National Occupational Standard for

Senior Research Scientist Engineer in Bio-Industrial, Bio-Energy

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Igniting the bio-economy's brainpower

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Avik Khan	Research Scientist	Chinova Bioworks
Brian Xu	Sr. Chemical Engineer	Planetary Hydrogen
Denis Groleau	Chief Science Officer	Proventus Bioscience
Doug Cossar	VP R&D	PlantForm Corporation
Emhemmed Youssef	Engineering Manager	SIXRING Ltd
Heather Pikor	VP, Corporate Affairs	Iogen Corporation
Hooman Rezaei, Ph.D., P.Eng., PMP	Lead of Projects - Biofuels and Bioenergy Department	FPInnovations
Jasleen Bains	Consultant	Self-employed
Jawad Jeaidi	Process engineer	CanmetENERGY
Jinwen Chen	Director Downstream and Renewables	Natural Resources Canada
Krishnamoorthy Hedge, PhD	Research Program Manager	Department of Civil Engineering, York University
Marcos Igreja	Associate Director of Engineering and Operations	Genecis Bioindustries Inc.
Matyas Kosa	Director Of Technology	Fortress Advanced Bioproducts Inc.
Peng Xiang	Polymer Chemist	PolyAnalytik Inc.
Raja Mathiazhakan	Senior Scientist	Northern RNA
Sandy Marshall	Executive Director	Bioindustrial Innovation Canada
Tony Chen	Senior Product Engineer	Advanced Electrophoresis Solutions Ltd. (AES)
Vijay Bansal, PhD	Senior Scientist	Radient Technologies Inc.
Xin Mian Chen	Senior Research Scientist	Elementa Group

2 A COMPETENCY FRAMEWORK FOR INDIVIDUALS WORKING IN THE BIO-ECONOMY

2.1 What is a National Occupational Standard?

In Canada, National Occupational Standards are industry-developed and validated documents that identify and group tasks/competencies associated with a particular occupation. They also describe the knowledge and skills that a worker must demonstrate to be considered competent.

The former Alliance of Sector Councils (TASC) outlined 11 guiding principles for creating National Occupational Standards (NOS). NOS for the Canadian bio-economy meet all 11 principles and are developed to meet the current and future human capital management needs of the Canadian bio-economy.

2.2 How are we defining a competency?

We define a competency as ***a set of related behaviors that describe successful performance in a designated area. It is a behavioural expression of how people integrate knowledge, skills, attributes, and attitudes to produce a value-adding result in a defined situation.***

The competency statement includes a description that integrates skills, knowledge, and actions into a sequence of activities that deliver a value-added product or service.

Performance Indicators is the term we use for the behaviours grouped under each competency that describe the level of mastery the incumbent role must demonstrate when executing a task.

For this project, we have organized the competencies into four categories.

Core Competencies are those competencies that describe the "essence of the role" — that is, they are the one to three most critical competencies that may be applicable across multiple roles in a function or job family. All levels of personnel in this function would typically share them. These competencies may also act as qualifiers that differentiate the function from other functions.

Technical Competencies are those competencies related to specific roles or professions that enable an individual to work, function, and succeed in that role. They address the various responsibilities that job incumbents encounter in a role. For example, a surgeon's technical competencies would encompass multiple surgical tools, techniques, and conditions that could be part of the position. Similarly, technical competencies for a lawyer would contain various legal situations that they encounter in the context of a particular field of practice.

Regulatory Competencies are those competencies that describe compliance with prescribed practices and mandated obligations under applicable laws, regulations, and industry standards. They ensure that critical work processes are implemented and integrated into all work activities. They are of absolute importance where economic behaviours can impact human conditions.

Personal/professional Competencies are those competencies that enable an individual to be successful working with others and fulfilling their responsibilities in a work context. Personal and professional competencies are not necessarily role specific.

2.3 Levels of complexity of work

It is important to recognize how the complexity of work varies along an organizational continuum. At one end of this continuum is low-complexity, clearly-defined, task-driven work. At the other end of the continuum is work that is higher in complexity, not as well-defined, and requires higher-level thinking and decision-making skills and a greater degree of autonomy. Results are recognised over a longer period of time and are more difficult to assess.

Figure 1: Demonstrates how the level of complexity changes with the role responsibilities

Complexity Level	Examples of Work at Different Complexity Levels	Typical Roles/Titles
Most Complex	Construct and pursue worldwide strategic plans in large corporations.	CEOs of the largest trans-global corporations
	Construct and pursue worldwide strategic plans.	C-suite executives at multi-national organizations
	Lead the accumulated impact of multiple business units.	C-suite executive at large, multi-location organizations
	Optimize the function of a single business unit or corporate support staff.	General manager; plant manager
	Manage multiple, interdependent projects; balance resources among departments.	Engineering manager
	Plan and carry out sequential projects while considering contingencies and alternatives.	Maintenance manager
	Accumulate information to diagnose and anticipate problems; proactive; notice trends.	Maintenance technician
Least Complex	Follow predefined procedures; seek help when encountering an obstacle. The ability to anticipate problems is not expected.	Maintenance labourer

We define the complexity levels within the profiles at four levels:

Foundational — performance focus is on the execution of procedures and tasks involving own job role.

Operational — performance focus includes some discretion in the planning and executing of work. The work typically includes assessing the quality of the work outcomes and taking corrective action to ensure quality.

Specialist — performance focus is on translating goals and standards to team members and ensuring that work done under the person's responsibility area complies with all corporate standards.

Strategic — performance focus is on leading work and the accumulated impact of work in an independent business unit or across a whole organization. The impact of work at this level is often not visible until the medium to longer term.

The following example illustrates the different complexity levels within a profile.

Competency Name: Research Ethics **Competency Definition:** Exercises integrity and professionalism to ensure all research is performed responsibly in keeping with the ethical principles of beneficence and nonmaleficence. Competence at this level is demonstrated when the **Research Manager**:			
Performance Indicators			
Foundational	Operational	Specialized	Strategic
Diligently follows research procedures and protocols mandated by legitimate authorities and professional organizations.	Regularly monitors own actions and decisions to ensure they align with professional and organizational values.	Holds self and staff accountable to the organization's values, ensuring compliance with the policies and procedures related to scientific ethics and rules of conduct.	Fosters an organizational culture of integrity and ethical business practices by unwavering personal example.

2.4 Overview methodology for the development of national occupational standards

National occupational standards were developed using a multi-step process.

