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FAO PESTICIDE DISPOSAL SERIES 10

FAO training manual for inventory taking of obsolete pesticides

Food and Agriculture Organization of the United Nations

TC/D/X8899E/1/11.01/2000

Preface

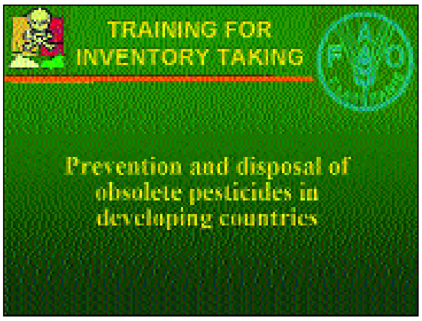

Figure 1

This training package has been designed to help prepare staff to carry out a safe and effective inventory of obsolete pesticides (Figure 1). Completion of a detailed inventory of obsolete pesticides is the first step in addressing the problem of obsolete pesticides effectively. It is vital to know not only the quantity of obsolete stocks in a country, but also their location, condition, source and other information that may be relevant to further actions to be taken.

Working with pesticides can be hazardous, particularly if they are in poor condition or stored in difficult conditions. It is always important for those working with pesticides to be appropriately trained and have a good understanding of the materials they are dealing with. Completion of this training course will equip personnel with the knowledge and understanding required to keep them, other people and the environment safe from harm.

No person should be asked to carry out an inventory of obsolete pesticides without having first undergone this or a similar programme of training.

No person should be expected to carry out any work with obsolete or other pesticides that may put themselves, other people or the environment at risk.

For the purposes of delivering this training course the following equipment should be available to the trainers and participants:

- a computer running Microsoft PowerPoint 2000;
- a PC projector and screen;
- several MSDS for different pesticides;
- several product labels for different pesticides;
- coveralls, boots, gloves, goggles, face shields and masks of all the types discussed in the training manual in sufficient quantities to allow all participants to try all equipment;
- a resuscitation training dummy;
- a complete set of printed notes for each participant.

The following publications are also required:

- **Tomlin, C.D.S., ed. 1997.** *The pesticides manual*, 11th edition. Farnham, United Kingdom, British Crop Protection Council (BCPC).
- **WHO.** 1998-1999. *Classification of pesticides by hazard and guidelines to classification*. Document No. WHO/PCS/98,21. Geneva, World Health Organization.
- International Code of Conduct on the Distribution and Use of Pesticides;
- **FAO.** 1995. *Prevention of accumulation of obsolete pesticide stocks. Provisional Guidelines*. FAO Pesticides Disposal Series No. 2. Rome.
- **FAO.** 1996. *Pesticide storage and stock control manual*. FAO Pesticides Disposal Series No. 3. Rome.
- **FAO.** 1996. *Disposal of bulk quantities of obsolete pesticide in*

developing countries. Provisional technical guidelines. FAO Pesticides Disposal Series No. 4. Rome.
- **FAO.** 1999. *Guidelines for the management of small quantities of unwanted and obsolete pesticides.* FAO Pesticides Disposal Series No. 7. Rome.
- **FAO.** 2000. *Assessing soil contamination: a reference manual.* FAO Pesticides Disposal Series No. 8. Rome.

The Food and Agriculture Organization of the United Nations (FAO) has been running a programme for the prevention and disposal of obsolete pesticides in developing countries since 1994. This *Training for inventory taking* is delivered under the auspices of the FAO programme on prevention and disposal of obsolete pesticides in developing countries.

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FAO has assisted in the completion of obsolete pesticide inventories in Africa and the Near East and is now working in Latin America and Asia.

Guidelines produced in the FAO Pesticide Disposal Series include:
- No. 2. *Prevention of accumulation of obsolete pesticide stocks. Provisional guidelines* (1995);
- No. 3. *Pesticide storage and stock control manual* (1996);
- No. 4. *Disposal of bulk quantities of obsolete pesticides in developing countries. Provisional technical guidelines.* (1996);
- No. 7. *Guidelines for the management of small quantities of unwanted and obsolete pesticides* (1999);
- No. 8. *Assessing soil contamination: a reference manual.* (2000).

In addition, a CD-ROM, videos and leaflets have been produced and are available from FAO.

Contents

1. Introduction

Figure 1

The training course is designed to run over five days. Each day is divided into two sessions: morning and afternoon. Topics are presented as a combination of lectures, demonstrations, practical exercises and/or videos.

The training course covers several issues as highlighted in figure 2.

Figure 2

By the end of 1999, FAO had facilitated the removal and safe destruction of nearly 700 tonnes of obsolete pesticides and 90 000 empty containers from six countries. The Organization has also played an important coordinating and information role in several other disposal operations funded and carried out by other agencies (Figure 2).

FAO carries out regional and national training on prevention and disposal of obsolete pesticides. This training for inventory taking is part of FAO's training programme.

FAO raises awareness about the problems of obsolete pesticides and the need for effective prevention and solutions in international fora, through the media and through its own information networks.

FAO supervises and monitors disposal operations to ensure that best practices and national as well as international legislation are adhered to. Disposal is also followed up to ensure that the accumulation of obsolete pesticide stocks does not recur.

Figure 3

Every element of this training course is relevant to the following overall objectives (Figure 3):

- *Complete effective inventories:* understand the importance of accurate and safe inventory taking, and adopt standard methods to be followed by all countries;
- *Protect workers, the public and the environment:* identify the hazards of obsolete pesticides and ways of protecting the people working with them, the public and the environment;
- *Prioritize sites for action:* decide which situations are most hazardous and need to be dealt with first;
- *Stabilize and clean storage sites:* establish how to work safely and effectively in order to prevent further contamination from leaking pesticides and contaminated material.
- *Prevent future accumulation:* decide how to prevent similar problems from occurring in the future;
- *Prepare proposals for disposal operations:* identify what needs to be done to solve existing problems and how progress can be made.

The workshop covers a lot of material in a short time. Please refer to Figure 4.

Figure 4

CURRENT SITUATION

In Africa and the Near East estimates of obsolete pesticides are based on

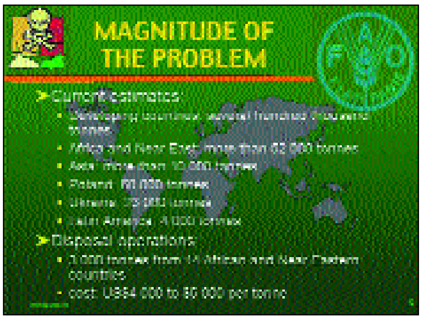

Figure 5

detailed inventories completed by 35 countries in compliance with the FAO format for inventories, and collated by FAO (Figure 5).

In Asia, estimates are available for very few countries, hence the need for this training programme and the completion of surveys and inventories for all Asian countries. An inventory has been completed for Pakistan and some work in identifying stocks has been carried out in Nepal.

Poland is the first Eastern European country to carry out a detailed inventory of obsolete pesticides, which are stored in underground bunkers. The pesticides have leaked in many situations and are corroding the bunkers, threatening groundwater and the wider environment. Poland is funding its own disposal and clean-up programme.

Other Eastern European members of the Commonwealth of Independent States (CIS) have begun to carry out inventories of persistent organic pollutants (POPs), including obsolete pesticides, under the auspices of United Nations Environment Programme (UNEP) Chemicals.

In Latin America, work has started on the completion of inventories of obsolete pesticides with the support of UNEP and the guidance of FAO. Some disposal has been carried out with World Bank funding in Nicaragua and Honduras.

Disposal operations

Since 1994, fewer than 3 000 tonnes of obsolete pesticides have been cleared from developing countries and safely disposed of. At this rate, it will take more than 40 years to clear Africa alone, and other regions are also heavily contaminated and require urgent attention.

The current cost of clean-up is between US$3 000 and $5 000 per tonne. This covers the costs of repackaging, site clean-up, overland transportation, shipment to Europe and incineration in dedicated high-temperature hazardous waste incinerators. Costs vary according to the condition and location, as well as the type, of the obsolete stocks.

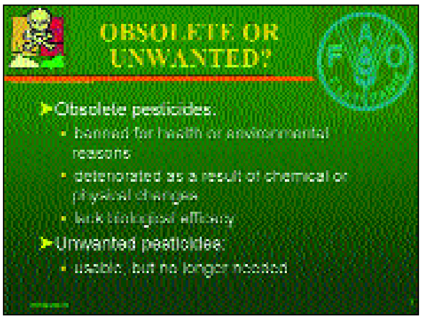

Figure 6

OBSOLETE PESTICIDES AND THEIR CAUSES

A distinction has to be made between obsolete and unwanted pesticides (Figure 6):

- *Obsolete pesticides* are pesticides that cannot be used for the purpose for which they were intended and must be processed for destruction, to render them harmless or to convert them into another useful product. Pesticides become obsolete when they have been banned, and it is therefore illegal to use them; because they have deteriorated physically or chemically so that they are no longer in the form they were supplied in; or after they have lost their pesticidal properties and are no longer effective against pests.
- *Unwanted pesticides* are still well packaged and clearly labelled, and could be used legally but are not needed, either because pest incidence is lower than expected or because they are no longer the most effective or appropriate products for a particular purpose. It may be possible for such pesticides to be transferred for use elsewhere.

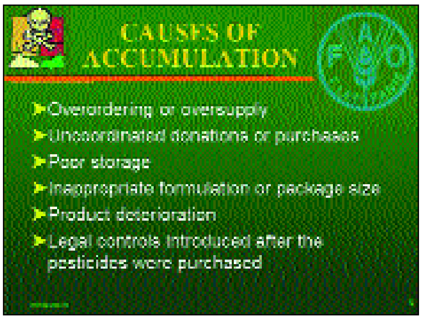

Figure 7

CAUSES OF ACCUMULATION (Figure 7)

Overordering or oversupply

Overordering or oversupply arise from purchasing systems that are not aware of actual pesticide needs in the field and therefore order too many. Sometimes this is the result of errors in ordering processes; in other cases officials are bribed to buy more pesticides than are needed. Sometimes high pressure or unscrupulous sales techniques convince officials to over-order pesticides.

Uncoordinated donations or purchase

Uncoordinated donations or purchases result when suppliers, whether commercial or donors, do not coordinate their activities. This can lead to the supply of more pesticides than are actually needed, or to duplicate supplies. It is sometimes difficult to refuse donations even if they are inappropriate. In the case of pesticides it is always important to refuse to accept products that do not exactly match national or local needs.

Poor storage

Poor storage of pesticides can lead to faster deterioration owing to temperature fluctuations, physical damage or contamination. Pesticides should always be stored in appropriate conditions in accordance with FAO guidance (see Pesticide stock control, on p. 67).

Inappropriate formulation or package size

Pesticides are sometimes supplied in large containers, which small-scale farmers cannot use, or in formulations that cannot be applied using locally available equipment.

Product deterioration

Pesticides deteriorate over time and have only a limited shelf-life, beyond which their efficacy or safety cannot be assured without laboratory analysis. Poor storage and container damage accelerate deterioration.

Legal controls subsequent to supply

When a chemical used in pesticide is banned, the pesticide stocks of farmers, retailers and other holders become obsolete immediately. Owners of obsolete products are either given a time limit within which to use the products they hold, or they are provided with facilities for the safe disposal of the banned products.

Figure 8

IDENTIFYING AND MEASURING THE PROBLEM

Few developing countries can confidently claim to have no obsolete pesticide stocks. Understanding the scope of the problem in each country is a vital first step to developing and implementing effective solutions. Without effective solutions, the risk to health and the environment from leaking and deteriorating pesticides will continue. Determining the scope of the problem entails gathering as much detailed information as possible about the following (Figure 8):

- *Quantity:* How much of each type of pesticide is there, and what other materials associated with the pesticides, such as contaminated soil or containers, might require disposal?

- *Identity:* What products are stored, what are their formulations, where are they from, and who manufactured them?
- *Condition:* How old are the products and what is the condition of the chemicals and their containers, as well as the storage sites?
- *Location and ownership:* Where are the pesticides, and who owns them and is responsible for them?

Risk assessment and prioritization

Using the information gathered to identify and measure the problem, it is possible to determine which sites are in the most hazardous condition and therefore require most urgent action.

Figure 9

FORMULATING SOLUTIONS

Dealing with obsolete pesticide stockpiles is expensive and technically complex. It is essential that a coherent plan of action be formulated in order to ensure that appropriate solutions are implemented by people with appropriate expertise. Carefully formulated plans are also needed when approaching donors for assistance with implementing solutions.

To solve the problem of obsolete pesticides and prevent recurrence, the following steps must be implemented (Figure 9):

- *Execute inventory and stabilization:* The quantity and quality of obsolete pesticides must be determined and storage sites stabilized in order to prevent any further environmental contamination and risk to health from leaking pesticides.
- *Implement prevention measures:* Measures to prevent accumulation of obsolete pesticides must be put in place before any action is taken to dispose of existing stocks. These should include regulation, policy, technical and educational measures.
- *Formulate a proposal:* This is necessary to guide national and local action, and when approaching donors for support.
- *Secure funds:* Disposal and clean-up operations are expensive because of the technical complexity and hazards they involve. Few developing countries can pay for such activities from their own funds.
- *Implement disposal operations:* Specialist expertise must be used to carry out operations, but projects should be formulated to support capacity building in developing countries.
- *Carry out ongoing prevention and monitoring:* Donor-funded disposal operations are one-off activities that are not repeated. Donors generally require that strong and effective prevention measures be put in place to ensure that there is no recurrence of obsolete pesticide accumulation.

SUMMARY

This introduction has looked at the aims of this training programme. It examined the nature and magnitude of the problem of obsolete pesticides as a global, regional and national problem, and discussed the causes of obsolete pesticide accumulation. The need for a comprehensive inventory of obsolete pesticides was highlighted as the first step in developing solutions to the problem of obsolete pesticide stockpiles in developing countries.

Figure 1

2. Health and environmental hazards

Pesticides are chemicals that are designed to be toxic to living organisms (Figure2). They therefore present potential risks to human health and the environment. Obsolete pesticides can present greater risks than new products because of their condition.

An understanding of the hazards of pesticides and the risks they pose is important when making decisions about how to deal with obsolete pesticides and how to reduce risks effectively (Figure 3).

Pesticides may cause short-term acute toxic effects. These are usually the results of exposure to a large dose and generally appear within minutes or hours.

Chronic, longer-term effects may result from a single acute exposure. More commonly however, chronic effects result from continued exposure over an extended period of time, for example, among people working in a pesticide manufacturing plant or applying pesticides regularly on farms.

Environmental damage from pesticides can take many forms and can be caused by a range of exposure routes.

Figure 2

Figure 3

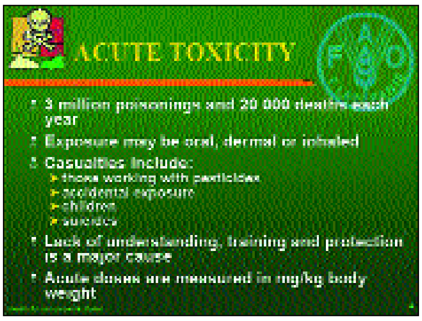

Figure 4

ACUTE EFFECTS (Figure 4)

Injuries may be caused either by a single massive dose being absorbed during one pesticide exposure, or from smaller doses absorbed during repeated exposures over an extended period of time. Illness or damage is referred to as acute when it has a sudden onset and lasts for a short period of time. The type and severity of the symptoms depend on the chemical mode action and toxicity and the amount of chemical the victim has been exposed to. The more extreme symptoms occur with highly toxic chemicals and/or high exposures.

The World Health Organization (WHO) estimates that 3 million people are poisoned by pesticides yearly and that most of these cases are in developing countries. Every year, some 20 000 of these poisoning victims die.

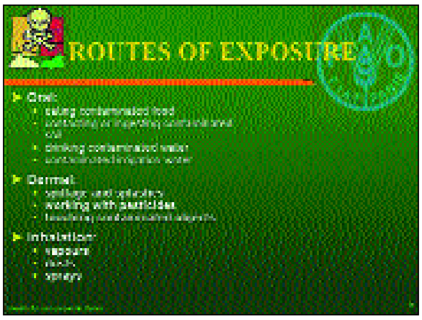

Figure 5

The victims of pesticide poisoning are not only those who apply the pesticides. Other people working with pesticides, such as storekeepers and farm workers, may also be exposed. Even those who do not work with pesticides may be exposed to them unknowingly, for example, by being sprayed accidentally or eating contaminated food. Children are frequent victims of pesticide poisoning when they eat or drink pesticides that are not properly stored or when they are fed contaminated foods. Pesticides are also widely used as suicide agents because of their easy availability.

Pesticides may enter the body orally (through the mouth) (Figure 5), they may be inhaled as vapours or dusts, or they may enter through the skin. Oral ingestion may occur by accidentally drinking a pesticide, by splashing spray materials or pesticide dust into the mouth, or by eating or drinking contaminated foods or beverages. Smoking while handling pesticides may also cause ingestion.

The ability of a pesticide to be absorbed through the skin depends on the chemical characteristics of the pesticide and its formulation. Respiratory exposure occurs when dust or vapours enter the lungs, or when aerosols are formed when pesticides are sprayed. Pesticides that are more soluble in oil or petroleum solvents penetrate skin more easily than those that are more soluble in water.

Figure 6

CHRONIC EFFECTS (Figure 6)

Chronic toxicity refers to the effects that occur after exposure over a long period of time, or to symptoms that occur long after exposure and/or persist for a long time. In general, these effects can occur with doses as low as a few micrograms of pesticide per kilogram body weight of the person or animal exposed.

Examples of the chronic effects of pesticides on humans are described in the following sections.

Cancer: tumours and the immune system

Pesticides can exert a carcinogenic effect through a variety of mechanisms, including:

- *Genotoxicity:* Pesticides react with DNA to cause mutations or cancer.
- *Hormonal action:* Pesticide lengthens the oestrous cycle, prolonging exposure to endogenous oestrogen, and can cause mammary and uterine tumours.
- *Immunotoxicity:* Pesticides can alter immune function in a number of ways that can cause cancer.

Neurological effects

Examples of neurological effects are numbness or weakness of arms, legs, feet or hands; lethargy; memory loss; loss of concentration; and anxiety. The following paragraphs describe only a small subset of the possible neurological symptoms of pesticide exposure.

Reproductive toxicity. Reproductive toxicity is "... the occurrence of adverse effects on the reproductive system that may result from exposure to environmental agents. The toxicity may be expressed as alterations to the reproductive organs or the related endocrine system. The manifestations of such toxicity may include alterations in sexual behaviour, fertility, pregnancy outcomes, or modifications of other functions that depend on the integrity of the reproductive system." Effects include:

- *Time to pregnancy.*
- *Infertility:* Clinical infertility is failure to conceive after 12 months of unprotected intercourse, and is clearly related to time to pregnancy.
- *Early pregnancy loss:* This is pregnancy that is detected through the use of highly specific pregnancy tests and that is lost prior to clinical recognition.
- *Spontaneous abortions:* These are pregnancies that terminate naturally prior to 20 weeks of completed gestation.
- *Foetal deaths:* These are pregnancies that terminate 20 weeks or more after gestation, where the conceptus shows no signs of life at time of delivery.
- *Reductions in fertility and sperm counts in men.*

Developmental toxicity. This is manifested by death of the developing organism, structural abnormality, altered growth and/or functional deficiency. Developmental toxicity is "... the occurrence of adverse effects on the developing organism that may result from exposure prior to conception (either parent), during prenatal development, or postnatally to the time of sexual maturation. Adverse developmental effects may be detected at any point in the life span of the organism. The major manifestations of developmental toxicity include death of the developing organism, structural abnormality, altered growth, and functional deficiency." Major effects include:

- *death of developing organism:* through spontaneous abortion or foetal death;
- *structural abnormality:* congenital malformations;
- *altered growth:* low birth weight as a result of intrauterine growth retardation.

Spontaneous abortions can result from both reproductive and developmental toxicity – in most instances the exact mechanism cannot be determined.

Endocrine disruption. This is manifested by effects on the hormone system. Many chemicals, including some pesticides, have structures that allow them to mimic the hormones in humans and animals. This can interfere with the organism's sexual and cognitive development, behaviour, fertility and survival. The United States Environmental Protection Agency (USEPA) is developing tests to screen pesticides for oestrogenic effects.

Organic disorders. Some chemicals can disrupt the activity of specific organs in the body such as the kidneys, liver, blood or digestive tract.

Others. Some chronic effects of pesticides and other chemicals have only recently been recognized. In time, other chronic health effects may be identified that are currently unknown.

Figure 7

ENVIRONMENTAL EXPOSURE

Environmental exposure occurs through many routes and can have many consequences (Figure 7).

Animals can be poisoned directly as a result of exposure to pesticides, or indirectly by consuming pesticide-contaminated food or water. The food sources of wildlife can be killed by pesticides, leading to starvation or sublethal effects such as reduced breeding success. In some cases predators can be deprived of food because the food sources of prey species have been destroyed by pesticides. An example would be the use of herbicides that kill the weeds on which insect larvae feed. Insect larvae may be the food source for birds, and so the bird population is indirectly affected by herbicide use.

Widespread use of broad-spectrum herbicides can destroy wildlife habitats by killing important plants. Some pesticides, in particular organochlorines, accumulate in body fat and become more concentrated as animals higher up the food chain consume them in their prey.

Some chemicals can affect wildlife populations in subtle ways such as by reducing reproductive success. This may be caused by the endocrine-disrupting properties of the pesticides, food deprivation, habitat damage or sublethal toxic effects.

Some pesticides may cause immunosuppression in wildlife species, making them more susceptible to disease.

Identifiable effects of pesticides have been measured in the environment at doses as low as $3x10^{-12}$g/kg (for example, tributyltin oxide (TBTO) causes reproductive abnormalities in dog whelks).

The effect of pesticides on wildlife populations, through poisoning, reduction of food sources or reduced fertility, can ultimately reduce biodiversity in an ecosystem.

Figure 8

Pesticides can enter water through a variety of routes, including leaching through soil, surface runoff or direct spillage into natural or constructed watercourses. The pesticides could then be consumed in drinking-water, be applied unintentionally to crops in irrigation water and affect natural aquatic biota (Figure 8).

Figure 9

PESTICIDE HAZARDS (Figure 9)

Of the pesticide active ingredients in widespread general use worldwide, 118 have been identified as endocrine disrupters; 60 have been classified by the International Agency for Research on Cancer (IARC), USEPA or the European Union (EU) as carcinogenic to some degree; 129 pesticides are defined by WHO as extremely or highly hazardous; and 111 are organophosphates and therefore pose severe health hazards.

Many pesticides have not undergone full toxicological and environmental reviews, and their carcinogenicity and endocrine-disrupting properties have not yet been fully assessed using modern evaluation techniques. It may be, therefore, that many more pesticides possess adverse health properties.

There are many ways in which the environment can be exposed to

Figure 10

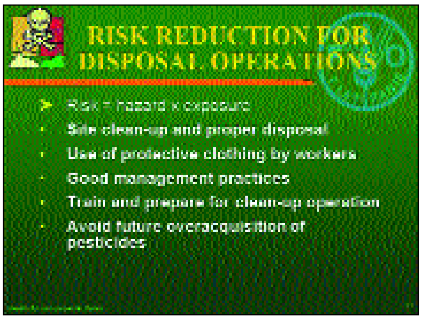

Figure 11

pesticides, either during the long-term storage of pesticide stocks or during a disposal operation. The list on Figure 10 identifies several routes of exposure which should be accounted for when carrying out risk assessments.

EXPOSURE FROM DISPOSAL OPERATIONS

Considering the hazards of pesticides to health and the environment, and the potential for exposure of people and the environment to stored obsolete pesticides, it is often decided that a clean-up and disposal operation should be carried out.

People and the environment can, however, also be exposed during the activities leading up to and during a clean-up and disposal operation, even though such an operation eliminates the risks posed by storing large stocks of pesticides.

The risks associated with storing stocks of obsolete pesticides and those associated with conducting an inventory, and later a disposal operation, must be minimized (Figure 11). Since the nature of the pesticides themselves cannot be changed, the only way of minimizing risk is by reducing exposure by taking the following steps:

- *Site clean-up and proper disposal:* Cleaning up the site and properly disposing of pesticides eliminates a source of environmental exposure to pesticides and chronic exposure to the surrounding population.
- *Use of protective clothing by disposal operation workers:* The most important way to minimize acute human exposure of workers during clean-up is to use personal protective equipment (PPE), which is discussed in greater detail on p. 25.
- *Good management practices during work with obsolete pesticides:* Following good management practices (GMPs) will minimize additional exposure. These are covered in more detail in Pesticide stock control, on p. 67, but include the following general rules:
  - clean spills immediately;
  - transfer or repackage pesticide in "contained" and impermeable areas only;
  - do not store or work with pesticides near wells or surface water;
  - establish a buffer zone between storage and surface water;
  - do not work outside when it is raining;
  - manage storm water runoff;
  - check wells for leaks and well casings for cracks;
  - seal unused wells;
  - protect against back-siphoning.
- *Train and prepare for the clean-up operation:* This topic is covered in greater detail in Inventory taking on p. 71. One way of reducing exposure is to train and prepare properly.
- *Be prepared for medical emergencies.* This does not really reduce exposure, but enables workers to do the right thing if there is an exposure. Anticipate emergencies and prepare the work site by:
  - notifying local doctors and medical facilities about the disposal operation;
  - posting emergency telephone numbers and addresses;
  - giving workers medical examinations to identify baseline

conditions and any health concerns;
- ensuring that the work site is well ventilated and well-lit; has a concrete floor and curbs; has fire exits and extinguishers; and has a water supply for routine and emergency use;
- training in how to use protective equipment, work safely, react in an emergency and protect against heat stress.

• *Prevent future overacquisition of pesticide:* This topic is covered in Pesticide stock control, on p. 67.

Figure 12

SUMMARY (Figure 12)

By their very nature, pesticides are hazardous to varying degrees. Obsolete pesticides are potentially more hazardous than new pesticides because they may be poorly identified, leak or be degraded physically or chemically. All activities requiring the handling of pesticides, and in particular obsolete pesticides, should be carried out with extreme care and with attention to all aspects of health and safety.

Despite these hazards, leaving obsolete pesticide stocks in their existing state is likely to lead to more serious health and environmental damage in the long term. It is therefore advisable to take appropriate action as quickly as possible.

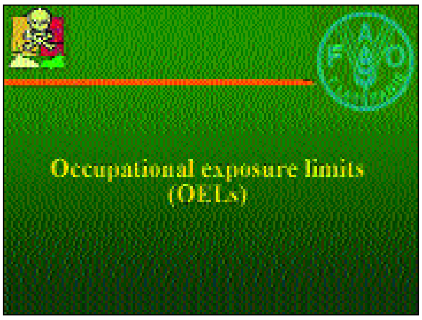

Figure 1

3. Occupational exposure limits

This unit discusses occupational exposure limits (OELs) which are designed to protect workers who may be exposed to chemicals in the workplace (Figure 2).

The purpose of OELs is to prevent harm to those working with chemicals or likely to be exposed to them in the course of their work. In many countries, OELs are set by government authorities. They are commonly updated annually and are legally binding. It is the duty of employers to ensure that OELs are not exceeded by anyone working for them (Figure 3).

The OEL is a reference figure with which actual exposure should be compared. Actual exposure can be determined by monitoring, but in some cases effective monitoring may not be possible. In such cases, appropriate precautions should be taken to ensure that OELs are not exceeded.

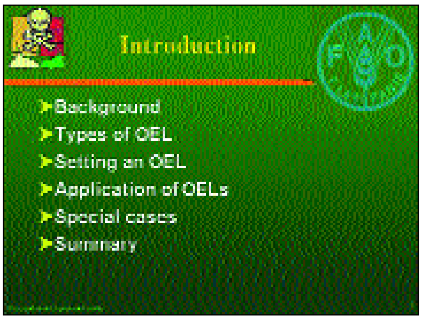

Figure 2

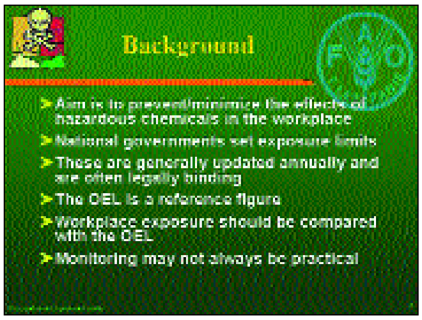

Figure 3

CLASSIFICATION OF PESTICIDES

A widely accepted method of categorizing pesticides based on their toxicity can be found in the *WHO Classification of pesticides by hazard and guidelines to classification 1998-1999* (see Preface for bibliographic details).

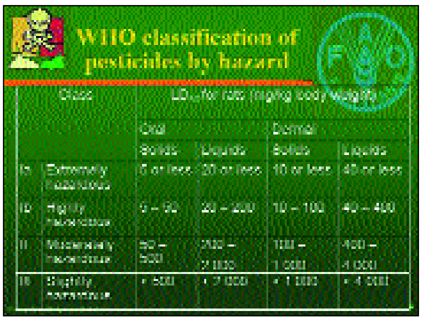

Figure 4

Classification is based primarily on the acute oral and dermal toxicity of the pesticide active ingredient to rats, since these determinations are standard procedures in toxicology (Figure 4).

