FAO Pesticide Disposal Series 16

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Environmental Management Tool Kit for Obsolete Pesticides

Volume 4

J. Zoning of workplaces

K. Risk assessment

L. Standard operating procedures

M. Selection and use of equipment

N. Health, safety and environment plan

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Foreword

Volume 4 of the Environmental Management Tool Kit (EMTK) series provides the user with a set of pro forma systems to mitigate the risks common to most obsolete pesticide safeguarding projects. It also provides a format for consolidating the relevant information from other volumes of the EMTK series to allow the preparation of a site-specific health, safety and environment assessment. This tool is an essential requirement for the planning and implementation of safeguarding of obsolete pesticides at higher-risk sites and will be a major contributor to the safe completion of activities in these locations.

The tools and formats presented here have been developed over many years of implementing pesticide safeguarding projects in developing and developed countries. They have a solid foundation in international regulations from the United States of America and Europe and so can be considered as complying with international best practice for worker and environmental safety.

The application of these systems has resulted in the safe implementation of repackaging and safeguarding operations in a wide variety of countries under different conditions. The systems can eliminate accidents and prevent any adverse impact on workers, public health or the environment. They have been applied equally successfully under field conditions by both specialist international contractors and trained national teams. Nationally implemented projects in Ethiopia, Mali, Mozambique, Tunisia and the United Republic of Tanzania have all used trained local staff (in varying levels of managerial, supervisory and operational capacity) working in collaboration with contractors, consultants and FAO staff to implement the systems presented in the tools. To date, over 3000 tonnes have been safeguarded under FAO lead projects using the systems presented in Volume 4 with no reported accidents affecting workers, public health or the environment.

Using the tools and formats presented in this document and applying basic health, safety and environmental management rules will make it possible to safeguard obsolete pesticides successfully – even under the most difficult local conditions. The formats outlined in Volume 4 give a standardized approach that can be applied in a variety of local circumstances and that can also be adapted to meet the specific needs of an individual site. Other formats (for elements such as risk assessment and standard operating procedures) do exist, and the user is encouraged to compare the formats presented here with those alternatives to ensure that their requirements are met. The advice presented in Volume 4 has a solid foundation in worker health and safety regulations from the United States of America and Europe and comply with what is currently regarded as international best practice for worker and environmental safety when handling hazardous materials such as pesticides. In addition, the principles presented here are equally applicable to the safeguarding of other hazardous materials and follow the guidance provided by the Secretariat of the Basel Convention on the safe handling of persistent organic pollutant (POP) wastes such as polychlorinated biphenyls (PCBs).

Contents

Acronyms

APF	assigned protection factor
AI	active ingredient
BA	breathing apparatus
COSHH	control of substances hazardous to health
decon	decontamination
EA	environmental assessment
EMP	environmental management plan
EMTK	Environmental Management Tool Kit for Obsolete Pesticides
EN	European Norm
ERA	environmental risk assessment
FAM	*Field Application Manual*
FLT	forklift truck
HSE	health, safety and environment
IDLH	immediately dangerous to life or health
IMDG	*International Maritime Dangerous Goods Code* [publication]
IMO	International Maritime Organization
LD_{50}	Lethal dose, %
M&E	monitoring and evaluation
MEL	maximum exposure limit
NGO	non-governmental organization
NPF	nominal protection factor
OES	occupational exposure standard
OEL	occupational exposure limit
OSHA	Occupational Safety & Health Administration (United States of America, Department of Labor)
PCB	polychlorinated biphenyl
PG	packing group
POP	persistent organic pollutant
PMU	project-management unit

PPE	personal protective equipment
RPE	respiratory protective equipment
PSMS	Pesticides Stock Management System
SBC	Secretariat of the Basel Convention
SOP	standard operating procedure
STEL	short-term exposure limit
TBRA	task based risk assessment
TOR	terms of reference
ULV	ultra low volume (pesticide formulation type)
UN	United Nations
USA-EPA	Environmental Protection Agency (USA)
WHO	World Health Organization

Table of tools in the EMTK series

The Environmental Management Tool Kit (EMTK) series for management of obsolete pesticides is composed of the following volumes, each of which contains a series of tools. For ease of the reading, references to the tools will only be mentioned by their numbering.

Environmental Management Tool Kit Volume 1:

- Tool A: Environmental risk assessment
- Tool B: Prioritization of stores
- Tool C: Regional prioritization and risk tracking

Environmental Management Tool Kit Volume 2:

- Tool D: Selection of collection centres
- Tool E: Management of collection centres
- Tool F: Transport planning

Environmental Management Tool Kit Volume 3:

- Tool G: Safeguarding strategy
- Tool H: Disposal strategy
- Tool I: Environmental assessment report and environmental management plan

Environmental Management Tool Kit Volume 4:

- Tool J: Zoning of the workplace
- Tool K: Risk assessment
- Tool L: Standard operating procedures
- Tool M: Selection and use of equipment
- Tool N: Health, safety and environment plans

Introducing the FAO Environmental Management Tool Kit for Obsolete Pesticides

Background

Volume 4 of the Environmental Management Tool Kit (EMTK) series for obsolete pesticides provides practical advice to project-management units (PMUs)[1] and partners, such as waste-management companies, who are implementing the *safeguarding strategy* presented in tool G, EMTK Volume 3. Whereas tool G provides guidance on the development of strategies for safeguarding of obsolete pesticide wastes (*who* will take the responsibilities and complete the safeguarding activities), the tools in EMTK Volume 4 provide practical advice on "how" to implement the strategy and ensure a minimum impact on public health and the environment. As a result, this volume looks at a number of instruments that can be used to reduce substantially the risk of accidents during the implementation of safeguarding activities.

- Tool J introduces the principal of *zoning* of the workplace. Zoning will eliminate the casual exposure of operational personnel and others to obsolete pesticides and prevent the spread of contaminants into the general environment during repackaging.
- Tool K can be used to assist the PMU in the safe implementation of the project by assessing and managing the main risks from safeguarding of obsolete pesticides at a specific location. The tool proposes the use of the *task based risk assessment* (TBRA) format provided to complete a step-by-step risk assessment of each site.
- Tool L provides essential guidance for elaborating and using *standard operating procedures* (SOPs) based on the specific conditions and hazards for each site to ensure that all implementation activities are completed safely. The tool describes how *activity-specific SOPs* can be used to provide detailed and clear instructions to supervisory staff on how to conduct the different activities (e.g. repackaging of solid pesticides or setting up the zoning), and how *site-specific SOPs* should be devised to present simple instructions to workers on work practices. These might include, for example, guidance on where they should be working, what personnel protective equipment (PPE) they should use, objectives of the day, and so on.
- Tool M provides technical guidance on selecting critical equipment common to most obsolete pesticide safeguarding projects.
- Tool N provides a format for the development of site-specific *health, safety and environment* (HSE) plans. It synthesizes all relevant data linked to the on-site management of safeguarding activities elaborated in the tools presented in this and earlier EMTK volumes (e.g. environmental risk assessment data, zoning plan, TBRA, transport rules and formats for daily briefings) into a plan specific to higher- and moderate-risk sites and into a generic plan for lower-risk sites.

The guidance and templates contained in EMTK Volume 4 offer a standardized approach to the principles of managing and implementing safeguarding activities. These principles are based on accepted best practices from the waste management and other industries. Experience has demonstrated that, by following these principles, impact to public health, worker health and the general environment can be eliminated. The formats and systems presented here have been developed and applied successfully during the implementation of a series of FAO-managed

1 For a definition, see "Institutional arrangements" section in the introduction of EMTK Volume 3.

obsolete pesticide projects, including in Yemen (1994), Zambia and the Seychelles (1996), Lebanon (1999), Ethiopia (2000–2003 and 2004–2008), Mozambique (2005–2008), the United Republic of Tanzania (2005), the Syrian Arab Republic (2005), Mali (Gao) 2006, Tunisia (Menzel Bourghiba Hospital 2007) and Eritrea (2009). The systems will also be applied in the forthcoming safeguarding phase of projects in Benin, Botswana, Cameroon, Ethiopia, Iran (Islamic Republic of), Jordan, Kenya, Malawi, Mali, Morocco, South Africa, Swaziland, the United Republic of Tanzania, Tunisia and Vietnam. To date, projects that have adopted these systems have seen no contamination of workers and no accidents that have affected the general public or entailed damage to the environment. The HSE plan, together with its components presented in tools J–M, therefore offers the strongest system to mitigate risk during this stage of any obsolete pesticide-management project.

In addition, the guidance is tailored to the needs of project implementation in the developing country context, where access to services such as water and electricity cannot be guaranteed and where the availability of emergency support services (e.g. ambulance, fire brigade and police) may be limited. As such, these tools provide a useful example of the practical application of *risk-management strategies* as presented previously in Box G6 of tool G.

Objectives

Tools J to M provide technical advice to the PMU and the safeguarding contractor/national team on how to manage the risks associated with pesticide safeguarding and how to prevent accidents by adopting proven project-management techniques.

The HSE plan presented in tool N can be applied to help the PMU, safeguarding contractor and technicians to implement difficult projects under challenging conditions. By taking into account the specific conditions at the work location, the HSE plan will help ensure that there is no impact on human health and the environment as a result of the safeguarding activities.

By applying the advice and using the formats provided in these guidelines, the PMU should be able to safely supervise and – where appropriate – implement the strategies defined in tool G for higher-, moderate- and lower-risk locations.

Audience

EMTK Volume 4 has been developed for:

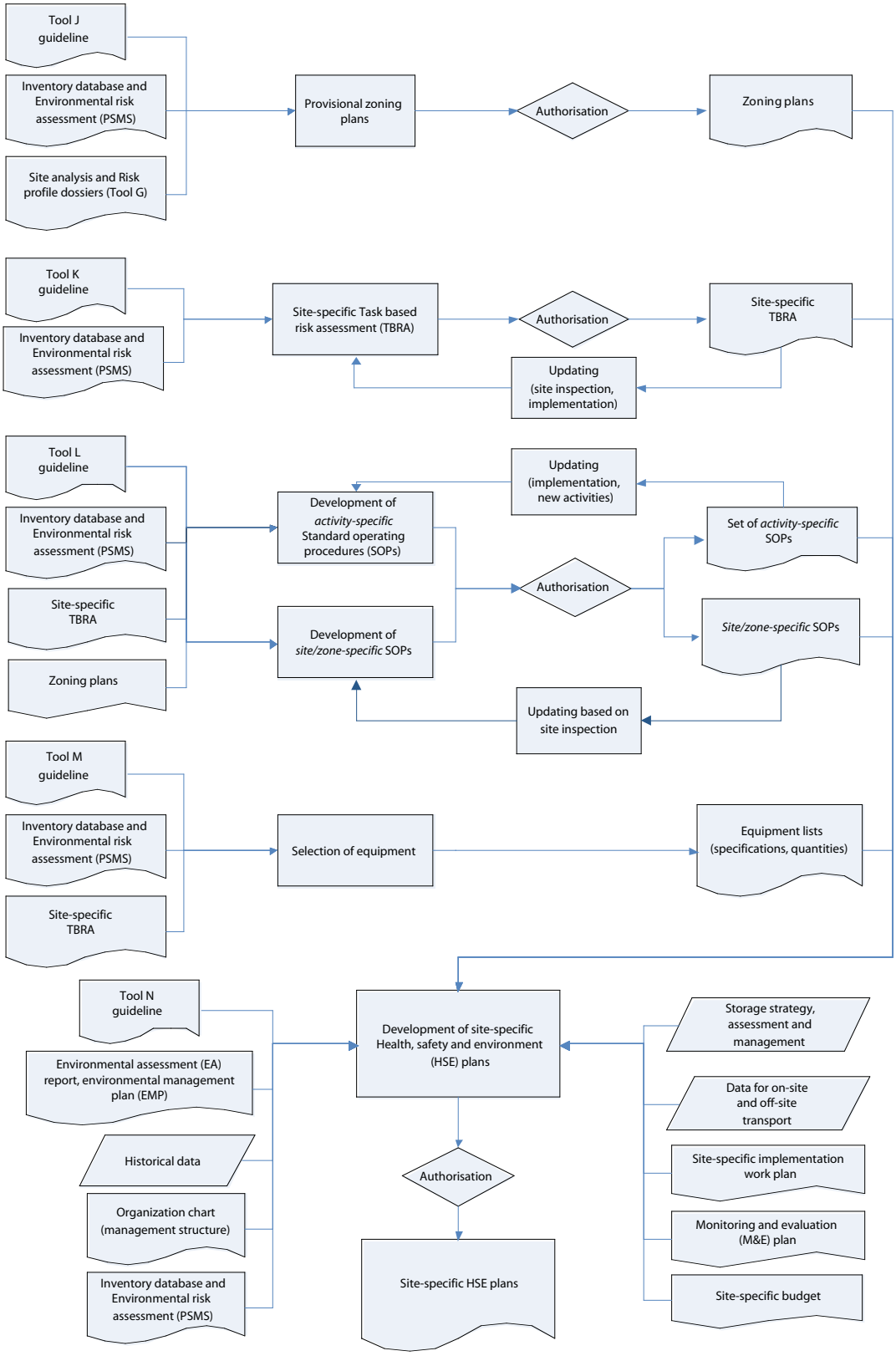
- **Government personnel** responsible for the supervision of specialist waste-management contractors who have been hired to complete the safeguarding of higher-risk locations.
- **Government personnel** with the capacity and competence to complete safeguarding operations.
- **Country PMUs** in charge of the project management and active in the development of site-specific tools based on the generic formats presented in this volume, which are typically drafted by the principal environment consultant or specialist hazardous-waste contractor.
- **National and international waste-management contractors** hired to complete safeguarding operations.

Presentation

The tools can assist the PMU in the planning of the safeguarding of affected sites by providing:

- guidance on the preparation of safe workplaces through the zoning of activities, and for the setting of rules for the movement of personnel and material between zones (tool J);
- a format for TBRA and an explanation as to how this process should be used to assist project implementation (tool K);
- formats for SOPs for supervisory and field staff (tool L);
- formats for recording staff briefings, and daily and weekly progress against the work plan (tool L);

Figure 1
Development of risk-management tools and health, safety and environmental (HSE) plans for safe workplaces



- recommended minimum medical standards for all project staff (tool L);
- specifications for PPE commonly used during pesticide safeguarding projects (tool M);
- a generic template for the presentation of the HSE plan with specific advice on how the document should be completed (tool N).

The tools emphasize the need for strong management systems, good supervision and a technically competent workforce. While they provide some guidance to the user on these systems, it is important to ensure that personnel from all levels (managerial, supervisory and operational) receive the appropriate training to allow them to work safely. FAO training modules can be made available in support of these guidelines, and additional training in areas such as using PPE, zoning and emergency response can be provided through a number of accredited training companies. Further details on training courses can be found through the United States of America Environmental Protection Agency (USA-EPA) Web site and by contacting the FAO obsolete pesticide programme at OPGroup@fao.org.

Dialogue boxes throughout Volume 4 provide detailed explanations of processes and activities, and give examples from past projects to illustrate key points. Links to reference resources and training modules are also provided to allow the user access to original source materials in cases where more background information is needed. Finally, Volume 4 is supplemented with annexes that contain exercises to practise the development of TBRAs, examples of SOPs and reporting formats as well as specifications for the main equipment.

Outputs

The application of tools provided in this volume should produce the following outputs.

- **For higher-risk locations:** Site-specific HSE plans for all sites, with a detailed zoning plan and site-specific TBRA and SOPs.
- **For moderate-risk locations:** A less detailed HSE plan, with a site-specific TBRA and SOPs for all sites.
- **For lower-risk locations:** A site-specific TBRA and site-specific SOP but using activity SOPs prepared for higher- and moderate-risk locations where available.

Note that the outputs should be prepared and approved *before* starting work, constituting the *site inspection* stage of the Basel Guidelines (see below). The HSE plans will be prepared based on a literature survey and use of the data contained in the inventory, the FAO Pesticides Stock Management System (PSMS), the environmental assessment (EA) report and the environmental management plan (EMP) (tool I). Data may require verification via a site inspection to account for any changes in conditions at the site and could result in an amendment of the plans to meet present conditions at an affected location. In this case, the approval step should be repeated to ensure all levels of supervision are working with the same set of documents. The final approved outputs will include the detailed zoning and site-specific TBRA.

Figure 1 above illustrates the whole risk-management process developed in this volume leading to the completion of comprehensive HSE plans.

