



CTAG

Certification & Training Assessment Group — National Partnerships for Safe & Effective Pesticide Management through Education, Training & Competency Assessment

A Flexible Process for Developing Effective, Integrated Licensure Tests and Pesticide Training Manuals

Tool Document – July 2007

Why this Tool?

Content-relevant licensure tests (also called certification exams) and training manuals are central to Certification and Training (C&T) programs nationwide in assuring that a person has the required knowledge and skills to perform the job of a pesticide applicator. The responsibility of creating exams and manuals to assure competency is certainly not new because EPA has long expected states to follow some type of coherent process as described in the Guidance Document when states develop their annual cooperative agreements. The importance of this responsibility has again surfaced as one of the proposed federal C&T regulation changes which would require states to implement a development process that measures competency for the most important and relevant aspects of an occupation. Thus, CTAG is taking a pro-active approach by creating this resource document to help states deal with the potential reality.

There is no single best method in creating content-relevant exams and training manuals. CTAG is neither advocating a particular process nor suggesting that EPA mandates states to adopt a particular method. The ultimate goal of this document is to help states set in motion a process to create a defensible test that supports sound decisions about who should, and who should not, be a certified pesticide applicator.

If a state were to implement the full model process described in this document, there would be need for significant expertise, resources, staffing, and time commitments –

although less daunting than the exhaustive and lengthy exam validation process. But, as the title of this document suggests, a flexible process allows states in varying degrees of readiness to adopt “something” from the flexible process that they can develop over time at their pace to improve their tests and manuals. It is an evolutionary process, transitioning a state from what it is doing now to what it could be doing better, allowing a state to adopt more and more of the components of this process as resources permit.

Because CTAG saw the need for state lead agencies (SLA), tribes, and Pesticide Safety Education Programs (PSEP) to improve their test and manual development by adapting and building on what they already are doing rather than having to start over with a new process, the purpose of this tool is three-fold: 1) provide the basic components of a flexible process for developing effective licensure tests and training manuals, 2) encourage the implementation of professionally credible testing practices, and 3) ensure that training curricula align with licensure tests.

CTAG also recognizes that for licensure tests to be effective, their development needs to occur in unison and in tandem with the development of the corresponding study material. Well-written manuals grounded in sound job analysis can do things that testing by itself cannot in terms of changing applicator behavior, reaching public outcomes, and providing program accountability. However, while it is important to incorporate each of the components of test and manual development, the specific order of which comes first, the test or the manual, is less

so. Therefore, states have great flexibility in devising a process that works best for them.

By using a flexible process, such as the one described here, for developing licensure tests and training manuals, states can be assured that:

1. Test and manual content relate directly to a job analysis (knowledge and skills = learning objectives) of a certified applicator.
2. Tests are good measures for determining who should and should not become a certified pesticide applicator.
3. Manuals are designed to be useful both for learners preparing for licensure tests, and as a basic educational tool to help new applicators properly handle and apply pesticides.

Document Layout

This document is divided into three parts: Part A - Licensure Testing, and Part B - Training Manual Development, describe the components of acceptable, defensible test and manual development. Part C - Overviews of Test/Manual Development Processes, shows how four states utilized development components to varying degrees into a single, flexible overlapping process. The overviews demonstrate how a state can improve test and manual development by adapting and building on what it is currently doing, and not having to start over or revamp every test and manual all at once.

Appendix I is a glossary of terms used throughout the text. Appendix II provides an example of how test format is directly linked to a manual chapter and its learning objectives (job analysis).

Part A. Licensure Testing

Pesticide applicator licensure programs attempt to strike a balance between public protection and protecting individual rights. Licensure tests should focus on job knowledge and skills critical to protecting the public and environment. Consequently, testing standards need to be sufficiently rigorous to meet this purpose. However, these standards should not be so strict that they are limiting the rights of qualified persons to engage in professional practice¹.

Licensure test development involves the following activities.

- **JOB ANALYSIS** identifies what a certified applicator does on the job and the knowledge/skills necessary to perform the work; thus, establishing the scope of training and testing.
- **TEST PLAN DEVELOPMENT** produces a content outline (blueprint) for the test as well as for its administration and scoring.
- **ITEM WRITING** creates test items (e.g. questions) that reflect the components of the test plan.
- **TEST ASSEMBLY** selects items for inclusion on the test.
- **ITEM ANALYSIS** determines whether items need to be revised or replaced (e.g., because they are too confusing, too difficult, possess more than one correct answer, etc.).
- **STANDARD SETTING** establishes the passing grade for the test (e.g., 70%, cut score).

The first five test development activities provide an evidentiary basis supporting a claim of content relevance for the finalized licensure test. The sixth activity establishes an appropriate passing threshold.

¹ See Chapter 14 in Standards for Educational and Psychological Testing. (1999). AERA, APA, & NCME.

Job Analysis

Job analysis² provides the proper basis for establishing licensure test and manual content. It is a systematic means of collecting and organizing information about what jobholders do and what qualities are necessary to perform a job. A thorough job analysis provides the means to ensure that licensure test/manual content reflects the important job knowledge and skills necessary to meet public protection interests while simultaneously offering an examination that is properly balanced (in terms of those same knowledge and skill areas) for the test taker.

Job analysis begins by defining the target population. This decision establishes which occupational group (or subgroups) is the focus of the analysis.

Once the target audience is determined, there are two kinds of job information that may be gathered: tasks and competencies. Tasks are work-related behaviors, and competencies are the knowledge, skills, and abilities that support task performance. Job analysis can focus on tasks, or competencies, or both. Note, however, that while tasks define a job, it is the knowledge and skill demands that licensure tests actually address (and not, generally, abilities).