A few points about this classification scheme should be clarified. First, classification focuses on acute toxicity, not chronic toxicity. Second, acute toxicity is represented by the 50 percent lethal dose (LD_{50}).

The oral LD_{50} is the dose of pure chemical, measured in milligrams per kilogram body weight of the animal, that was found to kill 50 percent of a sample population when fed to rats in laboratory tests.

Figure 5

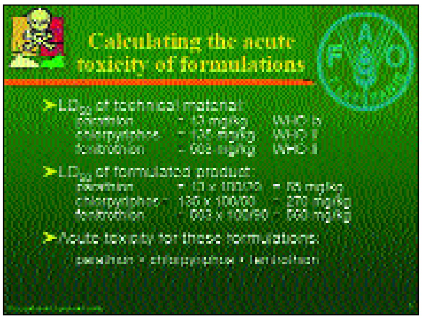

Figure 6

Figure 7

Figure 8

This figure is an indicator of the acute toxicity of an active ingredient. Note that pesticide products often contain very diluted active ingredients, and these are often diluted again for application.

Furthermore, hazards associated with pesticides vary according to the route of entry to the body. Normal routes of entry include the mouth, skin, eyes and lungs. The LD_{50} of a pesticide is usually established for skin-applied (dermal) and ingested (oral) exposure.

The WHO guidelines give the acute toxicity of the technical products, which are the products that are nearly 100 percent active ingredient. Most of the pesticides found in storage are formulated products, which have a lower percentage of active ingredient.

The WHO guidelines state that "It is highly desirable that, whenever practicable, toxicological data for each formulation to be classified should be available from the manufacturer. However, if such data are not obtainable, then the classification may be based on proportionate calculations from the LD_{50} values of the technical ingredient or ingredients, according to the formula (see Figure 5):

$$LD_{50} \text{ of formulated product} = \frac{LD_{50} \text{ of technical product}}{\text{\% active ingredient in formulated product}} \times 100$$

To get the LD_{50} of a specific formulated product in storage, multiply the LD_{50} (listed in the WHO guidelines) by 100 and divide by the percentage of active ingredient in the product.

In the example illustrated in Figure 5 three drums of pesticide have to be repackaged. These have been labelled and analysed, and the active ingredient concentration has been marked as a percentage on each drum. In the example, the fenitrothion is 90 percent active ingredient, the parathion 20 percent, and the chlorpyriphos 50 percent. All three are organophosphate insecticides and cause cholinesterase inhibition, a very serious condition that can be fatal. However, the toxicity of the *formulation* needs to be calculated as in Figure 6 in order to determine which products presents the greatest hazard.

The lethal dose does not provide information about chronic, long-term toxic effects. Furthermore, a pesticide that has a high LD_{50} (i.e. is relatively non-toxic) may cause skin or eye irritation or other ailments. Materials with these types of hazards require special precautions during handling. (This text is taken directly from the United Kingdom Government's Health and Safety Executive Publication No. EH 40.)

TYPES OF OCCUPATIONAL EXPOSURE LIMIT (Figure 7)

The occupational exposure standard (OES) is set, on the basis of current scientific information, at a level that will not damage a worker who is exposed repeatedly – day after day. Maximum exposure limits (MELs) are set for dangerous chemicals such as carcinogenic materials. Safe levels of exposure for these materials cannot be set, or control to the safe level of exposure is not practical. Levels are set by government expert committees.

Short-term averages are established to help prevent effects such as eye irritation, which may occur after a short exposure.

For a material to be assigned an OES the following criteria must be met (Figure 8):

Figure 9

Figure 10

Figure 11

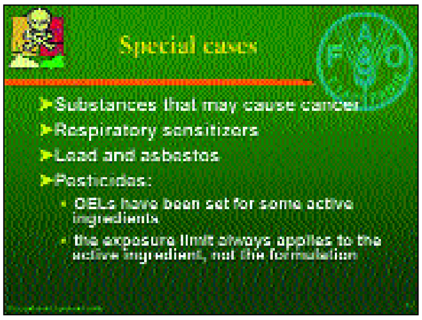

Figure 12

- A safe concentration has been identified by scientific means.
- Higher concentrations than those identified are also safe.
- The levels indicated are achievable under normal circumstances.

A material will be assigned a MEL (Figure 9) when neither of the first two points listed for assigning an OES can be met and exposure may or will result in serious damage to health. A MEL may be set when socio-economic factors make the control measures for an OES too expensive.

With OES (Figure 10), if the level of exposure set is never exceeded, no additional controls are needed, while with MELs, in order to comply with health and safety legislation, exposure should be reduced to as far below the MEL as possible. Exposure may be averaged over the period of exposure. For a substance with a short-term MEL, that MEL should never be exceeded.

If a substance (Figure 11) is not listed as having an OEL it may not be safe under any circumstances.

Advice on safe levels of exposure should always be sought from manufacturers, trade associations or other expert sources.

The OEL includes materials that are absorbed through unbroken skin, which should be taken into account in the selection and use of protective equipment, for example.

Other factors that affect an individual's response are ambient temperature and use of alcohol and medication.

SPECIAL CASES (Figure 12)

Some substances are special cases. These include:

- substances that may cause cancer;
- respiratory sensitizers;
- lead and asbestos.

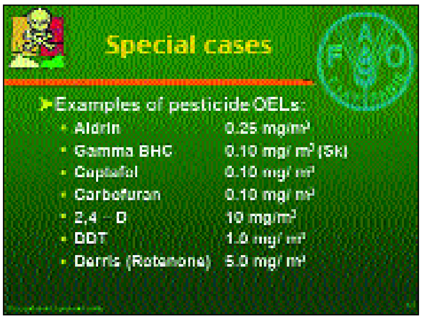

Figure 13

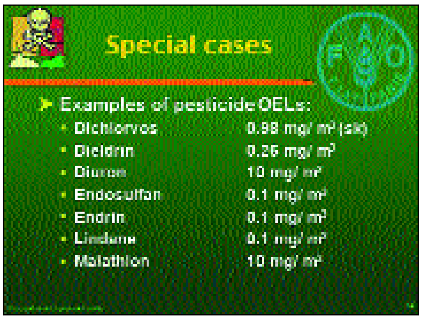

Figure 14

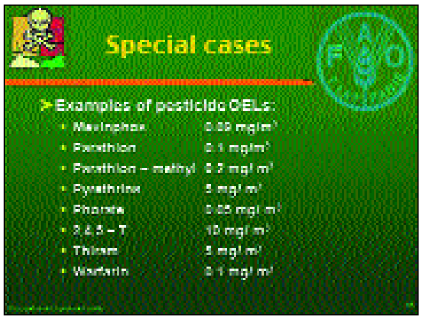

Figure 15

Figure 16

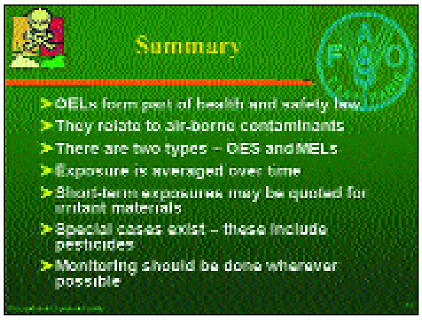

Figure 17

OELs have been set for some active ingredients, but not all. The exposure limit always applies to the active ingredient and not to any formulation.

Figures 13 to 15 list some examples of pesticide OELs.

The monitoring of exposure generally requires assessment in the work zone and/or general workplace. This can be achieved via:

- personal sampling;
- monitoring of air in the workplace.

Advice can be obtained on sampling and analysis strategies, especially for MELs.

Monitoring can also be done for biologically active materials (Figure 16).

SUMMARY (Figure 17)

OELs and MELs form part of health and safety law in many countries. They relate to air-borne contaminants. Exposure is averaged over time. Short-term exposures may be quoted for irritant materials. Special cases include pesticides. Monitoring should be done wherever possible.

4. Finding out about pesticides

Figure 1

This unit emphasizes how important it is to have information about the pesticides that are being worked with (Figure 2). It also identifies the type of information that is needed and the sources from which that information may be obtained.

Figure 2

Figure 3

INFORMATION AND ITS SOURCES

Figure 4

Figure 5

People need to have a good understanding of the hazards that they are working with so that they, other people and the environment at large can be protected effectively (Figure 3). Those working with chemicals (including pesticides) also need to know how to deal with any emergency situations such as fires, poisonings or spills that could occur during the course of their work. Information about the chemicals also helps ensure that proper packaging, transportation and storage procedures are followed.

The types of information needed are listed in Figure 4. Information is available from a range of sources (Figure 5). As soon as chemicals have been identified, the relevant references should be consulted to ensure that those working with the chemicals are well informed and properly equipped *before* they start work.

Information that is not available from the sources listed in Figure 5 should be requested from manufacturers or suppliers of pesticides. Companies have technical experts who can advise on specific matters.

There are many additional sources of information, including intergovernmental organizations such as FAO and the United Nations Environment Programme (UNEP), national government departments such as the United States Environmental Protection Agency (USEPA), and non-governmental organizations (NGOs) such as the Pesticide Action Network (PAN). These have Web sites and can be contacted via e-mail.

Figure 6

For non-product-specific information about working with pesticides or the consequences of an accident, for example, academia and private sector sources could be consulted.

Labels

The first place to look for information is the product label which should be securely fixed to the product container (Figure 6). The label should include the following information:

1. the FAO recommended hazard colour code (see Figure 9 in Pesticide stock control, on p. 68) and pictograms indicating product hazards;
2. product or brand name;
3. active ingredients, their concentrations and the formulation type;
4. summary of uses, e.g. the crops and pests for which the product can be used;
5. date of manufacture and batch number;
6. registration details according to national regulations;
7. details (including address) of the manufacturer or distributor;

8.-10. directions for use, crop rotation and pre-harvest or re-entry periods;

11.-12. safety precautions and good practice guidance;

13. first aid advice in case of poisoning;

hazards and precautions including protective equipment advice;
storage information;
disposal advice;
environmental hazards;
emergency and first aid procedures.

The label should be in a locally understood language and printed clearly enough to be easily readable.

Figure 7

Figure 8

Material safety data sheets

A material safety data sheet (MSDS) provides information about specific hazards associated with the product and how to deal with those hazards. The features covered are listed in Figure 7. MSDSs are available from product manufacturers or their agents. They should be held by storekeepers and be obtained for every product held. In many regions and countries it is obligatory for pesticide registrants to produce and make MSDSs available for every product that they register.

Figure 9

Publications

The World Health Organization (WHO) classification is widely used and recognized as an indicator of pesticide hazards (Figure 4, chapter 3). The list is updated every two years and is produced by the Inter-Organization Programme for the Sound Management of Chemicals (IOMC), whose member agencies and organizations are listed in Figure 8.

The classification system is explained in chapter 2: Health and environmental hazards.

The pesticide manual (Figure 9) (see Preface for bibliographic details) is a good basic reference which should be available to those working extensively on pesticide-related matters. It is also available on CD-ROM.

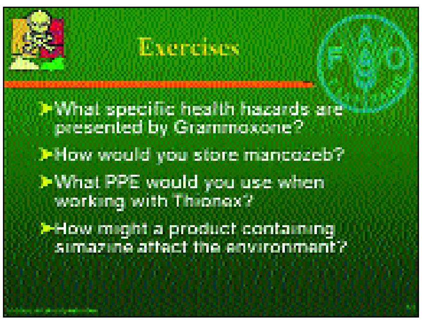

Figure 10

EXERCISE

Use any of the reference sources discussed, or others that you are familiar with, to answer the questions in Figure 10.

Figure 1

5. Technology options for the management and destruction of obsolete or unwanted pesticides in developing countries

Obsolete pesticide stocks in developing countries pose a serious and long-term threat to local health and the environment (Figure 2). They also pose a threat to the global environment and the health of people and wildlife further afield since many obsolete pesticides are persistent organic pollutants (POPs). As long as obsolete stocks remain in place, containers and products continue to deteriorate, increasing the risks posed. Changes in government or management regimes can undermine arrangements, such as long-term storage, that are meant to stabilize the stocks. There is therefore an urgent need for permanent solutions to clear such stocks from the developing countries in which they currently lie.

Figure 2

Figure 3

The following key considerations (Figure 3) must be taken into account when selecting appropriate solutions for obsolete pesticide stocks in developing countries:

- Obsolete pesticides tend to be mixtures of chemicals, often contaminated, plus contaminated soil and other materials and containers, all of which need to be disposed of safely. Some technologies are only able to deal with particular types of chemicals or waste materials and therefore their use can only be a partial solution to the problem.
- No disposal or management method that would not be permitted in industrialized nations should be applied in a developing country. If appropriately high standards of health and environmental protection

Figure 4

Figure 5

Figure 6

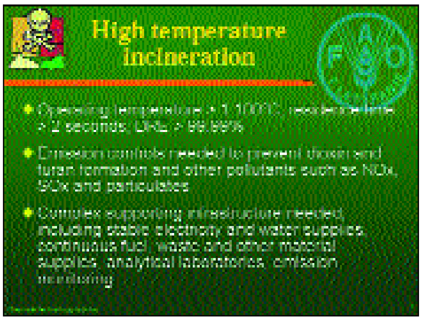

Figure 7

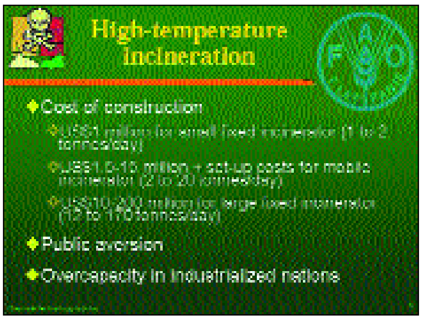

Figure 8

cannot be enforced locally, the export of waste to a facility that can satisfy these standards should be considered (Figure 4).

- Locally implemented initiatives must be part of a national strategy for the management of hazardous waste, with full approval of all stakeholders, and not merely isolated solutions for specific problems of obsolete pesticides that exist only at the time of implementation.

Developing countries seeking solutions to their obsolete pesticide stocks (Figure 5) suffer from a chronic lack of resources and therefore require external financial assistance to implement solutions. In general, they also lack the expertise needed to construct, operate and support high-technology installations for the destruction of organic chemicals.

Such facilities need a well-developed infrastructure for ongoing servicing, and infrastructure is often inadequate in developing countries. In some cases, the output of waste processing facilities also demands management procedures that are similar to those required by industrial chemicals, pesticides or hazardous waste. Developing countries tend to have underdeveloped management capacity which should not be overburdened with additional waste problems.

The following are technologies for dealing with obsolete pesticides (Figure 6):

- high-temperature incineration;
- chemical treatment;
- engineered landfill;
- long-term controlled storage;
- reuse/reformulation;
- new technology.

The applicability and appropriateness of each of these options are discussed in the following sections.

HIGH-TEMPERATURE INCINERATION (Figure 7)

The destruction of organic chemicals requires operating temperatures of at least 1 100°C, a residence time for the chemicals of at least two seconds at that temperature, and an ultimate destruction removal efficiency (DRE) of at least 99.99 percent. Emission controls are needed to prevent dioxin and furan formation and other pollutants such as nitrogen oxides (NOx), sulphur oxides (SOx) and particulates from being emitted to the environment. High-temperature incineration facilities require complex supporting infrastructures including stable electricity and water supplies and continuous supplies of fuel, as well as waste for destruction, to ensure constant and efficient operation. Supplies of other materials are also needed to maintain constant operation of, for example, emission control equipment. In addition, analytical laboratories and emission monitoring facilities are necessary.

The cost (Figure 8) of constructing a dedicated high-temperature waste incinerator is about US$1 million for a small fixed incinerator capable of burning 1 to 2 tonnes per day. Such incinerators are generally too small and inefficient to be relied on for the destruction of significant quantities of obsolete pesticides. Mobile incinerators, which are capable of burning 2 to 20 tonnes/day, cost between US$1.5 million and $15 million, plus set-up costs at the incineration site. Their mobility is limited since they generally require several trucks to transport them. They also require the same infrastructure and services as permanent installations. Large fixed incinerators cost US$10 to $200 million and have a destruction capacity of 12 to 170 tonnes/day.

There is strong public aversion to waste incinerators, particularly when they are intended for the destruction of toxic materials. This is the case in both industrialized and developing countries wherever such facilities have been proposed.

An important consideration relating to the construction of new hazardous waste incineration facilities is the current significant overcapacity of incineration facilities in industrialized nations such as the United States and European countries. European facilities are generally willing to import waste for destruction at competitively low cost.

Figure 9

CEMENT KILNS (Figure 9)

In several countries, cement kilns are used for the destruction of hazardous waste. Generally, only high calorific value chemicals are burned as co-fuel with oil. Wastes of low calorific value need to be dealt with by other means. The technical specifications for incineration in modern cement kilns are often better than those of dedicated incinerators in terms of operating at higher temperatures, longer residence times, better oxygen availability and equivalent or better DRE.

The use of cement kilns in developing countries has been proposed and tried as a possible local solution for obsolete pesticide disposal. A positive potential effect of this is the development of national capacity for the management of hazardous waste in general, including industrial, agricultural and clinical waste. Cement kilns do not, however, provide a solution for all types of waste, for example they cannot be used for burning contaminated soil or drums. Their use must therefore be seen as part of an integrated solution for hazardous waste that incorporates other technologies.

Nevertheless, cement kilns should not be seen as a cheap and easy solution. Their use for chemical waste destruction can only be contemplated for the most modern installations, where additional equipment is installed for waste input and emission controls. Full approval by all stakeholders should be sought and it is advisable to propose the use of the cement kiln as part of a national strategy and not a one-off solution to a critical obsolete pesticide problem.

The purpose of cement kilns is to produce cement and this objective should not be compromised by the introduction of chemical waste. Expert knowledge is also required for the careful loading of waste, in order to avoid technical problems and unwanted emissions, and for the operation of emission control, analytical and monitoring equipment. The staff of cement kilns are not trained to handle hazardous chemical waste or to deal with the consequences of any unexpected outcomes of hazardous waste incineration. The necessary skills must be developed and maintained for as long as hazardous waste is incinerated at the installation.

Figure 10

CHEMICAL TREATMENT (Figure 10)

Chemical treatment can be used to decompose hazardous wastes into their constituent compounds. The processes used tend to be highly specific and capable of dealing with only a single chemical compound at one time. Obsolete pesticides are often mixtures of chemicals of several types and rarely contain a sufficient quantity of one compound to justify chemical treatment.

Chemical treatment also provides limited or no solution for contaminated materials and containers. It also poses significant potential hazards to people and the environment, as many of the processes themselves are hazardous. High levels of expertise, and supporting infrastructure, are required and appropriate processing facilities must be constructed, making this an expensive and complex option for the wide range of chemicals that are found among obsolete pesticides.

In addition, chemical treatment generally produces larger volumes of less hazardous waste which needs further management or disposal.

Figure 11

ENGINEERED LANDFILL (Figure 11)

Landfill with hazardous waste requires the construction of sealed sites on geologically stable areas that are far from ground- or surface water. Facilities must be in place to collect and treat leachates and gas released from the waste.

Landfill with hazardous waste is not generally permitted in the European Union (EU) and the United States and its use in developing countries should therefore normally not be considered an option. Significant investment in infrastructure, together with long-term management and maintenance, are required. In addition, it should not be seen as a permanent solution since, over time, landfill linings deteriorate and ultimately waste must be removed to another site, or a different solution found.

Figure 12

REUSE/REFORMULATION (Figure 12)

In some cases, pesticides are found to be usable in their current state, or they can be reformulated into a form that makes them usable. This depends on the condition of the pesticides, the quantities available and the existence of a potential valid and approved use for the product.

It must be ensured that such solutions do not present any additional unacceptable hazards, such as the creation of a hazardous pesticide product that puts farmers at risk or the establishment of a reformulation facility that causes environmental contamination. Facilities for safe and appropriate use or reformulation must be available if this solution is to be put in place.

There is also a need to find out who benefits most from such a solution: local people and the environment, by being protected from further exposure to hazardous waste pesticides, or pesticide manufacturers and the owners of products, who may reap commercial benefit from the reformulation or reuse option?

Figure 13

NEW DEVELOPMENTS (Figure 13)

A number of new technologies have been developed for the destruction of toxic materials. Few of these are currently in commercial operation and are therefore not under consideration as viable destruction options for the obsolete pesticides. Pesticide stocks should only be treated in plants that operate tried and tested technologies, in accordance with European or United States standards.

The new technologies that are at the most advanced stage of development are summarized in Figures 14 to 20 and the Table.

Figure 14

Figure 15

Figure 16

Figure 17

Figure 18

Figure 19

Figure 20

New technologies for pesticide destruction

Technology	Process	Comments
Gas phase hydrogenation	Hydrogen reacts with chlorinated or non-chlorinated organic compounds at high temperatures decomposing them primarily to methane and hydrogen chloride. The system is closed and therefore produces no emissions.	Only one commercial plant (in Australia) and one experimental plant (in Canada) are operating. The Australian plant is destroying DDT and PCB successfully. The developer proposes that this technology may be appropriate for use in a country with very large stocks of pesticides.
Electrochemical oxidation	An electrochemical cell generates oxidizing agents in an acid solution to attack organic compounds, which are decomposed into carbon dioxide, water and inorganic ions.	The system is not yet in commercial operation and would apparently not be capable of dealing with contaminated materials such as mixed pesticides.
Molten metal	Organic materials are decomposed in a vat of molten metal at high temperature, generating gases and metals, which can be recycled, and inert waste materials, which can be used for landfill.	The technology appears to be on the verge of operating commercially in the United States. This may be an appropriate technology for the destruction of organometallic pesticides, since these cannot be incinerated. However, this technology has no proven track record so its use cannot be considered in the short term.
Molten salt	Organic chemicals are introduced on a bed of molten alkaline salt at a temperature of about 1000°C and decomposed into inorganic salts which are retained in the salt bed and must be disposed of as secure landfill.	The process is significantly more expensive than other comparable technologies which have greater destruction efficiencies. It cannot handle contaminated materials or materials that contain large amounts of inert matter, such as dry formulated pesticides.
Solvated electron process	This process strips halogens from organic compounds using an alkaline solution containing free electrons and metal cations.	It is primarily designed as a way of decontaminating soils holding halogenated pollutants and is not appropriate for large quantities of mixed pesticides.
Supercritical water oxidation	Organic compounds dissolve in supercritical water at high temperature and pressure to form benign compounds	This process is under trial and not yet used commercially.
Plasma arc	Waste is injected into a plasma arc field at extremely high temperatures of 5000° to 15000°C, at which compounds are broken down into their constituent atoms.	Only one such plant is known to be operating in Australia. Destruction costs are higher than those for incineration and destruction efficiencies vary. Dioxins can be produced at unacceptable levels.

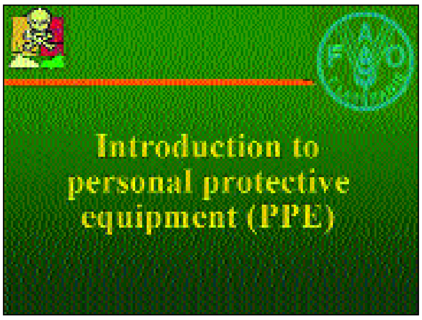

Figure 1

6. Introduction to personal protective equipment

This unit describes the selection and proper use of personal protective equipment (PPE), putting the selection of PPE into the wider context of risk assessment.

First, the reasons for using protective clothing are discussed, followed by guidance on how to select PPE that is fit for its proposed purpose. The unit then takes a brief look at the different types of PPE and when they should be used (Figure 2).

As emphasized in Risk assessment, on p. 55, workers should endeavour to avoid exposure to hazardous materials wherever possible. This can be achieved by control measures, engineering and adopting different working practices, among other ways (Figure 3).

When making an inventory, workers have to enter pesticide stores in order to get the required information. In many cases the storage methods will not be adequate and the condition of the pesticides will mean that there is a possibility of exposure (usually resulting from leakage and spillage). If there is a chance of exposure, workers will need protective equipment.

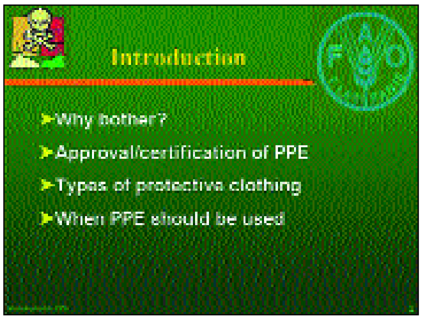

Figure 2

Figure 3

As well as protecting people within the store, such equipment will also result in the dangerous chemicals remaining in the store and not contaminating personal clothing. When they do not use such equipment as coveralls and gloves, workers risk carrying contamination home with them.

Figure 4

CERTIFICATION OF PPE (Figure 4)

Most countries have legislation covering dangerous chemicals. They also usually have guidance about what protective clothing is appropriate for use when handling such chemicals. This guidance takes many forms.

In Europe, for example, guidance is enshrined in law as a Council

Figure 5

Directive requiring that all equipment be subjected to specific tests at a registered testing centre; the tests are coded by a European Norm/Standard number (an EN number) (Figure 5). A specific item may be tested for a number of criteria and may therefore have several EN numbers. Following successful completion of the tests, an item is awarded a Conformité européene (CE) mark, which shows that it complies with the specific test requirements. The CE mark is related to a specific use and is not a universal certificate of compliance, relating as it does only to the tests performed.

The CE mark and EN number show that the item has been tested and, in Europe, only items bearing these codes can be sold. People working outside Europe should look for an equivalent at their local suppliers.

When it comes to deciding whether to use reusable or disposable protective equipment the points shown in Figure 6 should be considered. It is very much a case of balancing among cost, availability, the protection provided and the selection of clothing that is fit for the specific job. Wherever possible, disposable equipment should be used.

The best control measure is to ensure that there is no buildup of waste to begin with. Unfortunately, obsolete stocks accumulate unless a strong regulatory framework is in place. This is an existing problem when dealing with obsolete pesticides

Figure 6

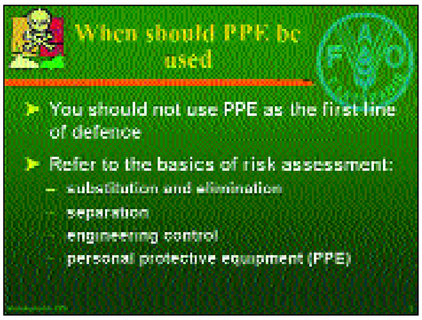

Figure 7

ALTERNATIVES TO PPE

PPE should be used as a last resort to protect workers after all possible alternative measures have been put in place (Figure 7). Other measures which should be considered in line with basic risk assessment practices include:

- *Substitution and elimination:* However, with obsolete pesticides, the product that is being handled cannot be replaced with a less hazardous one because it is waste material.
- *Separation:* Again, this measure is not usually appropriate because it is not usually possible to separate personnel from the hazards of waste cleanup or removal.
- *Engineering controls:* Control in this case is via the use of general ventilation or local exhaust ventilation. Contaminated air is vented away from the work area before it affects the surrounding atmosphere.
- *Administrative controls:* These include:
  - reducing the number of employees exposed;

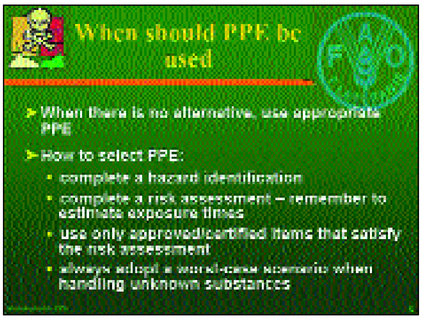

Figure 8

- reducing the time that workers are exposed;
- preventing the buildup of contaminants;
- prohibiting eating, drinking and smoking in the area.

Appropriate PPE can only be selected when the hazard has been identified and a risk assessment completed (Figure 8). Part of the assessment must include an estimate of potential exposure time. Reference must then be made to the specifications of the PPE to ensure that it will provide adequate protection. If there is doubt or if the waste may contain unknown materials, the worst-case scenario and the most rigid PPE protocol should be adopted.

Figure 9

SUMMARY (Figure 9)

This unit has shown the need for PPE and established that the testing and performance of PPE are strictly regulated. It has put the need for PPE into the context of full, adequate risk assessment and emphasized that, if there is any doubt, a worst-case scenario should always be adopted when selecting PPE.

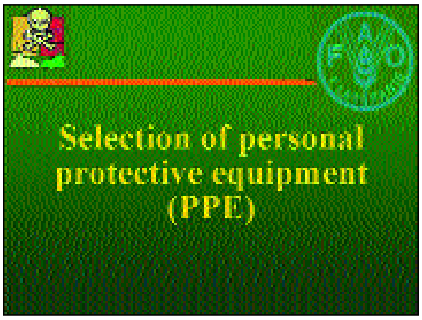

Figure 1

7. Selection of personal protective equipment

This unit outlines how to use the information contained in the previous unit to ensure that the correct type of equipment is available for a specific task.