Relationship with other guidelines

EMTK Volumes 1 to 3 (Tools A–I) plus the separate FAO guidance *The Preparation of Inventories of Pesticides and Contaminated Materials* provide advice on how to plan the elimination of obsolete stocks, available at http://www.fao.org/fileadmin/user_upload/obsolete_pesticides/docs/UNFAO-inventory.pdf. Here, tools J–N outline the practical systems that can be used to repackage the obsolete stocks safely. EMTK Volume 2 gives guidelines on transport and storage, which need to be addressed in the overall safeguarding and disposal strategies. Furthermore, tools J–N use significant levels of input from the EMTK series as well as other FAO guidelines. The

primary linkages to other guidelines are:

- the pesticide product inventory data from PSMS;
- the store layout and location (environmental data from the inventory);
- the risk profile from application of tools A–C and PSMS;
- location of nearest collection centre (tool D);
- safeguarding strategy data (tool G);
- EA report together with EMP data (tool I).

The EMTK volumes can also be considered as providing a practical set of outputs which are consistent with the systems developed by the Secretariat of the Basel Convention (SBC) for the sound management of POP wastes. Volumes A, B and C of the Basel Guidelines and the *Field Application Manual* (FAM) presented therein are compatible with the systems and tools presented in the EMTK series.

Refer also to the "Information and forms in support of the implementation of the Basel Convention" page in the "Training Manuals" section on the Basel Convention Web site (http://www.basel.int/) for further reading on the Basel Guidelines and the FAM.

The linkages between the two sets of guidance are summarized in Box 1. By using the tools contained in these guidelines, the country will therefore be in conformity with the SBC requirements during project implementation.

BOX 1
Relationship between the FAO and Basel Technical Guidelines on pesticide/POP management

Component of the Basel Convention Guidelines[2]	Component of FAO guidelines
Management plan	Safeguarding strategy (tool G) and EA/EMP documents (tools I)
Site inspection	Inventory/PSMS data (tools A–C, tools G–I), HSE plan (tool N)
Clearance plan	Site-specific TBRA (tool K)
Site preparation	Zoning of workplaces (tool J)
Packaging plan	Standard operating procedures (tool L)
Storage plan	Selection and management of collection centres (tools D and E)
Transport plan	Transport of pesticides wastes (tool F)
Disposal plan	Disposal strategy (tool H)
Insurance plan	EA and EMP (tool I, tool N)
Emergency plan	Health and safety plan (tool N)

2 Secretariat of the Basel Convention, 2002. *Destruction and decontamination technologies for PCBs and other POPs wastes under the Basel Convention: a training manual for hazardous waste project managers*, Volume B, p. 5.

Tool J

Zoning of the workplace

Throughout the safeguarding of obsolete pesticides, workers will come into direct contact with hazardous materials. It is the managers' responsibility to ensure that there is no impact on workers, the general public or the environment as a result of this work. Tools J–M provide guidance on a number of measures that can be taken to reduce greatly the risk of accidents during the implementation of safeguarding activities.

Tool J describes the principle of zoning of the workplace. This involves the demarcation of contaminated and clean working places, and the establishment of strict working rules to confine contaminants (hazardous waste, contaminated material, contaminated dust and liquid, etc.) to the area which is already contaminated (the "dirty zone"). Workers' observance of the zoning and the associated rules for movement between zones should prevent casual exposure and cross-contamination during the handling of obsolete pesticides or contaminated material. Cross-contamination is a critical threat to workers, their families and the community around the site. It occurs when workers leave the work site with contaminated hands, hair, clothing, shoes or other material and spread contaminants around the site or into their homes. It can also affect people involved in subsequent phases of the waste-pesticide processing – such as haulage contractors, workers or storekeepers at collection centres who might come into contact with contaminated material (e.g. repackaging material not properly decontaminated after repackaging). Zoning of workplaces can therefore be seen as the first step in containing contaminants and in protecting workers and people around the site.

Objectives of the tool

Tool J provides the PMU or equivalent national implementing body with guidance on how to develop a safe working place in order to protect the health of the workers directly and to avoid dispersion of the hazardous wastes into the environment. Tool J shows how to set up:

- strict and detailed organization of work sites and activities through the demarcation of three work zones, including instructions for the establishment of the zones and the construction of three-stage decontamination (decon) units;
- rules for the movement of workers and material between the zones, including instructions for the organization and procedure of the three-stage decontamination process;
- internal and external emergency plans to respond quickly and efficiently in the case of accident.

Description of the tool

The zoning of the workplace to eliminate casual exposure and cross-contamination during the handling of hazardous substances is a long-standing and well-proven technique. The principles are enshrined in the US Occupational Safety & Health Administration (OSHA) 29 CFR 1910.120 regulations for management of *Hazardous Waste Operations and Emergency Response*, Appendix C, Section 7 (Site Safety and Control Plans), and training programmes are run by a number of international organizations. More information can be found by searching for 29 CFR 1910.120 at the US government Web sites www.osha.gov and www.fema.gov.

The regulations stipulate that a work site be segregated into three zones. Using examples

from the field, Tool J defines the three zones, describes how they can be constructed, how to contain contamination within a zone, what equipment is required and how to control movement between zones. Typically, the implementation of any repackaging activity will start with training in how to apply this guidance. In addition, the tool provides instructions for the preparation of emergency planning for any critical situations that might arise during the safeguarding activity.

Demarcation of zones and the organization of movement between zones

Defining the zones

The configuration of the *zoning* or the organization of safe working areas depends on conditions at the site to be safeguarded (disposition, toxicity and quantity of obsolete pesticides and contaminated material, spatial arrangements in the building and their relation to the site, etc.) and on the activities planned during the intervention (repackaging, decontamination of building material, storage, etc.). In all situations, the zoning principles are the same: the organization and the management of operations into three distinct working zones. These are commonly termed and characterized as follows.

Zone 1: Hot or dirty zone

- Close proximity to hazardous materials.
- High risk of exposure when working.
- Focus on repackaging of waste into new containers.
- Control measures in place for the decontamination of workers.
- High levels of supervision and control during operations.
- Close monitoring of workers and work methods based on operating procedures.
- High levels of PPE and environmental protection.

Zone 2: Intermediate or buffer zone

- Lower risk of exposure when working.
- Focus on interim storage of repackaged containers.
- May include removal of residual contamination on the outside of containers.
- Labelling of new containers.
- Lower levels of PPE and environmental protection.

Zone 3: Clean zone

- No or minimal risk of exposure.
- Focus on storage of materials pending removal from site.
- PPE related to handling of new, clean packages.
- Use of drum-handling equipment to move items to reduce risk.

Development of safe working areas (see Boxes J1 and J2)

The main principle of zoning is the containment of contaminants within an area already deemed contaminated. Where possible, it is common to use existing building structures to demarcate the boundaries of each zone. Physical barriers preventing the spread of contamination and the casual entry of personnel into and out of the contaminated hot zone are usually employed. These may take the form of existing walls or fencing in a compound, or may be constructed from temporary or permanent fencing, or, in extreme cases, a temporary structure may be erected to contain fully the contamination. In all situations, a case-by-case assessment of the risk is necessary. Consider

factors such as the type and level of contamination, toxicity and main exposure routes of the chemical(s), proximity to other buildings and people, potential for impact on environmental factors (e.g. water) and other site-specific factors.

The inventory and the initial assessment of the potential impact on population and the environment completed for all pesticide storage sites, along with the site analysis completed in tool G, provide the basic information required for the demarcation of zones. This basic information should include site diagrams, photographs and the e*nvironmental risk factor* F_E (tool A), all of which were data used to prioritize all locations as higher, moderate and lower risk (tool B). The same information is equally important for establishing the zoning (or *site preparation plan* as defined in the Basel Guidelines).

Under normal circumstances, the PMU/contractor will complete an assessment of existing data, and then develop an outline of the zoning of the affected location *before* arriving at the location to complete the work. The site will then typically be divided into the three zones as outlined above. A *provisional site zoning plan* will be developed based on the original site plans completed at inventory, which highlights the interrelationship between the three zones and the surrounding environment. If there is a lack of data in the original inventory or it is understood that the situation at the location has changed since the inventory, it is usual to complete a *site inspection* visit to verify the current status of the store to allow the provisional zoning plan to be completed before work begins. Box J1 gives an example of a zoning plan based on the original inventory and site inspection data.

BOX J1

Assignment of zones – Tunisia, Menzel Bourghiba, 2007

The store at Menzel Bourghiba was understood to contain an unspecified quantity of DDT powder at two locations within a derelict compound. The compound is housed within a hospital complex, and the risk of contamination of the wider environment was felt to be too great to leave the materials to be dealt with as part of a national clean-up exercise. The site was therefore prioritized for emergency safeguarding intervention implemented by a national trained team under the supervision of specialist consultants and FAO personnel.

Defining the zones in the plan

The site plan (as entered into the PSMS), site photographs and the environmental questionnaire completed as part of the inventory process should provide the user with sufficient information to identify the three main zones. It is important that the person preparing the HSE plan has enough data to allow them to clearly define on the site plan where each of the zones begins and ends, and how personnel and equipment will move between zones. In cases where data is incomplete or unclear, it is recommended that a detailed site inspection be completed by the PMU.

BOX J1 *cont.*

Assignment of zones – Tunisia, Menzel Bourghiba, 2007

Figure J1

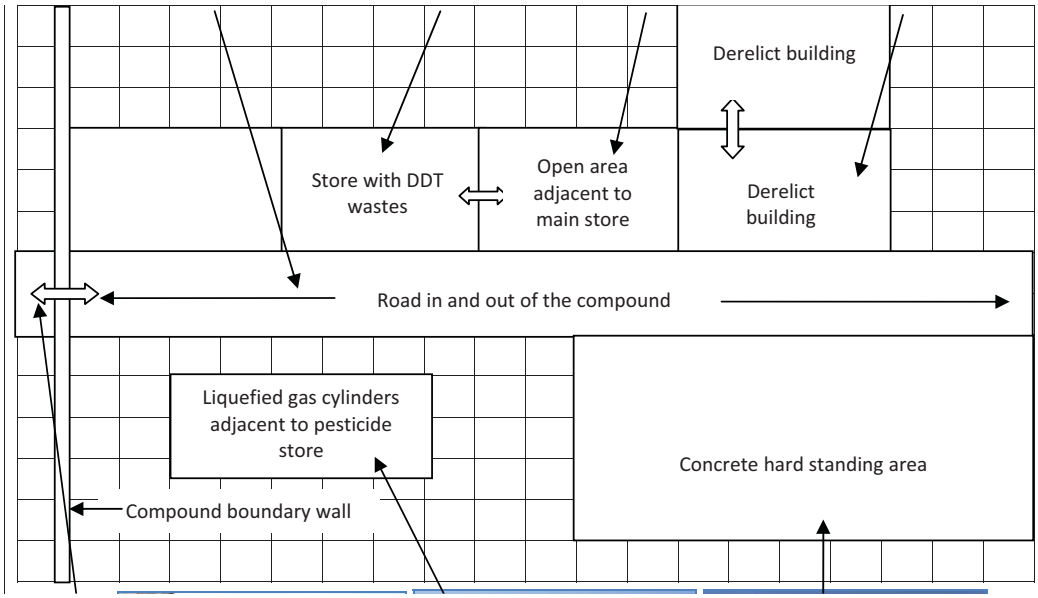
Site photographs and intial site plan from inventory and site inspection

(a) External view of store

(b) Contents of store

(c) Space next to store

(d) End of building



(a) Entrance to site

(b) Liquefied gas cylinders

(c) Concrete hard standing area

BOX J1 *cont.*

Assignment of zones – Tunisia, Menzel Bourghiba, 2007

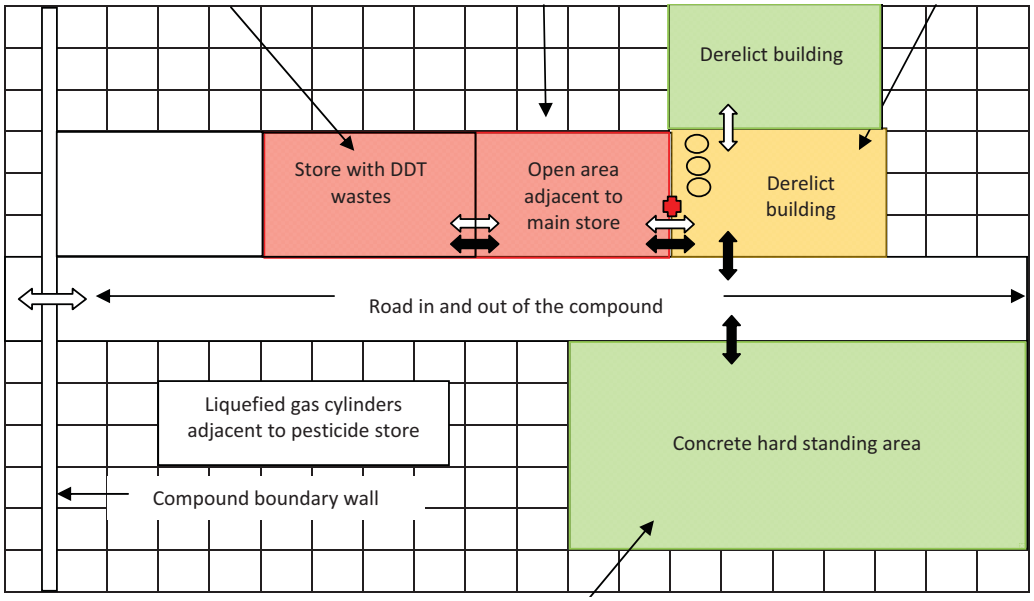
Figures J2

Provisional zoning plan with examples of activities

(a) Inspection of waste

(b)Loading of cartons

(c) Sealing of cartons



(d) Storage of new containers on handstanding

The provisional zoning plan should clearly identify:

- the three working zones: hot zone (red shading above), buffer zone (orange) and clean zone (green);
- where personnel enter and leave the zones (indicated by double-ended white arrows);
- where equipment enters and leaves the zones (indicated by double-ended black arrows);

BOX J1 *cont.*

Assignment of zones – Tunisia, Menzel Bourghiba, 2007

- where emergency equipment (shower, first-aid and fire-fighting equipment) will be placed (indicated here by a red cross);
- where equipment and repackaged waste will be stored and how materials will be transported across the site.

The photographs (Figure J2, a–c) illustrate the activities completed in each zone. Note that:

- In the hot zone, all personnel wear elevated levels of PPE, including full-face vapour masks and splash-proof coveralls (colour-coded yellow). The principal activity involved the handling of obsolete pesticides and placing them into new packages.
- In the buffer zone, personnel are required to inspect, seal, decontaminate and label packages. A lower level of PPE is required (colour-coded white to ensure it is easy to identify if personnel are in the wrong zone).
- In the clean zone, filled decontaminated packages are stored awaiting transport for disposal.

Construction of the zones (see Box J2)

Box J1 provided examples of locations that have been successfully divided into work zones. Although the examples may differ greatly in their actual appearance, a number of common features apply to most sites where zoning has been established. In all cases, containment and the prevention of spread of contamination are the guiding principles. The construction of the zones will ultimately reflect the risk associated with the activities to be completed in that zone. The zoning is therefore a vital part of the overall risk-management plan for safeguarding at a specific site and is central to ensuring that risks are mitigated adequately. It is likely that obsolete pesticides will be dispersed to some degree in the hot zone during safeguarding, with the associated higher risk of exposure to workers, the general population and the environment. The construction of the work areas is an important feature of limiting the spread of hazardous substances and potential impact. The features common to most working areas include the following.

Zone 1: Hot zone

- An existing building structure or a purpose-built physical barrier clearly shows the limits of the area.
- Migration of dust contaminants is prevented by the sealing of windows and other gaps in the containment area.
- Use of protective membranes (heavy-duty polythene, steel/plastic trays, plywood sheeting, etc.) to prevent worsening of contamination.
- Installation of emergency shower and first-aid equipment.
- Access to suitable spill-control materials based on the pesticide inventory data for the store.
- Appropriate fire-fighting equipment.
- Limited points of access and exit from the hot zone, with associated PPE removal and storage station.
- Warning signs in local language and work language, plus work instructions and site/zone-specific SOPs (see tool L).

BOX J2

Construction of the zones – Tunisia, Menzel Bourghiba, 2007

Upon arrival at the store, it is necessary to verify the exact location of the zones and compare them to the provisional zoning plan. Any variations or changes to the plan need to be completed on-site and approval from the supervising agency obtained before work starts. In cases where changes to conditions at the site are significant (increases or decreases in the amount of waste, changes in the condition of the store, etc.) it may be necessary to seek a change to the scope of the work and associated contracts for services and equipment. Once the general layout of the zones has been finalized as part of the site inspection process, it is possible to start the construction of the different zones.

