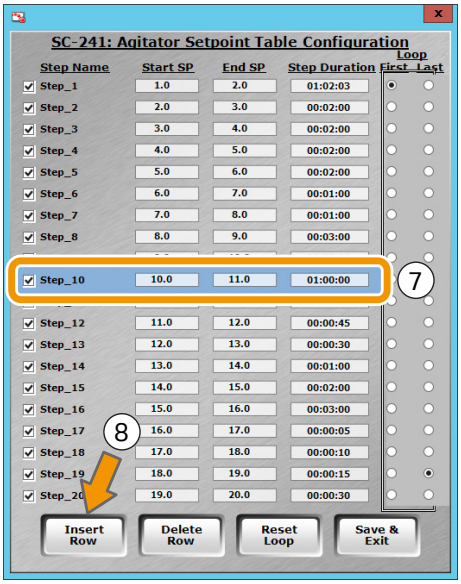
*Maximally 20 rows are allowed. When a row is added, the last row in the table (**Step_20**) is automatically deleted.*

a. Click the step where you want to add a new row.

Step	Action

Result:

The selected row is highlighted in blue (7).



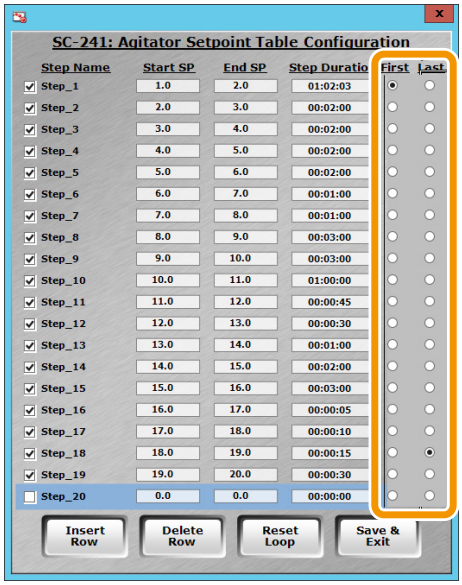
b. Click ***Insert Row*** (8) at the bottom of the ***Setpoint Table Configuration*** screen.

c. Click ***YES*** in the confirmation dialog box.

Result:

A new row is added below the highlighted row. The inserted row has the same configuration as the existing highlighted row. ***Step_20*** is deleted.

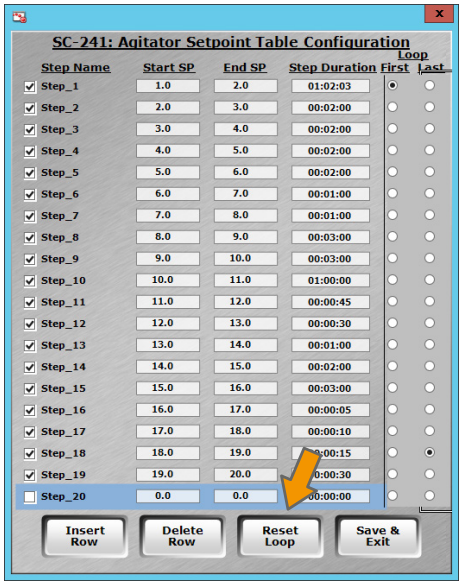
Step	Action
11	Set the steps to be repeated as a closed loop, if necessary for your process: click the applicable option buttons in the ***Loop First*** and ***Loop Last*** columns to define the first and the last step of the loop.



Result:

Loop start and end are defined. After reaching the ***Loop Last*** step, the process starts again at the ***Loop First*** step. The loop repeats continuously until it is stopped by the user.

Step	Action
12	Clear the first and last steps of the loop if needed: click ***Reset Loop*** at the bottom of the ***Setpoint Table Configuration*** screen, and then click ***YES*** in the confirmation dialog box.

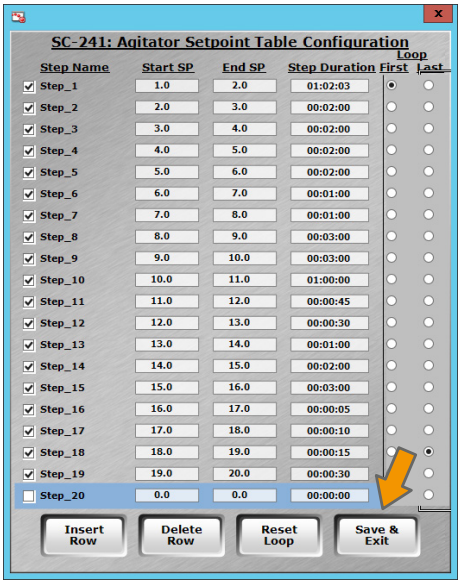


Result:

The selections in the ***Loop First*** and ***Loop Last*** columns are removed.

13	Verify that all steps are enabled or disabled as required for your process (select or deselect the check box in the ***Step Name*** column).

Step	Action
14	Click ***Save & Exit*** at the bottom of the screen, and then click ***YES*** in the confirmation dialog box.

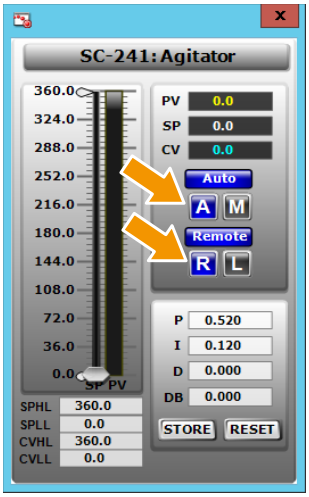


Result:

Setpoint Table Configuration screen closes. The setpoint values are saved.

15	Click ***PID Face Plate*** on the header toolbar and locate the PID faceplate for the process parameter that you configured in the steps above.

Step	Action
16	On the faceplate, click ***A*** and ***R*** to set the equipment in ***Auto/Remote*** mode.



Result:

The ***Setpoint Table*** is configured and ready to use.

Execute the *Setpoint Table*

Users with HMI Operator security access level can start and stop the ***Setpoint Table***, put the table on hold, and restart. Users with HMI Supervisor or higher access level can manually move the process forward to the next step during the run.

Follow the instructions below to start the process with the defined setpoint values. The agitator ***Setpoint Table*** is shown as an example.

Step	Action
1	Click ***Setpoint Table*** on the header toolbar.



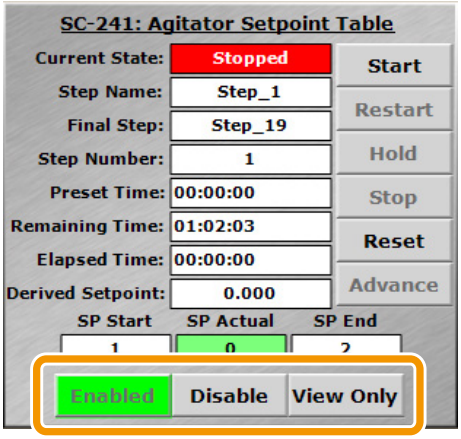
2	On the ***Setpoint Table*** screen, locate the applicable ***Setpoint Table*** for your process parameter.

Step	Action
3	Click ***Enable***.



Result:

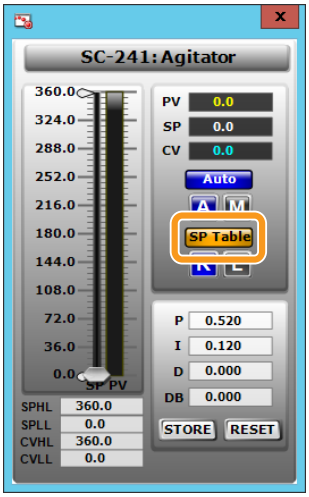
The ***Setpoint Table*** status is shown as ***Enabled***.



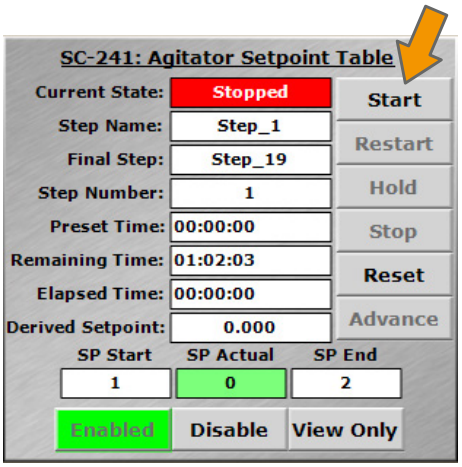
Note:
*The **View Only** button allows the operator to open and view the **Setpoint Table**, but editing is not allowed.*

4	Click ***PID Face Plate*** on the header toolbar and locate the applicable PID faceplate.

Step	Action
5	On the PID faceplate, verify that the PID control loop is in the ***SP Table*** mode.



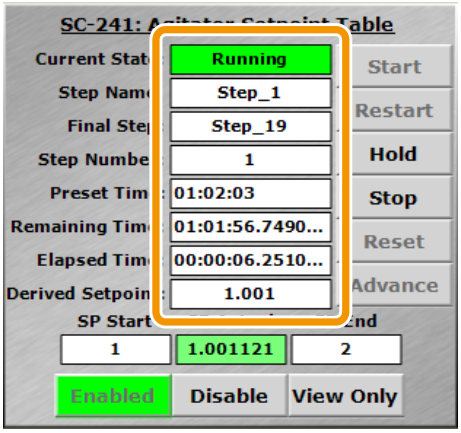
6	On the ***Setpoint Table*** screen, click ***Start*** for the applicable equipment.



Step	Action

Result:

The process starts, using the setpoint steps as configured on the ***Setpoint Table Configuration*** screen. The ***Current State*** is shown as ***Running***. The information in the text boxes is continuously updated. If steps are configured to be repeated (in a loop), the loop starts automatically.



Note:

See PID control loop setpoint table, on page 592 for explanations of the text boxes.

7 Use the ***Hold***, ***Stop***, ***Restart***, ***Reset***, and ***Advance*** buttons to change the state of the running ***Setpoint Table***. Confirm by clicking ***YES***, or discard the change by clicking ***NO***.

See *Appendix B.1.5 Setpoint Table, on page 567* for detailed explanations of the functions.

Note:
Only users with HMI Supervisor or higher access level can access the ***Advance*** *function.*

8 Click ***Disable*** if you want to release the equipment from the ***Setpoint Table*** control and set the PID control loop in the ***Remote*** mode. See *Appendix B.1.5 Setpoint Table, on page 567* for more information.

9 Click ***Enable*** if you want to give the control back to the ***Setpoint Table***.

When all configured steps are completed, the ***Setpoint Table*** state is shown as ***Complete***. Clicking ***Reset*** sets the ***Setpoint Table*** back to the start configuration.

Setpoint Table functionality

The following functions are available when the ***Setpoint Table*** is running.

Function	Description
Hold	The current step setpoint is held. The time shown in the ***Elapsed Time*** field continues to run.
Restart	The ***Setpoint Table*** functionality starts from the first defined step as configured.
Stop	The ***Setpoint Table*** functionality is paused at the current setpoint value. The time count in the ***Elapsed Time*** field stops and shows the value at the time of stopping. Clicking ***Start*** continues the ***Setpoint Table*** at the current setpoint value. The time count continues.
Reset	The ongoing step stops. The time count stops and the ***Setpoint Table*** functionality returns to the first defined step as configured.
Advance	The process proceeds to the next step defined in the ***Setpoint Table Configuration***. ***Note:*** *Only users with HMI Supervisor or higher access level can access the* ***Advance*** *function.*
Disable	The functionality continues to run in the background as defined in the ***Setpoint Table Configuration***, complying to the setpoint values and step duration. The equipment is set in the ***Remote*** mode and the PID control loop is not controlled by the ***Setpoint Table***. Clicking ***Enable*** gives back the control of the PID control loop to the ***Setpoint Table*** at the step that is valid at this time point.

7.5.2 Start, stop and hold a batch

Batch Manager display

The ***Batch Manager*** display is part of the ***Reactor Display*** screen. The ***Batch Manager*** display enables the user to define batch setpoints, monitor batch run time and batch held time, initiate, hold, and abort a batch. See *Batch Manager display, on page 560* for an overview.

Manage batches

Task	Action
Display the ***Batch Default PID Setpoints*** drop-down display.	Click the double-arrow button in the ***Batch Manager*** display.
Display the ***Default PID Setpoints*** dialog box.	Click any value in the ***Batch Default PID Setpoints*** drop-down display.
Change batch default setpoints.	• Type the setpoints into the applicable text boxes in the ***Default PID Setpoints*** dialog box.[1] • Click ***OKAY***. ***Note:*** *The new setpoints are applied when the batch is started.*
Start a batch.	Click ***Start***. *Result:* • The new setpoints are loaded. • All configured PID control loops are set to ***Auto*** mode with a zero output (except the pH control loop that has output 50). • All configured pumps are set to ***Auto/Remote*** mode. • The ***Batch Run Time*** counter starts.
Put the batch on hold.	Click ***Hold***. *Result:* • The batch state is shown as ***Held***. • The ***Batch Run Time*** counter stops. • The ***Batch Held Time*** counter starts. • All pumps are set into ***Manual/Remote*** mode.

Task	Action
Exit the ***Held*** state and continue the batch run.	Click ***Restart***. *Result:* • The current batch run continues. • The ***Batch Run Time*** counter continues. • The ***Batch Held Time*** counter stops. • The pumps return to ***Auto/Remote*** mode.
Stop the batch run.	1. Click ***Hold***. *Result:* The batch state is shown as ***Held***. The ***Abort*** button is activated. 2. Click ***Abort***, confirm by clicking ***YES***. *Result:* • The current batch run stops. • The batch state is shown as ***Aborted***. • All pumps are set into ***Manual/Remote*** mode.
Return the ***Batch Manager*** to the ***Ready*** state.	Click ***Reset***.

[1] When a PID control loop is in ***Remote*** mode and is not mapped to a device or configured via a setpoint table, the value specified in the ***Batch Default PID Setpoints*** is used as the active setpoint.

7.5.3 Execute recipes

Recipe management

Recipe Management is an AVEVA application for formula and recipe management. The application is started using a web browser.

The ***Execution*** functionality of the application is also available from the WindowViewer top toolbar. ***Recipe Manager*** is accessible for users with HMI Operator credentials for executing existing recipes. All other Recipe Management functions are only available for HMI Supervisor or HMI Engineer after logging on to the application in the web browser.

Refer to *Xcellerex XDR bioreactor Recipe Manual (29698395)* for more information on Recipe Management.

Log on to *Recipe Manager*

Follow the instructions below to log on to the Recipe Management application.

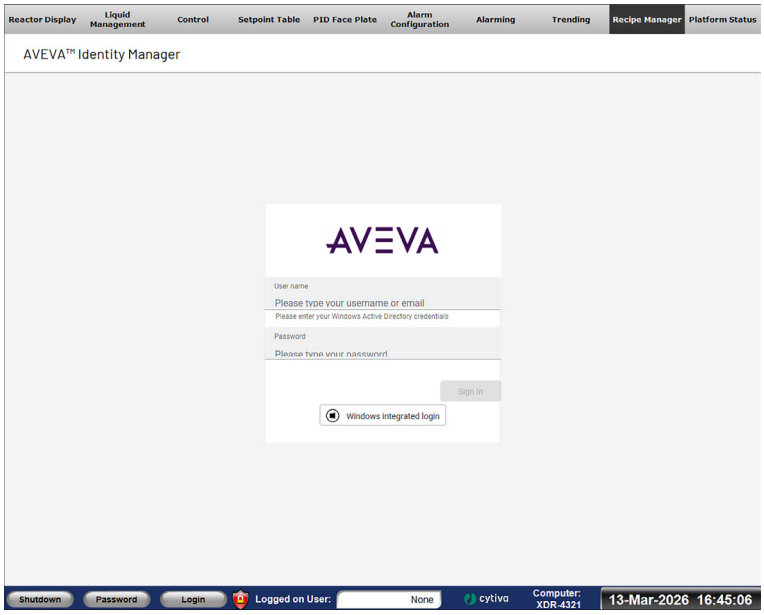
Step	Action
1	Click ***Recipe Manager*** on the header toolbar.



Result:

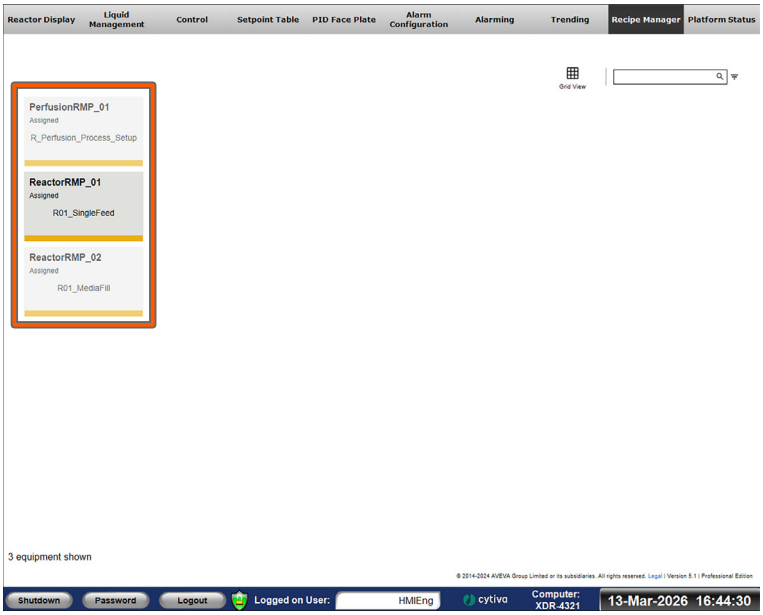
The ***AVEVA Identity Manager*** screen of the ***Recipe Manager*** is shown.

Step	Action
2	Type your user name and password in the text boxes, and then click ***Login***.



Result:

The Recipe Management application opens.

Step	Action
3	Select the equipment you want to work with. ***Note:*** *Unavailable equipment appears dimmed.*  *Result:* The execution view for the selected equipment opens.

Execute recipes

Refer to *Xcellerex XDR bioreactor Recipe Manual (29698395)* for detailed instructions on how to execute the existing recipes.

7.6 Work with alarms

Introduction

This section provides information about how to monitor and control the batch using alarms and alarm logs.

In this section

Section		See page
7.6.1	Set, view and acknowledge alarms	412
7.6.2	Use event and alarm logs	418

7.6.1 Set, view and acknowledge alarms

Alarms

The user can set and configure alarms for each individual instrument. Value based alarms can be configured for each parameter based on pre-specified ranges. More information about pre-specified ranges can be found in the Product Documentation package (ToP).

Refer to AVEVA software manual for more information about alarms, alarm states, and alarm handling, including alarm producers and consumers. The help is available in ***Start →Aveva Documentation →InTouch Alarms and Events Guide***, if installed at recommended location.

Alarm functionality

When a user-defined alarm is issued, a warning is displayed. The system continues to run.

When an alarm connected to an interlock is activated, the system stops. See *Section 2.5 Interlocks, on page 43* for more information.

If your system has an alarm stack, the alarms activate light and sound signals. See *Alarm stack colors, on page 86* for more information about the signals.

Alarm colors

The following alarm colors are used on all alarm screens.

Alarm state	Alarm text color
Acknowledged	Stable black on white background
Unacknowledged	Flashing red and green on white background
Unacknowledged on the ***Alarm History*** screen	Stable red on white background
Unacknowledged return (the alarm has been active but is no longer in active state)	Stable blue on white background

Access to alarm setup

To display the available alarms for a specific process variable follow the instructions below.

Step	Action
1	Click ***Alarm Configuration*** on the header toolbar to open the alarm setup screen for an individual instrument.



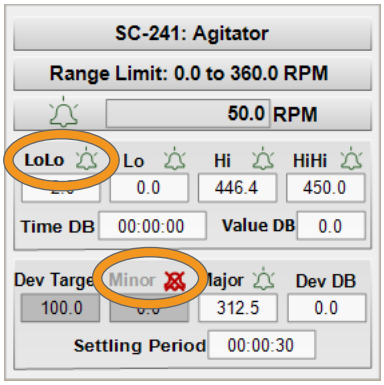
Result:

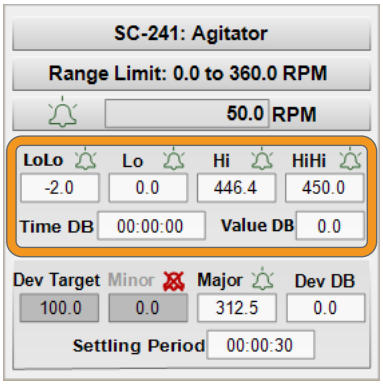
The ***Alarm Configuration*** screen opens.

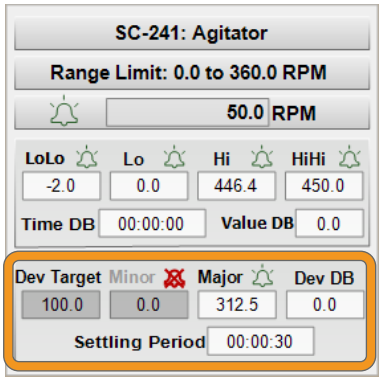
2	Find the relevant module for the process variable on the screen 1, screen 2, or screen 3.

Configure alarms

Display the alarm setup screen for the individual instrument as described above. Follow the instructions below to configure the alarms.

Task	Action
Enable or disable an alarm. ***Note:*** *Alarms should only be disabled after they have been acknowledged.*	Click the bell icon adjacent to the alarm you want to enable or disable.  *Result:* The bell icon changes to show the status of the alarm: • to green if the alarm is enabled • to red and crossed out if the alarm is disabled. The disabled alarm value is shown in a gray text box.

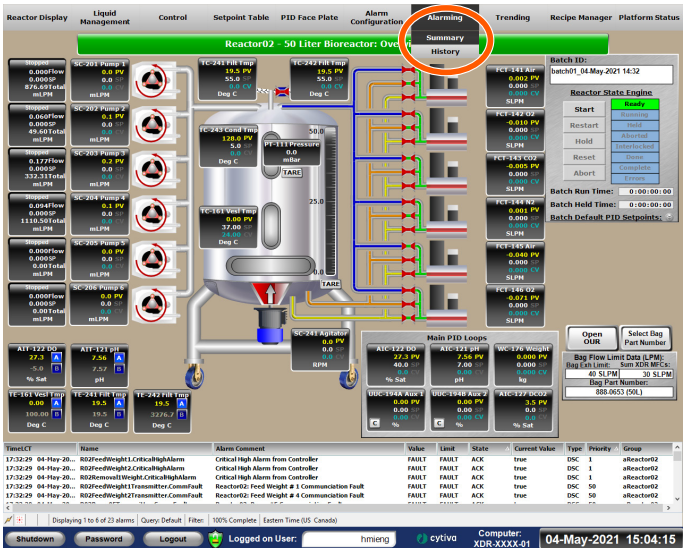
Task	Action
Define the range limits of the set alarm.	1. Make sure that the bell icons are green for the alarms you want to activate. 2. Type the applicable values into the applicable text boxes. 3. Type the values for ***Time DB*** (time deadband, hh:mm:ss) and ***Value DB*** into the text boxes.  The range limits of the alarm notify the operator when a parameter is outside of the expected range of operation. ***Note:*** *Setting the deadband values prevents the alarm from switching on and off ("chattering") when close to the limit.*

Task	Action
Set an alarm for deviation from parameter setpoint.	1. Make sure that the bell icons are green for the deviation alarms you want to activate. 2. Type the applicable values into the applicable text boxes. 3. Type the values for ***Dev DB*** (deadband) and ***Settling Period*** into the text boxes.  The limits ***Dev Target Minor*** and ***Dev Target Major*** notify the operator when a parameter does not reach the setpoint. ***Note:*** ***Dev Target Minor*** *is a warning alarm.* ***Dev Target Major*** *is a critical alarm.*

View and acknowledge alarms

Follow the instructions below to acknowledge the alarms.

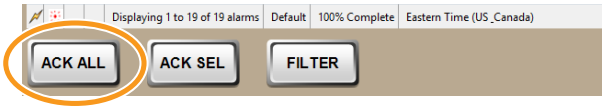
Step	Action
1	Select ***Alarming*** →***Summary*** from the header toolbar to view the ***Alarming*** screen.



2	To acknowledge an alarm: • select the alarm (one alarm or multiple alarms) • click ***ACK SEL*** (Acknowledge Selected) at the bottom of the screen



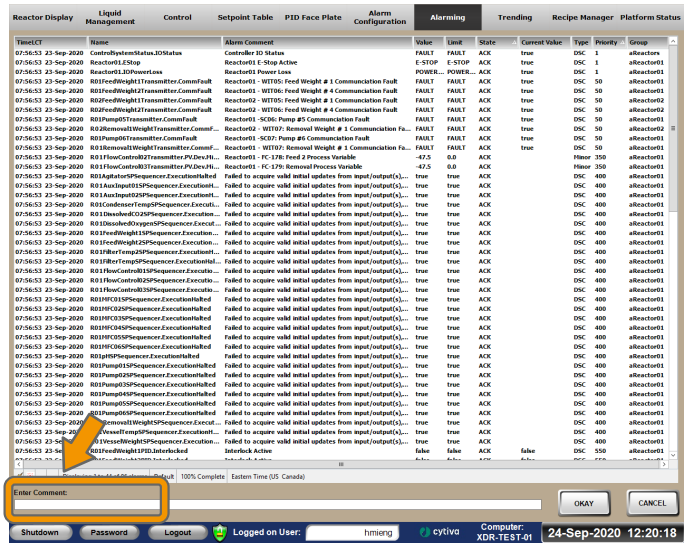
	• or click ***ACK ALL*** (Acknowledge All , Acknowledge All) at the bottom of the screen to acknowledge all alarms.



Step	Action

Result:

Enter Comment text box opens at the bottom of the ***Alarm Summary*** screen.



3 Type a comment in the text box if necessary. Click ***OKAY*** to save the comment.

Note:
User name and time of acknowledgement are recorded automatically by the system.

Tip:
It is good practice to provide detailed comments for alarms. This helps to keep appropriate batch records.

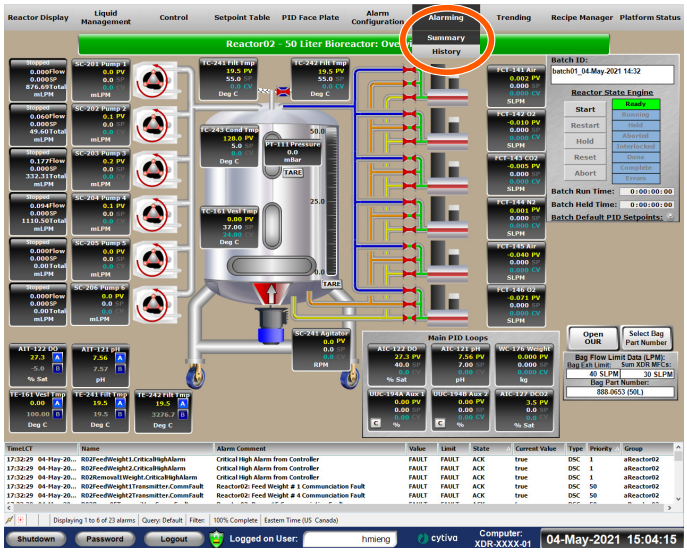
7.6.2 Use event and alarm logs

Apply filters to the alarm list

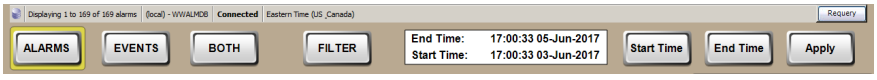
The filter function allows the user to display only a relevant group of alarms and events. The filtered list shows information for all bioreactors connected to the X-Station.

Follow the instructions below to apply the filter.

Step	Action
1	Select ***Alarming*** →***History*** on the header toolbar to display all alarms and events that are associated with the current process.



2	Select the items you want to view: ***ALARMS***, ***EVENTS***, or ***BOTH***, by clicking the applicable button at the bottom of the screen.



3	Click ***FILTER***. *Result:* A list of all available bioreactors is shown.
4	Click the bioreactor that you want to display, and then click ***Apply***.

Step	Action
	Result: The ***Alarm History*** table shows only the items connected to the selected system. ***Note:*** *The **All** filter allows the user to view platform status and system connectivity alarms and events.*

Search for an alarm or event

Follow the instructions below to perform a search.

Step	Action
1	Find out on which system the alarm or event occurred. Display the alarms and events for this system as described in steps 1-4 in *Apply filters to the alarm list, on page 418*.
2	At the bottom of the screen, click ***Start Time*** and type the relevant date and time in the dialog box.
3	At the bottom of the screen, click ***End Time*** and type the relevant date and time in the dialog box.
4	Click ***Apply***. *Result:* The alarms and events list is updated according to the specified limits. ***Tip:*** *Click the **Name** column header or the **AlarmComment** column header to sort the alarms and events alphabetically by their tag names or descriptions.*

7.7 Configure trends

Trending application

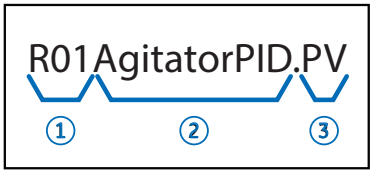
Trending application allows the user to display the historical process data as curves.

Refer to also the manufacturer's general help for Trending application. The application help is available in ***Start*** →***Aveva Documentation*** →***Historian Client User Guide***, if installed at the recommended location.

Tag naming principle

Historical data for all parameters for each bioreactory is available for viewing in Trending application. When a group is selected in the ***Servers*** pane, all available parameters in this group are shown in the ***Tags*** pane in alphabetical order.

The following illustration explains the principle for tag naming.



Part	Name	Description
1	Operating unit abbreviation	Bioreactor number
2	Parameter tag name	The tag name of the parameter
3	Variable type abbreviation	The measured value shown as the trend curve

View trends

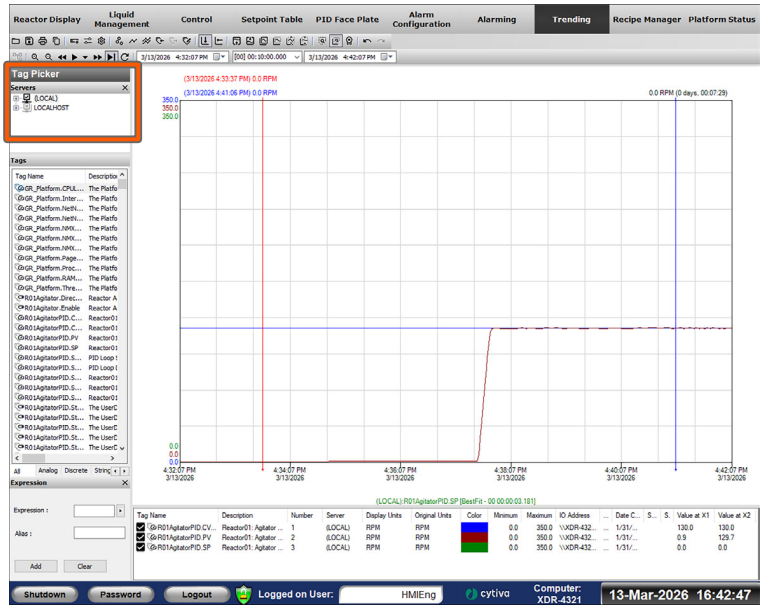
Follow the instructions below to view and configure the trends.

Note: *The illustrations in the steps below are examples. Your system interface may look different. The screen layout and functionality are identical to the illustrations shown below.*

Step	Action
1	Click ***Trending*** on the header toolbar.



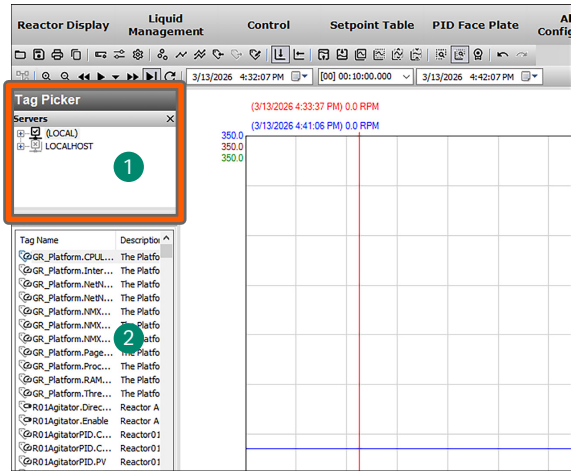
Step	Action
	Result: The ***Trending*** screen opens.
2	At the top of the left pane, in the ***Servers*** pane, select the ***(LOCAL)*** server.



Result:

A list of available trends is shown.

Step	Action
3	In the ***Servers*** pane, click an applicable tag group from the ***(LOCAL)*** server (1) to display the available tags for this group.



Result:

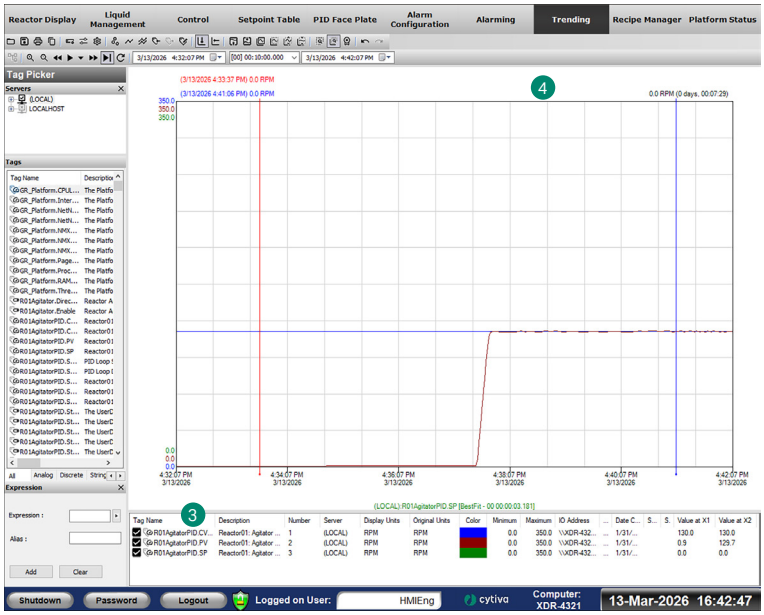
The tag list is shown in the ***Tags*** pane (2). All historical process data are included in the list.

4	Double-click a tag in the ***Tags*** pane to move it to the ***Pens*** pane (3). See *Tag naming principle, on page 420* for more information about tag names.

Step	Action

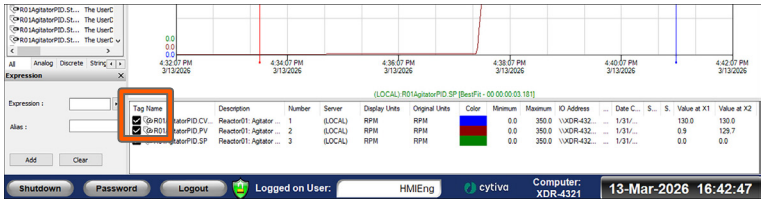
Result:

The curve for the selected tag is shown in the trend chart (4).



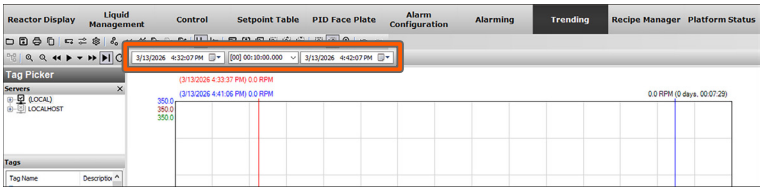
5 Add tags to the ***Pens*** pane as needed.

6 In the ***Pens*** pane select the check box at the left of the tag name to connect this pen with the vertical red and blue markers. Drag the markers left or right to read specific values at specific times.



Tip:

Right-click a pen, and then select ***Configure*** *in the shortcut menu to access the pen configuration parameters.*

Step	Action
7	Use the drop-down lists at the top of the screen for selection of times and dates for the trends. 
8	Click ***Save*** on the top toolbar to save the tag configuration for future use.

7.8 Complete a run

Introduction

This section provides information about how to complete a run and shut down the instrument.

In this section

Section		See page
7.8.1	Collect the cell culture	426
7.8.2	Remove the disposable bag	432
7.8.3	Shut down the system	442

7.8.1 Collect the cell culture

End the run

Follow the instructions below to end the currently active run.

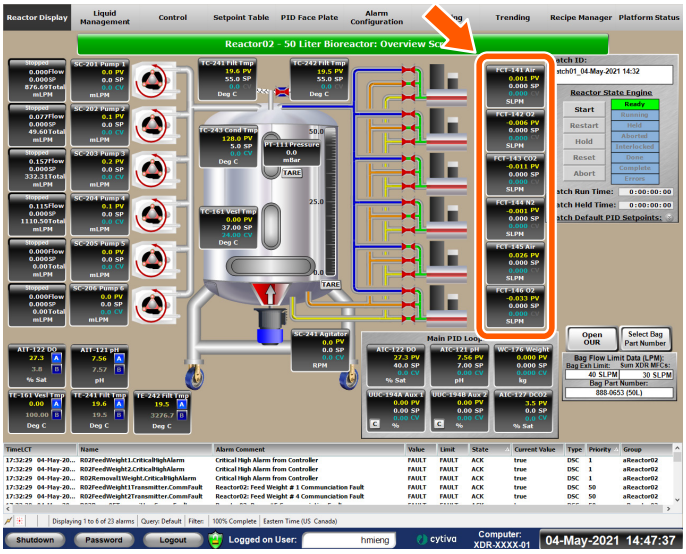
Step	Action
1	Put all MFC PID control loops to the safe state following the instructions below.

a. Click ***Reactor Display*** on the header toolbar. Select the relevant bioreactor from the drop-down menu, if available.



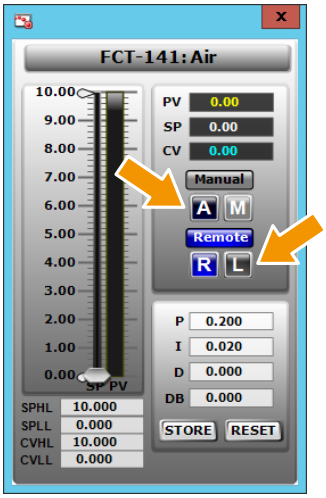
Result:
The ***Reactor Display*** screen opens.

b. Click the relevant MFC panel to open the MFC PID faceplate.

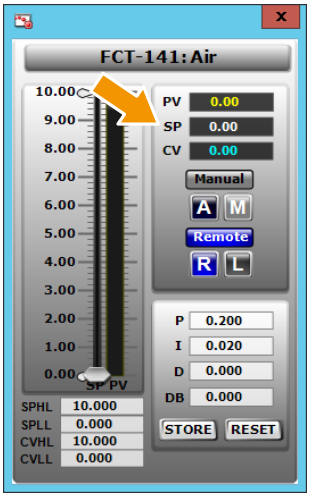


Step	Action

c. Click ***A*** and ***L*** to put the MFC into ***Auto/Local*** mode.



d. Type 0 into the ***SP*** text box (0 SLPM).



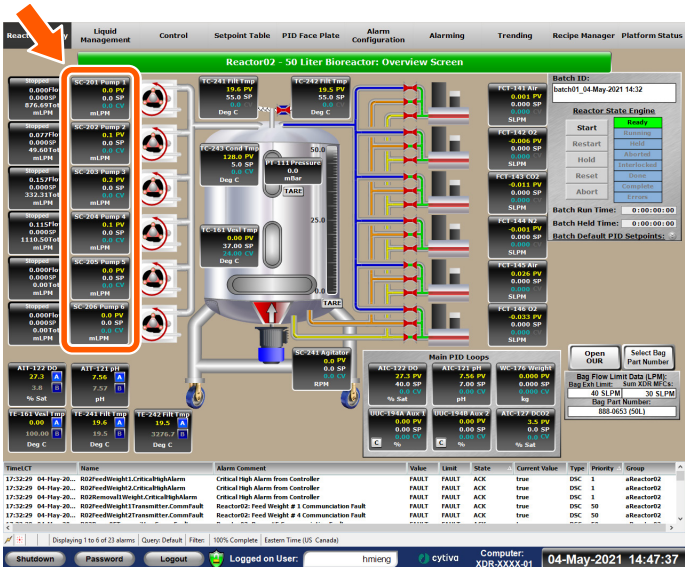
e. Repeat steps B–D for all active MFCs.

Result:
All mass flow controllers stop.

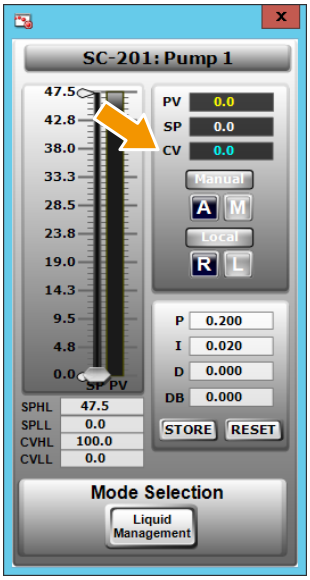
2 Put all pump PID control loops to the safe state following the instructions below.

Step	Action

a. Click the relevant pump panel on the ***Reactor Display*** screen to open the pump PID faceplate.



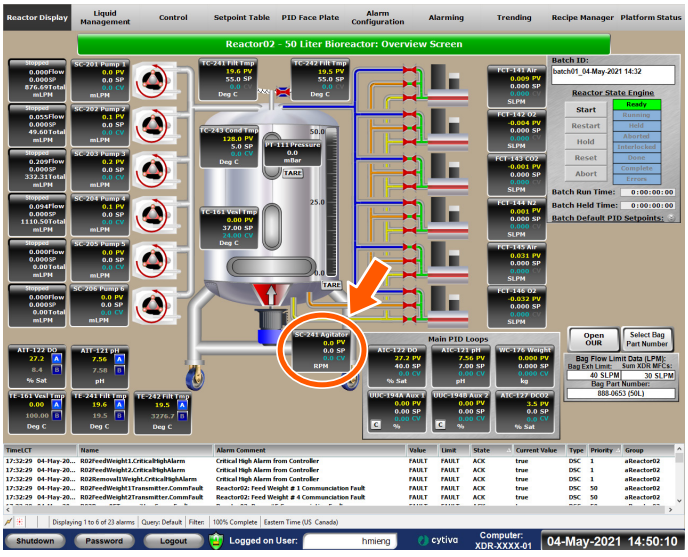
b. Type 0 into the ***CV*** text box.



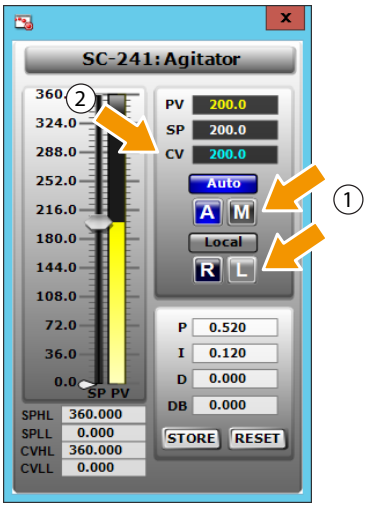
c. Repeat steps A–B for all active pumps.

Step	Action
	Result: All pumps stop.
3	Put the agitator PID control loop to the safe state following the instructions below.

a. Click the agitator panel on the ***Reactor Display*** screen to open the agitator PID faceplate.