Typically, an inductive job analysis method is used to gather pertinent job information. Inductive job analysis has two phases: 1) collection and organization, by qualitative means, of job information, and 2) corroboration and quantification of that information.

Qualitative data collection of job information typically includes any of the following activities (and often more than one).

- Jobholder observation
- Jobholder interview
- Small group [subject matter expert] discussion

² Job analysis in this context is frequently referred to as practice analysis

- Document analysis (study manuals, other resources)

After the desired information is collected and organized by qualitative means, it usually is quantified, in terms of importance, by rating or ranking or both. Quantification may be performed by questionnaire or by discussion among a small group of subject matter experts (SMEs). The former approach is appropriate where there are numerous perspectives on how the job is performed (e.g., multiple occupational settings), or when the licensure program is national in scope, or where jobholders are litigious, politicized, or suspicious of testing. Using SMEs is appropriate when working with small and/or homogeneous populations of jobholders, testing at the state or local level, or when revising a current exam.

Test Plan Development

A committee of SMEs generally formalizes a test plan (blueprint) by establishing knowledge and skill content areas derived from the results of job analysis. Content emphasis is determined on the basis of importance ratings (or ranking) of job information associated with each content area to facilitate item writing and test assembly. The test plan should also include total number of test items, item format (e.g., multiple choice, constructed response, etc.), number of items per content area, administration procedures, and scoring rationale (e.g., objectively scored, no penalty for guessing, etc.). Appendix II illustrates two formats for test items. Often, the SLA determines many of these elements beforehand and keeps them constant across multiple exams.

Item Writing

The test plan serves as an item-writing guide. It is important to provide training in good item writing practice to ensure clarity of expression and to mitigate the influence of test-wiseness. To complete the item writing process, SMEs review items for technical accuracy and editors

review items for grammar, punctuation, consistency, and format.

Reference material for item writing:

- Developing and Validating Multiple-Choice Test Items by Thomas Haladyna; and
- Constructing Test Items: Multiple-Choice, Constructed Response, Performance, and Other Formats by Steven Osterlind.

Test Assembly

Select items for inclusion on the test according to content and number, so as to reflect the test plan.

Item Analysis

Pilot testing the near-final exam to a subset of persons representative of the larger population of jobholders and, with the help of simple statistical analyses, identifies poorly functioning items. Item statistics include p-values (to calculate the percentage of persons scoring an item correct), discrimination indices (to determine whether a preponderance of high or low performers are scoring an item correctly), and a reliability estimate (to assess the degree to which random error influences test scores). Numerous statistical software packages are available to generate item statistics. Additional resources for conducting an item analysis may often be found in colleges of education or departments of psychology at the various Land Grant Universities.

Standard Setting

Standard setting (establishing a passing threshold), unless preempted by legislation, is also an SME committee activity. Commonly, SMEs make judgments about each item on the test regarding the proportion of minimally competent jobholders who would be expected to select the correct response. Individual SME responses are summed for each item and the results averaged across all SMEs to calculate a passing score. Standard setting activities and relying on SME judgment permit licensing

agencies to make sound decisions about who does, and who does not, deserve a license.

Note that pesticide regulatory agencies may elect to perform an item analysis after the first actual test administration (i.e., after a standard is set). In this instance, an agency must take care to review item statistics first to determine if there are any poorly functioning items (and if they had an adverse effect on score results of persons near the passing threshold). If necessary, items may then be repaired (and passing decisions corrected) before the next administration.

Licensure test development, while systematic in nature, is flexible to the extent that there are a variety of methods available to the certification and licensing manager to perform the above-mentioned activities. The judgment of the manager, the resources of the licensure agency, and the idiosyncrasies of the regulated occupation determine methods selection. Methodologies selected to perform each aspect of test development should, collectively, support strong links at each step in the chain extending from job analysis to a final exam where test scores are reflective of job knowledge and skills.

Part B. Training Manual Development

Training manuals for pesticide applicators may serve many of the following purposes.

1. A study guide for persons preparing to take pesticide licensure exams;
2. A basic pesticide user's guide;
3. Outreach by pesticide lead agencies and educators on background and other information regarding pesticide licensure, education, and pesticide regulatory programs; and
4. Being a comprehensive resource—well beyond the minimum knowledge and skill sets generated by the job analysis used to create exams—that provides advanced pesticide technical and use information for new and experienced pesticide applicators,

their employers, and others to further enhance the protection of human health, security, and the environment. However, the broader scope can be confusing and overwhelming for the entry-level applicator; it's critical that the author clearly delineate the content that is preparatory for the exams versus the reference material aimed at the broader audience.

This document limits its focus on development of training manuals to the first two purposes above, with an approach that could also be easily expanded for other purposes.

For a training manual that fulfills the first two purposes, it must place the results of the job analysis into a coherent framework, from the learner's point of view, providing context and background in a narrative so that the learner develops an understanding of the 'practice' of pesticide use. This understanding must help instill in pesticide applicators a respect for pesticides and for their obligations when using pesticides to ensure security and to protect human health and the environment for themselves, their co-workers, customers, family, community, and the general public.

As stated earlier, the job analysis provides the basis for licensure test content because it relates what knowledge and skills a person needs to perform the job of pesticide applicator. It follows, that a training manual can meet the two basic purposes only if the author correlates a manual's content with the knowledge and skill set identified in the job analysis. How the author does so greatly affects how effective the manual is from the learner's perspective. Therefore, an author needs to develop a training manual with these two goals in mind.

1. The answers to all test items must be found in or inferred from the training manual; and
2. The training manual must facilitate learning and test preparation rather than simply provide the necessary content identified by the job analysis.