Figures J3
Construction of working area (Zones 1 and 2)

(a) Protective membranes in hot zone

(b) Three-stage decon

(c) Emergency shower unit

The above illustrations show clearly that:

- Protective heavy-duty polythene membranes cover all floor surfaces. The floor area of the hot zone has additional protection with plywood sheeting to prevent tearing of the membrane, whereas the floor of the buffer zone has polythene sheeting only.
- The boundary of the hot zone where repackaging work will be completed is marked on three sides by the walls of the building and on the last side by a steel wire-mesh fence and warning hazard tape.
- Emergency shower and first-aid materials are placed at the interface of the hot and buffer zones.
- A three-stage decon unit has been set up at the interface of the hot and buffer zones. The system comprises three large plastic buckets for washing boots and gloves, plus a steel open-head drum for disposal of discarded coveralls and other wastes.
- After removal of contaminated items, workers exit the buffer zone via a hole in the rear wall of the building.
- Warning signs forbidding casual entry to the hot and buffer zones are clearly visible. To the right of the signs, a gap in the wire fence allows for the removal of filled drums and packages from the main work area across to the interim storage area. No worker access is allowed through this access point and only cleaned newly filled containers are removed through this point.

Zone 2: Buffer zone

- Area marked out using existing building structures and/or warning hazard mesh and tape.
- Reduced use of protective membranes based on actual activities to be completed.
- Access to emergency shower and first-aid equipment.
- Spillage-control equipment.
- Appropriate fire-fighting equipment.
- Three-stage decon unit leading out of the hot zone into the buffer zone.
- Vehicle-movement plan showing points of entry and exit.
- Warning signs and zone-specific SOPs.

Zone 3: Clean zone

- Storage plan and protocols in line with tools D and E.
- Vehicle-movement plan.
- Warning signs and zone-specific SOPs.

Box J2 provides another example of how the zones were constructed.

Movement between zones (use of decon units)

One of the key features of the zoning of work sites is the need to prevent the spread of contamination through *cross-contamination*. Cross-contamination is most likely when personnel working in the hot zone pass directly from the work site to the buffer or clean zones without removing PPE, especially work boots, gloves and coveralls. A serious risk is posed by workers who move directly from hot zones to take meals and drive vehicles, with the associated spread of contaminants.

The zoning strategy therefore employs a process of three-stage decontamination for any workers leaving the hot zone into the buffer zone or the buffer zone into the clean zone. These decon units have been developed based on the needs of a number of industries as detailed below.

- Activities such as the stripping of old asbestos insulation have resulted in the development of trailer-mounted decon units designed to ensure that workers can remove contaminated clothing safely without risk of exposure to harmful dusts, that all harmful asbestos particles are contained within the *dirty* end of the unit placed immediately adjacent to the hot zone and that no accidental release of fibres into the general environment is possible.
- Chemical industries handling highly volatile, malodorous materials with a high risk from inhalation often need to have similarly trailer-based or semi-permanent prefabricated systems for worker decontamination. In such cases, harmful or malodorous materials must be scrubbed from the air extracted from the work area. In some instances the entire hot zone may be contained within a gas-tight bubble kept under negative pressure through constant air extraction, with scrubbing of the exhaust gas by complex, purpose-designed filtration systems. The decon unit is then integrated into the airtight working area and forms the point of entry and exit into the enclosure. A constant flow of air must be continually drawn through the decon unit to ensure all harmful odours are drawn into the hot zone and are not allowed to diffuse into the general environment outside the decon unit.

The decon units can take many forms, including semi-permanent, vehicle-based systems, prefabricated units which are supplied as ready-to-use facilities and locally constructed systems which apply the principles of three-stage decontamination but use locally available materials for construction. In all cases, the units need to provide the following features:

- in-line layout ensures single point of exit from dirty side to clean side;
- clear demarcation of dirty and clean areas within the unit, often with a physical barrier to prompt workers to remove contaminated clothing;
- provision for safe storage of a change of clean clothing for each worker;
- shower/wash facilities for use by workers once clear of the dirty area;
- facilities for the safe disposal of contaminated PPE;
- facilities for the decontamination of PPE and storage, pending reuse of items such as cleaned boots, gloves and masks.

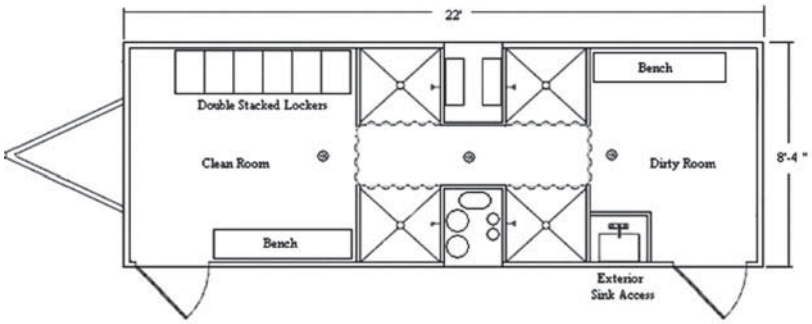
The following three options provide examples of how the decon unit can be achieved, based on the particular needs of the project, the available budget and access to materials/specialist equipment.

Option 1: Trailer-mounted, semi-permanent systems

The trailer mounted, semi-permanent option is commonly available in many developed countries, where it is used widely for asbestos-removal projects or large chemical-plant decommissioning or maintenance projects. A unit is typically designed to be fully mobile so that it can be moved by hitching it to a suitable tow vehicle. Units are usually leased on a weekly or monthly basis and can come with independent water and power supplies to ensure they are self-contained and not reliant on any inputs from the work location.

The plan (Figure J4) shows how the unit can be divided into "clean" and "dirty" rooms that are separated by a screened shower/wash area. The three-stage unit shown here is placed immediately adjacent to the working area and forms the only worker entry and exit point into the hot zone. Upon completion of a shift, heavily contaminated items are removed to outside the entry point and discarded directly into the on-site rubbish containers. Workers enter the unit through the exterior side access door and disrobe from their uncontaminated clothing. Boots and other reusable items are usually washed outside the dirty room and stored in kitbags in the dirty area after cleaning.

Figure J4
Plan of a trailer-mounted, three-stage decon unit



Workers enter the central shower area after removing the contaminated clothing and storing it in the dirty room. In many units the contaminated wash water is collected and treated as low-level waste requiring specialist disposal or on-site treatment through existing waste-water systems. Workers then proceed to the clean room where they dress in ordinary work clothing, which has been stored in lockers during the shift.

Figure J5
Example of trailer-mounted, three-stage decon unit[3]

3 Photograph provided courtesy of SMH Products Ltd. For more examples the reader is advised to conduct a Web site search under "three-stage decontamination units".

Figure J5 shows an example of a three-stage decon unit typically used for asbestos-removal projects and other hazardous-waste-management operations. These types of unit can be used successfully for pesticide safeguarding projects and they are particularly useful in projects where operations will be carried out at a location for an extended time period owing to high costs. This overcomes the potentially high mobilization costs for the units. However, units like these are not commonly available in developing countries, and access to them in the local supply market may be a factor that has severely limited their use to date.

Option 2: Commercially available prefabricated units

An alternative to the units presented in option 1 are the wide range of prefabricated units that can be purchased from various international suppliers. Again, the units can provide a temporary structure in which the necessary facilities such as clean and dirty rooms, shower units and cloth storage can be installed independently or supplied as part of the overall package. The units usually have an integrated sealed floor membrane to prevent contamination spreading from the confines of the module. Units such as those presented in Figure J6 are more commonly used by emergency services when responding to accidents involving hazardous substances. They can be erected at the work location very quickly, and provide an easily recognized entry and exit point into and out of the contaminated area.

Figure J6
Examples of commercially available mobile three-stage decon units

(a) Inflatable emergency shower

(b) Semi-dirigible enclosure

(c) Three-stage emergency responder unit

They can equally well be applied to pesticide safeguarding projects and are commonly supplied as relatively small units which can be inflated or erected at the project location. These types of decon unit are best suited to relatively flat locations with no sharp objects at the base which could tear the floor membrane and they need to be firmly secured to the floor area to prevent disturbance from wind. One further advantage of these units over the trailer-based option is the capacity to add modules and so increase the number of stages of decontamination, based on the particular needs at any specific work location. More information and supplier details can again be found on the Internet with the search term "mobile three-stage decontamination units".

Option 3: Locally constructed units

Local construction is by far the most commonly used option for three-stage decon units for obsolete pesticide safeguarding projects in developing countries. This option must, however, be used only if the principles inherent in the design of the other options (separate clean and dirty areas, integrated floors to prevent contamination, washing facilities, storage for clean clothing, etc.) are factored into the design of the locally constructed alternative.

The consistent challenges posed by obsolete pesticide safeguarding differ from those posed by the asbestos-removal industry or the needs of the emergency services responding to a spillage involving hazardous chemicals (when options 1 and 2 are most commonly used). Obsolete pesticide safeguarding projects are characterized by:

- the need to work in remote locations with limited access to water and electricity;
- poor road and general transport conditions, and limited capacity to tow trailers safely;
- relatively small quantities of waste (at higher-risk locations, typically 1–250 tonnes);
- relatively small quantities of highly hazardous pesticides of WHO Toxicity Class I, which are usually present as liquid formulations;
- relatively large amounts of solid pesticides present as powders of WHO Toxicity Classes II and III;
- varying levels of risk from toxic vapours and liquid splashes because of spillage of liquid pesticides;
- close proximity of work locations to other buildings and population centres with limited access and space to operate.

As a result, the construction of any three-stage decon unit must be based on the specific needs of the site (which is defined by inventory and other site-assessment data) and must be tailored to meet not only the chemical hazards but also limitations in terms of access to materials and size of the work space. The application of the principles outlined above (dirty and clean areas, access to washing facilities, etc.) needs to be employed in a pragmatic manner which meets not only the minimum requirement for worker and environmental safety but also takes adequate account of the realities of working under what are often very cramped and difficult conditions.

Figure J7
Fabrication of a three-stage decon unit based on local conditions and access to materials[4]

(a) Using a footbath

(b) Multistage decon unit

(c) Three-stage decon unit (Mozambique)

Figure J7 shows a number of examples of three-stage decon units used in projects in Africa and South America. The units use a combination of heavy-gauge polythene sheeting, plastic buckets and detergent and other readily available commodities to allow effective decontamination of workers leaving the hot zone at heavily contaminated sites. All photographs provide examples of facilities where workers can be decontaminated prior to the removal of PPE and the passage into a clean area where they can revert to normal wear. The application of a simple multistage

4 Photos provided by FAO and by Professor Ron McDowall of the University of Auckland, New Zealand and Mr Andre Tomlinson (independent waste-management consultant).

decon system, such as those presented above, requires careful supervision and management of the work site and the continued education of workers to appreciate the need for careful and thorough decontamination prior to leaving the hot zone. Worker awareness is a key aspect in the successful implementation of such regimes under local conditions.

Figure J8
US Occupational Safety and Health Administration (OSHA) training of project staff in Ethiopia (2004)

A local construction approach based on a detailed risk assessment was also the principle adopted during the US Occupational Safety and Health Administration (OSHA) training for emergency response under US Code of Federal Regulations (CFR) 29 in Ethiopia in 2004. Figure J8 shows a series of slides made during the training of national project staff. During training, the team was required to fabricate an effective three-stage decon unit using locally available materials that could be purchased from the local market. The results bear a strong resemblance to the slides presented in Figure J7 – underlining that it is possible to maintain standards of operation by applying the principles of health and safety carefully without needing to rely on access to sophisticated pre-engineered solutions.

In terms of what is actually used for control of cross-contamination during the safeguarding of obsolete pesticides, it is important that the options that provide the necessary level of protection from cross-contamination and the feasibility of practical implementation under local conditions are considered.

Box J3 presents some examples of site zoning based on real cases as well as some aspects of the decontamination set-up.

BOX J3

Examples of work sites divided into zones

The following examples demonstrate a series of actual project sites that have adopted the zoning principles presented above. The various examples illustrate various key aspects of how the zones should be constructed and how safe movement between zones can be achieved. The examples provide the necessary level of protection to workers, the general public and the surrounding environment, based on risk assessment of each location. All sites are different and these examples show how the principles of zoning, containment and sound construction can allow for safe project implementation under the most difficult circumstances.

BOX J3 *cont.*

Examples of work sites divided into zones

- Hot zone marked by building boundary; and all repackaging activities are completed within the confines of the building.
- Entrance to hot zone protected by heavy-duty polythene and plywood sheeting to prevent spread of contamination.
- Clean, new drums stored outside the hot zone to prevent cross-contamination of outer surfaces.

- Boundary of hot zone marked by orange polythene reflective mesh.
- Warning signs clearly visible.
- Exit from hot zone includes a red drum for placement of all contaminated clothing at the end of each working period.
- PPE for hot and buffer zones reflects the relative risk of contamination.

- Liquid pesticide pumped directly into new drums housed in the container, which will be used to export the waste for disposal (no additional handling of filled drums).
- Drums contained within a steel spill-control tray.
- Safety equipment immediately adjacent to work area (fire extinguisher, spill-control materials, first-aid kit, brushes).

- Hot zone contained within a secure compound by a purpose-built, chain-link fence.
- Warning signs clearly visible.
- Fence covered with heavy-duty polythene to prevent dust migration during excavation works.
- Single point of entry for staff which includes PPE changing station.
- Separate vehicle access for excavator via double gate (not covered in black polythene).

BOX J4
Removal of surface contamination – the role of the *dresser*

The safe removal of contaminated clothing and equipment is a key aspect of preventing contamination of workers. There is a need to ensure that all workers have adequate training in how to remove PPE. Best practice commonly states that workers should ideally assist each other to disrobe when leaving the work site. An alternative is for the assignment of a "dresser" to assist staff as they leave the working area.

Initial removal of gross contamination

Scrubbing of outer surfaces

Fit test of mask prior to entry to hot zone

When working at high-risk locations which result in the contamination of PPE there is typically a decontamination step that involves the removal of gross contamination at the edge of the hot zone before entering the main decon unit. The slides here show heavy contamination being removed from the external surfaces of a polyethylene coverall by a second person or dresser. The dresser is responsible for inspecting personnel as they exit the hot zone to determine the type and extent of the decontamination procedure that needs to be followed. In this example, the person exiting the hot zone is being scrubbed with a stiff brush using detergent solution. The dresser will require adequate PPE to prevent contamination during the procedure.

The types of preliminary decontamination used may include the washing of outer surfaces, the vacuuming of surfaces using a vacuum cleaner with a high efficiency particulate air (HEPA) filtering system (in cases where there is residual dust on outer surfaces or in cases of gross contamination, deluge in an emergency shower unit (all wash water being captured for treatment). The dresser can also assist in the general supervision of decon activities (e.g. washing of boots and gloves, safe removal of coveralls and cleaning of any respiratory protection that may be contaminated on the outer surfaces). The safe and clean storage of all reusable items is also an important aspect of protecting worker health. While all staff are responsible for the management of their assigned equipment, the additional supervision of equipment storage via the dresser may strengthen a management system.

The dresser can also assist workers before they enter the hot zone. The last slide shows a dresser helping test the fit of a full-face vapour mask, before finalizing all PPE and entry to the work site. In hot and humid conditions this simple assistance can be a great help to project workers and prevent unnecessary overheating and associated stress on the body before work starts.

Emergency planning

During safeguarding operations, it is likely that work at higher-risk locations will involve significant time being spent at any given work location. The law of averages dictates that the longer work is taking place at a hazardous location, the more potential there is for an accident. Workforce complacency and the relaxing of work rules over time can all contribute to accidents in the workplace. It is therefore recommended that the user should follow the guidance in tool E (Box E7) to develop an *internal emergency plan*, and an *external emergency plan* if the magnitude of the accident is such that it cannot be controlled within the site. These plans should be specific to the sites and the activities. The specialist hazardous-waste contractor should prepare these documents for review by the PMU. Formats for the emergency plans are provided in tool E and should feature as an integral component of the site-specific HSE plan presented in tool N of this volume.

The repackaging of a large quantity of pesticides involves significant risks of accident that can have severe impacts to both people's health and the environment. These risks are best minimized through the good preparation of staff and of the safeguarding activities by applying the guidance provided in this volume. However, accidents can still occur. An "accident" can be classified as being the result of either an on-site initiator or an off-site event. Both concepts have been presented in tool E. Refer to this tool for reference: it looks at the establishment of emergency plans related to the prolonged storage of hazardous materials.

Tool K

Risk assessment in workplaces

Zoning of the workplace presented in tool J is one example of an effective procedure that can be used to prevent the contamination of workers, the community and the environment during safeguarding. A second, very powerful tool is task based risk assessment (TBRA). Whereas the risk analysis of tool G provided guidance on how to assess the risks associated with preferred safeguarding options with potential impacts at project level, this section assists the PMU in assessing and mitigating risks at the site-specific level.

