



## Framework for a National Soil Fumigation Manual and Exam Question Item Bank

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### 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. Each responsibility noted below in column two is supported in column three by knowledge and skills statements that describe what information the applicator must possess and the skills in which they must be proficient. The last column details the learning objectives that must be included in any instructional material (i.e., study manual) to ensure the entry-level applicator has sufficient information to prepare for the state certification exam.

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. For each responsibility, learning objectives are listed that must be covered in the national

soil fumigation study manual. The learning objectives guide the development of national and/or state study manuals and certification exams.

In spring 2011, a committee will rank the required knowledge and skills statements, then assign an appropriate percentage of the soil fumigation certification exam assigned to each responsibility and how the exams should be weighted among the knowledge and skills items. Ultimately exam questions will focus proportionately on the learning objectives, which are all covered in the national manual. This set of learning objectives should be modified regionally or by a state to develop their own study manual and certification exam.

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

This document is divided into five broad subject matter units:

- A. Benefits and Risks of Soil Fumigants
- B. Basic Soil Fumigant Characteristics
- C. Federal and State Laws
- D. Pre-application Considerations
- E. Application and Soil Sealing Principles

<b>Subject Unit</b>	<b>Responsibilities</b>	<b>Knowledge / Skills</b>	<b>Learning Objectives</b>
Collection of related topics	An item for which a certified applicator is accountable and has control over, as in one's actions or the discharge of a duty or trust, also known as Duties or Tasks	Information or acquired proficiency that must be learned or developed in order for a certified applicator to responsibly handle and apply fumigants	Measurable description of what the learner is expected to achieve as a result of instruction, i.e., reading the manual

<b>Unit A</b>	<b>Responsibilities</b>	<b>Knowledge/Skills</b>	<b>Learning Objectives</b>
<b>Overview of the Benefits and Risks of Soil Fumigants</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 what necessitates their use.
	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 process of soil fumigants changing from a liquid or solid state to gas.  (2) Describe the factors that influence gaseous movement in the soil and in 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 effects of fumigants on human skin, eyes, mucous membranes, and respiration.  (2) Describe signs and symptoms of human exposure.
	4. Understand how applicators and 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 exposure can occur for those involved in using soil fumigants and removing tarpaulins.
		b. Familiarity with case studies that describe causative or contributable factors resulting in applicator and handler exposures.	<i>Addressed in A.4.a.(1)</i>

	<p>5. Understand how bystanders and field workers can be/have been exposed to fumigants and the significant risks to them.</p>	<p>a. Knowledge of exposure concerns for bystanders and field workers during/after nearby fumigations.</p>	<p>(1) Describe how exposure can occur for field workers and for people near areas that are undergoing soil fumigation or were recently fumigated.</p>
		<p>b. Familiarity with case studies that describe causative or contributable factors resulting in field worker and bystander exposures during/after nearby fumigations.</p>	<p><i>Addressed in A.5.a.(1)</i></p>
	<p>6. Understand how requirements on the label serve to protect applicators, handlers, bystanders, and field workers from exposure during and after an application.</p>	<p>a. Knowledge of how hazard and exposure risk assessment findings translate into requirements on labels.</p>	<p>(1) Explain the common problems and mistakes that can result in direct exposure; <i>Addressed in A.4.a.(1) and A.5.a.(1)</i></p> <p>(2) Describe specific concerns that were translated into protective requirements on labels regarding:</p> <ul style="list-style-type: none"> <li>(a) Restricted-use pesticide</li> <li>(b) On-site supervision (as compared to FIFRA or state definition for "Direct Supervision"</li> <li>(c) Personal protective equipment</li> <li>(d) Lower application rates</li> <li>(e) Buffer zones</li> <li>(f) Buffer posting</li> <li>(g) Limit on number of applications per area</li> <li>(h) Reentry notification/posting</li> <li>(i) Monitoring</li> <li>(j) Emergency response plans</li> <li>(k) Fumigant management plans</li> </ul> <p>(3) Explain the importance of reading, understanding, and following fumigant labels and labeling.</p> <p>(4) Describe how and why emergency preparedness and response are important to human protection.</p>