Step	Description	Result/Output
1	Identify critical roles in the bio-economy through primary and secondary research.	List of 50 key roles
2	Create draft profiles with critical competencies for the roles, performance, and knowledge indicators.	Draft profiles
3	Review the draft profiles with industry subject matter experts to refine the competencies, performance, and knowledge indicators.	Reviewed profile with design inputs from industry experts
4	Further validation and review by industry via online focus group.	Validated profiles by industry experts
5	Broader validation of the draft profiles via national online surveys.	Occupational Standards validated on a national level by experts from the different sectors
6	Addition of the Essential Skills and Canadian Language Benchmark (ES/CLB) ratings.	Nationally validated NOS profiles with ES/CLB profile for each NOS

3 SENIOR RESEARCH SCIENTIST ENGINEER IN BIO-INDUSTRIAL, BIO-ENERGY COMPETENCY FRAMEWORK

3.1 Competency diagram for Senior Research Scientist Engineer in Bio-industrial, Bio-energy

Competencies		Complexity Level				Complexity Level Legend
		1	2	3	4	
Core Competency						1. Foundational
1	Research Ethics			■		2. Operational
2	Collaboration			■		
Technical Competencies						3. Specialist/Manager
3	Developing &/or Overseeing an R&D Program		■			4. Expert/Executive
4	Designing an R&D Project			■		
5	Planning & Implementing R&D Projects			■		
6	Leading & Managing the R&D Team			■		
7	Applying Model Experimental Practices			■		
8	Data Generation & Analysis			■		
9	Managing Quality in R&D			■		
10	Conducting a Feasibility Study			■		
11	Engineering Modeling & Design for Commercialization			■		
12	Digital Skills for R&D			■		
13	Knowledge Transfer			■		
14	Professional Writing for R&D			■		

Competencies		Complexity Level			
		1	2	3	4
Industry Regulatory Competencies					
15	Legal/Regulatory Compliance in R&D		■		
16	Occupational Health & Safety in R&D			■	
Personal and Professional Competencies					
17	Continuous Learning			■	
18	Critical Thinking/Decision-Making in R&D			■	
19	Effective Interpersonal Communication			■	
20	Professionalism/Emotional & Cultural Intelligence			■	

3.2 Definition of occupation

The Senior Research Scientist/Engineer develops project proposals and study protocols, undertakes experiments and other tests, analyzes the results, conducts theoretical computations and analysis, prepares project reports and publications, and communicates with clients and stakeholders. The purpose may be to develop new products, processes/technologies, services and/or applications, or to improve upon currently existing practices or products through innovation, sustainability, automation, etc. Technology transfer and process scale-up from lab to pilot scale may be required as well. A project can be either experimentally based, theoretical/computation/modeling based, or the combination of both.

Research may be fundamental, such as investigating the underlying basis of bioprocessing and bioengineering, or it may be more applied, such as:

- developing a specific biochemical process to produce biopolymers, biofuels, biosolvents, or bioactives,
- conducting classic and/or modern genetic research for new strain development,
- conducting fermentation research for fermentation or enzymatic bioprocess development, and
- investigating methods for monitoring and control of bioprocesses.

Knowledge transfer/translation and communication of results are required as well. In addition, the Senior Research Scientist/Engineer may support the technical sections of grant applications, file patent applications, and publish research articles in peer-reviewed journals.

The role works in the following subsectors:

Applicable To	Bio-Health	Agri-Bio	Bio-Industrial	Bio-Energy
			■	■

The level of complexity of the role is:

Span of Complexity Levels	Foundational	Operational	Specialist/ Management	Expert/Executive
			■	

3.3 Level of education, training or designations requirements

Typical Education Required	Secondary	College	Bachelor	Master	PhD
				■	■
Typical Starting Experience	0–5 yrs.	5–10 yrs.	10–15 yrs.	15–20 yrs.	20+ yrs.
	■	■			

- PhD in bioengineering related disciplines (such as microbiology/biotechnology, chemical engineering, biochemical or biological engineering, bioinformatics, bioreactor design, or another related scientific discipline) with zero to five years of experience
- OR an MSc with equivalent relevant knowledge and a minimum of five years of experience
- OR a BSc/BEng with a minimum of ten relevant years of experience
- Professional accreditation or designation in a relevant engineering or science discipline is an asset
- Technical experience in areas specific to the type of research activity and process scale-up is recommended
- Experience in experiment planning and design, some statistical analysis, or in theoretical calculation/computation, modeling and simulation, and reporting of results is an asset
- Experience in training others on scientific techniques and skills and managing students/research technicians
- Experience working in a biochemical laboratory and/or industrial chemical facility is preferred
- Knowledge of the industry trends in upstream and downstream bio-processing technology is an asset

3.4 Core competencies list for Senior Research Scientist Engineer in Bio-industrial, Bio-energy

3.4.1 Research Ethics

Exercises integrity and professionalism to ensure all research and development (R&D) is performed in a responsible manner in keeping with the ethical principles of beneficence and nonmaleficence.

Competency in this role is demonstrated when the individual:

- Models integrity and respect in all related actions and decisions, ensuring own actions and decisions follow the letter and spirit of the professional code of conduct for R&D.
- Ensures supervised or team-member staff are sufficiently trained in policies/procedures related to ethics and conduct.
- Holds self and supervised staff accountable to the organization's values, ensuring compliance with the policies and procedures related to scientific ethics and rules of conduct.
- Includes all study parameters and data necessary to present a complete and accurate picture of study results.
- Ensures that the required ethics approval certificate is secured from the Research Ethics Board (REB) before undertaking a research project, if applicable.
- Ensures that the use of public funds and resources meet the policies of good stewardship.

- Ensures best statistical practices are applied to data analysis to produce the most accurate outcomes.
- Applies scientific principles to ensure that experiments minimize risk to self, colleagues, the environment, and/or the broader public.
- Respects intellectual property rights and the principles of the Nagoya Protocols on Biodiversity.

Knowledge required for competency at this level:

- Ability to maintain good standing with any professional certification/licensing body required for legal conduct of company activities (e.g., Society of Professional Engineers)
- Working knowledge of the organization's code of conduct
- Working knowledge of relevant scientific ethical issues, e.g., the use of genetically modified organisms in research and commercial production, the use and storage of materials and data, potential harmful environmental impacts, etc.
- Working knowledge of the ethical codes and requirements of the organization, partnered organizations, and funding bodies
- Working knowledge of the implications of the general data protection regulation (GDPR) for Canadian businesses

3.4.2 Collaboration

Works effectively with others to foster trust and cooperation in the achievement of R&D goals and project objectives.