An author can meet these goals by incorporating the following elements during manual development.

- Learning objectives
- Learner orientation
- Short, topic-specific chapters
- Review by SMEs
- Readability measures
- Cooperation between SLA and PSEP

Incorporating these elements helps the learner, but also makes the jobs of the author, reviewers, and licensure test developer easier and saves them substantial time and expense.

Learning Objectives

An under-utilized maxim of education is that learning is improved if people know what is expected of them. We already know—from the job analysis—the knowledge and skills we want pesticide applicators to learn from the training manual and demonstrate on the licensure test. By letting the applicators know these objectives, we increase the likelihood that they will learn.

A useful way to do this is to reshape the job analysis statements into a set of specific learning objectives and then align manual content to those objectives. Each learning objective represents a single concept and is expressed as an action phrase for learners. For example, learning objectives related to the task of storing pesticides could include:

- Distinguish between items you can and cannot store with pesticides.
- Identify steps you can take to prevent unauthorized access to a pesticide storage facility.
- Describe storage facility features and practices that help protect workers who enter the facility.

Note that each objective:

- 1) Relates to knowledge or skills you want the applicator to obtain.
- 2) Uses an action verb to tell the person what is expected of them.

- 3) Is measurable; for example, you can write a test item which determines whether or not the person can distinguish between items that can and cannot be stored with pesticides.

The learning objectives become the thread that ties the job analysis, training manual, and licensure test together. The sample document “Storing Pesticides” provides examples of learning objectives (hyperlink to):

http://pep.wsu.edu/ctag/pdf/FlexibleExamManual_Storage_Chapter.pdf

It is important to stress that learning objectives use action verbs, as these are measurable. Examples of action verbs include define, identify, list, compare, distinguish, explain, outline, and determine. In contrast, verbs such as know, understand, appreciate, learn, and be aware of are not action verbs and are not measurable. These verbs can be used to set out broad goals but are inadequate for learning objectives. A simple way of looking at this is to imagine yourself addressing a learner at a training session; stating a learning objective (e.g., “List three ways to prevent fire in a pesticide storage facility”) naturally elicits a response from a learner, whereas stating a goal (e.g., “Know how to store pesticides properly”) doesn’t.

Learning objectives also make the author’s job easier. Even for a seasoned writer, staring at a blank page can be daunting: unanswered questions such as “Where to begin?” and “What to include?” can stymie the writing process. With an outline based on learning objectives, however, an author already knows what bits of information to write about and in what order. This jumpstarts the writing process and greatly reduces time lost in reorganizing and rearranging text.

Reference material for learning objectives:

- Preparing Instructional Objectives by Robert F. Mager;
- Objectives for Instruction and Evaluation by Robert Kibler, Donald Cegala, Kittie Watson, Larry Barker, and David Miles; and

- Writing Behavioral Objectives: A Guide to Planning Instruction by William Krypsin and John Feldhusen.

Learner Orientation

Learning objectives are effective only if you share their meaning and importance with the learner. You can do this in the manual's preface or introduction. Let the reader know that the learning objectives indicate what they are expected to learn and what they are expected to demonstrate on the licensure test. You can also show the reader how to use the learning objectives as a study aid: after reading a particular chapter, they can identify areas where further study is needed by seeing which learning objectives still give them trouble. In this sense, the learning objectives also take on the role of review questions.

Additionally, tell the user how best to use other components of the training manual. For example, are appendices or glossaries (if any) meant purely as reference material or are they covered on the licensure test? Likewise, should the applicator make the effort to memorize calibration formulas, or are these formulas provided on the test so that the applicator can concentrate on learning the concepts of calibration?

You can further prepare applicators for the test by including several sample items that illustrate the test format. Show how items link to specific learning objectives in the manual and how a response is elicited. The sample items allow the applicators to become familiar with the test format ahead of time and to see how the learning objectives prepare them for the test. However, it is important to have a discussion between the SLA and PSEP regarding the number and scope of review questions at the end of the manual (or each chapter). The following are some considerations.

- Some SLAs have concerns for duplication between some manual review questions and exam questions.

- There may be concerns for similarities between manual review questions and exam questions, which some people perceive as giving away part of the test.
- When given a significant number of review questions, many applicators have a mistaken belief they can successfully prepare for the test by memorizing the answers to those questions rather than reading and learning the material in the training manual.
- Learning objectives cover everything an applicator needs to know to take the test, whereas review questions can only cover a subset of such knowledge.
- Learning objectives can serve the purpose of review questions.

Finally, consider providing a copy of the answer sheet style used for the licensure test. Many applicators are unfamiliar with the common "bubble" style answer sheet. Explain how the sheet is filled in and describe common problems with it (for example, skipping an item on the test requires you to skip a line on the bubble sheet as well). You could also teach the applicator about other common test-taking problems such as watching for negatives (e.g., not, never) in an item's stem (that part of the item which precedes the choices) or in the choices themselves. Remember that applicators are not professional students; the more you familiarize them with the test, the less anxiety they feel and the more likely their test score truly reflects their knowledge and skills.

Providing this sort of orientation to the training manual helps us meet our goal of facilitating learning and test preparation.

Short, Topic-Specific Chapters

Using learning objectives as a starting point, develop an outline of the manual's content with a hierarchy of chapters, major chapter sections, section headings, subheadings, and so on down to each individual paragraph that eventually appears in the manual. This provides for topic-specific chapters. Learning is

enhanced because the reader is able to focus on a small set of concepts that proceed one to the other in a logical sequence.

