



## Framework for the National Soil Fumigation Manual and Exam Item Bank

National Association of State Departments of Agriculture Research Foundation,  
developed under a Cooperative Agreement with US EPA (X8-83456201)

March 26, 2012

### Definitions:

- **Responsibility** – an item for which one is accountable and has control over, such as one's decision-making and actions related to handling fumigants
- **Knowledge** – information that must be possessed in order to responsibly handle and apply fumigants
- **Skill** – acquired proficiency that must be developed in order to effectively and safely use fumigants
- **Learning Objective** – description of what the learner is expected to achieve as a result of instruction, such as reading the manual.

Purpose: This framework document characterizes the important responsibilities of an entry-level soil fumigant applicator in sufficient detail for state certification (licensure) purposes. It is separated into Chapter sections from the Soil Fumigation Manual. Each chapter of the manual (Column 1) has its noted responsibilities (Column 2) and relevant knowledge and skills statements (Column 3) that describe what information the applicator must possess and the skills in which they must be proficient. Column 4 details the learning objectives that were included in the Soil Fumigation Manual to ensure the entry-level applicator has sufficient information to prepare for the state certification exam.

Background: For the development of the national soil fumigation manual and corresponding exam questions, a list of responsibilities with supporting knowledge and skill requirements and corresponding learning objectives was constructed. They were ultimately ordered to align with the manual chapters for ease of reference. For each responsibility, learning objectives are listed that are covered in the national Soil Fumigation Manual. The author of the exam item bank and the review team used the learning objectives to ensure the manual and exam items are well-correlated.

In summer 2011, a committee of subject matter experts, safety educators, and state lead agency certification managers ranked the

required knowledge and skills statements to assign an appropriate percentage of the soil fumigation certification exam assigned to each responsibility and how the exams was to be weighted among the knowledge and skills items. The exam items focus proportionately on the learning objectives, which are all covered in the national manual. A blueprint is available to state lead agency certification and training managers along with the exam item bank.

Material covered in the National Pesticide Applicator Certification Core Manual ([www.nasda.org](http://www.nasda.org) under Programs & Services) is not repeated in this framework or in the manual. Also space, burrow, and commodity fumigation are not covered since the basic fumigation principles and label language are significantly different. Limited information about pest identification and biology was considered necessary since the manual focuses on an application method and chemical characteristics, not on pest identification and pest management decision-making.

This document is divided into 12 sections, which are the same as the chapters in the Soil Fumigation Manual. A low-resolution version of the manual can be viewed at <http://ctaginfo.org>.

1. Overview of Soil Fumigants and Soil Fumigation
2. General Label and Regulatory Requirements
3. Soil Fumigant Chemical Characteristics
4. Soil and Pest Factors that Influence Fumigant Activity
5. Personal Protective Equipment and Respirators
6. Protecting People
7. Site Assessment and Weather
8. Fumigant Management Plans and Post-Application Summaries
9. Buffer Zones and Posting Requirements
10. Application Methods and Soil Sealing
11. Calculations and Calibration
12. Transportation, Storage, Disposal, Spill Response, and Emergency Response Plan

Chapter 1	Responsibilities	Knowledge/Skills	Learning Objectives
<b>Overview of Soil Fumigants and Soil Fumigation</b>	1. Understand what soil fumigants are and their benefits and function in crop, nursery, and greenhouse production.	a. Familiarity with the need for soil fumigants.	(1) Explain the benefits of soil fumigants.
			(2) Explain why fumigants are used.
	2. Understand the concept of and function of volatilization with soil fumigants and how fumigants move in air, soil voids, and water.	a. Knowledge of the principle of volatilization.	(1) Describe the general process of how soil fumigants change from a liquid or solid to a gas.
			(2) Describe the general process of gaseous movement in the soil and into the atmosphere.
	3. Understand dermal, ocular, mucus membranes and inhalation concerns for human exposure.	a. Familiarity with routes of entry and human exposure concerns.	(1) Describe the signs and symptoms of human exposure to fumigants
	4. Understand how certified applicators and fumigant handlers can be/have been exposed to fumigants and the significant risks to them.	a. Knowledge of exposure concerns for applicators and handlers during/after fumigations.	(1) Describe how fumigant exposure can occur for certified applicators, fumigant handlers, field workers, and bystanders.
		b. Familiarity with case studies that describe causative or contributable factors resulting in applicator and handler exposures.	<i>Repeat of above</i>
	5. Understand how bystanders and field workers can be/have been exposed to fumigants and the significant risks to them.	a. Knowledge of exposure concerns for bystanders and field workers during/after nearby fumigations.	<i>Repeat of above</i>
		b. Familiarity with case studies that describe causative or contributable factors resulting in field worker and bystander exposures during/after nearby fumigations.	<i>Repeat of above</i>
	6. Understand how requirements on the label serve to protect applicators, handlers, bystanders, and field workers from exposure during and after an application.	a. Knowledge of how hazard and exposure risk assessment findings translate into requirements on labels.	(1) Explain the common problems and mistakes that can result in direct exposure to fumigants.
			(2) Explain the importance of reading, understanding, and following fumigant labels.

