SOCMA’s Chemical & Process Operator Training Program (CPOT) was created in the late 1990s in response to industry needs. Since then it has been used in specialty chemical companies both large and small, either as a stand-alone educational tool or to complement company-specific training.

SOCMA’s CPOT prepares plant operators to work in chemical production facilities with a focus on batch processing operations. CPOT provides new operators with an understanding of the fundamentals required to conduct their jobs safely, effectively and in compliance with regulatory standards and industry risk management guidelines. It provides them with an understanding of basic physical and chemical hazard identification approaches and risk management concepts. If your facility is required to be in compliance with the OSHA Process Safety Management (PSM) Standard, the CPOT is a practical tool.

These Standards for Chemical & Process Operator Training are organized around five key activity areas critical to plant operations. “Work Standards” refer to competencies that students should be able to successfully master on the job. “Worker Standards” refer to those skills, proficiencies, and abilities to apply the knowledge learned:

- Basic Scientific Concepts for Chemical Operators
- Chemical Enterprise Risk Management
- Chemical Process Technology—Key Unit Operations / Equipment & Control Systems
- Chemical Plant Economics

SOCMA’s CPOT is an important training tool to help educate new workers wishing to pursue a career in a chemical or other process plant environment. It is a critical component in any formalized training curricula that wishes to offer more specialized training as a complement to basic manufacturing skills building.
SOCMA WORK STANDARDS

BASIC SCIENTIFIC CONCEPTS FOR CHEMICAL OPERATORS

Key Activities and Performance Indicators

1. Train workers in basic concepts of mathematics
   a. Prepare and accurately calculate batch sizes
   b. Determine proper amounts of chemicals needed to adjust batch formulations
   c. Regularly calculate production volumes and production schedules so as to minimize waste

2. Train workers in basic concepts of chemistry
   a. Understand the chemistry governing the mixing of compounds and/or reaction process of a product
   b. Pre-plan various chemical formulations and reactions to produce desired final product
   c. Safely perform chemical operations using appropriate caution and handling

3. Train workers in basic concepts of energy conversion
   a. Utilize different forms of energy to aid the production process
   b. Deploy proper equipment to provide necessary level of power for production activity
   c. Identify ways to optimize energy use during production process

4. Train workers in basic concepts of fluid flow
   a. Identify proper lubricating oil to use on certain equipment as needed
   b. Identify battery fluid levels and ensure batteries are adequately charged
   c. Identify pipe leaks and avoid damage by performing hydrostatic tests

5. Train workers in basic concepts of pressure and measurements
   a. Understand ways to measure pressure using various devices in a plant
   b. Identify ways to manipulate the units of pressure in the production process
   c. Properly control pressure levels to avoid damage to equipment

6. Train workers in basic concepts of temperature and heat
   a. Recognize temperature effects on process pipes
   b. Resolve temperature-related incidents quickly and properly
   c. Recognize and control properly heat transfer processes in plant operations

7. Train workers in properties of vapor and liquids
   a. Implement necessary precautions into standard operations when working with vapor, liquid and a mixture of the two
   b. Avoid damages to valve disc and pipe support due to water hammer occurrence
   c. Properly and safety handle liquid system isolation to avoid damage due to change in temperature
   d. Properly and safely handle vapor equipment to avoid vacuum breaker malfunction
8. Train workers on how to perform in-process testing
   a. Ability to set up and test chemicals by using gas chromatograph
   b. Ability to perform titrations
   c. Ability to run solids test
   d. Ability to run viscosity test
   e. Ability to run inhibitor test
   f. Ability to run color test
SOCMA WORKER STANDARDS

BASIC SCIENTIFIC CONCEPTS FOR CHEMICAL OPERATORS

Basic Technical Knowledge and Skills

1. Basic Mathematics
   a. Skill in performing basic calculations using fractions and percentages
   b. Skill in calculating volume and weight percentages
   c. Knowledge of density and specific gravity
   d. Knowledge in calculating material balance

2. Basic Chemistry
   a. Knowledge of composition of matter (atoms, elements)
   b. Understanding the concept of valence
   c. Knowledge of molecules and compounds
   d. Knowledge of radicals
   e. Understanding and balancing of chemical equations
   f. Ability to calculate amounts of reactants required for a chemical reaction
   g. Knowledge of units of measurement and concentration
   h. Knowledge of different types of solutions
   i. Knowledge of acids, bases, and salts
   j. Understanding and skill in measuring pH levels
   k. Knowledge of hydrocarbons, structures and names