The author can further facilitate learning by trying to keep chapters short because, for most people, the prospect of reading a large amount of material at once can be intimidating. Keeping chapters short does not mean leaving material out; it simply means limiting the scope of any given chapter. For example, splitting pesticide storage and transportation into two separate chapters allows you to cover all the necessary material, but in smaller, less intimidating, and more manageable chunks for the learner.

The organization of the learning objectives in the outline must be from the learners' point of view. For example, many of us have encountered trainees who were initially unaware that weed-and-feed products are pesticides. Such people learn little from chapters devoted to pesticide use or risks unless those chapters are preceded by one that explains what pesticides actually are. Likewise, the pesticide chapter must be preceded by a chapter that explains what we mean by "pests." Utilizing strong manual instructional design expertise by someone familiar with the learners is critical at this stage of organizing the manual's content in terms of both educational quality of the final manual and minimizing costs in producing the manual.

Review by Subject Matter Experts

At some point in the process of manual development, review by SMEs is needed to ensure that the manual content is pertinent, accurate, and complete. Obviously, the earlier this occurs in manual development, the less time is lost in rewriting and revising the text. Experts could also review the manual more than once. For example, they could review an outline derived from learning objectives and then review the text developed from that outline. The review is an essential component of manual development, but when and to what extent it fits within the process is quite flexible.

Readability Measures

In this document, we use "readability" in a broad context that includes those elements of layout design and writing style that make it easier for learners to read and understand a training manual's content. As with test development, there are 'good practices' for the design, development, and production of educational materials. These good practices are based on educational, communication, and technical/scientific writing research. Among the factors that affect the physical act of reading are:

- Font size and type (e.g., serif vs. nonserif),
- Line length (often measured in number of characters),
- Justification (left vs. full),
- Line spacing, and
- Use of white space.

As an example, lines of text that are too long make it more difficult for the eye to accurately move from the end of one line to the beginning of the next. On the other hand, if lines are too short, the eyes tire more quickly from the frequent back-and-forth motion. Factors that influence a reader's ability to comprehend text include:

- Reading (or grade) level of the text, which is typically a function of average sentence length and percentage of long words (e.g., those with three or more syllables);
- Effective use of headings and subheadings;
- Active versus passive voice;
- Vocabulary; and
- Writing that is clear and concise.

The last three items in this list also contribute, in part, to the overall reading level of the text. Note that popular books, magazines, and newspapers are generally written at a 7th to 10th-grade reading level. Several short, easy-to-read resources are available to help you write at a level that is appropriate to your audience.

Reference material for readability:

- How To Take the Fog out of Writing by Robert Gunning and Douglas Mueller;

- Manual for Use of the New Dale-Chall Readability Formula by Jeanne Chall and Edgar Dale; and
- The Art of Readable Writing by Rudolph Flesch.

Using active instead of passive voice keeps readers interested because it addresses them directly. For example, the active “Triple rinse empty pesticide containers” tells the reader what to do, whereas the passive “Empty pesticide containers should be triple rinsed” begs the question, “By whom,” or “what if I don’t?” This example also points out another advantage of active voice: it uses fewer words and, therefore, helps lower the reading level of the text.

Cooperation Between SLA and PSEP

Several of the training manual development elements we’ve discussed work only if there is close cooperation between the SLA and PSEP. The goal of ensuring that the answer to each licensure test item can be found in or inferred from the training manual is a prime example. The author can meet this goal only if the SLA communicates to the author the full range of topics and concepts from which the test plan is developed. Knowing this, the author can cover those topics even without knowing precisely which sets of knowledge and skills are addressed in actual test items. This in turn is contingent on the SLA and PSEP working from a common job analysis and reaching agreement on the scope and wording of learning objectives. After all, test items must align with learning objectives or else we end up in the disastrous position in which learners who are told by PSEP they must obtain one set of knowledge and skills find themselves being tested on a different set by the SLA.

SLA/PSEP cooperation also comes into play during the SME review phase(s) of manual development. The most obvious example derives from the SLA’s knowledge of enforcement issues. Recurring violation of a particular regulation or statute suggests that

further education may be needed in that area. Having at least one representative from the SLA involved as an SME helps ensure that the training manual targets such areas. Finally, at least one representative from both the SLA and PSEP should review the final draft of the licensure test to ensure consistency between the manual and each item on the test.

Last, but not least, both the SLA and PSEP must be willing to make sound, effective training manuals and licensure tests a priority. In fact, this is the foundation that makes the rest of what we’ve presented possible.

Other Manual Development Considerations

Considerable time, effort, and dollars can be saved in the construction of a quality test when starting with a well-designed manual. A manual grounded in a quality job analysis has all the essential content needed for new pesticide applicators.

Well-written and designed manuals require specific types of expertise and large amounts of staff time – all of which costs dollars. The payoff for the expense of quality manuals is in outcomes; good manuals use research-based techniques focused on maximizing the ability of pesticide applicators to be good practitioners on the job outside of the learning and testing environments.

Pricing is a consideration in manual development. PSEP must have the flexibility and authority to recover development costs (e.g., via manual sales). This requires a commitment from the SLA to identify the manual as the primary resource in preparing for the test and state CES policies to allow PSEP cost recovery funds on manual sales. Currently, states vary tremendously in how manuals are funded and in the level of cost recovery for manual development, printing, distribution, and revision expenses. Some state PSEPs operate essentially as entrepreneurs in a market environment with the ability to price manuals to what the market will bear to recover costs. Others use ‘training fees’ that directly or

indirectly subsidize manual costs. Still others have significant limitations placed on pricing, use of training fees, and the amount of cost recovery they are allowed. This results in the need to seek other sources of funding to subsidize manual costs.

