

Bend Research Equipment List Process Equipment

<i>Type and Model</i>	<i>Manufacturer</i>	<i>Scale</i>	<i>Notes</i>	<i>cGMP</i>	<i>Non-GMP</i>
Spray Dryers					
Mini Dryer	BRI	10mg –1g powder 0.005 – 0.1L spray solution	Yields > 90%		2
Lab-Scale Dryer	BRI (up to 35kg/hr gas)	0.2 to 250 g powder, 0.05 – 4L spray solution	Scaleable particle size	1	1
Pilot Scale	BRI/Niro (up to 150kg/hr gas)	0.1 – 40 kg powder up to 200 L spray solution	w/BRI modifications	3	2
Commercial	BRI/Niro (up to 800kg/hr gas)	up to 400+ kg powder/batch up to 2500 L spray solution	w/BRI modifications	2	1
Tray/Secondary Dryers					
Convective tray driers	Gruenberg / ES	<1kg to 150kg	w/ humidification control	2	2
Vacuum tray dryer	Walker Barrier	< 1.5 kg	nitrogen purged, integrated with hard walled isolator for containment	1	
Vacuum Desicator Model: 5530000	Labconco	<200g	small scale feasibility		2
Vacuum tray dryer Model: RS485	Cascade TEK	<1.5kg	Nitrogen Purged		1
Agitated Vacuum Driers	Ekato	3L to 1000 L	20 mbar, nitrogen purged	2	3
Twin Screw Mixers/Hot-Melt Extruders (HME)					
Prism Eurolab, 16mm	Thermo	0.05 - 8 kg/hr			1
ZSE-18, 18 mm	Leistritz	0.1 – 10 kg / hr	K-Tron loss-in-weight powder feeders, liquid feeders, Sandvik chilled roll, Leistritz side stuffer, and pelletizer	1	
MP-PH, 19 mm	Baker Perkins	0.1 – 10 kg / hr	same as above		1
ZSE-27, 27 mm	Leistritz	1 – 25 kg / hr	same as above	1	1
Ancillary HME equipment					
Chill roll flaker unit	Steer	2-15 kg/hr	works with 16, 18 or 27 mm extruders	1	1
Twin-screw loss-in-weight feeder, Model: KCLKT20	Coperion K-tron	0.1-200dm ³ /hr	gravimetric, w/ multiple powder feed units and liquid injection pump	1	1

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Melt Spray Congeal (MSC)					
Lab Scale MSC	BRI	< 50 g/hr, batch	With melt tank		1
Pilot Scale MSC	BRI	< 20 kg/hr, batch or continuous	Feed using melt tank or extruder	1	1
Homogenizers					
LZ-150 In-line High Shear Mixer	Bematek	< 6 L/hr		1	1
EmulsiFlex C-55	Avestin	20 - 55 L/hr	500-3,000 psi		2
Microfluidizer M-110Y	Microfluidics	600 - 9000 L/hr	1,500 - 23,000 psi		1
Fluid Bed Coater, Dryer, Granulators					
<i>NOTE: Scale assumes 0.75 g/cc bulk density for coating, 0.5 g/cc for granulating and drying</i>					
GPCG-1	Glatt	Coating: 0.5-inch (0.5 to 2g); 2-inch (10 to 20g); 3.5-inch (50 to 200g), 6-inch (0.5 to 2kg) Drying/granulating: 0.5 to 3 kg	Custom bowls to enable small scale coating		1
MP 1	Niro	Coating: 3.5-inch (50 to 200g); 6-inch (0.5 to 2kg) Drying/granulating: 0.5 - 3 kg	Custom bowls and inserts permit Wurster platform for tech transfer		1
MP 1 / 2	Niro	Coating: 3.5-inch (50 to 200g); 6-inch (0.5 to 10kg); 11-inch (2kg to 20kg) Drying/granulating: 0.5 to 15 kg	Custom bowls and inserts permit Wurster platform for tech transfer	1	
Particle Separation / Powder Delumping					
30" Vibratory Separator	Sweco	1 to 100kg/hr	Powders and Pellets	1	
Granulation and Spheronization					
<i>NOTE: Scale assumes 0.25 g/cc bulk density for high-shear granulators</i>					
Mini-Pactor - Roller Compactor	Gerteis	500 g batch to 150 kg/hr	Star and Pocket Rotor granulators	1	1
TF Mini - Roller Compactor	Vector	200 g batch up to 6 kg/hr	MCC instrumentation	1	1
WP120 Roller Compactor	Alexanderwerk	25 g batch up to 40 kg/hr			1
KG-5 high shear granulator	Key International	200- 600g	5L bowl	1	1
TMW high Shear granulator	Glatt	100-350g / 400-1500g	2L and 8L bowls, jacketed		1