3. Energy Conversion
   a. Skill in recognizing different types and forms of energy in production process
   b. Understanding velocity and kinetic energy
   c. Understanding the concept of conversion of potential energy into kinetic energy
   d. Ability to calculate units of work required for production
   e. Ability to determine units of horsepower required for production
   f. Ability to calculate how much electrical power is needed and produced in a process

4. Properties of Fluids
   a. Understanding concepts of weight, density, specific volume, specific gravity, viscosity and their application to plant operations
   b. Understanding the effect of temperature on fluid properties
   c. Understanding fluid flow concepts of pressure, flow and flow rate

5. Pressure
   a. Understanding the concept and measurement of pressure and application to plant operations
   b. Understanding the concept of force in relation to pressure
   c. Knowledge of various measuring devices for pressure in plant operations
   d. Understanding Boyle’s Law
6. Temperature & Heat
   a. Understanding the effects of temperature changes and application to plant operations
   b. Knowledge of various temperature scales and absolute temperature
   c. Understanding temperature pressure relationships for gases (Gay-Lussac gas law)
   d. Understanding thermal energy
   e. Understanding heat transfer processes found in a plant (convection, conduction, and radiation)
   f. Understanding endothermic and exothermic reactions

7. Vapor & Liquid Properties
   a. Understanding effects of pressure and temperature on liquids
   b. Skill in measurement of specific volume for liquids
   c. Understanding effects of temperature and pressure on vapor
   d. Skill in properly utilizing equipment for vapor condensation
   e. Understanding different types of water hammer and knowledge of precautionary methods
   f. Knowledge of chemical flash point, boiling point and melting point
SOCMA WORK STANDARDS

CHEMICAL ENTERPRISE RISK MANAGEMENT

Key Activities and Performance Indicators

1. Train workers in basic risk concepts and risk management practices to ensure compliance and avoid or minimize losses
   a. Properly identify and understand inherent hazards of chemical substances in use across all unit operations
   b. Instill a sense of vulnerability against chemical and physical hazards that drives workers to always follow appropriate safety, operating and maintenance procedures and use specified protective measures and equipment to conduct operations
   c. Investigate near miss and any release of hazardous substances from loss of containment events to identify both immediate and root causes
   d. Maintain a strong focus on controls to prevent any loss of containment events involving hazardous substances

2. Implement OSHA Occupational Safety and Health requirements
   a. Assess and determine applicable regulations and specific requirements for worker protection
   b. Evaluate all operations according to regulatory requirements
   c. Develop and execute completely a well thought out, prioritized action plan
   d. Create and update as necessary all permits, written programs and procedures
   e. Take predetermined and definite actions such as training, evaluation of equipment, new systems and/or documentation of activities
   f. Conduct self-audits and inspections to assess progress and determine if further actions are needed

3. Implement OSHA Process Safety Management requirements
   a. Establish procedures and systems for hazardous material processes
   b. Optimize plant productivity and product quality
   c. Prevent loss of containment incidents
   d. Achieve and document all regulatory compliance
   e. Maximize involvement of plant workforce training in PSM requirements
   f. Review and maintain process safety information for specific chemicals and processes; ensure it is easily available to all employees
   g. Conduct a process hazard analysis in five year intervals or more frequently as required based on changes
   h. Maintain standard operating procedures for all phases of operations and maintenance activities
   i. Assist in training/certifying all operations and maintenance personnel in process safety information and standard operating procedures in accordance with plant criteria
   j. Schedule and execute on time all compliance activities
   k. Review maintenance practices to maximize mechanical integrity
   l. Assist in review of any changes to processes
   m. Investigate all incidents, document findings and assign/implement corrective action
   n. Conduct routine drills test an established Emergency Response Plan
   o. Perform audits regularly, and address findings in a timely manner

4. Implement EPA Risk Management Program
   a. Register plant as a source of a regulated substance
   b. Assist in completion of Hazard Assessment
c. Assist in development and implementation a Prevention Program
d. Assist in development of an Emergency Response Plan
e. Assist in development and submission of a Risk Management Plan (RMP)
f. Update RMP as needed and re-submit regularly
g. Record all compliance and maintain for five years
h. Assist in regular audits as performed by appropriate agency