Unit B	Responsibilities	Knowledge/Skills	Learning Objectives
<b>Basic Soil Fumigant 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 for each fumigant: (a) Methyl bromide (b) Chloropicrin (c) 1,3-dichloropropene (Telone) (d) Metam sodium and metam potassium (e) Dazomet (f) Dimethyl disulfide (DSMS) (g) Iodomethane (methyl iodide)  (2) Explain how vapor pressure affects the volatility of each soil fumigant.
		b. Knowledge of active ingredient-specific human exposure concerns, sensory sensitivity (irritation) and characteristic symptoms.	(1) Describe specific human exposure concerns, sensory sensitivity (irritation) and characteristic symptoms, <i>beyond the concerns noted in A.3.a.(1)</i> . (a) odor (b) irritation (biomarker or bioindicators)
	2. Know the 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 IoMe 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 (i.e., fungi, nematodes, insects, weeds, seeds) controlled by each soil fumigant, <i>Note: details on identification and biology of pests are not to be included, though some specific pests can be named as examples.</i>  (2) Describe the site conditions and application methods that favor control of soil pest groups.

	4. Know the factors for each active ingredient that influence its requirements for application.	a. Knowledge of fumigant characteristics that influence application method, depth, rate, and timing.	<p>(1) Name the factors that influence application method, such as target pest group, fumigant volatility, soil temperature, soil moisture, soil sealing method.</p> <p>(2) Explain the importance of soil application depth in relation to the major targeted pest groups.</p> <p>(3) Explain the importance of application timing in relation to pest groups.</p> <p>(4) Explain the relationship between pest density and application rate.</p>
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Unit C	Responsibilities	Knowledge/Skills	Learning Objectives
<b>Federal and State Regulations</b>	1. Understand that all soil fumigants are restricted-use pesticides.	a. Knowledge of laws, rules, and definitions relating to restricted-use pesticides.	<p>(1) State the legal definition of a restricted use pesticide.</p> <p>(2) Explain who may purchase and apply restricted-use pesticides.</p>
	<p>2. Know state laws and rules regarding certification of private and commercial applicators* who purchase, apply, or supervise the application of soil fumigants.</p> <p>* states vary in how they define "FIFRA commercial applicators"</p>	a. Knowledge of state laws and rules relating to applicator certification.	(1) Describe the certification and recertification requirements <i>[in your state]</i> an applicator has to meet to purchase, apply, or supervise the application of soil fumigants.

	3. Know label requirements for training.	a. Knowledge of label requirements for training: applicator-in-charge and handlers.	<p>(1) With respect to label-specified retraining requirements for the certified applicator, tell:</p> <ul style="list-style-type: none"> <li>(a) Who provides it and tracks it</li> <li>(b) What, if any, alternatives are approved <i>[in your state]</i></li> <li>(c) How frequently an applicator-in-charge must get retrained</li> <li>(d) What training allows them to do</li> </ul> <p>(2) With respect to label-specified retraining requirements for the handlers, tell:</p> <ul style="list-style-type: none"> <li>(a) Who provides it and tracks it</li> <li>(b) How frequently handlers must get retrained</li> <li>(c) What training allows them to do</li> </ul>
	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.	<p>(1) Define the label term “on-site supervision” of non-certified applicators.</p> <p>(2) Explain how “on-site supervision” differs from FIFRA or state rule definitions for “direct supervision” of non-certified applicators.</p>
	4. Be familiar with other state laws and rules that govern transportation, storage, application, spill clean up or disposal of soil fumigants.	a. Knowledge of state laws and rules regarding transport, storage, application, spill clean up or disposal of soil fumigants.	<p>(1) Describe the laws and rules <i>[in your state]</i>, unless covered in your <i>Core manual</i>, such as:</p> <ul style="list-style-type: none"> <li>(a) Secondary containment</li> <li>(b) Chemigation</li> <li>(c) Hazardous materials transport</li> <li>(d) Spill reporting and clean up</li> <li>(e) Disposal</li> </ul>
	5. Read the label and labeling documents.	a. Skill at reading and understanding fumigant labeling.	(1) Interpret label directions for safe and legal transport, storage, application, disposal and emergency procedures.
	6. Be familiar with Material Safety Data Sheets and Hazardous Materials Handbook.	a. Knowledge of MSDS provisions.	(1) Locate information on product MSDS.
		b. Knowledge of appropriate sections in the Hazardous Materials Handbook	(1) Locate spill response information and procedures for specific products in the Hazardous Materials Handbook.
	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 <i>[your state's or USDA's]</i> recordkeeping requirements for soil fumigant applications. <i>No need to repeat requirements covered in your Core manual.</i>