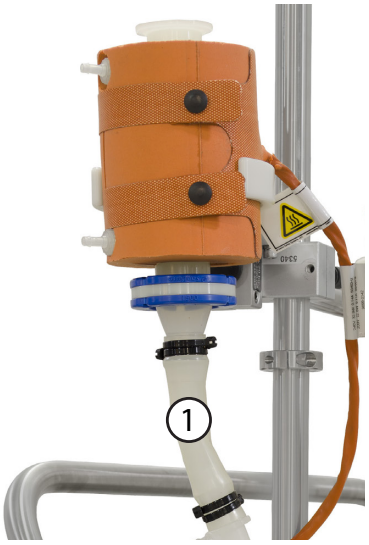
b. Click ***M*** and ***L*** (1) to put the agitator into ***Manual/Local*** mode.



Step	Action
	c. Type 0 into the ***CV*** text box (2). *Result:* The agitator stops.
4	Visually verify that the agitator, all pumps, and all MFCs have stopped.

Drain the disposable bag contents

Follow the instructions below to drain the cell culture from the disposable bag. Also consider your local requirements for product and waste handling.

Step	Action
1	Clamp all inlet and outlet tubing. Do not clamp the exhaust tubing (1). 
2	Insert the harvest line into a pump suitable for the diameter of tubing (unless draining by gravity is preferred). See *Section 6.10.1 Install tubing, on page 293* for instructions.
3	Insert the harvest line into a suitable receptacle.
4	Verify that the exhaust tubing is open and air can enter the disposable bag. This reduces vacuum during the draining process. ***Tip:*** *The conditions in the disposable bag remain aseptic if the incoming air passes the exhaust filter.*

Step	Action
5	Open the clamp on the harvest line.
6	Start the harvest line pump.
7	Monitor the draining process to make sure that it works as expected.
8	Gently adjust the disposable bag position during the draining procedure, if needed.
9	Allow all contents to drain from the disposable bag.

7.8.2 Remove the disposable bag

Disconnect the bag

Follow the instructions below to disconnect the cables, probes, and tubing after a finished run.

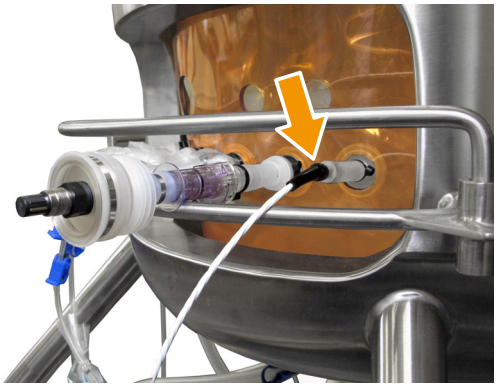
Step	Action
1	Drain the remaining liquid from the disposable bag.
2	Disconnect all probe cables: • pH probes • DO probes • CO_2 probe (optional)



3	Disconnect the bag pressure sensor cable.



Step	Action
4	Remove the temperature probe from the disposable bag. Clean the probe according to facility procedures. Store the probe in a clean place according to manufacturer's instruction.



5	Remove the pH and DO probes from the disposable bag. Clean the probes according to facility procedures. Autoclave and store the probes in a clean place according to manufacturer's instructions.

Step	Action
6	Disconnect the tubing from the pump heads.



Step	Action
7	Disconnect the sparge tubing from the sparge filter.



8	Disconnect the overlay tubing from the overlay filter.
9	Remove the exhaust filters from the exhaust filter heaters, as described below.

a. If your filter heater holder has a fastening strap, open the strap buckle and loosen the strap.

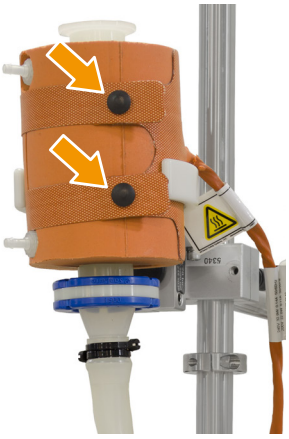
Note:

Exhaust filter heater color can vary. The images are for illustrative purposes only.

Step	Action



b. Open the button locks.



c. Open the filter heater.

Step	Action
	d. Pull out the filter.



Remove the disposable bag from 50–500 L bioreactors

Follow the instructions below to remove the the disposable bag from the XDR vessel.

Step	Action
1	Disengage the agitator motor lift (G-lift or X-lift) as described in *Section 6.6 Engage and disengage the agitator motor, on page 239*. Lock the lift in disengaged position.

Step	Action
2	At the top of the disposable bag, remove the tubing from the tubing support.



3	Remove the probe support bar.



4	Pull the disposable bag out from the XDR vessel.
5	If the site policy requires decontamination of the bag before disposal, rinse the walls of the empty bag with a decontamination solution, and then drain.
6	Dispose of the bag according to local procedures.

Remove the disposable bag from 1000-2000 L bioreactors

WARNING

Risk of fall from height. To prevent falling accidents, take adequate safety precautions and follow local regulations.

CAUTION

Use safety ladder. Use a safety ladder to reach the top of the 1000 L and 2000 L XDR vessels, where the bag hoist, exhaust filter heater assembly, and the supporting frame are located.

Follow the instructions below to remove the the disposable bag from the XDR vessel.

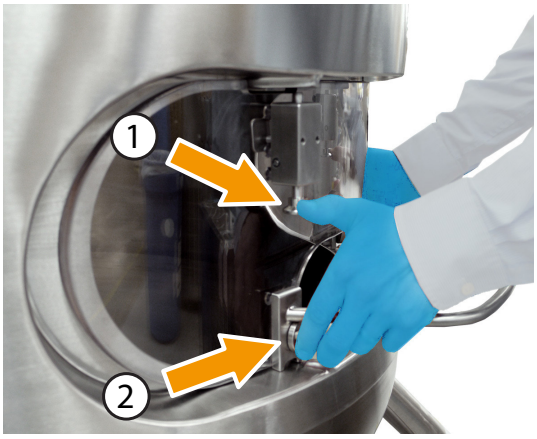
Step	Action
1	Disengage the agitator motor using the X-lift, as described in *Disengage agitator drive head using the X-lift, on page 251*. Lock the lift in disengaged position.
2	At the top of the disposable bag, remove the tubing from the tubing support.



3	Remove the the XDR vessel door as follows:

Step	Action

a. Using your thumbs, push down the retention pins (1).



b. Using your index and middle finger, push the cam locks (2) toward each other.

c. Remove the door.

4 Disconnect the bag support straps at the top of the XDR vessel.



Step	Action
5	Push and hold the **DOWN** button on the bag hoist operating panel to lower the hoist to the XDR vessel front opening.



6	Pull the disposable bag out from the XDR vessel.
7	Remove the bag hoist hooks from the disposable bag.



8	If the site policy requires decontamination of the bag before disposal, rinse the walls of the empty bag with a decontamination solution, and then drain.
9	Dispose of the bag according to local procedures.

7.8.3 Shut down the system

Shut down the bioreactor

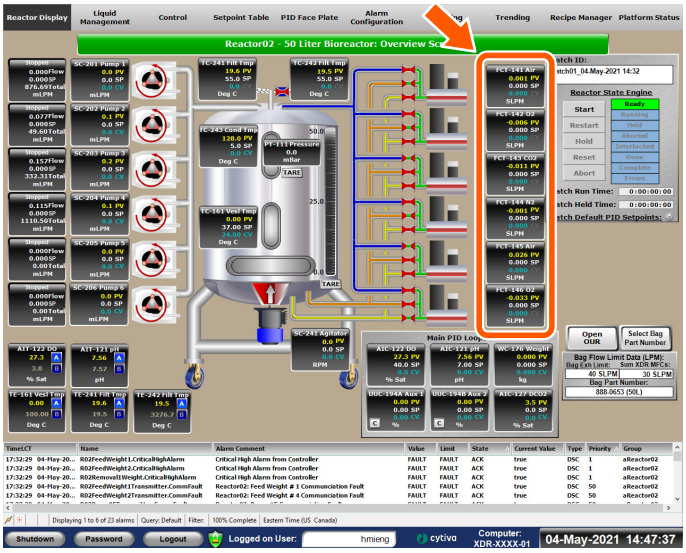
NOTICE

Only HMI Engineer or qualified service personnel should turn off the bioreactor.

Follow the instructions below to turn off the bioreactor.

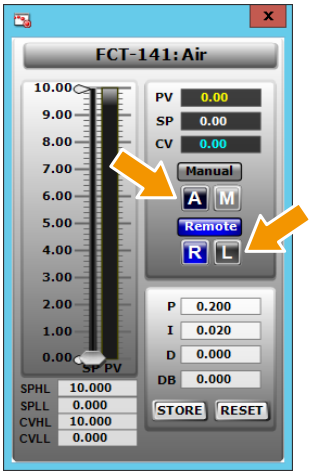
Step	Action
1	Close all gas supply valves to shut down the gas supply to the bioreactor.
2	Turn on the mass flow controllers to 1 SLPM for each gas supply:

a. Click the relevant MFC panel to open the MFC PID faceplate.

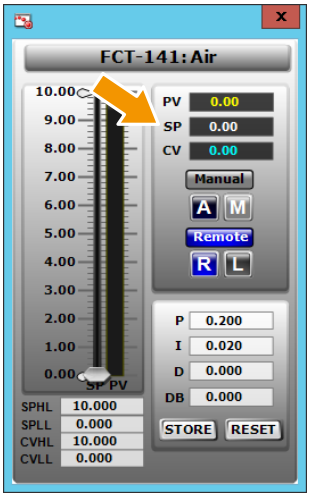


Step	Action

b. Click ***A*** and ***L*** to put the MFC into ***Auto/Local*** mode.



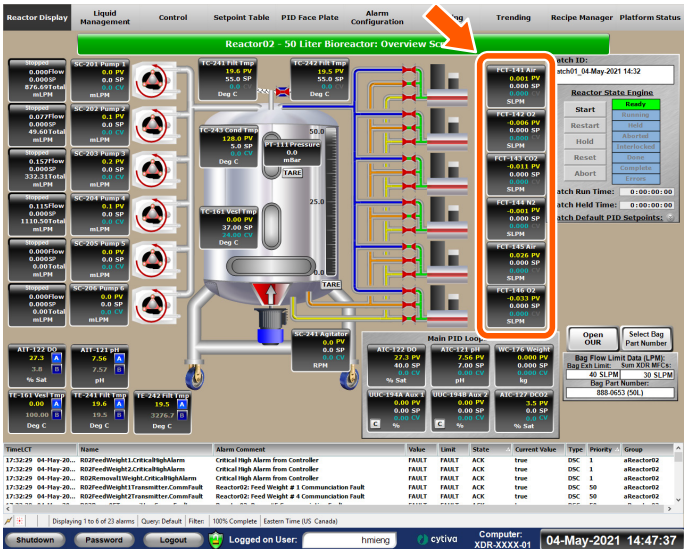
c. Type 1 into the ***SP*** text box (1 SLPM).



Result:
Any remaining pressure in the pneumatic lines bleeds.

3 Lock-Out / Tag-Out the gas supply valves.

Step	Action
4	Verify on the MFC PID faceplates that no gas flow is present.



5	Empty the vessel jacket as described in the TCU manufacturer's documentation.
6	Turn the system power switch on the I/O Cabinet to **O OFF** position.



Result:

The power supply to the I/O Cabinet is turned off.

7	If required:

- Disconnect the mains cable.

Step	Action
	or • Turn off the main circuit breaker. *Result:* All power is disconnected from the instrument. ***Note:*** *The external circuit breaker is provided by the user. The location of the circuit breaker depends on the facility.*

Exit software

NOTICE

Always shut down the software using the instructions below. Failure to shut down the computer in a proper way might result in software corruption and hardware failure.

NOTICE

Only the HMI Supervisor or the HMI Engineer can exit the software.

Before shutting down the software, make sure that the system is in a safe state and that all mechanical systems are switched off.

Follow the instructions below to exit the software.

Step	Action
1	Click ***Reactor Display*** on the header toolbar to open the ***Reactor Display*** screen.



2	Click ***Shutdown*** on the footer toolbar.



Step	Action
	Result: The WindowViewer application closes and the Windows desktop becomes visible.
3	Log off from Windows: • Press the Windows key on the keyboard or • Click ***Start*** on Windows taskbar. Select ***Shut down*** →***Log off*** from the shortcut menu.
4	Log on using the applicable credentials: • XDRAdministrator or • member of the Administrators user group.
5	Click ***Start*** on Windows taskbar.
6	Select ***Shut down*** from the shortcut menu. Follow the software messages to shut down the computer.

8 Maintenance

About this chapter

This chapter provides required information to enable users and service personnel to clean, maintain, calibrate and store XDR-50 to 2000 Bioreactor Systems.

In this chapter

Section		See page
8.1	Safety precautions	448
8.2	Cleaning before planned service	450
8.3	Maintenance schedules	451
8.4	Lock-Out / Tag-Out (LOTO): turn-off procedure	454
8.5	Lock-Out / Tag-Out (LOTO): turn-on procedure	459
8.6	Cleaning	463
8.7	Hardware maintenance	465
8.8	Software maintenance	480
8.9	Database maintenance	492
8.10	Storage	500

8.1 Safety precautions



WARNING

Tipping hazard. Pay extra attention when moving the system to make sure that the system does not tip.



WARNING

Trained personnel. Maintenance of this product must be performed by properly trained personnel only.



WARNING

Electrical shock hazard. All repairs should be done by service personnel authorized by Cytiva. Do not open any covers or replace parts unless specifically stated in the user documentation.



WARNING

Turn off equipment. Turn off the system and Lock-out / Tag-out (LOTO) the electrical equipment, the gas supply, and the temperature control unit before doing maintenance.



WARNING

High gas pressure. It is essential for the safety of personnel working with or around pressurized gas equipment to follow a company policy and procedure for Lock-Out / Tag-Out (LOTO).



WARNING

High or low temperature. It is essential for the safety of personnel working with or around temperature control equipment to follow a company policy and procedure for Lock-Out / Tag-Out (LOTO).



WARNING

Secure jacking bolts. Do not move the instrument without engaging the jacking bolts. Always secure the instrument using the jacking bolts to prevent damage to the load cells, thereby avoiding damage to the equipment and injury to operators.



WARNING

Improper use of jacking bolts. Improper use of jacking bolts may cause the instrument to collapse on the operator.



WARNING

Spare parts. Only spare parts that are approved or supplied by Cytiva may be used for maintaining or servicing the product.



CAUTION

Contamination hazard. Before performing any service work on the product, make sure that the product has been properly decontaminated.

8.2 Cleaning before planned service

Cleaning before planned maintenance/service

To protect the safety of service personnel, all equipment and work areas must be clean and free of any hazardous contaminants before a Service Engineer starts maintenance work.

8.3 Maintenance schedules

Introduction

It is the responsibility of the system owner to make sure that the required maintenance is performed.

The user should inspect the system for signs of wear and damage and request a service visit if anything abnormal is found. Contact your Cytiva representative to schedule maintenance and service.

User maintenance schedule

The following table describes maintenance activities that must be scheduled by customer personnel. All maintenance procedures that are not described in this manual must be performed by a Cytiva service engineer.

Frequency	Activity	Performed by	Reference
Weekly	Clean the system	Operator	*Section 8.6 Cleaning, on page 463*
Biannually	Test alarm stack functionality	Operator	*Section 8.7.3 Test alarm stack and emergency stop, on page 470*
	Test emergency stop functionality	Operator	*Section 8.7.3 Test alarm stack and emergency stop, on page 470*
	Verify agitator alignment[4]	Cytiva service engineer	Contact your Cytiva representative.
	Verify agitator speed accuracy[1]	Cytiva service engineer	
Annually	Change the TCU filter[5]	Properly trained personnel	Refer to the manufacturer's manual.
Annually and after system relocation	Inspect cables and connectors	Properly trained personnel	If anything abnormal is found, contact your Cytiva representative for service.
	Inspect hinges and handles	Properly trained personnel	
	Inspect jacking bolts	Properly trained personnel	*Inspect jacking bolts, on page 466*

4 If the instrument is used less than 12 times a year, the verification can be made annually.
5 For TCUs equipped with filters.

Frequency	Activity	Performed by	Reference
	Inspect pressure relief valve	Properly trained personnel	If anything abnormal is found, contact your Cytiva representative for service.
	Inspect pump heads	Properly trained personnel	
	Inspect the I/O Cabinet	Properly trained personnel	
	Inspect vent and drain valves	Properly trained personnel	

Calibration schedule

NOTICE

All critical components of the bioreactor must be calibrated annually or as outlined by the on-site metrology department. All critical components should be added to the on-site calibration database.

The following table shows the recommended calibration schedule for XDR-50 to 2000 Bioreactor Systems.

Frequency	Activity	Performed by	See section
Before each batch	DO probe calibration	Operator	*Section 6.3.3 Calibrate the DO probe with N2, on page 183* and *Section 7.4.8 Calibrate the DO probe with O2, on page 379*
	pH probe calibration	Operator	*Section 6.3.2 Calibrate the pH probe, on page 174*
	Pump calibration[6]	Operator	*Section 6.10.2 Calibrate the pump, on page 299*
Before each batch (at least semi-annually)	Temperature probe calibration	Calibration technician	*Section 8.7.4 Temperature probe calibration, on page 473*
Annually	Exhaust filter heater temperature calibration	Calibration technician	*Section 8.7.5 Exhaust filter heater calibration, on page 477*

6 The pump must be calibrated each time a different tubing size is used.

Frequency	Activity	Performed by	See section
	Load cell calibration (1 weight calibration)	Calibration technician	Refer to the manufacturer's manual.
	Mass flow controllers' calibration	Off-site calibration	Contact your Cytiva representative.
As needed	CO_2 transmitter calibration	Calibration technician	Refer to the manufacturer's manual.
	DO transmitter calibration	Calibration technician	Refer to the manufacturer's manual.
	pH transmitter calibration	Calibration technician	Refer to the manufacturer's manual.

8.4 Lock-Out / Tag-Out (LOTO): turn-off procedure

Introduction

This section describes the recommended Lock-Out / Tag-Out (LOTO) turn off procedure.

This section is not intended to describe or supersede a comprehensive Lock-Out / Tag-Out (LOTO) policy that includes thorough procedures and frequent training.

WARNING

Hazardous voltage. It is essential for the safety of personnel working in or around electrically powered equipment to follow a company policy and procedure for Lock-Out / Tag-Out (LOTO).

Turn off the instrument

Follow the instructions below to turn off XDR-50 to 2000 Bioreactor Systems.

Step	Action
1	Turn the system power switch on the I/O Cabinet to **O OFF** position.



Result:

The power supply to the I/O Cabinet is turned off.

Step	Action
2	Turn off the X-Station by standard computer shutdown procedure: select ***Start*** →***Shut down***. ***Note:*** *Only an XDRAdministrator or a member of the Administrators user group can shut down the computer.*
3	If the system is equipped with a UPS, open the hatch on the bottom front panel of the X-Station and find the UPS.



4	If a UPS is present in the system, turn off the UPS as described in *Turn off the UPS, on page 456*.
5	Attach a tag-out device onto the I/O Cabinet.
6	Lock-Out / Tag-Out the gas supply valves.
7	If the bioreactor is connected to a TCU, turn off the TCU following the manufacturer's instructions.
8	Empty the XDR vessel jacket as described in the TCU manufacturer's documentation.

Step	Action
9	Attach a tag-out device onto the XDR vessel coolant inlet.

Turn off the UPS

> **WARNING**
>
> **Hazardous voltage.** The built-in UPS in the X-Station contains hazardous voltage when instrument power is switched off. Use caution when working around the UPS.

Follow the instructions below to turn off the UPS inside the X-Station.

Step	Action
1	Press the power button.



Result:

The message ***Turn UPS Off →No*** is shown.



Step	Action
2	Press the down arrow button to select ***Yes***.



3	Press the enter button.



Step	Action
	Result: The message ***UPS Control →Off-Use Delay*** is shown.



4	Press the down arrow button to select ***Off-No Delay***.



5	Press the enter button. *Result:* The ***UPS*** is turned off.

8.5 Lock-Out / Tag-Out (LOTO): turn-on procedure

Introduction

This section describes the recommended Lock-Out / Tag-Out (LOTO) turn on procedure.

This section is not intended to describe or supersede a comprehensive Lock-Out / Tag-Out (LOTO) policy that includes thorough procedures and frequent training.

WARNING

Hazardous voltage. It is essential for the safety of personnel working in or around electrically powered equipment to follow a company policy and procedure for Lock-Out / Tag-Out (LOTO).

Turn on the instrument

Follow the instructions below to turn on XDR-50 to 2000 Bioreactor Systems.

Step	Action
1	If the bioreactor should be connected to a TCU, remove the tag-out device from the XDR vessel coolant inlet.
2	Connect the coolant tubing from the TCU to the XDR vessel coolant inlet and outlet, as described in *Connect TCU, on page 147*.
3	Fill the XDR vessel jacket with coolant as described in the TCU manufacturer's documentation.
4	Remove the tag-out device from the I/O Cabinet.
5	Turn the system power switch on the I/O Cabinet to **ON I** position.



Step	Action
6	If the system is equipped with a UPS, open the hatch on the bottom front panel of the X-Station to access the UPS.



WARNING

Hazardous voltage. The built-in UPS in the X-Station contains hazardous voltage when instrument power is switched off. Use caution when working around the UPS.

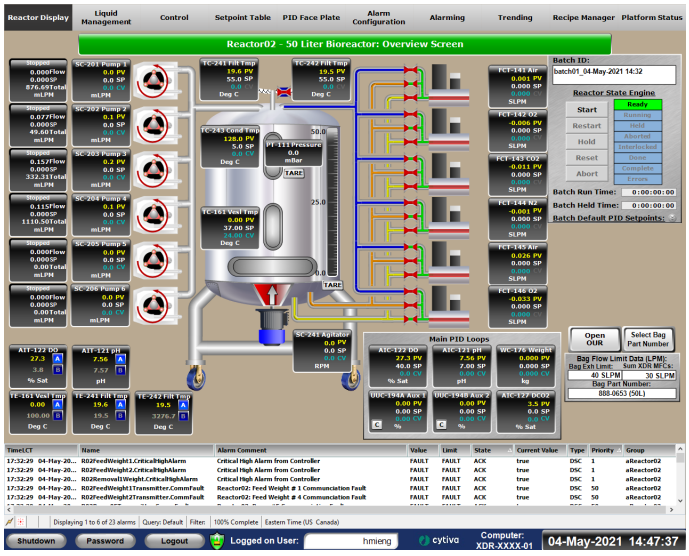
Step	Action
7	Press the power button on the front of the UPS to switch it on.



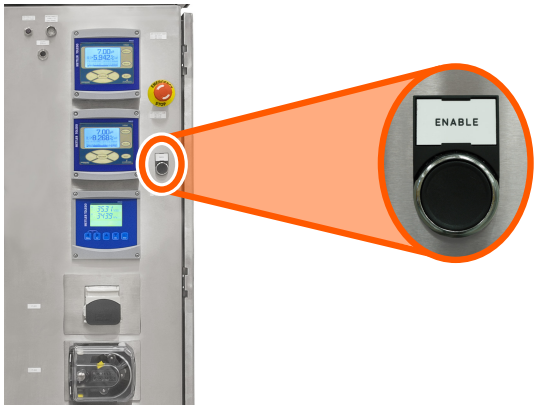
Result:
The computer starts.

8 Log on to Windows.

Result:
The WindowViewer application loads automatically. The ***Reactor Display*** screen is shown.



Step	Action
9	When the ***Reactor Display*** screen is visible, press the **ENABLE** button that is located on the front of the I/O Cabinet.



Result:

The control of the bioreactor is enabled.

10	If the bioreactor does not start, restart the system using an HMI Engineer account.
11	Remove the tag-out device from the gas supply valves.

8.6 Cleaning

Introduction

Any chemical spill on the instrument should be removed immediately to avoid risk for skin contact or stains on the instrument surface.

Safety precautions



WARNING

Cleaning. Always clean the equipment in a well ventilated area. Never immerse any part of the equipment in liquid. Always make sure that the equipment is completely dry before plugging it in. Always follow all environmental, health, and safety guidelines pertaining to the materials used.



WARNING

Squeezing or crushing injuries. Because of the significant weight of the instrument, great care must be taken not to cause squeezing or crushing injuries during movement. At least two, but preferably three or more, persons are recommended when moving the unit.



WARNING

Secure jacking bolts. Do not move the instrument without engaging the jacking bolts. Always secure the instrument using the jacking bolts to prevent damage to the load cells, thereby avoiding damage to the equipment and injury to operators.



WARNING

Improper use of jacking bolts. Improper use of jacking bolts may cause the instrument to collapse on the operator.

Secure load cells

The load cells must be secured during each move, including short moves, such as cleaning under the wheels of the instrument. Before moving the instrument, engage the jacking bolts. See *Section 6.2 Stabilize the XDR vessel, on page 153* for instructions.

Resistance to cleaning agents

XDR-50 to 2000 Bioreactor Systems are resistant to the following cleaning and disinfection agents:

Cleaning agent	Concentration
ACTISAN	Undiluted
Ethanol	70%
Spor-Klenz	Diluted 1:20

Instructions for cleaning

Step	Action
1	Use a non-abrasive cloth with mild detergent and water to clean the exterior of the I/O Cabinet, the gas supply cabinet, and the XDR vessel.
2	Use a non-abrasive cloth with mild detergent and water to clean the interior of the XDR vessel.
3	Check all stainless steel components for signs of surface rust. If rust is found, do as follows: **a.** Scrub areas of surface rust with an extra-fine mildly abrasive cleaning pad. **b.** Wipe the treated areas with a surface passivation chemical. **c.** Wipe the treated areas with a cloth soaked in Water For Injection (WFI) to remove the chemical.

8.7 Hardware maintenance

Introduction

This section gives information about hardware maintenance on XDR-50 to 2000 Bioreactor Systems. This maintenance should be performed by the user or by qualified personnel at the customer site.

In this section

Section		See page
8.7.1	Hardware responsibilities and tasks	466
8.7.2	Replace I/O Cabinet filter	467
8.7.3	Test alarm stack and emergency stop	470
8.7.4	Temperature probe calibration	473
8.7.5	Exhaust filter heater calibration	477

8.7.1 Hardware responsibilities and tasks

Responsibilities

It is the responsibility of the user to monitor the instrument. Regular functional verification of the system should be undertaken to make sure that the equipment is functioning properly, and to correct any problems before they have an operational impact. The customer should maintain operational logs according to local site procedures.

All inspection and maintenance performed by the user should be carried out in a safe operating manner using relevant health and safety standards and practices as established within the country where the equipment is installed. Local provincial bylaws must be followed. The owner of the instrument is responsible that relevant standards and practices are followed and a safe operating environment is maintained.

Inspect jacking bolts

Verify that the jacking bolts are not damaged or worn. If damage to the bolts is found, replace the bolts.

Contact your Cytiva representative for purchasing information.

Fuses

If a fuse blows, contact your Cytiva representative for help.

8.7.2 Replace I/O Cabinet filter

Introduction

This section gives instructions how to replace the I/O Cabinet filters.

Location

Two filters are present on the I/O Cabinet. The filters are located on the back of the I/O Cabinet and are covered with the ventilation hoods. The illustration below shows the location of the I/O Cabinet filters.



Part	Function
1	Air outlet
2	Air inlet

Replace the filter

Follow the instructions below to replace the I/O Cabinet filter.

Step	Action
1	Lift up the ventilation hood and remove it from the I/O Cabinet. Use light force. *Result:* The ventilator louver is accessible.
2	 Push down and hold the button (1) while pulling the upper edge of the louver toward you. *Result:* The filter under the louver is accessible.

Step	Action
3	
	Remove the filter.
4	Insert the new filter.
5	Push up the louver until a click is heard. *Result:* The louver is locked in correct position.
6	Put back the ventilation hood and push it toward the I/O Cabinet using light force.
7	Repeat steps 1–6 to replace the second filter.

CAUTION

Ventilation hoods. Make sure that the ventilation hoods are always attached to the I/O Cabinet and the gas supply cabinet, when the system is in operation.

8.7.3 Test alarm stack and emergency stop

Test functionality

This procedure is for testing of the alarm stack and the emergency stop functionality. For recommended testing frequency see *User maintenance schedule, on page 451*.

Follow the steps below to confirm that the alarm stack and emergency stop are working correctly.

Step	Action
1	Press the **EMERGENCY STOP** button.



Result:

The red light and the continuous sound alarm are turned on. ***E-Stop Active*** is displayed on the ***Reactor Display*** screen.



Step	Action

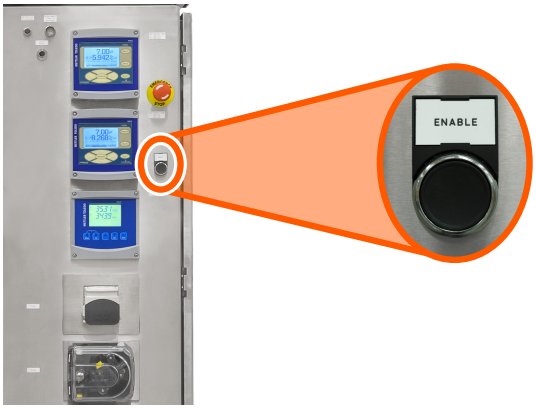


2 Disengage the **EMERGENCY STOP** by turning it clockwise.



Result:

The **EMERGENCY STOP** button pops out. The red light and the sound alarm are turned off.

Step	Action
3	Press the **ENABLE** button that is located close to the **EMERGENCY STOP** button.  *Result:* ***E-stop Active*** is no longer shown on ***Reactor Display*** screen. The bioreactor control is active.

8.7.4 Temperature probe calibration

Introduction

NOTICE
Do not use electronic simulation of resistance to calibrate the temperature probe.

NOTICE
Do not calibrate the temperature probe while the vessel is being controlled to a temperature setpoint.

Note: *If the instrument is used in a GMP compatible environment, the temperature probe is a GMP critical component.*

The temperature probe is calibrated using an offset.

Note: *The probe tip may contain one or two resistance temperature detectors (RTD), depending on your instrument configuration. Both RTDs have to be calibrated simultaneously.*

Qualifications

The temperature probe must be calibrated by a calibration technician.

Preparation

Before you start to calibrate the temperature probe, prepare the following:

- Temperature calibration instrument

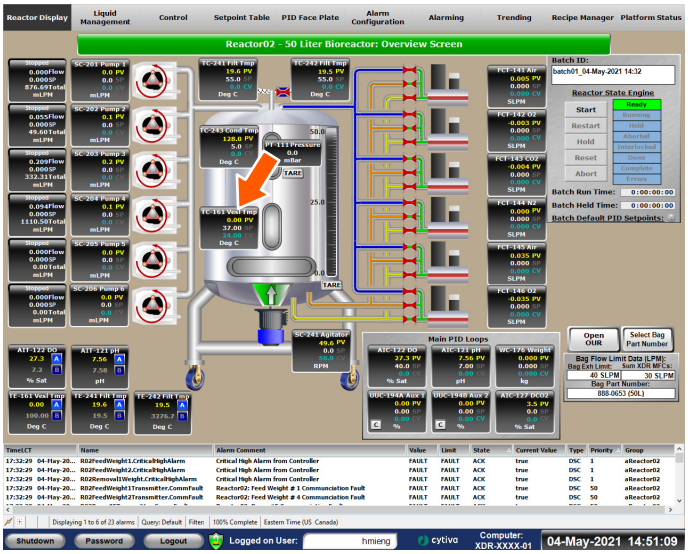
  Note: *The accuracy of the temperature calibration instrument is the responsibility of the site metrology department.*

- Constant temperature circulating bath

  Tip: *If additional circulating baths are available, they can be set to the two end-point calibration temperatures. This would allow to shorten the total calibration time, as there would be no need to change the temperature of the primary circulating bath.*

Calibration

Calibrate the temperature probe as follows:

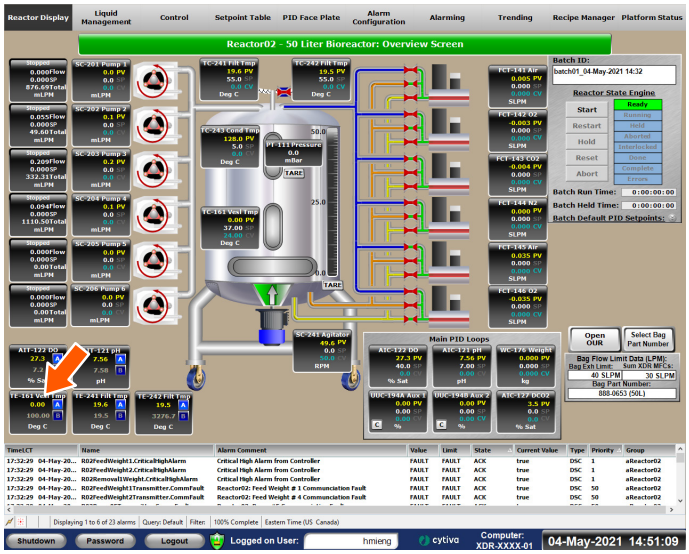
Step	Action
1	Set the circulating bath temperature to the batch operating temperature (middle calibration point). ***Note:*** *The batch operating temperature is the crucial temperature of the process.*
2	Verify that the temperature probe is correctly connected to the I/O Cabinet.
3	Set the standard probe of the temperature calibration instrument and the temperature probe into the circulating bath, no more than 20 mm apart. Make sure that the temperature probe is inserted into the liquid by at least 7.5 cm. ***Note:*** *Do not wet the probe connector.*
4	Wait until the system reaches the equilibrium.
5	Record the data for both the temperature probe and the standard probe. The following information describes where the data is found. • The data for the temperature probe is shown on the vessel temperature panel on the ***Reactor Display*** screen.  If the probe contains two RTDs, record both A and B channels. • The standard probe temperature is shown on the temperature indicator on the standard probe.
6	Set the circulating bath temperature to one of the calibration end point temperatures; or use another bath if available. Repeat steps 3 to 5 above.

Step	Action
7	Set the circulating bath temperature to the other calibration end point temperature; or use another bath if available. Repeat steps 3 to 5 above.
8	Evaluate the obtained results considering the following: • Manufacturer's tolerance: ± 0.2°C • Process tolerance: determined by the end user.

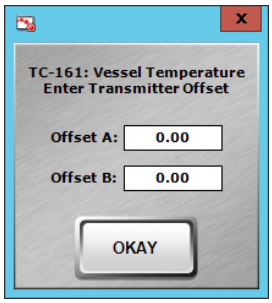
Adjustment

If the temperature probe is out of tolerance, follow the steps below to adjust the probe.

Step	Action
1	Using the data obtained during the calibration procedure, calculate the offset to adjust the probe temperature to the recorded standard probe temperature: Offset = reading of the standard probe temperature - probe reading. ***Note:*** *Use the data obtained at operating temperature (middle calibration point) for best overall accuracy.*
2	If the probe contains two RTDs, calculate the offsets for both A and B channels.
3	Click the temperature probe selection panel on the ***Reactor Display*** screen.



Step	Action
	Result: The calibration offset dialog box opens.



4	In the dialog box, type the calculated offsets into the text boxes.
5	Click ***OKAY***.

If the adjustment of the temperature probe at the operating temperature does not bring the system into tolerance, replace the temperature probe and repeat the calibration procedure.

If the calibration of the new temperature probe does not bring the system into tolerance, contact your Cytiva representative for service.

8.7.5 Exhaust filter heater calibration

Qualifications

The exhaust filter heater must be calibrated by a calibration technician.

Preparation

Each exhaust filter heater has two temperature sensors, both sensors must be calibrated.

Before you start to calibrate the exhaust filter heater, prepare the following:

- A temperature calibration standard with thermocouple with the following characteristics:
  - A beaded thermocouple or a thermocouple probe with diameter < 2 mm
  - The whole length of the thermocouple should be inside the filter heater
  - Suggested type: a narrow ungrounded sheath, or a flat surface measuring type
  - For test accuracy ratio 4:1, the minimum required accuracy of the thermocouple is ± 1.25°C
- Tape, rated for working environment

Calibration

The recommended calibration is a single point calibration at the batch operating temperature.

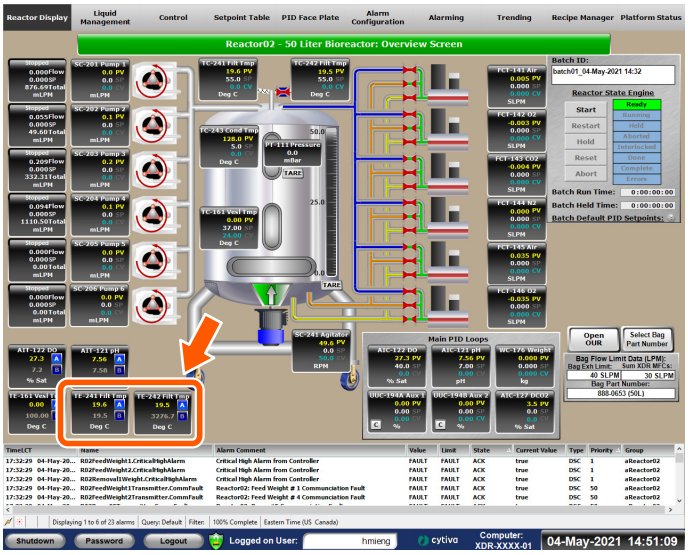
Follow the instructions below to calibrate the exhaust filter heater.

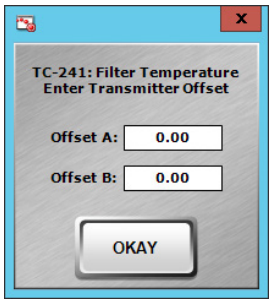
Step	Action
1	Place the thermocouple inside of the exhaust filter heater body, halfway up the length of the body and at an angle of 90° to the wire entry point.
2	Fasten the thermocouple with tape.
3	If the thermocouple is a probe type thermocouple, verify that the entire length of the probe is in contact with the inside wall of the exhaust filter heater.
4	Close the exhaust filter heater body using tape to prevent the leakage of warmed air and simulate the presence of the filter.
5	Warm the exhaust filter heater: set the exhaust filter heater in ***Auto/Local*** mode and enter the setpoint as described for actual use. See *Heat up the exhaust filter heater, on page 259* for detailed instructions.
6	Wait at least one hour for the system to come to thermal equilibrium.
7	Follow your metrology department procedures in recording and comparing the measured temperature for the tested unit and the standard.

Adjustment

If the exhaust filter heater temperature sensors are out of tolerance, follow the instructions below to adjust the heater.

Step	Action
1	Using the data obtained during the calibration procedure, calculate the offset to adjust the temperature to the recorded standard temperature: Offset = standard temperature reading - probe reading. ***Note:*** *Use the data obtained at operating temperature (middle calibration point) for best overall accuracy.*
2	Click the exhaust filter heater probe selection panel on the ***Reactor Display*** screen.



Step	Action
	Result: The calibration offset dialog box opens. 
3	In the dialog box, type the calculated offsets for each sensor of the exhaust filter heater into the text boxes.
4	Click ***OKAY***.

If the new calibration does not bring the system into tolerance, contact your Cytiva representative for service.

8.8 Software maintenance

Introduction

This section gives information about necessary maintenance of XDR-50 to 2000 Bioreactor Systems software.

In this section

Section		See page
8.8.1	Passwords	481
8.8.2	Add and remove users	483

8.8.1 Passwords

Password policy

Passwords are bound by 21CFR Part 11 and expire according to predetermined intervals set by the customer.

When logging on for the first time, the user needs to change the password.

When a password has expired, it needs to be changed.

Password requirements

The following restrictions apply to the passwords:

- Password minimum length is 12 characters.
- Password must contain at least 3 of the following categories:
  - English uppercase letters A through Z
  - English lowercase letters a through z
  - Numbers 0 through 9
  - Non-alphabetic characters, for example !, $, #, %
- The last 24 previously used passwords cannot be reused.
- The passwords expire every 180 days (by default).
- The user account is locked out after 3 failed logon attempts with incorrect password (by default).

Account lockout

Entering the wrong password three times results in account lockout. If your account has been locked out:

- Wait 30 minutes for an automatic unlock

  or

- Ask the XDRAdministrator to unlock it.

Note: *If the XDRAdministrator account is locked out, only Cytiva service personnel can reset their password.*

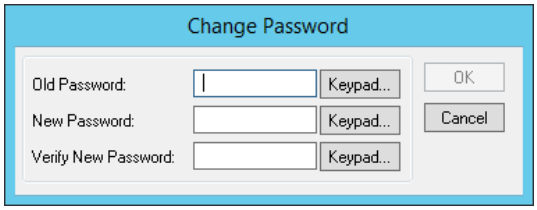
Change the password

Follow the instructions below to change the password.

Step	Action
1	Click ***Password*** on the footer toolbar.



Result:
Change Password dialog box opens.



2	Type the old password.
3	Type the new password. ***Note:*** *See Password requirements, on page 481 for information about passwords.*
4	Type the new password to confirm.
5	Click ***OK***. *Result:* The password has been changed.

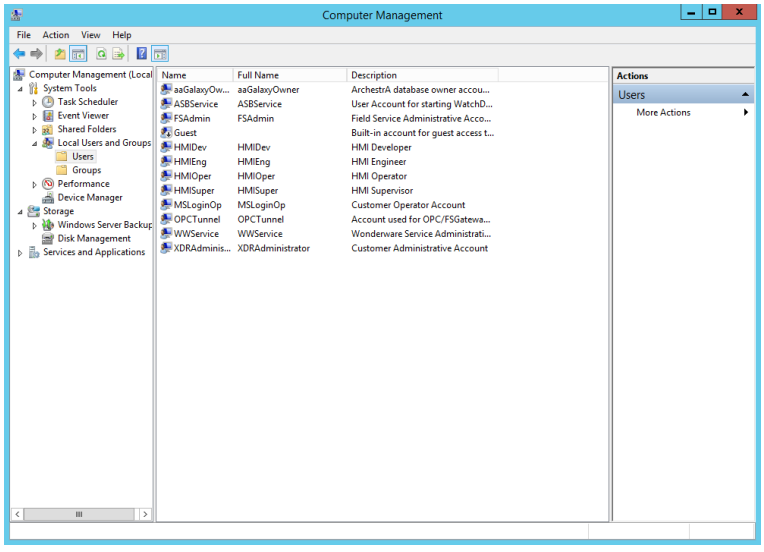
8.8.2 Add and remove users

Introduction

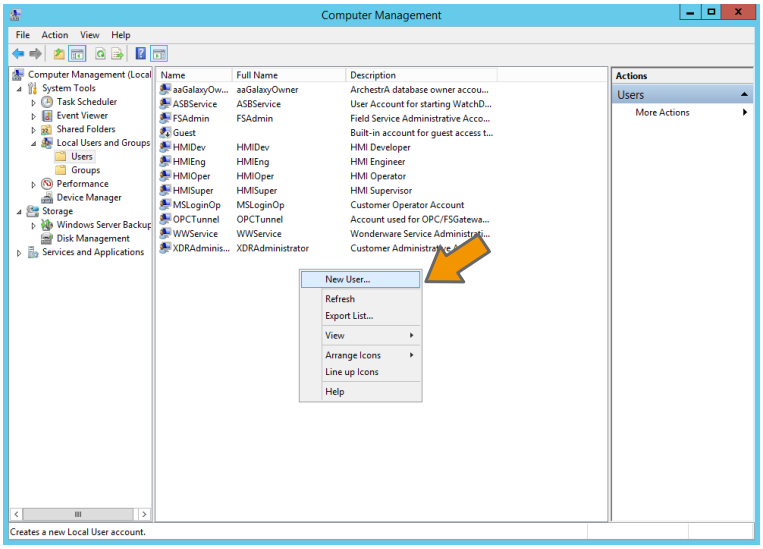
This section gives instructions on how to create, delete and manage user accounts. Only users with Windows Administrator access level have permission to perform these tasks.