Objectives of the tool

The completion of tool K will allow the PMU to:

- gain experience in the use of the TBRA format;
- make a site-specific TBRA for each higher- and moderate-risk site;
- assess TBRAs prepared by contractors and determine if they are adequate;
- use the TBRA to take risk-based decisions and to insure safe working conditions during safeguarding implementation;
- establish a process of constant reappraisal of risks and mitigation measures to adapt and improve the risk management of the safeguarding implementation.

Description of the tool (use also Annex 1)

Tool K provides a general introduction to risk assessment and management and outlines key risk-reduction strategies that can be used to safeguard implementation. It then describes the TBRA method. This method, which has been developed over a number of years and is based on projects in many countries, uses the practical risk assessment during the implementation of obsolete pesticide and other hazardous chemical safeguarding projects. This is a crucial step, which should be completed by the implementing partner (national team or contractor) and approved for each site by the PMU or consultant before any safeguarding implementation activities begin.

A useful summary of the steps of risk assessment and the definition of key principles such as hazard and risk can be found at the Health and Safety Executive of the United Kingdom government's Web site (http://www.hse.gov.uk/pubns/indg163.pdf), where the document *Five Steps to Risk Assessment*[5] can be downloaded. Other useful information can be found at the European Agency for Health and Safety at Work Web site (http://osha.europa.eu/en/topics/riskassessment) based on the EC Framework Directive 89/391. Consider this document as essential reading: it sets out the requirements of all parties (employer, employees and national authorities) related to completing an adequate risk assessment. The FAO can also provide training on the development and use of TBRAs as part of a project-support strategy.

Note that any risk assessment – irrespective of project or format for assessment – should be completed by competent staff. A lack of relevant experience or adequate training will flaw any assessment and increase the risk of accidents. Preparing the TBRA in accordance with the guidance outlined in these guidelines is crucial in order to gain an adequate level of experience in risk assessment and in deciding appropriate mitigation measures. Annex 1 contains a number

[5] Health and Safety Executive, Government of the United Kingdom. 2006. ***Five Steps to Risk Assessment.***

of exercises based on real case histories. Users can complete the TBRA for each of the sites presented in the annex to assess their own understanding of the principles and application of this important tool. The examples can then be reviewed as part of a training programme with the FAO on the supervision of safeguarding projects or through independent assessment by competent agencies.

Introduction to risk assessment and risk management

Many forms of *risk assessment* can be used to assist the PMU in the safe implementation of obsolete pesticide projects. Five commonly accepted main steps to risk assessment are:

Step 1: Identify and where possible quantify all hazards associated with an activity or process.
Step 2: Identify who or what may be affected by the hazard and how that could happen.
Step 3: Evaluate the risk (likelihood and intensity of exposure) and assess if current precautions are adequate.
Step 4: Record all findings and brief staff accordingly.
Step 5: Constantly review the assessment during project implementation to ensure assessments and assumptions are still valid (supervision).

A preliminary step in *risk management* is to identify the main risk categories. A review of past projects shows that the following risk classes are common to the implementation of obsolete pesticide projects.

I. Poor planning.
II. Financial problems (failure to pay staff and procure materials).
III. Personnel issues (illness, family commitments, etc.).
IV. Lack of political will (high level of government support needed).
V. Social difficulties (lack of communication).
VI. Environmental challenges (seasonal weather patterns).
VII. Reputational issues (to individuals and organizations);
VIII. Poor operating systems.
IX. Technical (failure of equipment, disposal).
X. Human factor (not following the rules).

Risks I–VII are outside the scope of these guidelines. Mitigation measures for these classes of risk are dealt with in EMTK Volume 3. Tool K provides further instruments that can assist in addressing the risks related to Classes VIII–X above.

For project implementation, the typical *risk-management responses* when confronted with a problem include:

- **Avoidance:** the risks posed may be considered too high and the decision made that under current conditions the best policy would be to isolate the location and try to limit the impact on all affected parties. Issues such as financial and reputational risk associated with getting involved in such high-risk projects are often the key determining factors.
- **Change the scope of work to be completed:** sometimes a project may become lower risk if the original scope of work is changed.
- **Increase the resource allocation:** additional resources can reduce risk through the development or use of new specialist equipment which reduces the potential impact on people and the environment. Tailored engineering solutions to a problem are often beyond the scope of a typical pesticide-management project.
- **Increase the flexibility of the plan:** the time frame for project implementation can be extended and the advantage of shift working or the training of new resources sought.

Such responses to risk can lead to the adoption of the following *risk-reduction strategies*.

- **Transference:** most typically done by using commercial insurance to cover events such as

accidents. Insurance categories include:

– *Worker insurance:* to cover both the risk to workers and the risk of claims by workers to the project implementation team. The risk of future claims related to health impacts from workers involved in project implementation is a recurrent issue with the implementation of projects involving the potential exposure to hazardous materials. Experience has resulted in the development of a strategy based on strict health surveillance, training and supervision of workers by competent staff, with a clear hierarchy and staff command structure linked to competence of personnel and the employment of all project workers through government structures, thus limiting liability arising from local laws and regulations.

Specialist contractors will have insurance cover for their employees; it is unlikely that they will agree to cover the insurance costs of locally engaged labour. In many cases, a system of local insurance through some form of worker fund is used to provide the necessary cover. *If worker training, management and supervision systems are used correctly, the potential for worker injury will be minimized or eliminated.*

– *Environmental liability/pollution insurance:* despite the best efforts to identify and reduce risks during the implementation of activities, the potential for accidents at any stage of the process (repackaging, transport and storage) remains. It is therefore vital that adequate insurance is in place to cover the cost of any claims arising from accidental contamination of the environment. This may be included as a condition in the contract agreement with any specialist disposal company, but in cases where governments are responsible for any part of the safeguarding activity, the liability issues in the case of an accident must be defined clearly. The simple question of "who pays for the environmental clean-up if there is an accident?" needs to be answered in advance.

– *Public liability:* any process or activity with the potential to affect third parties (members of the public, visitors, trespassers, subcontractors, etc.) should be covered by adequate public liability insurance. (In many countries this is compulsory.) This is often covered under a general insurance portfolio for a company, but some declaration of coverage should be made by the implementing body before work begins to ensure the situation is clear. If a third party is adversely affected and makes a claim, it must be very clear who is responsible for paying any damages.

- **Reduction**: improved planning and focus on supervision of implementation. This may include outsourcing of activities to specialist suppliers or contractors/consultants.
- **Acceptance**: based on the likelihood of an accident, the competence of staff and the ability to respond in the case of an accident, it may be decided to proceed with the project, provided there is close supervision and effective continuous monitoring and evaluation (M&E).
- **Policies and procedures**: the use of proven best practice, training of staff and the development of workable management systems can together result in successful risk management.

For obsolete pesticide safeguarding projects, the range of responses to risk is limited. It is not possible to ignore or avoid the risk as it is necessary to come into contact with materials to complete the task. Similarly, opportunities to change the scope and increase resource allocation may be limited. As a result, the PMU should try to make as flexible a plan as feasible to allow for changes in conditions as implementation proceeds. This will need to be reflected in any contract with specialist suppliers and contractors.

In terms of risk-reduction strategies it may be possible to combine all the options outlined above as part of an overall project-implementation plan during obsolete pesticide project implementation. As indicated in tool G, the use of external contractors with international insurance cover can mitigate some risks. In addition, careful planning and scheduling of work to account

for seasonal climate variation are important. In some cases, risks may be accepted because of a high level of competence in the staff completing the work. Finally, the use of clear policies and procedures and good on-site supervision and management will be crucial to mitigate risks. All these approaches should be considered when completing the safeguarding strategy as set out in tool G.

Guidelines for task based risk assessment (see Table 1 and Box K1)

The TBRA generic format presented in Table K1 makes a systematic record of all the above and is designed to assist the operator in making objective decisions on project implementation with an emphasis on worker and environmental protection at all times. It is important that the TBRA is completed and subsequently reviewed and approved by staff with the required level of competence. Indeed, a common mistake is that inexperienced risk assessors can make an immediate decision relating to PPE for a task without first completing a site-specific assessment of conditions. Or the highest level of personal protection for all activities – irrespective of the actual scale of the hazard present – may be used. Both issues can cause problems and actually increase the risk to workers through the introduction of new risks such as heat stress or stroke. The aims of a TBRA are straightforward:

- Break down all main activities (such as repackaging of pesticides) into their component tasks.
- Identify all risks associated with a substance and/or activity and task.
- Investigate methods and/or strategies to reduce or eliminate the risk.
- Determine the appropriate level of protection (for workers, general population and the environment) required for each individual task to be completed.
- Tailor the protection to reflect the hazard/risk for each task.
- Allow for the constant reappraisal of protection, based on feedback during implementation.
- Provide a mechanism for supervising the use of protection during implementation.

The format in Table K1 is simple to use and should be completed prior to work starting as part of the initial planning process for *higher-* and *moderate-risk* sites. It is not the only format available and the user is free to use other alternatives so long as their relative strengths and weaknesses are assessed carefully to ensure an adequate level of risk assessment.

The format also provides a methodology for prioritization of safeguarding activities to reduce risk in a progressive, step-by-step method.

Refer to Boxes K1–K3 for guidance on how to complete the form and what additional information is needed in order to use the form correctly to obtain the maximum benefit.

For *lower-risk* sites, a case-by-case analysis of the risks needs to be conducted. Ideally, a site-specific TBRA and zoning of the site (as presented in tool I) should be completed for all sites. This will be supported by SOPs for the site and the activity as presented in tools L and M. This is especially important in stores categorized as lower risk, but which contain pesticides that have a specific hazard requiring specialist handling and protective equipment.

Table K1
Task based risk assessment (TBRA) format (provided with an example)

TBRA for site safeguarding									
Location: **Site number:** **Site name:** **F_E: (see tool A, EMTK Volume 1)** **F_P: (see tool A, EMTK Volume 1)**	**Pesticides present:** [Give S_P, the quantity in kilograms or litres and indicate if material is leaking for each item] • Ultracide (2000 kg)[6] in 200 litre containers (damaged and leaking) **Other chemicals and contaminated materials present: [list solvents, fertilizers, seeds, etc.]** • Seeds contaminated by Ultracide (300 kg)								
Personnel: Contractor team leader, PMU focal point, contractor personnel, national government staff/technicians									
Zone	**Task**	**Risks evaluation**						**Risk mitigation**	
		Frequency	**Duration**	**Exposure route**	**WHO class**	**S_P**	**Likelihood of contact**	**Other risks**	**Exposure risk reduction**	**PPE**
1	Repackaging of Ultracide	10	Approx. 2 hrs (10 mins per container)	• Inhalation • Ingestion • Dermal contact • Dermal absorption	Ib/2	From PSMS or EMTK Volume 1	High	• Leakage • Combustible	• Stabilize leaking containers to prevent worsening of leakage and contamination. • Ventilate building prior to entry. • Use of closed system pumps to prevent spread of vapour. • Reduce contamination of new containers and pumping of liquid directly into new containers in Zone 2 so no cross-contamination.	• Air supply breathing apparatus • Type 3 coveralls • Nitrile gloves • Safety wellingtons
1	Repackaging of contaminated seeds	5	30 mins	• Inhalation • Ingestion • Dermal contact • Dermal absorption	Ib/2	From PSMS or EMTK Volume 1	High	• Cross-contamination of other items and new containers	• Following stabilization of leakage, remove contaminated seeds to prevent casual spread of contamination during pumping activities. • Removal of contaminated materials will also lower vapour concentration.	• Air supply breathing apparatus • Type 3 coveralls • Nitrile gloves • Safety wellingtons
Comments: Highly hazardous nature of the product and leakage makes the site high risk and so all activities should be completed by contractor personnel under supervision of PMU.										
Completed by: **Date:**										
Approved by: **Date:**										

[6] Example taken from the PSMS: "Ultracide" pesticide (active ingredient: methidathion; formulation: emulsifiable concentrate [40%]; organophosphorus pesticides family), liquid state, 10 full 200 litre closed-head steel drums, surface damage with leakage, WHO Class 1 (GHS category 1). Hypothesis: 300 kg (about 1 m3) of seeds were found next to the leaking Ultracide drums.

BOX K1
Completing the TBRA format

Some general guidance

- All boxes should be completed (see terms below in italics) and the form signed.
- Identify the store by its *unique number* assigned during inventory.
- *Personnel* include all entering the work area (indicate the zone they will be working in).
- List *pesticides* from inventory data (advice: enter the chemicals in alphabetical order, each one on a new row, and if there are two or more formulation/package types of a chemical give them a separate row in the table).
- List any other *chemicals/items* identified (solvents, fertilizers, seeds, etc.).
- Enter *activities* by *work zone* as defined in the zoning plan (see tool J). List all Zone 1 first, then Zone 2 and finally Zone 3.
- Use additional forms as needed but ensure the ordering of multiple forms is clear (e.g. *1/3, 2/3, 3/3*).
- The WHO *Recommended Classification of Pesticides by Hazard* (2009), available at http://www.who.int/ipcs/publications/pesticides_hazard/en/index.html, the *Pesticide Manual* of the British Crop Protection Council (see Annex 3, EMTK Volume 3) and the Web site *Chemical Safety Information from Intergovernmental Organizations* (www.inchem.org) of the International Programme on Chemical Safety (IPCS) are good sources of information for pesticides data (exposure route, lethal dose 50% (LD_{50}), chemical risks, etc.).

Definitions of table headings

- **Task/activity:** can vary from *repackaging* of *(chemical name)* to *loading* of drums for transport. It is important to record which zone the activity will be completed in. It may be simpler to complete a TBRA for each zone at larger sites.
- **Frequency of exposure:** relates to the quantity of materials to be repackaged [total amount divided by the package size = *number of packages/handling]*.
- **Duration of exposure:** relates to the time it will take to repack based on frequency, the number of workers assigned to repack that item and the estimated time necessary for each handling (the actual package size will affect this – e.g. 200 kg vs 5 kg, as will the method for repackaging, such as pumping, decanting, emptying of bags, etc.).
- **Exposure route:** relates to the physical form of the pesticide and the way – based on actual local conditions – they could enter the body. One or more of the following may be inserted: inhalation, ingestion, dermal contact, dermal absorption.
- **WHO class:** relates to the WHO toxicity class (Ia, Ib, II, III, U) or the Globally Harmonized System (GHS) acute toxicity categories (1, 2, 3, 4, 5) of active ingredient (AI) and formulation (form.). The toxicity class for the formulation is calculated using LD_{50} data as explained in EMTK Volume 1 (40% of methidathion for the example of Ultracide in Table K1). LD_{50} data is then converted to WHO toxicity class or GHS category using the following conversion tables.

WHO class[7]		LD_{50} for the rat (mg/kg body weight)	
		Oral	Dermal
Ia	Extremely hazardous	<5	<50
Ib	Highly hazardous	5–50	50–200
II	Moderately hazardous	50–2000	200–2000
III	Slightly hazardous	Over 2000	Over 2000
U	Unlikely to present acute hazard	5000 or higher	

[7] World Health Organization. 2009. *The WHO recommended classification of pesticides by hazard and guidelines to classification: 2009.*

BOX K1 *cont.*

Completing the TBRA format

Globally Harmonized System category	Classification criteria			
	Oral		Dermal	
	LD_{50}[8] (mg/kg body weight)	Hazard statement	LD_{50}[9] (mg/kg body weight)	Hazard statement
1	<5	**Fatal if swallowed**	<50	**Fatal in contact**
2	5–50	**Fatal if swallowed**	50–200	**Fatal in contact with skin**
3	50–300	**Toxic if swallowed**	200–1000	**Toxic in contact with skin**
4	300–2000	**Harmful if swallowed**	1000–2000	**Harmful in contact with skin**
5	2000–5000	**May be harmful if swallowed**	2000–5000	**May be harmful in contact with skin**

- S_P**:** is the pesticide-specific risk factor calculated for each line item in an inventory using Tool A in EMTK Volume 1. S_P relates the amount of the material (Q) to the WHO toxicity class (S_T) and the condition of the pesticide container (S_C) and is calculated using the equation $S_P = (3S_T + S_C) \times Q$.
- Likelihood of contact: can be described as ***high***/***medium***/***low*** depending on the amount of leakage (same criteria as for the environmental risk assessment (ERA) in tool A) and the activity to be completed.
- Other risks: relates to factors such as ***temperature***/***humidity***/***strong winds***/***poor road access***/any special features which may affect implementation.
- Exposure reduction risk: consider how to reduce the risk before work starts. Simple actions can assist implementation:
  - clean up leaking chemicals first (priority based on WHO data);
  - vacuum dusts/collect materials;
  - use absorbents for liquids;
  - ventilate store to reduce vapour build-up.[10]

Comments: insert any other relevant information:
- leakage seen in store but uncertain which chemical;
- prioritization of repackaging based on WHO for formulation and potential for exposure/contact;
- any security restrictions, etc.

