Draft Occupational Skills for Biofuels Technicians

Critical Work Functions

Critical work functions represent the general areas of responsibility for technicians in biofuels workplaces. The functions tell us what must be done to achieve the key purpose of an occupation.

Key Activities

Key activities are the tasks that must be performed by technicians to accomplish the related critical work function. The tasks are made up of work activities that are measurable, observable, and result in a decision, product, or service.

Critical Work Function	Key Activity	Key Activity	Key Activity	Key Activity	Key Activity	Key Activity	Key Activity	Key Activity	Key Activity
1. Perform record keeping and create documents.	1.1 Write and review operating procedures.	1.2. Prepare batch records.	1.3 Obtain, review and communicate data.	1.4 Write technical reports.	1.5 Maintain logbooks.	1.6 Participate in change control activities.	1.7. Monitor and record biofuels processing data: flow meter performance, batch, continuous flow, hybrid biofuels production processes, stored biofuels products or secondary by-products.	1.8 Track inventory.	1.9 Use process control software such as Computer-Aided Design. (CAD)
2. Clean, maintain, and trouble-shoot equipment.	2.1 Clean and maintain basic equipment.	2.2 Clean and maintain cell culture or fermentation equipment.	2.3 Perform calibration of instruments.	2.4 Perform preventive maintenance and schedule vendor maintenance.	2.5 Perform equipment validation.	2.6 Participate in the installation and modification of equipment.			
3. Prepare items for laboratory and biomanufacturing activities.	3.1. Order materials.	3.2. Store materials.	3.3 Prepare glassware.	3.4. Prepare equipment.	3.5. Make media, solutions, and buffers.	3.6 Store media, solutions, and buffers.	3.7 Preprocess feedstock in preparation for physical, chemical, or biological fuel production process.	3.8 Prepare biomass for conversion to biofuel.	
4. Perform cell culture and fermentation.	4.1 Establish working cell bank.	4.2 Initiate starter cultures.	4.3 Perform scale-up operations.	4.4 Inoculate seed reactor and perform media additions.	4.5 Monitor culture.	4.6 Execute sampling and assess materials for process release.	4.7 Perform process release for product.	4.8 Collect, characterize, and optimize microbes for specific traits and performance.	
5. Perform testing and data analysis.	5.1 Perform microbiology testing.	5.2 Perform chemical testing.	5.3 Perform upstream testing.	5.4 Perform downstream testing.	5.5 Troubleshoot aberrant results or parameters.	5.6 Assess the quality of biofuels additives for reprocessing.	5.7 Measure and monitor raw biofuels feedstock.	5.8 Monitor the blending operation to assure correct proportions of the products.	5.9 Obtain and review trend and benchmark data.
	5.10 Determine significant results using statistical analysis.	5.11 Present data for decision support.	5.12 Comply with industry standards for product.	5.13. Perform process flow and logistical modeling.					
6. Perform product purification.	6.1 Prepare purification equipment.	6.2 Receive product from upstream processing.	6.3 Filter product as necessary.	6.4 Perform product analysis.	6.5 Remove contaminants and concentrate product as necessary.	6.6 Bulk fill purified product for storage.	6.7 Complete final formulation.	6.8 Operate equipment (such as chemical processing equipment, centrifuges, pumps, valves and shredders) to extract biofuels products and secondary by-products or reusable fractions.	6.9 Package according to standard operating procedure (SOP) and ship according to customer needs.
7. Provide effective and appropriate communication.	7.1 Communicate with coworkers to ensure quality work.	7.2 Provide technical assistance to customers.	7.3 Provide training to coworkers.	7.4 Communicate with all plant personnel.	7.5 Manage personnel conflicts in a timely manner.	7.6 Practice emergency communication measures.	7.7 Maintain intellectual property security.		
8. Comply with environmental health and safety (EH&S), good practices (GXPs) and other national, state and local regulations.	8.1 Comply with Standard Operating Procedures.	8.2 Wear appropriate personal protective equipment.	8.3 Access and utilize safety data sheets (SDSs).	8.4 Comply with GXPs.	8.5 Handle, label, and dispose of hazardous and biohazard materials.	8.6 Follow Environmental Protection Agency regulations, and other applicable local, state, and federal regulations.	8.7 Participate in all company safety training and audits as required.	8.8 Maintain quality control (QC).	8.9 Respond to incidents such as spills, fires, gas releases, biocontamination.
9. Maintain clean and safe work environment.	9.1 Clean work environment according to SOPs.	9.2 Report unsafe conditions.	9.3 Attend company safety training.	9.4 Maintain security.	9.5 Comply with Occupational Safety and Health Administration (OSHA) regulations.	9.6 Wear appropriate personal protective equipment.			
10. Handle large-scale materials.	10.1 Reduce size of raw materials.	10.2 Sample raw materials.	10.3 Transfer and convey raw materials.	10.4 Coordinate raw product sourcing or collection.	10.5 Store raw materials.	10.6 Drain and inspect all trucks, railcars and vessels prior to loading.			