Add a user account

Follow the instructions below to add a user account.

Step	Action
1	Log off from Windows: **a.** Press the Windows button on the keyboard. **b.** Click ***Start***. **c.** Select ***Shut down*** →***Log off***.
2	Log on as Windows Administrator.
3	On the ***Start*** menu, click ***Administrative Tools*** →***Computer Management***. *Result:* The ***Computer Management*** screen opens. 
4	In the left pane, select ***System Tools*** →***Local Users and Groups*** →***Users***.

Step	Action
5	Right-click in the white space in the center pane, click ***New User*** on the shortcut menu.

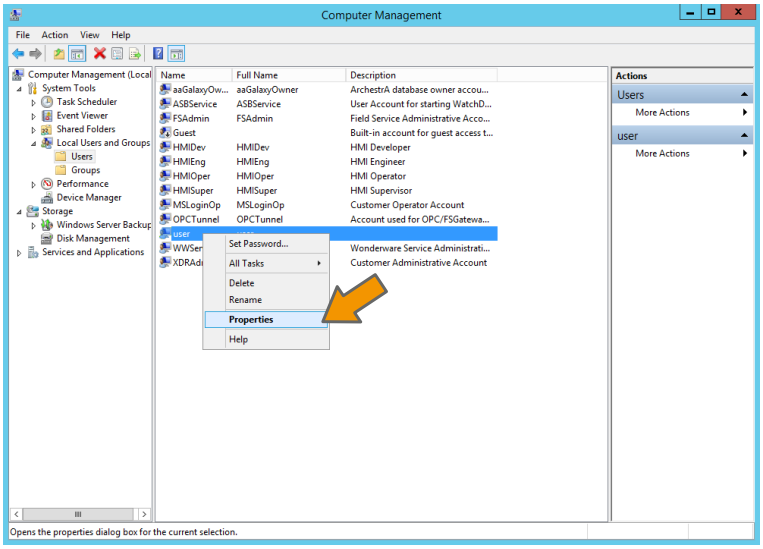


6	Complete the ***New User*** dialog. Set a temporary password for the new user according to your company policy. Select the box ***User must change password at next logon***. ***Note:*** *For 21CFR Part 11 compliance, the user must set their own password before using the system. The administrator may create a temporary password and provide it to the user.*
7	Click ***Create*** to add the user. *Result:* The dialog box closes. The new user is added to the list in the center pane.

Configure user properties

Follow the instructions below to configure the properties for the added user.

Step	Action
1	Right-click the new user in the center pane, click ***Properties*** on the shortcut menu.



Result:

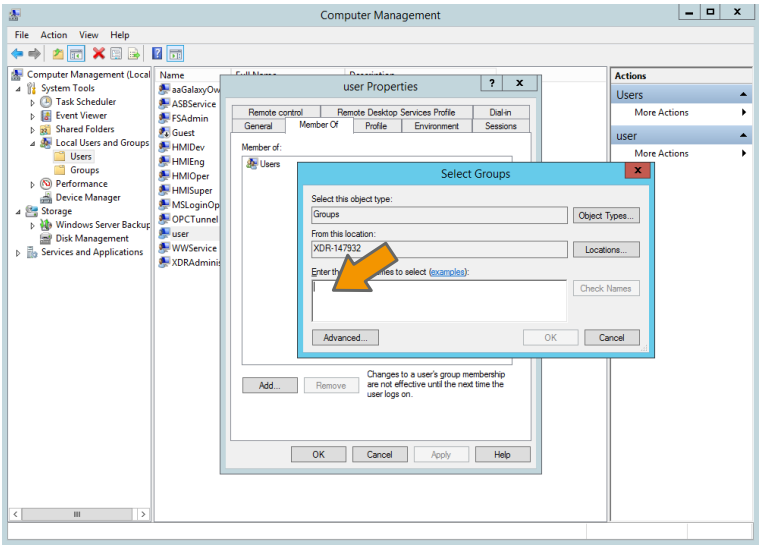
A dialog box opens.

2	On the ***Member of*** tab, click ***Add***.

Result:

A new dialog box opens.

Step	Action
3	Type the group names HMI Operators, HMI Supervisors, HMI Administrators, as applicable for the added user, in the text box in the topmost dialog box.



4	Click ***Select Names*** at the right of the text box. *Result:* The qualified group names are added to the user.
5	Close the dialog boxes by clicking ***OK***.
6	Close the ***Computer Management*** screen.
7	Log off.

Unlock a locked-out user account

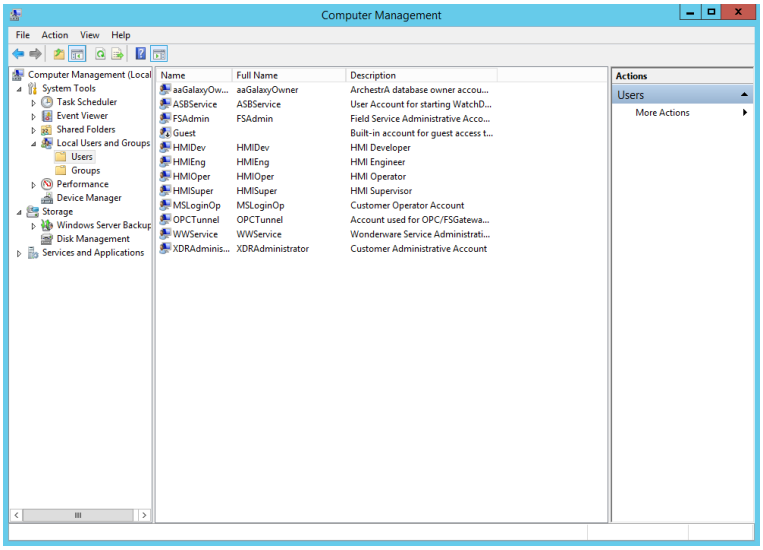
Follow the instructions below to unlock a user account.

Step	Action
1	Log on as Windows Administrator.
2	On the ***Start*** menu, click ***Administrative Tools*** →***Computer Management***.

Step	Action

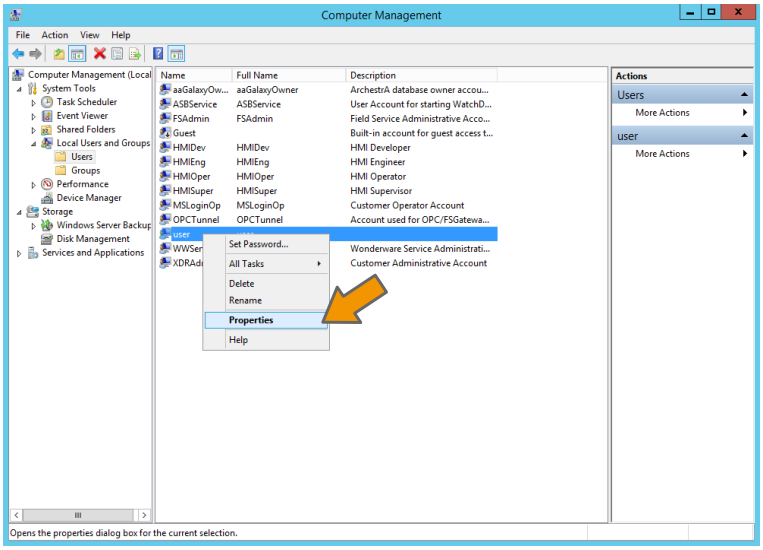
Result:

The ***Computer Management*** screen opens.



3 In the left pane, select ***System Tools*** →***Local Users and Groups*** →***Users***.

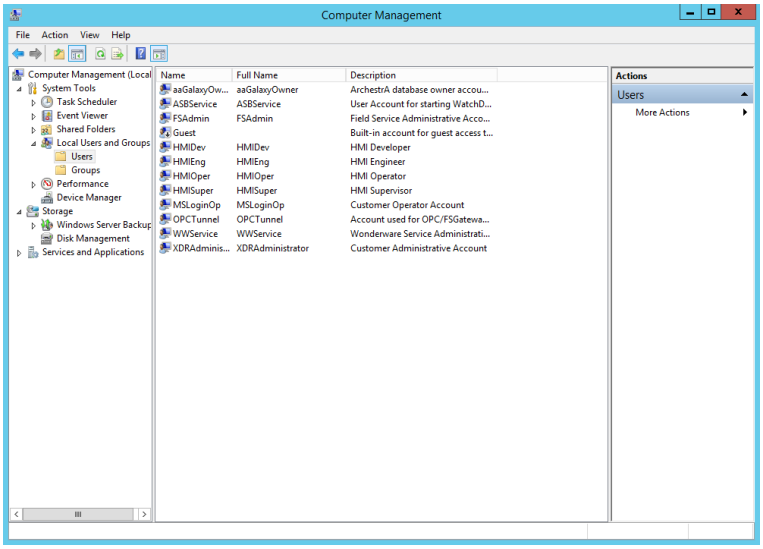
4 Right-click the new user in the center pane, click ***Properties*** on the shortcut menu.



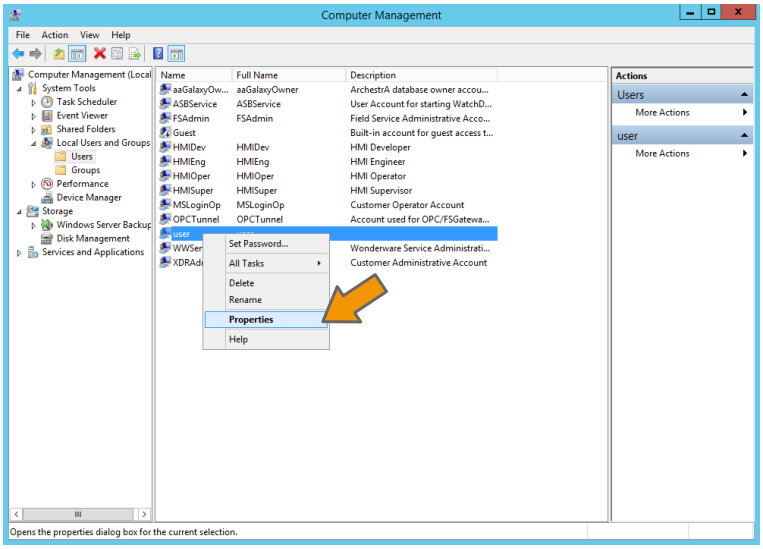
Step	Action
	Result: A dialog box opens.
5	Click to clear the ***Account is locked out*** check box.
6	Close the dialog box and the ***Computer Management*** screen.
7	Log off.

Disable a user account

Follow the instructions below to disable a user account.

Step	Action
1	Log on as Windows Administrator.
2	On the ***Start*** menu, click ***Administrative Tools*** →***Computer Management***. *Result:* The ***Computer Management*** screen opens. 
3	In the left pane, select ***System Tools*** →***Local Users and Groups*** →***Users***.

Step	Action
4	Right-click the new user in the center pane, click ***Properties*** on the shortcut menu.



Result:

A dialog box opens.

5	Select the ***Account is disabled*** check box. Click ***OK***.
6	Close the dialog box and the ***Computer Management*** screen.
7	Log off.

Delete a user account

The user is permanently removed and is not able to access any password-protected functions after this procedure. Historical data on the server are not changed.

Adding a new user with the same user name does not restore access to information connected to the original user. Consider disabling a user account instead if the user access might be renewed in the future.

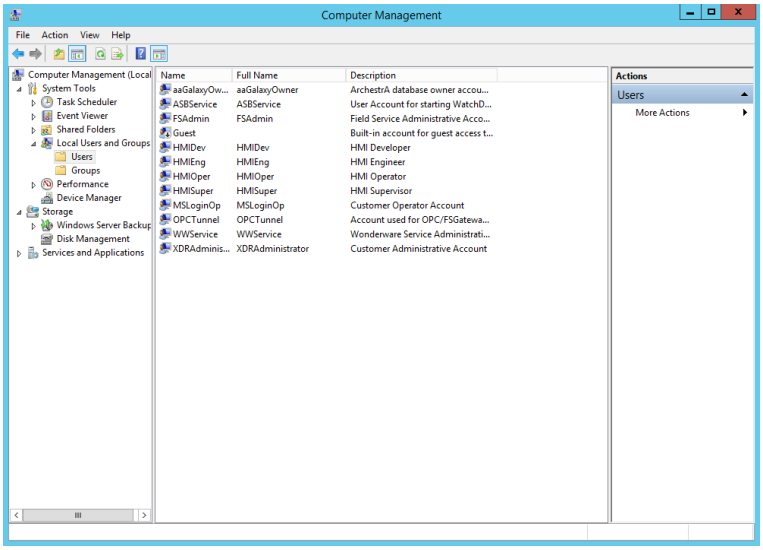
Follow the instructions below to permanently delete a user account.

Step	Action
1	Log on as an XDRAdministrator or as a member of the Administrators user group.
2	On the ***Start*** menu, click ***Administrative Tools*** →***Computer Management***.

Step	Action

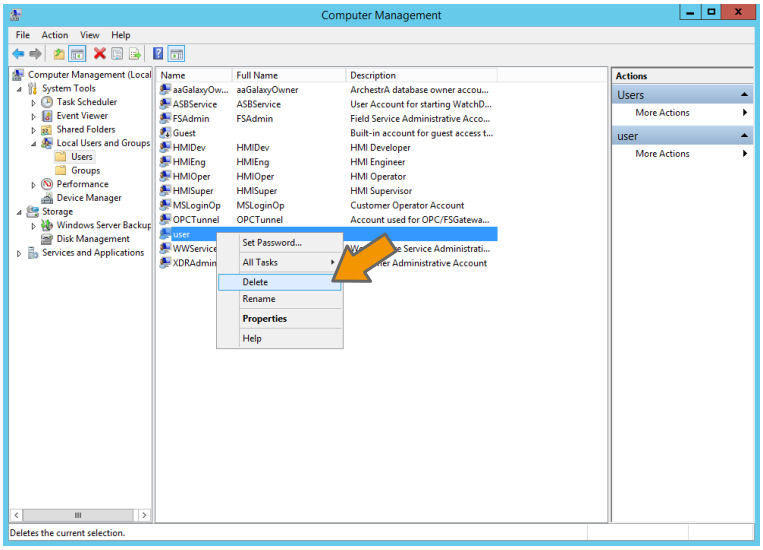
Result:

The ***Computer Management*** screen opens.



3 In the left pane, select ***System Tools*** →***Local Users and Groups*** →***Users***.

4 Right-click the user name in the center pane, click ***Delete*** on the shortcut menu.



Step	Action
	Result: A warning message is shown.
5	Click ***Yes*** to confirm the removal of the user account if the consequences of the removal are acceptable.
6	Close the dialog box and the ***Computer Management*** screen.
7	Log off.

8.9 Database maintenance

Introduction

NOTICE

It is recommended that backups of critical data files are taken regularly. Refer to the site policy on backup and restore time schedule.

This section gives information how to back up and restore AVEVA application database files (includeds alarms and events, trending) for XDR bioreactor.

An external USB hard drive is used to store the backups.

Only users with Windows Administrator access rights can work with these tasks.

In this section

Section		See page
8.9.1	General information	493
8.9.2	Data storage	494
8.9.3	Back up and store data	496

8.9.1 General information

More information

Refer to AVEVA manufacturer's manuals for more information about database backups and restoration. The application help is available in ***Start*** →***Aveva Documentation*** →***Historian Client User Guide***, if installed at the recommended location.

8.9.2 Data storage

Database storage

AVEVA Historian application stores alarm and event data, and historical data. Four paths are used to store historical data:

- Circular path
- Alternate path
- Permanent path
- Buffer path

Note: *Buffer path is not used in current system configuration.*

Each path defines a location for historical data storage. Circular path must be located on the local drive of the Historian server. Alternate path and Permanent path can be located on different servers outside the X-Station, including storage locations on the customer network, if applicable.

The default location for the Circular path is created by AVEVA software. The number of days the data is stored at Circular path location is defined by Cytiva.

Alternate path must be defined by the customer. If the Alternate path is not defined, older data at Circular path location is deleted.

Description of locations

The following table describes the purpose of the data storage locations.

Path	Description
Circular path	The real time trending data is stored at this location. Each day the software creates at least one folder for data storage. Additional folders for the same day are created when the Historian server is restarted, or when the computer, where the Historian server is located, is restarted. The number of days the data is stored at the Circular path location is defined by Cytiva. Older data is deleted, if the Alternate path is not defined.
Alternate path	When the number of days defined for data storage at the Circular path location has passed, the software moves data from the previous days to the Alternate path location. The customer must define the Alternate path. If the Alternate path is not defined, the data older than the defined number of days at the Circular path location is deleted and permanently lost.
Permanent path	When restoring the archived data, the restored files and folders are saved at the Permanent path location. AVEVA Historian Client Trending application automatically uses data from the Permanent path location.

Folder names

The following illustration explains the principle for folder names at Circular path location.



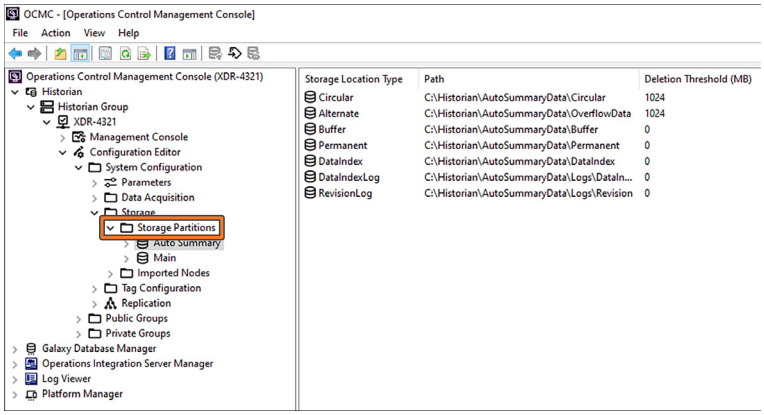
Element	Description
A	Constant prefix
YY	Year (two last digits)
MM	Month (two digits)
DD	Day (two digits)
ZZZ	Folder number for the current day (three digits)

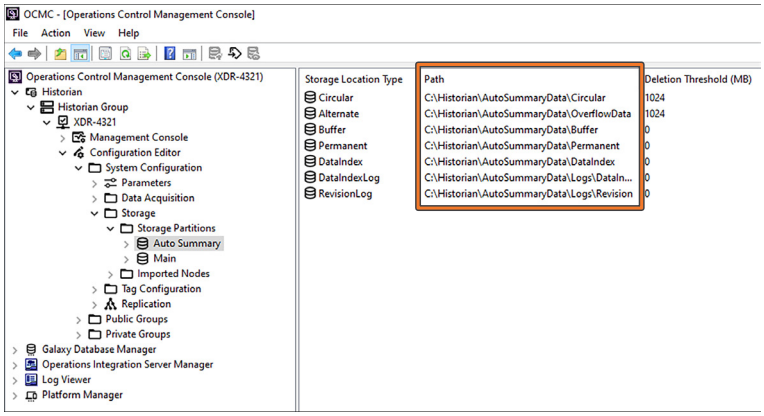
Example: ***A170905_001***.

8.9.3 Back up and store data

Record data storage locations

Before creating data backups you need to find the data storage locations on the server. All data (alarms and events, and historical data) is stored at the same location. Follow the instructions below to find and record the data storage locations.

Step	Action
1	Log on to the X-Station as Windows Administrator.
2	In the bottom left corner of the taskbar, click the Windows button and search for ***Operations Control Management Console (OCMC)***. Open this application.
3	In the left-hand pane of the ***OCMC*** screen, open the ***ArchestrA System Management Console*** →***Historian*** →***Historian Group*** →***[Your server name]*** →***Configuration Editor*** →***System Configuration*** →***Storage*** →***Storage Partitions*** folder. 
4	Record the paths shown in the right-hand pane: • Circular • Alternate

Step	Action
	• Permanent  ***Note:*** *Buffer path is not used in current system configuration.*

Back up data

All data is stored at the same location. Follow the instructions below to back up the data.

Step	Action
1	Remove the protective cover from the USB connection port on the X-Station.
2	Remove the USB port lock. See *Unlock USB port, on page 671* for instructions.
3	Connect an external USB hard drive to the USB connection port. ***Note:*** *The external USB drive must not require installation of drivers onto the X-Station computer.*
4	Log on to the X-Station as Windows Administrator.
5	In Windows Explorer, open the Circular path folder on the Historian server, as recorded in *Record data storage locations, on page 496*.
6	Select all subfolders in the Circular path folder, that contain data from previous days. Do not include the folders with data from the current day. See *Folder names, on page 495* for more information.

Step	Action
7	Copy the selected subfolders to the external hard drive. Create the folder structure as applicable. ***Tip:*** *We recommend that each backup folder on the external hard drive includes the current backup date, for example Circular_Backup_YYYYDDMM.*
8	Open the Alternate path folder on the Historian server, as recorded in *Record data storage locations, on page 496*. If this folder is empty, continue as described in step 9 below.
9	Select all subfolders in the Alternate path folder, that contain data from previous days. Do not include the folders with data from the current day.
10	Copy the selected subfolders to the external hard drive. Create the folder structure as applicable.
11	Open the Permanent path folder on the Historian server, as recorded in *Record data storage locations, on page 496*. If this folder is empty, your historical data backup is completed.
12	Select all subfolders in the Permanent path folder, that contain data from previous days. Do not include the folders with data from the current day.
13	Copy the selected subfolders to the external hard drive. Create the folder structure as applicable. *Result:* The historical data backup is completed.
14	Insert the USB port lock. See *Lock USB port, on page 673* for instructions.
15	Put the protective cover onto the USB connection port.

Restore data

Follow the instructions below to restore all data (alarms and events, and historical data) from the external USB hard drive.

Step	Action
1	Remove the protective cover from the USB connection port on the X-Station.
2	Remove the USB port lock. See *Unlock USB port, on page 671* for instructions.

Step	Action
3	Connect the external USB hard drive that contains your data backup to the USB connection port. ***Note:*** *The external USB drive must not require installation of drivers onto the X-Station computer.*
4	Log on to the X-Station as Windows Administrator.
5	In Windows Explorer, open the folder on the external hard drive where the backup for the Circular path folder data is located. See *Back up data, on page 497* for more information about backup creation.
6	Select all subfolders that you want to restore.
7	Open the Circular path folder on the Historian server, as recorded in *Record data storage locations, on page 496*. Copy the selected subfolders into the Circular path folder.
8	Open the folder on the external hard drive where the backup for the Alternate path folder data is located.
9	Select all subfolders that you want to restore.
10	Open the Alternate path folder on the Historian server, as recorded in *Record data storage locations, on page 496*. Copy the selected subfolders into the Alternate path folder.
11	Open the folder on the external hard drive where the backup for the Permanent path folder data is located.
12	Select all subfolders that you want to restore.
13	Open the Permanent path folder on the Historian server, as recorded in *Record data storage locations, on page 496*. Copy the selected subfolders into the Permanent path folder. *Result:* The Circular, Alternate, and Permanent path folder data are restored.
14	Insert the USB port lock. See *Lock USB port, on page 673* for instructions.
15	Put the protective cover onto the USB connection port.

8.10 Storage

Storage conditions

Follow the recommendations below to store the system.

- Store the system indoors in a dust-free environment with a well-controlled climate.
- Keep humidity and temperature fluctuations as low as possible to minimize condensation and corrosion.
- Maintain the storage area at a constant temperature in the range of 4°C to 40°C.
- Maintain the storage area at a constant relative humidity ≤ 80%, non-condensing.
- Do not expose the system to aggressive chemicals, for example strong acids, bases, chlorides, or salt.

Start-up after storage

After long term storage, it is recommended that trained and certified personnel perform a preventive maintenance test procedure on all system components, sensors, pumps, and valves.

9 Troubleshooting

About this chapter

This chapter provides information to help users and service personnel to identify and correct problems that may occur when operating XDR-50 to 2000 Bioreactor Systems. If the suggested actions in this guide do not solve the problem, or if the problem is not covered by this guide, contact your Cytiva representative for advice.

In this chapter

Section		See page
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9.2	Bag pressure	504
9.3	Condenser	505
9.4	I/O Cabinet	506
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9.1 Agitation

Problem	Possible causes	Corrective action
The agitator does not start.	The agitator is not enabled.	Enable the agitator. See *Start the agitator motor, on page 365* for instructions.
	A fuse has blown and the agitator is not powered.	Contact your Cytiva representative to replace the fuse.
	The system is in the state of ***E-Stop Active***.	Start the agitator when the system has been restarted after emergency shutdown. ***Note:*** *The agitator cannot be started while the system is in the state* ***E-Stop Active****.*
	The bioreactor is in ***Manual*** mode and cannot accept the setpoint.	1. Set the system to ***Auto*** mode. 2. Enter the setpoint. ***Note:*** *When the bioreactor is in* ***Manual*** *mode, the setpoint is ignored.*
The agitator assembly does not fit properly in place.	The agitator is not properly aligned.	Contact your Cytiva representative to schedule agitator alignment check and maintenance.
Agitator drive head rubs against the impeller baseplate support and a grinding sound is emitted. Plastic filings might be generated.		
Agitator drive is not functioning as expected.	Agitator is disabled in the software.	Enable the agitator. See *Start the agitator motor, on page 365* for instructions.
	The motor is overloaded.	Acknowledge the agitator fault and try to restart the motor. If the error continues, contact Cytiva for service.
	Power cable is not connected.	Connect the power cable.
	Circuit breaker is tripped.	Reset the circuit breaker.

Problem	Possible causes	Corrective action
	The fuse to the agitator drive is open.	Contact Cytiva to replace the fuse.
	The agitator drive is broken.	Contact Cytiva to replace the drive.

9.2 Bag pressure

Problem	Possible causes	Corrective action
Bag pressure is too high.	The bag pressure sensor cable is not connecting with the sensor assembly.	Make sure that the cable connector is oriented correctly and is firmly pushed together.
	The input on the system has an error.	Contact your Cytiva representative to schedule service.
	The exhaust filter has become wet.	1. Stop the mass flow controllers. 2. Clamp off the affected filter. 3. Install a new filter, keep aseptic conditions during the procedure. 4. Use a clamp to isolate the wet filter and prevent contamination of the batch.
	The exhaust filter is under-sized for the current gas flow rate.	Install a larger filter to prevent excessive back-pressure.
	The bag pressure was not tared when the bag was installed.	1. Stop all gas flow into the bag. 2. Wait until the bag pressure reaches 0 bars (15–20 seconds). 3. Tare the bag pressure sensor. See *Tare bag pressure, on page 287* for the instructions.
	The bag pressure sensor is unplugged.	Plug in the pressure sensor. ***Note:*** *If the sensor was tared previously, it does not need to be tared again.*
	The exhaust filters have been clogged and the pinch valve has not opened.	Check that the compressed air tubing to the pinch valve is correctly connected and without obstructions.
	Incorrect condenser bag installation.	Verify that the condenser bag is correctly installed.

9.3 Condenser

Problem	Possible causes	Corrective action
Condensate accumulation in condensate outlet tubing.	Temperature sensor on the cooling plates has failed.	Contact your Cytiva representative to replace the temperature sensor.
	Incorrect condenser bag installation.	Install the condenser bag as described in *Install the condenser bag, on page 235*.

9.4 I/O Cabinet

Problem	Possible causes	Corrective action
No power supply to the I/O Cabinet.	Cabinet main power is switched off.	Turn on the main power.
	Circuit breaker is tripped.	1. Verify that the condition which caused the trip is identified and fixed. 2. Reset the circuit breaker.

9.5 Exhaust filter heater

Problem	Possible causes	Corrective action
Filter heater temperature does not increase.	The filter heater cable is not connected to the I/O Cabinet.	Connect the filter heater cable to the I/O Cabinet.
	The wrong filter heater cable is connected to the I/O Cabinet.	Verify that the appropriate filter heater cable is connected to the I/O Cabinet.
	The filter heater fuse has blown.	Contact your Cytiva representative for help.

9.6 Liquid Management (optional function)

Problem	Possible causes	Corrective action
The pump CV increases to 100%, but the feed container weight does not decrease.	The pump is not working.	Replace the pump.
	The tubing is not correctly installed in the pump.	Install the tubing correctly.
	The tubing is clamped.	Verify that the tubing is not clamped.
	The outlet tubing from the feed container is feeding back into the container.	Connect the tubing to the input tubing of the disposable bag.

9.7 Mass flow controllers

Problem	Possible causes	Corrective action
The mass flow controller does not reach setpoint.	The incoming gas supply is insufficient.	Make sure that the gas supply is sufficient for the instrument.
	The gas supply has run out.	Replace the gas supply.
	Total gas flow rate specified in the software for all MFCs is higher than the gas flow limit that is allowed for the selected bag type.	• If the disposable bag type is not correct, select the correct bag type. See *Section 6.4.4 Select disposable bag, on page 229* for more information. • If the bag type is correct, decrease the CVHL values for the MFCs.
The cabinet makes a clicking sound when the MFCs are off.	The solenoid valves are opening and closing because of an error in the mass flow controller.	Calibrate the mass flow controller.

9.8 pH control

Problem	Possible causes	Corrective action
pH does not reach equilibrium even if the pumps are running.	The deadband is set to 0.	pH control must use a deadband. If no deadband is used, acid and base are alternately introduced. Define a deadband value appropriate to your process.
	Acid/base supply is empty.	Fill the acid/base supply vessel.
	The pumps are not primed.	Prime the pumps.
	Feed line before or after the pump is kinked.	Free the feed line.
	Feed line before or after the pump is clamped.	Free the feed line.
	PID parameters are not appropriate for the system.	Do a study to verify the control parameters. The following factors have been identified as important: • Quantity of media • The pump type • Concentration of acid and base • Mapping strategy • Buffering capability of media • Mixing of the XDR vessel contents (weight and viscosity dependent)

9.9 pH/DO monitoring

Problem	Possible causes	Corrective action
Measurement reading is not shown in the WindowViewer application but is shown on pH/DO transmitter on the I/O Cabinet.	PROFIBUS cable to the transmitter is disconnected.	Switch to the second probe. Contact Cytiva for equipment service.
	Sensor cable is not properly connected.	Connect the sensor cable.
pH sensor changes are very slow: two sensors change their readings at different rates.	The pH sensor needs cleaning.	If available, switch the input to the second pH channel. Keep probes clean between uses, and clean them with a solution designed to maintain their properties. Replace probes regularly.
pH sensor changes are very slow: pH control is not rapid enough for the application.	The tuning parameters or the concentration of the applied acid or base are not sufficient.	Do a study to find the best tuning parameters for your system and available reagents.
Measurement value is not as expected.	pH or DO connector was wetted and did not dry completely.	Verify that the connectors are clean and dry. The connector may be cleaned with isopropyl or methyl alcohol to remove water from beneath the contacts. ***Note:*** *Do not immerse the plug ends in liquid. Use an aerosol spray to introduce the alcohol.*
	The probe was not standardized prior to installation into the disposable bag.	Make sure all probes are standardized prior to installation.
	pH or DO connector is not properly tightened or installed.	1. Remove the sensor from the cable and re-attach the sensor. 2. Do not cross-thread the probe cable. Make sure that no thread is visible on the probe. 3. Tighten the connection properly. Carefully push the connector together when tightening it.

Problem	Possible causes	Corrective action
DO measurement value is not as expected: irregular or spiky signal.	DO probe is not fully inserted into the disposable bag.	Make sure that the probe is fully inserted: the probe tip should be approximately 8 mm above the inside surface of the disposable bag. Use a flashlight for inspection, if needed. See *Install probe sheath assembly, on page 265* for more information.
	Rosemount transmitter chassis is not grounded.	Verify that the chassis is grounded. Verify that the DO cable connector is grounded. If these items are not grounded, contact your Cytiva service engineer.
Different probes in the same solution show different pH readings.	One of the pH probes is not calibrated.	Calibrate pH probes before use.
	Probe may be at the end of its life cycle.	Replace the probe.
Large change in the DO value when the probe cable or probe connector is touched.	Electrolyte amount in the probe cap is not sufficient.	Half of the probe cap must be filled with electrolyte. If the electrolyte volume is not sufficient, the air inside the probe cap may move inside probe cap. This may cause signal disturbance. Always fill the probe cap with new electrolyte solution before autoclaving.
	Probe cap is not sufficiently tightened.	Always tighten the probe cap firmly before autoclaving. If the probe cap is not correctly tightened, squeezing or bending of the cap may cause sudden change of the signal.
	DO probe is not tilted. Air bubbles assemble on the probe membrane and cause signal disturbance.	Make sure that the DO probe is slightly tilted (approximately 15 degrees): the probe end inside the disposable bag must be lower than the connector end of the probe sheath.

9.10 Pumps

Problem	Possible causes	Corrective action
The tubing is moving in the pump head.	The tubing clamps in the pump head are not properly set for the installed tubing.	Tighten the tubing clamps in the pump head.
	The tubing is not fastened in the pump head (pump model 313).	Adjust the gripping elements using the adjustment wheels on the lower right and left sides of the pump. 
The pump drive head is not turning.	• Loose wiring • Failed motor • Broken gearbox	Contact your Cytiva representative for replacement.
	The system is in ***E-Stop Active*** mode.	Verify that the cause of the ***E-Stop Active*** condition is eliminated, and clear the ***E-Stop Active***. Try to use the pumps again.
	Instrument weight is more than 20% above its volumetric capacity. The system is automatically preventing an overfilling event.	Reduce the instrument weight.
	A fuse has blown.	Use a functional pump head until a repair can be made. Contact your Cytiva representative for service.
The tubing is worn out.	All tubing used in the pumps will wear out with use over time.	Move the section of worn out tubing to the left or right. Use only tubing rated for use in peristaltic pump head.

Problem	Possible causes	Corrective action
The pumped volume is inaccurate.	The pump was not calibrated after the tubing was changed.	Calibrate the pump using the same tubing as planned for operation.

9.11 Temperature control

Troubleshooting for most common TCU models is described below. If your TCU model is not described, contact your Cytiva representative for help with troubleshooting.

Problem	Possible causes	Corrective action
Temperature control unit (TCU) does not receive setpoint data: • the temperature is not regulated • XDR vessel jacket does not feel warm • TCU does not sound as running	TCU is not powered.	Switch on the power.
	There is no connection between the I/O Cabinet and the PolyScience TCU.	Check if the connection between the I/O Cabinet and TCU is functioning properly. Do the following: 1. Hold the clock button on the left side of the TCU until ***HL*** is displayed (a few seconds). 2. Press the clock button repeatedly until ***CC*** is shown on the left display. 3. If the display message is ***yes***, the connection is working properly. 4. If the display message is ***no***, the connection is not functioning. Check the connection cable between the TCU and the I/O Cabinet.
	There is no connection between the I/O Cabinet and the Mokon TCU.	Check if the connection between the I/O Cabinet and TCU is functioning properly. Do the following: 1. Verify that the controller located on the front of the TCU is powered. 2. Disconnect the cable between the TCU and the I/O Cabinet. 3. Verify that the connector pins are not bent or damaged. Check both ends of the cable. 4. Inspect the whole length of the cable for damage. 5. Verify that the controller is set up to accept a remote input. Refer to Mokon manufacturer's manual for this procedure.

9.12 Temperature monitoring

Problem	Possible causes	Corrective action
Temperature monitoring is not working as expected.	Temperature probe has failed.	Switch to the second input of the temperature probe if it is functioning.
	Temperature probe is not inserted into the disposable bag.	Insert temperature probe into the thermowell.

9.13 Valves

Gas supply valves

Problem	Possible causes	Corrective action
Valves are not opening or closing.	System air supply is cut off.	Verify that incoming air supply pressure is in the range shown in the PID faceplate.
	System air pressure is insufficient.	Make sure that adequate air pressure is available.
The gas supply cabinet emits a hissing sound when all mass flow controllers are off.	Pneumatic supply tubing is loose.	Verify that all pneumatic connections are properly made and not leaking.

Pinch valve

Problem	Possible causes	Corrective action
The pinch valve has not opened.	Pinch valve air pressure is insufficient.	Check that compressed air tubing to the pinch valve is correctly connected and that the supply pressure is applied.

9.14 X-Station

Problem	Possible causes	Corrective action
No power supply to X-Station.	Uninterruptible power supply (UPS) is switched off.	Switch on the UPS.
	Circuit breaker is tripped.	Verify that the circuit breaker is safe to reset. Reset the circuit breaker.
	System is controlled by a GFCI (Ground Fault Circuit Interrupter).	Make sure that the circuit is not GFCI controlled. GFCI controlled circuits reduce system reliability.
Ethernet switches are not communicating (the light on the port where the X-Station is connected is not blinking).	Broken or damaged Ethernet cable.	Determine which cable is broken or damaged using an Ethernet cable tester. Replace the cable.
	Broken or damaged Ethernet connector.	Verify all connections using an Ethernet cable tester. Replace the connector.
	Defective Ethernet switch.	Replace the switch.
X-Station does not display data.	PROFIBUS cable connecting X-Station with the I/O Cabinet is missing or broken.	Install or replace the cable.

9.15 Weight monitoring

Problem	Possible causes	Corrective action
Load cell is not functioning as expected.	Load cell is disconnected.	Connect the load cell.
	Load cell has failed (physically or electrically broken).	Contact the metrology department to perform a test (cornering test) and determine which load cell has failed.
	Physical obstruction of load cell motion.	Verify that the XDR vessel legs are free of any obstructions or blocking objects.
	Jacking bolt is engaged.	Disengage the jacking bolt. See *Section 6.2 Stabilize the XDR vessel, on page 153* for instructions. ***Note:*** *If the XDR vessel was filled while the jacking bolt was engaged, the weight measurements of the batch are not accurate.*
	The configuration on the load cell transmitter is incorrect or corrupt.	Contact your Cytiva representative.
	Load cells require calibration.	Schedule the calibration of the load cells.

10 Reference information

About this chapter

This chapter provides required information that is useful when installing, operating, maintaining and troubleshooting XDR-50 to 2000 Bioreactor Systems. It also contains ordering information.

In this chapter

Section		See page
10.1	System specifications	521
10.2	CV and SP units and ranges	523
10.3	Minimum working volumes	524
10.4	Pump characteristics	525
10.5	Disposable bag specifications	526
10.6	Environmental requirements	527
10.7	TCU coolant specifications	528
10.8	Recycling information	529
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10.1 System specifications

Property	System	Value
Supply voltage	I/O Cabinet	• 110 V AC ± 10%, 1 phase, 50/60 Hz, 14 A • 220 V AC ± 10%, 1 phase, 50/60 Hz, 6 A
	X-Station	• 110 V AC ± 10%, 1 phase and protective earth, 50/60 Hz, 2.9 A • 220 V AC ± 10%, 1 phase and protective earth, 50/60 Hz, 1.5 A
Maximal power consumption	XDR-50 to 2000 Bioreactor Systems	1.4 kVA
Dimensions (Width x Height x Depth)	X-Station	601 × 1466 × 798 mm (23⅝ × 57¾ × 31½ inches)
	50 L bioreactor (single frame design)	149 × 211 × 123 cm (58½ × 82¾ × 42⅛ inches)
	50 L bioreactor (split frame design)	162 × 211 × 123 cm (63¾ × 82¾ × 42⅛ inches)
	200 L bioreactor	148 × 233 × 107 cm (58⅛ × 91⅜ × 41¾ inches)
	500 L bioreactor	170 × 224 × 116 cm (66⅝ × 88 × 45½ inches)
	1000 L bioreactor	181 × 297 × 132 cm (70⅞ × 116⅝ × 51¾ inches)
	2000 L bioreactor	197 × 347 × 149 cm (77½ × 136¼ × 58½ inches)
Weight	X-Station	146 kg (321 lb)
	50 L bioreactor (single frame design)	466 kg (1028 lb)
	50 L bioreactor (split frame design)	550 kg (1213 lb)
	200 L bioreactor	570 kg (1257 lb)

Property	System	Value
	500 L bioreactor	669 kg (1475 lb)
	1000 L bioreactor	874 kg (1927 lb)
	2000 L bioreactor	1135 kg (2502 lb)
Jacket volume	50 L bioreactor	3.02 L
	200 L bioreactor	6.29 L
	500 L bioreactor	10.76 L
	1000 L bioreactor	19.73 L
	2000 L bioreactor	36.78 L
Ambient temperature	X-Station	0°C to 30°C
	XDR-50 to 2000 Bioreactor Systems	5°C to 30°C
Relative humidity	X-Station	5% to 95%, non-condensing
	XDR-50 to 2000 Bioreactor Systems	≤ 90%, non-condensing
Sound level	XDR-50 to 2000 Bioreactor Systems	< 70 dB(A)

10.2 CV and SP units and ranges

Product information

Refer to the Setpoint List and the I/O List in the Product Documentation package (ToP).

10.3 Minimum working volumes

Product information

Refer to the General Specification in the Product Documentation package (ToP).

10.4 Pump characteristics

Pump types

XDR-50 to 2000 Bioreactor Systems use Watson-Marlow pump models 114, 313, 520, and external pumps models 530, 630, and 730. Refer to the General Specification in the Product Documentation package (ToP) for more information.

10.5 Disposable bag specifications

Storage of the disposable bag assembly

The storage temperature for the disposable bag assembly should be between 10°C and 34°C. Information about the storage temperature is shown on the bag label, near the  symbol.

Operating temperature

The disposable bag assembly is rated for temperatures between 2°C and 60°C.

10.6 Environmental requirements

Environmental specifications

The installation site must comply with the following specifications:

Process	Parameter	Specification
Operation	Allowed location	Indoor use only
	Ambient temperature	5°C to 30°C
	Relative humidity	≤ 90%, non-condensing
	Altitude	Up to 2000 m
	Pollution degree of the intended environment	Pollution degree 2
Storage	Ambient temperature	4°C to 40°C
	Relative humidity	< 80%, non-condensing
Transportation	Ambient temperature	-25°C to 60°C
	Relative humidity	5% to 95%

10.7 TCU coolant specifications

TCU water quality specifications

Tap water can be used for the temperature control unit (TCU) for operations between 15°C and 50°C. Refer to the TCU manufacturer's manual for information on water quality specifications.

If vessel jacket temperature is set below +15°C, antifreeze needs to be added to TCU coolant. The use of corrosion inhibitor in the coolant is optional. For coolant composition refer to the TCU manufacturer's manual.

See *Section 10.1 System specifications, on page 521* for information on coolant volume needed to fill the XDR vessel jacket.

10.8 Recycling information

Introduction

This section contains information about the decommissioning of XDR-50 to 2000 Bioreactor Systems.

Decontamination

The instrument shall be decontaminated before decommissioning and all local regulations shall be followed with regard to scrapping of the equipment.

Disposal

When taking the bioreactor system out of service, the different materials must be separated and recycled according to national and local environmental regulations.

Recycling of hazardous substances

The instrument contains hazardous substances. Detailed information is available from your Cytiva representative.

Disposal of electrical components



Waste electrical and electronic equipment must not be disposed of as unsorted municipal waste and must be collected separately. Contact an authorized representative of the manufacturer for information concerning the decommissioning of the equipment.