	8. Know federal and state Worker Protection Standard (WPS) regulations and how they relate to fumigation.	a. Knowledge of WPS requirements for pesticide applications in general.	<i>Covered in Core manual, no need to repeat; if not adequately covered in your Core manual, add to this manual.</i>
		b. Knowledge of specific WPS requirements for soil fumigation.	(1) For any soil fumigant application, list handler activities and tasks.

<b>Unit D</b>	<b>Responsibilities</b>	<b>Knowledge/Skills</b>	<b>Learning Objectives</b>
<b>Protect Applicators, Handlers and Bystanders</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, including label requirements.	<p>(1) <i>For requirements beyond those covered in the Core Manual, list precautions that are specific to transporting soil fumigants.</i></p> <p>(2) <i>For requirements beyond those covered in the Core Manual, list precautions that are specific to storing fumigant containers.</i></p> <p>(3) <i>For requirements beyond those covered in the Core Manual, list precautions that are specific to fumigant spills.</i></p> <p>(4) Describe how to dispose of fumigant containers, contaminated soil, and manage leftover product.</p>
	2. Choose and use appropriate Personal Protective Equipment (PPE).	a. Knowledge of PPE selection and proper use, removal, decontamination, care, inspection, and disposal.	<p>(1) Interpret label instructions for proper PPE selection.</p> <p>(2) With respect to PPE, explain the importance of and proper procedures for:</p> <ul style="list-style-type: none"> <li>(a) selection</li> <li>(b) inspection</li> <li>(c) use</li> <li>(d) care and cleaning</li> <li>(e) replacement</li> <li>(f) disposal</li> </ul>

		<p>b. Knowledge of proper use of respiratory protection.</p>	<p>(1) Express that a medical evaluation is required.</p> <p>(2) Specify which types of respirators are appropriate or inappropriate when handling fumigants.</p> <p>(3) Explain the importance of fit-testing and fit-checking respirators.</p> <p>(4) Describe the requirements for fit-testing and fit-checking respirators.</p> <p>(5) Describe a cartridge change-out and disposal schedule.</p> <p>(6) Explain factors that affect a cartridge's useful life.</p> <p>(7) Explain how SCBA can be used by those who are required to wear one.</p>
		<p>c. Knowledge of label requirements and state laws/rules for respiratory protection requirements.</p>	<p>(1) Describe when respirators are required for handlers during:</p> <ul style="list-style-type: none"> <li>(a) Applicator and handler tasks</li> <li>(b) Tarp perforation or removal</li> <li>(c) Restricted-entry intervals</li> <li>(d) Entry-restricted period</li> </ul> <p>(2) Explain the difference between Restricted-entry intervals and Entry-restricted period</p> <p>(3) Explain the situations in which someone can enter a fumigated area without wearing PPE.</p> <p>(4) Provide details of labeling and laws regarding respiratory protection, including <i>[in your state]</i>.  <i>Some of this may be addressed in C.2.b.</i></p> <ul style="list-style-type: none"> <li>(a) medical evaluation</li> <li>(b) fit-test and fit check</li> <li>(c) maintenance/cleaning</li> <li>(d) training and recordkeeping</li> </ul>