Draft Educational Skills for Biofuels Technicians

Educational Knowledge and Skills

Educational knowledge and skills are basic academic and personal skills that biofuels technicians need to build more advanced competencies.

Science Skills	Math Skills	Engineering and Technology Skills

Basic and Applied Biology
• Cellular propagation
  • prokaryotic
  • eukaryotic
• Sterilization
• Sanitization
• Media preparation
 	
Basic and Applied Microbiology
• Identification of microbes
• Basic microbiology techniques
• Microscopy
• Aseptic techniques
• Growth and death kinetics
• Fermentation pathways
• Cell counting
 	
Basic and Applied Chemistry
• pH
• Acids and bases
• Solution mixing
• Organic chemistry
• Titration
• Solution mixing
 	
Basic and Applied Biochemistry and Basic Laboratory Activities
• Spectrometry
• Pipetting
• Weighing
• Volumetric measurement
• Sample collection
• Sample preparation
• Filtration
• Centrifugation
• Titration
	Basic Math
	
	Intermediate Math
	• Algebra (solving for one unknown)
	
	Applied Math
	• Molarity/Normality
	• Concentrations (ppm, ppb)
	• Mass per volume
	• Dilutions
	• Serial dilutions
	
	Advanced Math
	• Statistics and principles of data analysis
	• Advanced Algebra
	• Applied Calculus
	• Basic Statistics
	• Ability to apply theory to perform mathematical functions
		Basic and Applied Physics
		• Principles of electricity
		• Gas laws
		• Optics
		
		Basic Bioprocessing
		• Quality assurance and quality control
		• Standard operating procedures (SOPs)
		• Documentation/Batch records
		• American Society for Testing Materials (ASTM)
		• Facilities
		• Environmental health and safety (EH&S)
		• Metrology
		• Validation
		
		Bioprocess Engineering Principles
		• Heat transfer
		• Fluid flow
		• Chemical reactions and stoichiometry
		• Thermodynamics
		• Unit operations
		• Feedback control loops
		• Mass transfer
		• Reaction kinetics
		
		Computer Technology Skills
		• Microsoft Office
		• Spreadsheets
		• Industry standard software

Personnel Management Skills	Employability Skills
• Leadership • Self-confidence • Learn from failure • Display appropriate work ethic and etiquette (dress, cell phone, email, etc.) • Good general organizational skills • Ability to troubleshoot • Ability to apply knowledge • Ability to multitask; Time management skills • Ability to prioritize • Globally-minded; cross-cultural understanding • Accountable • Engage in life-long learning • Accept constructive criticism	• Problem-solving • Ability to work with minimal supervision • Initiative and self-direction • Ability to train others • Appropriate work ethic • Word processing and spreadsheet proficiency • Read and follow instructions • Detailed and accurate record keeping • Use interpersonal skills to work in a team setting • Written and oral communication skills • Goal oriented • Adaptable and flexible • Participate in the community • Analyze and interpret data

Draft Technical Skills for Biofuels Technicians

Technical skills, knowledge, and abilities are those areas of expertise which biofuels technicians must have in order to perform a given key activity with excellence. A collection of skills, knowledge, abilities, and tools make up competencies. Skills refer to proficiency in an applied activity. This activity could be physical, mental, or interpersonal in nature. Knowledge is a particular set of information. Abilities are broad human characteristics that result from natural talent, education, or experience. Tools are materials, equipment, and implements a biofuels technician must be able to use competently to meet the requirements of the job.