Instructions for disposal

Follow the instructions below for disposal of XDR vessel and control unit:

Step	Action
1	Separate all electronic components (terminal strips, power supplies, transmitters, external pumps, probes/sensors, etc.) from the control unit and XDR vessel.
2	Decontaminate the XDR vessel and the I/O Cabinet following appropriate procedures dependent on what type of environment the unit was located in. Contact the local processing facility or government official for specific disposal requirements for the vessel and the I/O Cabinet.
3	Decontaminate the probes and sensors that have come into contact with the process fluid. Dispose of the fluid by following the disposal of hazard materials according to the facility the unit is located in.
4	Dispose of electronic components as specified by local guidelines depending on material used in the construction of the components. Contact the local processing facility or government official for specific disposal requirements.

10.9 Regulatory information

Introduction

This section lists the directives and standards that apply to XDR-50 to 2000 Bioreactor Systems.

In this section

Section		See page
10.9.1	Contact information	532
10.9.2	European Union and European Economic Area	533
10.9.3	Great Britain	534
10.9.4	Eurasian Economic Union (Евразийский экономический союз)	535
10.9.5	North America	537
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10.9.1 Contact information

Contact information for support

To find local contact information for support and to send troubleshooting reports, visit *cytiva.com/contact*.

Legal manufacturer information

The table below summarizes the information about the legal manufacturer.

Contact information	Legal manufacturer
Name and address	Global Life Sciences Solutions USA LLC 800 Boston Turnpike Shrewsbury, MA 01545 USA
Telephone number	+ 1 800 526 3593

10.9.2 European Union and European Economic Area

Introduction

This section describes the information that applies to the product in the European Union and European Economic Area.

Conformity with EU Directives

Refer to the EU Declaration of Conformity for the directives and regulations that apply for the CE marking.

If not available at *cytiva.com* or included with the product, a copy of the EU Declaration of Conformity is available on request.

CE marking



The CE marking and the corresponding EU Declaration of Conformity is valid for the product when it is:

- used according to the *Operating Instructions* or user manuals, and
- used in the same state as it was delivered, except for alterations described in the *Operating Instructions* or user manuals.

10.9.3 Great Britain

Introduction

This section describes the information that applies to the product in Great Britain.

Conformity with UK Regulations

Refer to the UK Declaration of Conformity for the regulations that apply for the UKCA marking.

If not included with the product, a copy of the UK Declaration of Conformity is available on request.

UKCA marking



The UKCA marking and the corresponding UK Declaration of Conformity are valid for the product when it is:

- used according to the *Operating Instructions* or user manuals, and
- used in the same state as it was delivered, except for alterations described in the *Operating Instructions* or user manuals.

10.9.4 Eurasian Economic Union (Евразийский экономический союз)

Introduction

This section provides information in accordance with the requirements of the Technical Regulations of the Customs Union and (or) the Eurasian Economic Union.

Введение

В данном разделе приведена информация согласно требованиям Технических регламентов Таможенного союза и (или) Евразийского экономического союза.

Legal manufacturer and importer information

The following table provides summary information about the legal manufacturer and importer, in accordance with the requirements of the Technical Regulations of the Customs Union and (or) the Eurasian Economic Union.

Requirement	Information
Name, address and telephone number of legal manufacturer	See *Legal manufacturing information*
Importer and/or company for obtaining information about importer	Cytiva RUS LLC 109004, Moscow internal city area Tagansky municipal district Stanislavsky str., 21, building 5, premises I, offices 24,25,29 Russian Federation Telephone: +7 985 192 75 37 E-mail: *rucis@cytiva.com*

Информация о законном производителе и импортере

В следующей таблице содержится сводная информация о законном производителе и импортере в соответствии с требованиями Технического регламента Таможенного союза и (или) Евразийского экономического союза.

Требование	Информация
Имя, адрес и номер телефона законного производителя	См. *Информация об официальном производителе*

Требование	Информация
Импортер и/или лицо для получения информации об импортере	ООО "Цитива РУС" 109004, г. Москва вн. тер. г. муниципальный округ Таганский ул. Станиславского, д. 21 стр. 5, помещ. I, ком. 24,25,29 Российская Федерация Телефон: +7 985 192 75 37 Адрес электронной почты: *rucis@cytiva.com*

Description of symbol on the nameplate
Описание символов на заводской табличке

This Eurasian compliance mark indicates that the product is approved for use on the markets of the Member States of the Customs Union of the Eurasian Economic Union

Данный знак о Евразийском соответствии указывает, что изделие одобрено для использования на рынках государств-членов Таможенного союза Евразийского экономического союза

10.9.5 North America

Introduction

This section describes the information that applies to the product in the United States of America and Canada.

UL508A conformity



The UL Listed label appears only on products that are UL 508A compliant. If UL 508A compliance applies, the UL Listed mark is found inside the electrical cabinet.

FCC compliance

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Note: *The user is cautioned that any changes or modifications not expressly approved by Cytiva could void the user's authority to operate the equipment.*

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

CAN ICES/NMB compliance

This product complies with the Canadian standard ICES-001 (A) /NMB-001 (A) concerning electromagnetic compatibility.

10.9.6 General regulatory statements

Introduction

This section describes the information that is applicable to more than one geographical region.

General statement



NOTICE

This equipment is not intended for use in residential environments and may not provide adequate protection to radio reception in such environments.

Compliance statement



NOTICE

Class A equipment (equipment for business use).

This equipment has been evaluated for its suitability for use in a business environment.

When used in a residential environment, there is a concern of radio interference.



유의사항

A급 기기 (업무용 방송통신 기자재)

이 기기는 업무용환경에서 사용할 목적으로 적합성평가를 받은 기기로서 가정용 환경에서 사용하는 경우 전파간섭의 우려가 있습니다.

FDA 21 CFR Part 11 and EU Annex 11 compliance

This product and the product control system are technically developed to enable customer organization to meet requirements in 21 CFR Part 11 and EU Annex 11. For more information, refer to the following documents:

- Product Documentation package (ToP). Supplied with the product.
- Chapter "FDA 21 CFR Part 11 and GMP Annex 11 System Assessment Checklist" in Validation Support File. Available at *http://www.cytivalifesciences.com/rsf* for subscribing customers. Instructions for subscription are given at the website.

Requirement	Description
21 CFR part 11	FDA Code of Federal Regulations Title 21. Part 11: Electronic records; Electronic signatures
EU Annex 11	EudraLex - Volume 4 Good Manufacturing Practice Medicinal Products for Human and Veterinary Use Annex 11: Computerized systems

10.9.7 China

This section describes the information that applies to the product in China.

有害物质声明 (DoHS)
Declaration of Hazardous Substances (DoHS)

根据 SJ/T11364-2024《电子电气产品有害物质限制使用标识要求》特提供如下有关污染控制方面的信息。

The following product pollution control information is provided according to SJ/T11364-2024 Marking for Restriction of Hazardous Substances caused by electrical and electronic products.

电子信息产品污染控制标志说明
Explanation of Pollution Control Label



该标志表明本产品含有超过中国标准 GB/T 26572《电子电气产品中限用物质的限量要求》中限量的有害物质。标志中的数字为本产品的环保使用期，表明本产品在正常使用的条件下，有毒有害物质不会发生外泄或突变，用户使用本产品不会对环境造成严重污染或对其人身、财产造成严重损害的期限。单位为年。

为保证所申明的环保使用期限，应按产品手册中所规定的环境条件和方法进行正常使用，并严格遵守产品维修手册中规定的定期维修和保养要求。

产品中的消耗件和某些零部件可能有其单独的环保使用期限标志，并且其环保使用期限有可能比整个产品本身的环保使用期限短。应到期按产品维修程序更换那些消耗件和零部件，以保证所申明的整个产品的环保使用期限。

本产品在使用寿命结束时不可作为普通生活垃圾处理，应被单独收集妥善处理。

This symbol indicates the product contains hazardous materials in excess of the limits established by the Chinese standard GB/T 26572 Requirements of concentration limits for certain restricted substances in electrical and electronic products. The number in the symbol is the Environment-friendly Use Period (EFUP), which indicates the period during which the hazardous substances contained in electrical and electronic products will not leak or mutate under normal operating conditions so that the use of such electrical and electronic products will not result in any severe environmental pollution, any bodily injury or damage to any assets. The unit of the period is “Year”.

In order to maintain the declared EFUP, the product shall be operated normally according to the instructions and environmental conditions as defined in the product manual, and periodic maintenance schedules specified in Product Maintenance Procedures shall be followed strictly.

Consumables or certain parts may have their own label with an EFUP value less than the product. Periodic replacement of those consumables or parts to maintain the declared EFUP shall be done in accordance with the Product Maintenance Procedures.

This product must not be disposed of as unsorted municipal waste, and must be collected separately and handled properly after decommissioning.

有害物质的名称及含量
Name and Concentration of Hazardous Substances

产品中有害物质的名称及含量
Table of Hazardous Substances' Name and Concentration

部件名称 Compo-nent name	有害物质 Hazardous substance						
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr(VI)或 Cr6+)	多溴联苯 (PBB)	多溴二苯醚 (PBDEs)	邻苯二甲酸二(2-乙基己基)酯 (DEHP)
29058056	0	0	0	0	0	0	
29235429	0	0	0	0	0	0	
29257630	0	0	0	0	0	0	
29235430	0	0	0	0	0	0	
29235431	0	0	0	0	0	0	
29235432	0	0	0	0	0	0	
29235433	0	0	0	0	0	0	
29235449	0	0	0	0	0	0	

部件名称 Compo-nent name	有害物质 Hazardous substance						
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr(VI)或 Cr6+)	多溴联苯 (PBB)	多溴二苯醚 (PBDEs)	邻苯二甲酸二(2-乙基己基)酯 (DEHP)
29235434	0	0	0	0	0	0	
29235450	0	0	0	0	0	0	
29213017	X	0	0	0	0	0	
29224251	X	0	0	0	0	0	
29237455	0	0	0	0	0	0	
29277408	0	0	0	0	0	0	
29277407	0	0	0	0	0	0	
29056562	X	0	0	0	0	0	
29066964	X	0	0	0	0	0	
29066965	X	0	0	0	0	0	
29066966	X	0	0	0	0	0	
29066967	X	0	0	0	0	0	
29066968	X	0	0	0	0	0	

部件名称 Compo-nent name	有害物质 Hazardous substance						
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr(VI)或 Cr6+)	多溴联苯 (PBB)	多溴二苯醚 (PBDEs)	邻苯二甲酸二(2-乙基己基)酯 (DEHP)
29056565	X	0	0	0	0	0	
29051340	X	0	0	0	0	0	
29082556	X	0	0	0	0	0	
29056625	X	0	0	0	0	0	
29055820	X	0	0	0	0	0	
29055823	X	0	0	0	0	0	

0: 表示该有害物质在该部件所有均质材料中的含量均在 GB/T 26572 规定的限量要求以下。

X: 表示该有害物质至少在该部件的某一均质材料中的含量超出 GB/T 26572 规定的限量要求。

- 此表所列数据为发布时所能获得的最佳信息.

0: Indicates that this hazardous substance contained in all of the homogeneous materials for this part is below the limit requirement in GB/T 26572.

X: Indicates that this hazardous substance contained in at least one of the homogeneous materials used for this part is above the limit requirement in GB/T 26572.

- Data listed in the table represents best information available at the time of publication.

10.10 Ordering information

Visit cytiva.com

Refer to the Cytiva website or contact a Cytiva representative for more information about the following questions:

- System recommendations
- Literature
- Service
- Training
- Ordering information

Contact information

Contact information can be found on the back page of this document.

For more advanced technical information, contact the manufacturer. See *Section 10.9.1 Contact information, on page 532*.

Appendix A
Information about Appendices

Introduction

The Appendices provide general information about AVEVA software user interface for XDR-50 to 2000 Bioreactor Systems, general information about data handling, and important cyber security information. Following this information section, the following Appendices are found in this manual:

Following this information section, the following appendices are found in this manual:

- Appendix B: User interface description
- Appendix C: Liquid Management (optional)
- Appendix D: Use USB and Ethernet port locks
- Appendix E: Export and save data
- Appendix F: Generate reports

Appendices B, C, D, E, and F are provided in English only.

User interface description

This appendix provides a description of AVEVA software user interface, including the summary screens, dialog boxes and control functions. This appendix also gives an overview of setting up process control and describes the functioning of some control loops.

Liquid Management

This appendix gives information about the Liquid Management function. This function uses the gravimetric feed principle for liquid addition and simultaneous removal. Liquid Management is an optional function.

Use USB and Ethernet port locks

The USB port and the Ethernet port are protected from unauthorized access with a physical lock. The lock is inserted and removed using a key. This appendix gives information on how to use the port locks.

Export and save data

This appendix gives information about how to manage the collected data after a completed batch run.

Generate reports

This appendix provides information about how to create reports on the XDR bioreactor system components, or on alarms and events recorded in the system.

Appendix B
User interface description

Introduction

This appendix provides a description of AVEVA software user interface, including the summary screens, dialog boxes and control functions.

In this chapter

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B.2	User interface: dialog boxes	584
B.3	User interface: control functions	595
B.4	Auxiliary inputs configuration	610
B.5	Xcellerex APS	613

B.1 User interface: screens

Introduction

This section gives an overview of summary screens in the AVEVA software.

In this section

Section		See page
B.1.1	***Multivessel Overview***	551
B.1.2	***Reactor Display***	553
B.1.3	***Liquid Management***	563
B.1.4	***Control***	564
B.1.5	***Setpoint Table***	567
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B.1.10	***Trending***	580
B.1.11	***Recipe Manager***	582
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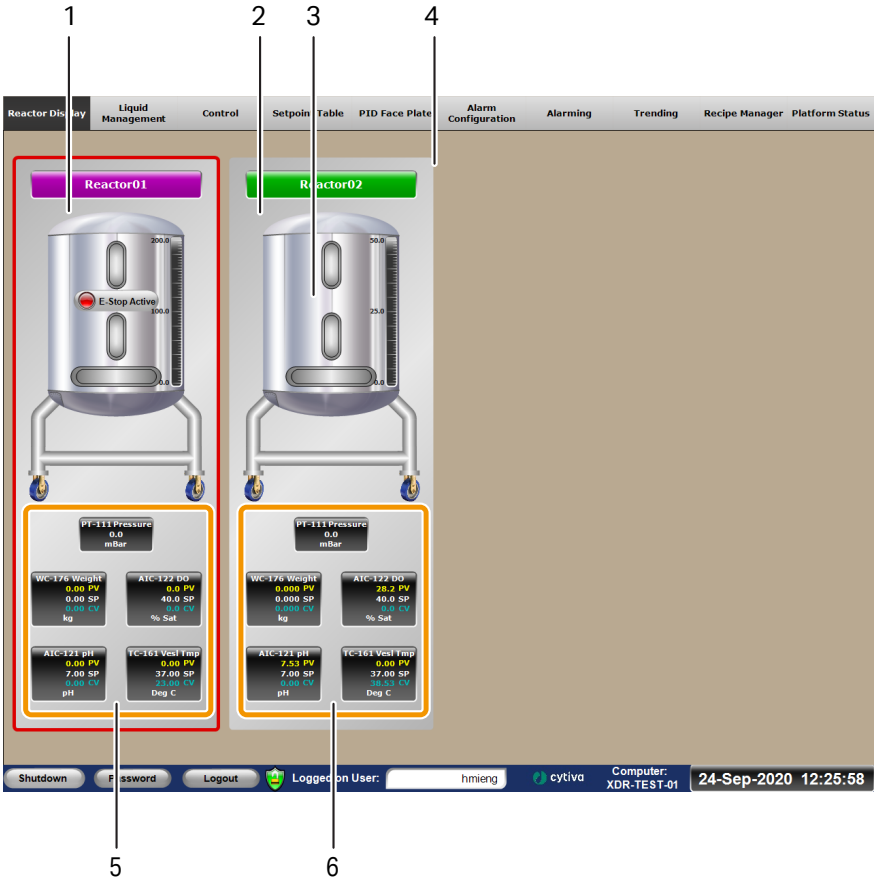
B.1.1 *Multivessel Overview*

Multivessel Overview screen description

Multivessel Overview is the default screen at startup for multi-vessel systems. The screen allows the user to see the general status of the XDR bioreactor, open the PID faceplates for the main control loops, and open the ***Reactor Display*** screen for the relevant XDR bioreactor.

Illustration of the *Multivessel Overview* screen

The following illustration shows an example of the ***Multivessel Overview*** screen. The screen shows all bioreactors that are configured on your system. The red frame on the bioreactor image indicates that alarms are currently active on this system.



Part	Function
1	***Reactor01*** panel
2	***Reactor02*** panel
3	***E-Stop Active*** (***Reactor02***)
4	Marking for active alarm
5	Main PID loop panels for ***Reactor01*** [1]
6	Main PID loop panels for ***Reactor02*** [1]

[1] See *PID loop overview panel, on page 557* for more information.

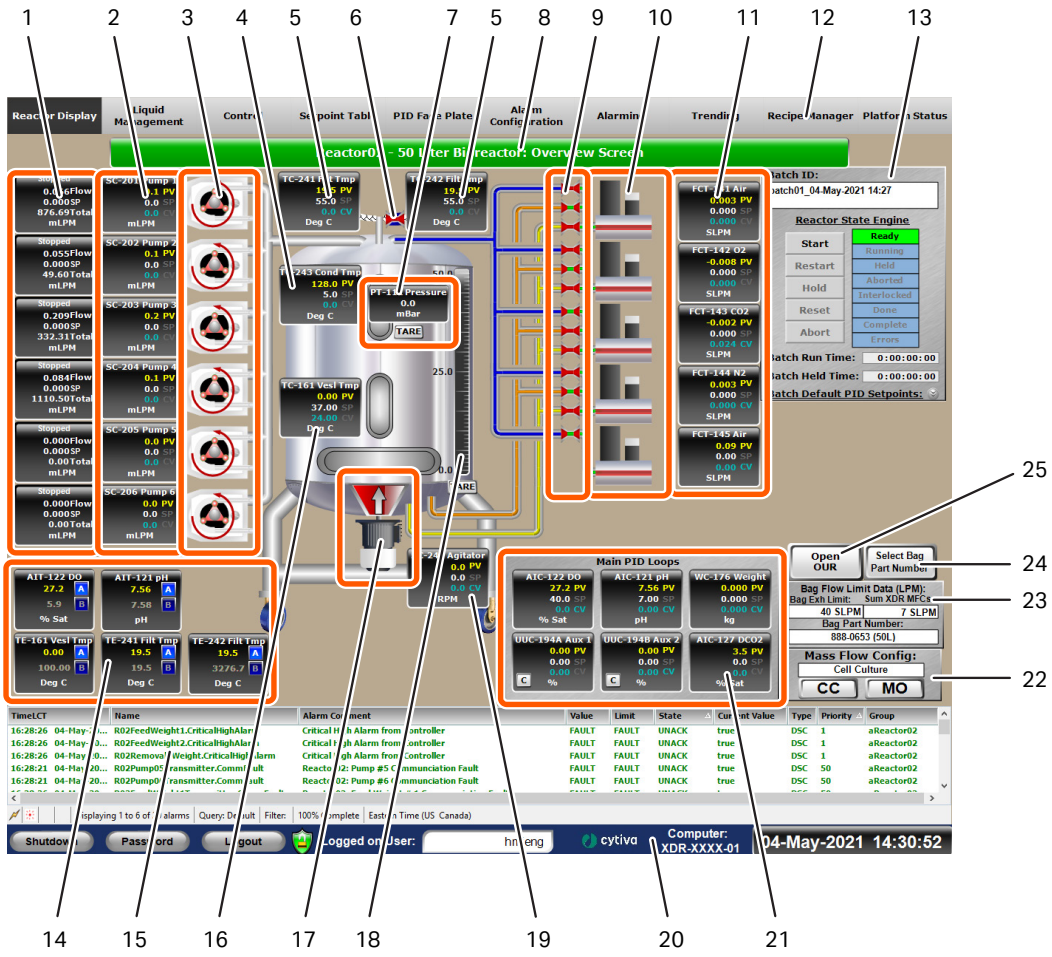
B.1.2 *Reactor Display*

Reactor Display screen description

Reactor Display is the default screen at startup for single-vessel systems. The ***Reactor Display*** screen provides a detailed graphical display of the bioreactor system layout.

Illustration of the *Reactor Display* screen

The following illustration shows an example of the ***Reactor Display*** screen.



Part	Description
1	Pump totalizer panels
2	Pump panels
3	Pump icons
4	Condenser temperature panel
5	Exhaust filter heater temperature panel (2)
6	Pinch valve icon ***Note:*** *The icon turns red if the disposable bag pressure exceeds the limit and the valve is forced to open.*
7	Bag pressure display and bag pressure tare button
8	Instrument identification banner
9	Solenoid valve icons ***Note:*** *Clicking a valve opens a dialog box displaying the options for that valve, if any are available.*
10	Mass flow controller (MFC) icons
11	Mass flow controller (MFC) panels (Air, O_2, CO_2, N_2)
12	Header toolbar See *Header toolbar, on page 555* for more information.
13	***Batch Manager*** display See *Batch Manager display, on page 560* for more information.
14	Probe selection and calibration panels See *Probe panel, on page 557* for more information.
15	Alarm summary pane See *Alarm summary pane, on page 556* for more information.
16	Vessel temperature panel
17	Agitator icon
18	Vessel weight graphics and weight tare button
19	Agitator panel
20	Footer toolbar See *Footer toolbar, on page 555* for more information.

Part	Description
21	Main PID loops panels ***Note:*** *Clicking **C** on the auxiliary input panel allows the user to configure auxiliary input. See Appendix B.4 Auxiliary inputs configuration, on page 610 for more information.*
22	Process mode display and mode selection buttons:[1] • ***CC*** - cell culture mode • ***MO*** - microbial fermentation mode
23	Gas flow limit display
24	Bag selection button
25	Oxygen uptake rate (OUR) measurement access button

[1] Process mode selection is available for 50 L and 200 L bioreactors.

Header toolbar

The header toolbar is located at the top of the screen and is available from all application interfaces. All screens are accessible from this toolbar. The following illustration shows a header toolbar.

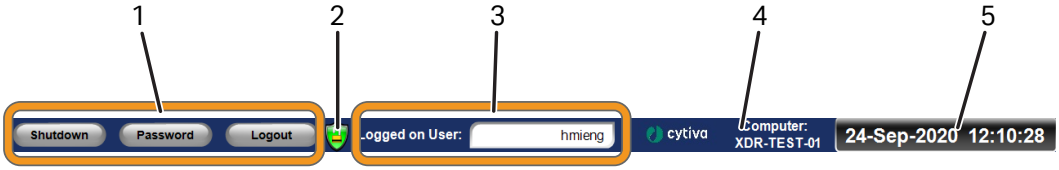


When a toolbar button is clicked, a drop-down menu with additional options may be available.

Footer toolbar

The footer toolbar is located at the bottom of the screen and is available from all application interfaces. It allows logging on, changing the password and shutting down the software. It also shows which user is currently logged on.

The following illustration shows the footer toolbar.



Part	Description
1	Interactive buttons

Part	Description
2	Security symbol
3	User identification text box
4	Computer identification
5	Date and time field ***Note:*** *Do not manually adjust the date and time. Adjusting the date and time can cause the AVEVA license to expire and cause loss of data in the AVEVA Historian. Refer to the AVEVA Tech Alert TA136 for more information.*

Alarm summary pane

The alarm summary pane is shown at the bottom of the ***Reactor Display*** screen and presents the current alarms with a date and time stamp. Full scale display of this pane is available from the header toolbar by selecting ***Alarming*** →***Summary***.

The following illustration shows the alarm summary pane.

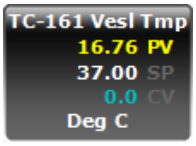


For the description of table contents see *Alarm Summary and Alarm History tables, on page 573*.

Panels on *Reactor Display* screen

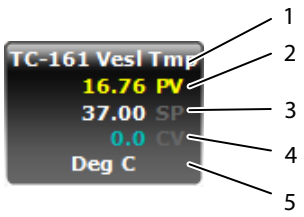
Two types of panels are shown on the ***Reactor Display*** screen: display panels and active panels.

Name and illustration	Description
Display panel  	Display panels are read-only objects and do not allow modification of the displayed values.

Name and illustration	Description
Active panel 	Active panels let the user access and modify the state of the process. Clicking the active panel opens a dialog box and allows the user to control the process. Clicking an active panel that is connected to PID control loop opens the relevant PID faceplate.

PID loop overview panel

PID loop overview panels are active panels that are connected to a PID control loop. PID loop overview panels are shown on the ***Reactor Display*** screen. Clicking a PID loop overview panel opens the relevant PID faceplate. The following illustration is an example of a PID loop overview panel.



Part	Name	Function
1	PID loop name	The tagname of the parameter
2	Process Variable (PV)	Current parameter values
3	Setpoint (SP)	The target value of the parameter
4	Control Variable (CV)	The controller output
5	Unit	The unit of measurement of the parameter

See *Appendix B.2.1 PID faceplate, on page 585* for description of PID faceplate.

Probe panel

Probe selection and calibration panels are shown on the ***Reactor Display*** screen.

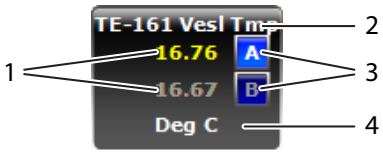
Clicking ***A*** and ***B*** buttons on the panel allows the user to to select a different probe when the primary control channel fails.

Clicking the panel opens the calibration offset dialog box for the selected probe. Calibration offsets are available for the following probes:

- DO
- pH

- Exhaust filter temperature
- Vessel temperature

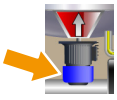
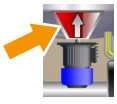
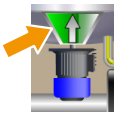
The following illustration is an example of probe selection panel.



Part	Description
1	Current parameter values
2	Probe tag name and description
3	Buttons to switch between the two channels
4	The unit of measurement of the parameter

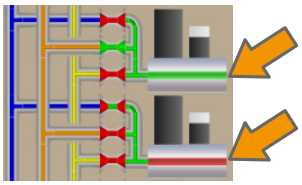
Agitator icon colors

The following colors are used to show the status of the agitator.

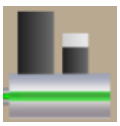
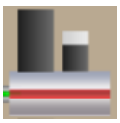
Illustration	Color	Description
	Agitator block blue	Agitator is enabled
	Agitator block flashes gray and white	Agitator is disabled
	Direction arrow background red	Agitator is not running
	Direction arrow background green	Agitator is running

Gas flow path colors

The MFCs are displayed as gray cylinders with a line through the center, representing the flow path.

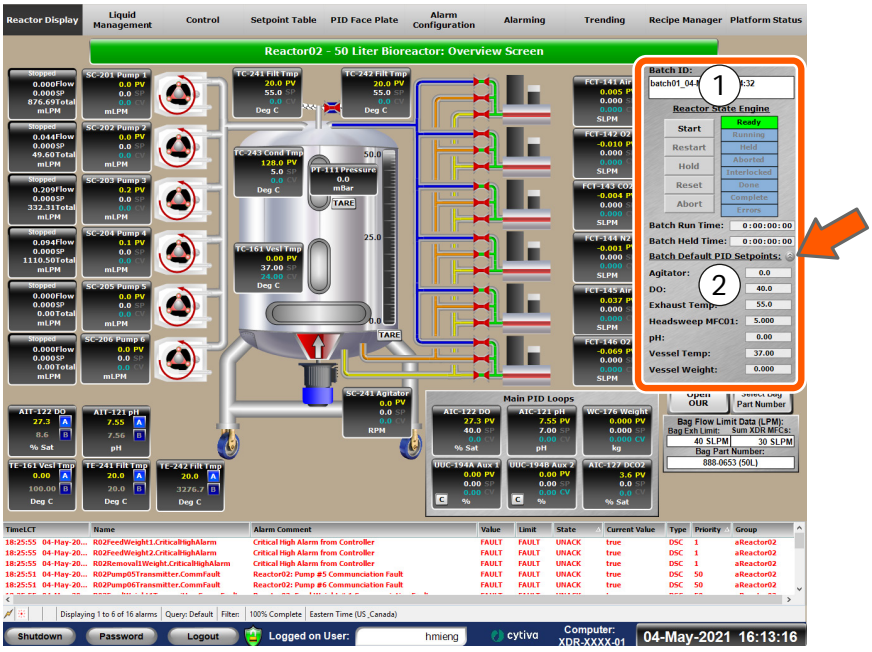


The following colors are used to show the state of the gas flow:

Illustration	Color	Description
	Solenoid valve green.	Valve selected. Gas flow active.
	Solenoid valve center block green.	Valve selected. No gas flow.
	Solenoid valve red.	Valve not selected. No gas flow.
	MFC gas flow path green.	Gas flow active.
	MFC gas flow path red.	No gas flow.

Batch Manager display

The ***Batch Manager*** display is part of the ***Reactor Display*** screen. The following illustration shows the location of the ***Batch Manager*** display.



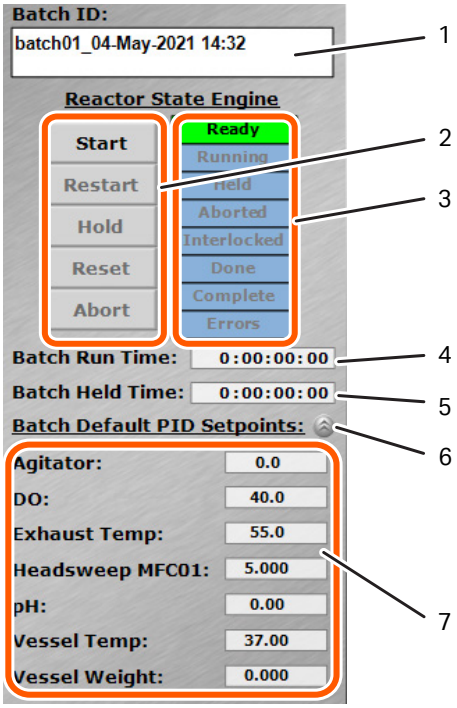
The ***Batch Manager*** display consists of two parts:

- ***Reactor State Engine*** display (1) (always shown)
- ***Batch Default PID Setpoints*** display (2) (drop-down display)

Clicking the double-arrow button at the bottom of the ***Reactor State Engine*** display opens and closes the ***Batch Default PID Setpoints*** display.

Illustration of the *Batch Manager* display

The following illustration shows the ***Batch Manager*** display with ***Batch Default PID Setpoints*** display.



Part	Function
1	Text box for batch ID information (optional). ***Note:*** *This text box can be left blank.*
2	Selection buttons to move to different reactor states: • ***Start*** • ***Restart*** • ***Hold*** • ***Reset*** • ***Abort*** ***Note:*** *Only valid reactor states are enabled.*
3	Batch state information. The current batch state is shown in green.

Part	Function
4	The length of time the batch has been in ***Running*** state (d:hh:mm:ss).
5	The length of time the batch has been in ***Held*** state (d:hh:mm:ss).
6	Double-arrow button to open or close the ***Batch Default PID Setpoints*** display.
7	***Batch Default PID Setpoints*** display

Clicking any text box in the ***Batch Default PID Setpoints*** display opens the ***Default PID Setpoints*** dialog box, that shows an overview of all current batch setpoints. See *Default PID Setpoints, on page 593* for more information.

B.1.3 *Liquid Management*

Liquid Management function (optional)

Liquid Management function connects scales and pumps to control liquid addition to and removal from the bioreactor. Liquid Management is an optional function for XDR-50 to 2000 Bioreactor Systems. See *Appendix C Liquid Management (optional), on page 614* for more information.

B.1.4 *Control*

Control screen description

The ***Control*** screen is accessed from the header toolbar. The ***Control*** screen allows users, who have appropriate access level, to map PID control loops, to configure the interaction of units that are part of the bioreactor control system. See *Section 7.3 Configure control loops, on page 319* for more information.

All elements on the ***Control*** screen belong in one of the three categories described below.

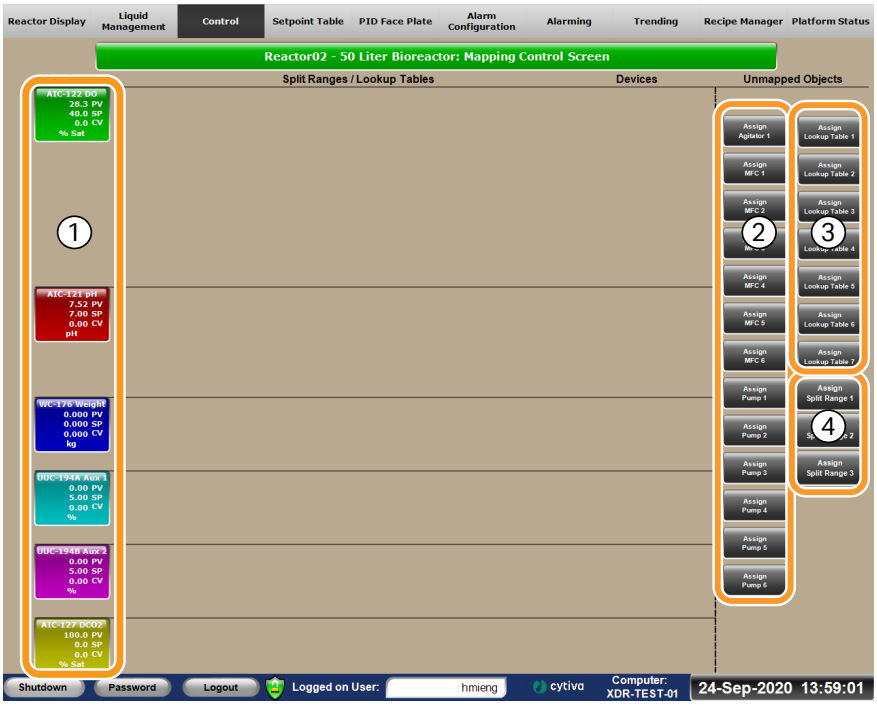
Type	Examples
Input devices (transmitters)	Auxiliary inputs Dissolved oxygen sensor pH sensor Vessel weight sensor
Output devices	Mass flow controllers Pumps Agitator
Intermediate control elements[1]	Lookup tables Split ranges

[1] See *Appendix B.3.3 Intermediate control elements, on page 602* for more information.

Mapping a PID control loop establishes a connection between a transmitter unit (input device) and a control unit (output device), optionally through an intermediate control element.

Illustration of the *Control* screen without mapped devices

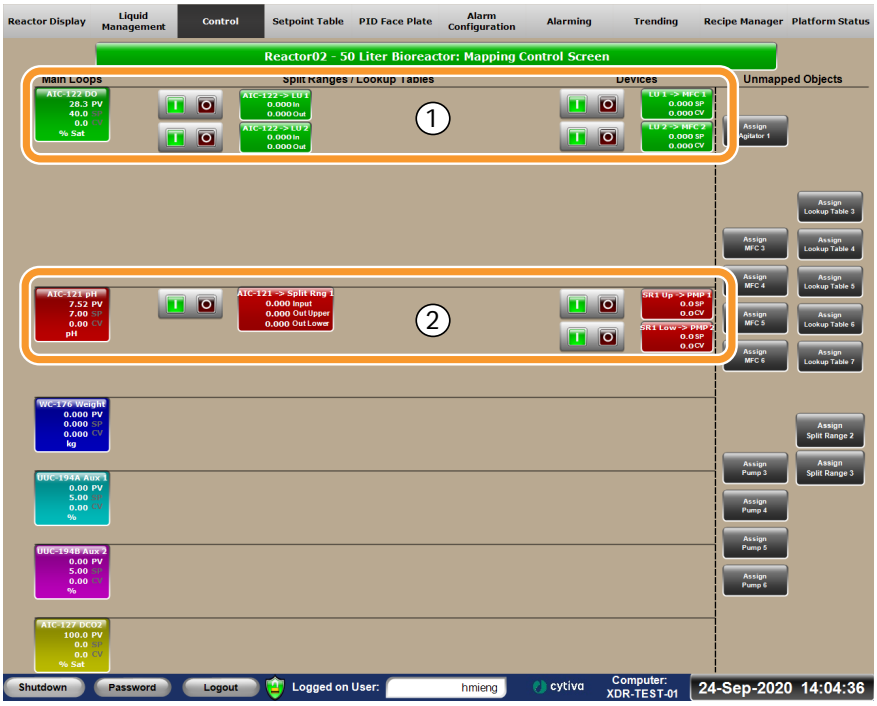
The following illustration shows an example of the ***Control*** screen without any mapped devices. Your screen layout may differ from the configuration shown below.



Part	Description
1	Inputs / Transmitters
2	Buttons for assignment of output devices
3	Buttons for assignment of lookup tables
4	Buttons for assignment of split ranges

Illustration of the *Control* screen with mapped devices

The following illustration shows an example of the ***Control*** screen with two sets of mapped devices. Your screen layout may differ from the configuration shown below.



Part	Description
1	Dissolved oxygen (DO) transmitter mapped to two lookup tables and a control device
2	pH transmitter mapped to a split range and two control devices

See *Section 7.3 Configure control loops, on page 319* for mapping instructions.

B.1.5 *Setpoint Table*

Setpoint Table screen description

The ***Setpoint Table*** screen is accessed from the header toolbar. The ***Setpoint Table*** screen allows users to define automatic changes to PID control loop setpoints according to selectable criteria. ***Setpoint Table Screen 1*** shows all primary PID control loops and ***Setpoint Table Screen 2*** shows all secondary PID control loops.

Screen 3 is used for Liquid Management function (optional). See *Setpoint Table screen, on page 628* for more information.

Screen 4 is used for the optional perfusion function (Xcellerex APS). The perfusion option is only available for ***Reactor01***. Refer to *Xcellerex APS Operating Instructions (29365080)* for more information.

Illustration of *Setpoint Table* screen

The following illustration shows an example of ***Setpoint Table Screen 1***, showing 11 primary PID control loop setpoint tables.



B.1.6 *PID Face Plate*

PID Face Plate screen description

PID Face Plate screens (***Screen 1*** and ***Screen 2***) are accessed from the header toolbar. These screens show all PID control loops related to the operating unit and allow users to access PID control loop parameters. If there are no PID control loops to display, the screen shows a message that it was intentionally left blank.

The contents of ***Screen 1*** and ***Screen 2*** are shown as follows:

PID Face Plate Screen 1	***PID Face Plate Screen 2***
• Dissolved oxygen (DO) • pH • Vessel Temperature • Agitator • Vessel Weight • Filter Temperature • Auxiliary Input 1 • Auxiliary Input 2 • Carbon Dioxide (CO_2) • Filter Heater 1 • Filter Heater 2	• Air mass flow controller • Oxygen mass flow controller • Nitrogen mass flow controller • Pumps

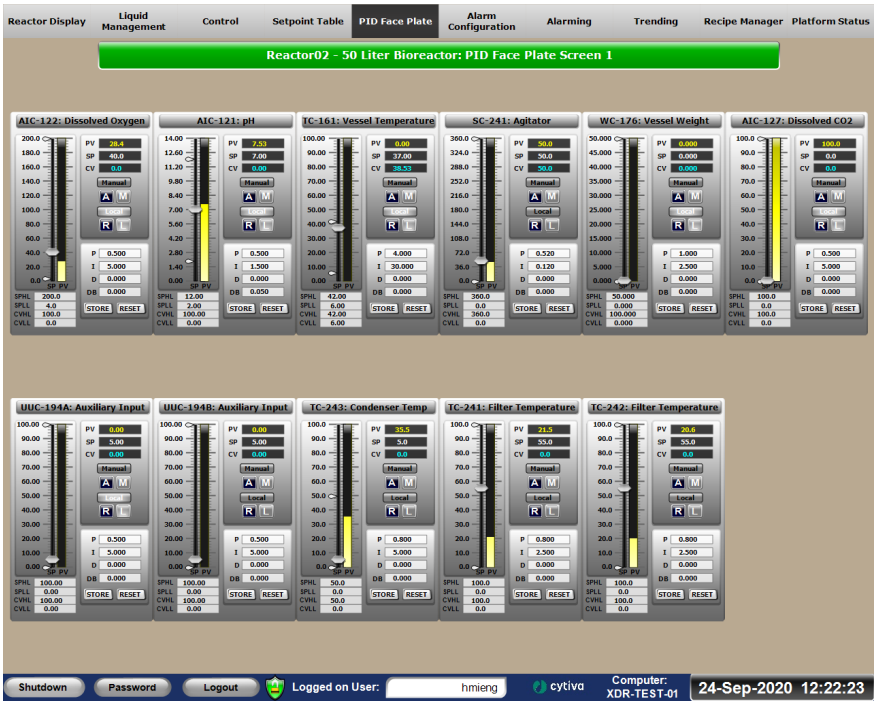
Screen 3 is used for Liquid Management function (optional). See *PID Face Plate screen, on page 628* for more information.

Screen 4 is used for the optional perfusion function (Xcellerex APS). The perfusion option is only available for ***Reactor01***. Refer to *Xcellerex APS Operating Instructions (29365080)* for more information.

For information about PID control, see *Appendix B.2.1 PID faceplate, on page 585* and *Appendix B.3 User interface: control functions, on page 595*.

Illustration of *PID Face Plate* screen

The following illustration shows an example of ***PID Face Plate Screen 1***.



For more detailed description of PID faceplates see *Appendix B.2.1 PID faceplate, on page 585*.

B.1.7 *Alarm Configuration*

Alarm Configuration screen description

Alarm Configuration screens (***Screen 1*** and ***Screen 2***) are accessed from the header toolbar. These screens show each available process variable and allow the user to configure alarm setpoints.

Screen 3 is used for Liquid Management function (optional). See *Alarm Configuration screen, on page 629* for more information.

Screen 4 is used for the optional perfusion function (Xcellerex APS). The perfusion option is only available for ***Reactor01***. Refer to *Xcellerex APS Operating Instructions (29365080)* for more information.

Illustration of the Alarm Configuration screen

The following illustration shows an example of ***Alarm Configuration Screen 1***.



A red text box shows that this parameter is currently in alarmed state.

For more details about alarm configuration for each variable, see *Appendix B.2.2 Alarm configuration for a variable, on page 589*.

B.1.8 *Alarm Summary*

Alarm Summary screen description

The ***Alarm Summary*** screen is the overview screen for all active alarms. This screen displays all currently active alarms with a date and time stamp and alarm status. When an alarm has been acknowledged by the user and the parameter value is not in alarmed state anymore, the alarm is removed from the ***Alarm Summary*** screen. It remains available on the ***Alarm History*** screen.

The ***Alarm Summary*** screen is accessed from the header toolbar by selecting ***Alarming*** →***Summary***.