One option that can offer cost efficiency is to adapt an existing manual from another state or work cooperatively to develop manuals. Multi-state manual development reduces the cost for any one state and creates a bigger pool of content expertise. This is already done with a number of manuals in various states. This approach requires close cooperation and shared vision between the SLA and PSEP. This is more difficult to achieve at the regional or national level because the relationships are more distant and less interdependent. While developing regional/national manuals or adopting a manual from another state has worked in some cases, in others it has increased the complexity of manual development. For example, a state that has adopted the model process for licensure tests and manual development (e.g., learning objectives based on a job analysis that are tied to a licensure test) cannot simply use a manual from a state without assessing the fit of the job analysis for their applicators. This can require extensive revision and may result in a longer development period and a greater level of project management and oversight.

One solution is to nationally or regionally share a category job analysis because the vast majority of the work performed by applicators is identical. States could then use their subject matter expert committees to adapt the job analysis to the state's unique legal, climatic, and pest issues when they revise or create new manuals. This ensures that the manual addresses the needs within the state and is aligned to the licensure test that the state deems appropriate.

Part C. Overviews of Test/Manual Development Processes

With respect to the elements associated with them, we have thus far discussed licensure testing and training manual development separately. However, when it comes to the process of actually developing tests and manuals, the two are best done in tandem. This is a natural consequence of basing the content of each on a common job analysis and of linking the job analysis, training manual, and licensure test via learning objectives.

The following are examples of actual or proposed approaches to licensure test and training manual development. Each incorporates most or all of the elements discussed earlier, but in different fashion. Thus, these examples illustrate how the process truly is flexible and can be adapted to meet the needs and resources of SLAs and PSEPs. They also show how the current approach used by any given state can be improved upon incrementally; it is not expected, nor is it practical, for any state to immediately incorporate every element into a single approach and then revise every set of manuals and exams simultaneously. Rather, a state should mold the elements described here into a manageable approach, implement it with the next new or revised test/manual combination, and then revise and build on the approach as warranted for the next project.

1. Colorado (Current)

In Colorado, pesticide safety education is the responsibility of Colorado State University Environmental Pesticide Education Program (CEPEP). The Colorado Department of Agriculture (CDA) is the regulatory agency which administers Colorado's pesticide laws and rules.

The CDA and CSU work closely on the study guide and exam development using a 12-step process. Each year an inter-agency agreement is entered into for CSU to develop, at a

minimum, one new study guide and to administer one examination item writing workgroup.

Manual Development – 4 steps

Step 1: Select guide. CDA and CEPEP work together to choose which guide is to be revised. Determining which guide is selected is based on several factors: examination pass/fail test statistics, the number of tests administered per category, age of the category since the last review, subject matter expert availability, and industry revision need (i.e.: public health issues in recent years).

Step 2: Recruit study guide workgroup. CDA recruits approximately 5 licensed commercial pesticide applicators with varying levels of experience to help develop the guide. Each year, the previous study guide and exam item writing committee must be taken into consideration to prevent using the same SMEs. Meetings are scheduled during the January – March timeframe to put the least amount of burden on industry participants.

Step 3: Develop guide job analysis / guide blueprint. The workgroup meets and discusses what information to include and in what order it should be presented.

Step 4: Develop study guide. CEPEP drafts a study guide using the blueprint. The guide is reviewed by workgroup participants as well as other CEPEP-identified individuals. Once reviews are incorporated, the guide is finalized and published.

Exam Development - after study guides are completed. – 8 steps

Step 1: Recruit item writing committee. CDA recruits 15-20 licensed commercial pesticide applicators with varying levels of experience, but they must hold a Certified Operator or Qualified Supervisor license in the exam category. All participants must sign a security agreement prior to participating.

Step 2: Orientation workshop. Participants meet with CEPEP and CDA staff and are taught the basic skills necessary to write high quality exam items.

Step 3: Conduct job analysis / exam blueprint. Participants meet with CEPEP and CDA staff and determine topics to be included and determine the percentage of questions that should come from each topic.

Step 4: Review existing questions. The item writing committee edits existing database items for content, format, style, grammar, and absence of potentially inflammatory or biased language. Items may be accepted, reworked and accepted, rejected, or referred to another item workgroup.

Step 5: Develop draft test items. Participants are asked to submit questions that they have written based on material from the study guide.

Step 6: Review draft test items. Submitted items are reviewed and critiqued by the full item writing workgroup. Items may be accepted, reworked and accepted, or rejected. If the item is accepted, it becomes the property of CDA.

Step 7: Finalize test items. CEPEP finalizes items to ensure that a minimum of 150% of total items needed have been produced.

Step 8: Enter test items into ParTEST. Test items are entered into a computerized item banking system.

Items are analyzed twice per year and corrective changes are made if the exam statistics reflect a problem with a question. CDA also shares all comments from testers with CSU. If there is a concern on the validity of a particular exam question, these comments are investigated accordingly and corrective actions are taken. To expedite this, all exam questions have notations as to where in the study guide the item was taken.

In FY 07, the CDA will implement a new step by inviting the item writing committee members back to take the examination for a post analysis examination.

2. Indiana (Current)

In Indiana, pesticide safety education is the responsibility of Purdue University Pesticide Programs (PPP). The Office of the Indiana State Chemist (OISC) administers Indiana's pesticide laws and rules.

Development of Indiana's pesticide applicator training curriculum is test-driven. OISC performs the preliminary stages of test construction before manual writing commences. The current mechanism for test and manual development was implemented in 1996. It entails the following steps:

1. Job analysis
2. Test plan development and manual draft
3. Item writing and manual assembly
4. Test assembly and standard setting
5. Item analysis

Step 1: Job analysis. OISC conducts a job analysis using the job task inventory method. Approximately 15 SMEs are identified who represent a cross section of the occupation of interest. The SMEs are assembled in a face-to-face meeting where they are encouraged to identify the important tasks associated with their work. The SMEs also organize the tasks (typically, one- to two- hundred) into job functions (generally five to eight) according to how the tasks relate to one another.