PPE: relates to:
- coveralls (Type 1/2/3/4/5/6/cotton);
- task (dust/half mask/full-face vapour mask/air hood/breathing apparatus (BA), airline BA, etc. – specify the assigned protection factor for particulates and vapour as appropriate – Annex 4);
- footwear (safety boots/overshoes);
- eye protection (glasses/goggles/face shield/air hood);
- gloves (nitrile/PVC/cut resistant/leather/combined/other with details);
- list any other optional or specialist equipment *(PVC aprons*, etc.).

[8] For oral data, the rat is usually the preferred species.
[9] For demal data, the rat or rabbit is usually the preferred species.
[10] There are occasions when ventilation of a store prior to work commencing should be avoided. In cases where the store is immediately adjacent to human habitation or the prevailing wind direction will result in strong and/or harmful odours affecting other people, then ventilation should only be considered once potentially affected parties have been moved. In addition, in cases where there is significant dust contamination in a store, ventilation should not be considered.

BOX K2
Preparing, authorizing and updating the TBRA format

All documents such as the TBRA should be completed, authorized and updated according to the personnel command structure and definition of roles and responsibilities set out in the overall project administration and management structure. Box K2 covers how this can be done.

Preparation

The TBRA is completed by technically competent persons aware of issues related to pesticide chemistry, WHO toxicity classification and the use of PPE (see EMTK Volume 3 for definitions of competence). Personnel should ideally have been on the FAO training module associated with this activity. As a general rule, an initial TBRA is prepared by the implementer as an office exercise based on either a site inspection or a review of the existing data from inventory and EA processes. The TBRA advises the implementation team on the equipment needed to complete the operation based on local conditions. Upon arrival at the site, the project manager/supervisor verifies that the TBRA is still relevant/adequate and makes adjustments as necessary. The M&E of the implementation of the TBRA should be completed by the PMU or by an independent monitor.

Authorization

To check the original drafting of the TBRA, an authorization is required prior to the assessment being used as the basis for implementation. This is completed by a national project manager or project technical adviser with a comprehensive understanding of risk assessment and the TBRA process. Any amendments to the TBRA made in the field should also be authorized to ensure compliance with best practice.

Updating

Implementation of the TBRA at the workplace may result in feedback on areas such as the selection of PPE. For example, during implementation of safeguarding work in Ethiopia, a specific grade of coverall was selected for handling powder pesticides. The selection followed all accepted risk and hazard assessments. During implementation, it was found that the PPE was allowing penetration of dust, resulting in worker exposure. This was investigated by the local team and taken up with the manufacturer. It was later confirmed that the specifics of the hot working conditions coupled with the ultra-fine particle size of the pesticide combined to create an exceptional set of circumstances that rendered the PPE unsuitable. The manufacturer advised the use of an updated model of the same garment, which was designed to meet these unusual conditions. This improvement in the standard of PPE was only possible because of the process of continual review of equipment completed as part of the ongoing TBRA process.

Supervising implementation of the TBRA

If preparation and implementation of the TRBA is completed by a contractor, the PMU should be able to monitor its application in the field. Adherence with the guidance in the final TBRA and application of working procedures is a key tool in ensuring safe project implementation. In cases where government personnel are implementing the project, an independent monitor should be assigned to fill this role.

BOX K3

Use of TBRA for planning and prioritization

The prioritization process follows the same risk profile used to generate the pesticide risk factor (F_p) presented in tool A. These are the amount of leakage (and hence risk of exposure), the toxicity class (the intrinsic hazard from the material) and the quantity. Common sense is also an important factor and issues such as access to packages and general layout of items within the store should also be included in the planning process as secondary considerations.

General rules

- Leaking materials should generally be dealt with first to minimize exposure to workers and to eliminate the risk of cross-contamination of the workplace during safeguarding. Poor access to leaking containers may limit the ability to follow this general rule but any leaking containers and spillages should be addressed as a top priority as they become accessible during project implementation.
- Deal with pesticides based on the S_p value (highest first) unless there is a need to deal with leaked materials to prevent a worsening of the situation and to prevent cross-contamination during operations.
- Treat all unknown materials as WHO Class I and adopt a worse-case scenario when selecting PPE and handling procedures.
- The remaining materials will then be addressed based on toxicity of the formulation (if known) or active ingredient if no formulation data is available. Repackaging will start with the most toxic, ending with the least toxic.
- If toxicity classes are the same, then quantity and access to packages may be used to determine the order of repackaging, with the largest quantity (the greatest risk according to the risk factors used in tool A) being addressed first.

The correct use of the TBRA can thus be seen as a powerful tool to assist the PMU during both the planning and the implementation phase of a safeguarding project, especially at higher-risk locations where site-specific TBRAs are essential.

Tool L

Standard operating procedures

Both zoning and TBRAs are tools that can help manage risks from obsolete pesticides via containment and by using a step-by-step approach to the repackaging exercise – including the selection of appropriate PPE to ensure no impact on worker health. Neither tool, however, provides detailed and clear instructions on the actual physical activities needed for the safe repackaging of hazardous chemicals. Tool L, which outlines how to prepare and use a series of s*tandard operating procedures* (SOPs) based on the specific conditions and hazards present at each site, provides this essential guidance.

Objectives of the tool

Tool L assists the PMU and other project implementers in developing two sets of instructions to ensure safe working conditions and a standardized, rigorous completion of all activities at all sites:

- *activity-specific* SOPs prepared as written instructions to supervisory staff and covering all foreseen activities;
- *site/zone-specific* SOPs to instruct work staff on simple measures to follow during the safeguarding activities at each site or zone.

Standard operating procedures can be seen as another important tool for developing capacity amongst field management personnel, site supervisors and work staff. They also provide a clear set of operating standards that can be monitored by PMU staff during the implementation of project activities by contractors. It is important that the zoning, TBRA and SOPs are prepared by the partner completing the safeguarding operations so that there is a clear chain of responsibility in the case of an accident.

Description of the tool

As noted above, this tool provides outlines for the preparation of the two levels of instructions– activity-specific SOPS and site-specific SOPs. The *activity-specific* SOP looks at the details of repackaging the different types of waste encountered at a site. Table L1 provides a generic format for activity-specific SOPs for field operations common to most, if not all, obsolete pesticide safeguarding projects. Its development is based on over 15 years of field-implementation experience. It is organized so that it provides specific written information on hazards, instructions on worker protection (including the selection and use of PPE), environmental protection (zoning, etc.) and equipment needs and maintenance.

Note that the format provided below is an example: actual formats will vary according to who is preparing the SOP. Waste-management contractors may have alternative formats based on their own ISO standard systems of working or requirements for activity-specific work instructions.

The second format, the *site/zone-specific* SOP, provides simple instructions for workers to follow during implementation – such as where they should be working, what activity they should be completing, what PPE they should be using and what they should do in the case of an emergency. Based on a poster design with illustrations and aims, the document can be used as an on-site visual aid to the general daily briefings and reviews completed as part of the daily management

of project implementation (see tool N). The generic format presented below is based on feedback from the FAO training of trainers for management of obsolete pesticides completed in Tunisia in February 2007.

It is anticipated that both generic formats presented in Tables L1 and L2 will be adapted to field conditions. The FAO can provide further assistance through the training of project teams in the preparation of SOPs specific to the needs of their country's project. As both SOPs provide vital information to safe project implementation, it is important that documents are prepared by competent and experienced personnel.

Some examples of activity-specific SOPs for hypothetical situations are provided in Annex 2. They should be used as *examples* only and should not replace SOPs prepared by the PMU for specific equipment; neither should they replace the use of competent staff to implement the project.

Likewise, an example of a completed site- and zone-specific SOP is presented in Annex 3 for reference and further guidance, along with a series of case-study exercises that may be completed by the users to confirm that they have understood the principles of SOP preparation.

Preparation of activity-specific standard operating procedures (see Table L1 and Boxes L1 and L2)

The activity-specific SOPs (sometimes referred to as *work instructions*/WIs) are generally prepared as written instructions to supervisory staff on how to complete safely an activity or task at a specific site, based on local conditions. They include guidance on activities such as the setting-up of the zoning and the installation of the three-stage decon unit, the repackaging of solid, liquid and mixed wastes, and the excavation of buried stocks or contaminated soils. During implementation of safeguarding at higher- and moderate-risk locations, it should be possible to amass a dossier of activity-specific SOPs covering most activities belonging to a safeguarding exercise. These SOPs can be used to formulate a set of generic SOPs for field operations at lower-risk locations.

Formats can vary, so revised SOPs will need to be prepared as the project encounters new activities to be completed. The aim is therefore to strengthen the capacity of field management personnel and site supervisors to develop SOPs based on generic templates, and enabling skills transfer from specialist trainers and consultants/contractors, allowing them to respond safely to actual field conditions.

Table L1

Format for activity-specific standard operating procedures (SOPs)

Activity-specific SOP # X at store [insert store number, location, etc.]	**[insert title of main activity]** **[insert site-specific data related to S_P for the product, F_E data, etc.]**
Prepared by: [insert name, date and signature]	Approved by: [insert name, date and signature]
Section 1: Background	[To include: • list of pesticides to be processed using the SOP; • potential for exposure to chemicals or other materials in the store; • WHO classification and the quantity of material to be handled; • TBRA data on the estimated frequency and duration of the activity.].

Section 2: **Aims**	[A simple statement along the lines of "the safe transference of materials X into new UN-approved package (type Y) by means of pumping/vacuuming/manual handling".]
Section 3: **Equipment**	[A list of equipment needed at the site, broken down into the following categories: • packaging (drum or bag type/specification); • materials handling (pumps/vacuums, etc.); • site equipment (zoning, emergency); • PPE. A separate detailed table of equipment may be developed and attached to the SOP if required.]
Section 4: **Environmental protection**	[A description of the construction of the zoning, decon procedures and any special steps such as installation of spill trays. Sealing of buildings when handling dust formulations should also be detailed.]
Section 5: **Worker protection**	[The list of PPE from the TBRA should be inserted along with any workplace monitoring procedures (dust and vapour) and medical surveillance procedures.]
Section 6: **Detailed activities**	[A detailed step-by-step description of the activity should be presented which guides the reader through the actual procedure to be completed: • Step 1: put on PPE and entry into hot zone. • Step 2: inspection of materials. • Step 3: filling of new containers and decon of outer surfaces. • Step 4: removal of filled new containers from hot zone and labelling for transport/storage. • Step 5: exiting from the hot zone and removal of PPE. This five-step approach can be adapted to all SOPs and provides an easy-to-use format when preparing SOPs for new activities.]
Section 7: **Special instructions**	[Some activities may benefit from the experience of past projects. Issues such as the need for electrical earthing of drums to prevent static electricity sparks, the filling of new containers on the back of the vehicle used to move them to interim storage, protocols for opening and closing valves when pumping liquids, use of weighing scales to estimate when a new container is full, ventilation of the store prior to work commencing (vapour) and use of vacuums to remove dust from outer surfaces of containers and workers as they leave the hot zone, are all examples of special instructions which may need to be followed when completing a specific activity at a location.]
Section 8: **Reference data**	[Any associated SOPs, technical guidelines, training modules, handbooks, user manuals for equipment, etc. should be listed to ensure the supervising staff member is fully aware of the project needs.]

BOX L1

Using the format for activity-specific SOPs

The format presented in Table L1 has been developed over a number of years of project implementation in a variety of countries. The SOP should be prepared by an experienced waste-management specialist and is typically completed either by an international consultant as part of a preliminary planning and training exercise at the start of a nationally implemented safeguarding project or by a specialist waste-management company contracted to complete the safeguarding at a higher-risk location. In both cases, it is important that a set of clear activity-specific SOPs are produced that can be used at a number of locations with only minor variations to the equipment, worker protection and special instructions based on site-specific conditions. SOPs common to most projects include:

- preparation of the safe working area (***zoning*** the site);
- repackaging of solid pesticides into open-head drums;
- repackaging of solid pesticides into flexible intermediate bulk containers (FIBCs or "Big Bags");
- repackaging of pumpable bulk liquids into closed-head drums;
- repackaging of non-pumpable bulk liquids into salvage drums;
- repackaging of small containers (less than 5 litres) into open-head drums;
- excavation of buried pesticides and contaminated land;
- emergency response in case of spillage and/or accident.

Generally, more than one activity-specific SOP will be needed at a specific location. In such cases, the technical adviser/contractor/consultant/project manager/site supervisor will need to have prepared a set of SOPs before arriving at the site, based on the inventory data and EMTK recommendation. Again, these should be approved by a competent manager. The supervisor on-site will then need to supervise the application of the SOP by project staff. The activity-specific SOP will then be referenced on the site-specific SOP (see below). As such, the two documents form part of a set of complementary management tools along with the TBRA and site zoning exercise

BOX L2

Medical surveillance for project staff

Extract from European Council Directive 89/391/EEC of 12 June 1989 on the introduction of measures to encourage improvements in the safety and health of workers at work:

Article 14 health surveillance

1. To ensure that workers receive health surveillance appropriate to the health and safety risks they incur at work, measures shall be introduced in accordance with national law and/or practices.

2. The measures referred to in paragraph 1 shall be such that each worker, if he [or she] so wishes, may receive health surveillance at regular intervals.

3. Health surveillance may be provided as part of a national health system.



An issue sometimes overlooked during the implementation of safeguarding projects is that of medical surveillance of project staff. As employers, there is a moral and legal responsibility to ensure that all personnel active in a project are not adversely affected through casual/accidental or intentional exposure to harmful materials. This duty of care is an important principle which is often emphasized in national labour regulations.

For the purposes of safeguarding of obsolete pesticides it is recommended that, as a minimum, all project staff complete a full medical visit (including blood enzyme tests) before, during (every three to six months) and after the project is completed. The aims of the tests are to:

- establish an initial minimum level of health for all workers (safeguarding is often physically demanding and, to be effective, workers should be fit);
- set a physiological baseline to allow for the monitoring of any changes during project implementation (changes in cholinesterase levels in the blood can indicate exposure to organophosphate pesticides and may result in workers being given other duties; similarly, changes in organochlorine pesticide levels in fat tissue can indicate uncontrolled exposure);
- give a final health check once all operations are over to ensure that there has been no adverse impact on worker health during the implementation of the project.

In addition to the *duty of care* aspects above, the completion of comprehensive health monitoring also contributes to the overall risk-management strategy. The risk from workers of claims of impaired health as a result of their activities requires that the project-management team must be able to prove – using medical evidence – that no such impact has occurred. The lack of clear medical evidence leaves the project open to claims and associated costs for compensation.

Linked to health surveillance is the recording and reporting of *lost-time injuries and work-related illnesses*. This data can be used as a good indicator of safe project implementation. It is widely used in the chemical and construction industries to demonstrate that operations have been completed safely with no impact on workers. This indicator, linked with the results of medical surveillance as outlined above, provides strong evidence that projects are being managed, supervised and implemented to the required standard of HSE compliance. The system can be further expanded

BOX L2 *cont.*

Medical surveillance for project staff

to include the reporting of so-called *near-miss* incidents where accidents did not occur but very nearly did. The reporting of non-lost-time injuries (such as cuts, crush injuries or car accidents) can also be incorporated into the project-accident reporting systems and provide additional information for the project M&E system. Such data can result in the identification of activities that need to be changed because of repeated worker injury or a change in the regime for protective clothing because of continued accidents (the use of cut-proof gloves when opening old rusted drums may be one example). This M&E role may be completed by an independent observer to the project, such as a national non-governmental organization (NGO) or by the appointment of a specialist consultant working in cooperation with the Ministry of Labour and/or Environment.
To date, in over ten years of application of the principles presented in this volume, there has been no lost-time injury due to contamination from pesticides in any safeguarding project conducted or supervised by the FAO.

Preparation of site-specific standard operating procedures (see Table L2 and Box L3)

The *site-* or *zone-specific SOP* format is aimed at project implementation staff and is based on posters and illustrations of risks to workers. The formats include simple instructions in local/workers' language for project staff (including any locally hired labour) that staff should follow during the implementation of safeguarding activities. It informs the workers on where they should be working, what activity they should be completing, what PPE they should be using and what they should do in the case of an emergency.