The unit recaps on how poisons can enter the body, and the areas that need protection. It also looks at how the risk associated with handling a hazardous material can be assessed and measured (Figure 2).

ASSESSING THE RISK

When workers enter a store that contains hazardous materials, they must aim to avoid exposure if at all possible. However, some exposure is very likely to occur. The aim of PPE is to act as a last line of defence to ensure that exposure is managed and adequate protection is provided to the individual. Employers have a "duty of care" to their staff and should provide adequate equipment and training in its use to prevent serious injury (Figure 3).

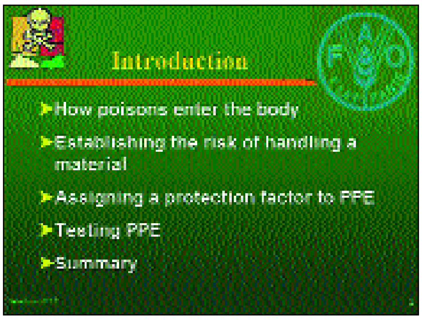

Figure 2

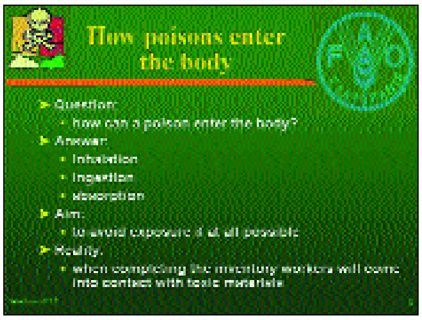

Figure 3

Figure 4

Such items as World Health Organization (WHO) classification and material safety data sheets provide detailed information on the particular hazards associated with a chemical (Figure 4). In addition, the possible exposure and proposed activity can affect how a hazard becomes a risk. Adequate protection should be provided, based on the hazard of the material and, most importantly, the actual task/activity that is to be carried out. A piece of equipment may provide adequate chemical protection but its mechanical strength may be insufficient – a consideration that is often overlooked, particularly with respect to gloves and overalls.

Other measures, such as engineering or control measures, should be considered before the necessary protective equipment is selected.

From this, it can be seen that risk assessment is closely linked to the selection of PPE. Such factors as occupational exposure limit (OEL) and

Figure 5

maximum exposure limit (MEL) show how risk is also closely linked to the time of exposure in most instances (Figure 5). Clearly, some materials (such as asbestos) require the highest level of protection, irrespective of the time of exposure, but as a general rule the duration of an activity will have an affect on the PPE selected. PPE effectively allows workers to remain in a hazardous environment for longer than would otherwise be possible.

ASSESSING THE PPE

The degree of protection offered by a particular piece of equipment is usually shown in terms of a protection factor. The protection factor is assigned after stringent testing (Figure 6). Protection factors are usually indicated as numbers – the higher the number the greater the protection factor. This is not true for coveralls, however, where Type 1 offers the highest level of protection and Type 6 the lowest.

Very specific tests are used to determine the protection factor of a piece of equipment (Figure 7).

Coveralls all undergo a series of tests. Their performance in each test will determine which type they are assigned to. The specific resistance level of coveralls is usually shown as a pictogram on the packaging (Figure 8).

Figure 6

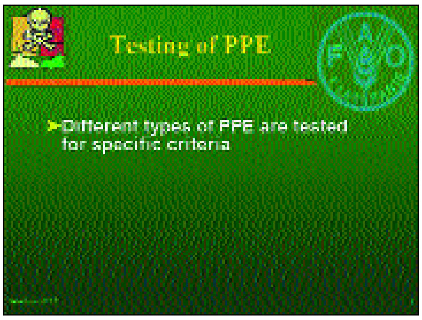

Figure 7

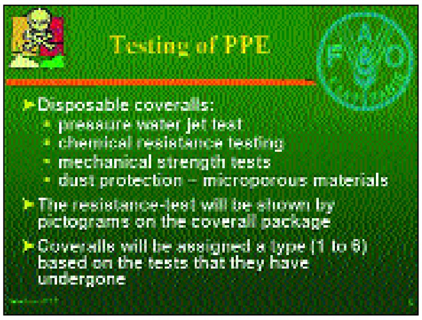

Figure 8

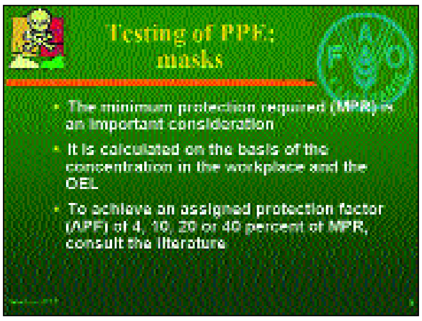

Figure 9

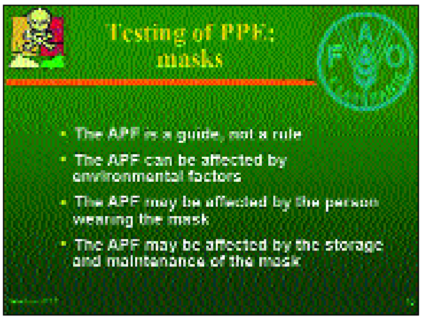

Figure 10

When selecting a mask (Figure 9), the minimum protection required (MPR) must be considered. In the general workplace this is a simple calculation based on workplace monitoring of the concentration of contaminants over extended periods of time. The value of actual contaminants is compared with the OEL set by the national government to give a value for the MPR.

The MPR will usually be between 1 and 40. By comparing this to a reference table (not supplied) it is possible to select a range of mask types that conform to the required European Norm (EN) standard. From this range it is then possible to select the most appropriate mask that provides the necessary level of protection.

The assigned protection factor (APF) should always be considered, but only as a guide (Figure 10). The APF may be affected by the following factors, which are external to the mask's construction or the filters it uses:

- *The environment in which the mask is to be used:* a hot climate may result in perspiration, which would compromise the seal of the mask on the wearer's face.
- *The shape of the wearer's face* (particularly the nose) can also have a

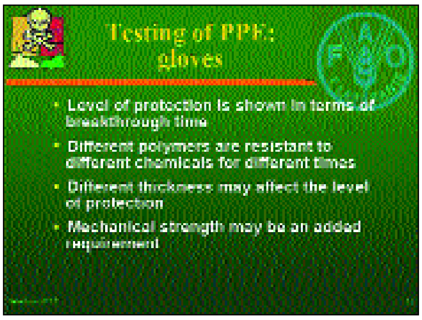

Figure 11

great affect on the effective seal of the mask.

- *Poor maintenance and storage* may result in the rubber of masks and seals perishing. Integral filters may lose their effectiveness if stored in hot conditions.

The breakthrough time is determined by an immersion test (Figure 11). Information about the chemical resistance of different polymers is available from the literature. The most commonly used polymers are PVC, butyl rubber, nitrile rubber and polytetrafluoroethylene (Viton). A nitrile rubber thin laboratory glove may be more chemically suitable but, because it is so thin, may offer less protection that a standard PVC glove. When the handling of sharp objects is identified as a factor in the risk assessment, the potential cut hazard needs to be managed – this is usually achieved by a combination glove or overglove.

Figure 12

SUMMARY (Figure 12)

This unit has shown how important it is to base the selection of PPE on the type of hazard and its affect on the body. It has also shown how the selection is integrally linked to the activity/task identified in the risk assessment. Where possible, control measures should be used to minimize the level of potential exposure.

The unit then looked at how the level of potential exposure and factors such as OEL affect PPE selection and how protection factors for different types of PPE are calculated.

8. Selection of coveralls

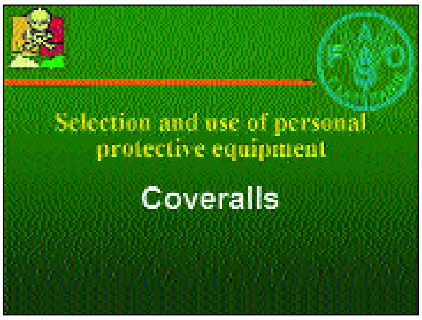

Figure 1

This unit examines the various types of disposable coveralls that are available in the market today (Figure 2). A wide range of excellent manufacturer's information is available to everybody; the two manufacturers whose details are given in the Box are particularly willing to supply full product data for their ranges of coveralls.

Figure 2

Figure 3

Figure 4

This unit gives a framework for the selection and use of disposable coveralls when carrying out an inventory of pesticide stores and/or an emergency intervention to prevent the spread of contamination.

For coveralls, the protection factor is expressed in terms of a type which is assigned to each garment. Each type is tested to a specific European Norm (EN) and then awarded a CE mark relating to the test results (Figure 3). Generally, when dealing with obsolete pesticides, coveralls of types 3, 4 and 5 are the most appropriate. The type selected (Figure 4) is entirely dependent on the chemical properties of the chemical(s) concerned and the activities to be performed (as discussed in Selection of PPE, on p. 29).

MANUFACTURERS

- Shiloh Healthcare Ltd, Park Mill, Royton, Oldham OL2-6PZ, United Kingdom; tel.: (+44) 161 6245641; fax: (+44) 161 6270902; e-mail: allanh@shiloh.co.uk. Contact: Allan Hamer; product name: Primeguard.
- Du Pont Engineering Products SA, Contern L-2984, Luxembourg; tel.: (+35) 2 36665126; fax: (+35) 2 36665021; e-mail: aloyes.wilmes@lux.dupont.com; Web site: www.dupont.com/tyvek/protective-appariel/europe. Contact: Aloyes Wilmes; product name: Tyvek.

Both of these companies are able to provide very comprehensive reviews of the legislation controlling disposable coverall certification and offer a wide range of coveralls designed for a wide range of applications. Other manufacturers supplying equivalent clothing include Kimberly Clark and Microguard.

Figure 5

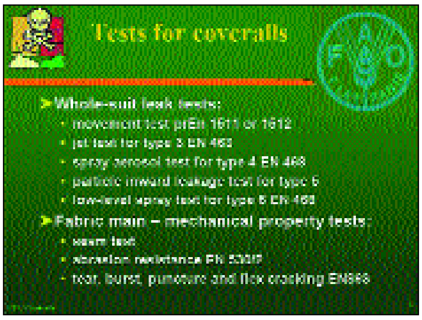

Figure 6

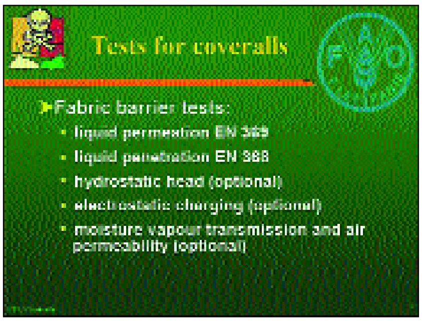

Figure 7

Figure 8

Figure 9

In some instances it may be necessary to use a higher level of personal protection. Certain substances pass through the skin barrier very easily. Their material safety data sheets (MSDS) will recommend the use of a gas-tight suit (self-contained – type 1, or positive-pressure – type 2) when handling these materials. Under normal circumstances, the completion of an inventory will not require close proximity to or handling of such materials. (The risk assessment will have drawn attention to the presence of the material and appropriate techniques/working practices will have been adopted in order to minimize or eliminate exposure.) This will not be the case during disposal operations. Figure 5 shows an example from the United Republic of Tanzania in 1992. The risk assessment identified that the material in question is very easily absorbed through the skin. An appropriate positive-pressure gas suit made from a suitable polymer was chosen and respiratory protection was offered by way of air-supply breathing apparatus, which also pressurized the suit. The risk was compounded by high daytime temperatures (> 35°C), which required work to start at 5 a.m., continue until 10.30 a.m. and stop for the afternoon until 3 p.m.

This example is an excellent demonstration of how important the risk assessment is and how, by adopting control measures and safe working practices, even the most dangerous materials can be handled safely.

In Figure 6, note how one of the tests has been assigned a prEN code, which shows that the test is under evaluation and demonstrates how comprehensive the tests for coveralls are. These tests relate to the garment as a whole.

The tests shown in Figure 7 relate to the material from which the suit is manufactured.

Were cotton coveralls to be subjected to the detailed material and leak tests outlined in Figures 6 and 7 they would be found inadequate. Cotton coveralls only provide nominal protection from liquids or fine dusts. The problem is compounded when items have to be washed, and can result in passive exposure when the people doing the cleaning are working at uncontrolled sites, even when cleaning is carried out a long way away from the original hazardous source.

It is therefore assumed that disposable coveralls will be used, because of their higher level of chemical resistance and the fact that a variety of types exist, each specifically manufactured for use with specific types of hazard (dust, spray, liquid or gas).

There are a wide variety of types and manufacturers of coveralls. Each type has been tested to an EN and certified by a CE mark, and assigned pictograms to show exactly what it may be used for. It is important that any locally supplied or manufactured items have been subjected to equivalent local or national certification and testing systems. This is the only way of confirming that the items are fit for a specific purpose.

The selection of coveralls should also always be done within the context of the overall risk assessment, and judgements should be made about what physical and chemical barriers are needed (Figures 8, 9, 10).

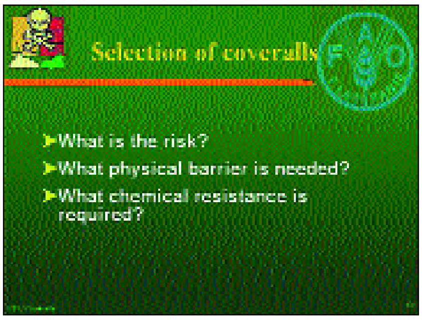

Figure 10

Figure 11

Figure 12

Figure 13

EXERCISE 1

What coveralls should be selected for each of the inspections listed in Figure 11?

Solution (Figure 12, 13)

The approach that should have been adopted is first to find the hazards for the different materials from the MSDS, the LD_{50}, the *Pesticide manual* and other reference literature. Then to determine the likelihood of exposure, considering any other factor that is peculiar to the material.

The answers to the questions on Figure 11 are:

- *For technical BHC powder:* Coveralls of type 4 or type 3, because sweat releases HCl, so standard dust-proof coveralls do not protect from acid irritation.
- *For malathion:* Coveralls of low type 4, or type 3, would be safe. The key here is the likelihood of exposure; although this active ingredient is only World Health Organization (WHO) class III, contamination is likely to occur when drums are moved.
- *For azinphos methyl:* Coveralls of type 3 if the material was being redrummed (which increases the risk of exposure), otherwise type 4 would be adequate for normal activities because, although this active ingredient is very toxic, the likelihood of exposure is minimal.

When in doubt, opt for the higher level of protection.

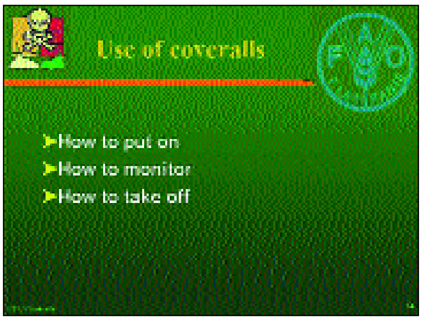

Figure 14

Figure 15

USING THE COVERALLS

Having selected the correct type of coverall, it is necessary to know how to wear it in order to get the maximum benefit from its design (Figures 14, 15). It is also important to know how to remove contaminated clothing without contaminating the wearer.

Figure 16

Figure 17

Figure 18

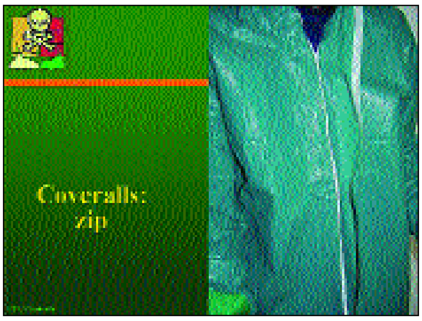

Figure 19

Figure 20

EXERCISE 2

What is wrong with the example of wearing a coverall shown in Figure 16?

Solution

The answers are:

- The gloves are worn over the elasticated cuffs of the coverall (Figure 17). This allows contaminants to roll down the sleeve and into the glove.
- Similarly, the boots are worn over the legs and elasticated ankles of the coverall; contaminants can roll down the coveralls and into the boots (Figure 18) .
- The coverall has a protective flap designed to prevent the zip fastener from becoming contaminated. This particular coverall is Type 3 – the zip is the most likely point for liquid to penetrate the coverall. The flap prevents this and must be used if supplied (Figure 19).

An optional additional answer is that the hood is not worn. This would depend on the specific risk assessment but, as a rule, if there is a hood it should be worn. It offers protection to hair, neck, ears and other sensitive areas of the face.

The correct way to wear coveralls is shown in Figures 20 to 22. The cuffs (Figure 20) may be further sealed with adhesive tape for added protection. Care must be taken to ensure that heat stress does not occur and that freedom of movement is not affected.

Only the foot of the boot (Figure 21) is likely to become contaminated. The ankle may also be sealed with tape.

Figure 22 shows the zip cover in place; now only the head risks possible exposure, and it could be protected by wearing the hood.

When coveralls are worn correctly, they will protect their wearers throughout the working day. They must then be removed correctly (Figures 23, 24, 25, 26); it would negligent if workers contaminated themselves when they took off their coveralls. When removing a coverall, it should always be assumed that the outer surfaces are all contaminated. Ideally there should be somebody to help workers remove their coveralls.

When they have finished working, workers move into the shoe/coverall changing area at the edge of zone 1 (the dirty area). Here visible signs of contamination are removed (dust by vacuum, splashes by absorbent wipes).

Helpers should not touch the contaminated outer surfaces of coveralls and boots unless they are wearing gloves; after gloves have been removed, only the inner surface (not contaminated) of the coverall can be touched.

Figure 27 shows how gloves remain on when touching the contaminated outer surfaces. The zip cover is removed. The zip is clean.

The gloves are then taken off (Figure 28) and held by their inner surfaces (Figure 29), which are free from contamination because the cuffs were over the glove.

The zip is then undone and, from the inside of the coverall, the hand pulls the coverall off one shoulder (Figure 30) and then the other (Figure 31).

The coverall is then rolled down to the knees (Figure 32) and stepped out of (Figure 33). The tops of the boots are not contaminated because the ankles of the coverall were over the top.

Finally the worker steps out of the boots (Figure 34).

The coverall is then rolled into a ball with the clean inner surfaces outermost (Figure 35). If a coverall is not contaminated, it may be removed in a similar manner but, instead of being rolled into a ball, it can be hung up until the next occasion (Figures 36, 37).

Figure 38 lists the procedure for dealing with cotton coveralls. The principles for inspection, use and removal still apply.

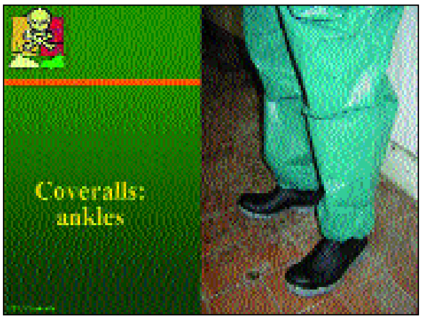

Figure 21

Figure 22

Figure 23

Figure 24

Figure 25

Figure 26

Figure 27

Figure 28

Figure 29

Figure 30

Figure 31

Figure 32

Figure 33

Figure 34

Figure 35

Figure 36

Figure 37

Figure 38

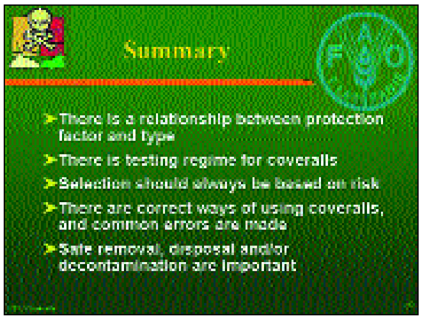

Figure 39

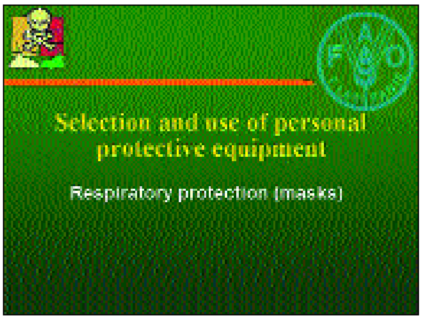

Figure 1

9. Selection and use of respiratory protective equipment

This unit focuses on the different methods of protecting workers from hazardous materials that enter the body through the respiratory tract or have an adverse affect on the mucus membranes (soft tissues of the eyes, nose, mouth and throat). Such protection is generally afforded by a mask of some sort (Figure 2).

The unit looks at respiratory hazards and their measurement and outlines how this information is used to select the most appropriate respiratory protective equipment (RPE).

It then goes on to discuss how to manage RPE, and training in the use of RPE, with particular reference to how the fit of a mask affects its effectiveness. Some examples of different RPE are given and the unit finishes by examining the maintenance and storage of RPE.

Figure 2

Figure 3

MEASURING THE HAZARD

Rather than specific chemical hazards, in the case of selecting a mask it is the generic respiratory hazard that is of significance. These are shown in Figure 3. The category or class of hazard greatly affects the final choice of RPE.

Of particular note is the first hazard in Figure 3 – oxygen deficiency. This unit does not discuss the use of RPE to cope with this hazard. Oxygen deficiency usually occurs in confined spaces where there is a source of chemical hazard. Leaking drums in a cellar is an example. The concentration of active ingredient or solvent may result in a lower than expected oxygen level and filtering of the contaminants (as occurs through a mask) may not be enough to make the air breathable. This may also be the case in instances where a buildup of a gas (either chemically

Figure 4

Figure 5

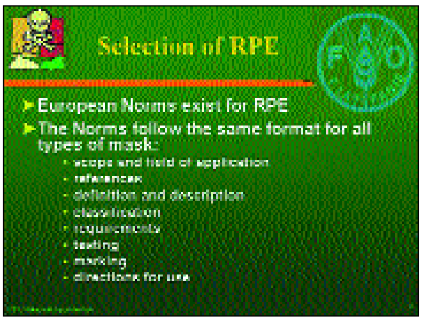

Figure 6

active or inert) results in the air becoming unbreathable. High levels of carbon dioxide, carbon monoxide or even nitrogen can result in a need for RPE that actively supplies oxygen to the person.

Other hazards are more easily dealt with by means of RPE that filters out the contaminant. The most common hazards encountered when working with obsolete pesticide stocks in old stores are dust and vapour.

Individual chemicals and pesticides fall into one of the generic classes/categories of hazard (Figure 4). The specific acceptable/safe level of exposure is determined by workplace monitoring and past experience and is expressed in terms of occupational exposure limit (OEL) or maximum exposure limit (MEL).

When the exposure results are higher than the MEL, control measures are required. The concentration of a contaminant may be greatly reduced by ventilation or air circulation.

The control measures that can be used for dust are vacuum extraction and water sprays, but normally not ventilation because dust is usually contained within a working area.

The control measures that can be used for vapours are carbon filter vacuum extraction and ventilation. Ventilation should not be used in instances where the exhausted vapour would have a direct adverse affect on the nearby environment or population.

Problems arise when workplace monitoring is not feasible (Figure 5). Dust and vapour can be monitored, but adequate analytical support is needed to carry out the monitoring and comment on its results. Such results need to be cross-checked constantly with the reference material on OELs/MELs.

Standard methods of field monitoring exist – United States Environmental Protection Agency (USEPA) Method 5 for dust monitoring, for example. In this case air is drawn through a glass filter using a pump. The level of contaminants is measured over an eight-hour period. When using this and similar methods of monitoring, measurements adjacent to the working area should be made. These will allow the integrity and efficiency of the working practices to be determined. A baseline level of contamination should also be measured, both inside and adjacent to the working area, before work starts. This way the affects of the monitoring actions can be related to the previous level of contamination and the analysis used to prove that there has been no adverse affect on the environment as a result of the measuring activity.

SELECTING THE MASK

All RPE is tested to a European Norm (EN) or Standard (Figure 6). The EN uses the following format for all types of mask:

1. scope and field of application;
2. references;
3. definition and description;
4. classification;
5. requirements;
6. testing;
7. marking;
8. directions for use.

Figure 7

Figure 8

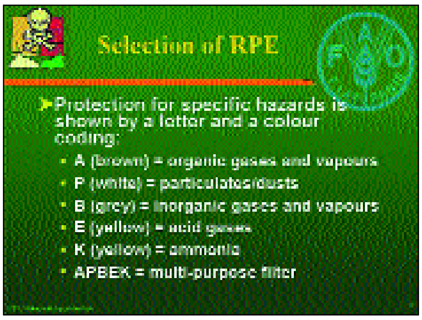

Figure 9

Figure 10

Figure 11

The following are the EN designations of the most commonly used masks (Figure 7):

- EN 136 – full-face masks;
- EN 140 – half masks and quarter masks;
- EN 141 – gas filters and combined filters;
- EN 143 – particle filters.

There are many types of RPE, but they are broadly categorized into the following two types, depending on the method by which protection is provided to the wearer (Figure 8):

- *Air-filtering equipment* takes air from the work area and cleans it before it is inhaled. This equipment relies on lung power or on an external power source to draw contaminated air through a filter providing clean air.
- *Air-supplying equipment* supplies uncontaminated air from an independent source to the wearer.

This unit focuses on air-filtering RPE.

The suitability of a mask to protect against a specific type of hazard is shown by a capital letter and an associated colour code on the mask or filter (Figure 9).

The level of protection offered in terms of protection factor and time for which the mask will remain effective is designated by a number (Figure 10). The exact protection afforded by the number should always be checked as it may vary depending on the manufacturer. In the case of dust protection, a rough estimate can be made where typically:

- 1 applies to an assigned protected factor (APF) of four times the OEL;
- 2 applies to an AFP of ten times the OEL;
- 3 applies to an AFP of 20 times the OEL.

For vapour protection the correlation between code numbers and actual protection factors is more complex:

- A1 applies to organic vapours with boiling point > 65°C that are ten times the OEL or 1 000 parts per million (ppm) (the lower of the two values to be taken);
- A2 applies to organic vapours with boiling point < 65°C that are ten times the OEL or 5 000 ppm (the lower of the two values to be taken).

It is important to check the manufacturer's specification for the exact protection factor of every type of mask needed and ensure that the mask is suitable for all of the planned activities.

Figure 11 shows a canister for a full-face vapour mask (FFVM). Its important features are:

- the CE mark;
- the expiry date;
- the colour coding;
- the ABEK, etc. coding (see Figure 9).

Now that both the hazards and ways of estimating the level of protection factor needed have been identified, attention should focus on other factors that have a great affect on the efficacy of the selected apparatus. These factors, and the ways in which they affect selection, include (Figure 12):

- *Face size and shape* will affect the fit.

Figure 12

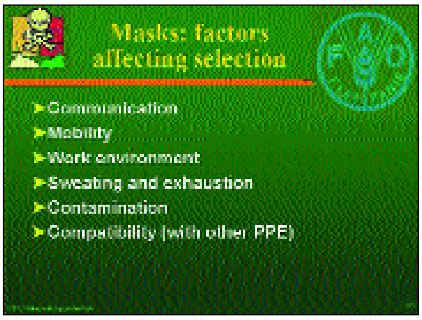

Figure 13

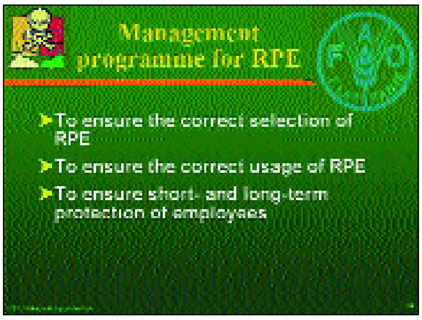

Figure 14

Figure 15

- *Facial characteristics:* Facial hair, for example, will affect the seal. This may be an issue in countries where facial hair is normal.
- *Work rate*: A high work rate will result in heavier breathing which draws more air through the filter thereby increasing the exposure of the filter medium to the contaminants. This will reduce the time for which the filter is effective as it will become saturated with contaminants, and breakthrough of hazardous vapours may occur.
- *Wear time* is linked to work rate.
- *Non-wear time* is a subtle affect. It is less important for simple dust filters but, in the case of FFVM filters, the active agent (usually carbon) has a definite shelf-life/expiry date, after which its effectiveness decreases or ceases.
- *Health and fitness:* A fit person will breath slower and so use less air. The result is less air is drawn through the filter than if the same operation was completed by an unfit person.

Other factors are given in Figure 13. When communication is an issue, a hood may be more appropriate than an FFVM. Space in the working area may be limited, so cumbersome equipment may increase the inherent risk of an activity. If there is an overhead hazard, the RPE can be incorporated into a hard hat. Sweating affects the fit, and exhaustion can result in a feeling of suffocation or difficulty in getting enough air – the wearer may try to remove the mask/RPE, in an attempt to ease breathing, without considering the chemical hazard. The outer surfaces of RPE may become contaminated. The removal and storage of contaminated RPE should be addressed in the risk assessment.