Step 2: Test plan development. The completed draft task inventory is transformed into a survey by attaching a five-point, Likert-type, importance scale to each task. The job task survey is mailed to a large sample of jobholders who are requested to:

- Provide demographic information,
- Identify how important each task is, and
- Assign (by percentage) test content weights to each main job function.

Survey results are compiled, descriptive statistics calculated (frequencies, means and standard deviations, etc), and the SMEs reconvened to review the data. The SME committee retains or deletes tasks based on an agreed upon decision rule related to mean task rating. Content weights for each job function are finalized based also on survey data, and the result is a descriptive test plan.

Manual draft. Using the completed test plan, PPP begins to draft a training manual using the major test content areas as organizing themes. Text focuses on job knowledge and skills that support important task performance. Presentation is intended to provide a meaningful, job-related context for this information, all of which is deemed "fair game" for the test. The draft manual text, not yet illustrated, formatted, etc. is provided to the OISC for item writing purposes.

Step 3: Item writing. OISC assembles another SME committee for purposes of item writing. Item writing begins after a presentation to the committee on good item writing practice. SMEs are each given a copy of the draft manual and assigned specific content areas over which to write test items. When a suitable number of items are written for each content area, the SMEs begin an item-by-item critique to correct for technical accuracy, good item writing practice, etc. The resulting item bank is subsequently provided to PPP.

Manual Assembly. PPP reviews the item bank to ensure that all of the items are addressed by, or can be inferred from, the draft manual. At this stage the manual is edited for clarity, punctuation, and grammar. It then undergoes a creative layout process where the text is placed in single-column format and illustrated with full-color photographs.

Step 4: Test assembly and standard setting. OISC selects items from the SME-generated item bank to reflect the test plan. Next, SMEs are reconvened, as a committee, to set a standard (establish a passing score) for the

exam. Each SME estimates a proportion of minimally competent test takers that they believe would score an item correct. They do this for each item and the group's results are summed and averaged to yield a "cut score."

Step 5: Item analysis. OISC and PPP coordinate implementation of the finalized test and companion manual so that they are both introduced prior to the first program of the upcoming training season (i.e., first working day of January). Item statistics, including a reliability estimate, are calculated post-administration.

The procedure outlined above documents evidence in support of OISC's claim of test content relevance. These activities provide the regulatory agency with a sound basis for making appropriate judgments about who does and who does not deserve a license. They ensure that manual content conforms to test content and also allow for a manual that relates information to how (and why) the job is performed.

3. New York State (Current)

In New York State, PSEP and SLA duties are assigned to Cornell's Pesticide Management Education Program (PMEP) and the Department of Environmental Conservation (DEC), respectively.

PMEP recognized the value of learning objectives to the learner and to manual development, and met with the DEC to discuss learning objectives with respect to test development. The DEC staff saw the potential for improving tests and made the commitment to write test items based on the learning objectives. Note: test length and passing score remains the same for most tests.

The flexible process blends the test and manual development elements into 5 steps:

1. PMEP author prepares draft with input from SMEs,
2. SMEs review draft (learning objectives and text)

3. Final manual developed,
4. Test content identified, and
5. Test items written.

Step 1: Author Prepares Draft. A first step is to communicate with the DEC to define the scope of the manual. For example, a Structural Pest Control manual covers vegetation management for the purpose of removing harborage and food sources for structure-invading pests? Defining the scope of the manual simultaneously defines the potential scope of the licensure test. The scope gives the author an idea of what job tasks are involved, but usually not the entire picture. The author takes the lead in identifying the set of knowledge and skills that relate to the pertinent job(s). The author relies on input from SMEs and DEC to confirm that the identified scope of the category accurately reflects the full range of job tasks. The PMEP author develops the learning objectives, which form the outline of the manual itself and each chapter therein.

Step 2: Draft Review. The first draft of the manual, containing learning objectives and text, is sent to the SMEs and DEC. They are specifically tasked to check to ensure the objectives fully cover the set of knowledge and skills necessary for performing the job tasks related to the category at hand. The reviewers then add, delete, and revise learning objectives and text as appropriate. This review of learning objectives is critical because it impacts the manual content and the potential items that will appear on the licensure test.

Step 3: Manual Is Completed. PMEP uses reviewer comments to finalize the manual. It is important to point out steps the author takes to facilitate learning. Each manual contains a preface with a section entitled "How To Pass the Certification Exam." Here, the author relates the importance of learning objectives and how to use them to prepare for the test, as described earlier in this document. PMEP also uses layout features to make manuals easier to read:

- Serif, 12-point font (similar to that used in this document);

- Narrow left-hand column for headings and subheadings (which makes it easy to find topics quickly and provides greater white space, making pages less “dense”);
- Wider right-hand column for text (maximum line length of 70 characters to avoid the problems of excessively short or long lines described earlier in this document);
- Left justification, as the consistent spacing between letters and words allows the eyes to move more quickly and with less effort;
- Double spacing between paragraphs to allow more white space and to set off text associated with different headings/subheadings; and
- Use of pictures and graphics to provide readers with visual memory clues.

