Forest Service Handbook
National Headquarters (WO)
Washington, DC

Forest Service Handbook 2109.14 – Pesticide-Use Management And Coordination Handbook

Chapter 50 - Quality Control Monitoring and Post-Treatment Evaluation

Amendment: 2109.14-2016-7

Effective date: August 31, 2016

Duration: This amendment is effective until superseded or removed.

Approved by: James E. Hubbard, Deputy Chief, S&PF

Date approved: August 30, 2016

Responsible Staff:

Last Change: 2109.14-2016-6 to 2109.14_40.

Superseded Document(s): 2109.14,50 Contents, Amendment 2109.14-94-1, December 6, 1994; 2109.14,50, Amendment 2109.14-94-1, December 6, 1994

Digest: Following is an explanation of the changes throughout the directive by section.

50: Makes minor technical, formatting, and editing changes throughout the chapter.

52.1: Removes code, caption, and direction and recodes direction to section 53. Changes caption from "Checking Application Procedures" to "Checking Application Procedures and Equipment". Adds direction that equipment calibration information should be entered into the Forest Service treatment database.

52.11: Removes code, caption, and direction and recodes to section 54.

52.12: Removes code, caption, and direction and recodes to section 53.1

52.13: Removes code, caption, and direction and recodes to section 53.2.

52.14: Removes code, caption, and direction and recodes to section 53.3.

52.2: Removes code, caption, and direction and recodes to section 55.1.

52.21: Removes code, caption, and direction and recodes to section 55.2.

52.22: Removes code, caption, and direction and recodes to FSH 2109.14, section 14.21.

52.3 through 52.36: Removes code, caption, and direction and recodes direction to sections 56 through 56.6.

53: Removes caption and direction and recodes to section 57.

53.1: Removes caption and direction and recodes to section 57.1. Changes caption from "Biological Effectiveness" to "Treatment Effectiveness." Recodes to this section caption and direction previously set out in section 52.12.

53.2: Removes caption and direction and recodes to section 57.11. Recodes to this section direction previously set out in section 52.13.

53.3: Removes caption and direction to recodes to section 57.2. Recodes to this section caption and direction previously set out in section 52.14.

53.4: Removes code, caption, and direction.

53.5: Removes code, caption, and direction and recodes caption and direction to section 57.3.

54: Establishes new code and recodes to this section caption and direction previously set out in section 52.11 on monitoring label compliance.

54.1: Establishes new code, caption, and direction for worker protection standard compliance.

55: Establishes new code and caption for effectiveness of drift management.

55.1: Establishes new code and recodes to this section caption and direction previously set out in section 52.2

55.2: Establishes new code and recodes to this section caption and direction previously set out in section 52.21

56: Establishes new code and recodes to this section captions and directions previously set out in sections 52.3, 52.31 through 52.36. Clarifies direction that all residue monitoring must be based on clear objectives, should answer specific questions, and should be technically and financially feasible.

57: Establishes new code and recodes to this section caption and direction previously set out in section 53.

57.1: Establishes new code and recodes to this section caption and direction previously set out in section 53.1.

57.11: Establishes new code and recodes to this section caption and direction previously set out in section 53.2.

57.2: Establishes new code and recodes to this section caption and direction previously set out in section 53.3.

57.3: Establishes new code and recodes to this section caption and direction previously set out in section 53.5.

Table of Contents

51 - General Considerations

Pesticide Coordinators, Invasive Species Program Managers, Incident Commanders, and Pesticide Project Directors shall endeavor to meet project objectives safely, without excessive exposure of non-target components of the environment. Use quality control monitoring to:

1. Ensure the success of pesticide project application procedures and ascertain effects of pesticide on target and, if necessary and appropriate, non-target components of the environment. Monitoring of application procedures is an important part of ensuring success

2. Respond to possible unintended impacts or conditions during a project and evaluate the magnitude of such impacts or conditions.

3. Determine the extent, severity, and probable duration of hazards from pesticide misapplication accident or incident (FSH 2109.14, ch. 60).

52 - Types of Quality Control Monitoring

Quality control monitoring should be employed to ascertain the condition of application equipment and its effectiveness, compliance with the pesticide label, the effectiveness of drift management, on- and off-site residues, and post-treatment effectiveness of the project.

53 - Checking Application Procedures and equipment

Ensure pesticides are used in accordance with project plans. Project/Incident Commanders shall verify equipment is used according to manufacturer's guidelines, the equipment delivery rate is properly calibrated (within plus or minus 5 percent of optimum), and the appropriate pesticide volume is applied to the target area. Corrective actions must be taken when there are deviations from the project work or safety plans (FSH 2109.14, ch. 10, secs. 14.3 and 16.1). Equipment calibration data should be recorded in project records, and calibrated volume per unit area and volume applied should be entered into the database of record.