RPE may form an integral part of an overall personal protection equipment (PPE) regime. Masks may be incorporated into coveralls to form sealed suits, as is usually the case for air-supply equipment.

RPE MANAGEMENT PROGRAMME

The cost of respiratory protection is factored into the running of many organizations. Such equipment is of benefit only if it is correctly selected and used (Figure 14).

The equipment must be matched to the worker's needs and must be worn for the entire time that the worker is exposed.

It is generally accepted that correct use of the workplace has a far higher effect on user protection than was previously thought to be the case.

To ensure that the optimum benefit is gained from investment in RPE, it may be a good idea to set up specific infrastructure within the organization, as shown in Figure 15.

Programme administrators

British Standard BS4275 refers to the concept of a competent person. Such a person should have a thorough knowledge of the working environment, the RPE chosen and its correct usage, and the ability to detect defects and problems that reduce protection. The programme administrator is responsible for the implementation of RPE use.

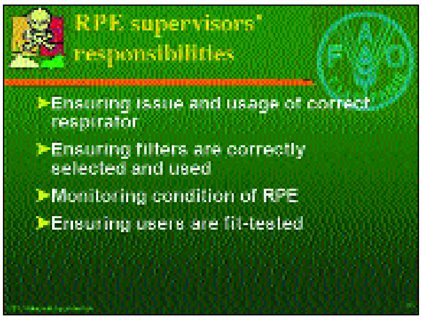

Figure 16

Figure 17

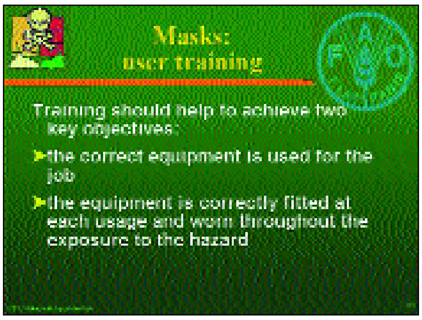

Figure 18

Figure 19

Supervisors (Figures 16,17)

Supervisors are selected to implement RPE usage with the workers. Supervisors and users should be involved as a programme is being devised in order to ensure that it is practical to use. It is essential that supervisors set workers a good example with regard to safety procedures.

TRAINING (Figure 18)

Training and advice on specific issues concerning the selection of RPE should be provided by the supplier; the provision of free training should be taken into account when selecting an equipment supplier. Price alone is not the main criterion. The training offered should address two key objectives:

- The correct equipment is used for the job.
- The equipment is correctly fitted at each usage and worn throughout the period of exposure to the hazard.

Training should also be repeated.

The training organization will advise on the selection of competent persons. It should then cover the topics listed in Figure 19. A good example of the type of training available is that offered by 3M. Note that if the organization offering the training course also supplies RPE, it is likely to encourage the use of its own equipment.

EXAMPLES OF RPE

Figure 20 shows a P2-level dust mask supplied by 3M. Note the CE mark on the ventilation disc. The mask has elasticated straps to allow it to fit to any head size. The bridge of the nose has a clip that allows the mask to be pinched tightly to the nose (the most common area at which dust may enter, thus reducing the efficacy of the mask).

Figure 21 shows a P3 dust mask supplied by Moldex. The CE mark is visible as is the EN test number. The mask is pre-moulded to the face so is appropriate for only a specific shape of face.

Figure 22 shows a disposable vapour mask. The head support makes the mask comfortable to wear. The nose area shows brown and white coding, which indicates that it is suitable for dust and organic vapour. Although this mask provides A2-level protection to the lungs, it offers no protection to the sensitive mucous membranes around the eyes. Even when worn with goggles, the level of protection is limited. In these cases the use of an FFVM is advised.

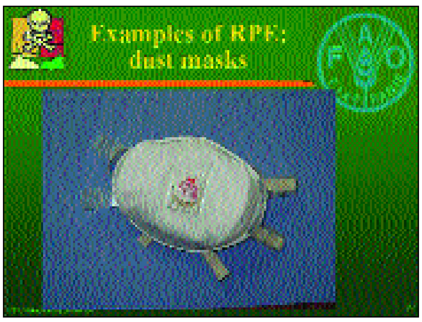

Figure 20

Figure 21

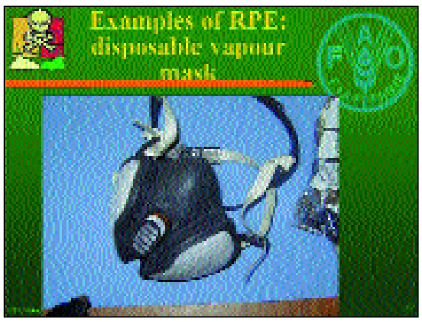

Figure 22

Figure 23

Figure 24

Figure 25

Figure 23 shows three varieties of FFVM. All have slightly different specifications and all need some sort of filtration system in order to offer any level of respiratory protection. The mask alone offers none.

Figure 24 shows a standard FFVM with a combination cartridge filter. The only drawback with this is that the weight of the mask and its filter can strain the neck if worn for extended periods. This mask offers good protection to the eyes and sensitive skin on the face.

The variety shown in Figure 25 offers increased visibility. This mask also provides excellent protection for the eyes and the skin on the face.

Figure 26 shows the power pack for a battery-powered filtration system. Such systems need to be recharged and so may be of little use in remote bush areas where power cannot be guaranteed.

The power pack fits into a belt unit fitted with a cartridge (Figure 27) similar to that seen on the standard FFVM. This solves the weight problem mentioned earlier.

Another variant (Figure 28) uses three filters in series, which increases the life of the unit.

Figure 29 shows how the mask is connected to the filter unit by a flexible hose. The filter unit is worn around the waist. This combination offers excellent protection in vapour hazard environments.

In dusty environments, the hood system (Figure 30) may be preferred. The whole head is protected from the dust and so contamination of hair and skin can be avoided.

A final variety (Figure 31) uses a sealed hard hat system for cases where there is an overhead hazard.

Figure 26

Figure 27

Figure 28

Figure 29

Figure 30

Figure 31

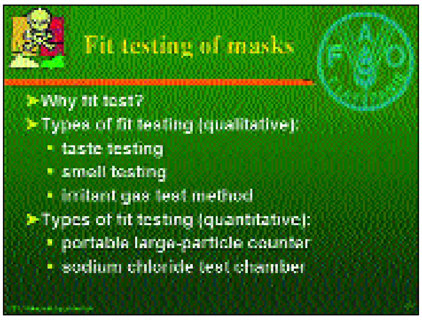

Figure 32

Figure 33

Figure 34

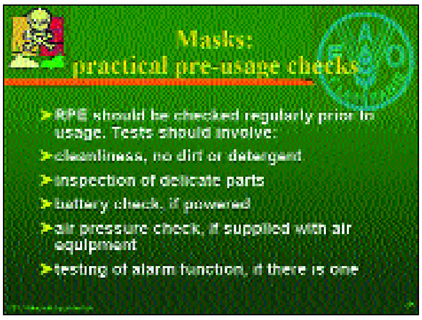

Figure 35

EXERCISE

The fit test described in Figure 33 needs to be performed on each of the people who may use the RPE and for each different type of RPE likely to be used. This can be arranged through the RPE supplier.

The single most important aspect of RPE is how well it forms a seal and thereby prevents contaminants from getting through the filter mechanism. The effectiveness of the seal is determined by testing the fit (Figure 32).

MAINTENANCE OF RPE

The maintenance of RPE should follow the systematic approach detailed in Figure 34. An important element is that all activities are recorded in appropriate maintenance logs. This applies to all reusable RPE, such as the FFVMs and filter systems shown in Figures 23 to 31, but not usually to disposable items unless they are used for more than one shift. Careful cleaning and inspection are equally important for all items (Figure 35).

Pre-shift checks must be performed. It is important that wearers identify their own equipment.

The wearer's name and the date on which the piece of equipment is first used should be entered on all disposable items. This allows the supervisor to check the age of a mask and the likely need for replacement.

All PPE must be accounted for. It must be securely disposed of after use as it will be contaminated and anybody who finds it is likely to use it, thus contaminating themselves (Figures 36, 37).

SUMMARY

Figure 38 provides a basic guide to RPE and its selection. It acts as a guide to questions that buyers should ask the suppliers of RPE. Buyers should ask the following questions, as a minimum:

- Is the equipment tested to an international or national standard?
- What is the APF for the mask?
- How was the APF determined?
- Do users have access to guidance/training programmes?
- Will each of the people using the equipment be offered a fit test?

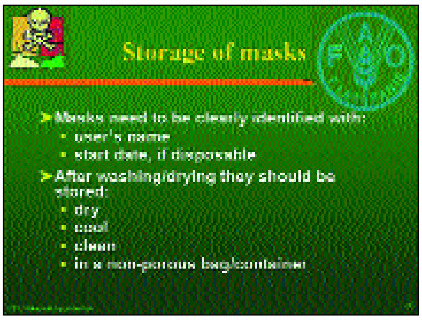

Figure 36

Figure 37

Figure 38

10. Gloves, eye protection and boot selection

Figure 1

This unit examines the selection and use of smaller items of personal protection equipment (PPE). These are just as important as the coveralls and masks discussed in the previous units and form an integral part of the complete protection of the individual. It is no use having excellent coveralls and masks if the risk of contamination to the eyes, hands or feet is not addressed.

GLOVES

Typically, hands are the first point of physical contact with drums or sacks in a store. If its integrity is compromised, the protection from coveralls and masks will not count for anything.

When selecting gloves the following factors must be considered (Figure 2):

Figure 2

- If the store is well laid out, minimum handling and movement of drums and/or bags will be required. If items need to be moved the likelihood of exposure (and therefore the risk) is increased.
- The chemicals that are to be handled will determine the polymer base of the glove. Some solvents and active ingredients pass through certain polymers, rendering them useless.
- In relation to the job in hand, if drums have to be moved in order to identify products there may be the risk of cuts or scratches from sharp surfaces. This risk should be noted during the risk assessment.

As usual, reference should be made to the detailed risk assessment when identifying the actions to be taken and the PPE required (Figure 3).

Figure 3

The final choice will again depend on the activities to be performed as determined in the risk assessment.

Splash and immersion need to be identified as potential exposure routes and the likelihood of contact should be assessed based on the conditions in the store.

The handling of drums necessitates that the gloves be mechanically strong enough to cope with the activities (Figure 4). Thin laboratory gloves may be made of the correct polymer but offer very little protection in terms of mechanical strength. The protective barrier may, therefore, easily be compromised.

Figure 4

Care should be taken when using leather gloves. These provide no chemical barrier and may act like a sponge, absorbing contaminants that can be spread to other surfaces.

During the inventory it is advisable to avoid handling drums and packages if at all possible.

Table 1 shows the large number of types of gloves that are widely

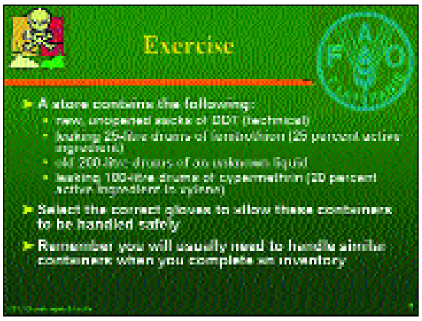

Figure 5

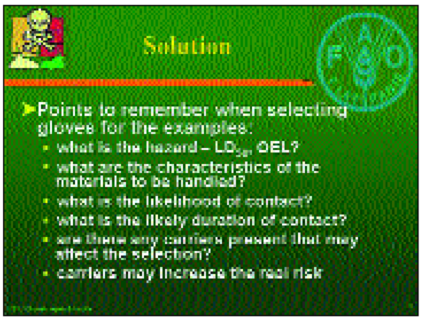

Figure 6

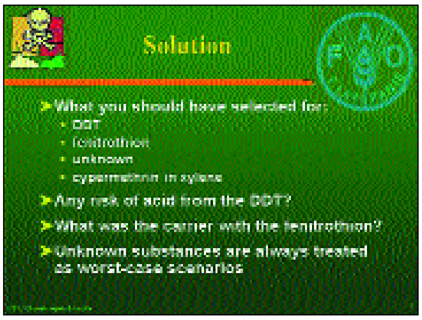

Figure 7

EXERCISE

Which of the gloves listed on the Table would be most appropriate for each of the situations mentioned in Figure 5?

Solution (Figures 6, 7)

The following are suggested answers:

- For DDT all types of glove are appropriate. DDT is in category A on the Table: dry/water-based.
- With fenitrothon it depends on the solvent, so more information is required before an accurate assessment can be made. If a decision must be made, select nitrile or barrier-laminate gloves.
- When the substance is unknown, avoid contact with the active ingredient. Barrier laminate offers the widest protection. Viton also offers good protection but at a very high price.
- For cypermethrin in xylene the solvent category is F. The best glove polymer is therefore nitrile.

available and shows their diverse resistances to different solvents. Typically, it is the solvent that is the main consideration when dealing with obsolete pesticides.

In the Figure 5 example, the risk of HCl from the DDT is minimal as the sacks are not opened.

FOOTWEAR (Figure 9)

The key here is to avoid absorption into the material of the boot. In addition, the top of the boot should be covered to prevent contamination (see Using the coveralls, on p.35).

Polymer selection is again important. There is not such a wide variety of boots as there is of gloves. The aim must remain to minimize the time of exposure to contaminants.

When handling drums a steel toecap should be considered as a way of minimizing the effects of crush injuries.

Overshoes should be worn when the exposure time is short and the area has very low signs of contamination.

As with coveralls (see p. 35), when removing footwear care must be taken to decontaminate (or at least avoid contact with) outer surfaces. A foot-bath with detergent may be considered at the entry/exit to the dirty zone (zone 1).

Figure 8

Figure 9

Figure 10

Remember when removing boots to try to step out of them. If this is not possible only touch soles, etc. with gloved/protected hands.

EYE PROTECTION (Figure 10)
Three types of eye protection are readily available. Some of the features of each are given in Figure 11. All of them have strengths and weaknesses (Figure 12).

The hoods and full-face vapour masks shown in the previous unit offer the best eye protection (Figure 13).

Figure 11

Figure 12

Figure 13

Table 1

Chemical resistance category selection chart[1]

Selection category[2] (based on solvent)	Type of personal protective material (i.e. gloves)							
	Barrier laminate Viton[3]	Butyl	rubber3	Nitrile rubber[3]	Neoprene rubber[3]	Polyvinyl chloride[3]	Natural rubber[3]	Polyethylene
A (dry and water-based)	High	High	High	High	High	High	High	High
B (ketones)	High	Slight	High	Slight	Slight	Slight	None	Slight
C (alcohols)	High	High	High	High	High	High	Moderate	Moderate
D (acetates)	High	Slight	High	Moderate	Moderate	None	None	None
E (aliphatic petroleum distillates)	High	High	Slight	High	High	Moderate	Slight	None
F (aromatic petroleum distillates)	High	High	High	High	Moderate	Slight	Slight	None
G (aromatic petroleum distillates)	High	High	Slight	Slight	Slight	None	None	None
H (halogenated hydrocarbons)	High	High	Slight	Slight	Slight	None	None	None
Cost per pair	$7	$175	$19	$3	$8	$4	$1	

[1] High = highly chemical resistant; clean or replace PPE at end of each workday; rinse off pesticides at rest breaks. Moderate = moderately chemical resistant; clean or replace PPE within an hour or two of contact. Slight = slightly chemical resistant; clean or replace PPE within ten minutes of contact. None = not chemical resistant; do not wear this type of material as PPE when contact is possible.
[2] The selection category is based on the solvent or solvents in the pesticide formulation. For the purposes of this chart, a solvent is any liquid, inert ingredient that constitutes more than 5 percent of the contents of an end use product.
[3] Minimum thickness of 14 mils (1 mil = 0.001 inch or 0.0254 mm).
For more details about chemical resistance categories, see Supplement Three, Main labelling guidance of PR Notice 93-7 *Labelling revisions required by the worker protection standard (WPS)*, p. 11-16.)

Source: United States Environmental Protection Agency (USEPA).

11. The safe working area

Figure 1

Figure 1 shows a typical example of the problems associated with the incorrect storage of pesticides. The material shown here includes sacks of Aldrin and other persistent organic pollutants (POPs). No records of the actual amounts or types of pesticide were available, and identification was made by close examination of labels and by laboratory analysis. All of this increases the cost. Pesticides should be properly stored and accurate records kept.

The materials in Figure 1 are unsafe because there is no control on their movement in the environment. Dust can be carried by the wind. Rain can wash the pesticides into the soil or into adjacent watercourses.

Figure 2

When discussing the working area it is first necessary to examine why it is needed. This is best done by defining its aims or objectives (Figures 2, 3).

Attention should then be turned to creating a suitable working area. By assigning levels of risk to different activities, a series of zones can be developed. Each zone will have specific activities associated with it and also its own very specific set of safe working rules.

Figure 3

The issue of containment concerns emissions into air and water. How can humans and the environment be protected in the case of an unforeseen release of toxic materials?

In addition to engineering controls, there is a need to examine how cross-contamination and spread of the risk outside the working area can be prevented. The safe working area is designed to increase the level of safety to humans and the environment. General safety issues such as the risk of fire and the possible need for emergency first aid need to be considered.

Documentation involves examining how the criteria concerned are recorded and measured.

In broad terms, the aim of the safe working area is simply protection.

CONSTRUCTING A SAFE WORKING AREA

Figure 4

The principles of safe working area construction are given in Figure 4. By dividing the working area into zones based on activities and risk it is possible to manage the waste and initiate a regime of controls and protective equipment that is activity-specific.

Through the careful use of barriers, the boundaries of activities can be marked and protection provided to the uncontaminated areas inside and outside the working area. Protective membranes, trays and other methods also help to minimize the potential for cross-contamination.

On a more practical level, through the adoption of a strict regime of changing shoes, coveralls, gloves and other personal protective equipment (PPE) on entering or leaving an active zone within the working area the risk of cross-contamination can be greatly reduced.

Rules concerning eating, etc. also have a direct effect on the reduction of risk and the increase of protection to the workforce.

Clear signs showing points of entry, exit, site rules, PPE requirements and a copy of the risk assessment all help to protect the workers in an area.

Although it is always hoped that there will never be a fire or incident resulting in harm to human health, sufficient equipment and materials must be available to deal with this eventuality.

ZONING

By dividing the working area into zones based on activities and potential exposure to harmful/toxic materials, personnel and the potential for incidents can be managed better (Figure 5).

Zoning should be the first step in any activity that involves entering a site where there is the potential for exposure to harmful materials.

The working area is typically divided into two or three zones; the final number depends on the nature of the location, the harmful material concerned and the activities that need to be completed.

Typically, the zones are identified by physical barriers (reflective bunting, mesh fencing, etc.). It is also likely that the boundaries of a zone may be marked by the fabric of the building. In most cases there is a single point of entry and exit from the area. This usually has a shoe/PPE changing station and containers for any contaminated clothing. In cases where the working area is an enclosed building, a conveniently situated doorway should be used. Other points of entry/exit should be sealed to avoid casual access. The need for adequate emergency exits in case of fire, injury, etc. must, however, always be borne in mind. Vehicle access should be separate and defined traffic routes need to be clearly marked to avoid any accidents.

All working areas have a zone 1 (Figure 6), which may be referred to as the dirty area. As the name suggests, this area typically represents the greatest risk to the workforce, the public and the environment. In some instances, the chemicals/hazards may be under control, but typically there will be leaking containers, spillages, a lack of stock records, poor ventilation, etc.

Generally, a strict regime of PPE is required for work in zone 1. This is formally identified on the risk assessment. Remember, if in doubt, adopt the worst-case scenario.

Typical activities in the dirty area are given in Figure 7. This is the zone where the workers actually come into physical contact with the hazardous materials. Once the physical limits of the zone have been clearly marked, a risk assessment needs to be completed to allow the selection of the correct PPE for all activities. *This zone poses a serious risk to all workers and must be very clearly marked.*

Zone 1 is usually bounded by zone 2 – the intermediate zone (Figure 8). Personnel leaving zone 1 will disrobe and remove all PPE before passing into zone 2. A lower level of PPE is adopted in this zone, associated to the risk posed by the activities. Activities in this area are

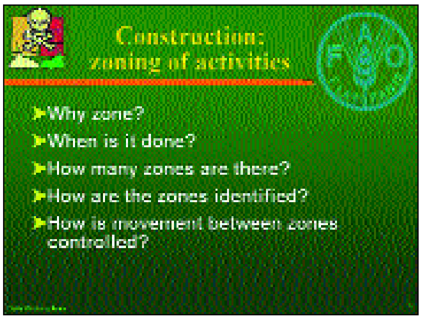

Figure 5

Figure 6

Figure 7

Figure 8

Figure 9

usually of lower risk. Chemicals are stabilized in zone 1 and materials are repackaged and labelled. Materials that have been repackaged no longer pose a serious exposure risk to humans. If, however, the new packages were to remain within the dirty area they may themselves become contaminated on their outer surfaces. As new packages are filled, they are typically moved to the entry point of the dirty area. Here they are usually inspected and cleaned if necessary. They are then transferred to the intermediate zone where they are stored to await final transport away from the site. Outer surfaces may be cleaned again as a final precaution to prevent cross-contamination.

The intermediate zone represents a secure storage area for repackaged wastes and equipment for use in zone 1. When equipment is no longer required in zone 1 it is cleaned before being sent to interim storage in zone 2.

When it is time for the materials to leave the site they are transferred to zone 3 – the clean area (Figure 9). PPE here is typically minimal, reflecting the fact that all packages and equipment are not contaminated. Personnel leaving the intermediate zone may be required to disrobe, but usually a lack of contamination will mean that PPE is equivalent for both zones.

Figure 10

CONTAINMENT (Figure 10)

Combinations of containment methods are available and should be considered. The containment of liquids will require a different approach to the containment of solid materials.

The containment of liquids is normally based on the prevention of spillage and leakage from existing containers when they are handled or their contents are transferred. Liquids usually require the use of a bunded, self-contained area where pumping and draining activities are performed. This may be a steel, concrete or plastic construction. Typically, a plastic membrane is used to cover a non-contaminated area adjacent to the items to be handled. If possible, a steel tray with a lip is used. If the liquid is stored in a building, it is advisable to ventilate the building as well as possible by opening all windows, etc.

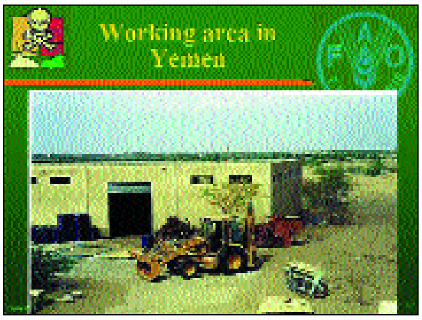

Figure 11

For solids the risk is associated with the spread of dust outside zone 1. In contrast to the protocol for liquids, if the solid material is dusty or friable and is housed in a building it is advisable to seal all windows and unused doors with polyethylene. This effectively seals the working area and prevents cross-contamination of the surrounding area. If possible, vacuum extraction should be considered, as long as the system employed has a suitable filter on the exhaust.

At the site shown in Figure 11, the following practices ensure containment:

- All activities are performed inside the store.
- The entrance to the store is covered by a protective membrane which has two layers:
  - polyethylene, to prevent chemical contamination;
  - plywood, to provide mechanical strength.
- New, empty drums are stored outside to prevent cross-contamination.
- Entrance to the store is by a single point of access.

Figure 12

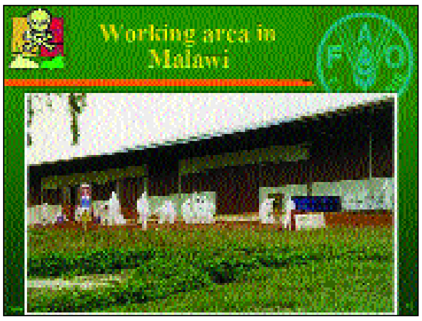

Figure 13

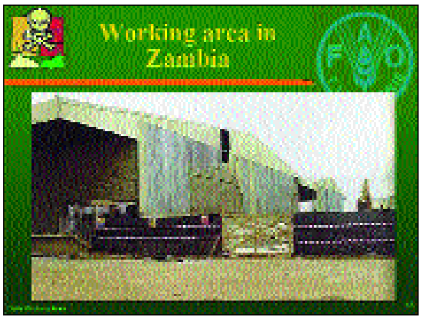

Figure 14

Figure 15

In Figure 12:

- The area is self-contained by a steel tray.
- The new drums are held inside the shipping container, minimizing the need to handle full drums.
- A spillage control kit is placed inside the working area.
- A first aid kit is placed within the working area.
- A dry-powder fire extinguisher is in the working area.

In Figure 13:

- The boundary of the area is marked by reflective mesh.
- Warning signs are clearly visible.
- Everybody inside the working area has appropriate PPE.
- There is a drum for contaminated clothing at the entrance to the working area.

In Figure 14:

- The entrance is via a shoe/coverall changing station.
- The boundary is clearly marked.
- Dust migration is minimized by a 2 m high polyethylene barrier.
- Warning signs are clearly visible.
- There is a separate entry point for vehicles.
- The floor is protected by polyethylene and plywood.

SUMMARY (Figure 15)

This unit has shown how the working area is used to protect workers, the public and the environment. Safe working areas add control to uncontrolled situations involving hazardous materials. The adoption of a zoned approach to activities makes it possible to focus on developing specific activities and so to manage the risk. Actual examples of working areas from past projects illustrate how the specific design is dependent on the activities being performed and the risks encountered.

The net result of following this approach is the successful completion of a project with no adverse affects on people or the environment. The final outcome will be the safe elimination of hazards and the production of a clean site that is fit for reuse.

12.
Risk assessment

Figure 1

Figure 2

Effective consideration of risk assessment requires that a number of issues be examined. These include the following (Figure 2):

- *Types of hazard:* Are they chemical, mechanical or physical? This unit focuses on the hazards associated with chemicals, but the hazards associated with storage are also considered, along with physical risks such as heat stroke caused by the need for protective equipment in hot climates.
- *The link between risk/hazard and quantified, well-defined factors* such as:
  - lethal dose (LD_{50}) for a chemical;
  - the material safety data sheet (MSDS) supplied by the manufacturer or supplier of a chemical;
  - the accepted occupational exposure limit (OEL) as defined in national or regional legislation (OEL is a United Kingdom term). This is usually expressed as an average concentration of toxic chemical over a given time period;
  - the maximum exposure limit (MEL) in terms of the highest one-off exposure that is regarded as safe. (Both the OEL and the MEL are based on extensive workplace monitoring and testing. A problem with many obsolete pesticide stores is that such testing is not always possible. In this case a worst-case scenario should be adopted in selecting appropriate personal protective equipment [PPE]. These factors can affect the estimate of hazard and, hence, the level of risk perceived.)
- *Definitions of hazard and risk* that are easily understood.
- *Personnel:* The key to a successful risk assessment is the availability of competent personnel; this unit gives guidance on how to determine competency.
- *The aims of risk assessment.*
- *A basic format for risk assessment* which has been found to be successful in the past.

Figure 3

TYPES OF HAZARD

There are many types of hazard (Figure 3). Most can be found in everyday life. Hazards such as slips and trips can have a great affect when handling a corrosive or poisonous chemical, so the utmost care must always be taken to avoid simple everyday hazards when dealing with potentially harmful chemicals.

It is also necessary to consider who could be affected by a hazard. Actions can have a far wider potential impact than just harming the person who is carrying them out and the wider implications of an action should always be considered. Contaminated clothing and footwear could be handled by another family member washing the wearer's clothes. Family members and other people could be contaminated by, for example, workers not removing contaminated clothing before greeting or hugging their children, or forgetting to wash their hands, touching a door handle, telephone or other surface and contaminating it so that the next person to touch it becomes contaminated. Basic hygiene is very important.

Figure 4

Figure 5

Figure 6

Figure 7

LINK BETWEEN RISK/HAZARD AND OTHER FACTORS

Lethal dose (Figure 4)

The oral LD_{50} is the dose of *pure* chemical, measured in milligrams of chemical per kilogram body weight of the animal, that when fed to rats in laboratory tests was found to kill 50 percent of a sample population. This figure is an indicator of the acute toxicity of an active ingredient. Note that pesticide products often contain very dilute active ingredients and these are often diluted again for application.

Material safety data sheets (Figure 5)

MSDS are available from product manufacturers or their agents. In many regions and countries it is obligatory for pesticide registrants to produce MSDS and make them available for every product they register.

MSDS provide information about specific hazards associated with the product and how to deal with those hazards. This is explained in more detail in Finding out about pesticides, on p. 15.

Occupational and maximum exposure limits (Figure 6)

Both the OEL and the MEL are very useful when assessing risk. They are based on extensive workplace monitoring where hazardous chemicals are used. They also consider any historical data that are relevant (asbestos). Where possible, during a disposal operation monitoring will be used (for example when dusty powders are repackaged into new containers). Generally, however, workplace monitoring is not possible and the level of exposure must be estimated on a worst-case scenario basis.