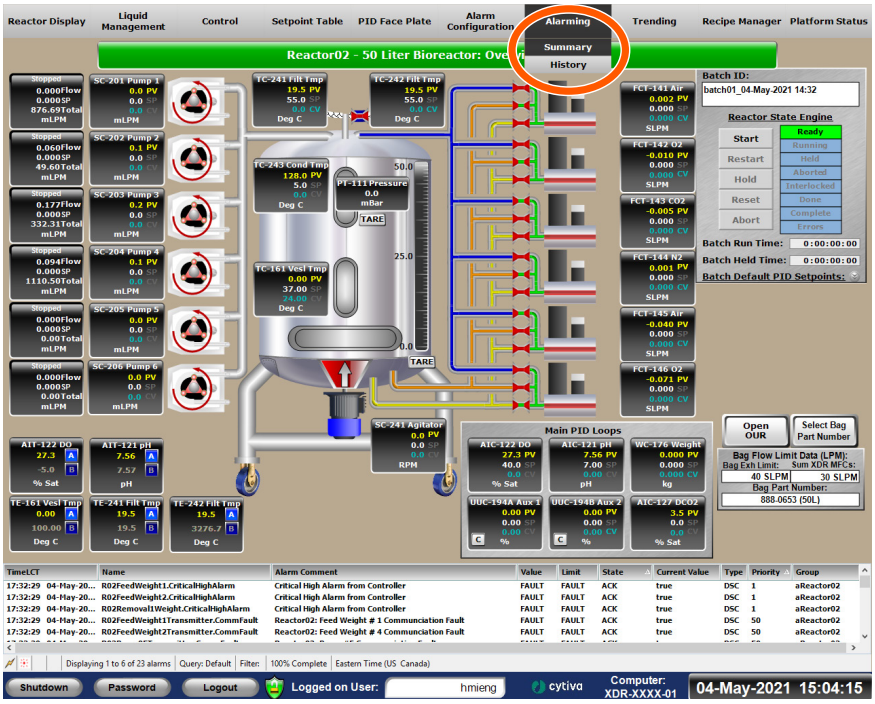
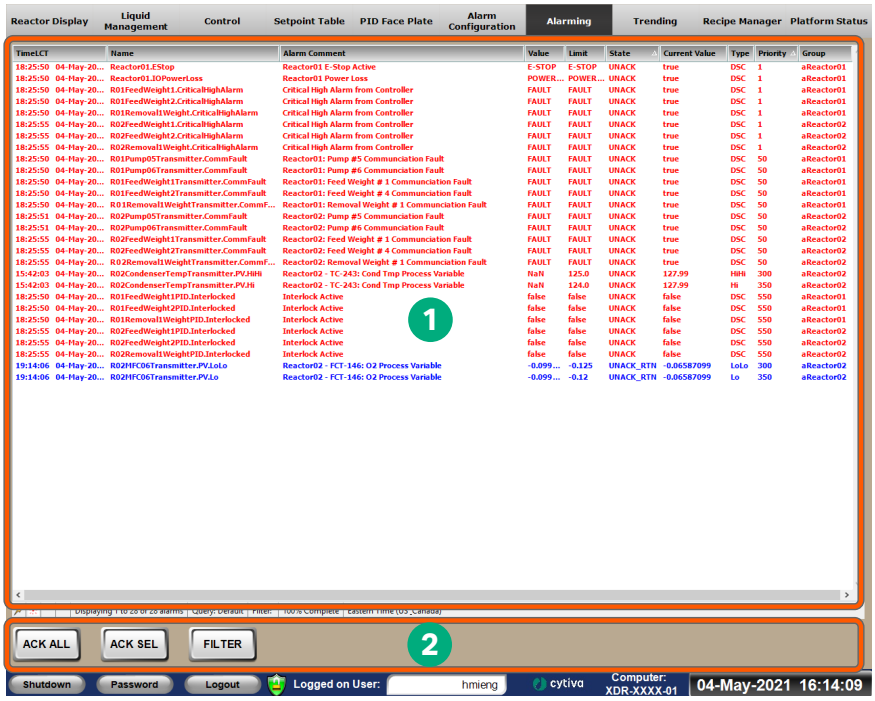


Illustration of the *Alarm Summary* screen

The following illustration shows an example of the ***Alarm Summary*** screen.



Part	Function
1	Alarm display pane
2	Buttons to acknowledge and view the alarms

The buttons at the bottom of the screen have the following functions:

Button	Description
ACK ALL	Allows the user to acknowledge all currently active alarms.
ACK SEL	Allows the user to acknowledge an individual alarm or a selected group of alarms.
FILTER	Allows the user to view a selection of alarms. ***Note:*** *See Filter function description, on page 573 for more information.*

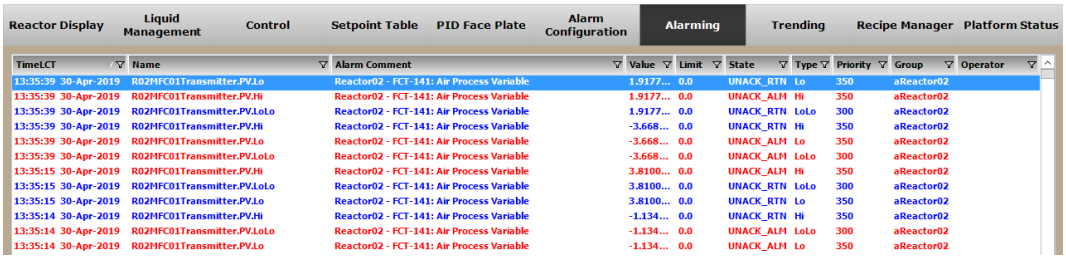
For description of other elements on the ***Alarm Summary*** screen see *Alarm Summary and Alarm History tables, on page 573*.

Filter function description

Alarm Summary and ***Alarm History*** tables show all alarms and events from the system. The filter function allows the user to select only a relevant group of alarms and events for viewing. The filtered list shows alarms and events from all bioreactors that are connected to the system. The ***All*** filter shows platform status and system connectivity alarms.

Alarm Summary and *Alarm History* tables

The following illustration shows an example of table contents that is presented on both ***Alarm Summary*** and ***Alarm History*** screens.



The following elements are shown in the table:

Element	Description
TimeLCT	Time when the state of the alarm changed.
AlarmComment	Specification of the alarm.
Name	Tag name or data point of the component that is in alarmed state.
Value	Value that triggered the alarm.
Limit	Limit value that was passed to trigger the alarm.
State	Current state of the alarm. See *Alarm states, on page 574* for more information. See *Alarm colors, on page 412* for more information about alarm display colors.
Current Value	Current value of the parameter. ***Note:*** *This information is displayed only on the **Alarm Summary** screen.*

Element	Description
Class	The following classes are possible: • Discrete alarms (for example on/off alarms) • Value alarms (deviation from a parameter level)
Type	Codes for alarm condition. For detailed explanation, see *Alarm type codes, on page 574*.
Priority	Characterizes the severity of the alarm. For more information, see *Alarm priority codes, on page 575*.
Group	The logical location the alarm originated from (for example, system platform, a bioreactor, or any other system).
Acknowledged By	The user name of the operator who acknowledged the alarm. ***Note:*** *This information is displayed only on the **Alarm History** screen.*

Alarm states

The alarm states are shown in the ***State*** column in the ***Alarm Summary*** and ***Alarm History*** tables.

The alarm states are described in the following table.

Alarm state	Description
UNACK	The parameter is in alarmed state and has not been acknowledged by the user.
UNACK_ALM	The parameter is in alarmed state. The user has disabled the alarm when it was in alarmed state, without acknowledging it first. ***Note:*** *This state is visible only on the **Alarm History** screen.*
UNACK_RTN	The parameter was in alarmed state at some time point but is now in normal state. It has not been acknowledged by the user.
ACK	The parameter is in alarmed state and has been acknowledged by the user.

Alarm type codes

The alarm type code is shown in the ***Type*** column in the ***Alarm Summary*** and ***Alarm History*** tables.

The alarm type codes are described in the following table.

Alarm type code	Alarm condition
DSC	Discrete (possible states "on" or "off")
LoLo	Variable: critical low limit
Lo	Variable: warning low limit
Hi	Variable: warning high limit
HiHi	Variable: critical high limit
Major	Major deviation (critical alarm)
Minor	Minor deviation (warning alarm)
OPR	Operator: the user name of the operator who made a change to a value in the control system.[1]

[1] This information is shown only in event records.

Alarm priority codes

The alarm priority range is 1-999. The highest priority is 1.

B.1.9 *Alarm History*

Alarm History screen description

The ***Alarm History*** screen displays all alarms and events associated with the process, both the active alarms and the acknowledged alarms that are not in active state anymore.

The information on the ***Alarm History*** screen is saved in the database for storage, retrieval, and auditing.

The ***Alarm History*** screen is accessed from the header toolbar by selecting ***Alarming →History***.

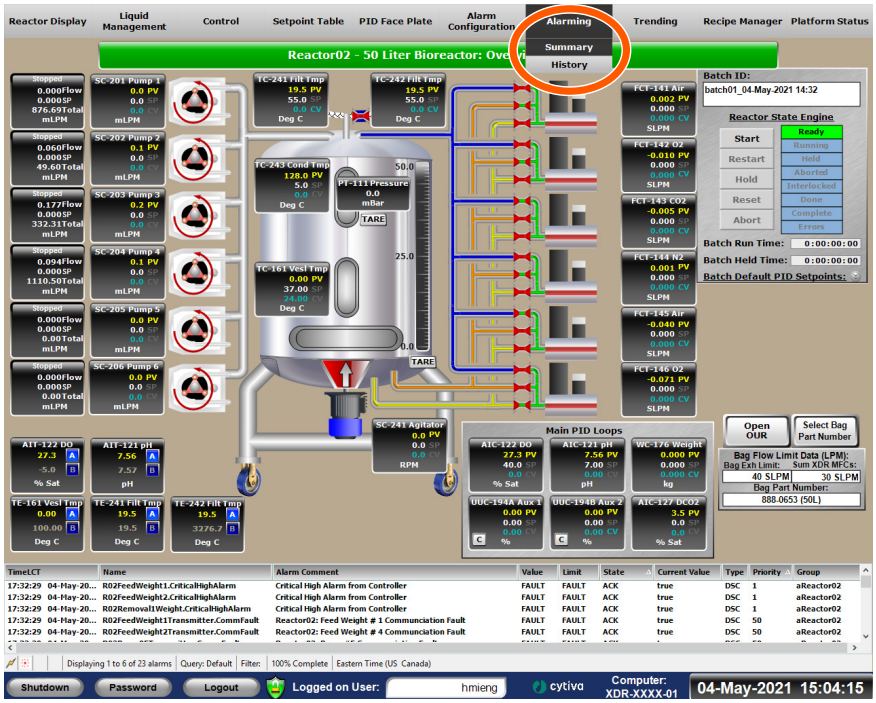
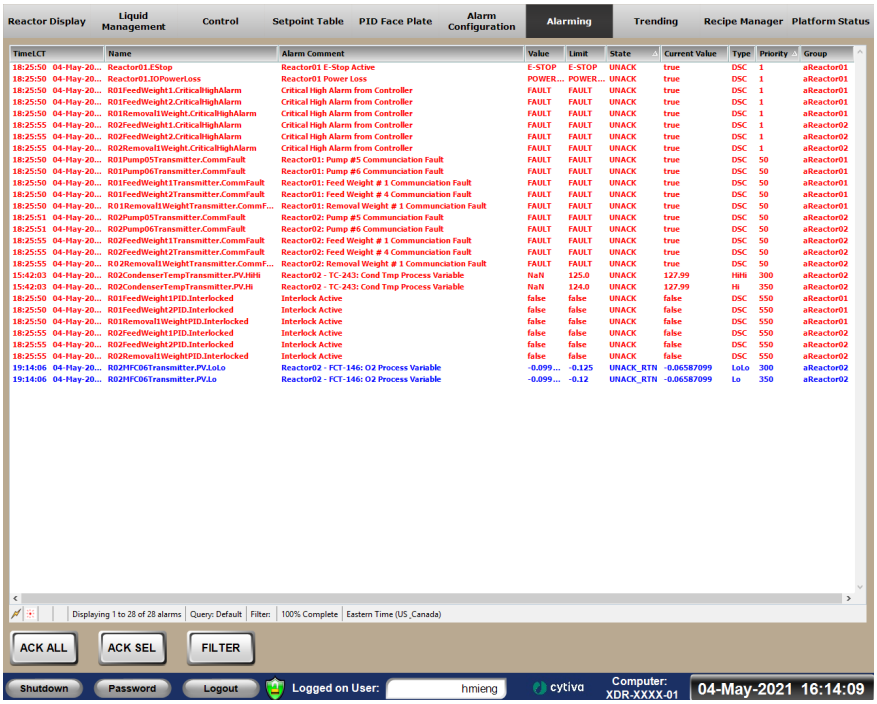


Illustration of the *Alarm History* screen

The following illustration shows an example of the ***Alarm History*** screen.

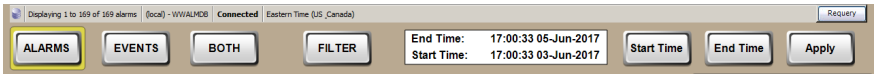


For description of the elements in the table see *Alarm Summary and Alarm History tables, on page 573*.

See *Alarm History footer toolbar, on page 578* for description of the footer toolbar buttons.

Alarm History footer toolbar

The following illustration shows ***Alarm History*** footer toolbar.



Element	Description
ALARMS	Displays only alarms and hides events.
EVENTS	Displays only events and hides alarms. ***Note:*** *Events are user actions in the AVEVA software. See Alarm History events, on page 578 for more information.*
BOTH	Displays both alarms and events. ***Note:*** *Both alarms and events are displayed by default.*
FILTER	Allows the user to view a selection of alarms or events. ***Note:*** *See Filter function description, on page 573 for more information.*
Text box	Shows the start and end time of the displayed group of alarms and events.
Start Time	Allows the user to define the start time for displayed alarms and events.
End Time	Allows the user to define the end time for displayed alarms and events.
Apply	Applies the modifications in start and end time.
Requery	Allows the user to refresh the list of alarms and events.

Alarm History events

Events are user actions in the AVEVA software. The following user actions are recorded as events in the ***Alarm History*** table:

- Alarm setpoint change
- Control mode change
- Controlled variable change
- Mapping change
- PID parameter change
- Reactor state change
- Sequence change
- Setpoint change

B.1.10 *Trending*

Trending application

Trending is an embedded AVEVA application.

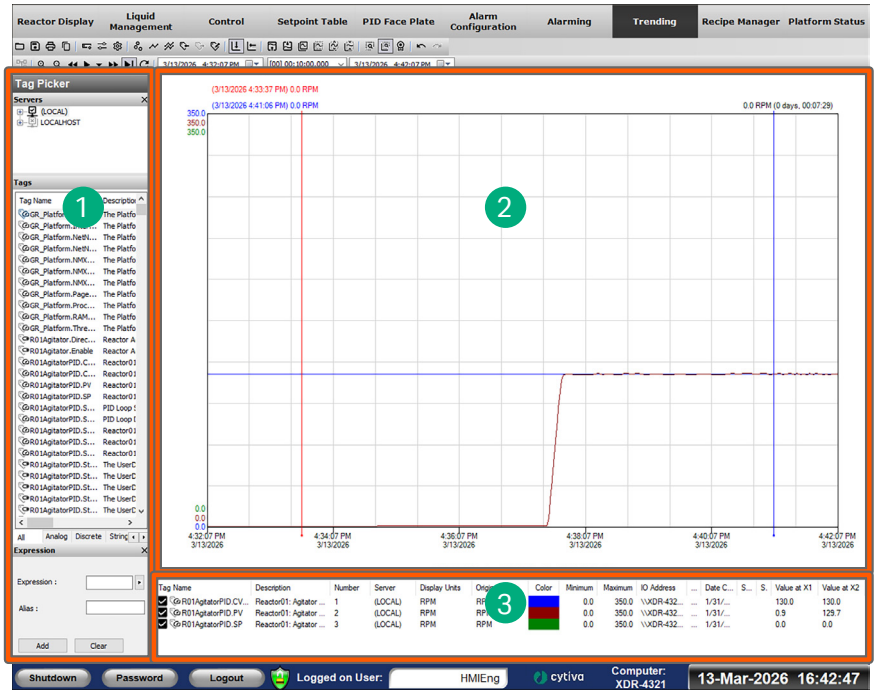
The application is accessed from the header toolbar by selecting the ***Trending*** option.

This selection opens a screen that displays data from any function that is monitored and controlled by the instrument control system. The Trending application allows the user to display historical and real-time data in graph format. All process parameters are recorded to create a historical trend display. The data is shown by AVEVA Historian Client Trending application.

Refer to AVEVA software manual for more information about the Trending application. The application help is available in ***Start →Aveva Documentation →Historian Client User Guide***, if installed at recommended location.

Illustration of the *Trending* screen

The following illustration shows an example of the ***Trending*** screen.



Part	Name	Function
1	***Tag Picker*** pane	Selects the variable to be shown in the trend chart.
2	Trend chart	Displays the trend for the selected parameter over the selected time period.
3	***Pens*** pane	Displays a list of tags selected for viewing and allows selection and editing of tag properties.

B.1.11 *Recipe Manager*

Recipe Management application

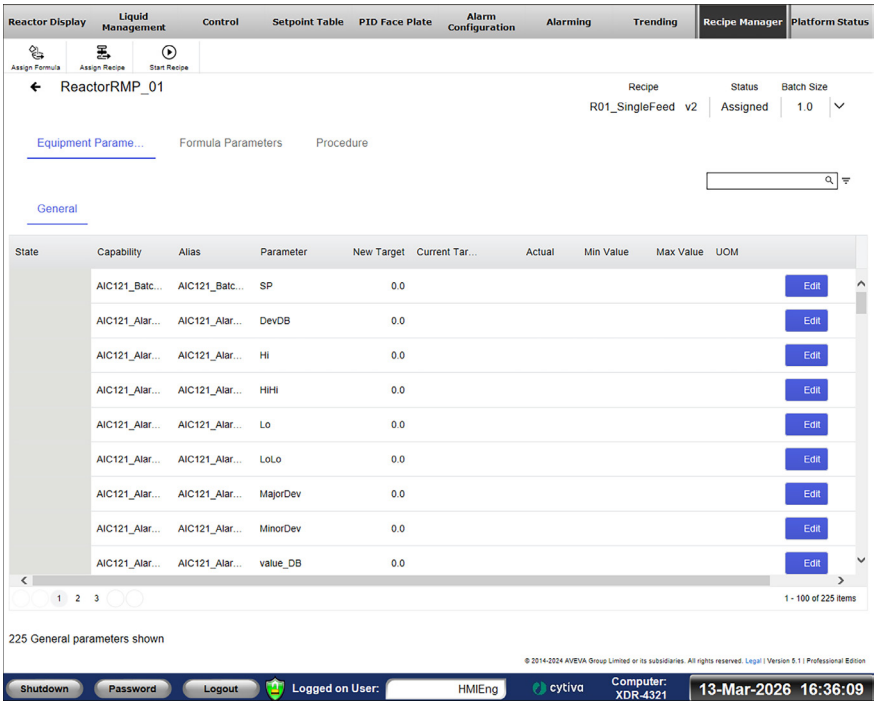
Recipe Management is a AVEVA application for formula and recipe management. The application is started using a web browser.

The user can also access the ***Execution*** functionality of the application from the InTouch HMI WindowViewer top toolbar by clicking the ***Recipe Manager*** button. Users with HMI Operator credentials can execute existing recipes.

Refer to *Xcellerex XDR bioreactor Recipe Manual (29698395)* for more information on Recipe Management and the access to the application in the web browser.

Illustration of the *Recipe Manager* screen

After logging on and selecting the applicable XDR bioreactor the recipe screen is shown. The following illustration shows an example of the screen.

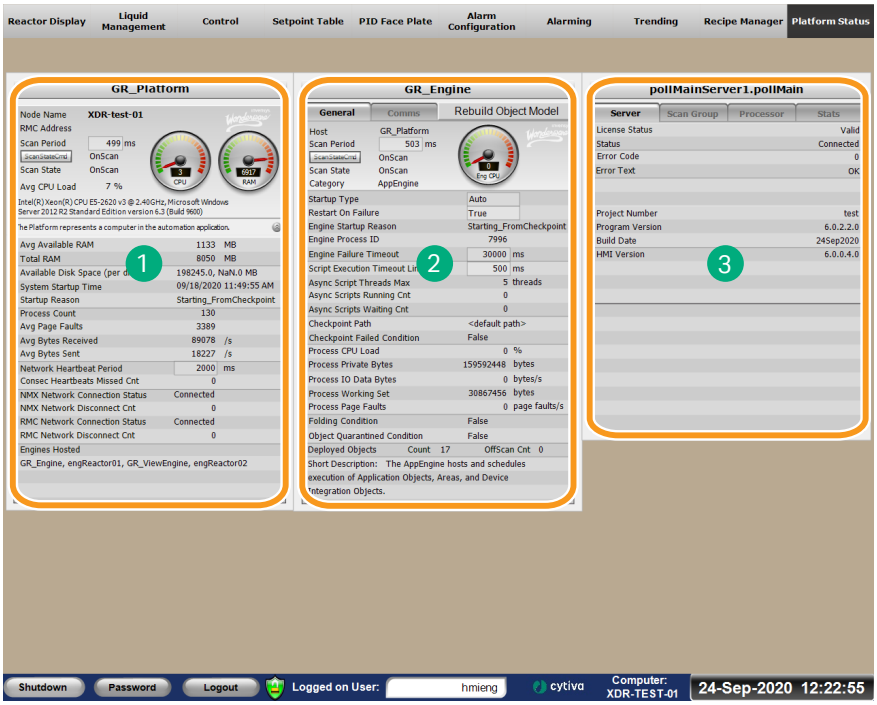


B.1.12 *Platform Status*

Platform Status screen description

The ***Platform Status*** screen is accessed from the header toolbar by selecting the ***Platform Status*** option. This screen displays information about the status of the bioreactor automation control system.

Illustration of *Platform Status* screen



Part	Name	Function
1	***GR_Platform***	Describes the status of the overall SCADA system.
2	***GR_Engine***	Describes the status of the sub-system responsible for accessing controller data in real time.
3	***MainServer***	Describes the overall status and details of the PLC.

B.2 User interface: dialog boxes

Introduction

This section gives an overview of dialog boxes available in AVEVA software.

In this section

Section		See page
B.2.1	PID faceplate	585
B.2.2	Alarm configuration for a variable	589
B.2.3	Setpoint managing dialog boxes	592

B.2.1 PID faceplate

PID faceplate dialog box

Proportional-integral-derivative (PID) control is used to control all bioreactor modules as well as most processes. Each PID faceplate contains the tuning parameters for an individual PID control loop. Process PID settings can be adjusted by a user with appropriate access rights.

PID faceplate dialog boxes can be accessed from the following locations:

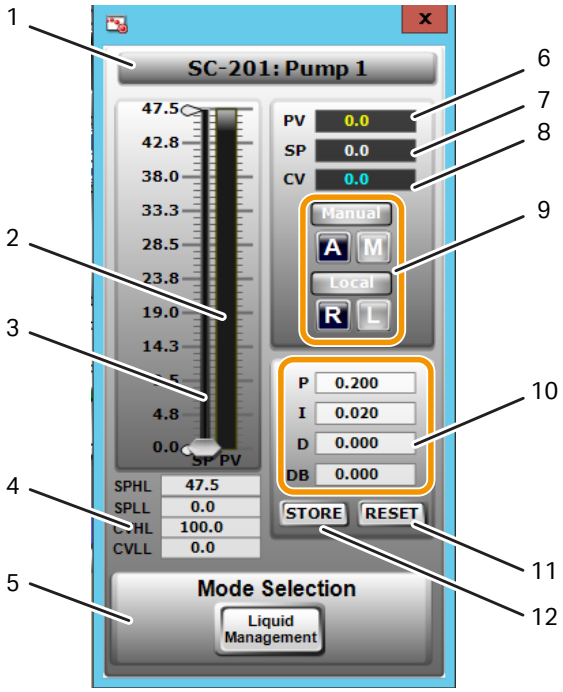
- ***Reactor Display*** screen
- ***Control*** screen
- ***PID Face Plate*** screens (***Screen 1*** and ***Screen 2***)

by clicking the associated PID control loop overview panels.

See *PID loop overview panel, on page 557* for description of the panels.

Illustration of PID faceplate dialog box

The illustration below shows an example of a PID faceplate dialog box.



Part	Description
1	PID faceplate tag name and description.
2	Process variable (***PV***) display bar.
3	Setpoint (***SP***) slider.
4	Range defining parameters. ***Note:*** *See PID control loop range defining parameters, on page 588 for more information of of range defining parameters.*
5	Mode selection button. Clicking the button assigns the pump to Liquid Management function. ***Note:*** *The mode selection button is shown on pump PID faceplates only.* ***Note:*** *Liquid Management is an optional function. See Appendix C Liquid Management (optional), on page 614 for more information.*
6	Process variable (***PV***), the measured value of the process.
7	Setpoint (***SP***), text box for input and output of the process target value.
8	Controlled variable (***CV***), text box for input and output.
9	PID control mode status indicator and changing buttons: • ***Auto***/***Manual*** mode • ***Remote***/***Local*** mode ***Note:*** *See PID loop control modes, on page 586 for more information.*
10	Text boxes for values of PID tuning parameters: • Proportional (***P***) • Integral (***I***) • Derivative (***D***) • Deadband (***DB***)
11	***RESET*** button, allows to go back to the default tuning parameter values.
12	***STORE*** button, allows to save the PID control parameters as the default tuning parameters.

Note: *Operator-introduced changes to tuning parameters take effect immediately.*

PID loop control modes

See the following table for description of PID loop control modes.

PID control modes	Description
Auto	The parameter is controlled by the computer control system to setpoint (***SP***), displayed in white on the PID faceplate. ***Note:*** *In **Auto** mode the user cannot change the controlled variable (**CV**).*
Manual	The loop is controlled by controlled variable (***CV***) value (%) defined by the user. The ***CV*** value is displayed in cyan. ***Note:*** *The user can change the setpoint (**SP**), but the change has no effect on the output (**CV**) until the loop is switched to **Auto** mode.*
Remote	The computer control system has control of the loop setpoint (***SP***).
Local	The operator has control of the loop setpoint (***SP***) in ***Auto*** mode or the loop controlled variable (***CV***) in ***Manual*** mode via the X-Station. When the instrument is in ***Auto/Local*** mode, the user can change ***SP*** values by typing a new value into the ***SP*** text box or by moving the marker on the display bar on the left of the PID faceplate. When the instrument is in ***Manual/Local*** mode, the user can change ***CV*** values by typing a new value into the ***CV*** text box or by moving the marker on the display bar at the bottom of the PID faceplate.
Cascade	The loop is controlled by an output device of another PID loop, that provides the setpoint (***SP***) for the loop that is in ***Cascade*** mode. ***Note:*** *The PID faceplate mode indicator **Remote/Local** is replaced by a yellow **Cascade** indicator when the loop is in **Cascade** control mode.*
Forced	May occur when a controller is mapped to a split range object. When the controlled variable (***CV***) of the master PID loop is within the configured deadband (***DB***), the controlled variable is forced to the configured split range percentage. ***Note:*** *This situation is typical to pH control through split range.*

PID control modes	Description
Setpoint Table	The loop setpoint control has been set via ***Setpoint Table.*** ***Note:*** *The PID faceplate mode indicator* ***Remote/Local*** *is replaced by an orange* ***SP Table*** *indicator when the loop is in* ***Setpoint Table*** *control mode.*

PID control loop range defining parameters

Range defining parameters are as follows:

Parameter	Function
Setpoint high limit (***SPHL***)	The control system cannot increase the setpoint above the ***SPHL***. The operator cannot type a setpoint value higher than ***SPHL*** into the ***SP*** text box.
Setpoint low limit (***SPLL***)	The control system cannot decrease the setpoint below the ***SPLL***. The operator cannot type a setpoint value lower than ***SPLL*** into the ***SP*** text box.
Controlled variable high limit (***CVHL***)	The control system cannot increase the controlled variable (output) above the ***CVHL***. The operator cannot type a value higher than ***CVHL*** into the ***CV*** text box.
Controlled variable low limit (***CVLL***)	The control system cannot decrease the controlled variable (output) below the ***CVLL***. The operator cannot type a value lower than ***CVLL*** into the ***CV*** text box.

The units for ***CVHL***, ***CVLL***, ***SPHL*** and ***SPLL*** always match the units and ranges of the CV and SP, respectively.

Note: *In some cases the limits (****CVHL****,* ***CVLL****,* ***SPHL*** *and* ***SPLL****) are applied to the system at the factory. This information can be found in Factory Acceptance Test documentation.*

B.2.2 Alarm configuration for a variable

Alarm configuration for a single controlled variable

Alarms for each controlled variable are activated and inactivated independently. The alarms are configured using alarm configuration dialog boxes for the variables. The alarm configuration dialog boxes are found on ***Alarm Configuration*** screens.

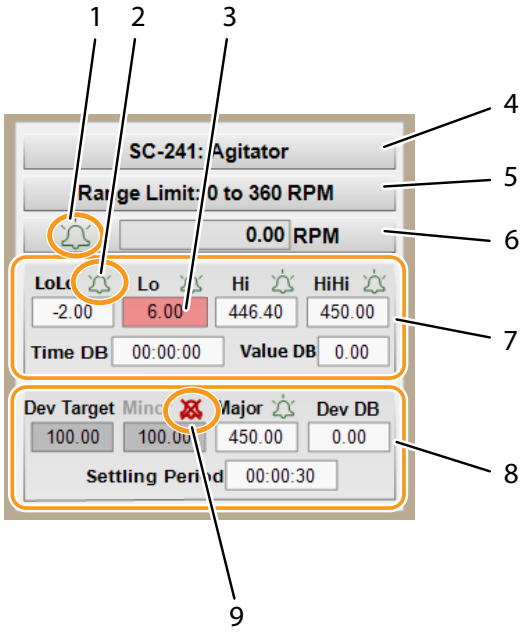
Alarm status

The following symbols and colors are used to describe the status of the alarms:

Object	Description
	The alarm is enabled.
	The alarm is disabled.
	A white text box shows that the parameter is active and not in alarmed state.
	A gray text box shows the value of a disabled alarm.
	A red text box shows that the parameter is currently in alarmed state.

Alarm configuration dialog box

The illustration below shows the details of an alarm configuration dialog box. A red text box shows that this parameter is currently in alarmed state.



Part	Function
1	Icon to enable or disable all alarms for the controlled variable.
2	Icon to enable or disable an individual alarm (enabled state).
3	Parameter in alarmed state.
4	Parameter tag name and description.
5	Parameter input range.
6	Current value of the alarmed parameter.

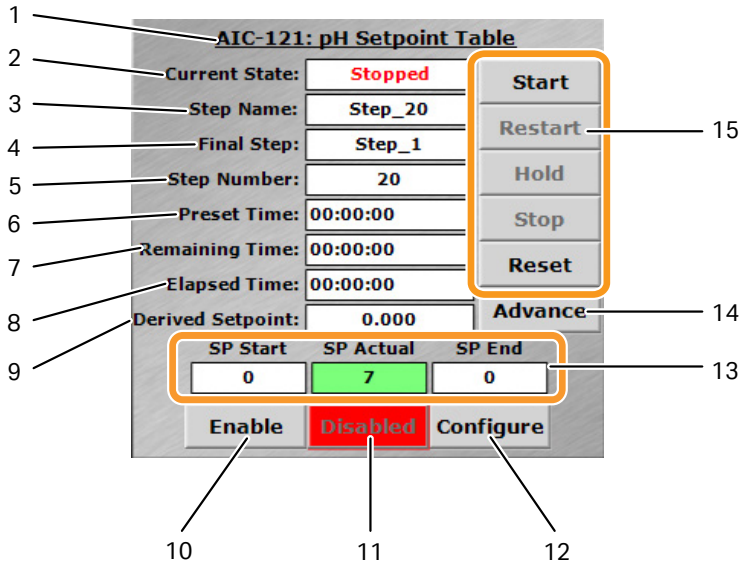
Part	Function
7	Range limits for the set alarm: • ***LoLo***, critical low limit • ***Lo***, warning low limit • ***Hi***, warning high limit • ***HiHi***, critical high limit • ***Time DB*** (time deadband), the length of time a value must be outside the value deadband to issue an alarm. • ***Value DB*** (value deadband), an interval around the set alarm value where the alarm is active. ***Note:*** *Setting the deadband values avoids the nuisance alarms, coming on and off ("chattering") when close to the limit.*
8	Parameter deviation from the setpoint: • ***Dev Target***, deviation target – current setpoint of the PID control loop • ***Minor***, the allowed deviation limit from a parameter setpoint before a warning alarm is issued. • ***Major***, the allowed deviation limit from a parameter setpoint before a critical alarm is issued. • ***Dev DB***, deviation deadband – a range around the setpoint where no alarm is issued. ***Note:*** ***Dev DB*** *keeps an alarm active until the parameter value is within the deviation deadband.* • ***Settling Period***, the length of time a setpoint change is allowed to take without issuing an alarm. ***Tip:*** *By defining the* ***Settling Period*** *you can avoid the deviation alarm being issued when you make a sudden change to a setpoint.*
9	Icon to enable or disable an individual alarm (disabled state).

See *Configure alarms, on page 413* for instructions on how to configure alarms.

B.2.3 Setpoint managing dialog boxes

PID control loop setpoint table

The PID control loop setpoint tables are shown on the ***Setpoint Table*** screens. The following illustration shows an individual PID control loop setpoint table.



Part	Function
1	PID control loop tag name and description
2	Current state of the setpoint table
3	Name of the current step in the ***Setpoint Table Configuration*** table
4	Name of the final configured step
5	Number of the currently running step
6	Total duration of the currently running step
7	Remaining execution time for the current step
8	Elapsed time for the current step
9	The currently valid setpoint value
10	Button/indicator to enable the setpoint table
11	Button/indicator to disable the setpoint table
12	Button to display ***Setpoint Table Configuration Screen***

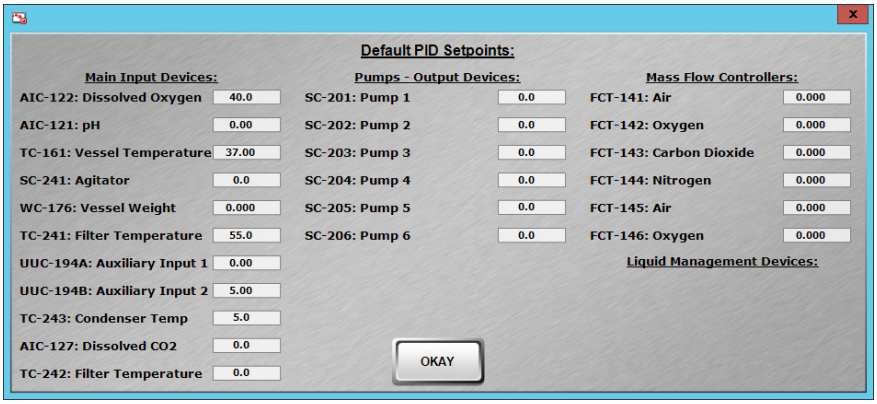
Part	Function
13	Display of start, actual, and end setpoint values of the current step ***Note:*** ***SP Actual*** *is the current setpoint value as shown on the PID faceplate of this parameter.*
14	Button to allow the user to move to the next step
15	Buttons to change the states of the running ***Setpoint Table***: • ***Start*** • ***Restart*** • ***Hold*** • ***Stop*** • ***Reset*** ***Note:*** *These buttons agree with the buttons on the* ***Batch Manager*** *display.*

See *Batch Manager display, on page 560* for further description of ***Batch Manager***.

See *Section 7.5.1 Configure setpoint tables, on page 390* for instructions how to use the individual setpoint tables.

Default PID Setpoints

The ***Default PID Setpoints*** dialog box can be accessed by clicking any text box in the lower part of the ***Batch Manager*** display. The illustration below shows an example of the ***Default PID Setpoints*** dialog box.



The default PID setpoints are used to define the setpoints that do not change during a batch run. The setpoints defined in the text boxes of the ***Default PID Setpoints*** dialog box are applied when the batch is started, and are not changed by the control system during the run. The setpoints can be changed by the operator during the run.

For information about ***Default PID Setpoints*** dialog box in Liquid Management (optional) function, see *Default PID Setpoints dialog box, on page 632*.

If Recipe Management is installed on your system, recipes can be used to define the setpoints shown in the ***Default PID Setpoints*** dialog box. Refer to *Xcellerex XDR bioreactor Recipe Manual (29698395)* for more information.

B.3 User interface: control functions

Introduction

This section gives an overview of setting up process control and describes the functioning of some control loops.

In this section

Section		See page
B.3.1	Control loops	596
B.3.2	Control loop mapping description	599
B.3.3	Intermediate control elements	602
B.3.4	Examples of control loop set-up	607

B.3.1 Control loops

Control loop mechanism

PID (proportional-integral-derivative) controller is a generic control loop feedback mechanism. A PID controller calculates the difference between a measured parameter value (process variable, PV) and a defined setpoint (SP). The controller tries to minimize the difference by adjusting the process control outputs.

PID controller is used to control all system modules as well as most processes. PID control is applied using four control parameters:

- P - Proportional
- I - Integral
- D - Derivative
- DB - deadband

These four parameters regulate how much, how fast, and how close to the defined value the control should act.

All control loops described in this chapter are PID control loops.

A PID control loop includes all following parts:

- The measurement device
- The controller
- The final output device

Types of process control loops

The process control loops belong to one of the following three PID control loop types:

PID control loop type	PID control loops
Primary	• Auxiliary input 1 control • Auxiliary input 2 control • Dissolved oxygen (DO) control • Dissolved CO_2 control (optional) • pH control • Volume (weight) control
Secondary	• Agitator • MFC: 1-4 (optionally up to 6) • Pumps 1-3 (optionally up to 6) ***Note:*** *Any secondary loop can also be used as standalone loop.*

PID control loop type	PID control loops
Standalone	• Condenser temperature control • Exhaust filter heater temperature control • Vessel temperature control

Control mapping limits

The following table shows the control mapping options for different PID control loops.

PID control loop / control element	Agitator	Lookup tables	MFCs	Pumps	Split ranges
Auxiliary input 1 and 2	✓	✓	✓	✓	✓
Dissolved oxygen (DO)	✓	✓	✓	✓	✓
Dissolved CO_2	✓	✓	✓	✓	✗
Lookup tables	✓	✗	✓	✓	✗
pH	✓	✓	✓	✓	✓
Split ranges	✗	✓	✓	✓	✗
Vessel weight	✗	✓	✗	✓	✓

The following table shows the maximal number of control elements that can be mapped to different PID control loops.

PID control loop	Mapping options
Auxiliary input 1 and 2	• 1 split range • 2 lookup tables • 2 devices directly mapped
Dissolved oxygen (DO)	• 3 split ranges • 5 lookup tables • 6 devices directly mapped
Dissolved CO_2[1]	• 0 split ranges • 1 lookup table • 1 device directly mapped

PID control loop	Mapping options
pH	• 1 split range • 3 lookup tables • 3 devices directly mapped
Vessel weight	• 1 split range • 2 lookup tables • 2 devices directly mapped

[1] The dissolved CO_2 loop is a reverse acting PID control loop.

B.3.2 Control loop mapping description

Control loop mapping principle

Mapping a PID control loop defines a connection between the controlled variable (CV) coming from an input device (for example pH transmitter) and a final control element (SP of the output device, for example a pump). The output of the final control element controls the input through the mapped connection. The output device must be in ***Auto***/***Remote*** mode. The input device (main PID control loop) can be in ***Local***, ***Remote***, or ***Cascade*** mode.

The following mapping options are available:

Option	Description
Lookup table	Lookup tables can be used in between primary and secondary control loops for transforming the output of the primary control loop before transmitting it to the setpoint of the secondary control loop.
Split range	As an alternative, any primary control loop can be connected to a split range. Split ranges are used specifically for pH control or to create a reverse acting cascade pair (see *pH control, on page 607*.

NOTICE
Any factory-installed map setups and lookup table configurations are examples and not intended for use in a manufacturing process. The end user is responsible for developing appropriate values for a particular process.

Control loop mapping options

Mapping PID control loops is designed to be flexible. Any primary control loop can be mapped to any secondary control loop. Automated control of each PID control loop may be enabled or disabled as necessary. One or several PID control loops can be configured to run under the control of the ***Setpoint Table***. Up to 20 changes per PID control loop may be configured, and each PID control loop is configured independently.

Note: *Some PID control loops are factory-configured and cannot be configured by the user. Contact a Cytiva representative for more information.*

The following table lists possible controller mapping options.

Control loops	Mapping options
• Auxiliary input 1 control • Auxiliary input 2 control • Dissolved oxygen (DO) control • Dissolved CO_2 control • pH control • Volume (weight) control	• Lookup tables • Split ranges • Directly to the devices: - Agitator - Pumps - Mass flow controllers

Control loop mapping procedure

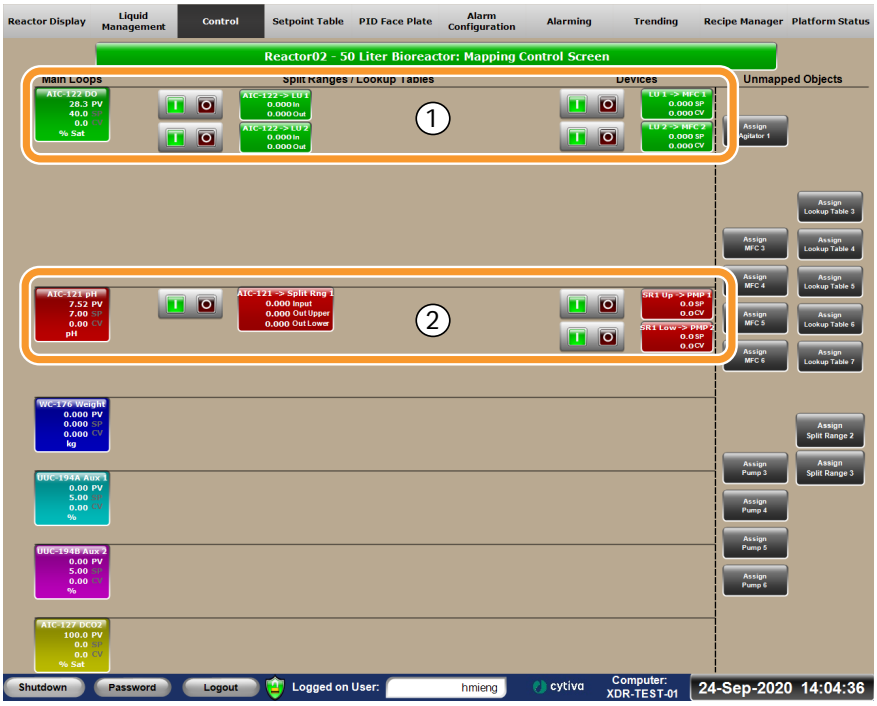
The mapping procedure comprises the following steps:

Stage	Description
1	Identify the parameter to be controlled (the input).
2	Identify the outputs that need to be adjusted to control the input.
3	Analyze how the input and the output should be connected: • If two different outputs are alternately used to control the upper and the lower parts of a parameter input, you need a split range. See *Split range description, on page 602*. • If the response of the system should not be linear, you need to set up a lookup table. The output and input are then connected in a non-linear manner. See *Lookup table description, on page 604*.
4	Map the control loop: connect the process input and the output according to your process requirements. Use the method suitable for your application: • Direct mapping • Split range • Lookup table

Example of mapped devices

When a device has been mapped to a PID control loop, the device panel is displayed in the same color as the PID control loop and is lined up with the PID control loop on the screen.

The following illustration shows an example of mapped devices.



Part	Description
1	DO control loop mapped to two lookup tables and two control devices
2	pH control loop mapped to a split range and two control devices

See sections *Section 7.3.1 Map a control loop using lookup tables, on page 320* and *Section 7.3.2 Map a control loop using split range, on page 328* for detailed descriptions of mapping procedures.

B.3.3 Intermediate control elements

Introduction

Intermediate control elements connect measured parameters (for example DO or pH) to final control elements (for example pumps or MFCs). There are two types of intermediate control elements:

- Split ranges
- Lookup tables

Access to intermediate control elements

Access buttons to intermediate control elements are located on the right side of the ***Control*** screen.