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Granulation and Spheronization - Cont.					
<i>NOTE: Scale assumes 0.25 g/cc bulk density for high-shear granulators</i>					
Nica E-140 Extruder	GEA	30-120 kg/hr	Extrusion spheronization		1
Nica S450 Spheronizer	GEA	0.1-0.5 kg	Extrusion spheronization		1
Tablet Presses					
Hydraulic Press	Carver	< 60 tablets/hr			1
F3 Eccentric	Colton	< 3,000/hr	1-punch; with force readout		2
T-100 Single-Sided Rotary	Killian	<100,000 tablets/hr	18 station, B Tooling		1
XL-100 Single-Sided Rotary	Korsch	<120,000 tablets/hr	10 station, B Tooling, D Tooling	1	1
Piccola Single or Bilayer Rotary	SMI	<100,000 tablets/hr	10 station, B tooling		1
XM12 Single or Bilayer Rotary	Korsch	<57,600 tablets/hr (bilayer mode); <115,200 tablets/hr (single layer mode)	16 station B; 12 station D interchangeable turrets, Korsch instrumentation and force control	1	1
AP55-3L Tri-Layer Rotary	Hata	30,000 - 198,000 tablets/hr	55 station; B Tooling		1
Table Pan Coaters					
<i>NOTE: Assumes 0.7 g/cc bulk density</i>					
LDCS, fully perforated	Vector	0.7 – 5.6 kg	1.5, 2.5, 4, 8L pans	1	1
VPC-1355, fully perforated	Vector	5 - 38 kg	13, 35, 55 L pans	1	1
Tablet Laser Drills					
BRI Phase 1 "Semiautomated"	BRI	<1,500 tablets/hr		1	1
BRI Phase 2 "Automated, Continuous"	BRI	5,000 tablets/hr	Continuous process	1	

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Encapsulators / Weight Sorters					
Profill Hand Encapsulator	Torpac	50 -100 capsules/tray	Powder fill	1	1
In-Cap	Dott. Bonapace	3000 capsules/hr max	Powder/granules, pellets (single or dual fill), minitables (Bend design)	1	1
CFS 1500	Capsugel	Up to 1,500 capsules/hr	Liquids and sealing		1
Zanasi 70E	IMA	Up to 70,000 capsules/hr	Pellets, microspheres, liquids	1	
AB Plus, checkweigher	Mocon	Up to 2500/hr	tablets, capsules	1	1
SP140, checkweigher	Sade	Up to 4500/hr	tablets, capsules	1	
Particle Size Reduction - Dry and Wet					
Custom Wet-Mill	BRI	0.01 g to 5 g	Wet mill		1
Micronizing Mill	McCrone	0.01 - 5 g	Wet and dry modes		1
Dynomill KDL Wet Mill	WAB	5 - 15 kg/hr, nominally 0.2 - 40 L suspension	0.15, 0.3, 0.6, 1.2 L flow-through chambers	1	1
1" Air-jet Micronizer	BRI	1 - 5 g/min			1
2" Micron Master Air-jet Micronizer	Jet Pulverizer	3 - 15 g/min		1	1
L1A Hammer mill	Fitzpatrick	0.05 - 20 kg/hr			1
FitzMill M5A hammer mill	Fitzpatrick	70 - 150 kg/hr		1	
Comil 193 cone mill	Quadro	<23 kg/hr			1
Comil U5 cone mill	Quadro	<195 kg/hr		1	1
Comil 197 cone mill	Quadro	<360 kg/hr		1	
Comil U10 cone mill	Quadro	<390 kg/hr		1	
BTS-100 cone mill	Bohle	1000 kg/hr	1500-3000 rpm		1

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Blenders					
T2F Shaker/mixer	Turbula	< 2 L	up to 2 L container		1
LabRam II	Resdyne	up to 500g	Acoustic mixer		1
Blenders - Cont.					
Blend Master	Patterson-Kelly	1.3 - 10.7 L	4, 8, 16 qt shells	1	1
Portable Bin Blender	Metolift	5 L - 160 L	25, 50, 100, 200 L bins	1	
Post Bin Blender	Metolift	120 L - 480 L	600 L Bins	1	
Portable Bin Blender	Niro	10 - 160 L	50 & 200 L bins		1

***Please Note: List contains all non-GMP and GMP process equipment. In addition, GMP equipment may be currently archived and would require re-qualification prior to GMP use. Please verify with a Bend Research representative to confirm current equipment status.**

Bend Research Equipment List Formulation Development/Process Analytical Equipment