53.1 - Equipment Usability

Frequent inspection of equipment condition is important to maintain quality control of pesticide applications. When in use, check equipment daily for cleanliness, leaks, loose nuts and bolts, and proper functioning of valves, screens, filters, gauges, and hoses. Correct leaks immediately and repair, or replace, worn parts. Verify equipment calibration rate at project beginning to ensure functionality.

53.2 - Volume of Pesticide Used

Monitor the volume of pesticide applied to each treatment area to verify appropriate application rates. Application volumes that are greater or less than intended may mean that the application

equipment is malfunctioning, that the calibration is incorrect, or that the application procedure is incorrect. Incorrect volume may be the result of incorrect swath overlap or frequency of spot application. Corrective action must be taken immediately whenever the volume of pesticide used is inconsistent with either the pesticide label or the project work plan (FSH 2109.14, ch. 10, sec. 14.3).

53.3 - Monitoring Flight Pattern

Pesticide spray models should be used (FSH 2109.14, ch. 10, sec. 14.22) to calculate effective swath widths. Once model runs have been completed, they can be checked in the field during aircraft calibration and characterization. Monitoring the flight pattern of aerial application craft is another method of quality control. Ground-based or aerial observation may be used to monitor swath patterns of application.

Electronic navigational monitoring and rate of application regulating systems can be used to monitor, control, and document pesticide applications.

54 - Label Compliance

Determine quality control requirements and post-treatment compliance with the label. Pesticide use must follow the directions in the manufacturer's EPA-approved label (FSM 2150). Pesticide use inconsistent with a label is a violation of FIFRA (7 U.S.C. 136). The following are allowable under FIFRA unless otherwise restricted by State or local law:

1. Applying a pesticide at any dosage, concentration, or frequency less than that specified on the label; unless the label mandates a specific rate,

2. Applying a pesticide to any pest not specified on the label, if the application is to the crop, animal, or site specified on the label, unless the label states that the pesticide may only be used for listed pests;

3. Employing any method of application not prohibited by the label; and

4. Mixing a pesticide or pesticides with a fertilizer when such mixture is not prohibited by the label.

54.1 - Worker Protection Standard Compliance

Pesticide use must follow the direction in the EPA's Worker Protection Standard (40 CFR 170), when applicable, and ensure appropriate quality control monitoring and post-treatment evaluation. This Standard, originally established in 1995, has caused changes to be made to product labels which will be monitored as directed in section 54. The Standard applies to all workers and handlers working in areas which are used for commodity production. Specific changes include the inclusion of rules for personal protective equipment (PPE) and other clothing required to be worn by handlers during application of the pesticide, and also PPE and other clothing to be worn by workers during the label-specified reentry interval in areas which are being, or have been, treated. There are also other requirements not printed as part of the product label which must be observed and are easily monitored. Among them are:

1. For those areas subject to the WPS, treated areas must be signed (following specific requirements for this signage) to alert workers and handlers of the treatment.

2. For those areas subject to the WPS, the location of treatments made in the last 30 days must be posted in a central area (such as a bulletin board in the District Office or in the work center). This central area should be where application crews or other workers prepare for work, who might then enter treated commodity production areas. This is to alert them to the treatments done within their work areas.

3. Information in paragraph 2 must be kept current and legible, and workers and handlers shall be told where to find it.

4. Only appropriately trained pesticide handlers may clean, adjust, or repair application equipment containing pesticides.

55 - Effectiveness of Drift Management

55.1 - Spray Deposition Accountability

Determine if the spray reached the target. Inspection of deposition samplers, or field assessment of surface water or soil, can provide qualitative means of spray accountability. Use drift modeling to help predict possible drift. Monitor air currents and wind speed during pesticide projects to permit on-site adjustment of spray strategies to minimize the effects of wind on spray deposit both on-site and off-site (drift).

55.2 - Spray Deposit Assessment

Deposit assessment is generally accomplished by visually inspecting flat cards placed in locations within the treatment area and at fixed distances downwind. Flat cards are very poor collectors of small droplets; and, droplets below 100 microns are very difficult to see without magnification. If more detailed information is desired or monitoring objectives require detection of very small droplets, then strings, artificial foliage, slides, rotating collectors, and suction

collectors might be used. In any collection scheme, it is imperative to test the collector with the spray material prior to collection. Occasionally, water sensitive paper is used to indicate droplet drift, but be aware that rainfall or dew might contaminate these samples.