All these reference data allow an examination of the ways in which a chemical can enter the body (Figure 7). They also give an estimate as to how much exposure is safe for an individual in the workplace. The main difficulty that remains is relating the reference data to real-life situations where workplace monitoring is either not practical or prohibitively expensive to install. Judgement has to be made as to the likely level of exposure, taking into account the duration of exposure and the actual conditions that exist in the store under examination. The chemical reference data allow assessment of the nature of the hazard. Application of these data to a real-life situation is the role of risk assessment. Unless there is workplace monitoring, judgements have to be based on experience and common sense. When in doubt, a worst-case scenario should be used.

DEFINITIONS OF HAZARD AND RISK

The best way of describing how to define hazard and risk is through the use of an example such as the one in Figure 8. In both instances the

Figure 8

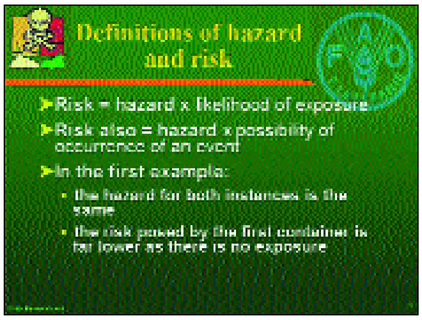

Figure 9

Figure 10

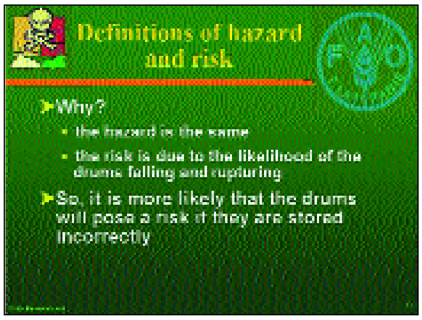

Figure 11

hazard associated with the chemical Dieldrin is the same. Using the *Pesticide manual* (see Preface for bibliographic details) or a similar reference text it is possible to find out the LD_{50} and the possible ways through which the material can enter the human body. It is also possible to assess its possible short- and long-term environmental affects. Its OEL gives some indication of the level of exposure that is regarded as safe.

EXERCISE (Figures 8, 9, 10, 11)

Which instance in Figure 8 poses the higher risk?

Solution

The answer is the leaking container, but why?

In order to determine why the leaking container poses the greater risk the definition must include the hazard posed by the individual chemical.

The two definitions supplied in Figure 9 are the most widely accepted. Both relate the hazard of a material to an external factor – exposure or an unforeseen event. In the example, the hazard remains constant for both scenarios. The level of potential exposure is, however, very different. In the second example, consideration should be given not to exposure but to the possibility of the event occurring. The hazard remains constant. The obsolete pesticide hazard data are the same in both instances.

The difference is in the likelihood of an event occurring; for example, how likely is it that the drums fall (because the pallets have collapsed) and become ruptured, leading to leakage of the pesticide over the store? Another risk is that the falling drums may crush personnel.

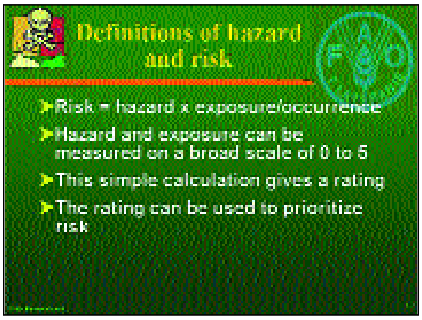

Figure 12

Figure 13

Figure 14

Figure 15

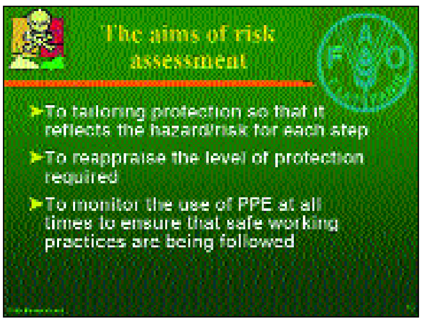

Figure 16

A rough (Figure 12) numerical value can be assigned to the risk posed by a specific situation. By assigning values of 1 to 5 to both the hazard and the exposure/potential occurrence, and multiplying the two values, it is possible to derive a risk rating of between 0 and 25. This can be used as a means of prioritizing a number of risks.

A word of caution is needed, however: it is dangerous to rely totally on a risk rating. Different individuals have different perceptions of risk and may assign it different values. For example, a person who is used to handling pesticides on a day-to-day basis will naturally take many of the hazards for granted. That person's actions may be almost automated as a result of repeating them over a long period of time. The hazard rating that he or she assigns may, therefore, be different from that assigned by somebody who is in the situation for the first time, and who is not familiar with the practical hazards of handling pesticides. Problems arise when the risk assessment is used alone because, although the different assessments may both be correct, if an inexperienced person were to use the assessment of an experienced person to carry out the work, there would be the potential for injury as the level of data supplied may be inadequate for the inexperienced person.

A risk assessment should always be made by an objective "new pair of eyes" so that no preconceived ideas influence it. The final assessment has to be applicable to all of the people who use it, from the project manager to the hired, temporary worker.

Competency

Figure 13 summarizes the issue of competency, but how can competency be determined?

There is no substitute for experience although, as already stated, the assessor must always look at a situation with a fresh pair of eyes. As summarized in Figure 14, the assessor should have experience of the type of situation encountered and, perhaps most importantly, a large amount of common sense.

Academic excellence is important for work in the laboratory, but when it comes to practical real-life circumstances, common sense is just as important. This makes managers' or supervisors' jobs more complex. It is their responsibility to ensure that adequate relevant training is provided and that people selected as assessors have sound judgement and common sense.

THE AIMS OF RISK ASSESSMENT (Figures 15, 16)

The aims of risk assessment can best be defined by answering a simple question: What is the assessment trying to achieve?

In its simplest form, risk assessment looks at the risk associated with handling a substance or performing an activity. It must then look at alternative methods of operation that will reduce that risk. Then, as a last resort, it considers the adequate level of personal protection that must be supplied to workers.

In all instances the protection selected must be fit for the purpose. A tailor-made, specific assessment is needed for each activity. It may be based on a generic, broad, standard risk assessment if an activity is repetitive, but the final risk assessment should be totally specific to the environment in which the activity is being performed. For example, the mechanics of transferring liquid from an old drum to a new one using a pump is comparatively standard. Factors such as the toxicity of the material, its flammability and its viscosity will affect the final approach, as will factors such as the distance the material should be pumped (because of lack of direct access to the site), the climatic conditions (potential heat stress of the workers must always be considered) and the ambient temperature (a volatile material may present less of a risk if it is pumped when the temperature is lower – first thing in the morning or at night).

A risk assessment is a living, working document. It is open to review and change as circumstances change. It is always related to the task at hand and is not merely an academic exercise.

Once the risk assessment has been completed and a set of site working rules or control measures have been established they must be monitored and enforced. It is no good completing a detailed assessment if the findings are not followed. The same is true for protective clothing. If an activity needs specific personal protective equipment (PPE) then it must be worn without exception. If workers raise objections at the daily meetings or during work their views should be considered. If the regime is not practical for the job then ways of reviewing working methods should be sought. Objections or complaints should never be dismissed without consideration. By considering the concerns carefully it may be possible to adjust actions and complete the activity in less time and with less risk. This willingness to listen must, of course, be weighed against the need to offer an adequate level of protection. At the end of the day it is the manager's/supervisor's decision.

Figure 17

Figure 18

Figures 17 and 18 list the five steps to effective risk assessment. Wherever possible, elimination, substitution and engineering controls should be considered.

There must also be clear and easily understood site rules or administrative controls and, finally appropriate PPE should be selected. PPE selection should never be the first line of defence.

The following supplement outlines a basic, simple format for completing a risk assessment.

Risk assessment supplement

The following Figures provide trainees with a step-by-step guide to carrying out a risk assessment before and during their inventory taking work. The presentation is designed to supplement the previous unit on risk assessment. It explains how to implement the measures described in that unit.

Because of the high level of detail and the sequential nature of the presentation, the content of the Figures is self-explanatory. There are therefore no accompanying notes to this presentation and only the Figures are reproduced here.

Figure 1

Figure 2

Figure 3

Figure 4

Figure 5

Figure 6

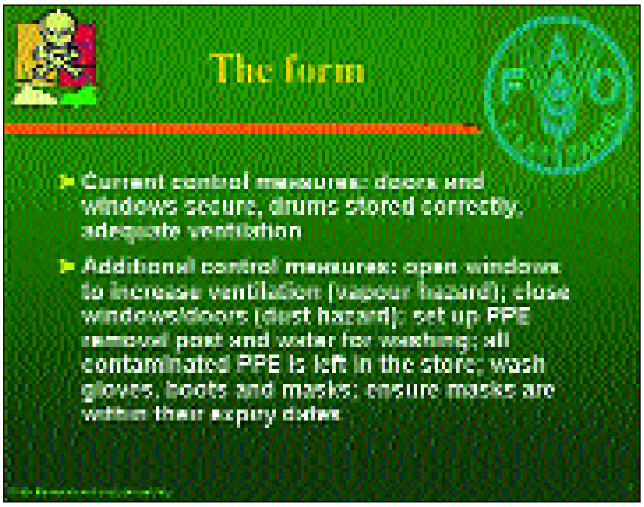

Figure 7

Figure 8

Figure 9

Figure 10

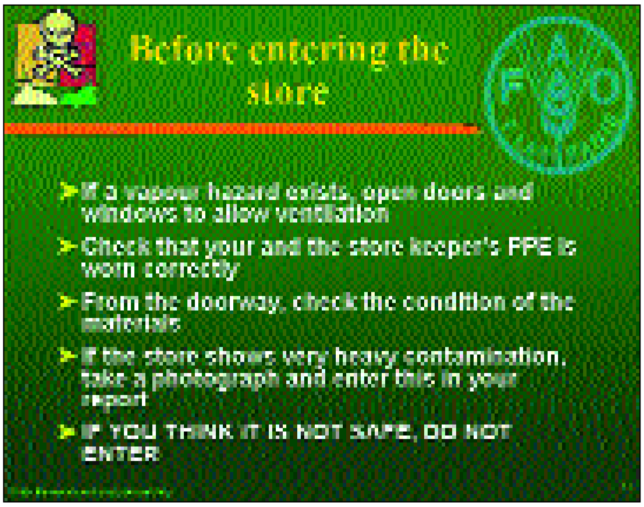

Figure 11

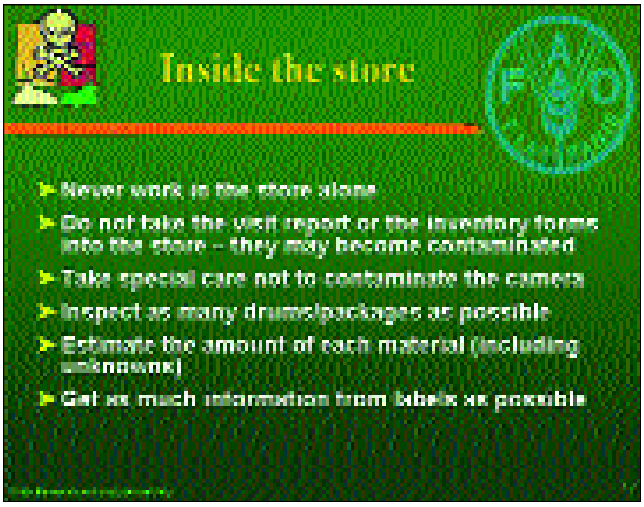

Figure 12

Figure 13

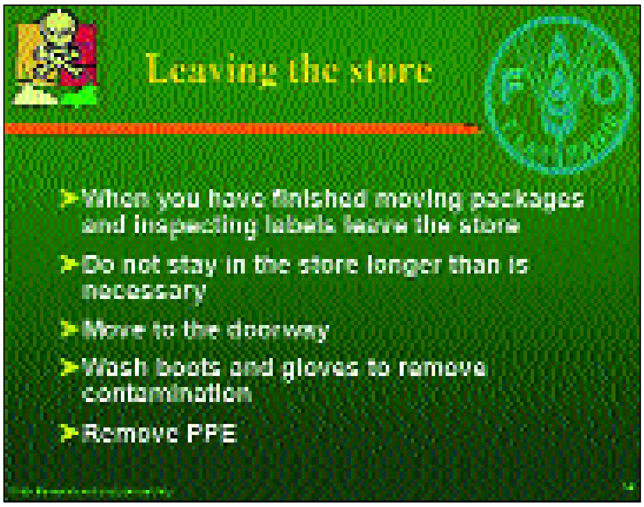

Figure 14

Figure 15

Figure 16

Figure 17

Figure 18

Figure 19

13. Pesticide stock control

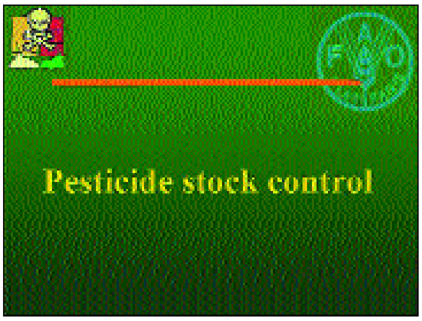

Figure 1

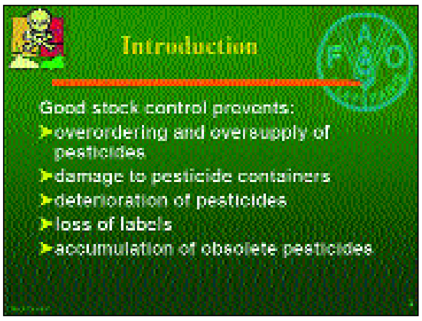

Figure 2

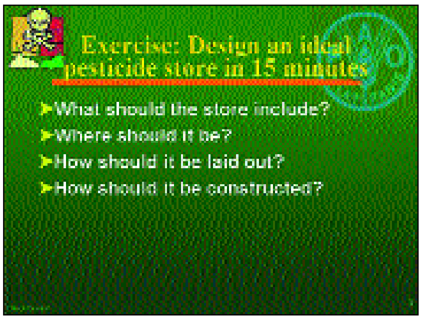

Figure 3

Figure 4

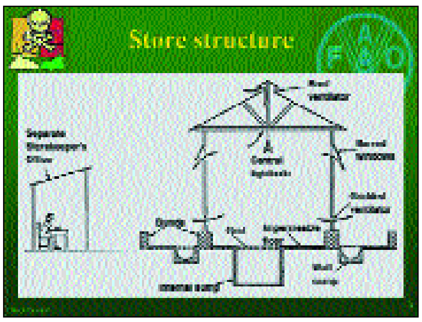

Figure 5

One of the most common causes of obsolete pesticides is poor storage and stock management. Poor storage of pesticides can also result in serious environmental contamination, health risks to workers and local residents and such emergencies as fires or water poisoning.

This unit highlights the important issues to consider when planning storage facilities and gives advice on good storage and stock management practices.

The whole section follows the advice given in FAO Pesticide Disposal Series No. 3 (see Preface for bibliographic details).

The causes of obsolete pesticides include the following (Figure 2):

- having too many pesticides, so that they cannot be used before they deteriorate;
- damage to pesticide containers caused by poor storage or handling;
- pesticides deteriorating more quickly than expected because they have been exposed to temperature extremes and fluctuations, or to air as a result of container damage or prolonged storage of part-used containers;
- loss of labels, so that pesticides cannot be identified and are automatically considered to be obsolete.

Good stock control minimizes these problems, thereby preventing the accumulation of obsolete pesticides.

EXERCISE

Draw a design for an ideal pesticide store based on the questions asked in Figure 3.

THE IDEAL PESTICIDE STORE

Pesticide stores contain large amounts of potentially hazardous materials (Figure 4). If anything should go wrong such as a spillage, fire or flood, it is important to ensure that the pesticides in the store do not harm people or the environment. There should also be good access to pesticide stores for easy delivery of goods and to allow emergency vehicles to reach them if necessary.

The store should be large enough to accommodate the maximum quantity of pesticides likely to be held at any one time plus a further 15 percent capacity to allow for stock movement and handling and empty containers (Figure 5). Its height should ideally be 6 to 7 m to allow for good airflow.

There should be good ventilation to keep temperatures down and allow vapours from the pesticides to escape.

Floors should be of smooth, impermeable concrete to prevent absorption of spillages and to allow easy cleaning. Walls can be whitewashed with lime, which can help to neutralize some acids.

Sumps that can hold the full maximum volume of pesticides stored should be incorporated inside and around the store. Bunds should be constructed to contain spillages inside and outside the store.

Offices, changing and rest facilities, including washing facilities, should be separated from the pesticides store. No person should be required to enter the store for any purpose other than store-keeping tasks.

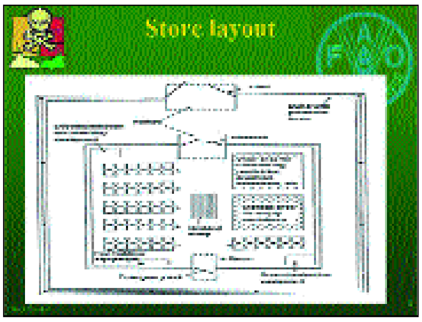

Figure 6

Store layout

The store layout should allow for (Figure 6):

- minimum handling of pesticide containers to avoid leaks and spills;
- direct access to the outside without having to pass through another building;
- a well-lit and ventilated work area for handling pesticides that is some distance from the entrance;
- storage space for empty containers and obsolete products awaiting disposal;
- washing facilities;
- protective clothing storage that is separate from the pesticides;
- separate storage for different types of products (herbicides, insecticides, fungicides, etc.) and incompatible chemicals (corrosive, spontaneously combustible, etc.).

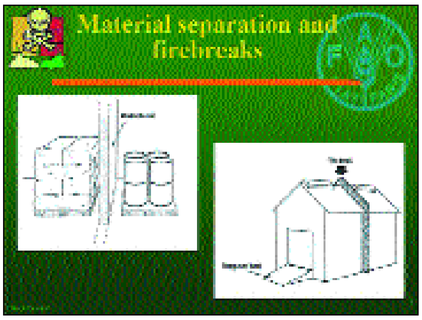

Figure 7

Different types of pesticides should be separated by a physical, fire-proof barrier (Figure 7).

Bunds that surround the whole store can be traversed by vehicles if ramps are constructed.

Figure 8 shows the complete storage site layout which includes:

- a perimeter fence to keep unauthorized people and livestock out;
- bunds built into the base of the store walls and the perimeter fence to contain any spills. The bunds should completely enclose the storage areas so that there is no opening through which spilled chemicals can flow out;
- ramps over the bunds to allow vehicle passage;
- a lightweight roof made of glass fibre or asbestos substitute that is designed to collapse inwards in the event of a serious fire. A roof structure that is too sturdy may allow vapour pressure to rise in a fire and eventually the roof would explode outwards, creating a greater environmental hazard.

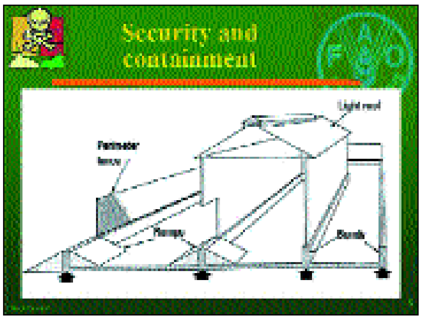

Figure 8

Security

Outside the store, signs should be posted in local languages reading “Danger pesticides. Authorized entry only” (Figure 9). Other clearly visible signs should be posted inside and outside the store reading “No smoking: no naked or half-dressed flame”.


Figure 9

Storekeepers should be aware of and be familiar with warning signs on pesticide and other chemical containers. They should follow storage advice in order to avoid possible fire hazards or chemical reactions. Stocks of hazard labels should be kept for application on containers that are not labelled.

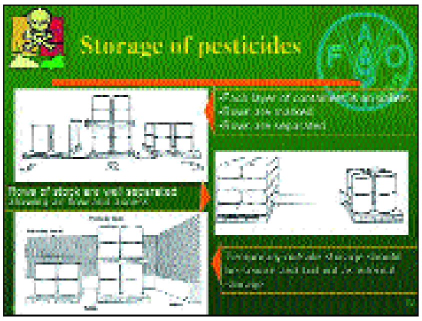

Figure 10

Figure 11

Figure 12

Note that *flammable* and *inflammable* have the same meaning.

STORAGE AND STOCK MANAGEMENT

A pesticides store should only be used to store pesticides and not other agricultural materials or anything else. This is to avoid contamination of other materials (Figure 10).

To prevent damage to pesticide containers and allow easy access for handling and stock control purposes, all stocks should be kept on pallets or other constructions that keep them off the floor. This also allows leaks to be spotted easily. The space between rows of stock should allow easy access for inspection and handling of material.

External storage should only be short-term – never permanent. It should always be secure and allow the same access as internal storage.

Stacking pesticide containers too high can cause damage to lower containers and make stacks unstable. The Table indicates maximum stacking heights for different containers (Figure 11).

Package type	Number of layers on basal pallets	Palletized: number of packages on each pallet
Steel drums (200 litre)	1	3-4
Steel drums (< 200 litre)	2	3-4
Fibre drums (200 litre)	1	3
Fibre drums (< 200 litre)	2	3
Plastic drums (200 litre	1	2
Plastic drums (< 200 litre)	2	2
Paper sacks	4-5	3
Plastic sacks	4-5	3
Fibre case containing tins	4-6	3-4
Fibre case containing soft packages (plastic bottles, sachets)	4-6	2
Wooden cases	2-4	3-4

Pesticide stock should always be managed on a first-in, first-out (FIFO) system (Figure 12). This ensures that the oldest stock is always used first and should prevent chemicals going out of date. This assumes that orders match annual use and not more. Over-ordering leads to product obsolescence.

Stock should be inspected regularly for leaks or damage. Even if containers are not physically damaged, leaks can occur because their contents corrode the containers. Product labels should also be regularly inspected to ensure that labels are present and readable and that the pesticides are not out-of-date. Containers without labels or with unreadable labels should be considered obsolete and taken out of use.

All damaged, leaking, out-of-date and unlabelled pesticides should be removed from the stock and placed with obsolete pesticides awaiting safe disposal.

EXERCISE

Why is record keeping for stocks and stores important?

Figure 13

Figure 14

Figure 15

Record keeping (Figures 13, 14)

Record keeping is an essential part of good stock management. It allows the use of particular products to be monitored and therefore helps to avoid over- or under-ordering in following seasons. It helps to ensure that FIFO stock management is applied effectively, that stocks do not become out of date before use, and that damaged or leaking pesticides are identified and dealt with promptly.

In the event of damage to the store or its contents, records help to deal with the problem effectively by identifying the contents of the store accurately and quickly.

SUMMARY (Figure 15)

This unit should have made it clear that good storage practices are an essential element of a programme to prevent the creation and accumulation of obsolete pesticides.

Stores themselves need to be carefully sited and well designed and laid out to protect stock and allow problems to be dealt with effectively.

Stock management and record keeping are crucial to the maintenance of pesticides in good condition and to ensuring that pesticides are used before they become obsolete.

14. Inventory taking

Figure 1

Figure 2

Figure 3

Figure 4

Figure 5

An inventory is the starting point and foundation of a workable clean-up plan. The scope of the problem has to be known before solutions can be developed.

The purpose of a good inventory is to identify and record, as accurately as possible, information about pesticides in stock. This information will make it possible to decide whether some of the pesticides are *obsolete* or *unwanted*.

The information generated by an inventory is essential in deciding how to deal with pesticide stockpiles (Figure 2). The following four key objectives must be met by the inventory taking process:

- identification of what type of chemicals, contaminated materials and waste matter are being dealt with;
- determination of the status of the chemicals in stockpiles that need to be dealt with, i.e. are they obsolete or can they still be used? (This is discussed in more detailed in Figure 12.);
- identification of who owns stockpiled chemicals and the sites in which they are held and how much of each type of chemical or other material is present at each site, and in the total national stockpile;
- any other relevant information that can be provided, for example: details about the physical storage conditions; the sensitivity of the area because of its vicinity to residential property or because of environmental factors; what is known about the service infrastructure at the store, i.e. are there electricity, water, good road access, etc.? This objective can be supplemented with photographs, maps and other documentary evidence.

WHAT CAN BE GAINED FROM A COMPREHENSIVE INVENTORY?

A detailed inventory is the first step in implementing an effective solution to the problem of obsolete pesticides (Figures 3,4). Without an inventory, no further effective steps can be taken.

An inventory helps to identify the source of the products. This may be useful in generating financial or technical support for disposing of them.

A comprehensive inventory allows risk assessment techniques to be applied that can prioritize particular sites for action on the basis of the threat they present to the environment, to people's health or to local natural resources such as water. Adequate risk assessment (Figure 5) is also important in knowing how to protect those working on the clean-up operations and the environment from the risks presented by the chemicals in store and their removal.

The problem of obsolete pesticides is not unique to one country. It is important to develop a broad picture of the global situation so that the

Figure 6

Figure 7

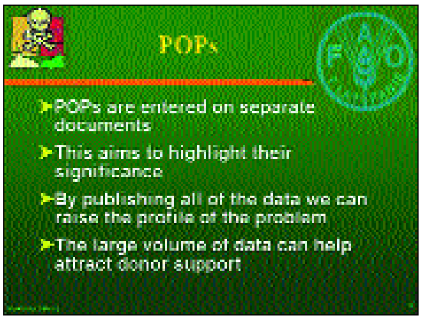

Figure 8

Figure 9

Figure 10

problems can be solved worldwide and their recurrence prevented.

Because of the global nature of the problem it is important that inventory data are collected in a standard format that can be compared and collated among countries.

An inventory must be highly detailed for several reasons (Figure 6). These include putting a specific obsolete pesticide problem within the context of the global situation and understanding why the stockpiles arose. Complete data also help in identifying sources of waste and applying the principle of return-to-sender.

It may be appropriate to develop a strategy for dealing with obsolete pesticides on a regional basis (Figure 7). Whether a disposal operation is planned nationally or regionally, the appointment of contractors to carry out the work depends on accurate inventory data.

Finally, if materials are not specified in detail, they cannot be properly packaged and labelled for transboundary shipping.

PERSISTENT ORGANIC POLLUTANTS (Figure 8)

Persistent organic pollutants (POPs) are dealt with as a special category of obsolete chemicals. This is because of their global significance as a group of chemicals that the international community is trying to eliminate from use and production.

POPs should be listed in the main inventory, but also separately. Listings of POPs will be collated with data from other countries and regions. These data will be used to raise the profile of the POPs issue and try to develop comprehensive solutions for disposal and clean-up.

Figure 9 gives a list of the pesticides currently designated as POPs. There are three other POP chemicals, which are not pesticides but may be contaminants of pesticides or by-products of their destruction. These are dioxin, furan and polychlorinated biphenyl (PCB), which is used in electrical equipment. Other chemicals, including pesticides, may be added in the future.

RELEVANT DATA

As well as technical information about the products found in stockpiles, the inventory should include any additional information and relevant comments (Figure 10). For example, the position of the storage site in relation to homes, schools, hospitals, workplaces, water bodies, sensitive environments and so forth, is particularly relevant. A rough assessment should also be made of the level of soil contamination at the storage site, and included in the inventory, as this will also need to be dealt with. Similarly, data about the producers and suppliers of obsolete pesticides should be noted as these may be helpful in securing funding or technical support to dispose of the products. Finally, colour photographs of the site, its surroundings and the contents of the storage area should be taken and submitted with the inventory forms.

Figure 11

Figure 12

Figure 13

THE FAO INVENTORY FORM (Figure 13)

FAO has developed a standard format for collecting inventory data on obsolete pesticide stockpiles. The format is based on extensive experience and should be followed.

At first, the FAO form may seem long and difficult. This section explains the form in detail and justifies the need for every bit of information. Once used it will become easier to continue with this format.

Do not rely on existing records if they were not collected recently in accordance with the FAO format. They are likely to be out of date and incomplete.

Site assessment is a crucial element of the inventory (Figure 11). Several colour photographs of each storage site and its surroundings should be taken. Its proximity to other facilities, in particular homes, public buildings, water bodies and sensitive environments should be noted. It is also necessary to know how easy it is to reach the site by various modes of transport and to have information about the infrastructure serving the site. This is particularly important in relation to formulating clean-up operation proposals.

The pesticides held in stores will fit into one of four categories (Figure 12):

- *Obsolete* pesticides are banned, damaged, contaminated, unlabelled or too old to be used safely. These pesticides need to be disposed of appropriately.
- *Unidentified* products may have lost their labels but look to be in good condition or be part of a batch that is labelled and usable. Unlabelled products that may be usable should be analysed to ensure that they are.
- *Old* products that seem to be in good condition and have not exceeded their expiry dates by very long need to be analysed to determine if they can be used safely, possibly with an adjustment to the dose rates applied to compensate for loss of active ingredient potency.
- *Usable* products will be in good physical condition in undamaged containers that are clearly labelled in a locally understood language. They will be contained in undamaged containers, be legally approved for use in the country and be in a formulation that can be applied safely. They will also be well within their expiry date and have an appropriate use.