5. Implement Environmental Protection Programs
   a. Identify applicable regulations and ensure necessary permits are in place and current
   b. Ensure equipment and management system controls are in place and in compliance with environmental regulations
   c. Assist in training plant operations and maintenance personnel to ensure they are knowledgeable of environmental compliance requirements
d. Schedule all compliance assurance activities and execute on time
e. Review maintenance practices to maximize mechanical integrity for environmental protection equipment and systems
f. Assist in review of all changes to processes to ensure that environmental compliance and performance is not compromised

6. Implement continuous improvement in EHS&S practices
   a. Communicate any concerns about environmental, health, safety and security programs as needed
   b. Promote the concept of product stewardship throughout a product’s lifecycle
c. Prioritize environmental, health, safety and security considerations in planning and operations for all new and existing products and processes
d. Assist in training employees to be held accountable for their specific environmental, health, safety and security responsibilities
e. Identify opportunities for optimizing resource efficiency and waste reduction
f. Assist in additional training, including but not limited to RCRA (hazardous/toxic waste management), first aid/CPR, GHS (global harmonization system), chemical hygiene and SCBA
SOCMA WORKER STANDARDS

CHEMICAL ENTERPRISE RISK MANAGEMENT

Basic Technical Knowledge and Skills

1. Basic Risk Concepts and Risk Management Practices

   a. Understanding the difference between a hazard and the risk of harm (to people onsite and offsite, the environment and production plant/property) from the hazard
   b. Knowledge of the different types of hazards and risks faced by a chemical enterprise and what they will typically be required to do to help manage the risks
   c. Understanding the differences between occupational safety and health programs and process safety which focuses on preventing and mitigating loss of containment events
   d. Understanding why it is necessary to implement multiple layers of protection (also known as barriers or safeguards) to prevent loss of containment events and to mitigate their consequences
   e. Knowledge of why safeguards or barriers are vulnerable, the hierarchy of barrier selection in terms of reliability, and numerous examples of chemical process industry accidents demonstrating how and why protective layers or barriers fail
   f. Ability to recognize from warning signs and labels the inherent hazardous properties of chemicals—flammability and combustibility (of flammable gases, flammable and combustible liquids and solids, including combustible dust hazards), chemical reactivity, toxicity and asphyxiation, materials attack, and ionizing radiation hazards,
   g. Knowledge of techniques used in chemical production facilities to identify hazards and estimate or predict consequences of releases of different types of chemicals including the potential impacts from explosions (overpressure effects, shrapnel effects, thermal radiation effects), fires, and toxic chemical releases, etc.
   h. Knowledge of how a risk matrix can be used to help make decisions for controls in process safety, occupational safety and environmental protection
   i. Knowledge of commonly used safeguards in chemical enterprises to control chemical hazards with many of them required under codes and standards
   j. Understanding that all accidents are preventable and the need to identify root causes as well as immediate causes for incidents
   k. Understanding a variety of safe handling practices for different types of hazardous substances and the necessity for personal protective equipment should a release occur

2. Implement OSHA Occupational Safety and Health requirements

   a. Knowledge of applicable regulations and specific requirements for worker protection related to different types of chemical hazards
   b. Understanding of key occupational hazards in different types of chemical production operations and the reasons for work permits and other key types of occupational safety and health

3. Implement OSHA Process Safety Management (PSM) requirements

   a. Knowledge of the key elements of a process safety management system as specified in the OSHA standards
   b. Understanding of roles and responsibilities of operators to assure compliance with OSHA PSM standard including ongoing identification and evaluation of hazards, and adherence to procedures
   c. Knowledge of possible top level loss of containment events and the safeguards in place to prevent and mitigate such an event
4. **Implement EPA Risk Management Program**  
a. Knowledge of hazardous chemical threshold levels and the need for onsite and offsite consequence analyses  
b. Understanding of what types of process safety safeguards can help prevent and mitigate a release  
c. Understanding of an operator’s roles and responsibilities to help prevent a release  
d. Understanding of an operator’s roles and responsibilities to help mitigate the consequences of a release  

5. **Implement Environmental Protection Programs**  
a. Knowledge of environmental regulations and types of permits and permit conditions required for chemical plant operations  
b. Understanding of typical equipment and management system controls required for compliance with environmental regulations and permits  
c. Understanding of an operator’s roles and responsibilities to help prevent a release / non-compliance event  
d. Understanding of an operator’s roles and responsibilities to help mitigate the consequences of a release  