<i>Type of Equipment</i>	<i>Notes</i>
Imaging	
Transmission electron microscope (TEM, FEI Tecnai G2)	
Scanning electron microscope (SEM, Hitachi S-3400N)	
Scanning electron microscope (SEM, Hitachi SU3500)	Energy Dispersive X-ray Spectroscopy (EDS) capability
Confocal Microscope (Nikon D-Eclipse TE2000-E)	
Optical microscope (Nikon Eclipse)	With Clemex image capture
Optical microscope (Olympus BX50)	With Linkam hot stage
Vitrobot (Mark 1)	
Materials Characterization	
Nuclear magnetic resonance spectrometer (NMR, 600 MHz Varian)	
Nuclear magnetic resonance spectrometer (NMR, 500 MHz Bruker)	
Fourier transform infrared spectrometer (FT-IR, Thermo Nicolet Nexux 670) with RAMAN module	
Powder X-ray diffractometer (PXRD, Bruker A25-D8 Advance)	
Fluorometer (Horiba Fluorolog)	
Mass spectrometer (Applied Biosciences 4000Q Trap)	
Gas Chromatograph (GC, Agilent model 7890A)	With FID and MS detectors attached
Rheometer (TA Instruments, Advanced AR1000-ST-B)	
UV/VIS In-line Dissolution Profiler (pION model R2D)	With fiber optic probe
Turbidimeter (HACH Company model 2100N)	
R&D Analytical Testing Equipment	
HPLC Instruments, (23) Agilent 1100 and (4) Agilent 1200	Diode Array Detectors
HPLC Instruments, (2) Shimadzu	Variable single wave length detectors
HPLC Detectors	<ol style="list-style-type: none"> 1. Charged Aerosol Detector (Thermo, 1) 2. Nano-Quantity Analyte Detector (Quant Tech, 1) 3. Refractive Index Detectors (Agilent, 2) 4. Fluorescence Detector (Jasco, 2)
Dissolution Baths (11)	Equipped with Autosamplers
Karl Fisher (2), Metrohm	(1) 870 Titrino Plus Volumetric KF and (1) 851 Titrando Coulometric KF with 774 Oven Sampler
SEC-MALLS system (Wyatt Technology)	Includes DAWN EOS with Optilab DSP Refractometer and VisoStart in-line Viscometer
UV Spectrophotometer (2), Agilent model 8453 and Cary50 Tablet flow-through detector	
Water Activity Meter, NovasinaAG, LabMaster aw	

Bend Research Equipment List Formulation Development/Process Analytical Equipment

<i>Type of Equipment</i>	<i>Notes</i>
Surface Characterization	
Mercury intrusion porosimeter (Hgl, Micrometrics Autopore IV)	
Variable gas porisimeter (Micrometrics ASAP 2020)	
Attenuated total reflectance infrared spectrometer (ATR-IR, Nicolet SMART accessory Nexus 670)	
Thermal Analysis	
Modulated differential scanning calorimeter (4) (mDSC, TA Instruments, Q1000 and Q2000)	
Thermogravimetric analyzer/moisture balance (TGA, TA Instruments, Q5000)	
Thermal activity monitor (2) (TAM, TA Instruments, TAM III)	
Thermogravimetric analyzer (Perkin Elmer, TGA 7)	
Dynamic vapor sorption (2), (DVS, SMS, models DVS 1000 and DVS Advantage)	
Automated melting point system (SRS, OptiMelt MPA100)	
Particle Sizing	
Dynamic light-scattering instrument (DLS, Brookhaven Zeta PALS)	
Dynamic light-scattering instrument (DLS, Brookhaven FOQELS)	Size Range: 0.002 to 2 microns
Aerodynamic Particle Sizer (TSI model TSI-3321)	Includes Aerosol Diluter and Powder Disperser
Laser Diffractometer (Malvern Mastersizer)	
Focused beam reflectance measurement (FBRM), Mettler Toledo D600	
General Bioanalysis	
Flow cytometer (FACS, BD FACSAria)	
Real-time polymerase chain reaction instrument (RT-PCR, Step-One Plus RT-PCR)	
Variable-Mode fluorometry scanner (Typhoon 9410)	
Pilot Plant Development Tools	
Nozzle Test Stand - Phase Doppler Particle Analyzer (TSI)	Solvent capable droplet size and velocity measurement for atomization quantization. Outputs can be used neat or as input to predictive models
En' Urga - SetScan	Laser Tomography system for measuring spatial spray pattern density
AeroProbe - Static Pitot system	5 and 7 hole probes for up to 70 degree incident angle measurement as well as a Omni-Probe for 160 degree incident angle data
Malvern MasterSizers 2000	Offline laser diffraction particle size measurements of slurries and powders
Phantom High Speed Camera v7.3	Up to 500,000 frames per second
Oxford Laser Particle Sizing System	Pulsed diode laser base high speed imaging system. Capable of 2 nanosecond flash duration