A generic format for the SOP poster is provided below as Table L2. The printed format for the poster can be expanded to A1 or A0 size to provide clear instructions that can be posted at the entry to the work site, the entrance to each of the main work zones and at other locations, such as the canteen/drinks venue and washrooms. This will help reinforce the SOP's message. While the format presented in Table L2 is a printed document that uses photographs or other graphical means to illustrate the main points of interest (e.g. zoning diagram, warning signs), it is equally possible to produce a similar document using an ordinary piece of flip chart paper as the base. The instructions can be handwritten in marker pen and photographs can be attached using tape. The end result will be the same: an effective tool for communicating the risks and activities associated with safeguarding activities at a site.

The site-specific SOPs form the focus of any daily briefings of the workforce or at the start of each work period. This allows the project manager to assign personnel to specific zones and activities whilst using the SOP poster as a tool to illustrate what needs to be done, what PPE is needed, what equipment will be used (and how it must be used), what packaging materials are needed and what must be done in the case of an emergency. The process of daily briefings forms a component of tool K in these guidelines.

It is anticipated that the *generic* format presented above will be adapted by competent and experienced personnel, based on field conditions to allow site-specific SOPs to be prepared by field managers and supervisors.

Table L2 has been annotated to explain to the person drafting the document what should be included under each section. As with the TBRA, it is important that all boxes are completed (left- and right-hand sides of the table), while the following section on selecting and using equipment will provide useful guidance on how to complete those sections of the SOP (see also Annex 3).

Table L2
Site-specific standard operating procedure (SOP) format

<table>
<tr><td colspan="2">Site-specific SOP
[List of pesticides (from inventory):]
[Amount of each pesticides (estimated):]
[Main hazards/exposure route (from TBRA):]</td></tr>
<tr><td rowspan="2">[Insert the site zoning diagram (see Figure J2 in Box J1, Tool J) scale of drawing needed].</td><td>Site description and zones
• Zone 1:
• Zone 2:
• Zone 3:</td></tr>
<tr><td>Personnel:</td></tr>
<tr><td>[Insert photographs of actual activities to be completed in each zone plus cross-reference the relevant activity-specific SOP.]</td><td>Main activities
• Zone 1:
• Zone 2:
• Zone 3:</td></tr>
<tr><td>[Insert photographs of PPE from list to illustrate PPE for each zone. If colour-coded coveralls are available, make sure it is clear which colour is to be worn in each zone.]</td><td>Personal protective equipment (PPE)
<table>
<tr><th></th><th>Zone 1</th><th>Zone 2</th><th>Zone 3</th></tr>
<tr><td>Overalls</td><td></td><td></td><td></td></tr>
<tr><td>Gloves</td><td></td><td></td><td></td></tr>
<tr><td>Respiratory</td><td></td><td></td><td></td></tr>
<tr><td>Footwear</td><td></td><td></td><td></td></tr>
<tr><td>Eyes</td><td></td><td></td><td></td></tr>
</table></td></tr>
<tr><td>[Insert photographs of different packaging materials and specify which packaging can be used for which product – if possible match photographs of packaging to products.]</td><td>Packaging materials
• Bags: [list products]
• Steel drum (open head) [insert drum volume]: [list products]
• Steel drum (closed head) [insert drum volume]: [list products]
• HDPE drum (open head) [insert drum volume]: [list products], etc.</td></tr>
<tr><td>[Insert examples of all relevant equipment such as pumps, hoses and vacuums, and give details on which equipment is to be used for each activity.]</td><td>Other equipment
• Electrical:
• Handling:
• Site set-up:
• Other:</td></tr>
<tr><td>[Insert photograph of emergency contact on-site (paramedic nurse and/or site supervisor) and highlight location of emergency shower, first-aid equipment and fire-fighting equipment on the main site diagram.]</td><td>Emergency procedures
• On-site: [nominated person and contacts] emergency actions to carried out]
• Hospital: [insert telephone and contact]
• Fire service: [insert telephone and contact]
• Local administration: [insert telephone and contact]</td></tr>
</table>

BOX L3

Preparing the site/zone-specific SOP

The left-hand column of Table L2 provides some written guidance on how to complete the SOP. For complex sites it may be helpful to complete a site-specific SOP supported by a series of *zone-specific* SOPs where the conditions in individual zones are presented in more detail. Preparation should also include the following.

Site description and zone: the site-zoning diagram is inserted on the left-hand side of the table. The diagram should clearly show the locations and boundaries of the main zones and the points of entry and exit for each zone. The location of any decon units must be clearly defined. The scale used to show the site/zones is important and should be shown on the diagram. On the right-hand side of the table, a written description of each zone is included to reinforce the zoning diagram. It is recommended that each zone be given a unique reference number which is then used throughout the SOP.

Main activities: the left-hand side of the SOP is divided into columns based on the number of zones (there could be more than one hot zone at a site where there are multiple storage locations and/or burial sites). Each column is used to illustrate the activities to be completed in that zone (making cross-reference to the unique number assigned above). A picture library is available to assist in the illustration of activities and can be provided as part of a training programme from the FAO. A list of activities with written descriptions is placed to the right-hand side of the zones. The description should also cross-reference any activity-specific SOPs that apply when completing the operations. Ensure that all SOPs are cross-referenced and interlinked.

Personal protective equipment: the left-hand column is divided into sub-columns, each used to illustrate a zone from the site plan. Photographs of the PPE to be used for each activity in each zone should be inserted. Colour coding of items such as coveralls is a useful way of distinguishing between activities to be completed in different zones. Most disposable coveralls can now be purchased in a wide range of colours. Gloves are automatically colour coded based on their polymer. Again, colour reference is an important tool to ensure that the appropriate equipment is used for each activity and in each zone. The right-hand column should be a matrix which lists the PPE used, based on the TBRA for each work zone.

Packaging materials: using the correct packaging material for sites where there are mixtures of pesticides is important. Pesticide chemical compatibility with steel or plastic and their physical form (solid, liquid, sludge, bottles, etc.) will affect which packaging can be used. The left-hand column therefore presents pictures of the appropriate type of packages together with pictures of the item in the store that will be placed in them. The inventory data should provide sufficient information to allow packaging selection to be completed before travel and thus to match inventory items to specific types of new packaging. The right-hand column provides a written description of the package type (e.g. open-head steel drum) and the types of pesticide that can be placed in it. If different specifications of the same type of packaging are used, they should be colour coded. If different pesticides are to be mixed in a single drum (a practice which should be avoided), clear instructions and increased levels of targeted supervision are vital.

Other equipment: for each site/zone, it is important that workers are trained in the use of specialist equipment. Items such as flameproof pumps or HEPA vacuums require careful maintenance and must be operated by personnel competent to use them properly. The incorrect use of electrical equipment or poor maintenance of equipment can have a serious negative impact on project implementation. Failure to respect simple procedures (e.g. choosing the wrong type of hose pipe for a pump or not cleaning pumps after use) can result in major accidents, resulting in spillage and contamination of both workers and the environment. The site-/zone-specific SOP therefore lists the equipment to be used and names the personnel assigned to use that equipment, based on a review of their training records and their experience. The SOP also includes a note that all equipment is inspected before use to ensure

BOX L3 *cont.*

Preparing the site/zone-specific SOP

it is operating correctly and that it is cleaned after use to allow safe storage and/or reuse. Tool M below provides more guidance on the selection and use of equipment commonly used in pesticide safeguarding projects.

Emergency procedures: it is mandatory that there is an adequate level of emergency planning for each safeguarding operation. At collection centres, this includes the development of a complete on-site and off-site emergency plan as presented in tool E. For safeguarding operations completed at higher-risk sites, a minimum level of emergency preparedness must be in place. This includes:

- an emergency plan including a chain of command in the case of an incident. This is presented on the SOP and should be triggered immediately in the event of any form of accident. The plan should include details of all necessary communications (on- and off-site) and all personnel should be briefed and fully aware of their responsibilities for when the plan is triggered;
- paramedic first-aid support in case of injury/contamination of personnel;
- paramedic first-aid equipment and pesticide-poisoning antidotes to be used by medical staff at the nearest hospital;[11]
- fire-fighting equipment to deal with small-scale fires on-site. The type and capacity of the equipment should allow for the evacuation of personnel and potential containment of the fire whilst local support services are alerted and respond.[12]
- key local administrators should be informed of planned activities and in the case of an accident should be informed immediately to assist in potential evacuation of residents living in close proximity to any site where there is a significant incident.

Emergency contact details should be clearly visible on the SOP. The SOP should also include maps indicating the location of on-site services such as the emergency shower, first-aid kit or fire extinguishers, plus off-site services such as doctors, hospitals, police and fire service.

Preparation of zone-specific standard operating procedures

The format presented in Table L2 can be adapted to allow greater detail to be provided to workers entering a specific zone at a work site. However, the space on the format does not allow the user to easily detail all activities that may be undertaken at complex, high-risk locations. A general site-specific poster should be prepared. This will allow all staff to have an understanding of the site layout, rules for entry/exit of zones and a general understanding of the activities to be completed in each zone. This general format can be supplemented by additional posters being placed at the entrance to each specific zone. This is especially useful for locations with more than one hot zone requiring different equipment and work methods. The SOP format in Table L2 can therefore be adapted to allow the user to adequately represent the specific activities scheduled to be implemented in a specific zone. This allows for a more in-depth explanation of the type of PPE to be used when entering a zone, the packaging to be used in a specific hot zone and the risks associated with working in one zone compared to another. The zone diagram in such a case would focus on the details of the single zone under consideration and the entry/exit/decon procedures to be adopted for that zone.

[11] In many developing countries, there is a network of local hospitals with qualified personnel but often lacking adequate equipment to treat injured or contaminated personnel. It is therefore recommended that the project safeguarding team review the level of medical support which can be provided through local hospitals/doctors and make provision for the supply of equipment to support the local capacity or put in place emergency evacuation procedures to ensure adequate levels of treatment.

[12] In many developing countries there will be a lack of a professional fire-fighting emergency service that can respond in case of a fire involving hazardous chemicals. This will need to be factored into the local emergency plan developed for the site and all personnel will need to be briefed on their responsibilities in case of a serious fire.

Tool M

Selection and use of equipment

The development of the TBRA and SOPs will allow managers to make strategic decisions on the equipment needs for the safeguarding exercise at a specific store. The type and number of new packages, amount and specification of PPE (taking into account the number of workers needed to complete a task) and specific needs with respect to waste handling (pumps, vacuums, drum-handling equipment, etc.) should all be estimated based on the details presented in the TBRA. The following sections provide specific guidance on the selection of critical items common to most obsolete pesticide safeguarding projects.

Objectives of the tool

Tool M aims to:

- provide guidance on the selection of equipment, based on site-specific risk assessment, experience, international standards, regulations and local conditions;
- draw the attention of the user to particular material specifications, to prevent common material dysfunctions associated with typical local conditions and pesticide waste characteristics;
- provide basic instructions regarding use and maintenance of the equipment to maintain their safety standards and to avoid cross-contamination.

Description of the tool

The selection of safeguarding equipment calls heavily on information gained in previous tools, such as inventory and PSMS data, TBRA or SOPs. Tool M provides guidance for the selection and use of packaging, electrical equipment, PPE and a list of other equipment typically required for repackaging activities – such as first-aid kits, wooden pallets or spill-control materials.
Annex 4 of this volume provides further details on this equipment, especially regarding the specifications of PPE.

Selection and use of packaging (use Box M1)

The choice of packaging is totally dependent on the physical and chemical characteristics of the waste under consideration. It is critical that any packaging selected has no potential for chemical reaction with the pesticide to be repackaged.

In the current developing country context, most highly toxic pesticide wastes are typically dispatched to a licensed disposal facility in Europe. This requires transportation by road/rail and by sea. The packaging requirements to allow shipment by sea are presented in the International Maritime Organization (IMO) publication *International Maritime Dangerous Goods Code* (IMDG).[13]

It is therefore important to clarify the type of packaging materials to be used for the waste at a specific site and to confirm that it meets not only the requirements for containment and subsequent storage of the chemicals at a specific location (as detailed in tools D and E), but also all requirements for safe national and international transportation as set out in the IMDG and as presented in tool F.

[13] Available at http://www.imo.org.

BOX M1
Misuse of UN-approved packages for pesticide wastes (see Annex 4)

As an example, there are instances where *flexible intermediate bulk containers* (FIBCs), or "Big Bags" as they are commonly known, have been used as packaging material for contaminated "empty" containers. This has been because of a belief that the old packaging is a solid waste and that the Big Bag is certified to carry solids. Big Bags, however, have not been tested when full of old crushed containers and have not been designed to contain any residual liquids still in the containers safely. The bags are therefore not suitable for the purpose proposed. Similarly, many Big Bags are not certified to be stacked one on top of another for storage or transport. The stacking of Big Bags in storage locations, on trucks or in shipping container units should therefore be avoided unless other precautions are put in place to avoid accidents or package failure. *Decontaminated old packaging* (if declared safe after analytical testing) may be transported as non-hazardous goods and, as such, a Big Bag can be used as an outer packaging to ease handling of the items.

As a minimum, any containers supplied for use in safeguarding projects should include a *Certificate of Packaging Performance* with an assessment of the suitability of the particular package type in terms of its chemical and physical compatibility for each waste under consideration. This certificate is usually issued by a competent authority responsible for package testing in the country of manufacture. It includes details on a number of tests performed on each package type in order for it to receive United Nations (UN) certification. The tests commonly include a *drop test*, *stacking test* and, in cases where the packages are used for liquids, a *hydraulic pressure test*. The certificate must also specify the types of material that were used in the container for the purposes of the test. For solids, this is usually an inert free-flowing granular solid; for liquids the test fluid is typically water. The use of the packaging for waste materials significantly dissimilar to the test materials in terms of density, grain size and shape, viscosity, etc. will require a justification and in some instances an authorization from the test agency or competent authority. Box M1 describes the consequences of misusing UN-approved packaging.

It is stressed that it is the responsibility of the packer[14] of the waste to select appropriate packaging materials and package types and to ensure the chemical and mechanical compatibility of the waste with the package selected. The contractor or agency supplying the packaging will be held liable for any incident as a result of the failure to select the correct type of packaging. Annex 4 provides more detailed advice on commonly used types of UN-approved packaging used in previous safeguarding projects.

Selection and use of electrical equipment

The use of electrical equipment for safeguarding obsolete pesticides poses a further set of hazards and risks to project staff and the general public. The risk of electrocution of workers caused by the use of incorrect or faulty equipment or as a result of contact with water (rain) must be mitigated. For this reason, the FAO recommends the use of either 110 V-rated equipment or equipment powered with compressed air for all activities completed out of doors (exposed to the elements), and the use of an adequate form of electrical insulation/protection for all appliances used in buildings such as storage locations.

In a standard safeguarding operation, the team needs a variety of electrical equipment. This may include:

[14] The packer of the waste has a responsibility to ensure all packages are chemically compatible and mechanically appropriate to safely hold the waste under consideration. The selection of the incorrect package type will have severe implications during handling, storage and transport of the waste. It is common for the responsibility for the selection of packaging materials for all waste included in the inventory to be passed to the appointed disposal contractor who should have competence to select and supply the most appropriate items.

- pumps
- vacuums
- lighting
- extension cables
- transformers
- pressure washers
- weigh scales
- computers
- printers (for labels)
- drum-crushing equipment (usually requiring a 415 V three-phase supply)
- chargers for breathing apparatus battery packs.

The use of 110 V equipment may in itself pose serious limitations on the ability to obtain essential items locally. The basic power supply in most countries is 220–250 V and single phase. The provision of a step-down transformer to achieve 110 V or the use of a 110 V-rated generator is therefore necessary. The power requirements of items such as pumps and vacuums further complicates the issue, as does the need for heavy-duty cables and connectors/sockets. It is therefore essential that the PMU takes the necessary steps at the time of procurement to identify the correct power requirements for equipment, and that the PMU ensures that adequate provision is made for the supply of transformers, extension cables and sockets/connectors to allow its use. Alternatively, the PMU must make clear the need to supply such equipment in the tender-bid documents on which contractors will be assessed. Experience has shown that one cannot assume the availability of these essential items from local suppliers.

As a general rule, the installation of any electrical equipment requires input from a qualified electrician. This includes the removal of plugs/sockets, installation of a local supply and the testing of an existing power supply. Similarly, the use of electrical equipment will have implications with respect to the training of personnel in the use of the equipment, and the ongoing maintenance and decontamination of the equipment to allow use with other pesticides and at other locations. The risk of cross-contamination of workers from non-decontaminated equipment is significant and measures must be taken to ensure that this step and the control are included in the daily work plan.

The alternative of using air-driven equipment – such as pumps – poses a further complication as it necessitates either a supply of compressed air or a specific compressor unit. This adds to the general maintenance requirement and the need to access spare parts.

In general, it is therefore recommended that projects use 110 V-rated equipment, especially when working with liquids or in exposed areas where rain may come into contact with the equipment. If it proves impossible to use 110 V equipment, it is essential that, as a minimum, all 220 V equipment be fitted with suitable residual-current circuit breaker devices to protect the worker from electrocution. The following sections provide some guidance on the selection of commonly used equipment such as pumps and vacuums.