R	Required Skills	p	Preferred Skills

Mechanical Skills	Biofuels	Biomaterials, Biopolymers, Bio-based Chemicals	Algae and Microbial Systems	Bioprocessing	Agbiotech	Forestry Resources
Operate distributed control systems (DCS)	R	R	R	R	R	
Troubleshoot & perform basic maintenance and repair on electromechanical devices	R	R	R	R	R	R
Read & interpret piping & instrumentation diagrams (P&ID)	p	R	p	R	R	p
Operate programmable logic controllers (PLC)	p	R	p	R	R	p
Interpret electrical schematics		R	p	p	p	p
Identify and maintain different types of pumps and drives	p	R	p	R	R	R
Understand technical information (manuals, blueprints, diagrams)	R	R	R	R	R	R
Handle large systems	p	p	R	R	p	p
Operate and monitor job-specific equipment and systems	R	R	R	R	R	R
Use the following:						
• Basic hand tools	R	R	R	R	R	R
CO_2 systems	p	p	R	R	R	p
H2O systems (RO, waste coilers, cooling)	p	R	R	R	R	p
Bioreactor, chemical reactor, and fermentation systems	R	R	R	R	R	p
Vacuum systems			R	p	p	p
Filtration, separation, and purification systems	R	R	R	R	R	R
Milling systems				p	p	R
Hydro heaters and jet coolers				p	R	p
Ovens and dryers	p	p	R	p	p	p
Pallet jacks and forklifts				p	p	p
Heat exchangers	p	p	R	R	p	p
Sieves		p		p	R	p
Evaporators		R	p	p	R	p
Agitation systems		p	R	R	R	p
Conveyor systems			p	p	R	R
Automotive vehicles (including manual drive vehicles and towing a trailer)		p	p	p	p	R
Pneumatic systems		p		R	R	R

Measurement and Calibration Skills	Biofuels	Biomaterials, Biopolymers, Bio-based Chemicals	Algae and Microbial Systems	Bioprocessing	Agbiotech	Forestry Resources
Operate scales and balances-basic weights and measures	R	R	R	R	R	R
Perform unit conversion	R	R	R	R	R	R
Knowledge of how to calibrate an instrument	R	R	R	R	p	p

Chemistry and Biology Laboratory Skills	Biofuels	Biomaterials, Biopolymers, Bio-based Chemicals	Algae and Microbial Systems	Bioprocessing	Agbiotech	Forestry Resources
Basic performance of the following:						
• Aseptic techniques	R	R	R	R	R	p
• Chemically clean techniques	R	R	R	R	R	p
• Culture methods (plating, replication, maintenance)	p	p	R	R	R	p
• Serial dilutions	R	R	R	R	R	p
• Media and buffer preparation	R	R	R	R	R	
• Manage chemical and basic lab inventory	R	R	R	R	R	p
• Sampling	R	R	R	R	R	R
• Cryopreservation	p	p	R	p	R	p
• Cell counting	R	p	R	R	R	p
• Assay design		p	R	p	R	p
• qPCR		p	p	p		p
• Genotyping		p	R	p	p	p