Guide to the form

Number is simply a sequential number for a record in the inventory.

Site/store affected is the name of the store or place where the pesticides are situated. This name should be widely recognizable so that other people can locate it easily.

Common name is the common name for the active ingredient(s) in the product. It does not refer to the scientific chemical name, or the Chemical Abstracts Service (CAS) number, but is the name by which the chemical is widely known. It appears on the product label, generally in small print. Examples are dieldrin, monocrotofos, permethrin, glyphosate and warfarin. Spellings may vary, but the name as it appears on the product should be used. There may also be more than one active ingredient in a commercial product, in which case all of them should be listed.

Commercial name is the name by which the pesticide is sold, This may be the same as the active ingredient name, but is often different. Examples include Grammoxone, Actellic, Roundup and Ratak. It will usually be the most prominent word on a label.

Formulation, if known, should be listed from the following options:

- EC = emulsifiable concentrate;
- ULV = ultra-low volume;
- P = powder or dust;
- G = granules;
- L = unknown liquid;
- S = unknown dry formulation;
- O = other (should be specified).

The percentage of active ingredient in the formulation should also be listed here if known.

Chemical group refers to the family of chemicals to which the active ingredient(s) belong. The common groups and their abbreviations are as follows (examples are given in brackets):

- arsenic compound – AS;
- bipyridylium derivative – BP (paraquat, diquat);
- carbamate – C (aldicarb, carbaryl, chlorpropham, carbofuran);
- coumarin derivative – CO (warfarin, coumatetralyl, brodifacoum);
- copper compound – CU (copper sulphate, bordeaux mixture);
- mercury compound – HG (mercurous chloride, mercuric oxide);
- nitrophenol derivative – NP;
- organochlorine compound – OC (aldrin, dieldrin, DDT, endosulfan);
- organophosphorus compound – OP (parathion, monocrotofos, malathion);
- organotin compound – OT (tributyltin oxide, fentin acetate);
- phenoxyacetic acid derivative – PAA (2,4,5-T, 2,4-D);
- pyrazole – PZ (pyrazoxyfen, pyrazolynate, benzofenap);
- pyrethroid – PY (permethrin, deltamethrin, cypermethrin);
- triazine derivative – T (atrazine, simazine, terbumeton);
- thiocarbamate – TC (asulam, dimepiperate, di allate, molinate).

Toxicity class of the active ingredient as listed in the most recent *Guidelines to classification* published by the International Programme on Chemical Safety. The World Health Organization (WHO) class of the formulation is not relevant since the product may be degraded and the concentration of active ingredient will not be known without analysis.

Container type and size is relevant since methods for dealing with small glass bottles or aerosol cans differ from those used to deal with 200-litre metal drums, for example.

Container condition should be listed as good for undamaged containers, reasonable for containers with signs of wear, rusting, dents, etc., and poor for leaking, punctured, badly corroded or worn containers.

Number of containers refers to the number of items listed in columns 8 and 9 with a separate entry (new line) for each container type, condition and for full and empty containers.

Quantity: As accurate an estimate as possible should be listed for solid (powder, granule) products (in kilograms) and liquid products (in litres) in separate columns.

Year manufactured, batch/lot no. are generally printed on the label and sometimes on the container. They are important in assessing the condition of the product and options for its treatment.

Country, manufacturer, donor source should indicate the manufacturing company's name as well as the organization that purchased the pesticides, if known, and the country the pesticides come from. This information will support approaches to those organizations for any necessary funding to dispose of these products.

Figure 14

WHERE TO FIND THE INFORMATION (Figure 14)

The first place to look for information is the product label which should be securely fixed to the product container. The label should include the following information:

1. the FAO recommended hazard colour code and pictograms indicating product hazards;
2. product or brand name;
3. active ingredient(s) and their concentration(s) and the formulation type;
4. summary of uses, e.g. crops and pests for which the product can be used;
5. date of manufacture and batch number;
6. registration details according to national regulations;
7. manufacturer's or distributor's details (address);
8. directions for use;
9. crop rotation;
10. pre-harvest or re-entry periods;
11. safety precautions;
12. good practice guidance;
13. first aid advice in case of poisoning.

In addition, the label will include:

- hazards and precautions including protective equipment advice;
- storage information;
- disposal advice;
- environmental hazards;
- emergency and first aid procedures;
- pictograms highlighting hazards and precautions;
- colour coding indicating the hazard rating of the product (see Figure 9 in Pesticide stock control, on p. 68).

The label should be in a locally understood language and printed clearly enough to be easily readable.

Figure 15

Everything found in each store should be listed (Figure 15). This includes small quantities, empty containers, contaminated soil and equipment.

POPs should be listed separately.

Photographs should be taken inside and around the store and of the store itself.

Figure 16

If problems arise, take the following actions and precautions (Figure 16):

- For unidentified products, always assume a worst-case scenario in terms of hazard and risk.

Figure 17

- For leaking products, first stabilize the leaks (as described in Spills and leaks, on p. 79) then repackage and relabel the leaking products.
- Site security should be maintained to prevent unauthorized access and to keep current, usable stocks away from obsolete pesticides. New and obsolete pesticides should not be stored together.

SUMMARY (Figure 17)
This unit has emphasized the importance of completing comprehensive inventories of obsolete pesticide stocks. The importance of detail and standardized inventory taking methods has been underlined. In addition to listing chemicals, good site assessments include photographs. As a complementary activity, POPs need to be to listed separately.

Obsolete, unwanted and/or banned pesticide stocks in ____________

Inventory updated: June 2000 **This is an example of a completed inventory**

1 No	2 Site/store affected	3 Common name	4 Commercial name	5 Formulation	6 Chemical group	7 Toxicity group (WHO)	8 Type of container	9 Condition of container	10 Number of containers	11 Quantity (Kg)	12 Quantity (litres)	13 Year manufactured batch/lot No.	14 Country, manufacturer, donor, source	15 Comments/ remarks
1	Jaja	Aldrex	Aldrine	EC	OC	II	Drums	Damaged	10	320	0	?	?	?
2		DDT	DDT	75%	OC	II	Drums	Good	0	5 000	0	?	?	Donated
3	Koludu	DDT	DDT	WC25%	OC	II	Plastic	Damaged	0	1 000	0	?	?	Purchased
4	Bimbo	DDT	DDT	EC	OC	II	Plastic	Damaged	0	180 000	0	?	?	?
5	Jarak	DDT	DDT	WP90%	OC	II	Jute Bag	Damaged	200	800	0	?	?	Crossborder trading
6	Jarak	Digigain	HCH	?	OC	II	Jute Bag	Good	0	0	150	?	?	?
7	Jarak	Endrune 20 EC	Endrune	?	?	?	Drums	Damaged	0	0	6.000	?	?	Found disbanded
8	Jarak	HCH+son	HCH	?	OC	II	Drums	Damaged	50	750	0	?	?	?
9	Jarak	HCH+son	HCH	?	OC	II	Drums	Damaged	0	700	0	?	?	?
10	Bimbo	HCH+son	HCH	?	OC	II	Drums	Damaged	0	300	0	?	?	?
11	Bimbo	Hexafor	HCH	?	OC	II	Drums	Damaged	0	500	0	?	?	?
12	Bimbo	Hexafor	HCH	?	OC	II	Drums	Damaged	0	25	0	?	?	Control campaign
13	Bimbo	Lindal	Lindal	?	?	?	Drums	Damaged	10	600	0	?	?	?
14	Bimbo	Lindane	Lindane	?	OC	II	Drums	Damaged	0	675	0	?	?	?
15	Bimbo	Lindane	Lindane	?	OC	II	Drums	Damaged	0	75	0	?	?	?
16	Bimbo	Lindane	Lindane	?	OC	II	Drums	Damaged	0	25	0	?	?	?
17	Bimbo	Lindane	Lindane	?	OC	II	Drums	Damaged	30	700	0	?	?	?
18	Bimbo	Lindanol	Isomer HCH	?	OC	II	Drums	Damaged	0	0	600	?	?	?
19	Haider	Lindanole	Lindane	?	OC	II	Drums	Damaged	0	200	0	?	?	?
20	Haider	Magirol	DDT	?	OC	II	Drums	Damaged	0	1 000	0	?	?	?
29	Haider	Magirol	DDT	?	OC	II	Drums	Damaged	0	400	0	?	?	?
30	Haider	Sectum	DDT	?	OC	II	Drums	Damaged	20	275	0	?	?	?
31	Haider	Contaminated soil	Contaminated soil	?	OC	?	?	Damaged	0	0	0		?	?
31	Kukodal	Sectumol	HCH	?	OC	II	Jute Bag	Damaged	0	600	0	?	?	?
								Total kg/litres & pieces of containers	320	193 945	6.750			
								Combined total in kg/Litres		200 695				
								Pieces of containers	320	XXXX	XXXX			
								Grand total in tonnes			201			

Notes:

[1] Heavily contaminated soil should be considered as obsolete pesticide stocks and therefore estimates taken from each affected site and recorded along with pesticides kg in column No. 11

[2] Where possible include all the 12 POPs in the inventory

[3] Use? marks where information is lacking

[4] Use “unknown” for unknown unidentified stocks

15. Spills and leaks

Figure 1

Figure 2

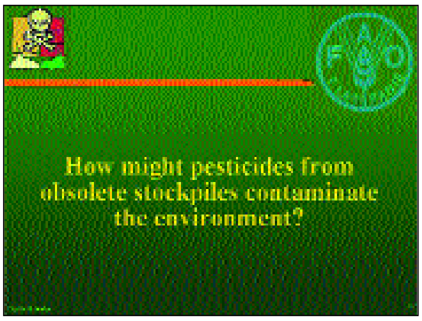

Figure 3

Figure 4

Figure 5

The sites and stores entered during the course of compiling an inventory of obsolete pesticides are likely to be contaminated as a result of previous or current leaks and spills of pesticides (Figure 2). Any disturbance of the contents of the store may cause additional spills and leaks. This unit highlights the need to be aware of the ways in which contamination by pesticides can occur, how to identify it rapidly, how to prevent new contamination as far as possible and how to deal with existing spills and leaks.

CONTAMINATION FROM OBSOLETE PESTICIDE STOCKS

Current environmental hazards from stored pesticides that are severely deteriorated include:

- leakage of pesticides to soil and dispersal in soil through capillary action and soil microfauna;
- leaching of pesticides to groundwater through contaminated soil;
- contamination of surface water by surface runoff, wind dispersal or animal transport. Some stores are sited on floodplains which periodically causes additional surface water contamination;
- dispersal of pesticides by air through volatilization and wind dispersal;
- contamination of vegetation through uptake of pesticides in soil and surface contamination of plants. Contaminated vegetation may be crop plants, food sources for people, livestock or wildlife, or other vegetation forming part of the natural environment;
- direct or indirect toxic effects on the human population, livestock and wildlife resulting from exposure to pesticides that have been released into the environment. Pesticides can also enter the food chain and contaminate organisms; the toxic effects of exposure can be short-term and acute or long-term and chronic.

The following are some of the ways in which clean-up operations have the potential to compound these problems (Figure 5):

- Movement and transfer of pesticides from one container to another can generate additional leakage and increase the area contaminated.
- Disturbance of pesticides and their movement can increase the area contaminated, thus causing additional leaching to groundwater sources beneath the contaminated area.

EXERCISE (Figure 3)

List the ways in which pesticides from obsolete stockpiles can contaminate the environment. The answers are given in Figure 4.

- Exposure of pesticides during periods of rainfall can increase ground- and surface water contamination.
- Disturbance of pesticides can cause additional pesticides to enter surface water through surface runoff or air movement.
- Additional exposure of pesticides to air during repackaging processes can lead to increases in volatilization and wind dispersal.
- Exposure of pesticides during periods of intense solar radiation, high temperatures or high winds could increase contamination.
- Increased release of pesticides to air, water and soil during movement could result in additional exposure of vegetation to pesticides and, hence, additional contamination.
- Additional releases of pesticides to the environment could result from their disturbance and movement thereby increasing the potential for organisms to be exposed to pesticides.

Figure 6

THE WELL MANAGED STORE (Figure 6)

All well-run pesticide stores should keep stocks of materials that can be used to contain and clean up any spills that occur. Such materials include absorbent dry matter such as sand, dry soil, sawdust or special commercial materials. Note, however, that sawdust can react with some chemicals such as chlorates and bleach to become spontaneously combustible.

When pesticide stocks are stored off the ground it is easier to identify signs of leakage early as they can be seen on the ground.

The tools for cleaning up spills include shovels, buckets and empty containers into which materials can be placed. The protective equipment needed for working with spilled pesticides should also be kept available.

All new stock arriving in stores should be checked for spills or leaks and rejected if it is leaking or damaged.

Figure 7

Providing easy access to all stock will help to allow regular inspection for signs of leakage or deterioration (Figure 7). Containers should always be handled gently to prevent damage which could result in leaks.

First-in, first-out (FIFO) stock management will ensure that older stock leaves the store first and that the materials held are the newest and in good condition.

Any problems identified should be dealt with promptly, otherwise they may expand and become much more serious.

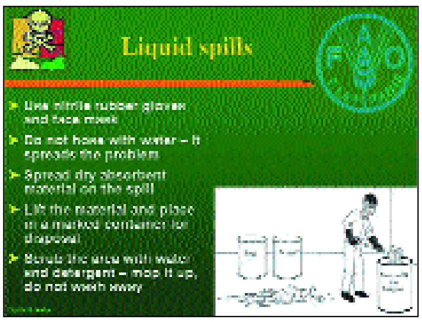

Figure 8

Dealing with spills

Nitrile rubber gloves and a face mask should be used by workers dealing with liquid spills of any pesticide (Figure 8). If the spilled product can be identified and the relevant safety equipment is available, it should be used. Otherwise a worst-case scenario should be assumed and the appropriate equipment used.

Never hose spills with running water as this could spread the contamination. Water also has a tendency to flow to other water bodies and could carry contamination with it.

Dry absorbent material should be spread over the spill to soak it up completely. The material should then be lifted and placed in a marked this is to ensure that all contaminated clothing (disposable or otherwise) remains at the working site. A series of shoe/coverall changing stations should be installed at every working site. Colour coding of disposable coveralls also provides a quick and simple means of monitoring activities and compliance with the regime. Regional managers have the responsibility of ensuring that all contamination stays at the work site and is not taken home by the workers.

Equipment should always be within reach to deal with the spills and accidents that are likely to occur when handling old and deteriorated pesticide containers.

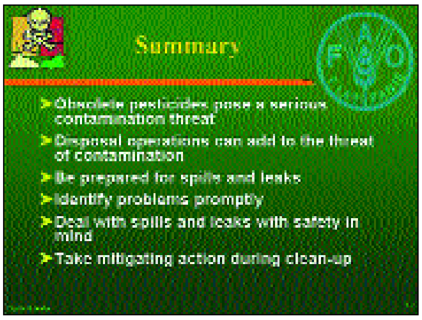

Figure 12

SUMMARY (Figure 12)

This unit has discussed how pesticides, particularly old and deteriorated stocks such as those in obsolete stockpiles, can pose a serious threat to the environment and a potential health risk.

Carrying out disposal and clean-up operations can potentially add to the threat of contamination as a result of disturbance and movement of pesticides. Store keepers and those working with pesticide stocks should be prepared for spills and leaks and hold appropriate equipment at the ready.

Incidents such as leaks or damage should be identified and dealt with promptly to prevent expansion of the problem. The safety of those working with spilled and leaking pesticides should be borne in mind. When removing obsolete stocks, mitigating action should be taken to minimize the risk of spills and leaks and to be ready to deal with them should they occur.

Figure 9

container ready for removal and disposal. The floor should then be scrubbed with water and detergent to remove traces of contamination. The water used for washing should be mopped up and drained into the container used for the waste – it should not be drained away.

Spills of dry materials such as powders or granules are dealt with similarly to liquid spills (Figure 9).

Appropriate protective equipment should be worn to deal with the spill.

Spills should not be washed with running water since, again, this could simply spread the problem further.

Dampened absorbent material should be spread over the spill. This will contain the pesticide and ease its removal. The absorbent material and spilled pesticide should be lifted with shovels and placed in a marked container ready for removal and disposal.

The area of the spill should be scrubbed with water and detergent which should be mopped up and added to the waste container – it should not be drained away.

Figure 10

Dealing with leaks

Leaking containers should be dealt with promptly using appropriate protective equipment (Figure 10). If possible, the container should be placed with the point of leakage at the top in order to prevent additional leakage until further action can be taken.

If the contents of damaged containers can be transferred safely and quickly to other similar containers which are sound, this should be done. Pesticides should only be transferred to containers of the same type in which they were supplied because some products can corrode certain packaging materials.

Otherwise all leaking containers should be overpacked, labelled and sealed ready for disposal. Drums should be overpacked with UN-approved steel or plastic drums. Sacks of dry material should be transferred into woven polyethylene sacks fitted with a sift-proof polyethylene liner. Wet material, such as contaminated absorbent matter that has been used to contain spills, should be loaded into steel drums that are then sealed. All new containers with pesticides in should be clearly and fully labelled.

Figure 11

Measures can be taken to contain any liquid pesticides within the working area by using physical containment barriers and applying handling techniques that minimize exposure and the release of pesticides from containers to the surrounding environment (Figure 11). Specialist pumps should be used, clean and dirty working areas designated and the working area set up so that it can take care of unplanned releases with spillage control materials, fire extinguishers and first aid kits. When handling dusty materials the use of specially designed vacuum systems, screening of working areas with heavy-duty polyethylene sheeting and the adoption of similar clean and dirty working areas as for liquids will provide the most effective way of minimizing or eliminating environmental impacts.

In all cases, great emphasis should be placed on the elimination of cross-contamination. The simplest and most effective means of achieving

16. Sampling and analysis

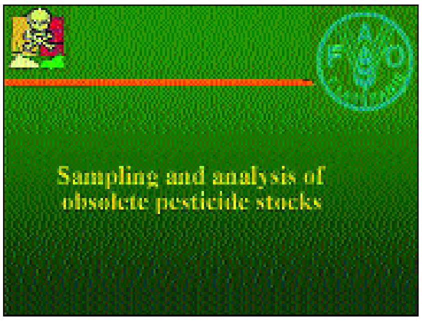

Figure 1

Analysis can be carried out at varying degrees of detail. Likewise, the cost of analysis can vary greatly depending on the level of detail required. When determining the appropriate level of analysis, and so the cost of the operation, a range of factors should be examined. From that it will be possible to select the appropriate level of detail (Figure 2).

Figure 2

When dealing with potentially obsolete stocks of pesticide it is first necessary to plan what to do with the material. It may be sent for disposal, irrespective of the analysis results (as may be the case for banned materials such as organochlorine pesticides and persistent organic pollutants [POPs]) or, depending on the analysis results, it may be given an extended shelf-life to be utilized as part of a well-organized pest management programme. Both of these scenarios require different analytical approaches so that the greatest cost benefit can be obtained. In addition, there may be no data on the material, and the identification of unknown materials needs special consideration. Different materials in the same store may require different levels of data to support the final decision with respect to their fate (disposal, use, reformulation, etc.).

This, in turn, will determine the type of analysis carried out. Another factor that is important in selection of the type of analysis is the local availability of analytical services. Provided the level of accuracy can be guaranteed and the costs are comparable, local services should be used where possible. A small number of samples to verify quality assurance (QA) may be sent for analysis to an independent laboratory if required.

The unit also looks at how to work with a specialist laboratory, including how to send samples, and examines the requirements for taking samples and how to ensure that there is no cross-contamination, that the samples are stored correctly and that the data are accurately recorded to allow cross-referencing and collation of all results.

REUSE OF OBSOLETE STOCKS

In some cases, "obsolete" stocks can be used, but only after accurate analysis of the original product. Issues such as breakdown of active ingredient may make the material ineffective against pests and/or increasingly toxic to humans. Unless the material is analysed to determine the amount of active ingredient and the level of breakdown products generated, a scientific justification for the extension of the material's shelf-life cannot be made (Figure 3).

Figure 3

The reformulation issue needs to be very carefully examined. It appears to be a good potential means for extending the shelf-life of a product and for changing the nature of the formulation (ultra-low volume [ULV] to emulsifiable concentrate [EC], for example). However, this process often fails because of a lack of suitably operated plants in the country with the obsolete stocks. Plants should only be used if they meet the required levels of environmental, health and safety compliance expected in the developed world. If the material needs to be sent to another country for reformulation it must not be sent to one where there are no controls and where it may become obsolete again.

It should be remembered that repackaging of the material may be required for its safe transportation. If this is the case, the empty original containers must also be included in the material sent to another country.

The need for the reformulated product should also be carefully examined. There is little value in reformulating a product that is not required. It will become obsolete again and pose a problem in the future. In addition, a reformulated product may lose its original identity and so the chances of getting support from its original manufacturer may be lost. The risk of flooding a market where pesticides are not currently used should also be taken into account. Any increase in pesticide applications should be carefully monitored and use of pesticides should only be considered as part of an integrated pest management (IPM) programme.

DISPOSAL OF OBSOLETE PESTICIDES

If obsolete stocks are to be sent for disposal, the needs of the analysis are different. The primary reasons for analysis in this case are to allow an adequate risk assessment to be made by the workers handling the material and to allow a full and adequate description of the waste to be given on the new packages and during transportation. In this instance, the analysis merely has to verify the labelling of the material (if present). For unknown materials, a generic classification such as organochlorine compound, organophosphorus compound or carbamate is often all that is required.

Figure 4

Analysis allows the hazard to be fully identified, and this in turn allows a full and adequate risk assessment to be made via LD_{50} etc. and potential for exposure (Figure 4). It is important to take into account subsidiary hazards from active ingredients and carrier solvents. Both may be flammable or corrosive and these data will be important.

Figure 5

Specific data (shown in Figure 5) that fall outside the scope of standard pesticide analysis are required in cases where the majority of the obsolete stocks on the inventory need to be repackaged and sent for overseas disposal by incineration. Such data include the iodine, bromine and mercury levels in the stocks.

These data are required by the disposal plant that is handling the waste. Many incinerators have definite limits on the elements listed in Figure 5. Some may have additional limits in their licence to operate, and so consultation with the end disposer of the material will be needed to ensure that all the relevant data are collected.

SELECTING THE ANALYSIS METHOD

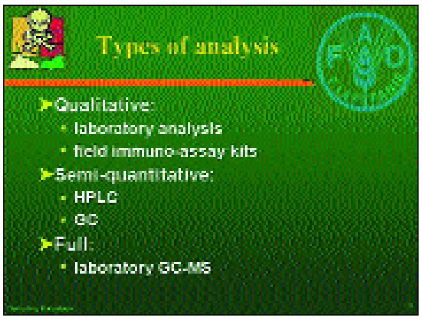

Figure 6

When it comes to selecting an appropriate method of analysis it is necessary to examine the level of data needed to allow an accurate decision to be made on the fate of the obsolete stocks (Figure 6). Qualitative analysis may provide a sufficient level of data when considered along with label data and import records, etc. Such verification analysis will typically be done as a QA step to support the data collected as part of the inventory process. Field-test kits also exist for many organochlorine compound (OC) and organophosphorus compound (OP) pesticides. Many kits have been approved by the United States Environmental Protection Agency (USEPA) and their use should be considered in remote areas where access to laboratory analysis is not possible and the time required to store the samples is too long. The kits have also been very useful in identifying the extent of soil contamination caused by pesticide spillage and handling, which they can determine by removing all contaminated soil on-site while the contractor is present.

Figure 7

Where more accurate data are needed (for example, the percentage of active ingredient in a sample or type of carrier, and the quantity of breakdown products) methods such as high-pressure liquid chromatograph (HPLC) and gas chromatograph (GC) are useful diagnostic tools. These are not typically field-based applications and the results are only as accurate as the technician doing the analysis. Use of this method should be combined with a close examination of the institution completing the analysis. Internationally accepted quality standards are essential.

Figure 8

The final, analytical tool is complete analysis using a GC linked to a mass spectrometer (GCMS). This is a very powerful method that allows the differentiated identification of very similar materials. It offers the greatest degree of confidence, but an international quality standard is also essential in these cases.

Where possible, the analysis should be completed in the country of origin (Figure 7). Any obsolete pesticide project should include laboratory upgrade and commissioning as part of its overall plan. Advice on the issues to consider should be obtained from the laboratory completing the analysis.

The costs shown in Figure 8 are estimates based on 1999 prices. They do not include the costs of sending the samples to an overseas laboratory. The cost implications of using GCMS to complete all analyses compared with an appropriate selection of several field kits, GC/HPLC and a small number of verification analyses using GCMS are clear.

Figure 9

Laboratory requirements include the following (Figure 9):

- *Size of sample:* i.e. do they need to be 10 g or 1 kg for the analysis?
- *Number of samples:* Is one sample sufficient or are more needed?
- *How long will it take* for the laboratory to complete its analytical work? This may have a bearing on other aspects of the disposal work.
- *Payment method:* How does the laboratory expect to be paid and within what timeframe?
- *Any special requirements* of the laboratory that need to be accounted for during sampling.

Figure 10

SAMPLING

When samples are collected it is important to know what size of sample is required and to ensure that all the necessary equipment is available (Figure 10).

It is essential that the samples are truly representative of the drum contents. Many materials segregate over time. Materials must be properly mixed before a sample is taken. This can be done by rolling the drum three times. In many cases, however, the original containers are not sound enough to allow this to be done safely: there must be no impact on the environment as a result of the sampling process. This problem may be overcome by taking a composite sample. Here samples are taken from drums believed to contain the same material. The quantities are combined and the sample for analysis is taken from this homogenized mixture. This is a means of ensuring that all components are present in the final sample submitted for analysis.

How many samples should be taken? For any population of drums (i.e. those believed to contain the same material) the number of samples taken should be equal to the square root plus 1. For example, when there are 80 drums of material labelled as 96 percent EC malathion, ten samples should be taken (the square root of 80 is between 8 and 9 – to be safe, the higher figure is taken; 9 plus 1 equals 10). This is based on statistics and allows for the possibility of some drums being incorrectly labelled and described.

These principles hold when the contents of the drums are known. As soon as unknown materials are present, every container must be sampled and/or composite samples taken from all populations of containers.

When taking samples, workers are exposed to the toxic material. Adequate personal protective equipment (PPE) must be used. The other items listed in Figure 11 remove the risk of cross-contamination from sample to sample.

Figure 11

Samples should be kept in a cool, dark place. If possible a mobile fridge should be fitted to the vehicle used for transport; if not, cooled insulated boxes should be provided. This will reduce the amount of evaporation from the sample and so ensure a full and accurate result.

The following are guidelines for the storage and transport of samples (Figure 12):

- Samples should be kept cool.
- Samples should be transported to the laboratory as quickly as possible.
- All shipping/export-import documentation for overseas transport must be prepared.

Figure 12

The following data must be recorded for all samples (Figure 13):

- site number/name;
- date sampled;
- by whom;
- analysis required;
- sample number (usually site number/0001, etc.);
- type of sample (unknown/product/composite).

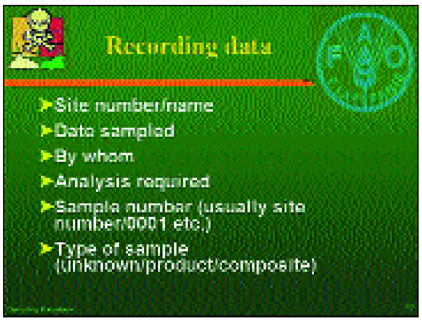

Figure 13

This part of the process is critical to the success of the sampling and analysis activities. It must be possible to trace each sample back to its original container. A disposal company and/or manufacturer will need evidence that the results provided can be clearly attributed to a specific drum or batch of obsolete stocks. If these simple principles are not adopted the whole exercise becomes worthless.

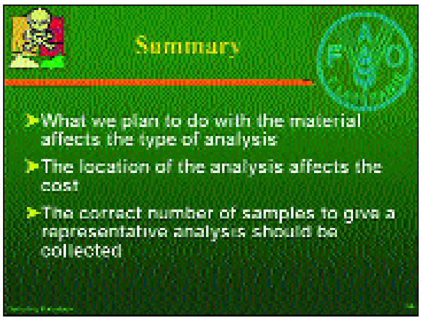

Figure 14

SUMMARY (Figure 14)

This unit has examined:

- how the type of analysis selected depends on what is to be done with the obsolete stocks;
- how the location of the analysis affects the cost;
- how to collect the correct number of samples to give a representative analysis.

Figure 1

17. Classification, labelling and packaging of obsolete pesticide stocks

Figure 2

The classification, labelling and packaging of pesticide wastes is covered by international regulations. In order to destroy obsolete pesticide stocks safely it is likely that they will need to be classified, repackaged, labelled and finally sent for disposal by incineration. The facilities capable of destroying pesticides safely are almost exclusively found in Western Europe or North America (Canada and the United States) (Figure 2).