The sample document “Storing Pesticides” illustrates these objectives (hyperlink to):

http://pep.wsu.edu/ctag/pdf/FlexibleExamManual_Storage_Chapter.pdf

Step 4: Test Content Identified. Learning objectives always outnumber test items because the objectives cover the full set of job knowledge and skills whereas any test only covers a subset. Category exams usually contain 50 questions, while a manual may contain over 200 learning objectives (typically, about 12 to 14 per chapter). The SMEs are mailed a list of chapter learning objectives. Using the following procedure, they select which ones they consider to be the most important.

1. PMEP identifies how many objectives (typically 25% to 33%) are to be selected within each chapter; so if 10 chapter learning objectives SME would select 3 or 4 objectives for that chapter). This approach guarantees that the number of objectives selected within a chapter is proportional to the total number for the chapter; thus, the selections are balanced across the entire manual.
2. Each SME reviewer selects the appropriate number of objectives but does not rank them; all receive an equal vote from that reviewer.

3. PMEP tallies the responses and provides the results to DEC. The majority of learning objectives get selected at least once, confirming the importance of the manual content. However, certain objectives get selected time and again by the different reviewers. Experience shows that by shooting for 33% selection, we actually end up with about 50 out of 210 that stand out as being the most important.

Step 5: Test Item Writing. By specifically identifying what knowledge and skills (learning objectives) are to be covered on the exam, the item writing is much easier which has benefited DEC greatly and increased the quality of their exams. The DEC writes test items based on the “stand-out” objectives. DEC values PMEP’s input and has them review a draft of the test. The process gives DEC flexibility. If more than 50 objectives stand out, the DEC can choose from among them; if fewer stand out, there are always objectives that were slightly less popular, from which DEC can choose items for the test.

PMEP and DEC are considering a modification to their approach. PMEP would first draft only an outline which would be broken down into chapters, with each chapter broken down into learning objectives, and each objective broken down into key points. The SMEs would review this draft. The absence of text would force reviewers to focus on the manual’s scope and on the learning objectives, rather than getting caught up in the “minutiae” of phrasing, grammar, and punctuation. The author would then revise the outline accordingly and begin to write the manual. While this is being done, the SMEs can select learning objectives for exam development.

By finalizing the learning objectives and content outline first, there is less rewriting and rearranging for the author after the text is reviewed and the test content is defined before the manual is finalized.

Experience shows that when test items are written after a manual is completed, subtle problems are exposed in the writing that interfere with an SLA's ability to write a particular question. Note that the new process does not mean the manual is "written to the test." The manual still covers the full range of learning objectives. The new process would just help make test items that much stronger.

testing the draft exam and ask SMEs to seek volunteers. After the third meeting, WSDA finalizes the draft exam and administers it to a test group. Test items and exam scores are analyzed. WSDA makes necessary changes to the exam. The exam is implemented one month after the new manual is available.

4. Washington (Under Consideration)

The procedure being considered consists of several meetings between Washington State University (WSU), the Washington State Department of Agriculture (WSDA), and SMEs.

WSU and WSDA work together to identify the target population and develop a draft job analysis, which is sent out to the SMEs prior to the first meeting. SMEs review the job analysis for gaps or unnecessary tasks.

First Meeting. WSU, WSDA, and SMEs (workgroup) review the exam/manual development process. They discuss target population and if necessary refine and finalize job analysis. After the meeting, WSDA develops a survey based on job analysis and it is sent to SMEs. WSDA receives and compiles the results.

Second Meeting. The workgroup reviews the survey task rankings and comments from respondents and develops the test blueprint. They also discuss the difficulty level for each section of the blueprint. After the meeting, WSU develops manual learning objectives and send them to the SMEs for review. WSU and WSDA develop a draft manual and exam items using the final blueprint and learning objectives, and send the draft manual to SMEs for review and comment.

Third Meeting. The workgroup discusses the draft manual. WSDA gives an overview of exam item writing and importance of exam security. The group reviews each exam item and finalizes it or discards it. Next, they discuss

Special Thanks

Special thanks in the preparation of this resource guide go to the CTAG Exam & Manual Development Workgroup members who shared their current procedures on exam and manual development, and who worked to develop a model process: Tim Drake, South Carolina Dept. of Agriculture; Margaret Tucker, Washington State Dept. of Agriculture; John Scott, Colorado State Dept. of Agriculture; Drew Martin, Purdue University; Ron Gardner and Dan Wixted, Cornell University; Clyde Ogg, University of Nebraska; and Dean Herzfeld, University of Minnesota. In addition, thanks go to Carol Ramsay, Washington State University, and Michelle Devaux, US EPA, for steering the project through to its completion.

How to Improve this Resource Guide

CTAG welcomes your comments and suggestions. If your exam and manual development procedures provide for defensibility and vary significantly from those presented in this document, or if you would like to recommend additional procedures, or if your circumstances make one or more recommendations difficult or impossible, send a note to Michelle Devaux at devaux.michelle@epa.gov so CTAG can continue to improve this document.

Appendix I: Terms

Competencies: The collective knowledge, skills, and abilities necessary to perform a job.

- **Knowledge:** An article of information that jobholders need to possess in order to perform a range of tasks (e.g. knowledge of factors that affect herbicide application rate).
- **Skill:** An acquired proficiency necessary to perform a range of tasks (e.g., skill at performing basic arithmetic functions).
- **Ability:** A stable attribute necessary for performing a range of tasks (e.g., ability to effectively perform tasks in an unsupervised environment).

Content-relevance: Degree of congruence between a test and the domain of interest (e.g., job knowledge).

Cut Score: Minimum passing score for the exam. The cut score differs from exam to exam because it is based on an item-by-item determination of the percentage of candidates who answered the item correctly and who would be expected to answer the item correctly. The cut score is determined by a group of experts.

Item: An item is the basic unit of any test. Items (generally in the form of a question or a statement) are designed to elicit a response from the test taker. Responses may be selected (e.g., multiple choice) or constructed (e.g., short answer).