Competency in this role is demonstrated when the individual:

- Identifies the personal interests of clients and other key stakeholders in the success of the R&D program or project in order to better engage them in achieving program/project goals.
- Fosters an environment of trust and mutual respect with relevant colleagues and stakeholders, at any level of relative authority, by consulting them in key decisions and taking their views, expectations, and priorities into account.
- Solicits feedback throughout the project from project staff and stakeholders to proactively identify potential issues.
- Seeks to understand difficult situations and issues from the others' perspectives, providing support where necessary to move things forward.
- Continuously coordinates with internal colleagues, clients, suppliers, investors, regulators, etc. in order to effectively achieve goals and responsibilities.
- Liaises between key project groups such as laboratory staff, informatics researchers, sales and marketing, manufacturing, and collaborators in order to enable and facilitate the efficient flow of data and resources.

Knowledge required for competency at this level:

- Working knowledge of effective collaboration models such as networking, managed teams, self-directed teams, strategic alliances, etc., and software tools such as Microsoft Teams, Asana, Zoom, etc.
- Working knowledge of change management resources to affect staff culture (e.g., Kotter's 8-Step Change Model)
- Working knowledge of successful teamwork models and theories such as the Google teams' Project Aristotle, Tuckman's FSNPA, and Katzenbach and Smith's "The Wisdom of Teams"

3.5 Technical competencies list for Senior Research Scientist Engineer in Bio-industrial, Bio-energy

3.5.1 Developing &/or Overseeing an R&D Program

Defines the focus and strategy of the laboratory/organization's R&D program, determines which projects will be included in the program, generates funding to support the program, and oversees the program from inception to commercial development, if applicable.

Competency in this role is demonstrated when the individual:

- Conducts systematic literature reviews to identify potential areas of focus for the organization's R&D program, considering the value of this area of focus to both society and the organization.
- Contributes scientifically viable ideas and suggestions to stimulate discussion in the development of the organization's strategic R&D plan.
- Works within an interdisciplinary team, including stakeholders, to help develop and define the R&D program, assisting in testing hypotheses and developing funding proposals.
- Participates in the evaluation of the R&D program.

Knowledge required for competency at this level:

- Working understanding of how to effectively review scientific literature and evaluate different areas of focus
- Basic understanding of the process for translating R&D to commercial products
- Basic understanding of interdisciplinary sciences

3.5.2 Designing an R&D Project

Defines the parameters and specifications of a research/development project, including the project scope, objectives, goals, resource requirements, project timeline, and budget. Also designs the experiments, identifies the testing and validation methodologies that can be employed to create a manageable research/development project, and if applicable, takes the application, translation, and scale-up of research discoveries/results into considerations during the design phase.

Competency in this role is demonstrated when the individual:

- Contributes to writing proposals in order to secure project funding from internal or external sources, including application for tax incentive programs.
- Contributes to defining the project scope, including the inquiries to be addressed by the project, the major objectives, critical success factors for performance measurement and project evaluation, deliverables, assumptions, and constraints, as well as commercialization and scale-up considerations, if applicable.
- Contributes to verifying that all governance procedures and regulatory requirements are defined and communicated to stakeholders.
- Assists in determining go/no-go decision points (stage gating approach), key milestones, high-level budgets, timelines, and resource requirements.
- Ensures that the project design incorporates the ethical parameters required to secure a certificate of ethical approval from the Research Ethics Board (REB) or other equivalent approval body, if required.
- Contributes scientifically viable considerations for application, translation, and scale-up of research results that advance the organization's strategic R&D plan.
- Participates in the evaluation of the R&D project.
- Collaborates with the team to generate the overall experimental strategy, hypotheses, and matrix for the research/development project.
- Ensures the experimental strategy is of optimum quality in order to deliver meaningful research/development results.
- Collaborates with the team to identify the potential testing and validation methodologies that are compliant with regulatory requirements for this type of project.
- Prepares a project initiation document to facilitate a smooth hand-off from project design to project planning and implementation.

Knowledge required for competency at this level:

- Working knowledge of project management principles and techniques
- Working understanding of the project stages and the transition management process at the end of each stage
- Comprehensive knowledge of the regulatory requirements related to the project
- In-depth knowledge of the project context and requirements, and other standards
- In-depth understanding of the stages of a research process
- In-depth knowledge of the analytical and statistical design of research experiments, including relevant GLP, DOE, and International Council for Harmonisation (ICH) guidelines
- Comprehensive knowledge of relevant literature and technical tools available to the field of R&D
- In-depth knowledge of the organization's onsite measurement/testing capabilities and what testing would need to be outsourced to an offsite lab
- In-depth understanding of the organization's strategic direction, roadmaps, and milestones
- Working understanding of the process for translating R&D to commercial products
- Working understanding of the design and manufacturing processes, including GMP

3.5.3 Planning & Implementing R&D Projects

Prepares a deliverable-oriented work breakdown structure that details milestones, resources, schedules, and budget for the planned project outcomes. Also develops a risk management plan, manages activities, provides project updates, and oversees project close-out to ensure project outcomes are delivered on time and in budget.

Competency in this role is demonstrated when the individual:

- Collaborates with stakeholders to clearly articulate project deliverables, create a shared understanding of the full scope of the project (what is and is not included), and establish communication frequency and methods.
- Breaks the deliverables down into major milestones with input from subject matter experts in each work stream.
- Works collaboratively to establish a milestone schedule, identifying the planned start and finish dates of each milestone.
- Works collaboratively to determine staffing and physical resource requirements for each milestone, scheduling them as required.

- Works collaboratively to identify risks that may be encountered throughout the project, developing a risk elimination or mitigation strategy for each one.
- Works collaboratively to design and implement quality assurance (QA) and quality control (QC) criteria for the project.
- Collaborates with stakeholders to develop a detailed project budget, identifying when funds will be required throughout the project.
- Manages the project schedule and budget and any associated contracts in order to ensure the project is delivered within the defined scope, budget, and schedule.
- Provides regular project updates to management and other stakeholders.
- Leads the ongoing and final evaluation of the R&D project with input from clients and stakeholders.
- Leads project close-out by confirming completion of deliverables and payments, preparing a final report on the budget, methodology, results, lessons learned, and recommendations, and transferring all files to the project file storage system.

Knowledge required for competency at this level:

- Intermediate knowledge of a project management system and tools, such as Primavera, Microsoft Project, Microsoft Excel, Microsoft Teams, etc.
- Working understanding of the project management process, including project stages and the transition management process at the end of each stage, as would be gained in PMP, CPM, or PRINCE2 programs
- Intermediate knowledge of the regulatory requirements related to the project
- Comprehensive knowledge of schedule management techniques such as critical path management, Program Evaluation & Review Technique (PERT) analysis, GANTT charts, and decision trees
- Working knowledge of the latest references like publications, patents, white papers, etc.

3.5.4 Leading & Managing the R&D Team

Applies positive leadership and performance management principles and practices to foster high performing R&D teams.