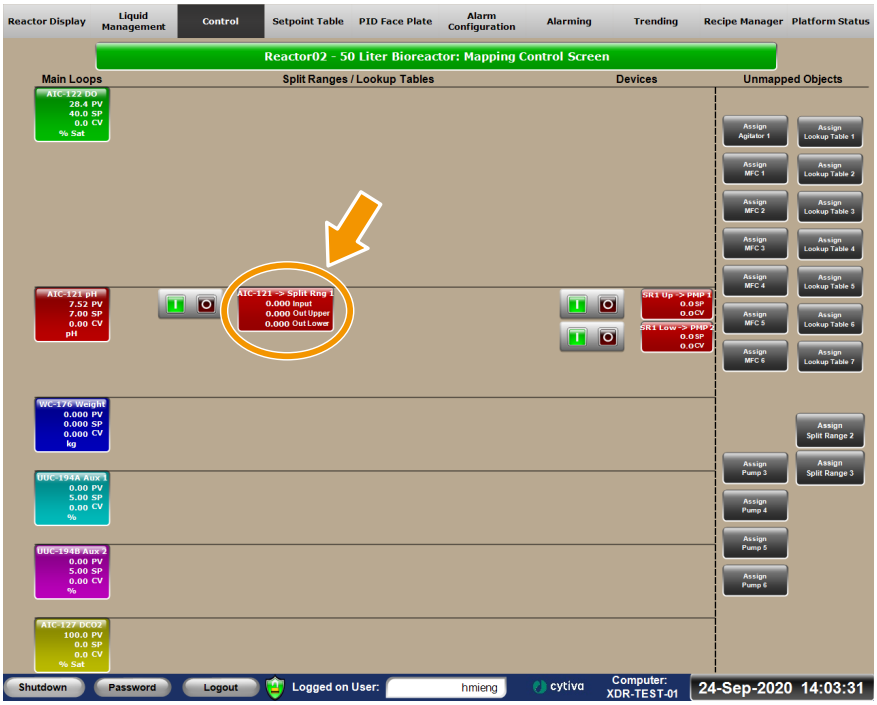
Split range description

A split range is used when one primary controller (input) must control two final control devices (two outputs) and each final control device does the opposite of the other. The final control devices operate alternately and control different CV ranges. The measured input is increased by one output and is decreased by the other output. Splitting the range makes sure that the final control devices never run simultaneously.

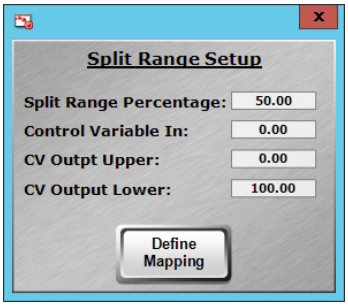
An example is pH control, where one final control device decreases the pH (addition of acid) and the other device increases the pH (addition of NaOH), but they should not run simultaneously. The pH is mapped to acid pump and NaOH pump via split range to control the pH.

Split Range Setup dialog box

To access a ***Split Range Setup*** dialog box click a split range panel on the ***Control*** screen. The location of one split range panel is shown in the following illustration.



The ***Split Range Setup*** dialog box allows the user to change or reset split range mapping and change split range parameters. The following illustration shows a ***Split Range Setup*** dialog box.



Part	Description
Split Range Percentage	Allows the user to change the point where the primary control loop is split to upper and lower ranges. At this point neither output has a controlled variable.
Control Variable In	The current controlled variable input from the primary controller.
CV Output Upper	The controlled variable value where the ***Split Range Upper*** is 100%. ***Note:*** *This is a read-only field.*
CV Output Lower	The controlled variable value where the ***Split Range Lower*** is 100%. ***Note:*** *This is a read-only field.*
Define Mapping	• Changes the device to which the split range is mapped • Resets the split range mapping

Lookup table description

Lookup tables are used to apply a stepwise-defined modification to the setpoint of the final control device (output). The input field in a lookup table is a CV value from a primary control loop. The output field in the lookup table is the setpoint (SP) for a final control device, or a control variable for a split range.

Lookup tables give the possibility to connect a controlled variable output and a PID control loop input, even if they are in different units (for example percent DO and liters per minute).

For example, a lookup table can be configured to make sure that a pump that delivers a solution would not slow its output until the weight control loop reaches 97.99%. When this point is reached, the pump turns off rapidly.

The values in the lookup table are set by the user, based on the previous knowledge of the process. Up to 20 steps can be defined in a lookup table. The output of a lookup table is linear from one step to the next, and is proportional to the full output range.

Lookup tables are the most common method for controlling dissolved oxygen in the cell culture. A unique lookup table must be used for each secondary MFC.

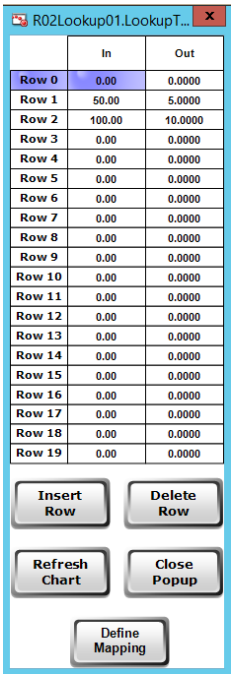
Lookup table location

To access a lookup table click a lookup table panel on the ***Control*** screen. The location of one lookup table panel is shown in the illustration below.



Lookup Table dialog box

The following illustration shows an example of a ***Lookup Table*** dialog box.



The buttons in the ***Lookup Table*** dialog box have the following functions:

Button	Description
Insert Row	Inserts a row above the selected row.
Delete Row	Deletes the selected row.
Refresh Chart	Updates the lookup table.
Close Popup	Closes the dialog box.
Define Mapping	Opens the mapping dialog box and allows to change the device, or reset the lookup table mapping.

B.3.4 Examples of control loop set-up

pH control

The pH PID control loop is a split range loop, where controlled variable of each half of the split range is zero at 50% output.

A pH control loop is always set up as a primary controller in a cascade loop. The output of the pH PID control loop is the setpoint of secondary control loops (acid and base pump control loops, or CO_2 control loop). The acid and base PID control loops are nested loops inside the pH control loop.

The following table explains the process of pH regulation.

Condition	Action
pH value increases	Base pump flow is decreased or CO_2 flow is increased (via mass flow controller) or Acid pump flow is increased
pH value decreases	Base pump flow is increased or CO_2 flow is decreased (via mass flow controller) or Acid pump flow is decreased

If the pH PID control loop is within the deadband range of the setpoint and calling for neither the base nor the acid or CO_2, the output of the loop is 50%. A deviation from 50% output changes the setpoint of either the top half or the bottom half of the split range:

- If the controlled variable goes above 50%, the split range upper setpoint is increased to bring the whole system to setpoint.
- If the controlled variable goes below 50% , the split range lower setpoint is increased to bring the whole system to setpoint.

When the controlled variable (***CV***) of the master PID control loop is within the configured deadband (***DB***), the controlled variable is forced to the configured split range percentage and the instrument goes into the ***Forced*** mode. The pumps remain in this state as long as the pump controlled variable is less than 10%. During this time the pump continuously switches on and off, running at 10% speed while switched on. The pump standby time is inversely proportional to the controlled variable value. When the controlled variable is above 10%, the pump operates in normal variable speed control mode.

Dissolved oxygen (DO) control

DO control is a primary control loop. The output of the DO PID control loop is the setpoint of the secondary control loop, which can be the agitator or an MFC. When DO mapping is complete, the DO may be used via ***Auto***/***Manual*** mode or operated via a setpoint table.

Lookup tables are used when mapping MFCs to the DO control, because the output of the primary control loop is in percentage units and the setpoint of the MFCs is in SLPM. See *Lookup table description, on page 604* for more information.

Dissolved CO_2 control (optional)

Dissolved CO_2 control is a primary control loop. The dissolved CO_2 control works similarly to dissolved oxygen (DO) control. See *Dissolved oxygen (DO) control* above for more detailed information.

Headsweep (overlay) control

Mass flow controller headsweep (overlay) control is typically configured as a standalone loop, but this is not obligatory. MFC-04 is designated as the headsweep (overlay) MFC, although any MFC can be used. Headsweep (overlay) is generally used to reduce the amount of water vapor in the stream of exhaust gases. The same mapping functionality is available for headsweep (overlay) control as for all six MFCs.

Exhaust filter heater temperature control

Exhaust filter heater temperature control is a standalone PID control loop. The controller is accessed through exhaust filter heater temperature panels on the ***Reactor Display*** screen. The task of this PID control loop is to maintain the exhaust filter heater temperature at setpoint.

Vessel temperature control

Vessel temperature control is a standalone PID control loop. The controller is accessed through the vessel temperature panel on the ***Reactor Display*** screen. The vessel temperature control loop maintains the temperature of the vessel at setpoint.

Weight (volume) control

Vessel weight control is a primary control loop that is mapped to secondary control loops (for example pumps) for filling, harvesting, or draining the XDR vessel. Vessel weight control is achieved by adding, removing, or simultaneously adding and removing fluid.

Task	Action
You want to fill or drain the XDR vessel.	• Map the weight control loop to a single pump that adds or removes the media solution, or • Map the weight control loop to a split range, if you need to use two pumps.
You want to exchange media during a batch run and want to maintain the quantity of media in the XDR vessel during this process.	• Set one pump to remove media from the system at a constant rate, • Set this pump in ***Auto***/***Local*** mode and define a setpoint, • Map the second pump to a lookup table to control the vessel weight.

Agitator speed control

Agitator speed control can be configured as a standalone loop or as a secondary loop in a cascade arrangement, mapped to DO control loop.

The controller is accessed using the agitator panel on the ***Reactor Display*** screen. Agitator PID control loop maintains the speed of the agitator at setpoint.

The following table describes agitator speed control modes.

Mode	Function
Auto/Local	Agitator speed is controlled to the SP defined via the agitator PID faceplate.
Manual/Local or ***Manual/Remote***	Agitator speed is controlled to the CV defined via the agitator PID faceplate.
Auto/Remote	Agitator speed is controlled to the default value in the ***Batch Manager***, or in the ***Setpoint Table*** if this is enabled and a batch is running. The control loop is set to batch setpoint.

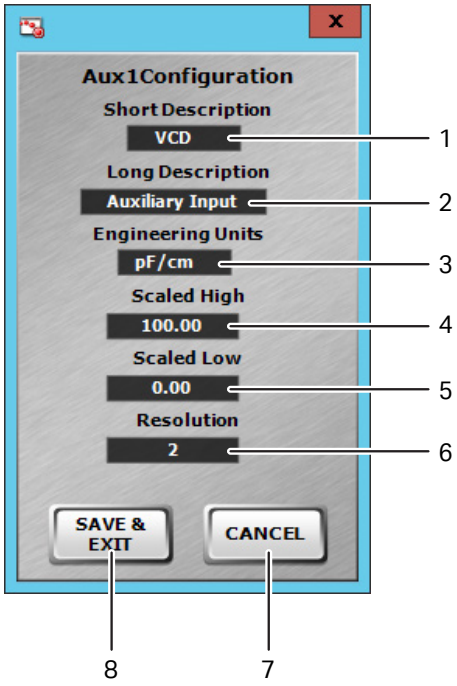
B.4 Auxiliary inputs configuration

Description

XDR-50 to 2000 Bioreactor Systems have two auxiliary inputs. Each auxiliary input can be configured independently in the software.

Aux X Configuration dialog box

The following illustration shows the ***Aux 1 Configuration*** dialog box.



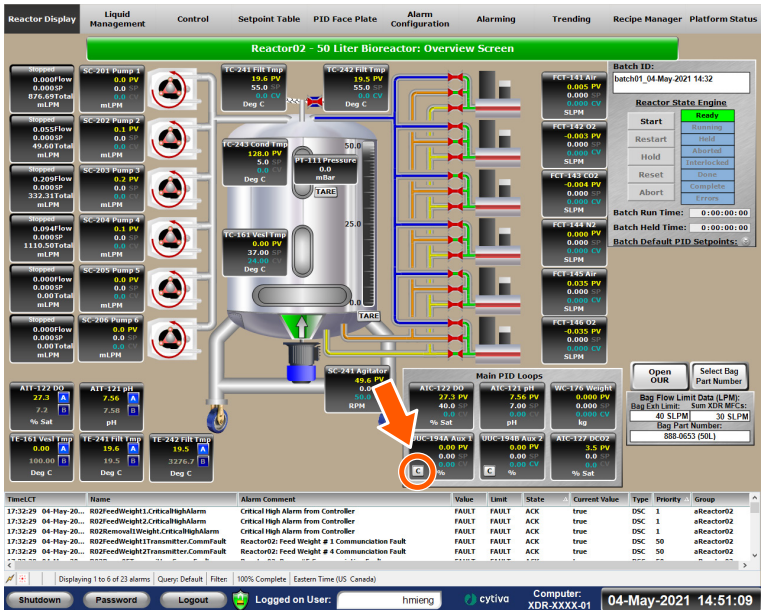
Part	Name	Characteristics
1	***Short Description***	Limited to 5 characters.
2	***Long Description***	Limited to 15 characters.
3	***Engineering Units***	Limited to 5 characters.
4	***Scaled High***	Defines the maximum value for the engineering range.
5	***Scaled Low***	Defines the minimum value for the engineering range.
6	***Resolution***	Defines the number of displayed decimal places.

Part	Name	Characteristics
7	***CANCEL***	Closes the dialog box without saving.
8	***SAVE & EXIT***	Saves the defined parameters and closes the dialog box.

Configure auxiliary inputs

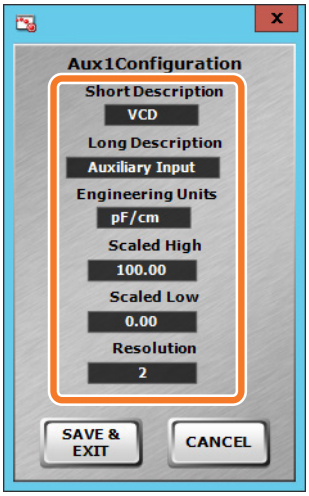
Follow the instructions below to configure an auxiliary input. ***Aux Input 1*** is shown as an example.

Step	Action
1	On the ***Reactor Display*** screen, on the auxiliary input panel, click ***C***.



Result:
The ***Aux 1 Configuration*** dialog box opens.

Step	Action
2	In the dialog box, specify the parameters for the auxiliary input. See *Aux X Configuration dialog box, on page 610* for parameter explanations and limit descriptions.

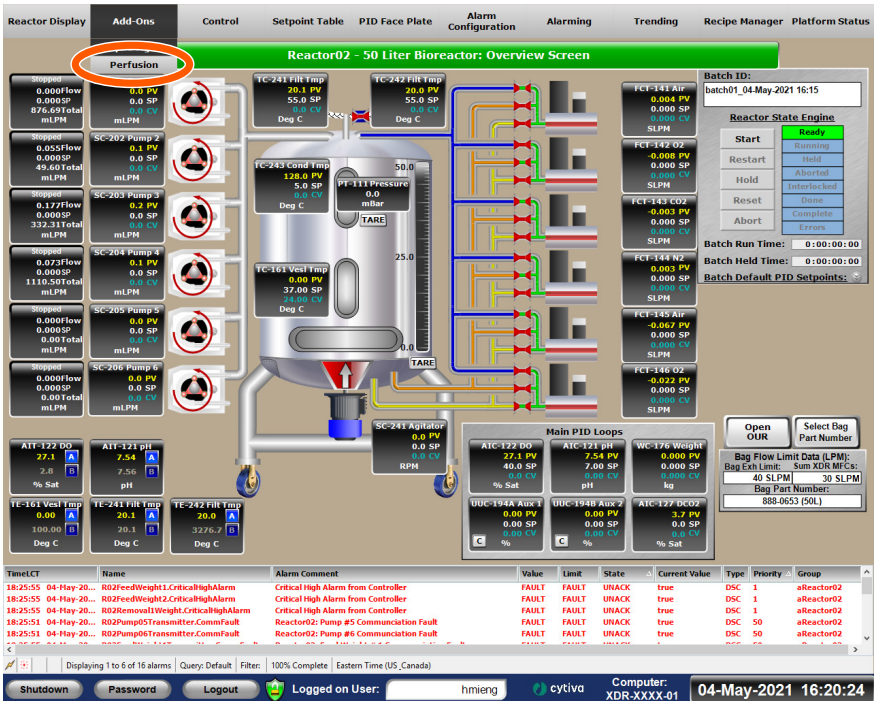


3	Click ***SAVE & EXIT*** to save the defined parameters, or click ***CANCEL*** to close the dialog box without saving.

B.5 Xcellerex APS

Access to the functionality

If the perfusion option Xcellerex APS (available only for ***Reactor01***) is configured on the system, the access to this functionality is located on the ***Add-Ons*** drop-down menu (***Add-Ons*** →***Perfusion***). Refer to *Xcellerex APS Operating Instructions (29365080)* for more information on this functionality.



Appendix C
Liquid Management (optional)

Introduction

This section gives information about Liquid Management function. This function connects scales and pumps to control liquid addition to and removal from the bioreactor. Liquid Management is an optional function for XDR-50 to 2000 Bioreactor Systems.

For information of interlocks that are specific to Liquid Management, see *Interlocks, Liquid Management (optional function), on page 47*.

For troubleshooting, see *Section 9.6 Liquid Management (optional function), on page 508*.

In this chapter

Section		See page
C.1	Function overview	615
C.2	Hardware description	619
C.3	User interface	621
C.4	Liquid Management operation	634

C.1 Function overview

Description

The Liquid Management function uses the gravimetric feed principle for liquid addition and removal. This function uses scales and pumps to control the liquid addition and removal from the bioreactor. An amount of liquid is added into the disposable bag during the cell cultivation process, and an amount of liquid is optionally removed during the process. The addition (feed process) and the removal of the liquid are controlled by the PID control loops in the software.

Operating principle

A feed or a removal control loop consists of a scale and a pump that are connected to the PID controller. The scale continuously transmits data (weight samples) to the controller. The controller processes the data, using the gravimetric control algorithm, and adjusts the pump speed according to the gravimetric feed rate (g/min), defined by the user.

One, two, or thee control loops can be set up using the Liquid Management function. All combinations of the feed and removal control loops are supported by the software.

Feeding process

A container with the feed liquid is set on a scale which is connected to the bioreactor I/O Cabinet. The liquid output tubing from the container is connected to a liquid addition line of the disposable bag. The tubing is installed in a peristaltic pump (feed pump). The PID controller receives weight data from the scale and regulates the speed of the feed pump according to the user-defined gravimetric feed rate (g/min).

Two modes are available for the feeding process:

- Dual feed
- Sequential feed

The feed mode is selected in the software before starting the process.

Dual feed mode

In dual feed mode, liquid is added to cell culture from different containers independently, using separate feed controllers. Each feed control loop (a scale, a pump, and a controller) is set up independently. The flow rates are defined separately for each feed control loop.

The dual feed mode is mainly used for the addition of relatively small liquid volumes into the disposable bag during an ongoing cell cultivation process.

Sequential feed mode

In sequential feed mode, two feed inputs from different containers are controlled by one feed controller and are used alternately. Only one feed control loop (a scale, a pump, and a controller) is active at a time. The user defines a switchover setpoint, which is a minimum volume (weight) for each feed input container. When this volume (weight) is reached, the controller switches to the other feed input container.

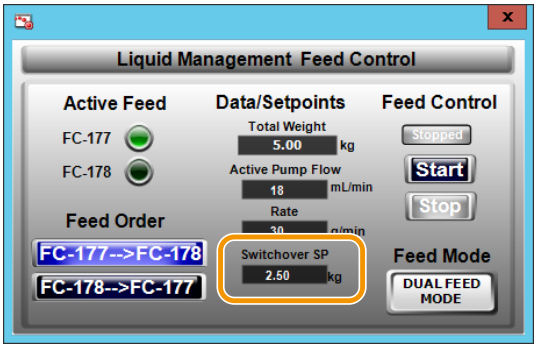
During the input from the second feed container, the user may fill the first feed container again. When the second container reaches the minimum defined volume (weight), the controller switches back to the first feed container. The switchover can be repeated as many times as needed. The sequential input from the two containers continues, until one of the following conditions is true:

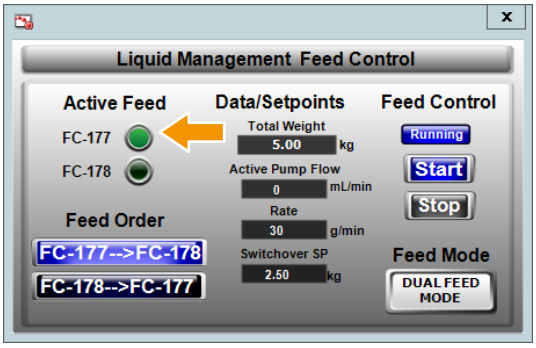
- The user stops the process.
- The next sequential feed container is not ready (the weight is less than the user-defined minimum).
- The added liquid weight reaches the ***Total Weight*** setpoint.

The sequential feed mode is mainly used to add bulk volumes of liquids into the disposable bag during an ongoing process.

Switchover setpoint

The switchover setpoint is used in the sequential feed mode. The switchover setpoint value (***Switchover SP***) is defined in the ***Liquid Management Feed Control*** dialog box.



Stage	Description
1	When the process is started, the input from the first feed container starts to run. The ***Active Feed*** indicator for ***FC-177*** is green. 
2	When the weight on the first scale ***WIT-177*** becomes equal to the defined ***Switchover SP*** value, the first feed input turns off.
3	• If the weight on the second scale ***WIT-178*** is higher than the defined ***Switchover SP***, the input from the second feed container starts to run. The ***Active Feed*** indicator for ***FC-178*** turns green. • If the weight on the second scale ***WIT-178*** is lower than the defined ***Switchover SP***, the feeding process stops.
4	The input from the second feed container runs until the weight on the second scale ***WIT-178*** becomes equal to the defined ***Switchover SP*** value.
5	• If the user has added liquid to the first container and the weight on the first scale ***WIT-177*** is higher than the defined ***Switchover SP***, the system switches back to the input from first feed container. • If no liquid was added and the weight on the first scale ***WIT-177*** is lower than the defined ***Switchover SP***, the feeding process stops.
6	Stages 2 to 5 are repeated until one of the following conditions is true: • The weight of the next sequential feed container is lower than the ***Switchover SP***. • The added liquid weight reaches the ***Total Weight*** setpoint. • The user stops the process.

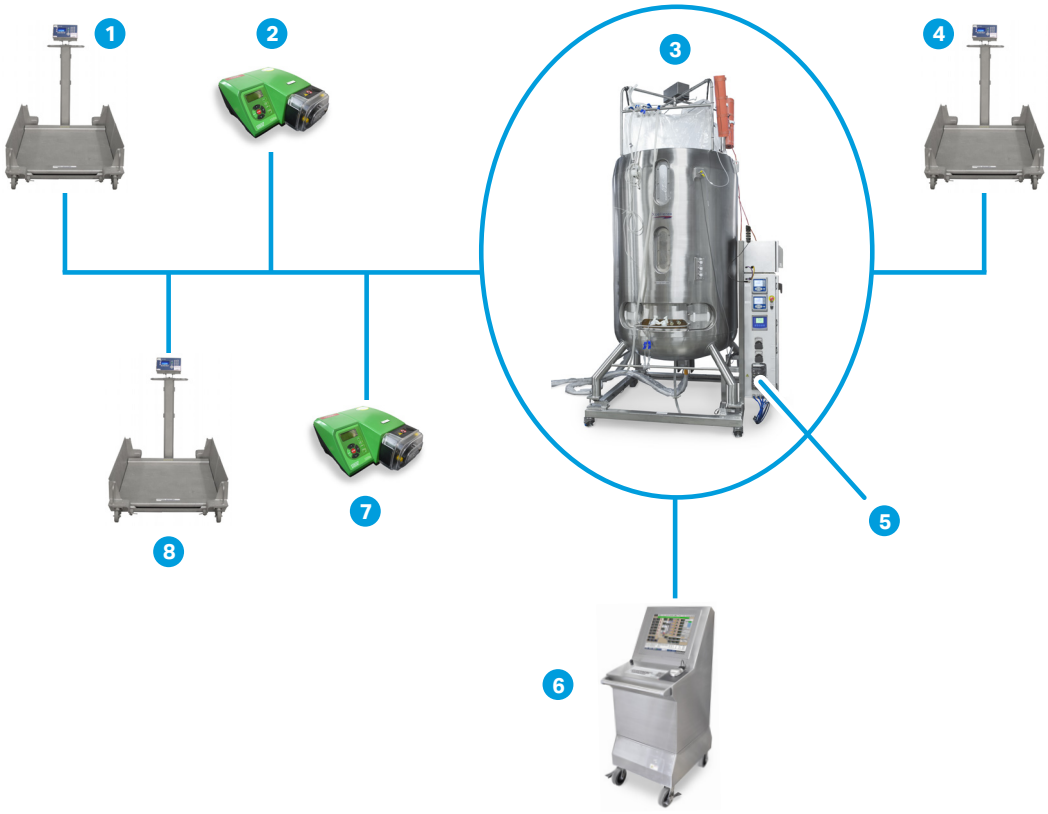
Removal process

An empty container is set on a scale which is connected to the I/O Cabinet. The harvest line of the disposable bag is connected to the input tubing of the container and the tubing is installed in a pump. The removal controller receives weight data from the scale and regulates the speed of the removal pump according to the user-defined gravimetric feed rate (g/min).

C.2 Hardware description

System overview

The following illustration shows a general system setup for Liquid Management.



Part	Name	Description
1	Feed 1 scale	The scale monitors the feed 1 input weight.
2	Feed 1 pump	The pump feeds liquid into the bioreactor.[1]
3	XDR bioreactor	The bioreactor contains the cell culture.
4	Removal scale	The scale monitors the removed liquid weight.
5	Removal pump	The pump removes liquid from the bioreactor.[1]
6	X-Station	X-Station contains the control system.
7	Feed 2 pump	The pump feeds liquid into the bioreactor.[1]

Part	Name	Description
8	Feed 2 scale	The scale monitors the feed 2 input weight.

[1] Any external or a built-in pump (mounted on the I/O Cabinet) can be used for both feed and removal, depending on the required flow rate.

The pumps and scales shown above are for illustration only. The actual hardware models depend on the process capacity.

Pumps

The software supports maximum six pumps: four pumps mounted on the I/O Cabinet and two external pumps. Each pump can be used for the Liquid Management function. The pumps can be assigned to any scale (feed or removal), depending on the specified flow rates.

The following Watson-Marlow peristaltic pumps are available:

- Models 114, 313 and 520 – built-in pumps (mounted on the I/O Cabinet)
- Models 530, 630 and 730 – external pumps, optional

The different types of pumps have specific flow rates depending on the type of tubing. Refer to the manufacturer's documentation for more information on flow rates. Before assigning a pump to a scale, make sure that the combination is applicable.

The pumps on the I/O Cabinet are tagged ***SC-201*** to ***SC-204*** in the software, and the two external pumps are tagged ***SC-206*** and ***SC-207***.

Scales

The software supports a maximum of three scales for the Liquid Management function:

- Two scales support the feed process.
- One scale supports the removal process.

The scale model depends on the process capacity. Contact your Cytiva representative for information about the available scales for the Liquid Management function.

Hardware connections

The external feed pumps and the corresponding scales are connected using a daisy chain scheme. The daisy chain sequence is connected to the bioreactor control system using the **PROFIBUS SLAVE A** connection port on the back of the I/O Cabinet.

The removal scale is connected to the bioreactor using the **PROFIBUS SLAVE B** connection port on the back of the I/O Cabinet.

C.3 User interface

Introduction

This section describes the software screens that are used for Liquid Management function.

In this section

Section		See page
C.3.1	***Liquid Management*** screen	622
C.3.2	Additional screens	628
C.3.3	Dialog boxes	631

C.3.1 *Liquid Management* screen

Liquid Management screen description

Liquid Management is the main screen for this function. The ***Liquid Management*** screen shows a detailed graphical display of the hardware layout and provides access to the specific dialog boxes that are needed to set up the liquid management control.

Clicking ***Liquid Management*** on the header toolbar opens the ***Liquid Management*** screen.



If the perfusion option Xcellerex APS (available only for ***Reactor01***) is configured on the system, the Liquid Management button is located on the ***Add-Ons*** drop-down menu.

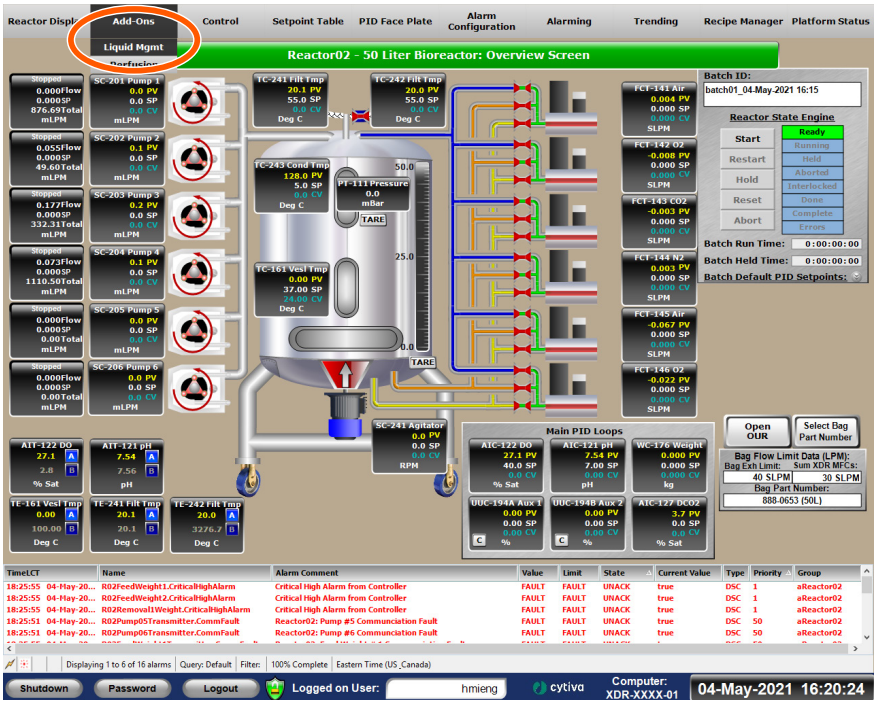
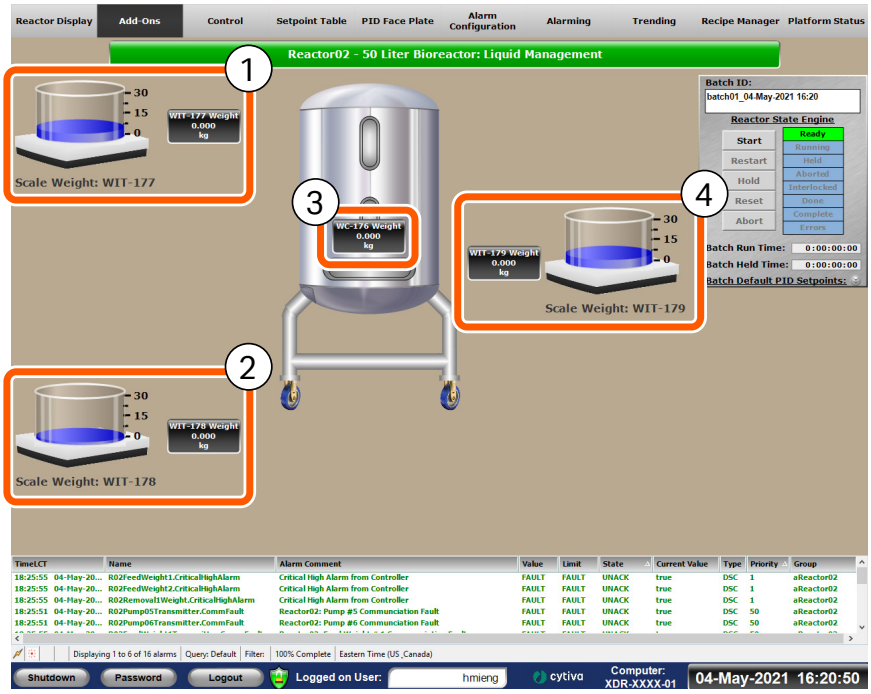


Illustration of the *Liquid Management* screen without assigned pumps

The following illustration shows the ***Liquid Management*** screen before any pumps are assigned to the Liquid Management function.



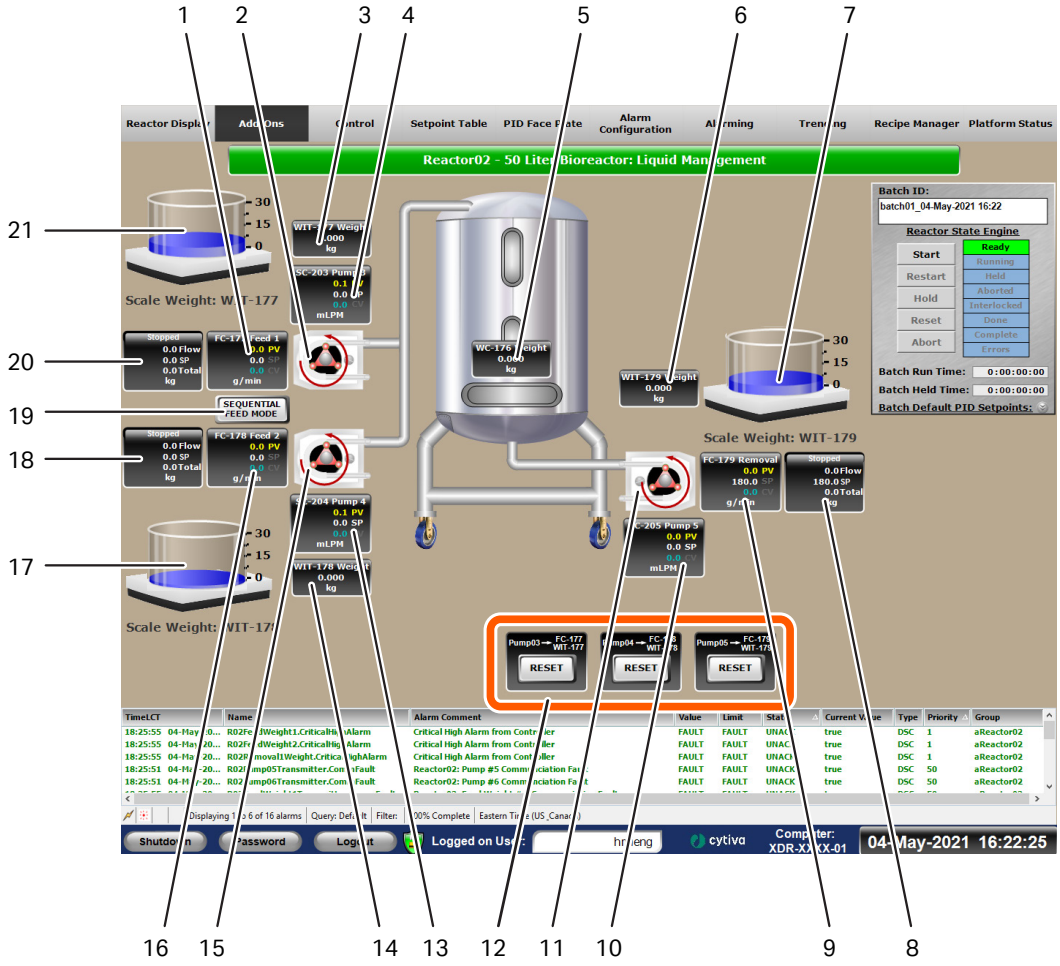
Part	Tag name	Function
1	***WIT-177***	Feed 1 scale icon and scale weight display
2	***WIT-178***	Feed 2 scale icon and scale weight display
3	***WC-176***	Vessel weight display
4	***WIT-179***	Removal scale icon and scale weight display

Each scale icon is also a weight display: the blue bar on the icon shows the current weight of the container on the scale.

For explanations of other components on the screen, see *Illustration of the Reactor Display screen, on page 553*.

Illustration of the *Liquid Management* screen, dual feed

The following illustration shows the ***Liquid Management*** screen in dual feed mode, with three assigned pumps.

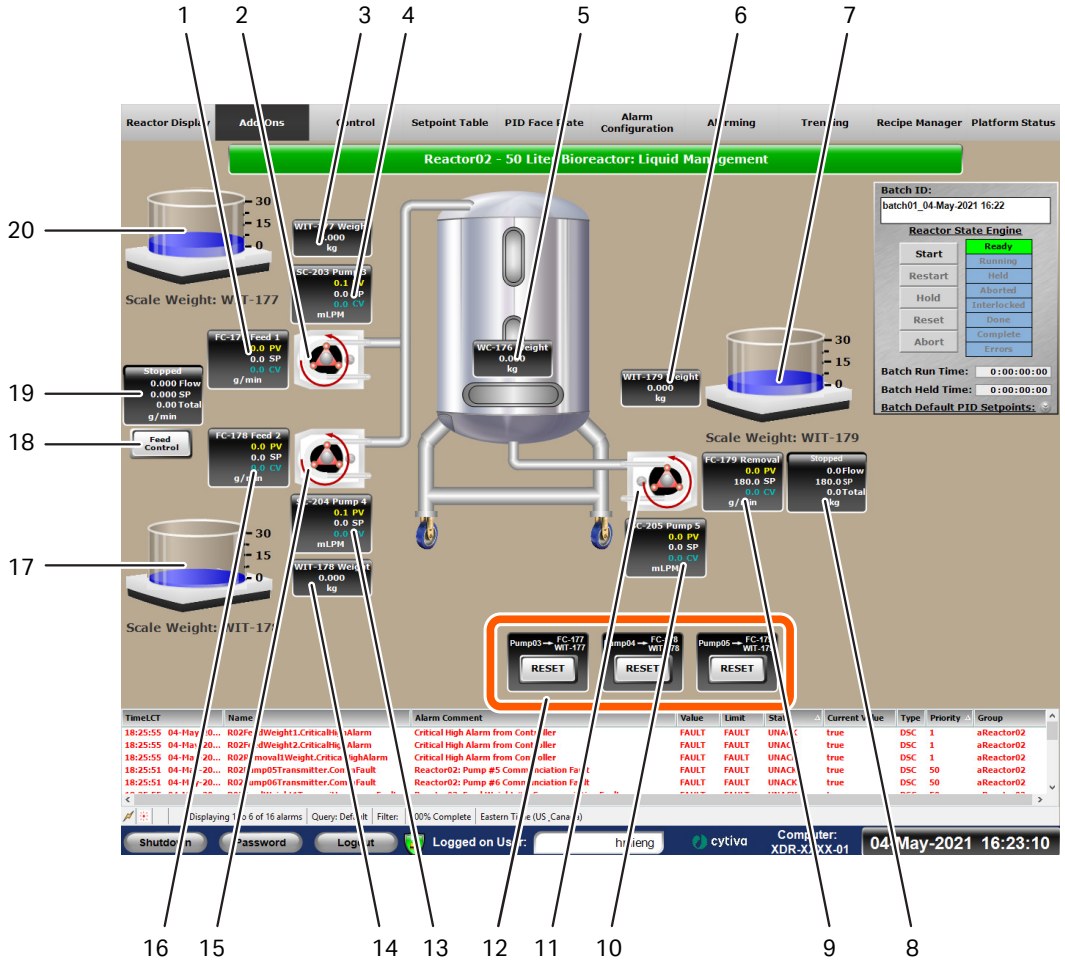


Part	Description	Function
1	Feed 1 control panel	Clicking the panel opens the ***Feed Control 1*** PID faceplate.
2	Feed 1 pump icon	Shows the current flow direction. The arrow is green when the pump is running. Clicking the icon opens the ***Pump Flow Calibration*** dialog box.
3	Scale 1 weight display	Shows the current weight on the scale 1.

Part	Description	Function
4	Feed 1 pump panel	Clicking the panel opens the feed 1 pump PID faceplate.
5	Vessel weight display	Shows the vessel weight.
6	Removal scale weight display	Shows the current weight on the removal scale.
7	Removal scale icon and weight display	Illustrates the current weight of the container on the removal scale.
8	Removal totalizer panel	Clicking the panel opens the ***Removal Totalizer*** dialog box.
9	Removal control panel	Clicking the panel opens the ***Removal Control*** PID faceplate.
10	Removal pump panel	Clicking the panel opens the PID faceplate for the removal pump.
11	Removal pump icon	Shows the current flow direction. The arrow is green when the pump is running. Clicking the icon opens the ***Pump Flow Calibration*** dialog box.
12	Pump assignment panels	Clicking ***RESET*** allows the user to disconnect the pump from the flow control loop.
13	Feed 2 pump panel	Clicking the panel opens the feed 2 pump PID faceplate.
14	Scale 2 weight display	Shows the current weight on the scale 2.
15	Feed 2 pump icon	Shows the current flow direction. The arrow is green when the pump is running. Clicking the icon opens the ***Pump Flow Calibration*** dialog box.
16	Feed 2 control panel	Clicking the panel opens the ***Feed Control 2*** PID faceplate.
17	Feed 2 scale icon and weight display	Illustrates the current weight of the container on the feed 2 scale.
18	Feed 2 totalizer panel	Clicking the panel opens the ***Feed 2 Totalizer*** dialog box.
19	***SEQUENTIAL FEED MODE*** button	Clicking ***SEQUENTIAL FEED MODE*** sets the system into the sequential feed control mode.
20	Feed 1 totalizer panel	Clicking the panel opens the ***Feed 1 Totalizer*** dialog box.
21	Feed 1 scale icon and weight display	Illustrates the current weight of the container on the feed 1 scale.

Illustration of the *Liquid Management* screen, sequential feed

The following illustration shows the ***Liquid Management*** screen in sequential feed mode, with three assigned pumps.



Part	Description	Function
1	Feed 1 control panel	Clicking the panel opens the ***Feed Control 1*** PID faceplate.
2	Feed 1 pump icon	Shows the current flow direction. The arrow is green when the pump is running. Clicking the icon opens the ***Pump Flow Calibration*** dialog box.
3	Scale 1 weight display	Shows the current weight on the scale 1.

Part	Description	Function
4	Feed 1 pump panel	Clicking the panel opens the pump 1 PID faceplate.
5	Vessel weight display	Shows the vessel weight.
6	Removal scale weight display	Shows the current weight on the removal scale.
7	Removal scale icon and weight display	Illustrates the current weight of the container on the removal scale.
8	Removal totalizer panel	Clicking the panel opens the ***Removal Totalizer*** dialog box.
9	Removal control panel	Clicking the panel opens the ***Removal Control*** PID faceplate.
10	Removal pump panel	Clicking the panel opens the PID faceplate for the removal pump.
11	Removal pump icon	Shows the current flow direction. The arrow is green when the pump is running. Clicking the icon opens the ***Pump Flow Calibration*** dialog box.
12	Pump assignment panels	Clicking ***RESET*** allows the user to disconnect the pump from the flow control loop.
13	Feed 2 pump panel	Clicking the panel opens the pump 2 PID faceplate.
14	Scale 2 weight display	Shows the current weight on the scale 2.
15	Feed 2 pump icon	Shows the current flow direction. The arrow is green when the pump is running. Clicking the icon opens the ***Pump Flow Calibration*** dialog box.
16	Feed 2 control panel	Clicking the panel opens the ***Feed Control 2*** PID faceplate.
17	Feed 2 scale icon and weight display	Illustrates the current weight of the container on the feed 2 scale.
18	***Feed Control*** button	Clicking ***Feed Control*** opens the ***Liquid Management Feed Control*** dialog box.
19	Feed totalizer panel	Clicking the panel opens the ***Sequential Feed Totalizer*** dialog box.
20	Feed 1 scale icon and weight display	Illustrates the current weight of the container on the feed 1 scale.