The shipment, classification, labelling and packaging of all wastes moved by sea to the point of final destruction is covered by the International Maritime Dangerous Goods (IMDG) Code. Similar legislation exists for road, rail and air transportation. The basic principles of all these rules are based on the United Nations Orange Book. This unit gives a brief overview of the IMDG Code before moving on to describe classification, labelling and packaging, including how to use the current packaging of obsolete stocks to estimate the date of manufacture of the product. The labels of old stocks (when they have survived) often do not have adequate information on manufacturing date, expiry date or date of delivery. The outer packaging can give a rough estimate as to the delivery date.

Figure 3

THE IMDG CODE

The IMDG Code covers more than just waste materials. Its rules apply to all hazardous cargo moved by sea (Figure 3). The original pesticide needs to be classified, packaged, labelled and shipped in compliance with the regulations.

The code is based on an international convention called the Solas Convention and, thus, on international law. Its basic principles are based on a set of United Nations guidance principles set out in a publication known as the "Orange Book" because of its orange cover.

Figure 4

In addition to the general requirements of the code, an individual country may have additional requirements. The code sets out the national competent authorities responsible for administering and monitoring the regulations. These national authorities can also supply advice and guidance on aspects of the code and its requirements.

The code is updated every two years to allow new developments to be implemented as soon as possible (Figure 4). It currently exists as two large volumes: the first volume describes the principles of the code and its rules; and the other volume give the details for the materials and groups of materials listed in the code.

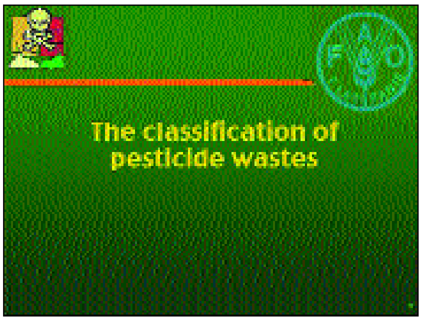

Figure 5

Figure 6

Figure 7

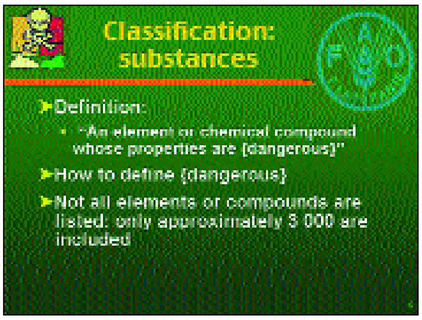

Figure 8

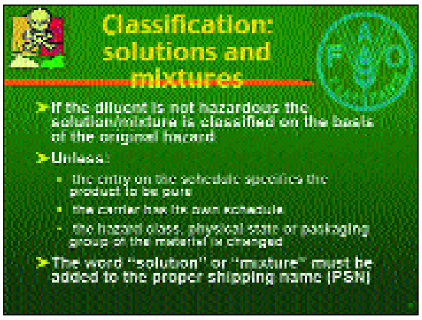

Figure 9

The code is published by the International Maritime Organization (IMO). It is policed by national competent authorities. Goods may be inspected at random or as a matter of routine. Goods that do not satisfy the requirements set out in the code can be seized or impounded. If this occurs in another country, an international diplomatic incident or a public outcry could result, as has sometimes occurred with shipments of obsolete pesticides or other hazardous waste. It is therefore vital that all aspects and regulations set out in the code are strictly adhered to.

CLASSIFICATION (Figure 5)

Classification concerns, first, types of material (Figure 6) (article, substance and solution/mixture), then how the materials are placed in a designated UN class and packaging class and, finally, how different hazards are ranked when more than one are present (Figure 7).

Most pesticides fall into the category of substances (Figure 8). Some may exist as solutions or mixtures, but generally they are found as pure (technical) materials or mixtures with specific carrier solvents. The characteristics of the carrier influence how a material is classified under the code. This has a direct effect on what information needs to be collected on obsolete stocks. Data on carrier solvents are very important. The danger associated with a substance is defined through extensive testing.

There are many hundreds of thousands of "substances" in existence but there are only approximately 3 000 entries in the code. This is because substances are placed in family groups. Common pesticide generic family groups include organochlorines (OC), organophosphates (OP), carbamates (C) and pyrethroids (PY).

Many carrier solvents have their own entry under the code (Figure 9). Substances such as diesel (gas oil), xylene and hexane are all used as carriers in many formulations. They pose hazards in their own right and these must be considered when examining the true hazard of the mixture

EXERCISE 1

List the reasons that it is important to classify the various materials in obsolete pesticide stocks and compare them with the answers given in Figure 6.

EXERCISE 2

Pesticides (obsolete or new) generally fall into which class(es)?

Sample solutions

Sulphur is an example of a flammable solid that may be found in a pesticide store. Examples of toxic pesticides are common – they are designed to be toxic to some species of animal or plant. Class 9 substances include concentrations of active ingredient that are so low that the final formulation may no longer be classed as toxic, although it is still hazardous. Contaminated soil also usually falls into this category.

Figure 10

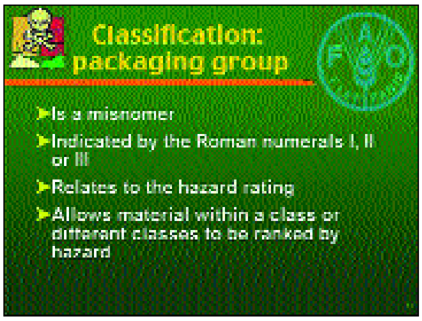

Figure 11

(pesticide plus solvent) as a whole. The usual result is that the formulation mixture becomes flammable as well as toxic.

As well as the class, classification also looks at the hazard rating or packaging group of a material. Materials within a class may have vastly different hazard ratings. The hazard rating for a substance or solution/mixture is determined by testing.

A substance may have a different packaging group when it is made into a formulation. The formulation of the substance results in a dilution of the active ingredient. The toxicity may be reduced as the percentage of active ingredient decreases. Hence a 95 percent emulsifiable concentrate (EC) formulation will generally be in a higher packaging group (and have a higher hazard rating) than a 50 percent EC formulation of the same pesticide. Eventually, a substance may be diluted to such a degree that the resulting formulation falls out of the packaging group scheme as it becomes non-toxic as far as transportation is concerned. It remains, however, toxic in terms of its World Health Organization (WHO) classification, which is based purely on the active ingredient and not on the actual concentration of a given formulation.

If a formulation contains materials from two or more classes (toxic, flammable, corrosive, etc.) (Figure 10) the packaging group (Figure 11) (which takes account of the concentration of active ingredient) allows the different classes to be ranked in terms of importance and level of danger that they pose to individuals. Figure 12 shows the packaging groups.

Some substances may pose multiple hazards and must be classified accordingly (Figure 13).

Formulations of pesticide may contain two or more components, for instance, a carrier and the pesticide active ingredient. For example: chemical A is a poisonous liquid and chemical B is a flammable liquid. Each is assigned a packing group (PG) according to the tests described. Refer these PGs to the Hazard Precedence Table, - copy given in Figure 14.

Figure 12

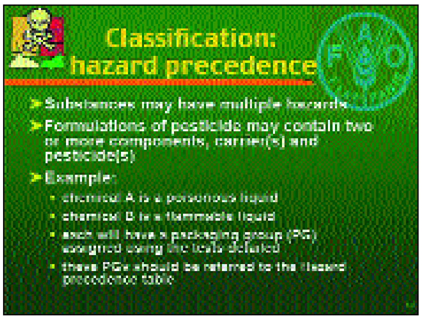

Figure 13

Appendix 1: Precedence of hazards table (from UN Orange book)

	4.2	4.3	5.1 I	5.1 II	5.1 III	6.1,I Dermal	6.1,I Oral	6.1 II	6,I III	8,I Liquid	8,I Solid	8,II Liquid	8,II Solid	8,III Liquid	8,III Solid
3 I						3	3	3	3	3	-	3	-	3	-
3 II						3	3	3	3	8	-	3	-	3	-
3 III						6.1	6.1	6.1	3**	8	-	8	-	3	-
4.1 II*	4.2	4.3	5.1	4.1	4.1	6.1	6.1	4.1	4.1	-	8	-	4.1	-	4.1
4.1 III*	4.2	4.3	5.1	4.1	4.1	6.1	6.1	6.1	4.1	-	8	-	8	-	4.1
4.2 II		4.3	5.1	4.2	4.2	6.1	6.1	4.2	4.2	8	8	4.2	4.2	4.2	4.2
4.2 III		4.3	5.1	5.1	4.2	6.1	6.1	6.1	4.2	8	8	8	8	4.2	4.2
4.3 I			5.1	4.3	4.3	6.1	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3
4.3 II			5.1	4.3	4.3	6.1	4.3	4.3	4.3	8	8	4.3	4.3	4.3	4.3
4.3 III			5.1	5.1	4.3	6.1	6.1	6.1	4.3	8	8	8	8	4.3	4.3
5.1 I						5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1
5.1 II						6.1	5.1	5.1	5.1	8	8	5.1	5.1	5.1	5.1
5.1 III						6.1	6.1	6.1	5.1	8	8	8	8	5.1	5.1
6.1 I, Dermal										8	6.1	6.1	6.1	6.1	6.1
6.1 I, Oral										8	6.1	6.1	6.1	6.1	6.1
6.1 II, Inhalation										8	6.1	6.1	6.1	6.1	6.1
6.1 II, Dermal										8	6.1	8	6.1	6.1	6.1
6.1 II, Oral										8	8	8	6.1	6.1	6.1
6.1 III										8	8	8	8	8	8

* Substances of Division 4.1 other than self-reactive and related substances and desensitized explosives
** 6.1 for pesticides
\- Denotes an impossible combinatio
For hazards not shown in this table, see 1.44.

Figure 14

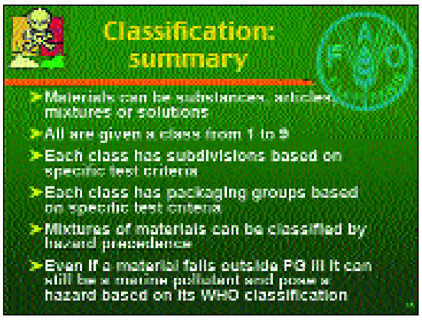

Figure 15

Figure 16

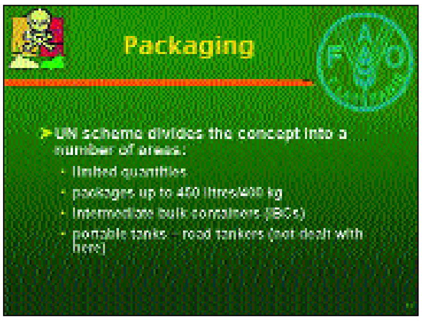

Figure 17

Summary of classification (Figure 15)

For the purposes of IMDG classification, materials can be substances, articles, mixtures or solutions. Each is given a class from 1 to 9. Each class is subdivided on the basis of specific test criteria. Each class has packaging groups based on specific test criteria. Mixtures of materials can be classified by hazard precedence. Even if a material falls outside PG III it can still be a marine pollutant and pose a hazard based on its WHO classification.

PACKAGING (Figure 16)

Pesticides are delivered in a wide variety of package types: cartons containing small bags or plastic/glass bottles; a range of sacks containing from 10 g to 100 kg each; and a range of drums, typically of 25, 50, 100 and 200 litres capacity. Generally, pesticides are not delivered in bulk containers, i.e. containing more than 400 kg (Figure 17).

When transporting waste or obsolete pesticides for destruction, or moving obsolete stocks to central storage locations prior to shipment overseas, great care must be taken to check that the original containers are of sufficient mechanical strength to allow the transportation to be safe and to eliminate the risk of leakage and hence contamination. If the containers are not sound the material will need to be repackaged prior to movement from its present location. Examination of the original packaging at the inventory stage is vital to allow adequate assessment of the numbers and types of new packages needed to move the stock safely. If one material is present in three different formulations and in a variety of package types and sizes, each combination of formulation type and package type should have its own entry on the inventory form. The same rule holds for contaminated empty containers.

This section focuses on the main types of new packages available and how they are described in the code. Of particular interest are packages of up to 450 litres/400 kg (typically metal or plastic drums) and intermediate

Figure 18

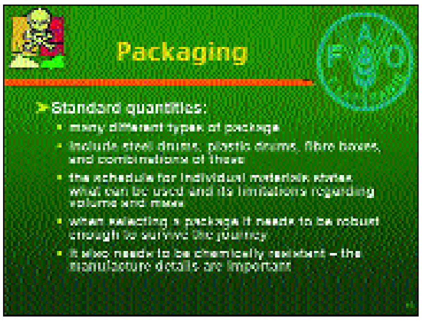

Figure 19

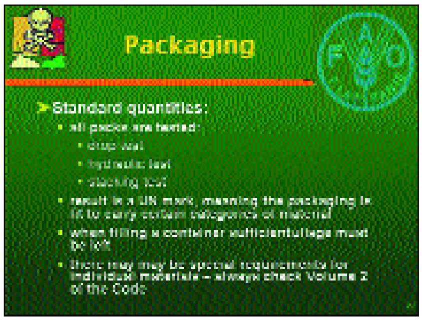

Figure 20

Figure 21

Figure 22

Figure 23

EXERCISE 3

Figure 23 shows the UN mark commonly found on bags. What is the date of manufacture?

Solution

The date of manufacture (recorded as 10 95) is October 1995.

bulk containers (IBCs, especially flexible IBCs or “big bags” used for granular powders and dry soil).

The limitation of this category of containers is that they are two small to be used for moving waste pesticides (unlike supplying new pesticides, which are often packaged in 1 litre bottles or 500 gram bags) (Figure 18). The main reason for not adopting a similar packaging regime for waste materials is based on the need to collect materials in a package that is large enough for economic shipment. In addition, small bags and bottles are filled in dedicated packaging plants or similar factories which are not available in the field; waste materials therefore usually have to be put into larger containers such as drums or big bags. This can be done by hand and no automation is needed.

When considering how to repackage waste pesticides, it is important to ensure that the new packaging is compatible with the substance or mixture (Figure 19). For example, azodrin can corrode standard mild steel drums within weeks and, as a minimum, drums must be lined with a protective epoxy resin lining. The details of what specific packaging is allowed can be found in the IMDG Code in Volume 2.

In general, packages need to be robust and suitable for conditions in the store – especially with regard to ease of handling and access. The use of a forklift truck will often not be possible, so the size of the package selected may be limited by the availability of muscle power to move it.

Every UN-approved package has undergone rigorous testing (Figure 20). Unless it passes all the tests shown in Figure 20, it will not be certified as fit to carry the substance/mixture. Ullage is the empty space above the contents in a container that allows for expansion of the contents.

Typically, a container will bear a mark similar to the one shown in Figure 21. The mark will either be embossed into the side of the container (usually for drums) or written on the outside (for big bags, etc.). Of particular interest is the date of manufacture of the container. Most non-steel containers have an expiry date and must be used within that date; this makes it possible to narrow down the date of supply of obsolete stocks. If the material is in its original container, it could not have been supplied prior to the date of manufacture on the container. This rule breaks down when materials have been repackaged because the date of the new container may be many years later than that of the original, creating confusion.

IBCs and big bags are generally used for powder formulations and contaminated soils (Figure 22); large woven bags with a sift-proof plastic liner can only be used if the material is dry. If there is moisture, big bags

Figure 24

Figure 25

Figure 26

Figure 27

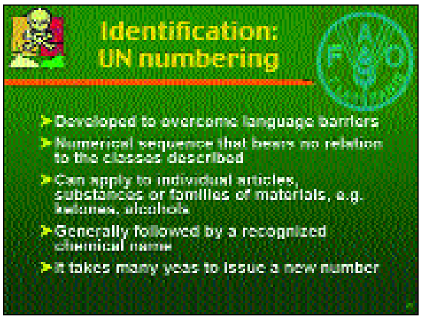

Figure 28

should not be used.

Salvage packs, or overdrums as they are sometimes termed, are a simple solution to the problem of repackaging leaking drums or drums whose contents have become impossible to pump (Figure 24). They are, however, very expensive and typically cost two to three times as much as a standard new drum. Sometimes their use will be unavoidable but under general circumstances this option for repackaging is not considered because of the high cost. If overpacks are to be used for shipment of hazardous cargo Competent Authority Approval from the country of Dispatch is needed. Overpacks, for the purposes of the Code, are considered as Emergency packages used under exceptional circumstances. If large numbers are to be used for leaking drums the appropriate authorities must be approached officially. If no competent authority exist in the country of dispatch (typical in land-locked countries) then the competent authority of the country of registration of the vessel commissioned to carry the cargo must give the necessary approvals.

IDENTIFICATION AND LABELLING (Figure 25)

Before it is shipped, waste pesticide must be correctly and accurately identified (Figure 26). In order to do this, very accurate and detailed data must be obtained during the inventory. Materials that cannot be identified will require analysis, and this greatly increases the cost of any proposed disposal operation. No unknown items may be moved by sea for disposal.

Materials can be identified in terms of a number of different criteria which are shown in Figure 27.

Pesticides are generally identified in terms of the generic or family group to which the formulation belongs. An example is organochlorine pesticide, toxic (Aldrin). Note that the actual pesticide name occurs in brackets. If the material is a formulation that is flammable, the name will

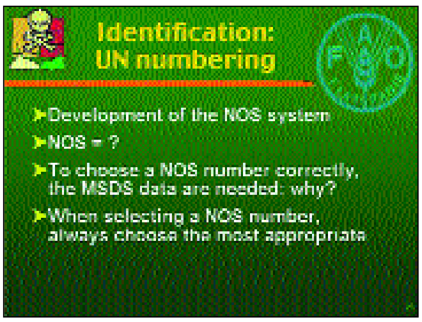

Figure 29

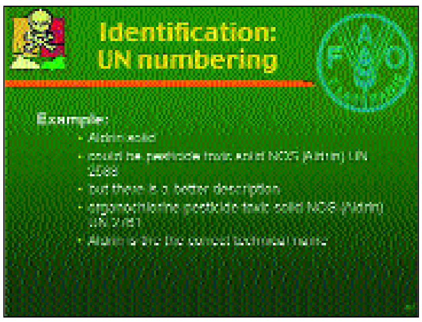

Figure 30

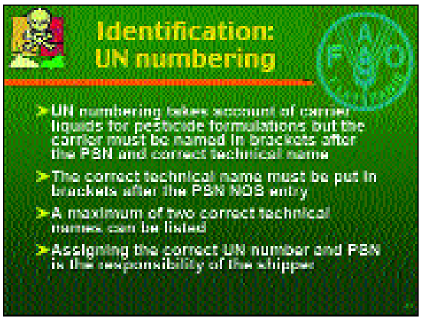

Figure 31

Figure 32

Figure 33

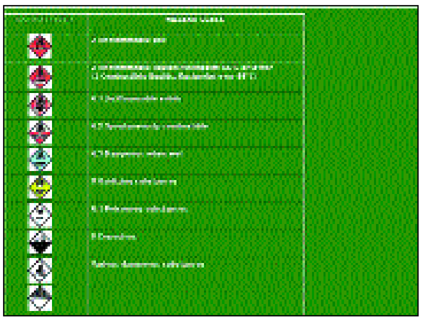

Figure 34

change to organochlorine pesticide, toxic, flammable (Aldrin), so it is very important that all data concerning the formulation are collected at the inventory stage.

The UN numbering system has been developed to overcome the barrier of language (Figure 28). NOS means "not otherwise specified" (Figures 29, 30). For example, families of substances may be assigned a single UN number, but to choose the most appropriate NOS number the hazard needs to be identified. This is best done via the material safety data sheet (MSDS) for the material, which allows the most accurate description to be chosen from the list of NOS UN numbers available.

UN numbering takes account of carrier liquids for pesticide formulations, but the carrier must be named in brackets after the proper shipping name (PSN) and correct technical name (Figure 31). Note that the correct technical name must be put in brackets after the PSN NOS entry. A maximum of two correct technical names can be listed. Assigning the correct UN number and PSN is the responsibility of the shipper.

The UN marks commonly found on every package are (Figure 32):

- the UN number;
- the marine pollutant sign;
- the UN certification code for the substance/solution/mixture;
- sensitivity to elevated temperature.

Labels

Marks should not be confused with labels. The label is the hazard diamond for the class or subclass (Figure 33). These are the internationally recognized hazard warning diamonds (Figure 34). Note that *flammable* and *inflammable* have the same meaning.

Each package must have its own label of at least 100 mm square (Figure 35). The primary hazard label has the class number in the bottom corner. Subsidiary hazard labels have no class number in the bottom corner.

Identification placards are large labels of at least 250 mm square which are applied to shipping containers or crates for ease of identification of the contents (Figure 36). A different placard is required for each class of goods in the container or crate.

The same rules apply to the placing of identification placards as for subsidiary hazards and marine pollutant/elevated temperature marks – they must be applied to two sides only (Figure 37). Primary hazard diamonds must be applied to each side and each end of the cargo unit. If only one product is in the cargo unit, the UN number should be displayed on an orange rectangle, but not if multiple products are in the unit. For a

Figure 35

Figure 36

Figure 37

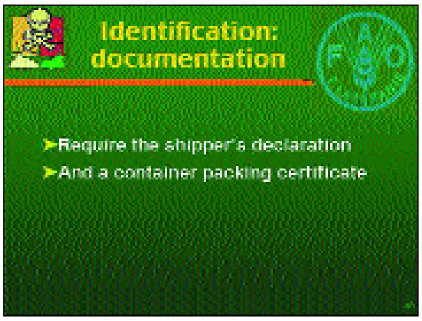

Figure 38

Figure 39

Figure 40

mixed load, no UN number should be applied, but a marine pollutant mark should be placed on each side and each end.

After discharge of the cargo from the cargo unit, all identification placards must be removed to avoid future confusion.

Identification documentation is covered in sections 9, 12 and 17 of the IMDG Code (Figure 38). Two requirements are the shippers' declaration and a container packing certificate.

All the information listed in Figure 39 is needed to identify the waste correctly. Much of this information can be obtained from the inventory. Without careful collection of all data at the start of the process this correct, detailed identification may not be possible.

The shippers' declaration must contain (in the following order):

- the PSN;
- the UN class, division and compatibility group;
- the UN number preceded by the letters "UN";
- the packaging group.

In addition it must contain:

- the number and type of packages and the total quantity;
- the flash point, if it is 61°C or below;
- subsidiary hazards not communicated in the PSN.

Additional information required includes (Figure 40):

- the word "waste" in front of the PSN;
- empty/uncleaned packages must be identified;
- for classes 4.1 and 5.2, control and emergency temperatures must be shown;
- the words "marine pollutant" where appropriate.

In addition, the individual schedules of materials should be checked for any special conditions.

18. First aid

Figure 1

In every emergency situation there is a logical order to be followed (Figure 3). First, it is important to assess the scene of an emergency carefully before any further steps are taken. The purpose of such assessment is to assure that it is safe to provide first-aid care. For example, an unconscious casualty might be lying on a live power line. If a rescuer were to touch the casualty before the power could be shut off, the rescuer would become a casualty as well. Always be sure it is safe before attempting to help a casualty.

Once it has been established that it is safe to help a casualty, the first-aid provider should immediately determine whether or not the casualty has any life-threatening conditions.

The first-aid provider begins by checking to see if the casualty is responsive. This is best established by asking "Are you all right?" If there is no response, help should be summoned immediately. Recent studies have shown that casualties who are not breathing and do not have a heartbeat have a substantially greater chance of survival if they receive prompt advanced medical care in a hospital or from trained paramedics.

Only after a call for emergency medical services has been made should a volunteer attempt to help an unconscious casualty. If there are bystanders on the scene, they can be summoned to provide assistance.

Figure 2

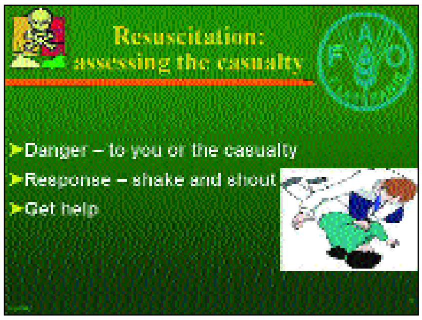

Figure 3

RESUSCITATION

The following initial steps of checking the airway, breathing and circulation (pulse), together with a check for major bleeding, constitute the primary survey, which looks for life-threatening conditions before commencing with the resuscitation.

If the casualty is on his or her stomach, the casualty's arm that is closest to the first-aid provider should first be placed above his or her head (Figure 4). The casualty should then be turned over by placing one hand on his or her hip and the other hand at the shoulder. The body should be

Figure 4

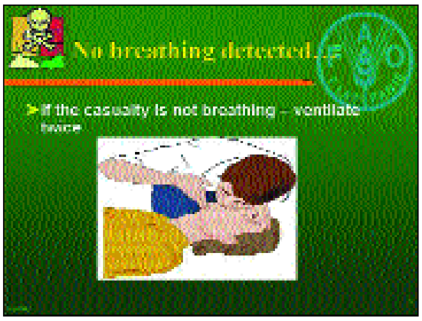

Figure 5

Figure 6

turned in a smooth, straight line so as not to cause further damage in the event of existing spinal cord injury.

With the casualty now on his or her back, the airway should be opened by placing the heel of the first-aid provider's hand on the casualty's forehead and the tips of the first-aid provider's fingers under the bony part of the casualty's jaw.

The first-aid provider now pushes down on the casualty's forehead while lifting up the chin until the jaw is pointing straight up. By placing his or her ear over the casualty's mouth the first-aid provider can look, listen and feel for breathing for three to five seconds; *looking* at the chest to see if it is rising, *listening* for sounds of breathing and *feeling* for air coming from the casualty.

If the casualty is not breathing (Figure 5), rescue breathing is required immediately.[1]

Rescue breathing will provide vital oxygen to a casualty who cannot breath on his or her own.

In every instance in which first aid is to be provided, it is important to ask conscious casualties for permission to help them. If a casualty is unconscious, it is presumed they have provided such consent for assistance.

After a non-breathing casualty has been given two breaths, the pulse is checked at the carotid artery to ascertain the presence of a heartbeat (Figure 6). This artery is located on the side of the neck and is found by positioning the fingers on the casualty's Adam's apple, then sliding them down into the soft groove on the side of the neck. The pulse is checked for five to ten seconds.

If the casualty has a heartbeat but is not breathing, rescue breathing is required. If the casualty is not breathing and does not have a heartbeat, cardio-pulmonary resuscitation (CPR) is required without delay.

When there is no pulse, chest compressions are given on the sternum – the bone in the centre of the chest as shown in Figure 7. The elbows of the first-aid provider should be locked with the hands placed on top of each other. The whole upper body of the first-aid provider leans forward rapidly on the hands. Compressions are given at a rate of approximately one per second; 15 compressions are followed by two breaths.

The pulse should be rechecked after one minute (Figure 8). If there is

[1] While this unit identifies life-threatening conditions requiring rescue breathing or CPR, these skills require intensive classroom skill development and practice and cannot be presented or taught effectively in this unit.

Figure 7

Figure 8

Figure 9

Figure 10

Figure 11

Figure 12

no pulse, the cycle of 15 compressions to every two breaths should be continued until help arrives or until the first-aid provider feels too tired to continue.

When the casualty has a pulse but is not breathing, ensure there are no obstructions to breathing (Figure 9). The first-aid provider should give ten breaths initially and call for help, then continue to give ten breaths per minute until help arrives, the casualty revives or the first-aid provider becomes too tired to continue.

If an unconscious casualty has a pulse and is breathing, the first-aid provider should check for life-threatening injuries such as bleeding wounds or broken bones and deal with these within the limits of his or her knowledge (Figure 10). The first-aid provider should then call for help and place the casualty in the recovery position, if this does not place him or her at further risk, for example, of spinal injury.

In the recovery position the casualty is laid on his or her side with one leg and one arm bent to prevent rolling on to the front (Figure 11). This ensures maintenance of an unblocked airway even though the casualty may be unconscious.

CONTROL OF BLEEDING

Major bleeding may be a life-threatening condition requiring immediate attention (Figure 12). Bleeding may be external or internal. Bleeding may be from an artery, a major blood vessel that carries oxygen-rich blood from the heart throughout the body, or it may be from a vein, which carries blood back to the heart to be oxygenated. Bleeding may also be from a capillary, which is the smallest of the body's blood vessels.

Arterial bleeding is characterized by spurts with each beat of the heart, is bright red in colour (although blood darkens when it meets the air) and is usually severe and hard to control. It requires immediate attention.

Venus bleeding (bleeding from a vein) is characterized by a steady flow of blood that is dark, almost maroon, in shade. Venus bleeding is easier to control than arterial bleeding.

Capillary bleeding is usually slow, oozing in nature and usually has a higher risk of infection than other types of bleeding.

First aid for bleeding is intended to:

1. stop the bleeding;
2. prevent infection;
3. prevent shock.