Two important factors influencing the effectiveness of pesticide application are the quantity and uniformity of spray deposition over the spray area. Many factors influence the deposit of pesticides, including skill of the applicator, pesticide formulation, adjuvants, drop size and atomization, spray release height, weather, canopy, and target site location.

The evaluation of the numbers and sizes of spray droplets on deposited surfaces is called spray deposit assessment. Water-sensitive paper, oil-sensitive paper, and other specialty sheets and cards are commonly used in spray assessment; but, cards will under sample fine droplets. Assessment of spray deposit allows project monitors to:

1. Check operation of the spray equipment, make adjustments of spray equipment, and calibrate the flow rate to get uniform, consistent spray patterns and target coverage;

2. Determine the relative quantities of pesticide that are deposited on the target area versus that which drifts from the target;

3. Determine relative droplet size distribution to evaluate coverage; and,

4. Maintain a record of spray coverage and distribution in the project file for future evaluation of results.

There are automated systems available to evaluate card deposit using scanners and automated photo analysis software. Cards can be evaluated for drops/area or converted to mass/area using a spread factor and stain diameter. Cards can be assessed by hand; and, if that is necessary, a sub-area of the card is selected and droplets are simply counted under magnification. If the deposit is to be converted to mass, a means to measure stain diameter is required. This can be very time consuming, but, is facilitated using automated technique to reduce measurement errors. If more detailed assessment is necessary, all the collectors mentioned have specific collection considerations and are generally used (with some exceptions) to determine mass/area through washing and chemical analysis.

56 - Pesticide Residues Monitoring

Determine which pesticide projects require residue monitoring on a case-by-case basis. The project planning team and the deciding official must carefully consider the need for project-level monitoring, as costs can be considerable. Requirements for the monitoring of residues, including specific sampling protocols, should be documented in the work plan. Before a residue monitoring plan can be written, the monitoring objectives must be specified. A complete set of objectives provides reasons for specific parameters to be monitored, and when, how long, and where monitoring will occur. The monitoring plan should focus on the management need for specific information to answer questions or solve problems related to soil, water, vegetation, wildlife, or human health. The plan must also be technically feasible and within constraints of

time, personnel, and funding. Development of monitoring objectives and a monitoring plan must involve the appropriate specialist (Hydrologist, Aquatic Biologist, and so forth.). Laboratories that are able to analyze any collected samples should be consulted when developing the monitoring plan to provide sample collection and handling procedures necessary for accurate analysis.

On controversial operational pesticide projects, residue monitoring might be used to determine the presence or absence of unacceptable environmental concentration of a pesticide. During field experiments or pilot control projects, residue monitoring data may be required to secure registration. Sample points for monitoring should be determined when monitoring plans are developed for such projects. The number of samples needed varies with statistical requirements, the substance(s) being sampled, and specific conditions of the project area.

Whenever necessary, pesticide residue sampling can be used to evaluate the accumulation, movement, and degradation of pesticides following introduction into the environment. Residue monitoring activities may include monitoring pesticides or their degradation products in air, soil, water, vegetation, animals, or humans.

56.1 - Soil

Where determined to be necessary, depending on the type of pesticide used and the risks indicated, monitor soils in and adjacent to treatment sites before and after pesticide applications and where spills of pesticides have occurred.

56.2 - Water

Where determined to be necessary, or required by law, depending on the type of pesticide used and the risks indicated, conduct water quality monitoring to determine if water contamination has occurred as a result of pesticide applications or related incidents and if so, to what extent. The contamination of water by pesticides is a function of various factors that may operate singly or in combination during and/or after a project.

Objectives of water monitoring are to:

1. Determine whether best management practices are effective and to verify that expected levels of pesticides, if any, in water are not exceeded; or

2. Provide warning of pesticide contamination of areas such as municipal watersheds, fish hatcheries, or private domestic water supplies.

3. Ensure compliance with NPDES permits if determined necessary by State or Federal law.

Sample points for flowing water are normally established downstream near boundaries of treatment areas. Pre-treatment water samples are useful to establish whether pesticide is already present in the water prior to the application.

If a spill occurs in or near water, additional monitoring beyond that which was planned for the project might be required. Notify appropriate State and local agencies. Outline contingency plans for such an occurrence in the project safety plan (FSH 2109.14, ch. 60)

56.3 - Vegetation

As determined to be necessary, depending on the type of pesticide used and the risks indicated, use vegetation monitoring procedures to check residues in or on target and non-target vegetation, as well as non-target symptomology. Vegetation monitoring might become necessary in response to a misapplication of pesticides onto nearby non-target vegetation such as food crops, seed orchards, or tree-improvement areas, so proximity of the application might be sufficient reason for planning such monitoring. Vegetation monitoring can be problematic due to possible biochemical reactions of residues on or within the plants sampled.