Chapter 2	Responsibilities	Knowledge/Skills	Learning Objectives
<b>General Label and Regulatory Requirements</b>	1. Understand that all soil fumigants are restricted-use pesticides.	a. Knowledge of laws, rules, and definitions relating to restricted-use pesticides.	(1) State who may purchase and use a restricted-use pesticide (RUP).
	2. Know label requirements for training.	a. Knowledge of label requirements for training: applicator-in-charge and handlers.	(1) Describe the requirements for label-specified training for the certified applicator in-charge.
			(2) Define fumigant handlers, list their tasks, and explain the safety information that certified applicators are required to provide to fumigant handlers.
	3. Know the difference between "direct" supervision by state rules compared to label required "on-site" supervision of handlers who are non-certified applicators.	a. Knowledge of non-certified applicator supervision terms as referenced by state laws or the label.	(1) Define the label term on-site supervision of non-certified applicators.
	4. Follow field entry-restricted period noted on the label or in state law.	a. Knowledge of where to find field entry-restricted requirements on labels.	(1) Define the label term entry-restricted period and interpret entry-restricted period on a label for different tarped and untarped field application scenarios.
	5. Be familiar with state laws and rules that govern chemigation.	a. Knowledge of state laws and rules relating to chemigation.	(1) Define water-run and non-water-run application methods.
	6. Follow the fumigant's good agricultural practices (GAPs).	a. Knowledge of fumigant-specific good agricultural practices and how to implement them.	(1) List some good agricultural practices (GAPs) that may be found on fumigant labels.
7. Keep accurate fumigant application records as prescribed by state law/rule or USDA (for private applicators).	a. Knowledge of state or USDA recordkeeping requirements as they pertain to fumigants.	(1) List recordkeeping requirements for soil fumigant applications.	

Chapter 3	Responsibilities	Knowledge/Skills	Learning Objectives
<b>Soil Fumigant Chemical Characteristics</b>	1. Know characteristics of each soil fumigant active ingredient.	a. Knowledge of soil fumigant characteristics for each active ingredient.	(1) Describe the chemical characteristics of each fumigant.
		b. Knowledge of active ingredient-specific human exposure concerns, sensory sensitivity (irritation) and characteristic symptoms.	(1) Describe the specific human exposure concerns for each fumigant.
	2. Know about warning agents used in some product formulations.	a. Knowledge about the function of warning agents.	(1) Explain the purpose of chloropicrin in methyl bromide and methyl iodide formulations.
	3. Know the basic pest groups (e.g., fungi, nematodes, insects, weeds) controlled by specific fumigants.	a. Knowledge of pest groups to determine which fumigant will be most effective.	(1) Name the major groups of pests controlled by each soil fumigant.
	4. Be familiar with the proper application methods and equipment in applying fumigants.	a. Knowledge of the various application methods and which one is best for each fumigant.	(1) List the application methods commonly used for each fumigant.
		b. Knowledge of the fumigant's dispersal properties after being applied.	(1) Describe how far the fumigant disperses from the application zone.
		c. Knowledge of compatibility issues between the equipment components and the fumigant chemical properties.	(1) List compatibility concerns for tanks, hoses, tubing, and other equipment.
	5. Know that different fumigant products have different risk mitigation measures.	a. Knowledge of the label differences between 1,3-D sole active ingredient products and 1,3-D products containing chloropicrin.	(1) Explain why 1,3-D products have different label requirements than most other fumigants.

Chapter 4:	Responsibilities	Knowledge/Skills	Learning Objectives
<b>Soil and Pest Factors that Influence Fumigant Activity</b>	1. Check the condition at the site of application.	a. Knowledge of soil and pest factors that affect fumigant selection, rate, depth, and timing.	(1) List the factors that influence gaseous movement through the soil profile and into the air.
	2. Be familiar with the soil factors that impact fumigant volatilization.	a. Knowledge of soil characteristics and how they affect fumigation.	(1) Describe the influence of important soil factors on fumigant volatility and movement within the soil profile.
			(2) Describe how soil characteristics affect the success of a fumigation operation.
			(3) Describe how to assess soil moisture.
			(4) Describe ways to correct for soil characteristics that might hinder a successful fumigation.
	3. Be familiar with the pest factors that impact fumigant activity and effectiveness.	a. Knowledge of the characteristics of the target pests and how they affect fumigation.	(1) Explain the importance of knowing which pest is causing the damage.
			(2) Explain the importance of application depth in the soil.
			(3) Explain the importance of application timing.
			(4) Explain the relationship between pest density and application rate.