Competency in this role is demonstrated when the individual:

- Ensures consistent application of organizational HR practices within the team.
- Ensures team members are properly trained and proficient in current research practices.
- Assigns work to individual team members appropriate to their competencies, experience, and career development plan.

- Uses a positive, collaborative approach that motivates team members to achieve performance goals.
- Holds team members accountable for their conduct and performance results through regular feedback.
- Ensures that performance issues are dealt with promptly and ethically in accordance with company values, policies, and procedures.
- Conducts or contributes to regular performance reviews with direct reports/team members.
- Actively coaches and mentors team members.
- Effectively address conflicts within the team.

Knowledge required for competency at this level:

- Working understanding of organizational HR policies and procedures
- Working understanding of motivational techniques
- Working understanding of positive leadership and performance management practices such as Situational Leadership, SMART, etc.
- Working understanding of effective coaching and mentoring techniques
- Working understanding of the management of multidisciplinary teams

3.5.5 Applying Model Experimental Practices

Applies knowledge, skills, and model experimental practices related to the scientific and technical components of laboratory and field testing, the use, collection, and storage of samples and reagents, the proper handling and disposal of waste products generated during research activities, and the use, maintenance, and calibration of instruments and equipment in order to produce optimal research results in a safe, effective, and efficient manner.

Competency in this role is demonstrated when the individual:

- Ensures that staff are professionally trained in and comply with current model experimental techniques and practices.
- Ensures that currently accepted scientific and experimental concepts and theories are integrated and applied to laboratory and field operations.
- Ensures staff compliance with policies, processes, and procedures for safe transporting and handling of reagents, samples, supplies, and waste products.

- Oversees the policies, processes, and procedures for the maintenance, calibration, repair, and replacement of experimental instruments and equipment.
- Develops new/updates existing standard operating procedures (SOP), as needed.
- Implements procedures for processing and storing sensitive/hazardous materials, e.g., cell banks for biological materials used in the laboratory.

Knowledge required for competency at this level:

- Intermediate understanding of and certification in WHMIS
- Comprehensive understanding of Good Laboratory Practices (GLP) and the scientific method
- Comprehensive understanding of relevant organizational policies and procedures
- Intermediate understanding of compliance practices for the use of GMOs as part of the experimental process

3.5.6 Data Generation & Analysis

Collects, generates, analyzes, and manages research data according to approved standards and model practices in order to ensure data integrity and optimize the value of the data.

Competency in this role is demonstrated when the individual:

- Determines appropriate sample size or number of experiments needed to ensure research data collected has statistical validity and reliability.
- Designs data collection and entry methods that meet data quality standards.
- Adequately validates experimental samples and techniques before generating data.
- Generates research data by conducting advanced experiments and tests in accordance with research standards.
- Works with others to apply advanced mathematical and statistical concepts and practices in the analysis of complex research data.

Knowledge required for competency at this level:

- Working awareness of potential biases
- Comprehensive knowledge of mathematical and statistical concepts and practices

- Comprehensive knowledge of statistical/analysis software
- Comprehensive knowledge of data documentation and information storage/management best practices
- Working knowledge of industry's ethical requirements and GLP (where necessary) for data handling and storage

3.5.7 Managing Quality in R&D

Implements and monitors the standard quality management processes to ensure that all R&D activities are conducted according to required standards and create reproducible results in the tests performed, the data generated, the results reported, and the products and technologies created.

Competency in this role is demonstrated when the individual:

- Ensures the implementation of a quality control plan and SOPs that incorporate best practices for all R&D processes and activities.
- Keeps adequately detailed records of all experimental procedures, data, and data analysis.
- Ensures staff compliance with record-keeping procedures.
- Ensures that appropriate and timely corrective action is taken when made aware of noncompliant R&D practices.
- Ensures that any deviance or proposed changes to R&D procedures comply with required quality control standards.
- Ensures R&D procedures are developed with operational/practical constraints in mind.
- Ensures staff adhere to the guidelines of the organization’s quality management system (QMS) and regulated quality standards.
- Contributes to the development of formal training and SOPs for the handling of all tools, materials, and resources used and waste products generated during R&D activities.

Knowledge required for competency at this level:

- Intermediate knowledge of relevant quality standards
- Intermediate knowledge of QMSs and best practices
- Intermediate knowledge of quality assurance tools such as flowcharts, check sheets, deviation reports, root cause analysis, Pareto diagrams, cause and effect diagrams, histograms, scatter diagrams, and control charts
- Working knowledge of organizational data integrity processes (e.g., lab notebooking, data storage formats and locations, etc.)
- Working knowledge of AI, machine/deep learning, and data science
- Working knowledge of relevant ISO standards for QMSs, e.g., ISO 13485

3.5.8 Conducting a Feasibility Study

Conducts a feasibility study—including a thorough literature review, an analysis of market, technical and economic viability, environmental, safety and permitting considerations, and performance of preliminary experiments if required—in order to minimize the likelihood of error, manage costs, and determine the probability of success of commercialization of a research venture before scaling-up to a pilot plant.

Competency in this role is demonstrated when the individual:

- Leads/guides the development of a plan for the feasibility study, including identification of the areas to be investigated, the tasks involved, and the projected timelines and budget for the study.
- Directs/conducts a literature review on market demand and potential problems, successes, and costs of other scale-up efforts in related ventures.
- Works with an interdisciplinary team, including stakeholders, to envision and articulate the parameters and objectives of a full-scale commercial operation.
- Weighs scientifically viable alternatives and their potential risks in order to determine the most viable approach for the translation, application, and scale-up of the research venture.
- Works with an interdisciplinary team to conduct an in-depth economic analysis of the commercialization process, including key factors such as time from lab scale to full production, capital construction expenditures, operating costs, anticipated turnover numbers, cost to production ratio, return on investment, etc.
- Identifies process byproducts and adverse environmental impacts, as well as effective means of handling and disposing of byproducts and of mitigating adverse environmental impacts.
- Assists in ascertaining which environmental, safety, and other regulatory permits will be required, the likelihood of obtaining them, and how long the permitting process will take.
- Investigates the availability and sustainability of the supply chain for raw materials.
- Works with an interdisciplinary team to conduct a comprehensive analysis and synthesis of the feasibility study in order to report on the projected feasibility of commercializing the research venture.

Knowledge required for competency at this level:

- Working understanding of the commercial applications and goals of the laboratory or organization's R&D program
- Working understanding of interdisciplinary sciences
- Working understanding of the process for translating R&D to commercial products
- Working understanding of analytical tools such as R, Six Sigma, Aspen, etc.
- Working knowledge of regulatory and permitting factors
- Working understanding of the principles and factors of life cycle assessment (LCA)

3.5.9 Engineering Modeling & Design for Commercialization

Uses working knowledge and experience in biotechnology and industrial microbiology, engineering principles, and an iterative-experimental design approach to develop and operate a lab model and to develop and examine a pilot scale simulation of a full production plant based on the results generated from the bench scale trials for the purpose of transferring the research to commercial scale. Also anticipates reactions, identifies and optimizes key engineering parameters and crucial operational factors, and predicts the cost of full production during the simulation.