			<ul style="list-style-type: none"> <li>(e) cartridge change out schedule</li> <li>(f) SCBA requirements</li> <li>(g) number of people and respirators required on site.</li> </ul>
	3. 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.	<ul style="list-style-type: none"> <li>(1) Define the actionable maximum contaminant (trigger) level.</li> <li>(2) Find the actionable maximum contaminant level on the label.</li> <li>(3) List label options for a handler who experiences sensory irritation.</li> <li>(4) Discuss the exposure limits during the application process.</li> </ul>
	4. Understand Maximum Use Concentrations (MUC)	a. Knowledge about maximum atmospheric concentration of a hazardous substance from which an employee can be expected to be protected when wearing a respirator.	<ul style="list-style-type: none"> <li>(1) Explain the purpose of the Maximum Use Concentrations (MUC).</li> <li>(2) Find the Maximum Use Concentrations (MUC) on the label.</li> </ul>
	5. Monitor fumigant levels at application site and along buffer perimeter.	a. Knowledge about monitoring devices to check fumigant levels in air.	(1) Describe the relative sensitivity of detector tubes, halide leak detectors and Photo Ionization (PID) devices.
		b. Skill in using monitoring devices to check fumigant levels in air.	<ul style="list-style-type: none"> <li>(1) Describe operation of a bellows pump in collecting an air sample.</li> <li>(2) Explain when and how to use detector tubes, PIDs and halide leak detectors to measure fumigant concentrations.</li> </ul>
		c. Knowledge of the criteria and procedures for monitoring off-gassing at buffer perimeter.	(1) Describe procedure and timeframe for monitoring off-gassing during applications.

	6. Know posting and worker notification requirements.	a. Knowledge of posting and notification requirements based on label or state rules.	(1) Describe the label-specified posting and notification requirements.  (2) Describe WPS requirements and those <i>[in your state]</i> for notification and posting, including signage text size and legibility.
	7. 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 field entry-restricted period  (2) Find and interpret field entry-restricted period on a label for different tarped and non-tarped application scenarios.  (3) Describe any additional field-entry requirements <i>[in your state]</i> .
	8. Recognize human poisoning symptoms.	a. Recognize poisoning symptoms.	<i>Addressed in A.3.a.(2)</i>
	9. 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.
	10. Know the conditions that require emergency preparedness and response measures.	a. Knowledge of emergency preparedness and response measures.	(1) List emergency preparedness and response measures in preparation of an emergency response plan.  (2) Outline the procedures involved in providing emergency response information to neighbors.  (3) Outline procedures for buffer zone monitoring.  (4) Describe options for neighbor notification or buffer zone monitoring.  (5) Describe the process to initiate an emergency response plan.

Unit E	Tasks	Knowledge/Skills	Learning Objectives
<b>Pre-Application Considerations and Good Agricultural Practices</b>	1. Develop a Fumigant Management Plan (FMP).	a. Knowledge of and skill at writing a Fumigant Management Plan (FMP).	(1) Identify who is responsible for drafting a Fumigant Management Plan (FMP).  (2) Identify who is responsible for verifying that a FMP is accurate.  (3) Describe the elements of an FMP.  (4) Specify when an FMP must be in place, how long it must be kept on file, and who must receive and keep a copy.  (5) Describe where the FMP must be kept during the application and who must be provided access to it.  (6) Describe the purpose and content of the post-application record and summary in the FMP.  (7) Identify sources available for the preparation of FMPs, such as templates and menu-driven programs.
		b. Knowledge of the post-application summary for a Fumigant Management Plan.	(1) Identify who must complete the post-application records.  (2) Identify when the post-application summary must be completed.  (3) Explain the purpose of the post-application summary.  (4) Describe the content of the post-application records.

	2. Conducting site assessments	a. Knowledge of the factors used for evaluating site suitability and in determining the existence of sensitive areas.	<p>(1) List sites that are a concern or considered sensitive based on human activity, topography, slope, and aspect (e.g., businesses, residences, public meeting sites, hospitals, schools).</p> <p>(2) Identify corrective courses of action to prevent exposures during and after applications.</p>
	3. Check soil condition at site of application.	a. Knowledge of soil characteristics and how they affect fumigation.	<p>(1) Describe how soil characteristics (e.g., temperature, moisture, tilth, type, crop residue) affect the success of a fumigation.</p> <p>(2) Describe how to assess soil moisture.</p> <p>(3) Describe ways to correct for soil characteristics that are not optimal for a successful fumigation.</p>
	4. Determine the size and duration of buffer zones.	a. Know the purpose of buffer zones and their duration.	<p>(1) Explain the purpose of buffer zones.</p> <p>(2) Define a buffer zone period.</p> <p>(3) Identify who may and may not be in a buffer zone during the buffer zone period.</p>
		b. Apply reasoning in determining size of buffer zones as specified on labels.	<p>(1) Interpret a buffer zone table from the label.</p> <p>(2) List the factors that enter into assessing credits that influence the size of a buffer zone (e.g., product, field size, tarp characteristics, application rates)</p> <p>(3) Describe how to assess soil organic matter content, soil temperature, soil moisture and/or soil texture for calculating buffer zone credits.</p> <p>(4) Determine credits that influence the size of the buffer zone.</p> <p>(5) Calculate the size of a buffer zone based on credits using different scenarios (e.g., rates, application block size, application method, soil type, soil temperature, soil organic matter, tarp type).</p>