C.3.2 Additional screens

Setpoint Table screen

Setpoint Table Screen 3 shows all available PID control loops related to the Liquid Management function.

The following illustration shows an example of ***Setpoint Table Screen 3***.

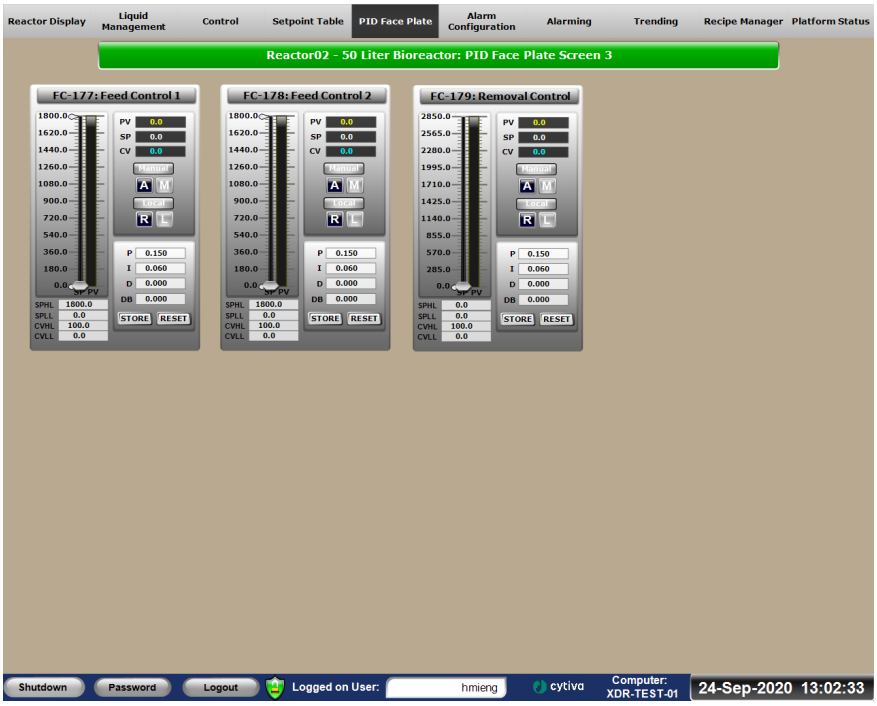


For more information about the ***Setpoint Table*** screen, see *Appendix B.1.5 Setpoint Table, on page 567*.

PID Face Plate screen

PID Face Plate Screen 3 shows all available PID control loops related to the Liquid Management function.

The following illustration shows an example of ***PID Face Plate Screen 3***.



For more information about the ***PID Face Plate*** screen, see *Appendix B.1.6 PID Face Plate, on page 568*.

Alarm Configuration screen

Alarm Configuration Screen 3 shows all available process variables for the Liquid Management function.

The following illustration shows an example of ***Alarm Configuration Screen 3***.



For more information about the ***Alarm Configuration*** screen, see *Appendix B.1.7 Alarm Configuration, on page 570*.

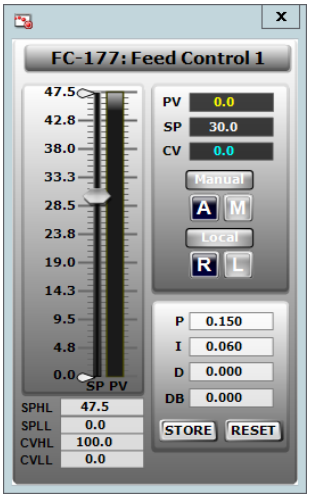
C.3.3 Dialog boxes

PID faceplate dialog box

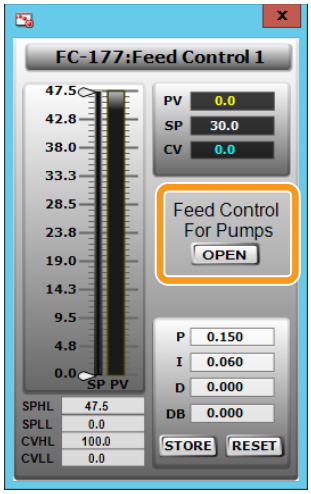
Each PID faceplate dialog box contains the tuning parameters for an individual PID control loop. ***Feed Control*** PID faceplate dialog box is used in the Liquid Management function to control the feed process.

The following illustration shows examples of ***Feed Control*** PID faceplate dialog box.

Dual feed mode



Sequential feed mode

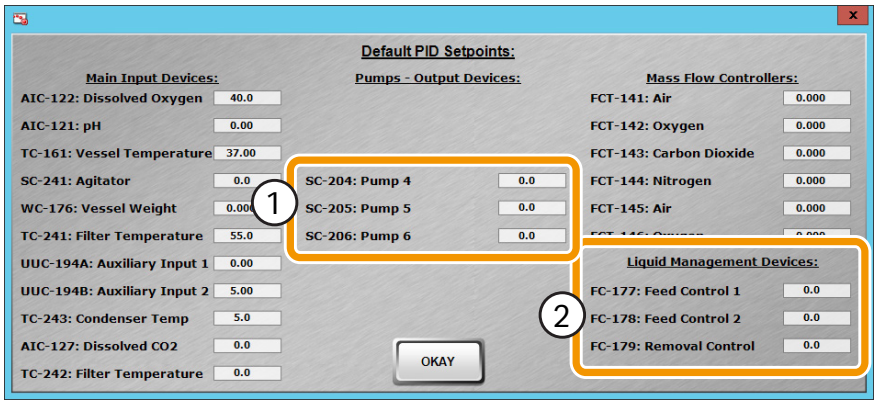


In sequential feed mode, clicking ***OPEN*** opens the ***Liquid Management Feed Control*** dialog box.

For more detailed information on PID faceplate dialog boxes, see *Appendix B.2.1 PID faceplate, on page 585*.

Default PID Setpoints dialog box

The default PID setpoints are used to define the setpoints that do not change during a batch run. The following illustration shows an example of the ***Default PID Setpoints*** dialog box.



Generally, the pump setpoints are shown in the ***Pumps - Output Devices*** column (1). When the pumps are assigned to the ***Liquid Management*** mode, they are shown in the ***Liquid Management Dual Feed - Devices*** column (2). This column is named ***Liquid Management Sequential Feed - Devices***, if the sequential feed mode is selected.

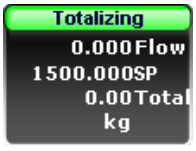
For more information about the ***Default PID Setpoints*** dialog box, see *Default PID Setpoints, on page 593*.

Feed totalizer

Clicking a feed totalizer panel or a removal totalizer panel on the ***Liquid Management*** screen opens a related totalizer dialog box. When the process is running, the totalizer panel shows a green ***Totalizing*** header on the ***Liquid Management*** screen.

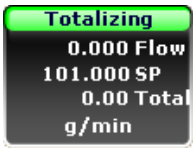
The following illustration shows the examples of the totalizer dialog box and the totalizer panel for the dual feed mode. Similar dialog box and panel are applicable for the removal process.





The following illustration shows the examples of the totalizer dialog box and the totalizer panel for the sequential feed mode.





C.4 Liquid Management operation

Introduction

This section gives instructions to the user how to work with the Liquid Management function.

In this section

Section		See page
C.4.1	Connect hardware	635
C.4.2	Set up software connections	636
C.4.3	Start addition or removal process	649
C.4.4	Stop addition or removal process	661

C.4.1 Connect hardware

Set up pumps and scales

Connect the external pumps and the scales to the bioreactor control system as applicable for your process. See *Hardware connections, on page 620* for information about the hardware setup principles.

C.4.2 Set up software connections

Introduction

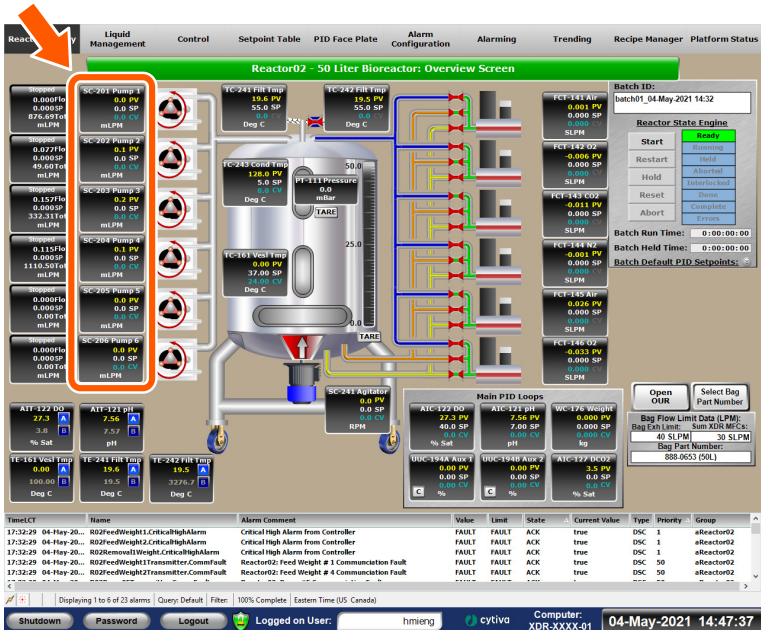
A control loop (a feed or a removal control loop) consists of a scale and a pump that are connected to the PID controller. The following sections give instructions how to set up and start the Liquid Management control.

One, two or three control loops (feed or removal) in different combinations can be set up, according to the process requirements. The following instructions describe a setup using three pumps (three control loops).

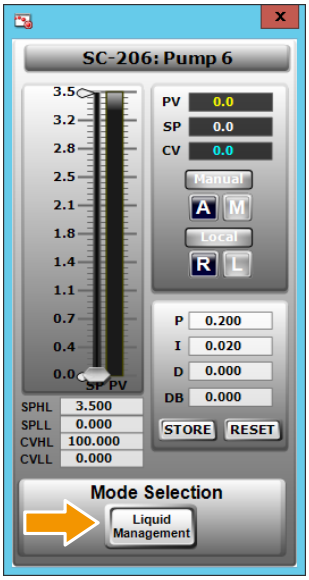
Assign pump to *Liquid Management*

Follow the instructions below to assign a pump to the ***Liquid Management*** mode.

Step	Action
1	Click ***Reactor Display*** on the header toolbar to open the ***Reactor Display*** screen.
2	Assign a pump to ***Liquid Management*** mode: click the relevant pump panel on the ***Reactor Display*** screen to open the pump PID faceplate. All connected pumps are available for the Liquid Management function.



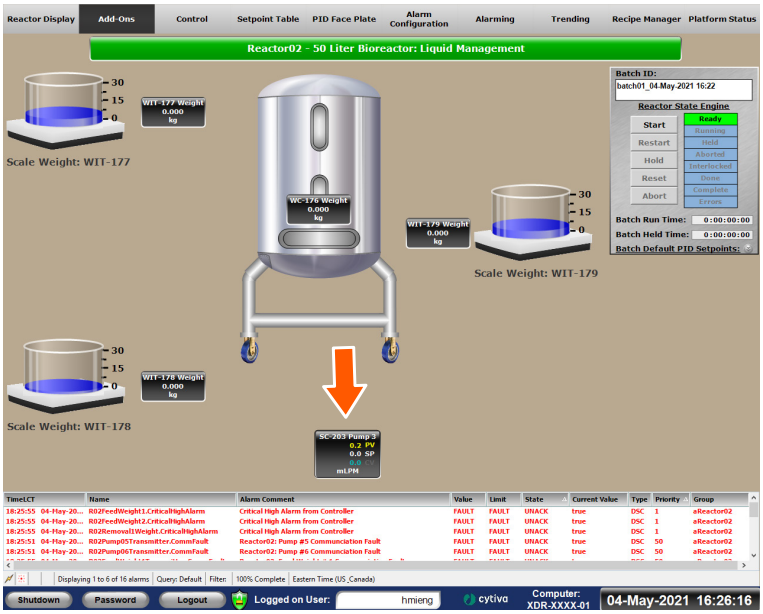
Step	Action
3	On the the pump PID faceplate, click ***Liquid Management***.



Step	Action

Result:

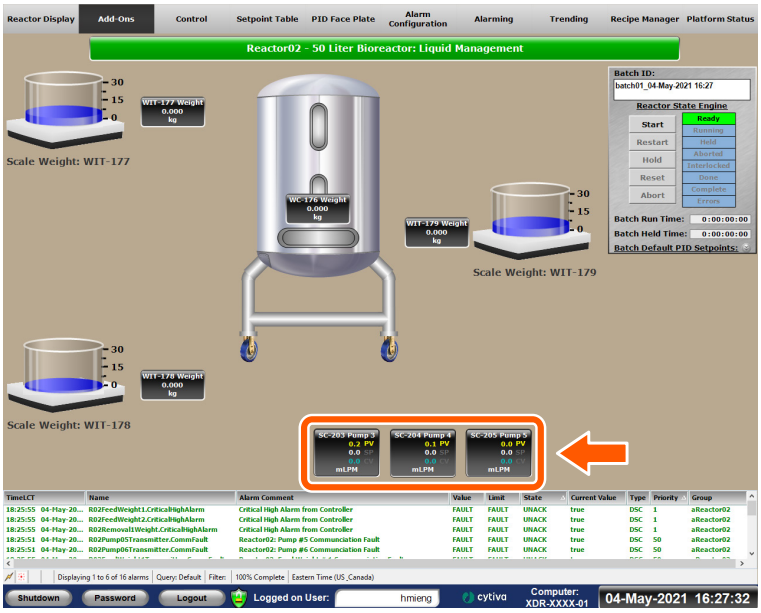
The PID faceplate closes. The pump panel is removed from the ***Reactor Display*** screen and is not available for other purposes. The assigned pump panel is shown at the bottom of the ***Liquid Management*** screen.



4 Assign all pumps that are needed for your process to ***Liquid Management*** mode. Repeat steps 2 to 3 above for each applicable pump.

Result:

All pump panels are shown at the bottom of the ***Liquid Management*** screen.

Step	Action
	

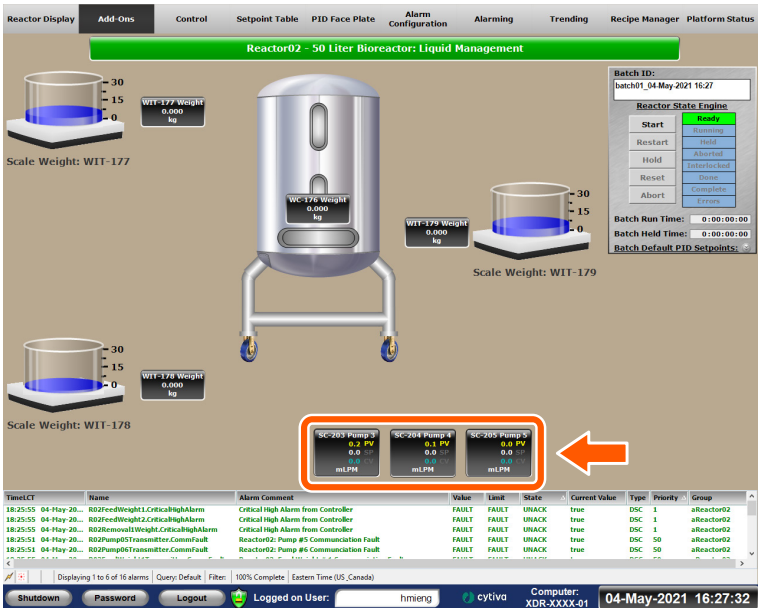
Continue the setup process as described in the next section.

Set up a control loop

The software automatically selects the most recently used feed mode for the setup process. The user can change the feed mode after all pumps are assigned to the scales.

Follow the instructions below to assign the pumps to the scales and select the feed mode (dual feed or sequential feed).

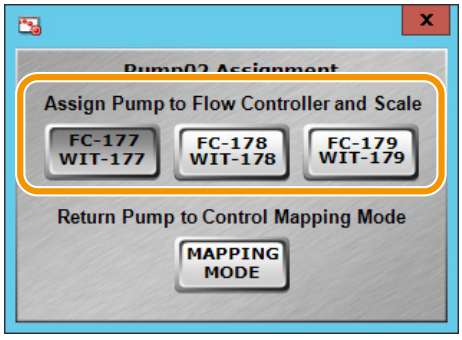
Step	Action
1	On the ***Liquid Management*** screen, click a pump panel at the bottom of the screen.



Result:

PumpXX Assignment dialog box opens.

2	Click an applicable button to assign the pump to a scale and to a flow controller. The gray options are not available.



Step	Action
3	If the system was in sequential feed mode during the most recent use, the screen shown below is displayed. Continue the setup process as described in steps 6 to 9.



If this screen is not shown, the system was previously in dual feed mode, as shown below.

Step	Action

Result:

The first pump is assigned to a flow control loop in dual feed mode. The pump panel moves near to the scale icon. The pump icon, the feed control panel, and the feed totalizer panel are displayed (1). The pump assignment panel at the bottom of the ***Liquid Management*** screen shows the connection details (2).



Continue as described in steps 4 to 5.

4 Assign all pumps to the feed control loops and to a removal control loop, as described above in steps 1 to 2.

Step	Action

Result:

The three control loops are set up in the dual feed mode. Two feed totalizer panels (4) and a removal totalizer panel (7) are displayed. Two feed control panels (5) and a removal control panel (6) are displayed. All pump assignment panels at the bottom of the screen show the connection details.



Step	Action
5	To change the control feed mode, click ***SEQUENTIAL FEED MODE***.



6	If your system was in sequential feed mode during the most recent use, then the screen shown below is displayed.

Step	Action

Result:

The first pump is assigned to a flow control loop in sequential feed mode. The pump panel (1) moves near to the scale icon, and the pump icon (2) is displayed. The pump assignment panel at the bottom of the ***Liquid Management*** screen shows the connection details (3).



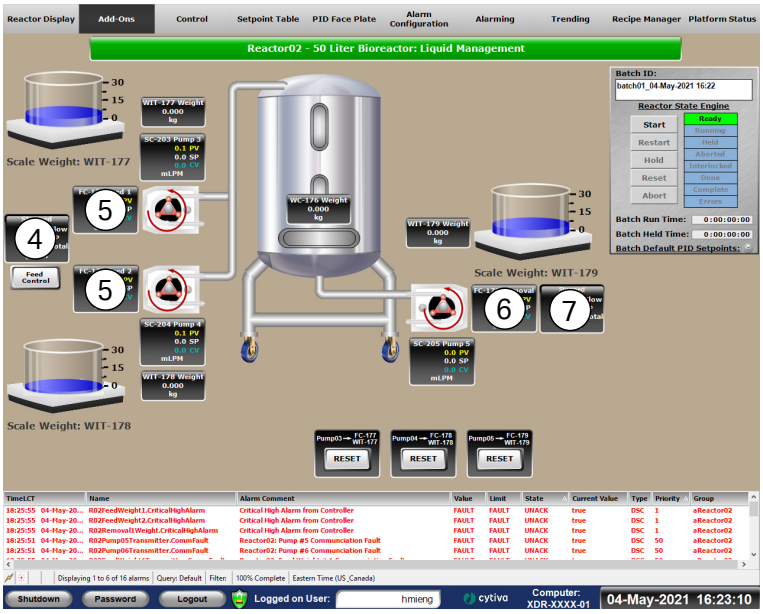
Continue the setup process as described in steps 7 to 9.

7	Assign all pumps to the feed control loops and to a removal control loop, as described above in steps 1 to 2.

Step	Action

Result:

The three control loops are set up in the sequential feed mode. A feed totalizer panel (4) and a removal totalizer panel (7) are displayed. Two feed control panels (5) and a removal control panel (6) are displayed. All pump assignment panels at the bottom of the screen show the connection details.



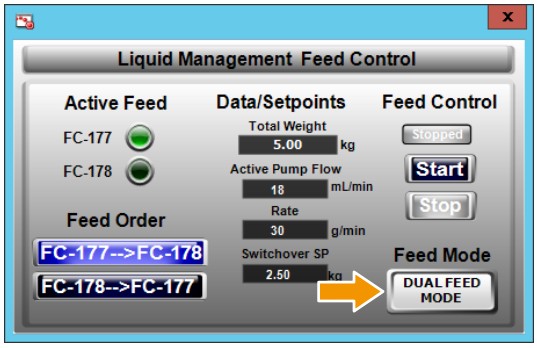
Step	Action
8	To change the control feed mode, click ***Feed Control***.



Result:

Liquid Management Feed Control dialog box opens.

9	To set up feed control in dual feed mode, click ***DUAL FEED MODE*** in the dialog box.



Configure the alarms

When the pumps have been assigned to the control loops, the alarms can be defined for the liquid management components. Follow the instructions below to configure the alarms.

Step	Action
1	Click ***Alarm Configuration*** on the header toolbar and select ***Screen 3*** on the drop-down menu.



2	On the ***Alarm Configuration*** screen, define the alarms for each parameter as applicable. See *Configure alarms, on page 413* how to configure the alarms. See *Appendix B.2.2 Alarm configuration for a variable, on page 589* for more information about alarm configuration dialog box.

C.4.3 Start addition or removal process

Start addition in dual feed mode

Follow the instructions below to start the feeding process in dual feed mode.

Step	Action
1	On the ***Liquid Management*** screen, make sure that the system is in dual feed mode.



Note:
*Clicking **SEQUENTIAL FEED MODE** sets the system into the sequential feed mode.*

Step	Action
2	On the ***Liquid Management*** screen, click the feed 1 totalizer panel (1).



Result:

Feed 1 Totalizer dialog box opens.

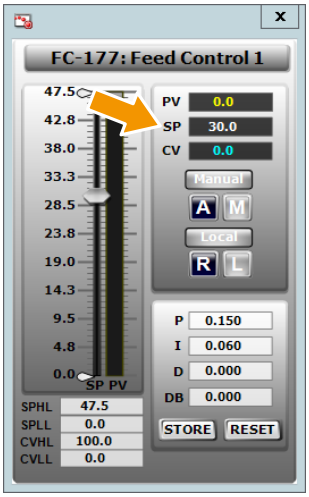
3	In the dialog box, click ***START***.



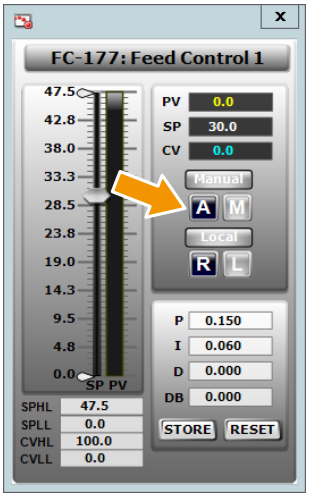
4	Click the close button to close the dialog box.
5	On the ***Liquid Management*** screen, click the ***FC-177 Feed 1*** panel (2).

Result:
The feed control PID faceplate opens.

Step	Action
6	On the feed control PID faceplate, type the applicable value into the ***SP*** text box.



7	Click ***A*** to set the feed process in ***Auto/Local*** mode.



Step	Action

Result:

The feed input from the container on the ***WIT-177*** scale starts. On the ***Liquid Management*** screen, the ***FC-177 Feed 1*** totalizer panel shows a green ***Totalizing*** header.



8 Click the close button to close the PID faceplate.

9 To start the independent feed process from the other feed container (***WIT-178***), repeat steps 2 to 8 above:

- In step 2, click the feed 2 totalizer panel (3).

Step	Action
	• In step 5, click the ***FC-178 Feed 2*** panel (4).



Result:

The feed input from the container on the ***WIT-178*** scale starts. On the ***Liquid Management*** screen, the ***FC-178 Feed 2*** totalizer panel shows a green ***Totalizing*** header.

See also *Section 7.5 Control the batch, on page 389*, *Illustration of the Batch Manager display, on page 561*, and *Default PID Setpoints, on page 593*.

See *Appendix C.4.4 Stop addition or removal process, on page 661* for information about stopping the process.

Start addition in sequential feed mode

Follow the instructions below to start the feeding process in sequential feed mode.

Step	Action
1	On the ***Liquid Management*** screen, make sure that the system is in sequential feed mode.



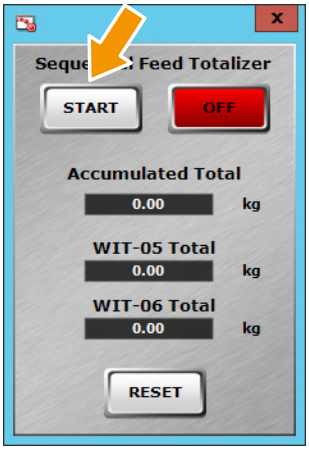
Note:
*Clicking **Feed Control** opens the **Liquid Management Feed Control** dialog box. Clicking **DUAL FEED MODE** in the dialog box sets the system into the dual feed mode.*

Step	Action
2	On the ***Liquid Management*** screen, click the feed totalizer panel (1).



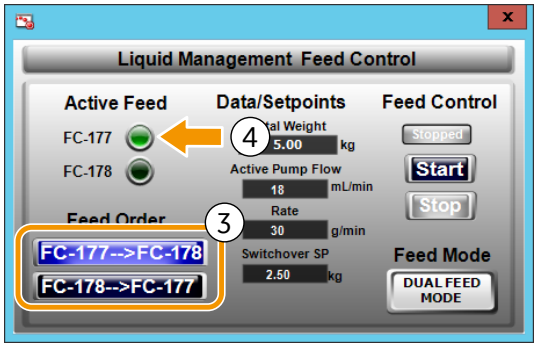
Result:
Sequential Feed Totalizer dialog box opens.

3	In the dialog box, click ***START***.

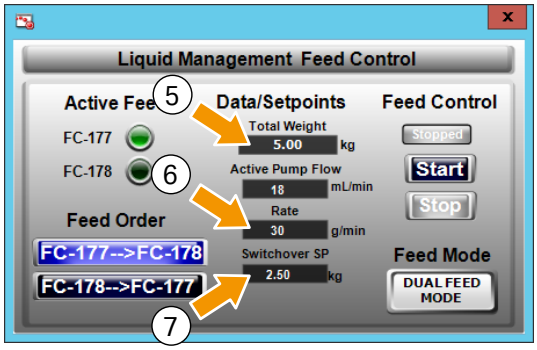


4	Click the close button to close the dialog box.

Step	Action
5	On the ***Liquid Management*** screen, click ***Feed Control*** (2) to open the ***Liquid Management Feed Control*** dialog box.
6	Specify if the feed sequence should start with ***FC-177*** or ***FC-178***: click the applicable button to select the starting loop (3). When the feed loop is active, the status indicator (4) is green.

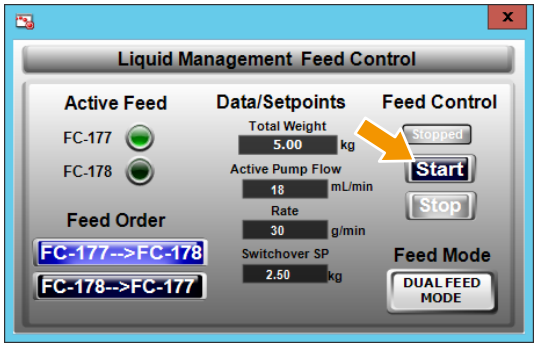


7	Type the applicable value for the total weight to be added into the ***Total Weight*** text box (5).



8	Type the applicable value for the feed rate (g/min) into the ***Rate*** text box (6).
9	Type the applicable value for ***Switchover SP*** into the text box (7). When the container weight on the scale decreases to the defined ***Switchover SP*** value during an active feed, the controller switches the feed input to the other container. See *Switchover setpoint, on page 616* for more information about the switchover setpoint.

Step	Action
10	Click ***Start***.



Result:
The sequential feed process starts, using the feed control loop defined in step 6 above. On the ***Liquid Management*** screen, the feed totalizer panel shows a green ***Totalizing*** header.



See also *Section 7.5 Control the batch, on page 389*, *Illustration of the Batch Manager display, on page 561*, and *Default PID Setpoints, on page 593*.

See *Appendix C.4.4 Stop addition or removal process, on page 661* for information about stopping the process.

Start the removal process

Follow the instructions below to start the removal process.

Step	Action
1	On the ***Liquid Management*** screen, click the removal totalizer panel (1).



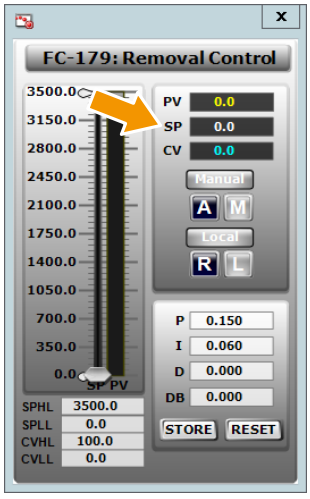
Result:
The ***Removal Totalizer*** dialog box opens.

2	In the dialog box, click ***START***.

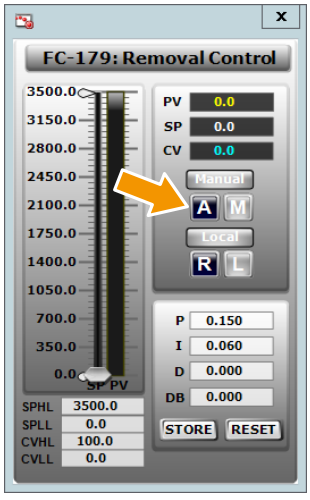


3	Click the close button to close the dialog box.
4	Click the ***FC-179 Removal*** panel (2).

Step	Action
	Result: The removal control PID faceplate opens.
5	On the removal control PID faceplate, type the applicable value into the ***SP*** text box.



6	Click ***A*** to set the feed process in ***Auto/Local*** mode.



Step	Action

Result:

The removal of the liquid from the bioreactor starts, the liquid is collected in the container on the ***WIT-179*** scale. On the ***Liquid Management*** screen, the removal totalizer panel shows a green ***Totalizing*** header.



7 Click the close button to close the PID faceplate.

See also *Section 7.5 Control the batch, on page 389*, *Illustration of the Batch Manager display, on page 561*, and *Default PID Setpoints, on page 593*.

The removal process continues until the user stops the process. See *Stop removal process, on page 665* for instructions.

C.4.4 Stop addition or removal process

Automatic stop

In the sequential feed mode the feeding process stops, when the container weight on the next feed input scale is lower than the defined ***Switchover SP***, or when the total added liquid weight reaches the ***Total Weight*** setpoint.

In the dual feed mode the feeding process stops, when the container weight on the scale ***WIT-177*** or ***WIT-178*** is 0 kg.

When the currently active cell cultivation batch ends, all liquid management processes are also stopped.

Stop the totalizer

Follow the instructions below to stop the totalizer.

Step	Action
1	On the ***Liquid Management*** screen, click the applicable totalizer panel. In dual feed mode:



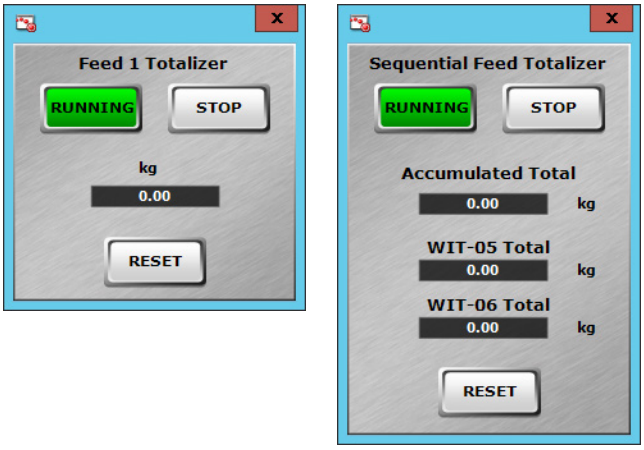
In sequential feed mode:

Step	Action



Result:
The totalizer dialog box opens.

2 In the dialog box, click ***STOP***.



3 Click the close button to close the dialog box.

4 Repeat steps 1 to 3 above to stop each totalizer.

Stop addition in dual feed mode

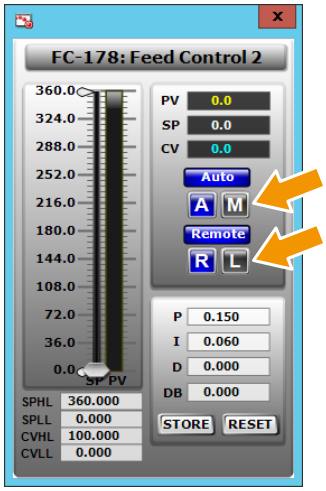
Follow the instructions below to stop the feeding process in dual feed mode.

Step	Action
1	On the ***Liquid Management*** screen, click the applicable feed control panel.

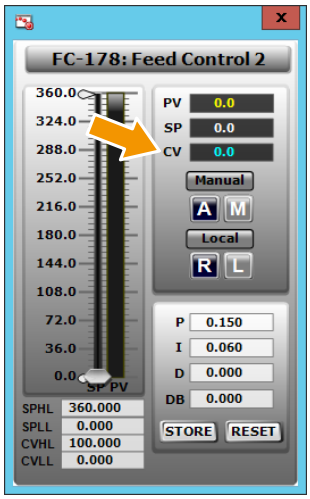


Result:
The ***Feed Control*** PID faceplate opens.

Step	Action
2	On the PID faceplate, click ***M*** and ***L*** to set the feed process in ***Manual/Local*** mode.



3	Type 0 into the ***CV*** text box on the ***Feed Control*** PID faceplate.



Result:
The feed process stops.

4	Click the close button to close the PID faceplate.
5	Repeat steps 1 to 4 above to stop the other dual feed process.

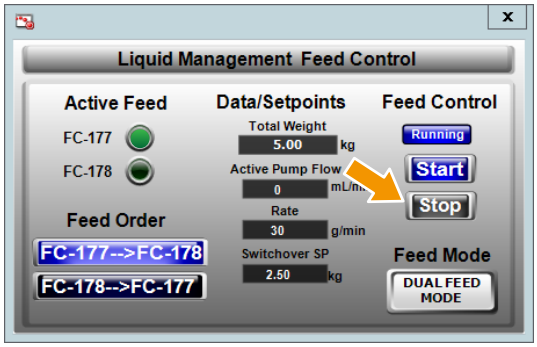
Stop addition in sequential feed mode

Follow the instructions below to stop the feeding process in sequential feed mode.

Step	Action
1	On the ***Liquid Management*** screen, click ***Feed Control*** to open the ***Liquid Management Feed Control*** dialog box.



2	Click ***Stop***.



3	Click the close button to close the dialog box.

Stop removal process

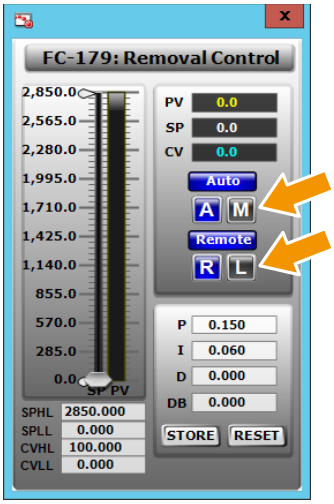
Follow the instructions below to stop the removal process.

Step	Action
1	On the ***Liquid Management*** screen, click the removal control panel.

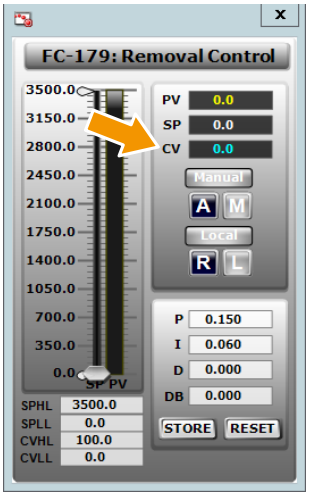


Result:
The ***Removal Control*** PID faceplate opens.

2	On the PID faceplate, click ***M*** and ***L*** to set the removal process in ***Manual/ Local*** mode.



Step	Action
3	Type 0 into the ***CV*** text box on the ***Removal Control*** PID faceplate.



Result:
The removal process stops.

4	Click the close button to close the PID faceplate.

Remove pump from *Liquid Management*

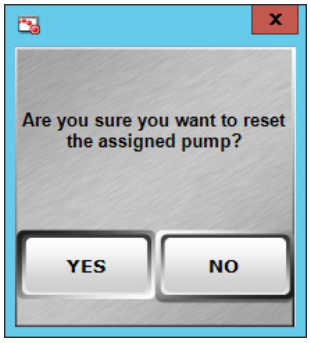
The pumps that are assigned to the ***Liquid Management*** mode are shown at the bottom of the ***Liquid Management*** screen. Follow the instructions below to remove a pump from ***Liquid Management*** mode.

Step	Action
1	On the ***Liquid Management*** screen, click ***RESET*** on the applicable pump assignment panel at the bottom of the screen.



Result:
A dialog box opens.

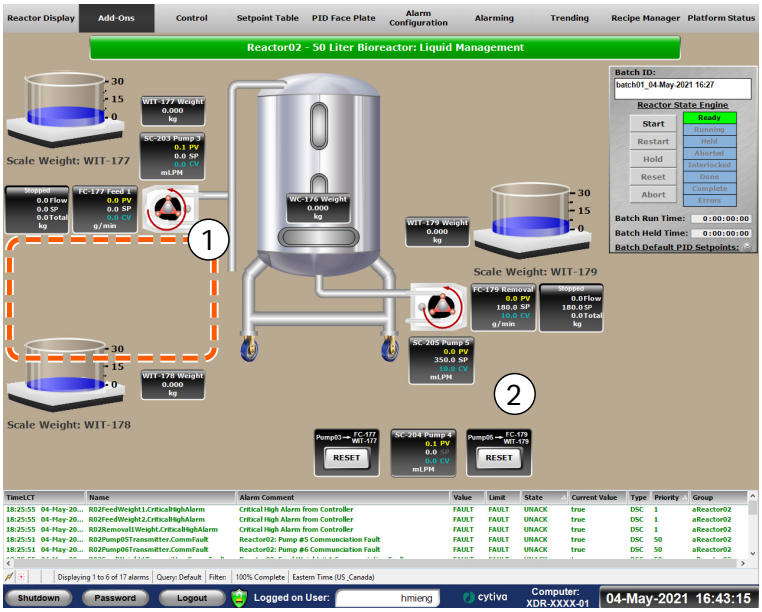
2	In the dialog box, click ***YES***.



3	Click the close button to close the dialog box.

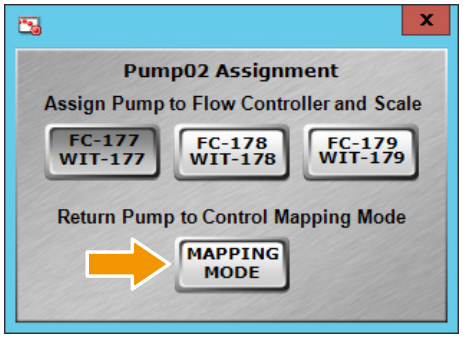
Result:
The pump is removed from a flow control loop, and the pump assignment panel is removed from the ***Liquid Management*** screen. The pump panel moves from the scale icon (1) to the bottom of the screen (2).

Step	Action



4 Click the pump panel (2) at the bottom of the ***Liquid Management*** screen to open the ***PumpXX Assignment*** dialog box.

5 In the dialog box, click ***MAPPING MODE***.



Result:
The pump is disconnected from the Liquid Management option and is available for other purposes. The pump panel is removed from the ***Liquid Management*** screen and is shown on the ***Reactor Display*** screen.

6 Repeat steps 1 to 5 above for each pump you want to remove from the Liquid Management function.

Appendix D
Use USB and Ethernet port locks

Introduction

The USB port and the Ethernet port are protected from unauthorized access with a physical lock. The lock is inserted and removed using a key. The locks should always be inserted when the ports are not in use.

This Appendix gives information on how to use the port locks.

In this chapter

Section		See page
D.1	Lock and unlock USB port	671
D.2	Lock Ethernet port	674

D.1 Lock and unlock USB port

Unlock USB port

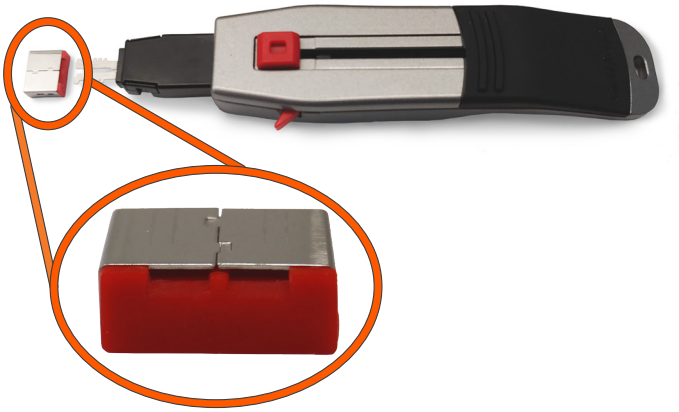
Follow the steps below to remove the lock from the USB port.

Step	Action
1	Remove the protective cover from the USB connection port on the X-Station. *Result:* The USB port lock is visible. 
2	Push the key top button forward until the end. 

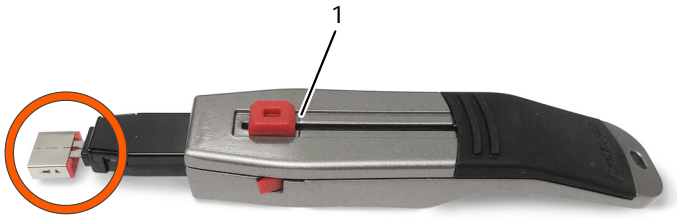
Step	Action
	Result: The key head is displayed.



3	Insert the key head prongs into the USB lock.



4	Push the key top button forward until the end. *Result:* The key head expands and the key is attached to the lock.

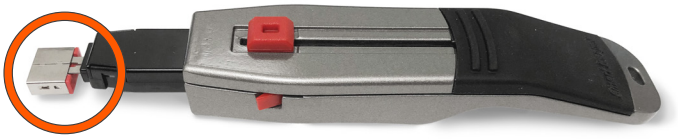


5	Pull out the USB lock from the USB port.

Step	Action
	Result: The USB port is accessible for connecting external drives.

Lock USB port

Follow the steps below to insert the lock to the USB port.

Step	Action
1	Insert the lock with the attached key into the USB port. 
2	Push the key top button forward until the end. *Result:* The key head expands and the key is attached to the lock. 
3	Pull out the key. *Result:* The USB port is locked.
4	Install the protective cover on the USB port.

D.2 Lock Ethernet port

Ethernet port lock

The connection to external systems is done using the Ethernet port on the back of the X-Station. The Ethernet port lock should always be inserted when the port is not in use.

Ethernet port lock



Locked Ethernet port



The Ethernet port lock is inserted and removed similarly to the USB port lock. See *Appendix D.1 Lock and unlock USB port, on page 671* for instructions.

Appendix E
Export and save data

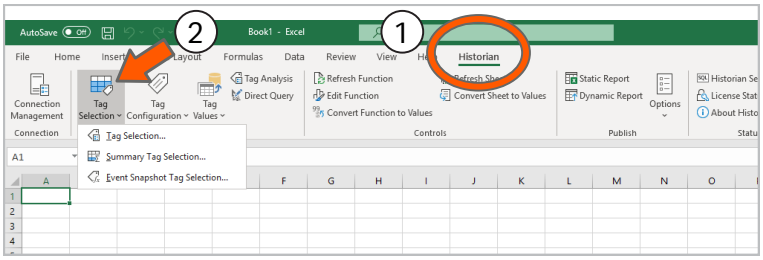
Introduction

This appendix provides information about how to manage the collected data after a completed batch run.