Bend Research Equipment List Formulation Development/Process Analytical Equipment

<i>Type of Equipment</i>	<i>Notes</i>
Pilot Plant Development Tools - Cont.	
Texture Analyzer - Texture Technologies TA-XTPlus	Force and displacement profile for mechanical property measurements of solids and powders, roller compacted ribbons, tablets, powders and films
GeoPyc Envelope Density Analyzer, Micromeritics	Envelope density analyzer to measure volume and density of ribbons, tablets, etc.
AccuPyc 1330, Micromeritics	Density analyser for powders and slurries
Johansson Flow Indicizer	Powder flow instrumentation to assess flow rate, rathold potential, arching potential, etc.
ABB FT-NIR	Online process NIR for online monitoring of chemical signature
Bruker FT-NIR	Lab - reflectance, transmittance
Metler-Toledo - ReactIR	Online process IR for reaction monitoring and other IR sensitive signatures
Lasentec - FBRM	Online process measurement of particle cord length. Relevant for suspensions and dry powders
Kaiser Raman RXN1	Online process Raman probe for chemical signature
Linux Cluster	64 node parallel computing system
GMP Analytical Testing Equipment	
High Performance Liquid Chromatographs (9)	Diode Array Detectors
Gas Chromatographs (2)	FID/TCD
Headspace Autosamplers (2)	
Dissolution Baths (5)	Apparatus 1 & 2; Equipped with Autosamplers
Fourier transform infrared spectrometer (2)	
Karl Fisher (3)	2 instruments have oven-prep capability
UV Spectrophotometer	
Tap Densimeter	
Water Activity Meter	Decagon AquaLab
Disintegraton Tester	
Differential Scanning Calorimeter	TA Instruments DSC Q2000
Particle Size Analyzer	Malvern Mastersizer 3000; Wet and dry dispersion units
Environmental Chambers for storage of stability samples (7)	5°C; 25°C/60%RH; 40°C/75%RH
Incubators for Environmental Monitoring (2)	
Ultra High Performance Liquid Chromatographs	Potentially available
Powder X-ray diffractometer (PXRD, Bruker A25-D8 Advance)	Potentially available for GMP use

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Bend Research Equipment List: Biotherapeutics and Bioprocessing

<i>Type and Model</i>	<i>Manufacturer</i>	<i>Number/Scale</i>	<i>Notes</i>
Cell Culture			
BioNet Bioreator Systems	Broadley-James	2x -3L, 2x-7L	DeltaV Based Control and Data historian
Fermac 360 Bioreactors	Electrolab	2x -3L, 2x-7L	
BioFlo 3000	New Brunswick	30L	Steam in Place Reactor
Wave BioReactor System	GE	1x - (1-10L)	Disposable Bioreactor
SterilGard 111	The Baker Company	1x	
Climo-Shaker ISFI-X Incubators	Kuhner	2x	CO2, temperature, humidity controlled incubator shakers
Autoclave	Consolidated	1x	
Cell Culture Process Analytical			
Bioprofile Flex	Nova	1x	
RC6 Plus Centrifuge	Thermo	1x	
IEC CL40R Centrifuge	Thermo	1x	
Flex Autosampler	Nova	1x	
Modular Automated Sampling Technology™ (MAST) System	Bend Research	N/A	modular, customizable - collects from ≤ 8 bioreactors, sends samples to ≤ 4 destinations
MAST™ Cell Removal System	Bend Research	N/A	
Futura Dielectric Spectroscopy Probes	Aber Instruments	2x	
iBiomass 465 Dielectric Spectroscopy Probes	Fogale Nanotech	2x	
CedexCell Counting System	Innovatis	1x	
Protein Simple iCE3	Protein Simple	1x	Imaging Capillary Electrophoresis
Downstream Separations			
Akta Purifier	GE	1x - (0.1-100 ml/min)	
Akta Explorer	GE	1x - (0.1-100 ml/min)	
Gilson GX271 ASPEC	Gilson	1x	
Cell Characterization			
Flourescent Confocal Mocroscope	Nikon	1x	
FACS- Aria	BD	1x	Flourescence Activated Cell Sorter

Molecular Biology			
Typhoon 9410 Gel Imager	GE	1x	
Step One Plus RT-PCR System	Applied Biosystems	1x	
Nanodrop 8 sample Spectrophotometer ND-8000	Nanodrop	1x	
Nanodrop 1 sample Spectrophotometer ND-1000	Nanodrop	1x	
HPLC with autosampler	Agilent	2x	Amino Acid Analysis, Product Titer, Product Quality Analysis

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