Chapter 5:	Responsibilities	Knowledge/Skills	Learning Objectives
<b>Personal Protective Equipment and Respirators</b>	1. Choose and use appropriate Personal Protective Equipment (PPE).	a. Knowledge of PPE selection, inspection, proper use, removal, decontamination, and disposal.	(1) Interpret label instructions for required personal protective equipment (PPE). (2) Explain the importance of and proper procedures for selection, inspection, use, care and cleaning, replacement, and disposal of PPE.
		b. Knowledge of the proper use of respiratory protection.	(1) Describe the responsibilities of the certified applicator supervising handlers and fumigant handlers that wear respirators.
			(2) Describe types of respirators that are required and appropriate when handling specific soil fumigants.
			(3) Explain the need for medical evaluation prior to respirator use.
			(4) Explain the importance of handler training on proper respirator use.
			(5) Explain the importance of fit-testing and fit-checking respirators.
			(6) Describe a cartridge change-out and disposal schedule.
			(7) List the factors that affect a cartridge's useful life.
		c. Knowledge of label requirements and state laws/rules for respiratory protection requirements.	(1) Explain the details of product labeling and laws regarding medical evaluation for respirator use, fit-tests and fit checks, training, and recordkeeping.

Chapter 6	Responsibilities	Knowledge/Skills	Learning Objectives
<b>Protecting People</b>	1. Recognize actionable maximum contaminant (trigger) levels that may occur during and/or after the application.	a. Knowledge of label-stated threshold limits for work cessation and continuance.	(1) Explain when air concentrations of a fumigant might trigger handlers to wear respirators or leave the work area entirely Explain where on a label to find this information.
			(2) Interpret labels to determine the number of people and respirators required on site.
			(3) Describe the steps a fumigant handler should take if they experience sensory irritation.
			(4) Explain the purpose of trigger levels, and find them on the fumigant label.
	2. Monitor fumigant levels at the application site and along the buffer perimeter.	a. Knowledge about air monitoring and how to conduct it.	(1) Describe what air monitoring is, when it is required, and where samples are taken.
		b. Skill in using monitoring devices to check fumigant levels in air.	(1) Describe the relative sensitivity of air monitoring devices, including detector tubes and Photo Ionization (PID) devices.
	3. Know the conditions that require emergency preparedness and response measures.	a. Knowledge of emergency preparedness and response measures.	(1) Describe emergency preparedness/response requirements for neighbor notification or buffer zone monitoring.
		b. Knowledge of the criteria and procedures for monitoring off-gassing at buffer perimeter.	(1) Outline procedures for buffer zone monitoring. (2) Describe the situation that initiates an emergency response plan.
	4. Know first aid procedures for dealing with fumigant exposures.	a. Knowledge of first aid measures for fumigant exposure.	(1) Outline the first aid measures for fumigant exposure.

<b>Chapter 7</b>	<b>Responsibilities</b>	<b>Knowledge/Skills</b>	<b>Learning Objectives</b>
<b>Site Assessment and Weather</b>	1. Conducting site assessments	a. Knowledge of the factors used for evaluating site suitability and in determining the existence of sensitive areas.	(1) Identify site characteristics that should prevent fumigant exposure.
	2. Understand the importance of weather forecasting and monitoring prior to and during the application.	a. Know the weather factors that influence off-target concerns during and after a soil fumigation.	(1) Define and describe a temperature inversion.
			(2) Explain the requirements for forecasting air stability.
			(3) Identify sources of weather information.
	b. Knowledge of label requirements that may prevent a soil fumigation.	(4) Explain the influences of air stability, air temperature, humidity, and wind currents.	
		(1) Find and interpret label statements limiting applications during specific weather conditions.	
<b>Chapter 8</b>	<b>Tasks</b>	<b>Knowledge/Skills</b>	<b>Learning Objectives</b>
<b>Fumigant Management Plans and Post-Application Summaries</b>	1. Develop a Fumigant Management Plan (FMP).	a. Knowledge of and skill at writing a Fumigant Management Plan (FMP).	(1) Describe the elements of an FMP and resources available for its preparation.
			(2) Specify when an FMP must be in place, how long it must be kept on file, who must receive and keep a copy, where it must be kept during the application, and who must have access to it.
			(3) Identify who is responsible for verifying that an FMP is accurate.
	2. Prepare a Postapplication Summary (PAS).	a. Knowledge of and how to prepare a postapplication summary (PAS) for a Fumigant Management Plan (FMP).	(1) Describe the purpose and content of a PAS and who must prepare it.
(2) Identify when the PAS must be completed.			