Item Analysis: Statistical analyses of test items (piloted or post-administration) including percentage of persons scoring the correct response, percentage of responses to alternatives, and an item discrimination index. Analysis also typically entails determining [a] reliability estimate and score frequency distribution.

Job: A coherent and relatively stable collection of work tasks.

Job Analysis: The identification and organization of information about tasks and/or competencies associated with a job. Often referred to as practice or occupation analysis in the context of credentialing activities.

Job Function: A job subdivision composed of related tasks.

Occupation: An instance of a job common to two or more organizations.

Task: A discrete unit of work related behavior.

Reliability: Score consistency over repeated measurements.

SMEs: Subject matter experts may be applicators, consultants, extension agents or specialists, researchers, biologists, etc.

Test Plan: An outline of content for test construction purposes including types and numbers of items, administration procedures, and scoring rationale. Alternatively referred to as test specifications or a test blueprint.

Test-wiseness: The ability to select the correct response with little or no knowledge of item content by capitalizing on unintended cues contained in the item.

Validity: A judgment of the extent to which theory and evidence support appropriate score interpretation and use.

Validation: A systematic, information gathering process preparatory to implementing a testing program. For credentialing purposes, validation entails: (1) job analysis, (2) test plan development, (3) item writing, (4) test assembly, (5) item analysis, and (6) standard setting.

Appendix II: Sample Chapter and Test Items

Manual Chapter

The sample document “Storing Pesticides” is a truncated version of a chapter from a training manual developed by Cornell University’s Pesticide Management Education Program (PMEP) (hyperlink to):

http://pep.wsu.edu/ctag/pdf/FlexibleExamManual_Storage_Chapter.pdf

Note that the learning objectives reflect the scope and content of the entire 9-page chapter. We truncated the chapter text at the end of the fifth page in the interest of keeping the document as brief as possible.

The chapter is included because it:

- Is an example of a brief, topic-specific chapter;
- Shows how learning objectives are structured and how they relate to the text;
- Illustrates features described in the model document that enhance readability (e.g., two-column format to highlight headings and subheadings, line length and justification, paragraph spacing, font style and size, active tense); and
- Will be used to show how learning objectives and test items are linked.

Test Items

Three sample test items are derived from the chapter “Storing Pesticides.” To help illustrate

the link between the chapter’s learning objectives and the test items, the appropriate learning objective is listed before each sample item. As you review the sample test items, note how:

- An item directly addresses a single learning objective,
- The correct response to an item can be found in or inferred from that portion of the chapter text which addresses the learning objective, and
- The learning objectives clearly inform an applicator as to what he/she is expected to learn in preparation for the licensure test.

The corresponding test items are provided in two different formats: fill-in-the-blank and multiple choice question. The multiple choice question format is traditionally preferred within the test development community. However, there is little hard data to support this preference. Therefore, because each format has been used successfully, we suggest that each state be able to choose the format it prefers.

Note that the third fill-in-the-blank item puts the blank at the end of the item’s stem. This particular version of fill-in-the-blank is called sentence completion. It is traditionally preferred over having blanks elsewhere in the stem, though again there is little supporting data.

Sample Test Items: Fill-in-the-Blank Format

Learning Objective A

Distinguish between items you can and cannot store with pesticides and pesticide-impregnated materials.

Sample Item A

Always store _____ outside of the pesticide storage area.

- a. Pesticide rinsate
- b. Fire extinguishers
- c. Respirators
- d. Spill response materials

Correct Response: c (“Storing Pesticides,” page 2, last paragraph)

Learning Objective B

Identify steps you can take to prevent unauthorized access to a pesticide storage facility.

Sample Item B

A warning sign indicating that a facility contains pesticides should be posted on _____ point of access to the facility.

- a. The most prominent
- b. Each
- c. Each unlocked
- d. The most commonly used

Correct Response: b (“Storing Pesticides,” page 4, 3rd paragraph)

Learning Objective C

Explain why and how you should regulate temperature and humidity in your storage area.

Sample Item C

Excessively cold temperatures in a pesticide storage facility can cause _____.

- a. Pesticide fires
- b. Toxic fumes to build up
- c. Dry formulations to cake
- d. Containers to rupture

Correct Response: d (“Storing Pesticides,” page 5, 2nd paragraph)

NOTE: These items do NOT appear on actual licensure tests. They are for demonstration purposes only.

Sample Test Items: Question Format

Learning Objective A

Distinguish between items you can and cannot store with pesticides and pesticide-impregnated materials.

Sample Item A

Which of the following should you always store outside of the pesticide storage area?

- a. Pesticide rinsate
- b. Fire extinguishers
- c. Respirators
- d. Spill response materials

Correct Response: c ("Storing Pesticides," page 2, last paragraph)

Learning Objective B

Identify steps you can take to prevent unauthorized access to a pesticide storage facility.

Sample Item B

At which access point(s) should you post a warning sign indicating that a facility contains pesticides?

- a. The most prominent one
- b. Each one
- c. Each unlocked one
- d. The most commonly used one

Correct Response: b ("Storing Pesticides," page 4, 3rd paragraph)

Learning Objective C

Explain why and how you should regulate temperature and humidity in your storage area.

Sample Item C

Excessively cold temperatures in a pesticide storage facility can cause which of the following?

- a. Pesticide fires
- b. Toxic fumes to build up
- c. Dry formulations to cake
- d. Containers to rupture

Correct Response: d ("Storing Pesticides," page 5, 2nd paragraph)

NOTE: These items do NOT appear on actual licensure tests. They are for demonstration purposes only.