Competency in this role is demonstrated when the individual:

- Leads the design of the overall lab scale system configuration with detailed technical documentation of the process including schematics, diagrams, layouts and specifications.
- Develops the lab scale model with identified configuration and parameters to investigate, test and prove the best techniques to use in the pilot scale trial, using solid models as applicable.
- Conducts experiments to investigate operating ranges for raw materials, operating conditions, tools, instruments and processes to identify those that meet product specifications and provide maximum tolerance.
- Presents the results of the lab scale investigations to gauge interest and support for proceeding to a feasibility study on pilot and commercial scale-up.
- Develops or contributes to the scale-up plan for the pilot model, including objectives of the trial, pilot plant design parameters, and testing and evaluation protocols, using solid models as applicable.
- Contributes to the optimization of the production process by monitoring the pilot plant operations, analyzing test and cost data, modifying/redesigning as required.

- Conducts an ongoing risk assessment and problem identification process, implementing viable solutions to barriers as they arise in the scale-up operations and returning to the underpinning science as required.
- In collaboration with others, implements effective means of managing process by-products and mitigating adverse environmental impacts throughout pilot operations.
- Participates in the ongoing and final evaluation of the pilot project.
- Works interactively to provide scientific/technical advice to the engineering and operational teams during full scale-up and ongoing commercial operations.

Knowledge required for competency at this level:

- Comprehensive understanding of the bio-mass process being scaled-up
- Working understanding of the commercial applications and goals of the laboratory or organization's R&D program
- Working understanding of interdisciplinary sciences
- Comprehensive understanding of the process for translating R&D to commercial products
- Working understanding of the principles and factors of life cycle assessment (LCA)
- Working proficiency with analytical, design and modeling software such as R, Six Sigma, MS Visio, Aspen Plus, etc.
- Working understanding of biomass components and biomass conversion processes
- Comprehensive knowledge of testing methods and instrumentation related to analysis of biomass
- Working understanding of the interdependencies between the functionality of new and emerging materials/devices and their associated manufacturing technologies

3.5.10 Digital Skills for R&D

Makes effective use of the Internet and computer software in order to identify existing scientific activity relevant to the area of study, investigate the depth and breadth of that research, record and maintain data, develop and disseminate reports and presentations, and drive R&D and process digitalization with the use of modern approaches to data science, etc.

Competency in this role is demonstrated when the individual:

- Develops strategies to manipulate web databases in order to gather information in the most effective way and identify data gaps.

- Uses Microsoft Excel or an equivalent spreadsheet/database software to organize and analyze data for inclusion in records, reports, and filings.
- Uses Microsoft Office or an equivalent organizational software to keep experiments/data trackable and accessible for all users.
- Uses specialized data analysis software as appropriate to project needs, e.g., Design of Experiments (DOE), Spotfire, GraphPad Prism, R Statistical Software, etc.
- Successfully navigates existing and emerging technologies and electronic tools required for tracking and reporting R&D projects and budgets such as SAP for budget and Microsoft Excel, Provantis, and SigmaPlot for reporting.
- Uses the Internet to file complex technical documents and reports such as electronic documents to government regulators.

Knowledge required for competency at this level:

- Comprehensive knowledge and skill in the application of the Microsoft Office Suite and Google Analytics
- Comprehensive knowledge and skill in the use of the Internet and scientific data bases for targeted research
- Working knowledge of software applications used within the organization such as ERP, eQMS, and CRM and their compliance requirements
- Working knowledge of project management tools
- Working knowledge in AI, machine/deep learning, data science, and other relevant technical domains

3.5.11 Knowledge Transfer

Shares and disseminates technical or scientific knowledge, experience, and ideas from one individual or source to other individuals, groups, or organizations for purposes such as building others' knowledge, training them in a new process, ensuring reproducibility in the event of absence, creating efficiencies, preserving corporate memory, and providing a foundation for scientific collaboration and development.

Competency in this role is demonstrated when the individual:

- Assists in implementing a formal "succession of knowledge" plan to transfer knowledge within the team, incorporating techniques such as mentoring, job shadowing, guided experience, cooperative learning, and documentation.
- Documents scientific and technical advances within own work to preserve corporate memory and lay a foundation for further R&D, if applicable.

- Documents the evolutionary history of processes and procedures, problems encountered, and solutions implemented in order to facilitate future troubleshooting, if applicable.
- Delivers scientific presentations to the R&D team that inform them of studies, advances, and new regulatory requirements that may optimize the team's R&D projects and processes.
- Shares insights regarding issues and adverse events encountered in R&D in order to help the organization avoid or reduce the impact of such issues and barriers on their R&D program.
- Shares insights regarding successes and discoveries encountered in R&D in order to help the organization's R&D program continue to grow and perpetuate effective strategies.
- Delivers presentations to other departments (e.g., Quality Assurance/Control, Operations, Production, etc.) detailing the results and potential implementation of R&D discoveries/processes at larger scales.

Knowledge required for competency at this level:

- Intermediate understanding of effective secondary R&D techniques
- Intermediate understanding of adult learning techniques such as coaching and mentoring
- Comprehensive knowledge of technical and scientific document structure
- Working understanding of how to communicate complex scientific ideas and results together with their impact on the project/organization in clear, plain language

3.5.12 Professional Writing for R&D

Develops and publishes scientific papers in refereed journals or scientific reports and other technical documents internally in order to chronicle and advance the body of R&D knowledge. Also creates project reports to ensure that all relevant R&D information is tracked and available to stakeholders as required and to demonstrate compliance with all regulatory requirements.

Competency in this role is demonstrated when the individual:

- Develops synopses of scientific papers, documents, and/or reports to provide base knowledge and guidance for R&D projects.
- Uses clear, plain language to provide a written interpretation of complex technical information for the understanding of a non-technical audience.
- Prepares scientific reports in accordance with professional standards to chronicle R&D processes and findings and to demonstrate compliance with all regulatory requirements.

- Explains the impact of scientific results on project and organizational goals.