Chapter 9	Tasks	Knowledge/Skills	Learning Objectives
<b>Buffer Zones and Posting Requirements</b>	1. Determine the size and duration of buffer zones.	a. Know the purpose of buffer zones and their duration.	(1) Explain the purpose of buffer zones and define the buffer zone period. (2) Identify who may and may not be in a buffer zone during the buffer zone period.
		b. Apply reasoning in determining size of buffer zones as specified on labels.	(1) Interpret a buffer zone table from the label to determine the size of a buffer zone. (2) List the factors that determine the buffer zone credits for a specific scenario.
			(3) Calculate the required buffer zone using those credits.
			(4) Outline the steps to secure permission for buffer zones that include structures or extend onto neighboring land.
	2. Post warning signs.	a. Knowledge of the difference in warning signs that may need to be posted at the treated site.	(1) Explain how buffer zone posting and treated area posting differ. (2) Explain warning sign placement and what type(s) of sign and wording to use.
			(3) Explain the preapplication and postapplication posting timeframes for buffer zones and treated areas.
			(1) Identify a difficult-to-evacuate site and explain label restrictions for these sites.
	3. Recognize difficult-to-evacuate sites.	a. Knowledge of the exceptions to buffer requirements.	(1) Identify a difficult-to-evacuate site and explain label restrictions for these sites.

Chapter 10	Tasks	Knowledge/Skills	Learning Objectives
<b>Application Methods and Soil Sealing</b>	1. Choose the proper equipment based on whether the application is being non-water run or water run.	a. Knowledge of the different types of fumigant application equipment.	(1) Describe the application equipment and methods used to apply fumigants.
			(2) Describe backflow prevention devices and (e.g., check valves) how they work.
	2. Fumigate greenhouse soil and potting mixes.	a. Knowledge of techniques for fumigating greenhouse soil and potting mixes.	(1) Outline the procedures for fumigation greenhouse and nursery soil and potting mixes.
	3. Make an application.	a. Knowledge of proper application techniques.	(1) Outline a pre-application inspection of the application equipment.
			(2) Describe a step-by-step process for changing fumigant cylinders.
	4. Seal soil.	a. Knowledge of soil sealing techniques and their characteristics for soil sealing.	(1) State the purpose and methods of soil sealing.
			(2) Discuss the factors that help determine which soil sealing method to use.
		b. Knowledge of the use of tarpaulins and their characteristics for soil sealing.	1) Describe the general range of tarps available.
			(2) Explain how to seal tarps.
	5. Remove tarps.	a. Knowledge of tarp removal techniques and precautions.	(1) Describe the legal time and restrictions for tarp removal and perforation.

Chapter 11	Tasks	Knowledge/Skills	Learning Objectives
<b>Calculations and Calibration</b>	1. Calculate or measure area to be fumigated.	a. Skills in basic math to perform calculations for determining treatment area.	(1) Calculate the area of a rectangle, circle, triangle, and an irregularly-shaped site.
			(2) Calculate the circumference of a circle and the revolution time of a center pivot.
	2. Calibrate equipment.	a. Skills in math to calculate amount of product needed to treat an area.	(1) Calculate the amount of product required for a specific treatment area.
			(2) Calculate the row acre application rates for bedded or strip applications.
(3) Calculate the broadcast equivalent rate for bedded or strip applications.			
	b. Knowledge of calibration techniques/requirements for the types of fumigation equipment.	(1) Outline basic techniques for calibrating soil fumigation application equipment.	
Chapter 12	Responsibilities	Knowledge/Skills	Learning Objectives
<b>Transportation, Storage, Disposal, Spill Response, and Emergency Response Plans</b>	1. Safe transport, storage, and disposal of fumigants.	a. Knowledge of safe and legal handling methods for transport, storage, spill cleanup, and disposal of fumigants.	(1) Describe and interpret label requirements for transportation, storage, spill cleanup, and emergency response for soil fumigants.
			(2) Explain how to safely dispose of fumigant containers and contaminated soil.
			(3) Describe how to manage empty containers.
	2. Be familiar with Material Safety Data Sheets (MSDS) and <i>Emergency Response Guidebook</i> .	a. Knowledge of MSDS provisions.	(1) Explain what information is found on a MSDS and how to locate it.
b. Knowledge of appropriate sections in the <i>Emergency Response Guidebook</i> .			(1) Locate spill response information and procedures for specific products in the <i>Emergency Response Guidebook</i> .