To control bleeding, direct pressure should be applied to the wound, using a dressing, if available. If a dressing is not available, the first-aid provider should use a rag, a towel, a piece of clothing or his or her own hand.

It is important to remember that, once pressure has been applied, it must be kept in place. If dressings become soaked with blood, new dressings should be applied over the old dressings. The less the bleeding wound is disturbed, the easier it will be to stop the bleeding.

If bleeding continues, and the first-aid provider does not suspect a fracture, he or she should elevate the wound to above the level of the heart and continue to apply direct pressure.

If the bleeding still cannot be controlled, the next step is to apply pressure at a pressure point. For wounds of the arms or hands, pressure points are located on the inside of the wrist (the radial artery, where a pulse is checked) or on the inside of the upper arm (brachial artery). For wounds of the legs, the pressure point is at the crease in the groin (femoral artery). Steps 1 and 2 should be continued through use of the pressure points.

The final step to control bleeding is to apply a pressure bandage over the wound. Note the distinction between a dressing and a bandage. A dressing may be a gauze square applied directly to a wound, while a bandage, such as roll gauze, is used to hold a dressing in place. Pressure should be used in applying the bandage. After the bandage is in place, it is important to check the pulse to make sure circulation is not interrupted. When faced with the need to control major bleeding, it is not important that the dressings used are sterile; first-aid providers should use whatever they have at hand and work fast.

A slow pulse rate, or bluish fingertips or toes signal that a bandage may be impeding circulation.

Internal bleeding

The following are the signs and symptoms of internal bleeding:

- bruised, swollen, tender or rigid abdomen;
- bruises on chest or signs of fractured ribs;
- blood in vomit;
- wounds that have penetrated the chest or abdomen;
- bleeding from the rectum or vagina;
- abnormal pulse and difficulty breathing;
- cool, moist skin.

First-aid facilities in the field for internal bleeding are limited. If the injury appears to be a simple bruise, cold packs should be applied to slow the bleeding, relieve the pain and reduce the swelling. If more severe internal bleeding is suspected, the casualty should be monitored carefully and the first-aid provider prepared to administer CPR if required (and he or she is trained to do so). The first-aid provider should also reassure the casualty, control external bleeding, care for shock (covered in next section), loosen tight-fitting clothing and place the casualty on his or her side so fluids can drain from the mouth.

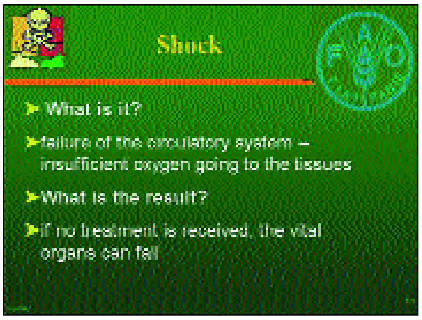

Figure 13

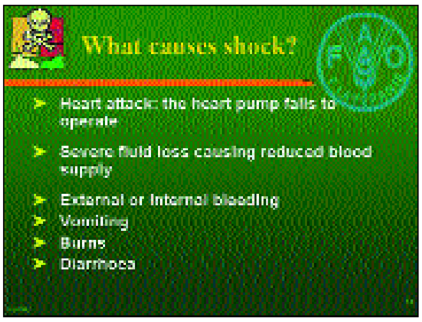

Figure 14

Figure 15

SHOCK

Shock is common with many injuries, regardless of their severity (Figure 13). The first hour after an injury is the most significant because it is during this period that symptoms of shock appear.

Shock is failure of the cardiovascular system to keep adequate blood circulating to the vital organs of the body, namely the heart, lungs and brain. *If shock is not treated, it can progress to cause death. Any type of injury can cause shock.*

Possible causes include heart attack, dehydration due to internal or external bleeding, vomiting, diarrhoea or burns (Figure 14).

It is good practice, when providing first aid, always to assume that shock may develop and to take precautionary measures in advance.

Signs and symptoms of shock include (Figure 15):

- confused behaviour;

- very fast or very slow pulse rate;
- very fast or very slow breathing;
- trembling and weakness in the arms or legs;
- cool and moist skin;
- pale or bluish skin, lips and fingernails;
- enlarged pupils.

Treatment for shock

A good rule to follow is to anticipate that shock will follow an injury and to take measures to prevent it before it happens by following these procedures (Figure 16):

- putting the casualty in a lying-down position to improve circulation;
- if the casualty is not suspected of having head or neck injuries or leg fractures, elevating the legs;
- if head or neck injuries are suspected, keeping the casualty lying flat (on his or side if vomiting has occurred);
- if the casualty is experiencing trouble breathing, placing him or her in a semi-reclining position; maintaining the casualty's body temperature, but not overheating.

Figure 16

POISONING

Poisons can enter the body through ingestion or swallowing via the mouth, through inhalation by breathing gases or vapours, or through the skin by direct contact (Figure 17).

Figure 17

Poisons can affect many different parts of the body if taken in sufficient quantity (Figure 18). The damage that they cause may be temporary, permanent or, sometimes, fatal. The following are some of the effects that poisoning can have on the different organs of the body.

- *The brain:* If the brain is affected by a poison, convulsions may occur and the casualty may lose consciousness.
- *The lungs:* If a poison is inhaled and reaches the lungs, the casualty may experience serious difficulty in breathing.
- *The heart:* Certain poisons can cause an irregular heartbeat and, in severe cases, lead to cardiac arrest.
- *The liver and kidneys:* The liver and kidneys act as the body's waste disposal system and usually filter out any harmful substances, for example, alcohol. However, if a large amount of poison enters the body, the liver and kidneys may be overwhelmed and suffer serious damage.
- *The digestive system:* If a poison reaches the digestive system, severe vomiting, diarrhoea and abdominal pains may occur.
- *Other organs:* Other areas that may be affected by the ingestion of, inhalation of or contact with a poison include external areas such as the skin or the eyes, which may be splashed with a pesticide. The lips, mouth and throat may be burnt if the casualty has swallowed a corrosive poison.

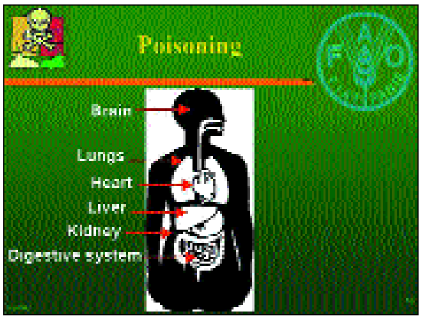

Figure 18

Pesticides poisoning

When poisoning from a pesticide occurs, several steps should be taken (Figure 19).

Figure 19

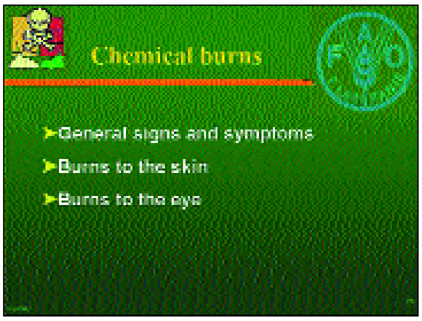

Figure 20

Figure 21

Figure 22

Figure 23

Figure 24

First, the *exposure should be stopped immediately* by separating the person from the source of the pesticide, moving the casualty away from the pesticide, removing contaminated clothing and washing the casualty.

First aid should be started immediately. If breathing is weak, artificial respiration should be given. The casualty should be helped to remain calm, and kept as quiet, warm and comfortable as possible. The serious effects of most pesticides are not instantaneous, so there is some time to protect the victims of pesticide poisoning.

Medical help should be called, but without stopping first aid. The doctor will require as much information as possible from the pesticide label, and the label should be kept with the casualty during transportation to a hospital or clinic. The first-aid provider should give the hospital or clinic the probable arrival time. The doctor should not be asked to come to the casualty because the equipment needed for proper treatment may be difficult to move. If the casualty has been exposed to a highly toxic pesticide and begins to feel ill, he or she should be taken to a doctor immediately, along with the pesticide container and label. Vomiting should be induced only when the pesticide label instructs it.

CHEMICAL BURNS (Figures 20, 21)

The signs and symptoms of chemicals burns include:

- chemicals near the casualty;
- stinging pain;
- discoloration, swelling and blistering.

Chemical burns to the eye

Chemical burns to the eye may be identified by swelling around the eye and watering, or the casualty may be unable to open his or her eye (Figure 22).

Chemical burns to the eye may be caused by:

- lack of eye protection;
- rubbing eyes with dirty gloves;
- incorrect eye protection (gases such as HCl require full-face protection).

Be extremely careful and gentle when treating eye injuries (Figure 23).

Floating objects in the eye that can be seen may be flushed out with water. If the object cannot be removed in this manner, the casualty should seek medical attention.

Never attempt to remove objects embedded in the eye.

First-aid care for these injuries consists of bandaging both eyes and seeking professional care promptly. An inverted paper cup covered with a bandage is appropriate for serious eye injuries while the casualty is transported to the hospital.

For chemical burns of the eye, the eye should be washed with copious amounts of water for 15 to 30 minutes. Then a bandage should be wrapped around both eyes and professional help should be sought.

Eyes are delicate and sight is precious. Prompt professional attention to eye injuries is required to preserve sight.

First aid for chemical burns (Figure 24)

The source of the burn should be removed before treatment is started.

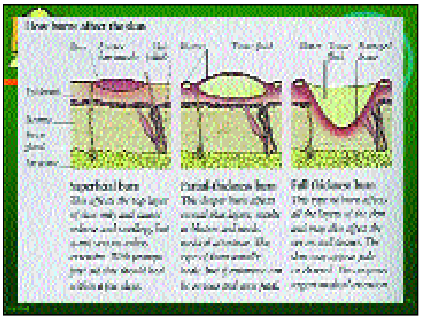

Figure 25

Gloves, sterile dressings and cold running water should be used.

First-degree burns should be flushed with cool running water before moist dressings are applied and bandaged loosely.

For second-degree burns, dry dressings should be applied and bandaged loosely. Water should not be used as it may increase risk of shock.

Third-degree burns should be given the same treatment as second-degree ones.

Clothing on which chemicals have been spilled should be removed and the affected body area(s) flushed with copious amounts of water for 15 to 30 minutes.

All casualties of serious burns should seek professional help quickly.

The severity of a burn depends on its size, depth and location (Figure 25). Burns are most severe when located on the face, neck, hands, feet and genitals; when they are spread over large parts of the body; or when they are combined with other injuries.

Burns result in pain, infection and shock. They are most serious when the casualties are very young or very old.

First-degree burns are the least severe. They are characterized by redness or discoloration, mild swelling and pain. Overexposure to the sun is a common cause of first-degree burns.

Second-degree burns are more serious. They are deeper than first-degree burns, look red or mottled and have blisters. They may also involve loss of fluids through the damaged skin. Second-degree burns are usually the most painful because the nerve endings are usually intact, despite severe tissue damage.

Third-degree burns are the deepest. They may look white or charred and extend through all skin layers. Casualties of third-degree burns may have severe pain, or no pain at all if the nerve endings have been destroyed.

ELECTICAL BURNS

Burns can also be caused by electricity, in which case the casualty may be suffering from the effects of the electric shock as well as the burn (Figure 26).

When treating a casualty of electrical burns, first-aid providers should look for electrical equipment or cables that may still be live.

Any electrical supply should be switched off or the source of electricity be removed before the casualty is touched (Figure 27). The first-aid provider should do this without placing him- or herself at risk of

Figure 26

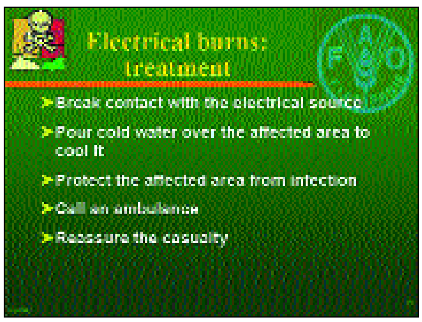

Figure 27

electrocution. Non-conducting materials such as plastic or dry timber should be used to push live items away from the casualty.

The casualty may be unconscious. The skin may be charred and there may be a smell of burned skin. The casualty may develop symptoms of shock. High-voltage (HV) shock may leave a brown residue on the skin.

To treat the casualty of electric shock, after the source of electricity has been removed, he or she should be assessed for consciousness, breathing and pulse and treated accordingly. Burns, should be treated as described in Figure 25.

Figure 28

HEAT EMERGENCIES

There are three types of heat emergencies that may occur when working with obsolete pesticides: heat stroke; heat exhaustion; and heat cramps (Figure 28).

Heat stroke

Heat stroke is the most serious type of heat emergency. It is life-threatening and requires immediate and aggressive treatment.

Heat stroke occurs when the body's heat-regulating mechanism fails. Body temperature rises until it becomes so high that brain damage – and death – may result unless the body is cooled quickly.

The signs and symptoms of heat stroke are:

- hot, red and usually dry skin;
- very small pupils;
- very high body temperature, sometimes as high as 40.5°C.

Professional help should be summoned immediately and the casualty should be moved to a cool place.

The first-aid provider should cool the casualty as quickly as possible in any manner possible, such as immersion in a bathtub of cool water, wrapping in wet sheets, or placing in an air-conditioned room.

The casualty should not be given anything by mouth and should be treated for shock.

Heat exhaustion

Heat exhaustion is less dangerous than heat stroke. It is caused by fluid loss which, in turn, reduces the blood flow to vital organs, resulting in a form of shock.

The signs and symptoms of heat exhaustion are:

- cool, pale and moist skin;
- heavy sweating;
- dilated pupils (wide);
- headache, nausea, dizziness and vomiting;
- body temperature remains near normal.

The casualty should be moved out of the heat into a cool place and placed in the shock position, lying on his or her back with feet raised. Clothing should be removed or loosened and the body cooled by fanning or applying cold packs, wet towels or sheets. If conscious, the casualty should be given water to drink every 15 minutes.

Although heat exhaustion is not itself a life-threatening emergency it can develop into heat stroke, which is life-threatening, if left untreated.

Figure 29

Heat cramps

Heat cramps are muscular pain and spasms caused by heavy exertion. They usually involve the abdominal muscles or legs. This condition is generally thought to be caused by loss of water and salt through sweating.

The casualty should be moved into a cool place and, if he or she can tolerate it, given half a glass of water every 15 minutes. Heat cramps can usually be avoided by increasing fluid intake when active in hot weather.

REPORTING INCIDENTS

All incidents requiring first-aid treatment should be reported (Figure 29). Reports should include the following information:

- the casualty's name and address;
- history of the accident or illness;
- a brief description of any injuries;
- any unusual behaviour;
- any treatment given, and when;
- observations on pulse, breathing and level of response, recorded every 10 minutes.

Monitoring should continue until the casualty has reached hospital or other professional medical care has been provided.

19. Turnkey disposal projects

Figure 1

This unit examines the reasons for selecting a turnkey project in preference to local disposal or investment in a new facility (Figure 2). It then looks at the process of international tendering. It also provides some broad selection criteria that should be considered when selecting a disposal contractor. Finally it discusses the process of monitoring to ensure that best international practice is followed during the operation.

The following are some of the main problems with the alternatives to turnkey projects (Figure 3):

- Local disposal usually means lower environmental standards and greater environmental impact. Using local personnel to complete the operation requires careful selection of staff followed by extensive training and expert supervision. Staff often have little relevant experience, thus the risks of serious injury and environmental impact are increased.
- Establishing new technology locally seems attractive on first examination. The problems of this approach are associated with use of an untested technology resulting in failure, accident and environmental impact.
- Investment in a local incinerator requires:
  - a full survey of the entire waste market;
  - strong legislation to ensure that the waste goes for incineration;
  - even stronger local enforcement of legislation in order to clamp down on industries that do not follow it;
  - a trained workforce;
  - a high level of infrastructure in terms of power, water, etc.
- Modification of a local cement kiln may seem an attractive option but:
  - cement kilns are designed to make cement not burn waste;
  - staff are not trained to handle hazardous waste;
  - investment will be needed for storage, introduction of the waste into the kiln, training, and monitoring of emissions, the quality of the cement and the fly ash produced.

Figure 2

Figure 3

BENEFITS OF TURNKEY DISPOSAL PROJECTS

A point that must be made is that the disposal operation will generally only be part of a larger project in the country (Figure 4). The whole project may include inventory, training, upgrading of local laboratories, construction of new stores, review of pesticide registration practices, examination of donor policies and actions, and reduction in pesticide usage through adoption of integrated pest management (IPM) techniques. By removing the disposal element by awarding it as a turnkey operation under tender it may be more easily fitted into the overall project management analysis.

Figure 4

Figure 5

Figure 6

Figure 7

Figure 8

A turnkey project with a detailed technical specification allows easy comparison of bids from different companies. Technical specification leads to clear definition of the responsibilities of the various stakeholders in the project. It makes it possible to select the best contractor based purely on technical specifications. A single contract may be awarded for the full project, allowing continuity of service and the insurance liability to be fully defined.

By awarding a single contract to a main contractor, the responsibility for the performance of any and all subcontractors lies with the main (usually the disposal) contractor (Figure 5). This is a tried and tested way of getting a job completed.

The number of contractors offering turnkey services is increasing, leading to competition and lower prices. Many European incinerators are operating at far from full capacity. Unit prices for disposal are, therefore, decreasing as more companies look further afield for waste to fill their plants.

INTERNATIONAL TENDERING (Figure 6)

International tendering for disposal services is a complex matter. All high-temperature incineration facilities capable of handling hazardous waste are currently found in developed countries – Europe and the United States (the United States has not signed the Basel Convention and does not currently allow the importation of waste for disposal). In order to select the best total service, a tender needs to be issued. Selection should also consider how the project will be managed and coordinated. The various responsibilities of the different stakeholders must be examined and defined, and it must be decided how the tender will be issued.

PROJECT MANAGEMENT

The success of a disposal operation is very closely related to how well it is managed (Figure 7). Without careful, accurate project management even the simplest operation can fail. The whole operation must be based on sound project management principles, specifically satisfying the aims and scope of the project by matching tasks and resources and also by preparing a sound critical path analysis for all aspects of the operation.

Figures 8 to 11 outline the benefits of and problems created by three proposed examples of how projects can be managed.

Option 1 (Figure 9) has proved successful to date. Both FAO and the German Agency for Technical Cooperation (GTZ) have completed numerous operations throughout Africa and the Near East. However,

Figure 9

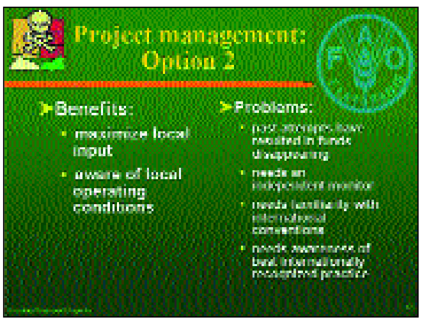

Figure 10

Figure 11

Figure 12

Figure 13

Figure 14

Figure 15

Figure 16

local government agencies may lack the necessary experience to make operations a success. The involvement of different government departments, each with their own responsibilities, may result in uncertainty, conflict and delay. Generally, the learning curve is too steep to allow this option to work without significant input from international organizations/donor embassies. The agencies that use option 1 have taken ten years to get to their current level of expertise. To expect any agency to develop a similar level of competence overnight is not reasonable or realistic.

Increasingly donor countries look to bilateral aid as a potential solution to the obsolete stocks issue. This offers the benefits shown in Figure 11; problems may occur as a result of inexperience and the lack of international, independent monitoring. There are also questions over the availability of adequate, competent supervisors. The disposal element is only a part of the picture: will the embassy concerned cover all aspects of the project?

Bilateral aid often utilizes the expertise of international organizations, such as FAO, to manage projects, thereby overcoming many of the problems listed here in Figure 11.

In this unit, several assumptions have been made (Figure 12). These are based on experience of operating in the field of disposal of obsolete stocks gained over the past ten years. FAO is named as the project management organization. To date FAO has championed the cause of obsolete stocks via a project funded by the Government of the Netherlands. It continues to work closely with other UN organizations such as the United Nations Environment Programme (UNEP).

STAKEHOLDERS

The term "stakeholder" is often used in disposal and other aid operations. As shown in Figure 13, almost everybody can be regarded as a stakeholder – the only variable is the level of responsibility that each has. For an operation to be a success, all the stakeholders must be aware of their responsibilities and committed to fulfilling them.

Donors fund the projects (Figure 14). Once funding has been agreed it is their responsibility to ensure that all actions are in full compliance with all relevant international conventions and laws. They should also ensure that all financial statements are in order and be members of any national project coordination committee that may be established.

In practical terms, the success of the project is greatly dependent on the support, commitment and competence of the local government counterpart staff assigned to it (Figure 15). Often the project base will be at the government department offices to allow the closest possible liaison between the project manager and government counterparts. Where possible, the local government counterpart department should intervene or act at the most senior level to overcome difficulties and red tape which can delay or interfere with the progress of the project, for example, by ensuring the swift customs clearance of equipment shipped as part of the disposal operation.

The *international organization* is ultimately responsible for the stimulation of donor support for a project (Figure 16). This will usually be achieved following a successful inventory. The inventory is the first step in the elimination of the problem, and its importance cannot be overemphasized. A task force may then be established to generate the complete project document that is used to secure donor support.

Part of the project document will focus on the project plan. This will give an estimated time frame for the complete operation and will also detail any additional areas for concern such as pesticide registration and distribution and possible implementation of IPM techniques.

The organization will also recruit a qualified project manager for the duration of the project. Part of the project manager's role will be regular reporting of progress to the stakeholders via the national project coordination committee.

Finally, the organization will provide fully transparent financial statements to show exactly where the entire donor funding has been spent. This is important in order to build trust and demonstrate value for money to the donors.

Figure 17

The international *non-governmental* organizations (NGOs) operating in this arena allow the fully independent monitoring of the entire operation (Figure 17). They also work closely with local NGOs to involve them in the immediate process, as well as in ongoing issues such as sustainable agricultural development which can help to prevent future accumulation of obsolete pesticide stocks. NGOs are also able to give a different perspective on the proposed goals of the project.

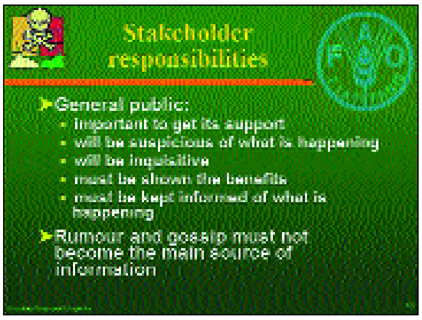

Figure 18

The support of the *general public* can affect the project (Figure 18). In areas where concerns over the possible pollution caused by the waste have been voiced the local community groups need to be kept informed of the activities proposed. In areas where there has been no local interest, the arrival of people wearing personal protective equipment (PPE) will attract interest and possible concern. The support of local community groups is even more important in these instances.

Figure 19

A *disposal contractor* should have a good track record (Figure 19). Only those who have experience in similar operations should be considered. The contractor should provide "peace of mind" because the level of confidence in their ability is high. Contractors have a responsibility to ensure compliance (legislation, conventions, etc.) and should be sensitive to any cultural aspect of the project.

Figure 20

A pesticide industry association, the *Global Crop Protection Federation* (GCPF) has a commitment to pay for the disposal of stocks manufactured by their members (Figure 20). To date there are very few examples of this actually happening. Usually, the organization/local government provides samples and GCPF verifies that the stocks are from one of their members. This can be a simple process when virgin stocks with good, accurate labels are concerned, but it becomes far more difficult and time-consuming when the materials are not in their original containers and/or their chemical nature is unknown. Unfortunately, the latter conditions are the most typical for obsolete stocks. GCPF also tends to favour reformulation, which can be affective but the environmental impact of the process must be very carefully assessed from outside the industry perspective. NGOs and trade unions should be involved in the study of any proposed reformulation plant to ensure that worker safety

Figure 21

Figure 22

Figure 23

and environmental considerations are factored into the decision-making process.

When all the stakeholders are involved and informed a disposal contractor needs to be selected (Figure 21).

SELECTION CRITERIA

The aim is to ensure that only competent contractors are selected (Figure 22). By setting selection criteria and judging all contractors on the technical proposals that they submit the best contractor for the project can be appointed. Each project is unique, so different contractors may be selected for apparently similar projects in different countries with different detailed technical requirements. All the information supplied must be verified – whenever possible through independent references.

The factors listed in Figure 23 are some of the principal questions that need to be covered in any proposed tender process.

The process will incorporate either two or three stages. Stages 1 and 2 (Figures 24 and 25) may be combined to compress the time frame.

The technical proposal (stage 2) is the first real test of the contractor's competence. It is a complex document which is submitted following the issue of a detailed technical specification. The specification addresses very specific questions and may also require a site visit to allow contractors to finalize their proposals.

Once a clear preferred contractor has been identified on the basis of the technical proposal, the financial proposals (Figure 26) are considered. Negotiations with the preferred contractor will commence, provided that the financial proposal is acceptable.

The factors and conditions listed in Figure 27 should be included in negotiations and formulation of the contract.

Figures 28 to 30 describe an example in which 100 tonnes of obsolete DDT powder are to be disposed of. The following are the degree of

Figure 24

Figure 25

Figure 26

Figure 27

Figure 28

Figure 29

importance that should be attached to each of the criteria in the three stages of selection:

- Stage 1: pre-qualification:
  - 15 percent to contractors who have completed similar operations;
  - 15 percent to disposal technology that has been proven;
  - 25 percent to the level of insurance coverage provided;
  - 15 percent to the level of experience of the subcontractors;
  - 30 percent to the references that are available.
- Stage 2: technical competence:
  - 10 percent to other similar projects that have been completed;
  - 25 percent to the health and safety provisions;
  - 25 percent to an adequate risk assessment;
  - 25 percent to a suitable packaging method;
  - 10 percent to training given to the local workforce;
  - 5 percent to the record of the disposal facility.
- Stage 3: financial proposal:
  - financial proposals will be considered only from contractors that score at least 75 percent on the technical proposal;
  - the bid should be binding and not open to significant further negotiation;
  - any special conditions added to the bid should be checked;
  - judgement should be used to determine whether a proposal is acceptable;
  - the lowest bid should be accepted.

Figure 30

INDEPENDENT MONITORING

The disposal project and implementation of prevention measures must be independently monitored to ensure that best practice is being applied in all activities and that funds are being used in the most cost-effective manner to achieve sustainable results (Figure 31).

Project management should monitor ongoing day-to-day activities while spot checks and reviews are carried out by external bodies not involved in running the project. These bodies might be local or international NGOs, donors, specialist consultants or similar. In any event, the monitoring should be impartial.

The independent monitoring should ensure that:

- activities comply with the highest health and safety standards;
- activities comply with the highest environmental protection standards;
- the project is run with financial transparency;
- the aims of the project are achieved.

Figure 31

SUMMARY (Figure 32)

This unit has discussed the benefits of a turnkey approach to prevention and disposal projects. It has also looked at the ways in which projects can be managed.

The roles of various stakeholders have been discussed, as have the selection criteria for a contractor to carry out a project and the importance and role of independent monitors for the project.

Figure 32

Abbreviations

APF
assigned protection factor

AS
arsenic compound

BP
bipyridylium derivative

C
carbamate

CE
Conformité européene

CO
coumarin derivative

CPR
cardio-pulmonary resuscitation

CU
copper compound

DRE
destruction removal efficiency

EC
emulsifiable concentrate

EU
European Union

FFVM
full-face vapour mask

FIFO
first-in, first-out

G
granules

GC
gas chromatograph

GCMS
gas chromatograph mass spectrometer

GCPF
Global Crop Protection Foundation

GMP
good management practice

GTZ
German Agency for Technical Cooperation

HG
mercury compound

HPLC
high-pressure liquid chromatograph

IARC
International Agency for Research on Cancer

IBC
intermediate bulk container

ILO
International Labour Organization

IMDG
International Maritime Dangerous Goods

IMO
International Maritime Organization

IOMC
Inter-Organization Programme for the Sound Management of Chemicals

IPM
integrated pest management

L
unknown liquid

LD
lethal dose

MEL
maximum exposure limit

MPR
minimum protection required

MSDS
material safety data sheet

NGO
non-governmental organization

NOS
not otherwise specified

NOX
nitrogen oxide

NP
nitrophenol derivative

OC
organochlorine compound

OECD
Organisation for Economic Co-operation and Development

OEL
occupational exposure limit

OES
occupational exposure standard

OP
organophosphorus compound

OT
organotin compound

P
powder or dust

PAA
phenoxyacetic acid derivative

PG
packaging group

POP
persistent organic pollutant

PPE
personal protective equipment

PSN
proper shipping name

PY
pyrethroid

PZ
pyrazole

QA
quality assurance

RPE
respiratory protective equipment

S
unknown dry formulation

SOX
sulphur oxide

T
triazine derivative

TC
thiocarbamate

ULV
ultra-low volume

UNEP
United Nations Environment Programme

USEPA
United States Environmental Protection Agency

UNIDO
United Nations Industrial Development Organization

UNITAR
United Nations Institute for Training and Research

WHO
World Health Organization