			(6) Outline the steps to secure permission for buffer zones that include structures or extend onto neighboring land.
	5. Recognize difficult-to-evacuate sites.	a. Knowledge of the exceptions to buffer requirements.	(1) Identify what constitutes a difficult-to-evacuate site.  (2) Tell what a difficult-to-evacuate site means with respect to buffer zone sizes and distance from an application block.
	6. 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) Explain what constitutes a temperature inversion.  (2) Explain how to forecast air stability for the duration of the application.  (3) Identify sources of historic and predictive weather information.  (4) Explain the influences of air stability, air temperature, humidity, and wind currents.  (5) Find and interpret label statements limiting applications during specific weather conditions.
	7. 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 reentry posting of the treated site differ.  (2) Explain warning sign placement and what type(s) of sign/wording to use.  (3) Explain the pre-application and post-application posting timeframes for buffer zones and reentry.

Unit F	Tasks	Knowledge/Skills	Learning Objectives
<b>Application Principles and Soil Sealing</b>	1. Choose proper equipment based on application being non-water run or water run.	a. Knowledge of fumigant application equipment based on application being non-water run or water run.	(1) Define water run and non-water run application methods. (2) Describe the types of equipment used to apply high-volatility, low-volatility, and granular fumigants. (a) injection (b) shanks or spray blades (c) granular, soil incorporation (d) drip-line or water run-chemigation (3) Describe suitable and unsuitable materials used for fittings, tubing, and valves for specific products, if appropriate. (4) Describe the common components of a fumigant ground rig setup. (5) Diagram the common components of an application apparatus. (6) Describe backflow prevention system requirements <i>[in your state]</i> and their function for chemigation. (6) Outline a pre-application inspection of the application equipment. (7) Describe a step-by-step process for changing fumigant cylinders.
	2. 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(n): <ul style="list-style-type: none"> <li>• Rectangle</li> <li>• Circle</li> <li>• Triangle</li> <li>• Irregularly-shaped site</li> </ul>

	3. Calibrate equipment.	a. Knowledge of calibration techniques/requirements for the types of fumigation equipment.	(1) Outline basic techniques for calibrating soil fumigation application equipment.
		b. 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.
	4. Make an application.	a. Knowledge of proper application techniques.	(1) Describe how to carry out a liquefied-gas injection application.
			(2) Describe how to carry out a shank application using shanks or spray blades.
			(3) Describe how to carry out a granular formulation, soil-incorporation application.
			(4) Describe how to carry out a drip-line or water-run (chemigation) application.
	(5) List common problems and mistakes.		
5. Seal soil.	a. Knowledge of soil sealing techniques and their characteristics for soil sealing.	(1) Tell why sealing is important.	
		(2) Describe the methods used.	
		(3) Discuss the factors that help determine the method to use.	
		(4) Tell how the sealing method influences the application method.	
	b. Knowledge of the use of tarpaulins and their characteristics for soil sealing.	1) Describe the general range of tarpaulin products available in terms of their thickness, density, and permeability.	
		(2) Explain effective methods to seal tarpaulins.	
6. Remove tarpaulins.	a. Knowledge of tarp removal techniques and precautions.	(1) Describe the legal time for tarpaulin removal and perforation.	
		(1) Describe the restrictions on tarpaulin removal and perforation.	
7. Fumigate greenhouse soil and potting mixes.	a. Knowledge of techniques for fumigating greenhouse soil and potting mixes.	(1) Outline the procedures for fumigating greenhouse soil and potting mixes.	

	8. Fumigate nursery soil and potting mixes.	a. Knowledge of techniques for fumigating nursery soil and potting mixes.	(1) Outline the procedures for fumigating nursery soil and potting mixes.
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