56.4 - Animals

1. Aquatic. In most cases effects to aquatic organisms are determined by monitoring water quality. Only rarely would direct monitoring of aquatic plants and animals be necessary. Proper monitoring of aquatic species will involve considerable time and expense, and should only be planned where necessary. An Aquatic Biologist shall be consulted prior to including aquatic organism monitoring at the project level and outline necessary procedures in a monitoring plan.

2. Terrestrial. If determined to be necessary, conduct post-treatment surveys for dead or distressed animals. If such animals are found, they should be:

   a. Collected and sent to an appropriate laboratory for residue analysis, or

   b. Buried if such impacts have been predicted, as in the use of rodenticides.

56.5 - Human Beings

If determined to be necessary, use health monitoring to determine pesticide handler exposure and to protect human health. The Forest and Regional Safety and Health Coordinators are responsible for medical surveillance programs (FSM 2160.43b). Monitor human health parameters on a case-by-case basis, depending on the type of pesticide used and the health risk indicated. Sampling blood cholinesterase levels in Pesticide Handlers who apply organophosphate pesticides is a typical human monitoring activity (FSH 6709.12, ch. 20, sec. 21.3). If handler monitoring is conducted, monitor pre-exposure conditions to establish baseline conditions. Maintain records of personal medical analyses as confidential portions of the employee's file in accordance with Privacy Act requirements (FSH 6209.13).

57 - General Considerations for Post-Treatment Evaluations

Post-treatment evaluations (FSM 2152.1) are required for all projects involving pesticides, except for household-type uses, field experiments, and minor uses of less than one pound active ingredient, or less than one gallon of formulated product for any one project. Regardless of pesticide application method employed or size of area treated, the effectiveness of the treatment must be determined for those representative projects that are chosen for post treatment evaluation.

The project work plan and its associated, approved Pesticide-Use Proposal (form FS-2100-2) may prescribe quantitative procedures by which treatment effectiveness can be accurately assessed. For example, conduct comparative pre-suppression and post-suppression samples for defoliating insects. For vegetation control, pre-treatment and post-treatment sampling of the plant population may be needed. Specific or quantitative sampling methods cannot be prescribed here since state-of-the-art sampling varies between pests. Use sampling techniques tailored to individual pest conditions, objectives of the monitoring, and desired level and precision of information needed. Keep sampling data in the project file and enter results into the treatment database of record.

The minimum standard for post-treatment evaluations is a qualitative estimate of the effectiveness of the treatment for a specified target pest. The following elements should be collected and entered into the treatment database of record:

1. Evaluation date;
2. Target species monitored;
3. Estimated control level; and
4. Name of examiner.

57.1 -Treatment Effectiveness

Use post-treatment evaluations to determine whether project objectives were met. If the identified objectives were not met, an evaluation must be conducted to identify the cause of project failure, and to determine whether corrective action is necessary. Consider use of photography or transect observations to document treatment effectiveness.

57.11 - Application Effectiveness

Although the majority of monitoring for application effectiveness is done during quality control monitoring (sec. 53), some post-treatment checks might be needed. For example, if it is determined that an area was missed, re-application may be necessary. Use post-treatment evaluations of applications to improve future project planning and effectiveness (ch. 70, sec. 72).

57.2 - Environmental Impacts

Conduct post-treatment evaluations to determine whether there were unanticipated adverse environmental impacts that resulted from the project. Impacts might be direct or indirect. The format for reporting post-treatment evaluations can be found in FSH 2109.14, chapter 70.

The extent of post-treatment evaluation of direct impacts of pesticide application depends on the type of pesticide and the extent of application. Examples of environmental components to be possibly evaluated for direct impacts include:

1. Water and air quality;
2. Soils;
3. Non-target vegetation and animals (for example, parasites and predators);
4. Wildlife;
5. Sensitive, threatened, or endangered species; and
6. Fish.

57.3 - Follow-up Action

Consider follow-up action whenever a post-treatment evaluation indicates a problem with a pesticide-use project. Take follow-up or corrective action such as:

1. Documenting problems and solutions;
2. Conducting a new biological evaluation;
3. Recommending retreatment;
4. Describing mitigation measures for future projects;
5. Changing equipment or pesticide formulation; and/or
6. Recommending alternatives.