Selection of pumps

As with the selection of packaging materials, it is critical when selecting electrical and other equipment that the chemical reactivity of the pesticide is taken into consideration. This is especially important when considering the specifications for items, such as pumps which rely on the integrity of components (e.g. seals), operate effectively. The selection of an incorrect pump specification can result in large-scale leakage of materials and resultant contamination of the workplace and workers.

In addition to the chemical stability of the pump's components, the physical characteristic of the material to be pumped will determine its suitability. Generally, obsolete pesticides will have degraded to some degree, resulting in particulates in what was originally a liquid formulation.

In such cases, the pump will need to have sufficient tolerance to particulates to allow effective operation under normal field conditions. In other cases, liquid formulations may have separated out into layers of different viscosity. Pumps are available that employ a mixing process, generally through the introduction of air.

Finally, with respect to pump selection, the presence of flammable solvents in many formulations results in a direct risk of ignition of vapour from sparks generated by electrical equipment. If there is the slightest chance of flammable materials, it is recommended that only explosion-proof-rated equipment be used. Equipment should be suitable for use in *Zone 0* as set by the ATEX standards[15] defined in the EU Directives 99/92/EC and 94/9/EC, which govern the protection of workers operating in potentially explosive conditions and specify the selection of equipment for use in potentially explosive environments. Air-driven pumps may be used as an alternative to overcome this problem, provided that the associated compressors and other equipment are suitable under local conditions.

Selection of vacuum systems

Vacuum methods provide a very useful mechanism for the transfer of powder pesticides into new containers. Many commercially available systems exist, and they typically operate by expelling air from the container into which the solid pesticide will be sucked (the new container). This process results in the extraction of the air remaining in the container as it fills. It is therefore essential that any vacuum system used for obsolete pesticides be fitted with a fine-particle filtration system in the exhaust air flow. The filtration system will trap any fine particles of pesticide in the air stream and ensure that the exhaust air is free from contaminants. The most commonly adopted filtration system is the *high efficiency particulate air* (HEPA) filtering system. Typically, a HEPA removes 99.97% of all particulates larger than 0.3 microns. The efficiency of the filter and rate of air flow decrease as the filter is blocked. This requires maintenance of the filtration unit with potential exposure of the worker to the contaminants on the filter.

Systems are available which attach directly to standard UN-approved steel drums (100 and 200 litres) allowing extraction of the pesticide directly into the final container, removing the need for handling and related exposure. Larger systems can be custom made to allow the filling of packages such as 1 tonne Big Bags. In general, vacuum systems which fit directly onto 200 litre standard open-head drums provide a useful tool in any safeguarding project involving the repackaging of powder pesticides.

The systems do, however, have the following limitations:

- The nozzles that come into contact with the pesticides are easily contaminated, as are the hoses connected to the vacuum unit.
- The bore size of the nozzles and hoses is usually less than 10 cm and so the nozzle or hose is easily blocked by the large concretions typically found in large masses/volumes of solid pesticides.
- The systems are generally heavy and cumbersome and require two people to transfer the unit to the next container.
- Transfer of the unit also requires care with respect to cross-contamination from particulates – they can be trapped in the filter which is easily dislodged.
- Storage of the contaminated extraction unit and hoses also poses a further challenge and must be considered in the daily operational plan developed at the store.

Combination wet/dry systems are also available which increase the flexibility of the unit and provide a useful way to collect wash water from decontamination activities directly into containers. Such devices require the removal of the HEPA system, storage of the contaminated filter unit in a sealed container and installation of an alternative float system, used to indicate when the

[15] ATEX derives its name from the French title of above mentioned EC directive ***Appareils destinés à être utilisés en atmosphères explosibles***.

container is full. The issue of 110 V versus 240 V systems needs consideration based on the site-specific requirements in terms of outdoor use, proximity to water, etc.

Selection and use of personal protective equipment (use Annex 4)

The type and amount of PPE required for a safeguarding project is defined by the TBRA and the SOPs. They both take into account the hazards posed by the chemicals to be repackaged (the WHO hazard classification), the possible exposure route, the likelihood of exposure, the duration of exposure and the frequency of the activity, as well as the number of personnel involved in the handling of each pesticide. The chemical reactivity and subsidiary hazards such as corrosive, flammable or oxidizing properties are also accounted for. The TBRA and SOPs also take into account the location where an activity is carried out. In this way, it is possible to use the zoning of the workplace to demarcate the PPE to be worn.

The project manager will also be required to factor in the number of workers and supervisors in each working area. The need to make provision for visitors to the site may also influence the number of sets of PPE allocated to a specific operation.

The number and types of PPE have a direct impact on the project budget. There is a temptation to have PPE to cover every possible eventuality (however unlikely) at a site. Whilst this will address the needs of the risk assessment, it may well result in a significant budget overspend. Care is therefore needed when calculating PPE requirements to ensure that the risks are addressed adequately but that budget limitations are factored into the final decision. The project manager must, however, ensure that the risk assessment is adequate. In cases where the scope of work changes during implementation, such as when a new risk is identified, he or she should ensure that the risk assessment is updated and any new PPE and other equipment requirements are addressed.

Annex 4 provides further advice on the selection and use of PPE. The guidance focuses on the use of disposable PPE in order to eliminate the need to maintain and decontaminate equipment. The FAO can provide further assistance through training of project teams in the specification of the various PPE used for safeguarding.

Selection and use of other equipment

The successful completion of a safeguarding exercise will require the supply of other equipment. Typically, these items are purchased locally through national suppliers. The items include materials used to construct the safe working areas (protective membranes, warning signs, etc.), first-aid kits, hoses and valves for pumps, brooms, shovels, drum-handling equipment (trolleys, pallet trucks, etc.) wooden pallets, foot baths, detergent, worker clothing (cotton T-shirts, shorts/trousers, etc.), fencing and fence posts, reflective warning tape, polythene bags, cable ties, emergency shower and many other items.

The PMU must make a complete assessment of the needs for each site and ensure that local procurement is completed to meet the time line for implementation. The importance of the supply of these items should not be underestimated. Failure to locate suppliers and place orders for the additional equipment will result in the delay or even failure of project implementation.

In addition to purchased items, there may be a necessity to hire essential inputs. This may include the provision of a suitable forklift truck and driver (type selected based on the terrain of the site), shipping container units for storage of equipment and/or storage of repackaged pesticides, excavation equipment plus driver, trucks for local transport to a storage depot (plus drivers) and heavy-lifting equipment such as a crane. For all such services, it is the responsibility of the PMU to ensure that all licences and permits are up to date and that the equipment supplied is suitable for the activities to be completed (well-maintained, full-service records, etc.). When considering the supply of local equipment such as an excavator or a forklift truck, it is essential that the project's risk assessment takes into account the need for briefing the driver of the vehicle, provision of protective equipment and the decontamination of the equipment at the end of each

working period. Cross-contamination of hired equipment must not occur: it poses a risk to people outside the general working area.

The following are typically supplied through local purchase:

- drum trolleys, wheelbarrows and sack trucks for movement of new containers;
- footbaths, buckets, detergent, heavy-duty polythene, plywood boards, fencing and posts, reflective tape, warning signs, emergency showers and hose pipes for construction of the safe working areas;
- shovels and brooms for collection of loose debris;
- heavy-duty plastic bags, cardboard cartons and cable ties for tins of DDT and any loose debris;
- first-aid kits;
- aluminium ladders;
- tool kits (to include spanners to open drum lids, screwdrivers and Stanley knife);
- flip charts and markers for briefing workers and for preparing on-site instructions (SOPs).

Tool N

Site-specific health, safety and environment plan

Tool N provides a format for the consolidation of the variety of data and outputs from previous tools into a HSE plan to allow for a complete dossier of information relevant to ensure safe workplaces. It can help in assessing the variety of site-specific data needed to manage the safeguarding of obsolete pesticides. It allows for the review of inventory and EA data to formulate site-specific plans aimed at managing HSE risks and ensuring safe and effective project implementation.

The specific HSE plan applies to higher- and moderate-risk sites, whereas HSE measures are included in normal procedures for lower-risk sites in most cases. The HSE plan is usually drawn up by the specialist hazardous-waste contractor hired to complete the safeguarding activities and typically forms part of the duties of the contractor covered by the contract.

Objectives of the tool

Tool N aims to provide the teams completing the safeguarding activities with easy-to-follow instructions regarding the hazards, risks and working methods to follow at each location where obsolete pesticides are found.

The HSE plan should provide practical and focused advice ensuring the safe implementation of safeguarding activities.

Description of the tool

The tool provides guidance first on who should prepare and approve the plan and when the plan should be drawn up. It then introduces the HSE format and provides guidance on how to complete it. This is essentially done by introducing site-specific data such as analyses, plans, lists or SOPs from tools of previous EMTKs.

The format of the HSE plan presented here is based on established HSE practices that have been used successfully for many years around the world. It calls on the Basel Guidance previously referred to and the United Kingdom government's guidance on the Construction (Design and Management) Regulations 2007 (CDM 2007).[16]

The format below calls heavily on the FAO EMTK Volumes 1–3 and on inventory data which has ideally been uploaded into the FAO Pesticide Stock Management System (PSMS). These documents are available on the FAO Web site at www.fao.org/ag/obstocks. The guidance here also uses established procedures as defined in a variety of national and regional regulations such as of the US Occupational Safety and Health Administration (OSHA) regulations and European Commission (EU) Directives.[17]

16 A free download of the UK Health and Safety Executive publication "Managing Health and Safety in Construction" can be found at http://www.hse.gov.uk/pubns/books/l144.htm. Users are recommended to download a copy of this publication as a reference text along with the relevant EC Directives and Basel Convention guidelines cited in this section of this volume.

17 These include, but are not limited to: the US Occupational Safety and Health Administration (OSHA) regulation 29 CFR (1910.120 ***Regulations for Management of Hazardous Waste Operations and Emergency Response***, Appendix C, Section 7 (Site Safety and Control Plans). In addition, a list of the US Occupational Safety and Health Administration regulations and detailed texts can be found at the US Environmental Protection Agency's Web page at www.epa.gov.complaince/civil/programmes/osha.
A range of European Commission Directives and regulations (including the one listed below) related to health and safety, and detailed texts relevant to the preparation of the HSE PLAN can be found at http://europe.osha.eu.int/legislation/directives/:
89/391/EEC (Health and Safety Framework Directive);
89/655/EEC (Use of Work Equipment);
89/656/EEC (Use of Personal Protection Equipment);
90/269/EEC (OM Handling);

In general terms:

- It is recommended that a site-specific HSE plan be drawn up for each higher-risk site.
- HSE plans should also be prepared for locations in the moderate-risk category. The level of detail may be reduced, while employing the systems and work methods developed for the higher-risk locations.
- At lower-risk locations, the preparation of a complete TBRA and related SOPs for staff to follow is usually sufficient, though certain sites may require fuller HSE planning if they contain small amounts of highly toxic materials, for example.

Who prepares the plan?

It is important that the HSE plan is prepared by personnel who are:

- competent to complete the preparation of the document;
- able to train the operational staff who will implement the measures presented in the HSE plan;
- familiar with the implementation of projects in the developing country context.

Higher-risk site HSE plans are typically prepared by the specialist hazardous-waste contractor hired to complete the safeguarding activities, whereas the country PMU could draw up the plans for lower-risk sites under the supervision of the contractors as part of the skills-transfer/capacity-building component of the project. The formats presented here provide a simple standardized approach. The guidance provided here should also allow the PMU to assess and approve the plans prior to work commencing. The outputs of tool N can also be used to monitor and evaluate implementation as it proceeds at the affected sites.

At first glance, HSE planning may seem very onerous on projects: it requires consolidating a lot of information from a number of sources to prepare the final document. However, the process – together with the preparation of the risk assessments, site-zoning diagrams and SOPs – should be considered as an investment in ensuring the safe implementation of the project. As the PMU becomes more familiar with the completion of the HSE documents and a library of similar plans is amassed, the preparation process becomes easier and quicker. The active engagement of the PMU in this task contributes to mitigating the risk factors of the project.

Time line for plan preparation

Health, safety and environment (HSE) planning is critical to overall project planning and features as a key step in the project work plan. The HSE plans are generally prepared and approved at the *site-inspection* phase of the project after the approval of the project environmental assessment (EA) report and the environmental management plan (EMP) presented in tool I. The plans are completed using data from the FAO PSMS and the outputs from tools G, H and I, and may require supplemental *site inspections*. It is important that a site-specific HSE plan for all higher- and moderate-risk sites is completed, reviewed and approved before work starts on the safeguarding of stocks.

Approval of the plan

Approval of the HSE plans is a critical step in the process of implementation of the safeguarding strategy. The plan cannot be approved by the same organization or government department that prepares the plan. The approval step allows for review of the proposed methodologies and

92/57/EC (Health and Safety at Temporary or Mobile Construction Sites);
92/58/EEC (Safety Signs);
93/259/EEC (Shipment of Waste into Europe);
96/82/EC (Control of Major Accident Hazards Involving Dangerous Substances (Seveso II));
99/92/EC and 94/9/EC (ATEX – Use of Electrical Equipment in Flammable Environments);
European Agreement for the Transport of Hazardous Goods by Road (ADR).

provides an opportunity for the supervising agency to query any of the activities and processes included in the plan. In cases where the plan has been prepared by a third party such as the specialist hazardous-waste-management contractor, it should then be submitted to the PMU for review and approval based on the guidance provided in this document. The approval step may also involve comments and inputs from other government departments such as ministries of environment and labour. In all cases, the approval process takes time (ideally one week) and should be factored into the overall project implementation plan. Government agencies involved should be forewarned and requested to undertake to expedite approval of the plans quickly so as not to delay project implementation. If required, the FAO can offer independent advice on the review of HSE plans and can also assist the country in the identification of an independent consultant who can critically review the documents and identify any gaps or lapses.

Contents of the health, safety and environment plan (use Box N1)

Box N1 provides an outline format for the HSE plan. The following sections provide guidance on key components, outline the expected content under each heading, and provide linkages to inputs from other tools in the EMTK series related to environmental risk assessment, products to be safeguarded and storage and transport requirements.

BOX N1
Generic format for site-specific health, safety and environment (HSE) plan

Country:

Site name:

Date:

Location:

Store number(s):

Prepared by:

Approved by:

List of contents:

1. Background: historical context; site description; site layout and store conditions; environmental risk assessment data.
2. Command structure.
3. Communications: off-site and on-site.
4. Zoning of site.
5. Risk assessment: risk management and risk assessment.
6. Standard operating procedures.
7. Equipment.
8. Storage of repackaged materials.
9. Transport rules: on-site transport and off-site transport.
10. Budget.
11. Time line.
12. Monitoring and evaluation (M&E): quality assurance; supervision; health surveillance; workplace and environmental monitoring.

1. Background

The background should provide a clear description of the site and the products which are found there by using a combination of written text and site photographs, inventory data and plans from PSMS. The background should also identify clearly what factors make the site a higher risk (quantity of stocks, degree of leakage/exposure and/or toxicity of the materials to be handled). Typical, the background includes the following.

Historical context

The history of the site, previous use, current use, etc. should be presented here. This will typically be prepared following interviews with staff and a review of old records.

Site description

The site description data should be extracted directly from the PSMS. The data collected at the time of inventory includes site photographs and site plans as described in tool A. This data should form the baseline assessment of the site and will be used in the formulation of the site working areas and plan for safeguarding. Illustrate the site with photographs.

Figure: [Insert, e.g. general view of compound]

Figure: [Insert main entrances to compound]

If there are multiple stores at a single location covered by this HSE plan the author(s) will need to provide the site and store information for each store.

Site layout and store conditions

Again, the site layout data is extracted directly from the PSMS data collected at the time of inventory. Illustrate condition of the store(s) with photographs.

Figure: [Insert site plan (schematic)]

Figure: [Insert plan of store(s) (schematic)]

Environmental risk assessment data

Explain the environmental risk level of the store(s) covered by the HSE plan by indicating where it falls within the plot (critical zone, problematic or low priority). As a reminder, the assessment of the environmental risk factor F_P is presented in tool A and the FAO PSMS provides an easy-to-use system for assessing the risk factor F_P.

Figure: [Insert copy of the plot of F_E vs F_P from PSMS]

2. Command structure

The management of multidisciplinary teams at hazardous work sites requires a clear management or command structure. This is echoed in the US OSHA emergency response guidance and in the Construction (Design and Management) Regulations (CDM 2007) cited earlier in these guidelines. An organizational diagram in the HSE should outline a clear command structure and the various HSE roles assigned to named personnel. The complete structure for management, supervision, implementation and technical support/advice functions for work at the site should be set out clearly and personnel should be briefed as to who is responsible for fulfilling what HSE role in the project.