Export data to Excel spreadsheet

To export data to an Excel spreadsheet, follow the steps below.

Step	Action
1	Open Microsoft Excel: ***Start →All Programs →Microsoft Office →Excel 2019***
2	Click a spreadsheet cell where you want your data table to start.
3	On the ***Historian*** tab (1), on the ***Tag Selection*** menu (2) click ***Tag Selection***.



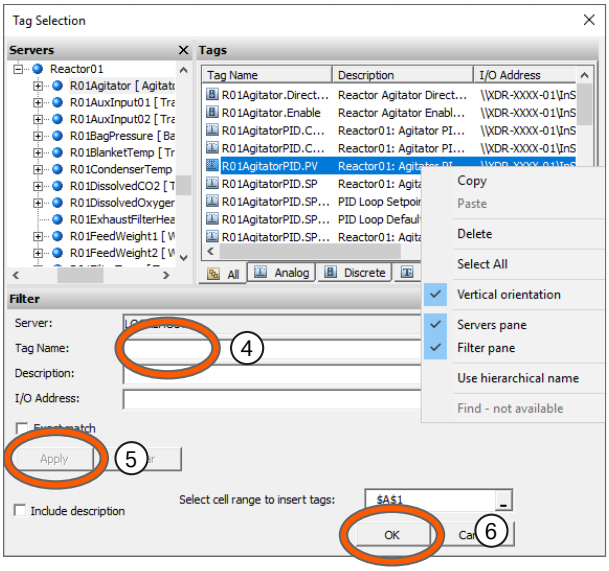
Result:

A ***Tag Selection*** dialog box opens.

4	Find the tag of the parameter that you want to export. If you know the tag name or part of the tag name, use the method below. If you do not know the tag name, use the method described in the next step.

Step	Action

a. Type the tag name in the ***Tag Name*** text box (4) and click ***Apply*** (5).



Result:

The tag list is updated with all tag names that match the search criteria.

b. Click ***OK*** (6).

Result:

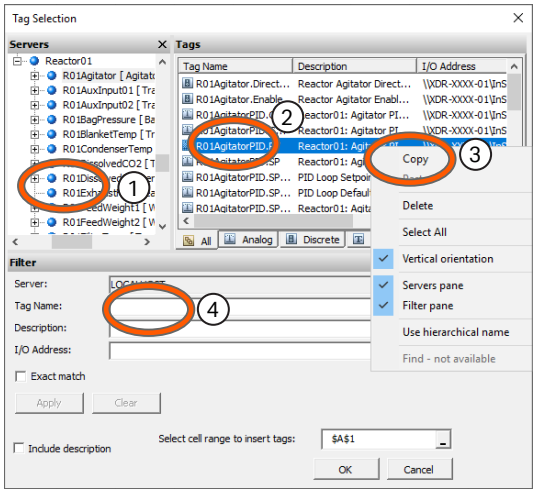
The tag is pasted into the selected cell in the spreadsheet.

5 If you do not know the tag name, use the left navigation pane as described below. The list in the pane shows all objects within the current instrument configuration.

a. Navigate to the item of your interest in the left pane and click it (1). The tags connected to this item are shown in the right pane.

Step	Action

b. Right-click the relevant tag in the right pane (2), and then click ***Copy*** (3) on the shortcut menu.



c. Right-click the ***Tag Name*** text box (4), and then click ***Paste*** on the shortcut menu.

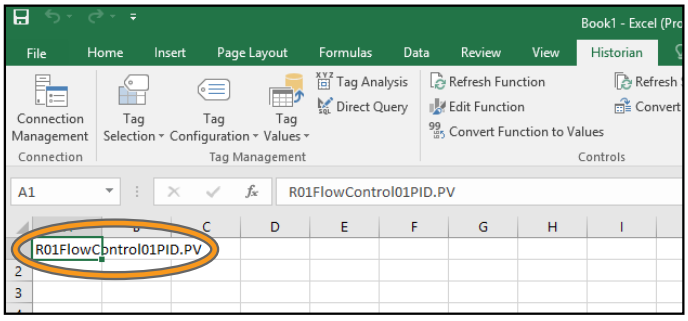
Result:

The value is pasted into the text box.

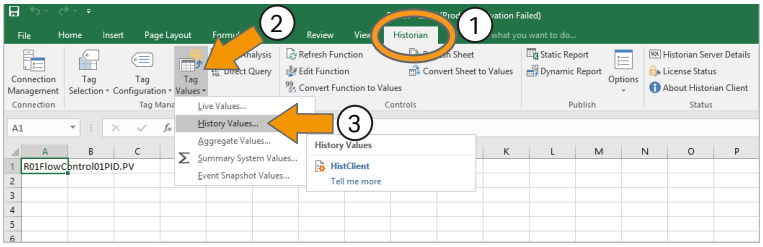
d. Click ***OK***.

Result:

The tag is pasted into the selected cell in the spreadsheet.

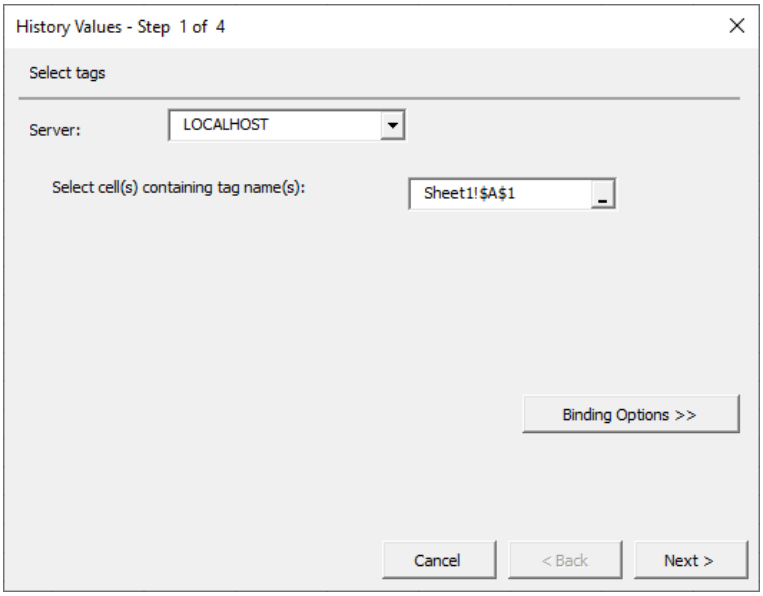


Step	Action
6	On the ***Historian*** tab (1), on the ***Tag Values*** menu (2) click ***History Values*** (3).



Result:

A dialog box opens.



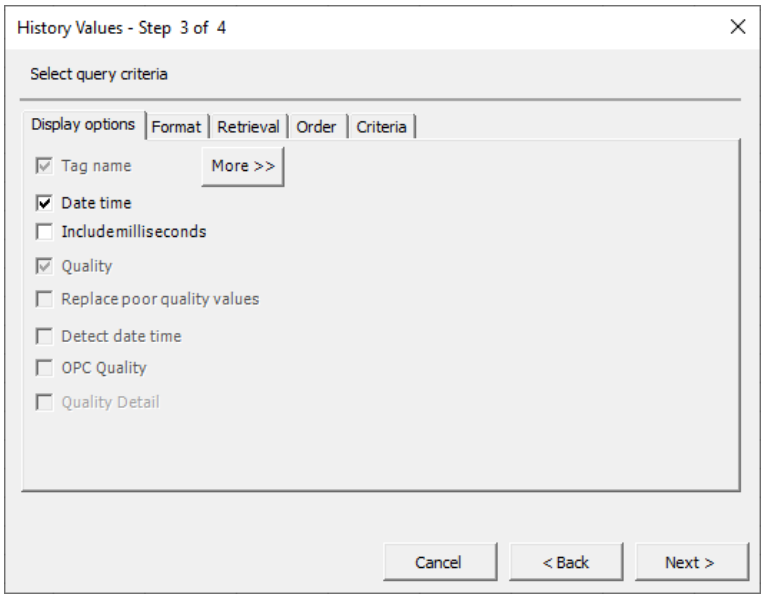
7	Select the cell containing the tag name in Excel spreadsheet and click ***Next***.
8	Select the cell in the Excel spreadsheet where you want the top left corner of your output data table. Click ***Next***.

Note:
Previous data in the output area is deleted.

Step	Action

Result:

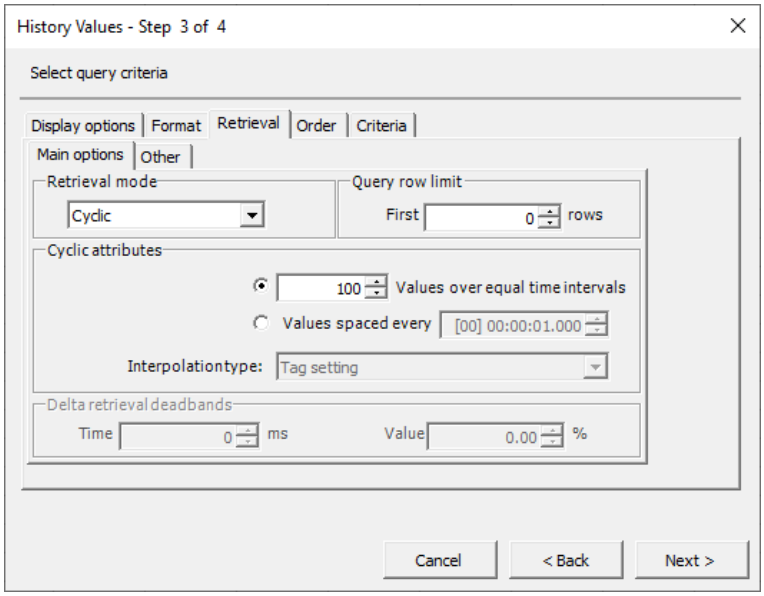
A dialog box with multiple tabs opens.



9 Select the ***Display options*** tab and make your choices for data output. ***Date time*** check box is selected by default.

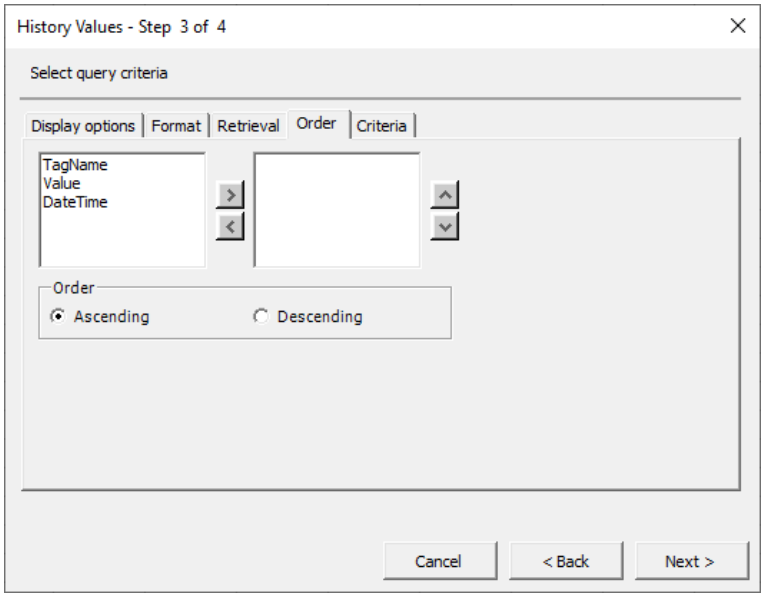
10 Select the ***Format*** tab and select ***Value based criteria*** or ***Tag based criteria***.

Step	Action
11	Select the ***Retrieval*** tab and make your choices.

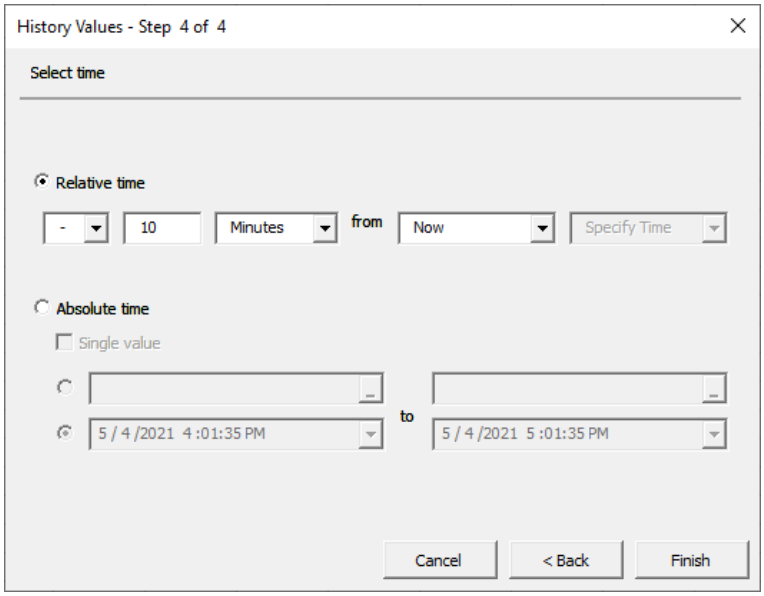


Note:
The historian function only saves data when it detects a change in the parameter that is greater than a threshold value. Consult Excel Historian client help for more information about retrieval modes.

Step	Action
12	Select the ***Order*** tab and define the sequence of the columns in your data table.



13	Select the ***Criteria*** tab. You can limit the data collection by the search of historical values to an object, such as Batch ID. When you have made your choices, click ***Next*** to open a new dialog box.

Step	Action
14	 Define a time range for your query. You can choose an absolute time (start time and date, end time and date) or relative time (for example, last eight hours).
15	Click ***Finish*** to complete the formatting of your output data table. *Result:* Your data are extracted into Excel spreadsheet. Large queries might require several seconds to retrieve the data.

Based on the exported data table you can also create a graph in Excel.

Tip: *More information on working with data can be found in the application help, available in* ***Start →Aveva Documentation →Historian Client User Guide****, if installed at recommended location.*

Export data via OPC server

Contact your Cytiva representative for information on configuring an OPC server on your instrument.

Appendix F
Generate reports

Introduction

This appendix provides information about how to create reports on the XDR bioreactor system components (for example pumps, MFCs), or on alarms and events recorded in the system.

The reports are created using specific Excel worksheets with built-in macros. The scope and the time range for each report is specified by the user. The reports can be generated for viewing as Excel worksheets or PDF files. The PDF files can be exported to an external computer and printed.

Excel Historian Export (DO NOT DELETE) file is used to create reports on bioreactor system components.

Excel Historian Alarm and Event Export (DO NOT DELETE) file is used to create reports on alarms and events.

The file location for the generated reports should be changed to one of the following:

- `C:\User\MSLoginOP\Descktop\` (this file location is used if ***MSLoginOP*** was used to log on to Windows)
- `C:\User\XDRAdministrator\Descktop\` (this file location is used if ***XDRAdminstrator*** was used to log on to Windows)

In this chapter

Section		See page
F.1	System component reports	684
F.2	Alarm and event reports	696

F.1 System component reports

Description

The Excel file ***XDR Reports*** is used to create reports on the XDR bioreactor system components (for example pumps, MFCs). The report is based on the configured ***.PV***, ***.SP***, and ***.CVEU*** WindowViewer tags. It is possible to create a full report on all configured tags at once, or on a specific system component (for example the agitator). The report shows all data points for the selected WindowViewer tags for the time period specified by the user.

The report generator ***XDR Reports*** (e.g., ***Excel Historian Export (DO NOT DELETE)***) file is available in `C:\User\MSLoginOP\Desktop` folder on the X-Station.

In this section

Section		See page
F.1.1	***XDR Reports*** file overview	685
F.1.2	Create reports	690

F.1.1 *XDR Reports* file overview

Overview

The Excel file contains four active tabs with built-in macros for report generation. All other tabs in the file show the report results and are updated when a macro is started. The following tabs are active tabs and need user input:

- ***Config***
- ***MFC Config***
- ***Pump Config***
- ***Other Config***

The report is created on two tabs for each system component, for example the tabs ***MFC 1 Raw*** and ***MFC 1 Chart*** for the mass flow controller 1 (MFC1). The ***Raw*** tab contains all data points for the selected ***.PV***, ***.SP***, and ***.CVEU*** WindowViewer tags during the specified time period. The ***Chart*** tab shows the line graph of the same data points.

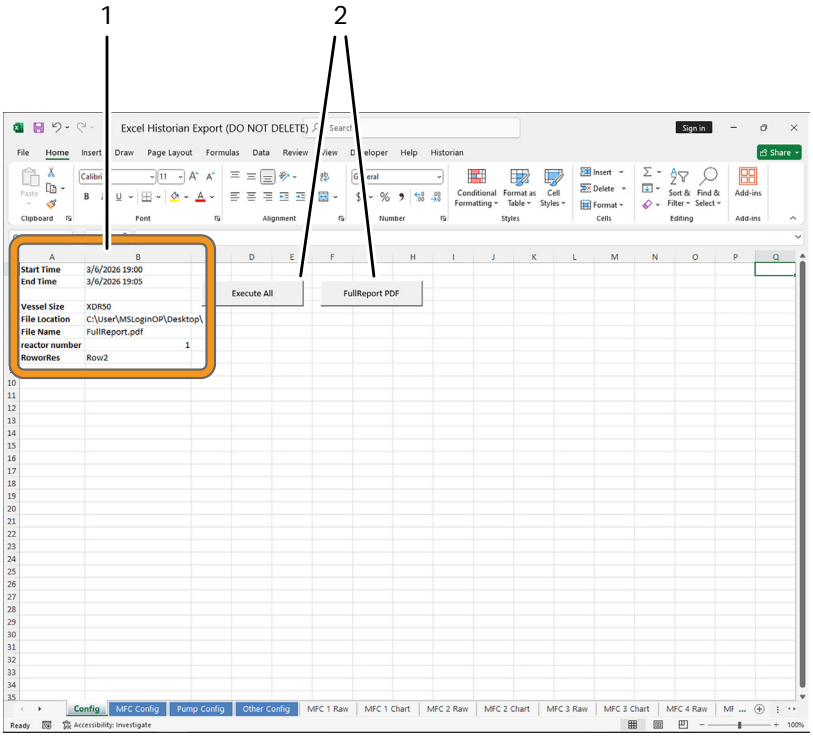
Full report of the whole bioreactor system is created using the macros on the ***Config*** tab. The other three active tabs are used to create reports on specific components of the system.

It is also possible to create an additional report in PDF format.

Config tab

The ***Config*** tab is the start tab for report generation. The user defines the necessary parameters and starts a macro to create a report. The parameters specified on the ***Config*** tab are also used to define the scope for the reports on specific system components that are created using the ***MFC Config***, ***Pump Config***, and ***Other Config*** tabs.

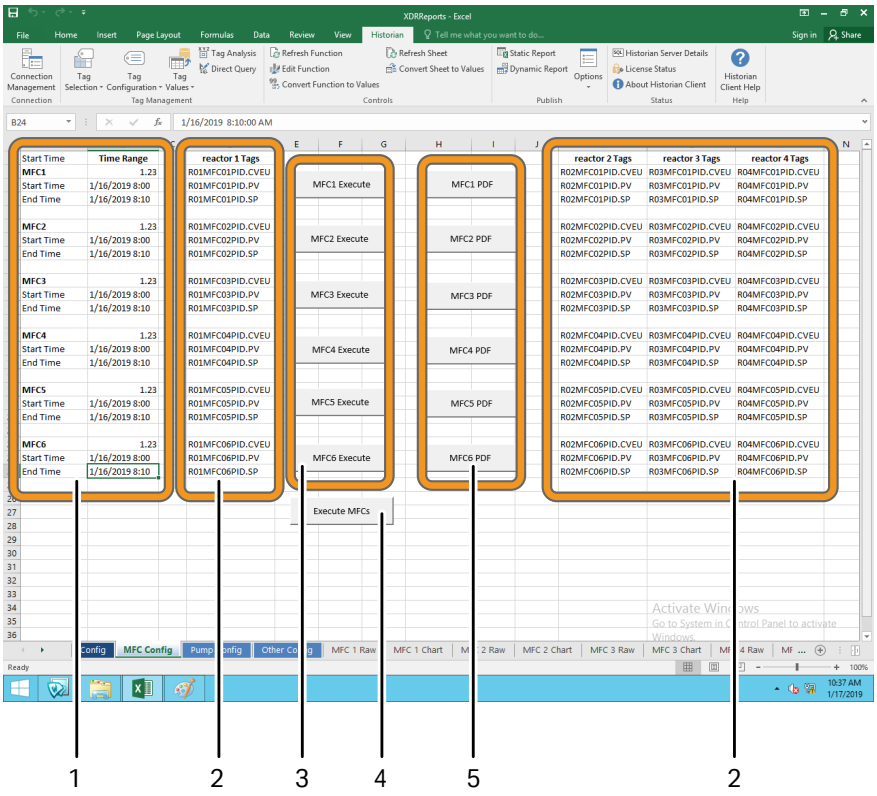
Illustration of *Config* tab



Part	Function
1	Input fields for parameters to define the report scope
2	Buttons for report generation • ***Execute All*** button updates information on all ***XXX Raw*** and ***XXX Chart*** tabs. • ***FullReport PDF*** button updates information on all ***XXX Raw*** and ***XXX Chart*** tabs, and creates a report in PDF format.

Illustration of *MFC Config* tab

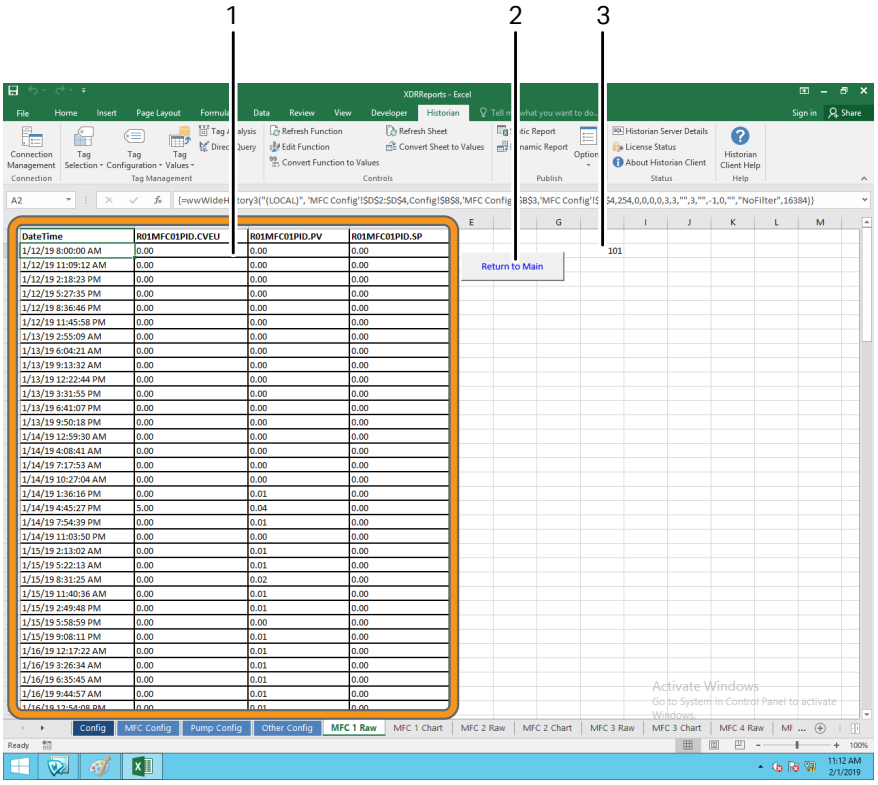
All component-specific ***Config*** tabs have similar layout. The following illustration shows the ***MFC Config*** tab as an example.



Part	Function
1	Information defining the scope and the output of the report
2	Software tags used to create the reports on specific components for the defined XDR bioreactor (not editable)
3	Buttons (***MFC0 Execute***) to update information on a specific component on ***XXX Raw*** and ***XXX Chart*** tabs
4	Button (***Execute MFCs***) to update information on all ***XXX Raw*** and ***XXX Chart*** tabs
5	Buttons (***MFCx PDF***) to update information on a specific component ***XXX Raw*** and ***XXX Chart*** tabs, and to create a report in PDF format for this specific component

Illustration of *XXX Raw* tab

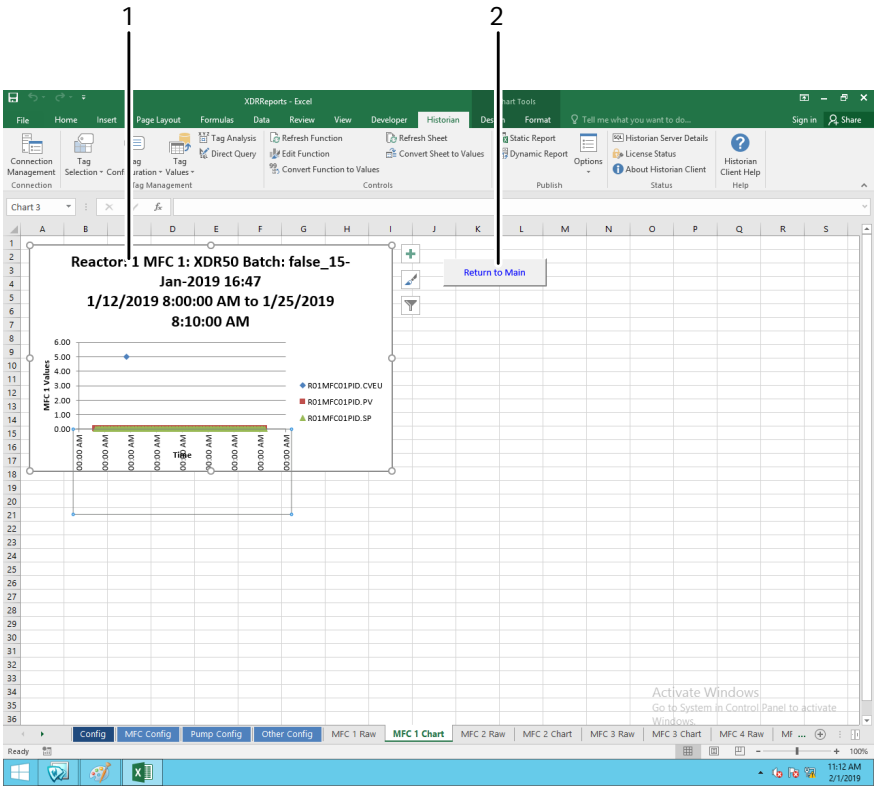
The following illustration shows an example of the ***MFC 1 Raw*** tab with data table of a completed report.



Part	Function
1	Data table
2	Button (***Return To Main***) for returning to the ***Config*** tab
3	Total number of data points used for report generation (not editable)

Illustration of *XXX Chart* tab

The following illustration shows an example of the ***MFC 1 Chart*** tab with a completed graph.



Part	Function
1	Chart
2	Button (***Return To Main***) for returning to the ***Config*** tab

F.1.2 Create reports

Create full system report

Follow the steps below to create a report on all configured ***.PV***, ***.SP***, and ***.CVEU*** tags of the XDR bioreactor. You can create a report in only Excel spreadsheet format, or add a printable report in PDF format to the report in Excel format.

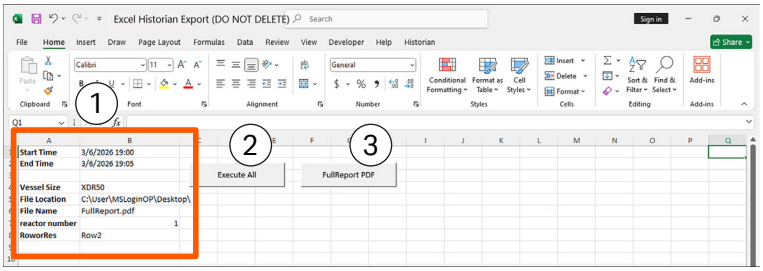
Step	Action
1	On the X-Station, in the `C:\User\MSLoginOP\Desktop` folder, open the ***XDR Reports*** (e.g., ***Excel Historian Export (DO NOT DELETE) file***) file.
2	Open the ***Config*** tab.
3	Fill in the required information in the spreadsheet cells in column B (1). See the illustration further down.

Information	Description
Start Time	Report start time. Use formatting m/d/yyyy h:mm.
End Time	Report end time. Use formatting m/d/yyyy h:mm.
Vessel Size	Use formatting XDR00, where 00 shows the vessel volume in liters.
File Location [1]	The default location is the `C:\XDRReports\` folder. The user should specify the location as `C:\User\MSLoginOP\Desktop\`. The file location must end with \.
File Name [1]	The default file name is FullReport.pdf. The user can specify another file name. The file name must end with .pdf extension.
reactor number	The reactor number corresponds to the bioreactor selected in WindowViewer from the header toolbar. Numbers 1 to 4 are allowed.

Step	Action

Information	Description
RoworRes	Data sampling method for the report. The following options are available: • The data is presented on a defined number of rows that are equally spread between the start and end time. Type RowXXXX to specify the number of rows. • The data is presented with user-specified time interval. Type ResYYYY to specify the time between the consecutive data points. YYYY denotes the time in milliseconds.

[1] Only needed for a report in PDF format.



4 Click the applicable button to start the macro:

- ***Execute All*** (2), if you want to generate a report in Excel worksheet format.
- ***FullReport PDF*** (3), if you want to generate both a report in Excel worksheet format and a report in PDF format.

Result:
The contents of all ***XXX Raw*** and ***XXX Chart*** tabs in the ***XDR Reports*** file are updated. For ***FullReport PDF*** option also a report in PDF format is created and saved in the folder specified in step 3 above.

Create component report

The user can create a report on collected data points for a specific XDR bioreactor system component, for example vessel temperature. It is also possible to create reports on component groups, for example all pumps or all MFCs. You can create a report in only Excel spreadsheet format, or add a printable report in PDF format to the report in Excel format.

It is recommended to use this procedure to create reports on a limited number of components. For a large number or components create a full system report as described in *Create full system report, on page 690*.

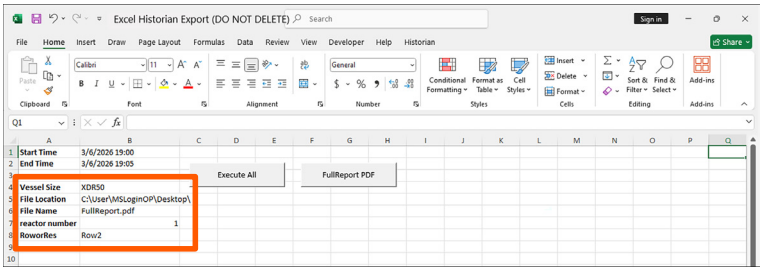
Follow the steps below to create a report on a specific component or a component group.

Step	Action
1	On the X-Station, in the `C:\User\MSLoginOP\Desktop` folder, open the ***XDR Reports*** (e.g., ***Excel Historian Export (DO NOT DELETE)***) file.
2	Open the ***Config*** tab.
3	Fill in the required information in the spreadsheet cells in column B. See the illustration further down.

Information	Description
Vessel Size	Use formatting XDR00, where 00 shows the vessel volume in liters.
File Location [1]	The default location is the `C:\XDRReports\` folder. The user should specify the location as `C:\User\MSLoginOP\Desktop\`. The file location must end with \.
File Name [1]	The default file name is FullReport.pdf. The user can specify another file name. The file name must end with .pdf extension.
reactor number	The reactor number corresponds to the reactor selected in WindowViewer using the header toolbar. Numbers 1 to 4 are allowed.
RoworRes	Data sampling method for the report. The following options are available: • The data is presented on a defined number of rows that are equally spread between the start and end time. Type RowXXXX to specify the number of rows. • The data is presented with user-specified time interval. Type ResYYYY to specify the time between the consecutive data points. YYYY denotes the time in milliseconds.

[1] Only needed for report in PDF format.

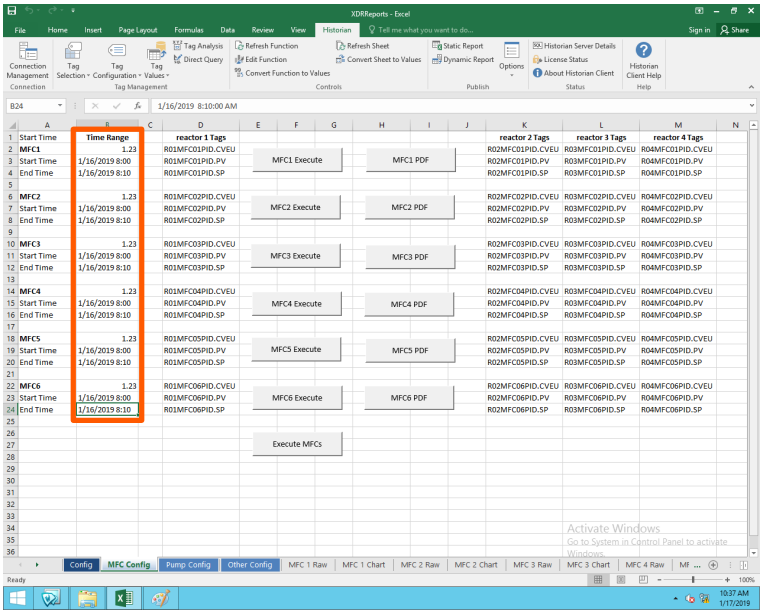
Step	Action



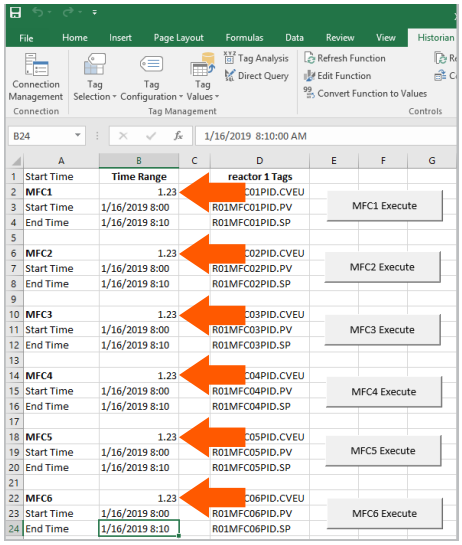
4 Open the applicable tab for the component:

- ***MFC Config*** for report on mass flow controllers (individual or all MFCs)
- ***Pump Config*** for report on pumps (individual or all pumps)
- ***Other Config*** for report on other system components

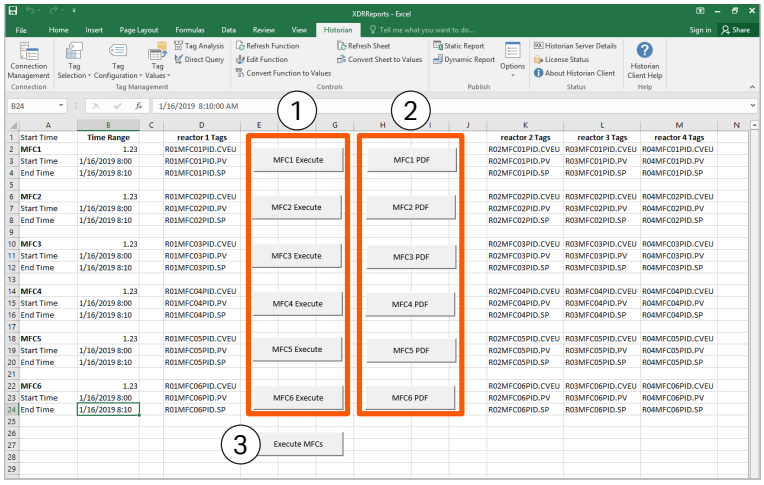
5 Specify the report start time and the report end time for each component you want to create the report on. Use formatting m/d/yyyy h:mm.



Step	Action
6	Specify the number of decimal places (in the spreadsheet shell B2 for MFC1, for example). This specifies the number format for the report results that are shown on the corresponding ***XXX Raw*** tab for the component.



7	Click the applicable button for the component to start the macro: • ***XXXXX Execute*** (1), if you want to generate a report in Excel worksheet format. • ***XXXXX PDF*** (2), if you want to generate both a report in Excel worksheet format and a report in PDF format.



Step	Action
	Result: The contents of ***XXX Raw*** and ***XXX Chart*** tabs applicable for the selected component are updated. For ***XXX PDF*** option also a report in PDF format is created for the selected component. The report is saved in the folder specified in step 3 above.
8	Click the button at the bottom of the spreadsheet (for example ***Execute MFCs*** (3) on the ***MFC Config*** tab), if you want to generate both a report in Excel worksheet format and a report in PDF format for all components shown on this tab. *Result:* The contents of all applicable ***XXX Raw*** and ***XXX Chart*** tabs are updated. A report in PDF format is created and saved in the specified folder.

F.2 Alarm and event reports

Description

The Excel file ***Excel Historian Export (DO NOT DELETE)*** is used to create reports on the recorded alarms and events of the XDR bioreactor system. It is possible to create a report on either the alarm history or the event history separately, or on the complete alarm and event history.

See *Appendix B.1.9 Alarm History, on page 576* for more information on alarm and event history.

The report generator file (***Excel Historian Export (DO NOT DELETE)***) is available in `C:\User\MSLoginOP\Desktop\` folder on the X-Station.

In this section

Section		See page
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F.2.1 *XDRReports_Alarm_Events* file overview

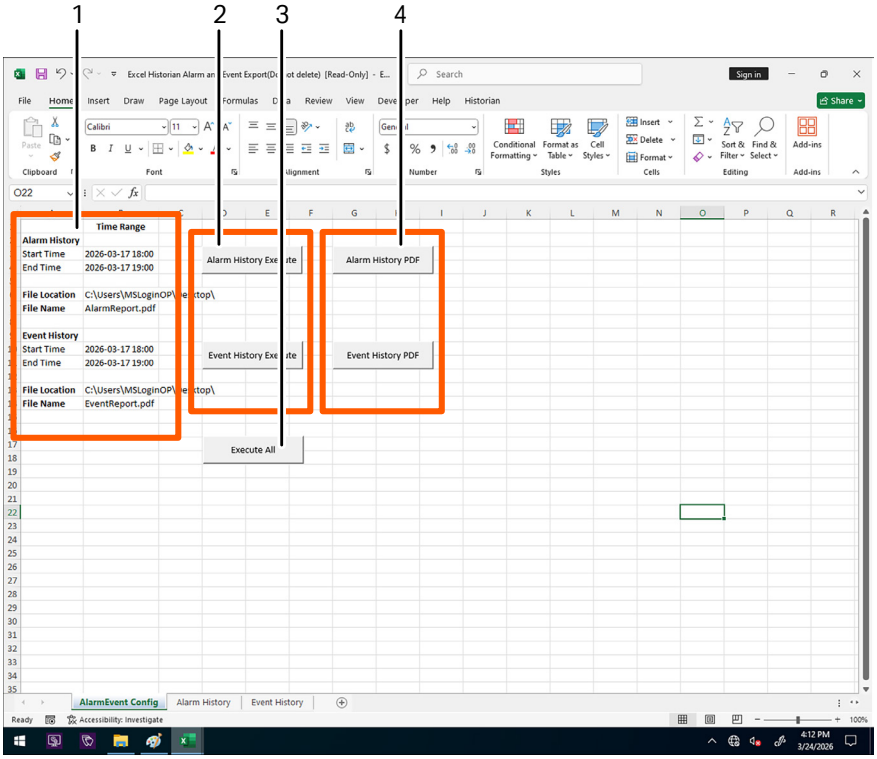
Overview

The Excel file contains three tabs. The ***AlarmEvent Config*** tab is an active tab with built-in macros for report generation. The other two tabs in the file show the report results and are updated when a macro is started.

The ***AlarmEvent Config*** tab is the start tab for alarm report and event report generation. The user defines the necessary parameters and starts a macro to create a report.

The reports are created on two tabs: ***Alarm History*** and ***Event History***. It is also possible to create an additional report in PDF format.

Illustration of *AlarmEvent Config* tab



Part	Function
1	Information defining the scope and the output of the report
2	Buttons (***Alarm History Execute*** and ***Event History Execute***) to update information on ***Alarm History*** or ***Event History*** tabs

Part	Function
3	Button (***Execute All***) to update information on both ***Alarm History*** and ***Event History*** tabs
4	Buttons (***Alarm History PDF*** and ***Event History PDF***) to update information on ***Alarm History*** or ***Event History*** tabs, and to create a report in PDF format on alarm history or event history

F.2.2 Create reports

Create specific or full report

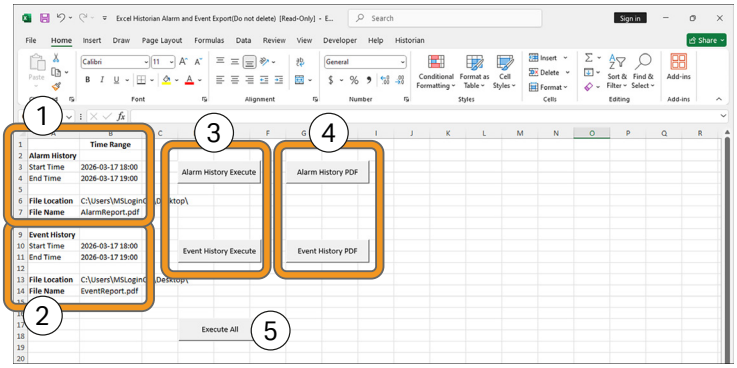
Follow the steps below to create a report on alarm and event history. You can create a report in only Excel spreadsheet format, or add a printable report in PDF format to the report in Excel format.

Step	Action
1	On the X-Station, in the `C:\User\MSLoginOP\Desktop\` folder, open the ***Excel Historian Export (DO NOT DELETE)*** file.
2	Open the ***AlarmEvent Config*** tab.
3	Fill in the required information in the spreadsheet cells in column B. See the illustration further down.

Information	Description
Start Time	Report start time for ***Alarm History*** (1) or ***Event History*** (2). Use formatting m/d/yyyy h:mm.
End Time	Report end time time for ***Alarm History*** (1) or ***Event History*** (2). Use formatting m/d/yyyy h:mm.
File Location [1]	• For ***Alarm History*** (1): The default location is the `C:\XDRReports\Alarm History` folder. The user should specify the location as `C:\User\MSLoginOP\Desktop\`. • For ***Event History*** (2): The default location is the `C:\XDRReports\Event History` folder. The user should specify the location as `C:\User\MSLoginOP\Desktop\`. ***Note:*** *The user can specify another location. The file location must end with* \.
File Name [1]	• For ***Alarm History*** (1): The default file name is AlarmReport.pdf. • For ***Event History*** (2): The default file name is EventReport.pdf. The user can specify another file name. The file name must end with .pdf extension.

[1] Only needed for report in PDF format.

Step	Action



4 Click the applicable button to start the macro:

- ***Alarm History Execute*** or ***Event History Execute*** (3), if you want to generate a report in Excel worksheet format.
- ***Alarm History PDF*** or ***Event History PDF*** (4), if you want to generate both a report in Excel worksheet format and a report in PDF format.

Result:

The contents of ***Alarm History*** or ***Event History*** tabs are updated. For ***Alarm History PDF*** and ***Event History PDF*** options also a report in PDF format is created and saved in the folder specified in step 3 above.

5 Click ***Execute All*** (5) if you want to generate a report in Excel worksheet format on both alarm history and event history.

Result:

The contents of ***Alarm History*** or ***Event History*** tabs are updated.

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