6. **Implement continuous improvement in EHS&S practices**  
a. Understanding of the importance of complying with all applicable EHS&S requirements to the success of the business and to all stakeholders including the neighboring community  
b. Knowledge of metrics that can be used to measure how well the site and individuals work areas to improve their overall EHS&S performance  
c. Understanding how an operator can help drive continuous improvement through EHS&S management programs such as SOCMA’s ChemStewards
SOCMA WORK STANDARDS

CHEMICAL PROCESS TECHNOLOGY:
KEY UNIT OPERATIONS / EQUIPMENT & CONTROL SYSTEMS

Key Activities and Performance Indicators

1. Determine process flow and unit operations
   a. Determine the proper sequence of unit operations
   b. Document heat and material balances, used in operator training and available to employees, in accordance with OSHA’s PSM standard
   c. Works to ensure production costs are in line with estimates
   d. Works to ensure chemical processes are practical and effective

2. Determine heat and material balance
   a. Determines the amount of finished product for shipping use
   b. Calculates the expected yield to measure performance
   c. Defines the amount and type of utilities (steam, cooling water) required
   d. Works diligently to avoid potential problems from improper mixing of materials, misapplied utilities
   e. Accurately defines critical operating zone for the process (upper, lower temperature, pressures, mix ratios)
   f. Recognizes and calculates process losses

3. Follow specified system operation procedures
   a. Follows a standard operating procedure (SOP)
   b. Adheres to a recipe card/batch sheet for all batch operations for each particular product
   c. Follows all plant practices for safe and efficient operations
   d. Identifies dangerous and costly conditions and takes action to safely and effectively correct them before they lead to more serious problems
   e. Recognizes what chemicals are present in a production process and what hazards are associated with them

4. Perform, monitor and document phases of operation procedures
   a. Ensures start-up requirements are complete before starting a new batch or continuous operation
   b. Checks all items/equipment specified by SOP before and during production process
   c. Ensures process control data is in proper range so that the manufacturing process is meeting product specifications
   d. Ensures manufacturing process cycle time meets customer and business needs
   e. Ensures product meets customer specifications
   f. Ensures production operations comply fully with all health, safety, and environmental policies and practices
   g. Ensures chemical reaction is properly and safely terminated and products and by-products are properly discharged
   h. Checks and cleans equipment and ensures it is prepared for next process according to SOP procedure
5. **Perform basic equipment maintenance**
   a. Maintains proper production levels and product quality/consistency
   b. Takes steps to reduce chances of safety, health and environmental problems
   c. Reports all problems with equipment to appropriate personnel in a timely fashion
   d. Maintains mechanical integrity
   e. Identifies proper type of pipe for specific purposes
   f. Adds hoses to plant piping systems when necessary
   g. Operates valves properly to start, stop or regulate flow
   h. Operates valves properly to prevent backflow and/or relieve pressure for a liquid or gas through a piping system
   i. Operates centrifugal and positive-displacement pumps properly
   j. Identifies warning symptoms and corrects to prevent system failure
   k. Refers to plant drawings/diagrams to define role of equipment in plant processes
   l. Properly connects utilities to equipment for various uses in production process
   m. Utilizes reactor auxiliary equipment properly to support production process

6. **Monitor control systems**
   a. Oversees chemical manufacturing process so it is performed in a safe, efficient and environmentally sound manner
   b. Measures and controls all process variables (temperature, flow, pressure level, etc.) to within specifications
   c. Performs all in-process testing to ensure product is within specification
   d. Ensures final product meets customer’s specifications
SOCMA WORKER STANDARDS

CHEMICAL PROCESS TECHNOLOGY:
KEY UNIT OPERATIONS / EQUIPMENT & CONTROL SYSTEMS

Basic Technical Knowledge and Skills

1. Process flow and unit operations
   a. Knowledge of common unit operations for the chemical industry
   b. Skill in interpreting unit operations in a production sequence
   c. Understanding the concept of heat and material balances
   d. Skill in calculating and documenting heat and material balances
   e. Skill in making job assignments and coordinating workflow
   f. Skill in knowing that the appropriate resources are available to meet customer specifications
   g. Skill in ensuring that set-up and operation procedures are available and up-to-date
   h. Skill in correctly reading and interpreting a production schedule and manufacturing work order
   i. Knowledge of production process, including flow and bottlenecks
   j. Knowledge of lead-time required for a production plan
   k. Skill in correctly reading and interpreting bills of materials and routing sheets
   l. Knowledge of methods of productivity measurement and improvement
   m. Knowledge of ways to perform a physical inventory