Knowledge required for competency at this level:

- Fluency in English or French language and grammar, as applicable
- Comprehensive knowledge of technical and scientific document structure
- Working understanding of how to communicate complex scientific ideas and results together with their impact on the project/organization in clear, plain language
- Awareness of language in the documentation that may impact staffing, political, and financial resources

3.6 Industry regulatory competencies list for Senior Research Scientist Engineer in Bio-industrial, Bio-energy

3.6.1 Legal/Regulatory Compliance in R&D

Manages R&D documents, data, tools, resources, waste products, processes, and procedures in accordance with relevant safety, security, environmental, and ethical protocols—including intellectual property protection—in order to ensure legal protection and compliance with regulatory and funding requirements.

Competency in this role is demonstrated when the individual:

- Ensures compliance with applicable employment standards for all contracted R&D staff.
- Implements best practices and regulatory compliance within the R&D project.
- Instructs staff on regulatory requirements and guidelines relevant to R&D activities.
- Ensures utilization of established paper and electronic documentation methods or systems.
- Ensures all appropriate legal documentation such as NDA forms are signed and collected from relevant stakeholders and staff.

Knowledge required for competency at this level:

- Working knowledge of the organization’s SOPs and regulatory framework

- Working knowledge of all regulatory requirements relative to the organization's operations from sources such as Environment Canada, the Province, etc. and other regulations, as required
- Working knowledge of systems and processes for documentation of experiment and testing procedures and results
- Working knowledge of relevant employment standards

3.6.2 Occupational Health & Safety in R&D

Actively participates in/manages the health and safety program for R&D staff and their workplace in order to ensure the health and safety of staff. Also ensures the organization's compliance with legislation and regulations related to safe work practices and procedures, corporate procedures, and facility health, safety, and environmental rules.

Competency in this role is demonstrated when the individual:

- Audits all aspects of R&D projects to ensure compliance with applicable health and safety requirements.
- Ensures health and safety standards and practices are up to date.
- Enforces staff compliance with safety requirements and guidelines in R&D activities.
- Ensures all staff, students, and volunteers have received all course-based and on-the-job health and safety training required to work safely in the laboratory and/or field environment prior to starting their work.
- Identifies additional/ongoing health and safety training and equipment requirements.
- Ensures that hazards are evaluated and mitigated in a timely manner where required.
- Leads/participates in safety audits and incident investigations, as required.
- Continually monitors corporate policy and current safety guidance to facilitate compliance.
- Ensures all adverse safety incidents and accidents occurring during the project are documented and that the team learns from them.

Knowledge required for competency at this level:

- Intermediate understanding of WHMIS and Workplace Health & Safety, as applicable
- Intermediate understanding of the organization's Occupational Health & Safety (OHS) framework and corporate HR policies
- Intermediate knowledge of safe work procedures (de-energize, lockout, guarding, etc.) and the use of proper personal protective equipment
- Intermediate knowledge of required and available Health and Safety professional development courses

3.7 Personal and professional competencies list for Senior Research Scientist Engineer in Bio-industrial, Bio-energy

3.7.1 Continuous Learning

Continuously undertakes introspection to understand current knowledge and skills in a changing environment, recognizes personal knowledge gaps, undertakes independent action to actively seek targeted opportunities to acquire new knowledge, and reflects on how new knowledge can be integrated and applied.

Competency in this role is demonstrated when the individual:

- Applies feedback and self-reflection to identify knowledge gaps and development opportunities.
- Attends scientific symposia and conferences in order to address technical knowledge gaps and stay abreast of current theories and advances in the field of R&D.
- Actively pursues opportunities in order to develop and sharpen personal and professional skills and competencies.
- Dialogues with research experts and industry leaders in order to become informed of trends and future directions in R&D practices and policies.
- Masters the latest technology trends, integrating relevant advances and best practices into own R&D work.

Knowledge required for competency at this level:

- Working knowledge of current adult learning principles, processes, and techniques that accelerate learning
- Working knowledge of training resources that can be utilized for personal and professional development
- Working understanding of personal learning style

3.7.2 Critical Thinking/Decision-Making in R&D

Analyzes, synthesizes, and evaluates arguments, information, and data, and exercises sound judgement to solve problems and make timely decisions that strategically benefit the laboratory/organization's R&D activities and strategy.

Competency in this role is demonstrated when the individual:

- Engages in scientific discussions with peers through journal clubs, online forums, conference meetings, debates, etc. to hone critical thinking skills and evaluate scientific developments.
- Seeks opinions from scientists with different areas of expertise in order to explore other perspectives on new scientific concepts.
- Seeks opinions and validation of the practicality of the research/development solution in light of the organization's objectives.
- Uses experience and logic to evaluate and refine creative options and solutions.
- Explores new scientific technologies and approaches to determine their applicability considering competitive products and technological advances.
- Recommends a course of action based on an analysis of preliminary and incomplete information when action must be taken immediately.
- Uses creative processes such as mind mapping, brainstorming, and visualization to generate options.
- Uses creativity and imagination to view issues from a new perspective and create revolutionary breakthroughs.
- Contributes to the synthesis of information from multiple sources to formulate entirely new ideas and products.
- Utilizes the power of chance happenings to create new products such as the development of penicillin from mold and the invention of Post-it Notes.

Knowledge required for competency at this level:

- Working understanding of problem-solving frameworks and techniques
- Working understanding of root cause analysis tools such as the Ishikawa diagram or the 5 Whys method
- Working understanding of systems thinking approaches
- Working understanding of the organization and its relationship to the larger economic and political environment

3.7.3 Effective Interpersonal Communication

Communicates in ways that create shared understanding, generate support for the achievement of goals and objectives, and facilitate conflict resolution and problem-solving.

Competency in this role is demonstrated when the individual:

- Delivers multi-mode communications that convey a clear understanding appropriate to the target audience and context, e.g., using plain language to communicate technical research details to a non-technical audience.
- Uses persuasive language to ethically advocate for R&D program/project goals and objectives while allowing others room to share their opinions.
- Invites participative decision-making where appropriate, encouraging input from staff.
- Uses discretion and integrity to resolve conflict with a resistant audience in a manner that maintains a positive working relationship.
- Provides regular project updates in meetings with funders or other stakeholders.
- Makes scientific presentations at advisory boards, key scientific meetings, and external committee meetings.
- Develops strategies to appropriately communicate non-confidential and confidential information.

Knowledge required for competency at this level:

- Working knowledge of communication and conflict management models (e.g., DISC)
- Working knowledge of change management resources to affect staff culture (e.g., Kotter's 8-Step Change Model)
- Working understanding of how to communicate complex scientific ideas and results together with their impact on the project/organization in clear, plain language

3.7.4 Professionalism/Emotional & Cultural Intelligence

Applies emotional and professional sensitivity to become aware of own emotions and those of others they interact with in such a way that they can manage personal and professional decorum to cope with challenging situations, enhance performance, and maintain productive relationships within a diverse, globalized working world.