Instrumentation Skills	Biofuels	Biomaterials, Biopolymers, Bio-based Chemicals	Algae and Microbial Systems	Bioprocessing	Agbiotech	Forestry Resources
Basic operation, maintenance, and troubleshooting of:						
• Autoclave	R	R	R	R	R	
• Conductivity meter	R	p	R	R	R	p
• Centrifuge	R	R	R	R	R	p
• Shaker and water bath	R	R	R	R	R	
• Incubator	p	R	R	R	R	
• Dissolved oxygen meter	R	p	R	R	R	
• Temperature probe	R	R	R	R	R	p
• pH meter and pH probe	R	R	R	R	R	p
• Turbidity probe	p	p	R	R	R	p
• Light meter	p	R	R	p	R	p
• Autopipettor and pipettes	R	R	R	R	R	p
• Microscopes	p	p	R	R	R	p
• Autotitrator	R	R	R	p	p	p
• Ovens (drying and ashing)	R	R	R	p	R	p
• Hydrometer	R	p	p	p	R	p
• Viscometer	R	R	p	p	p	p
• Sieve	R	R	R	p	R	p
• Spectrophotometer	R	R	R	R	R	R
• Chromatographs	R	p	R	R	R	p
• Gas chromatography	R	p	R	p	R	R
• Liquid chromatography/high-performance liquid chromatography (HPLC)	R	R	R	R	R	p
• Spectrometers (near infrared [NIR], atomic absorption [AA], inductively coupled plasma [ICP], mass [MS])	p	R	R	p	p	p
• Autohemocytometer	p	p	R	p	p	p
• Flow cytometer	p	p	R	p	p	p
• Flow meter	R	R	R	R	p	p
• Flash point tester	R	p		p	p	R
• Identification key	p		p	p	p	R
• Protein analyzer	p	p	R	R	R	R
• Bulk density analyzer	p	R	p	p	R	p
• Total organic content (TOC) analyzer and carbon-nitrogen-sulfur analyzer	p	p	p	p	R	R
• Vacuum apparatus	p	R	R	p	R	R

Process Engineering Skills	Biofuels	Biomaterials, Biopolymers, Bio-based Chemicals	Algae and Microbial Systems	Bioprocessing	Agbiotech	Forestry Resources
Develop, follow, optimize a workflow	R	R	R	R	R	R
Read & interpret process flow diagrams (PFD)	R	R	R	R	R	R
Minimize wasted energy, resources, time	R	R	R	R	R	R
Know how to develop and follow a standard operating procedure (SOP)	R	R	R	R	R	R
Basic quality control related to feedstock, process, and products.	R	R	R	R	R	R

Laboratory and Workplace Safety Skills	Biofuels	Biomaterials, Biopolymers, Bio-based Chemicals	Algae and Microbial Systems	Bioprocessing	Agbiotech	Forestry Resources
Know how to:						
• Perform first aid and cardiopulmonary resuscitation (CPR)	p	R	p	p	R	R
• Perform lock-out and tag-out	R	p	R	R	R	R
• Read and interpret safety and material signage and general safety nomenclature	R	R	R	R	R	R
• Implement acid and base spill procedures	R	R	R	R	R	R
• Handle hazardous waste and materials according to chemical hygiene plan	R	R	R	R	R	R
• Monitor ISO and HAACP	R	R	R	R	R	R
• Follow Occupational Safety and Health Administration regulations (OSHA)	R	R	R	R	R	R
• Comply with HAZMAT/EHS/HAZCOM	R	R	R	R	R	R
• Prevent explosions	R	R	R	R	R	R
• Read a material safety data sheet (SDS)	R	R	R	R	R	R
• Don personal protective equipment (PPE)	R	R	R	R	R	R
• Dispose of chemical, biological and hazardous materials properly	R	R	R	R	R	R
• Use of a fume hood	R	R	R	R	R	R
• Prepare a vehicle for safe transport including rigging and handling	p	p	p		p	R
Work in the following areas:						
• High decibel	R	R	p	R	R	R
• Electrical	R	R	p	R	p	p
• Hot works	R	R	p	R	p	p
• Steam systems	R	p	p	R	p	p
• Pressurized gases	R	R	R	R	p	p
• Bulk machinery	R	R	R	R	p	R
• Confined spaces	R	p	p	R	p	p

Data Management Documentation and Communication Skills	Biofuels	Biomaterials, Biopolymers, Bio-based Chemicals	Algae and Microbial Systems	Bioprocessing	Agbiotech	Forestry Resources
Data Management	R	R	R	R	R	R
• Record and enter data (keep a written and/or electronic laboratory notebook)	R	R	R	R	R	R
• Report data (for internal laboratory use, presentations, publication)	R	R	R	R	R	R
• Perform bioinformatics, data analysis, and trends analysis	R	R	R	R	R	R
Computer Proficiency	R	R	R	R	R	R
• Use word processing and spreadsheet programs	R	R	R	R	R	R
• Operate basic data management system	R	R	R	R	R	R
• Perform Internet research	R	R	R	R	R	R
• Communicate in writing (reports and email) with proper etiquette	R	R	R	R	R	R
• Interact via online social networks	p		p			