2. Reactor system and operations
   a. Knowledge of equipment and its function in a chemical reactor system
   b. Knowledge of common types of chemical reactions that occur in a reactor during a production process
   c. Knowledge of ways to control chemical reactions in a production process (heating, cooling, feed rate adjustment, catalyst or inhibitor addition, agitation, pressurization, solvent addition)
   d. Knowledge of reactor types, features and operations
   e. Knowledge of reactor design considerations (pressure, heat transfer, material, agitation)
   f. Knowledge of common structural forms for reactors
   g. Ability to recognize dangerous conditions in system operations and to safely and effectively deal with them
   h. Knowledge of the four major phases of a reactor system operation (start-up, shutdown, normal operation and operator maintenance) for batch and continuous operations

3. Plant Equipment
   a. Knowledge of basic types of processing equipment for all operations (piping, valves, pumps and tanks)
   b. Knowledge of common measurements that are used in classifying pipe for various purposes
   c. Knowledge of commonly used techniques of connecting pipes
   d. Knowledge of pressure ratings that affect hoses
   e. Knowledge of when hoses are necessary additions to piping systems
   f. Knowledge of different types of valves (PRV’s, SRV’s, etc.), their parts and function
   g. Knowledge of function of rapture discs
   h. Knowledge of centrifugal and positive-displacement pumps and their function
   i. Knowledge of pump inspection steps
   j. Ability to recognize problematic symptoms and troubleshoot pumps
   k. Ability to safely handle pump failures and prevent damage
l. Knowledge of various types of tanks in chemical plants and their function
m. Skill in interpreting piping and instrumentation diagrams

4. Utilities
   a. Knowledge of uses and characteristics of instrument air
   b. Knowledge of uses and characteristics of service plant air
   c. Understanding various water treatment methods
   d. Knowledge of various uses of water in plant operations
   e. Knowledge of inert gas blanketing/sparging
   f. Knowledge of various uses and characteristics of steam

5. Reactor auxiliary equipment
   a. Knowledge of raw material handling equipment and uses
   b. Knowledge of heat exchangers and uses
   c. Knowledge of separation equipment and uses

6. Control Systems
   a. Knowledge of factors and components in closed loop operations
   b. Knowledge of factors and components in open loop operations
   c. Knowledge of various materials used in production
   d. Knowledge of machinery operation, set up and testing
   e. Knowledge of lubricants and coolants
   f. Skill in setting up, programming, and operating the computerized control process
   g. Knowledge of equipment capabilities to maximize productivity
   h. Skill in making machine adjustments
SOCMA WORK STANDARDS

CHEMICAL PLANT ECONOMICS

Key Activities and Performance Indicators

1. Plant Economics
   a. Identifies plant-wide income and cost elements
   b. Identifies product specific fixed and variable costs accurately
   c. Prior to start-up, computes volume variances per product run.
   d. Understands that any changes in raw material or utility costs must be figured into price variance.
   e. Understands that deviations in input consumption are figured into resource utilization.

2. Cost Management
   a. Works effectively and efficiently across all departments in managing costs.
   b. Avoids excessive usage of raw materials by reviewing all in-plant procedures, recommending ways to improve specific steps in a process.
   c. Works with quality control to identify ways to improve and sustain product quality.
   d. Proactively addresses integrity of all utility systems; knows equipment and how to operate; identifies and repairs leaks on a continuing basis.
   e. Applies due diligence and preventative maintenance across all plant operations.
   f. Utilizes in-house maintenance/inventory information systems and offers recommendations on how to enhance usability.
   g. Has working familiarity with concepts of lean manufacturing/six sigma; makes recommendations on how to develop and streamline procedures.
SOCMA WORKER STANDARDS

CHEMICAL PLANT ECONOMICS

Basic Technical Knowledge and Skills

1. Introduction to Plant Economics
   a. Knowledge of the components of cost, income, net profit and loss
   b. Knowledge of fixed and variable costs
   c. Understanding the concept of volume cost variance and its dependence on variable costs
   d. Understanding the concept of price variance and its dependence on input costs
   e. Understanding the concept of resource utilization and its dependence on volume of inputs used

2. Cost Management
   a. Understanding the roles different departments play in managing costs
   b. Understanding how Operations plays a direct role in utilizing raw materials to avoid excessive usage, spills and leaks, poor yields, and bad quality of finished product.
   c. Knowledge of how to efficiently manage costs of utilities
   d. Knowledge of how to efficiently manage maintenance costs and maintenance information systems
   e. Understanding the concepts of productivity and lean manufacturing