Competency in this role is demonstrated when the individual:

- Consistently models ethical conduct such as discretion, personal integrity, and respect for diversity in order to foster cooperation and collaboration with colleagues (self awareness).
- Exercises initiative and drive to proactively address emerging organizational, regulatory, and technological concerns (self management/regulation).
- Demonstrates resilience by remaining tenacious and committed to goals even in the face of opposition and ambiguity (self management/regulation).

- Implements positive personal stress management techniques to effectively deal with stress (self management/regulation).
- Works cooperatively with multiple stakeholders, demonstrating tact, diplomacy, and a willingness to consider alternative approaches or ideas that achieve results within ethical guidelines (relationship management).
- Navigates effectively through personal and political agendas to avoid or overcome barriers to the organization's progress (social awareness).

Knowledge required for competency at this level:

- Working understanding of the principles of emotional and social intelligence (see the work of authors like Daniel Goleman and Travis Bradberry)
- Working understanding of motivational theories

3.8 Essential Skills for Senior Research Scientist/Engineer (Bio-industrial/Bio-energy)

Essential Skills (ES) are foundational skills required for all types of work. They are not technical skills, but the core skills people need to acquire knowledge and complete workplace tasks and daily activities.

Understanding the ES requirements for a role can allow individuals to compare their skills to those required, assist training/learning providers in developing appropriate supports to ensure ES levels are developed during training, and provide employers with an additional tool for determining who/how to place in particular roles.

Human Resources and Skills Development Canada has defined Essential Skills as follows:

- Reading
- Document Use
- Numeracy, which is further divided into:
  - Money math; Scheduling, budgeting, and accounting math; Measurement and calculation math; Data analysis math.
  - Several different factors related to estimations, including the presence of a set procedure, the number of items being estimated, the consequences of errors in estimation, the amount of information missing, and the accuracy required.
- Writing
- Oral Communication
- Thinking Skills, which are further divided into:

  - Problem Solving
  - Decision Making
  - Critical Thinking
  - Job Task Planning and Organizing
  - Finding Information
  - Significant Use of Memory
- Digital Skills
- Working with Others
- Continuous Learning

Most of the ES have levels based on complexity, and a role can be analyzed to determine the appropriate levels of ES. The exceptions are noted below:

- "Working with Others" does not have a complexity rating: it simply describes the ways in which the role would be required to interact with other people, either internally within the organization or externally (i.e., with clients, customers, or the public).
- "Continuous Learning" does not have a complexity rating: it describes the types of learning expected in the context of the role (e.g., on the job, being mentored by others, formal training as part of the job, etc.).

NOTE: as of January 2020, ESDC was undertaking a comprehensive review of ES with the intent of adding additional skills, refining existing ones (particularly digital skills) and better aligning ES with similar approaches used in other countries. However the detail was not finalized in time to be used, therefore the profiles developed for this project follow existing standards as of December 2019.

3.9 Canadian Language Benchmark for Senior Research Scientist Engineer (Bio-industrial, Bio-energy)

Canadian Language Benchmarks (CLB) are a 12-point scale for task-based language proficiency descriptors which were originally developed as a guide for measuring the teaching and assessment of English as a Second Language (ESL) learners in Canada. Since they were originally developed, the Canadian Centre for Language Benchmarks (CCLB) has continued to refine CLB, and it now includes scales for both English and French language proficiency. [1]

The CLB has been validated against both the Common European Framework for Language (CEFL) and the American Council for the Teaching of Foreign Languages (ACTFL) benchmarks and is considered accurate for high-stakes evaluation[2].

The ES levels for Oral Communication were developed with reference to the Canadian Language Benchmarks[3]. Comparative work to determine the alignment between the CLB and other Essential Skills has been ongoing, with recent work providing additional alignment with the ES for Oral Communication in both spoken and listening domains, Reading, Writing, and Document Use.[4]

CCLB has developed a set of crossover tables that align CLB ratings with ES ratings for reading, writing oral communication and document use.

Senior Research Scientist/Engineer (Bio-industrial/Bio-energy) ES/CLB Profile

Essential Skills	Equivalent CLB Level	ES Level				
Reading	Reading: 11–12	1	2	3	4	5
Document Use	Reading: 11–12 Writing: 11–12	1	2	3	4	5
Writing	Writing: 9	1	2	3	4	5

[1] Centre for Canadian Language Benchmarks. Theoretical Framework for The Canadian Language Benchmarks And *Niveaux De Compétence Linguistique Canadiens.* CCLB. Ottawa 2015. p8
[2] Centre for Canadian Language Benchmarks. Canadian Language Benchmarks: English as a Second Language for Adults, CCLB. Ottawa 2012 p.II
[3] Essential Skills Research Group. Readers Guide to the Essential Skills. ESDC. Ottawa ND. p57
[4] Canadian Centre for Language Benchmarks. Relating Canadian Language Benchmarks to Essential Skills: A Comparative Framework. 2015, p3

Essential Skills	Equivalent CLB Level	ES Level				
Oral Expression	Speaking: 11–12 Listening: 11–12	1	2	3	4	
Numeracy	n/a	1	2	3	4	5
Thinking Skills – Problem Solving	n/a	1	2	3	4	
Thinking Skills – Decision Making	n/a	1	2	3	4	
Thinking Skills – Job/Task Planning and Organizing	n/a	1	2	3	4	
Thinking Skills – Significant Use of Memory	n/a	Types 1,2,3				
Thinking Skills – Finding Information	n/a	1	2	3	4	
Digital Skills	n/a	1	2	3	4	5
Working with Others	n/a	See Below				
Continuous Learning	n/a	See Below				

Explanation of the Essential Skills and the Canadian Language Benchmark for Senior Research Scientist/Engineer (Bio-industrial/Bio-energy)

Reading: ES 5 CLB: 11–12

Senior Research Scientists/Engineers read and interpret a wide variety of dense and complex technical and scientific documentation, including studying scientific research papers and articles in peer-reviewed journals, conducting systematic literature reviews to identify potential areas of focus for the organization's R&D program, and interpreting the significance and relevance of complex scientific research data.

Document Use: ES 5 CLB: Reading: 11–12, Writing: 11–12

Senior Research Scientists/Engineers access and interpret information from a wide variety of digital and paper-based sources and use the information gathered to make inferences and draw conclusions within their area of scientific specialization. The information they interpret may be textual, graphical, and/or numerical in nature, and they must synthesize and summarize information to inform their own research, as well as to inform decisions by others in the organization.

Writing: ES 4 CLB: 9

Senior Research Scientists/Engineers compose and publish scientific research reports in peer-reviewed science journals and also create a variety of technical documents including research project reports, summaries of research (their own and others), and documentation of experiments. They may also contribute to writing funding proposals for research projects from both internal and external (government, foundation) sources, and document the results of R&D efforts so that financial personnel can claim government subsidies and incentives (SRED, etc.) for tax purposes.

Oral Expression: ES 4 CLB: Speaking: 11–12, Listening: 11–12

Senior Research Scientists/Engineers work within an interdisciplinary team and must be adept at communicating complex technical and scientific information to a wide variety of audiences both inside and outside their organization. They contribute to peer forums, provide information to inform the decisions of senior managers and other stakeholders, instruct junior personnel in techniques and technologies, and solicit feedback from research project staff and stakeholders. Additionally, they make scientific presentations at advisory boards, regulatory bodies, and other external stakeholders. They instruct others on research techniques and protocols and may be called upon to communicate the details of scientific and technical research non-technical audiences.

Numeracy: ES 4 (Money Math: n/a, Scheduling, Budgeting, and Accounting: 3, Measurements & Calculation: n/a, Data Analysis: 4)

Senior Research Scientists/Engineers are responsible for formulating and tracking budgets for research grants, as well as tracking project expenditures for ongoing projects. In the course of their research they will conduct complex calculations with a wide array of dependent and independent variables. In many cases they will analyze data to predict future results in a climate of uncertainty, where the consequences of mistakes can be dire.

Thinking Skills:

Thinking skills are subdivided into five domains:

- Thinking Skills — Problem Solving
- Thinking Skills — Decision Making
- Thinking Skills — Job/Task Planning and Organizing
- Thinking Skills — Finding Information
- Thinking Skills — Significant Use of Memory

- **Thinking Skills — Problem Solving: ES 4**

Senior Research Scientists/Engineers solve complex, multi-variate problems in the course of their work. They deal with problems of a scientific and technical nature, where the interactions of variables may be unknown or unpredictable, and they must develop a process for solving these problems in order to optimize the outcomes.

- **Thinking Skills — Decision Making: ES 4**

Senior Research Scientists/Engineers analyze, synthesize, and evaluate arguments, information, and data and must exercise sound judgement in deciding between alternative courses of action. The decisions they make can have significant and severe consequences for their organization, and the decisions are difficult or impossible to reverse

- **Thinking Skills — Job/Task Planning and Organizing: ES 4**

Senior Research Scientists/Engineers must plan their own work, taking into account the availability of shared resources and the potential scheduling conflicts with others. They have wide discretion over the what and how of their work, and are expected to manage their time to meet specific milestones in a project schedule. They work within an interdisciplinary team to execute research projects that will impact the future of their organization.

- **Thinking Skills — Finding Information: ES 4**

Senior Research Scientists/Engineers collect, analyze, and interpret data from a wide array of multidisciplinary scientific and technical resources in the course of their work. Information must be collected and synthesized in order to be used in their research.

- Thinking Skills — Significant Use of Memory: Types 1, 2, 3

Senior Research Scientists/Engineers must memorize, retain, and use information through one or all of the following methods:

- Purposeful memorization of procedures, codes, parts numbers, memorization through repetition (Type 1)
- Remembering information for brief periods, e.g., minutes or hours (Type 2)
- Unique events in which learning occurs from exposure (Type 3)

Digital Skills: ES 4

Senior Research Scientists/Engineers utilize standard office productivity software tools (Word processing, spreadsheets, presentations, etc.), electronic communication tools (email, text, instant messaging, video conferencing, etc.), and a variety of data retrieval and analysis tools and technologies in the performance of their duties. They may use specialized data analysis and statistical software and other specialized digital tools to design, conduct, and analyze their research.

Working with Others: Work Contexts 2, 3 & 4

Senior Research Scientists/Engineers liaise between key project groups such as laboratory staff, informatics researchers, sales and marketing, manufacturing, and collaborators to enable and facilitate the efficient flow of data and resources. They also continuously coordinate with internal colleagues, clients, suppliers, investors, regulators, etc. to effectively achieve goals and responsibilities. They train others on scientific techniques and management of students/research technicians, so they are required to have working understanding of effective team facilitation skills with an ability to foster trust and cooperation in the achievement of the R&D project's goals and objectives. The following work context and functions are relevant to the Senior Research Scientist/Engineer role:

- Works independently (Work Context 2)
- Works jointly with a partner or helper (Work Context 3)
- Work as a member of a team (Work Context 4)

They are also involved in supervisory or leadership activities, as follows: Functions 1–6 & 9–11

Senior Research Scientists/Engineers make sure the staff are sufficiently trained in policies/procedures related to ethics and conduct, and recruit and manage a qualified workforce in order to ensure the organization's R&D program and projects are properly staffed,

and that the team is managed in a way that fosters not only compliance to requirements and protocols, but also high performance, strong morale, and a high retention rate. They also hold self and staff accountable to the organization's values, ensuring compliance with the policies and procedures related to scientific ethics and rules of conduct.

- Participate in formal discussions about work processes or product improvement (S/L Function 1)
- Have opportunities to make suggestions on improving work processes (S/L Function 2)
- Monitor work performance of others (S/L Function 3)
- Inform other workers or demonstrate to them how tasks are to be performed (S/L Function 4)
- Orient new employees (S/L Function 5)
- Make hiring recommendations (S/L Function 6)
- Assign routine and new tasks to others (S/L Function 9 & 10)
- Identify training that is required by or would be useful for other workers (S/L Function 11)

Continuous Learning: Types of Learning 1, 2, 3 How Learning Occurs: 1, 2, 3, 4, 5, 6

Senior Research Scientists/Engineers are required to continuously learn in order to remain current in the constantly evolving scientific world. They must recognize personal knowledge gaps and undertake independent action to close them through acquiring and applying new knowledge.

Type of learning may include:

- Training in job-related health and safety (Type 1)
- Obtaining and updating credentials (Type 2)
- Learning about new equipment, procedures, products, and services (Type 3)

The learning may occur:

- As part of regular work activity (Context 1)
- From coworkers (Context 2)
- Through training offered in the workplace (Context 3)
- Through other forms of self-study (Context 4):
    - At work
    - On worker's own time

    - Using materials available through work
    - Using materials obtained through a professional association or union
    - Using materials obtained through worker's own initiative
- Through offsite training (Context 5):
    - During working hours at no cost to the workers
    - Partially subsidized
- With costs paid by the worker (Context 6)

4 REFERENCES

Gathering the data

The development of the National Occupational Standards started with a review of existing information for the role. This review process included: referencing books, job postings, websites, articles, and BioTalent Canada's existing skills profiles to create the first draft. After several iterations via written feedback, focus groups and a national survey with subject matter experts, the National Standards were developed. The following are sources consulted during the creation of the Senior Research Scientist/Engineer in Bio-industrial/Bio-energy profile:

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