Figure: [Insert an organization chart of the management structure for the operation]

For each of the posts included in the structure, simple terms of reference (TOR) should be prepared which stipulate the role and responsibility, line-reporting relationship and qualifications. Any personnel appointed in any of the positions listed below must be assessed against the relevant TOR and demonstrate through qualifications and experience that they are competent to complete the role as presented in the TOR:

- management
- technical support and supervision
- site supervision
- implementation.

The command structure should also include details of all training which personnel have received prior to implementation, and provide expanded details on all training to be provided to project staff during implementation.

The data on training should be presented as a detailed training matrix. This should include all informal skills-transfer activities such as the mentoring of national project staff by experienced consultants or contractor personnel during the day-to-day project implementation.

3. Communications (use also Annex 5)

Effective communication will be a critical aspect in ensuring safe project implementation. For ease of reference, communications can be divided into *on-site* and *off-site*.

Off-site

Off-site communications will form a part of the overall project communications strategy, which is in general rolled out in parallel to the implementation of project activities. This can include briefing of local communities, notification of local authorities (police, hospital, fire, local government) and the general population in the vicinity of the site and the preparation of an emergency response as outlined in the section on SOPs in tool L. Even for one-off stand-alone projects, it is necessary to invest time in this element. Cooperation with government focal points, national non-governmental organizations (NGOs) and community leaders may play an important part in this element of the project.

On-site

The management of communications on-site will be achieved through the adoption of a series of morning briefings and evening reviews of progress. The site supervisors will take responsibility for the conduct of these meetings with the local labour force and will record all findings on the formats provided. A system of daily briefings, daily progress reports and weekly summary reports will be used to ensure adequate documentation of the project progress. The system is a proven methodology commonly adopted in all FAO managed safeguarding projects.

Formats for daily briefing, progress reports and incident reporting are provided in Annex 5.

4. Zoning of site (use also tool J)

As presented in tool J, the zoning of the site and the development of site rules associated with each zone are critical risk-mitigation steps to eliminate casual exposure and cross-contamination during safeguarding activities. They should be completed prior to arrival at the site and then reviewed on-site before work starts.

Figure: [Insert the site-specific zoning plan]
Figure: [Insert the site-specific emergency plan based on application of tool E]

5. Risk assessment (use also tool J)

Tool K provides guidance on the preparation of risk-management strategies and the TBRA. Key outputs of these two elements should also be included in the HSE plan.

Risk management (use also tool K)

The PMU should complete a risk analysis of the implementation of safeguarding activities at the site in question. As indicated in tool K, risk management includes risks associated with project activities as well as with issues related to liabilities and insurance requirements.

Figure: [Insert the results of the risk analysis for the site in question]

Risk assessment (use also tool K)

As indicated in tool K, the process of the TBRA is based on standard risk-assessment methodologies that aim to identify the hazards, pinpoint who could be harmed/affected, evaluate the risk (probability of intensity of occurrence), document all actions, and constantly review and revise the assessment during implementation. The TBRA records all the above and is designed to assist the operator in making objective decisions on project implementation with an emphasis on worker and environmental protection at all times. The format also provides a methodology for the prioritization of safeguarding activities to reduce risk in a progressive, step-by-step method.

Figure: [Insert the TBRA of the site in question]

6. Standard operating procedures (use also tool L)

The TBRA does not give detailed instruction to supervisory or operational personnel on how to actually complete the safeguarding operations. This detailed instruction is provided through the system of SOPs presented in tool L. As indicated above, SOPs are provided in two formats aimed at different levels of personnel within a command structure as follows.

Activity-specific SOP: typically a written instruction to supervisory staff on how to safely complete an activity or task. It is important that all safeguarding activities listed in the TBRA have a SOP. New SOPs are needed when new activities are completed as part of a site-safeguarding exercise. As noted in tool L, the format provided is an example, and formats can vary based on who is completing the preparation (waste-management contractors may have alternative formats based on their own ISO standard systems of working). The aim is to strengthen the capacity of field management personnel and site supervisors to develop SOPs based on the generic templates and actual field conditions. For a specific site covered by the HSE plan, a set of activities will be identified in the TBRA and each activity will require an activity-specific SOP. They should be listed here and annexed to the HSE plan for the site.

Figure: [Insert a list of all activity-specific SOPs for the store in question]

Site- or zone-specific SOP: a standard format based on posters and illustrations to include warning signs, and aims to provide simple instructions to workers on where they should be working, what activity they should be completing, what PPE they should be using and what they should do in the case of emergency. As with the instructions to supervisors it is anticipated that the generic format presented in tool L will be adapted for field conditions to allow site- and zone-specific SOPs to be prepared by field managers and supervisors for the site under consideration. The site-/zone-specific SOPs should be listed here and annexed to the HSE plan for the site. Cross-reference to the TBRA and SOPs are essential components of the on-site communications element outlined in Section 3 of the EA

document dealing with on-site communications. It is critical for workers to completely understand their roles and responsibilities during implementation of the SOPs.

Figure: [Insert a list of site-/zone-specific SOPs for the site in question]

7. Equipment (see Table N1, tool M and Annex 4)

Tool M and Annex 4 of this volume provide detailed information on the selection and use of a wide variety of equipment commonly used during the implementation of safeguarding projects.

All equipment to be used at a specific store should be listed in the HSE plan along with any special instructions on its use and maintenance from the supplier.

Table N1 summarizes PPE requirements for a store.

Table N1
Summary of personal protective equipment (PPE) requirements

No.	PPE	Specification and supplier	Activity	Store	Location	No. of workers	No. of days	No. of item
1	**Coveralls**							
2								
3								
4								
5								
6								
							Total	
							Total	
7	**RPE***							
8								
9								
10								
							Total vapour masks**	
							Total dust masks	
11	**Gloves**							
12	**Boots**							
13	**Eye**							

* RPE – respiratory protective equipment (vapour or dust mask).

** Vapour masks are supplied based on exposure, and typically last one week per worker.

8. Storage of repackaged materials (use tools D, E and G)

Tools D (*Selection of collection centres*) and E (*Management of collection centres*) show that there are a number of scenarios for the storage of obsolete pesticides after the safeguarding process is completed. The main three options (*pack and go*, *go and pack* and *pack and store*) are presented in the section of tool G dealing with the selection of storage options.

For the HSE plan it is necessary to present the rationale for which scenario is to be adopted. In the case of the first two options, the data used to select the collection centre and system for ongoing storage at the centre should be presented. In the case of the third option, the HSE plan should provide details on the location of the storage areas on the work site, an evaluation of the location to demonstrate that it is suitable as a storage location (using tool D), permission to use

the facility from the local permitting authority, and an emergency plan and storage management plan for the site to allow effective storage pending final transport.

It is suggested that, for the purposes of the HSE plan, the user presents the information in the following structure.

- Storage strategy (from tool G).
- Storage assessment (from tool D).
- Storage management (from tool E).

9. Transport rules (use tool F)

The transport of waste and chemicals poses the biggest potential risk to public health and the environment during safeguarding operations. It is therefore essential that the HSE plan includes details on the methodologies to be used for all transport during implementation of the safeguarding exercise. The general rules concerning vehicle selection, driver training, route planning and supervision of the waste transport are presented in tool F. This tool also provides pro forma documents for the development of country-/site-specific documentation to allow safe transport to the proposed destination.

Further to the advice provided in tool F, the site-specific HSE plan should also address the following issues related to transport of waste, equipment and personnel.

On-site transport

The safeguarding of obsolete pesticides may involve the use of wheeled or tracked vehicles to assist in materials handling. The types of vehicle include forklift trucks, cranes, excavation equipment and – in cases where the site covers a large land area – bicycles, motorbikes and cars. The proximity of large vehicles, workers and hazardous materials such as obsolete pesticides require the installation of a management system to control access and routes used by personnel and vehicles. The system should allow the project manager to confirm that all vehicles are mechanically sound and fit for purpose, that all personnel operating the machinery are qualified to do so and that all other site personnel are informed where machinery is in operation and how they should behave when working in such an area. For the purposes of the HSE plan, the file should contain, as a minimum:

- vehicle/equipment maintenance and service history;
- vehicle/equipment inspection certificate by nominated person;
- driver/operator licence;
- driver/operator training/briefing notes;
- worker briefing notes.

It is also advised that a site map indicating the routes that vehicles and equipment can take to and from their work location be prepared and that all workers are familiar with the plan. The plan should also indicate alternative access routes for workers.

Vehicles and equipment used on-site must be decontaminated completely before they are allowed to leave the site. Alternatively, contaminated items such as wheels, excavation buckets and other components may be removed and remain in the hot zone at the end of the working day. Decontamination procedures may include installation of a wheel-wash facility, which all vehicles will have to pass through before being allowed off-site. Pressure washing of surfaces with an anionic surfactant detergent may also be considered. In all cases, the decontamination must be completed in a suitably constructed designated decontamination area and all wash water must be collected and packaged as waste for disposal.

Off-site transport

Off-site transport covers a wide variety of aspects: transport of personnel to the work site, delivery

of equipment to the work site, transport of the repackaged materials from the work site to a storage location and, typically, international transport to a final disposal facility. All these aspects need to be managed as part of the safeguarding exercise.

Personnel transport

The transport of personnel to and from the workplace represents a significant risk to project implementation. The mobilization of project personnel over long distances under difficult and often unfamiliar conditions can easily result in accidents. Project managers need to therefore indicate in the HSE plan what steps have been taken to mitigate the risk to personnel as a consequence of mobilization to the work site. The HSE plan should therefore contain the following information:

- vehicle registration documents and all service/maintenance records;
- driver licence and training certificates along with a record of performance;
- vehicle inspection checklists;
- vehicle equipment checklists.

The risk to project personnel can often be limited through the use of experienced national government drivers who are familiar with the routes and driving conditions. Project personnel should be discouraged from driving under normal circumstances.

Equipment delivery

Safeguarding activities may require the delivery of significant amounts of equipment such as steel drums, protective clothing and tools. The safe successful transfer of these items to the work site is central to effective and efficient project implementation. The responsibility for delivery of the materials to the work site is often subject to a local transport contract. The quality of the vehicle and the driver will have a direct impact on the ability to deliver materials in the required time frame. The author of the HSE plan is therefore required to detail the selection and inspection processes for haulage companies, in line with requirements as set out in tool F. It is suggested that, where possible, contractors make use of dedicated project vehicles or haulage companies which are on a national supplier database. The HSE plan should therefore contain details of the vehicles and the drivers for inspection and approval by national authorities.

Movement to storage location

The transport of the repackaged waste to a storage location poses a potentially significant risk to public health and the environment. It is therefore essential that the HSE plan provides details on a number of key aspects related to the safe transport of the waste. Much of the methodology to be followed is presented in the tool F. In summary, the contractor must provide details on the following key aspects:

- vehicle registration documents and all service/maintenance records;
- driver licence and training certificates along with record of performance;
- vehicle inspection checklists;
- vehicle equipment checklists;
- route plan;
- documentation to accompany the load;
- escorting arrangements.

All movements of waste to the collection centres need to be escorted by a team with the necessary equipment to mitigate any spillage en route. The load must be accompanied by all relevant documentation in the official and local language. All prior notifications to emergency services and local administrations on the road to the collection should be in place. The road to be followed must take into account rules associated with overnight parking of vehicles in secure

compounds (police stations) and limitation of speed whilst passing sensitive areas. In addition, double trailers are not recommended for the transport of waste in developing countries because of the risk of accidents on poor roads.

Movement to final disposal facility

The same general rules apply as for the movement to the storage location. In addition, the contractor must ensure that all overseas shipments are completed in full compliance with the IMDG Code[18] and the requirements of the Basel Convention. The HSE plan should therefore contain all relevant data for in-country transport plus copies of all correspondence related to the approval of the export permit issued under the Basel notification procedure.

10. Budget

Under some circumstances, there may be a requirement to develop a site-specific budget related to the implementation of the HSE plan. It is recommended that the budget should be presented in terms of the following main categories of expenditure.

a. Personnel (international):
   - managerial (workday and rate);
   - supervisory (workday and rate);
   - labourer/technician (workday and rate).

b. Personnel (local):
   - managerial (workday and rate);
   - supervisory (workday and rate);
   - labourer/technician (workday and rate).

c. Transport:
   - mobilization of personnel;
   - delivery of materials;
   - transfer to collection centres;
   - delivery to the disposal facility.

d. Equipment:
   - internationally supplied (details on subcategories, suppliers, specifications and quantities);
   - local purchase (details on subcategories, suppliers, specifications and quantities);
   - local hire (details on subcategories, suppliers, specifications and quantities).

11. Time line

The HSE plan should include a detailed *time line* for implementation at the specific site under consideration. The time line should cover all aspects of the activities at the site: planning; equipment supply and delivery to the work location (including time lag for customs and import formalities); approval of waste export permits; mobilization of personnel; training of any local personnel; completion of safeguarding activities at the work site; demobilization; transport; storage; and final transport to the disposal facility.

For the purposes of the HSE plan, a *network diagram* and/or *Gantt chart* should be prepared to illustrate the time line. This plan should clearly demonstrate the steps to be followed, the associated time line and the interdependency of activities. Specialized project management software should be used. The final time line should also include a M&E plan for the duration of the activities at the site (see below). If possible, a *cost-schedule analysis* can also be prepared indicating expenses incurred over the time of implementation. Further technical guidance on the development of a time line, work plan and M&E plans for pesticide safeguarding projects is available from the FAO as part of the technical guideline on *Work Planning and Effective Monitoring and Evaluation for Project Delivery* (under development).

18 International Maritime Dangerous Goods Code of the International Maritime Organization (IMO), www.imo.org.

The time line for implementation at the specific site should be integrated into the overall work plan for the project. It will be used to develop a series of project milestones which will be incorporated into the M&E system as outlined in Section 12 below.

12. Monitoring and evaluation

The M&E of the HSE plan comprises two main aspects: (i) a *standards-based* supervision of the implementation of the HSE plan at the work site and (ii) a *time-based* monitoring of the implementation to ensure that *milestones* set out in the time line are met on time. The focus here is on the standards-based aspects of the M&E plan as follows.

Quality assurance

The HSE plan should indicate the process for ensuring that all materials and equipment supplied to the project meet the required technical specifications and standards required.

Supervision

The HSE plan should include details on the management systems to be employed to ensure that all work is completed as presented in the document. This may include the use of an external body with the required experience such as an NGO. In addition, a government body may take on the supervision role in cases where work is completed by a contractor

Health surveillance (use Box L2 and tool L)

One of the best indicators of safe and effective implementation is the health surveillance of project staff, which will include the completion of a standard medical examination for all locally hired labour involved in the project (as indicated in Box L2 of tool L). The project implementer should therefore specify in the HSE plan the health surveillance modality to be used at the specific location, based on an analysis of the risks.

Workplace and environmental monitoring

Under certain circumstances, workplace (in Zones 1, 2 and 3) and environmental monitoring may be considered appropriate. Air-sampling technology combined with analysis of samples from the workplace and adjacent to the workplace can give a good indicator of how effective the system used to prevent contamination of workers or the spread of contamination outside the workplace (cross- or vector contamination) is. The HSE plan should therefore detail the potential for worker and environmental contamination based on the location and the specific waste type present.

During the repackaging stage of a safeguarding exercise, for example, a light powder of DDT can spread easily. This dust must be suppressed or contained within the working area, and workers provided with adequate protection from exposure to the dust. *Workplace monitoring* of air quality in the *hot zone* and *environmental monitoring* of the areas immediately adjacent to the working area should be used. They can provide objective evidence to evaluate to what extent the SOPs and the project implementation measures as a whole are affecting worker health and the level of contamination in the surrounding environment.

This may be supported by soil and water sampling in the work area before and after project implementation. It is the project manager's responsibility to provide a rationale for the use or non-use of systems such as those outlined above.

The time-based milestones will be developed based on the time line submitted with the HSE plan.

The FAO technical guideline on *Work Planning and Effective Monitoring and Evaluation for Project Delivery* (under development) provides further guidance on this subject.

Annexes

Annex 1: Exercises to complete task based risk assessments (TBRAs)
Annex 2: Example of activity-specific standard operating procedures (SOPs)
Annex 3: Example of site-specific standard operating procedures (SOPs)
Annex 4: Equipment specifications
Annex 5: Example of reporting formats

Annex 1: Exercises to complete task based risk assessments (TBRAs)

To complete the following exercises, you need to complete a TBRA form based on the advice provided in the main body of the text. You are provided with inventory data, photographs and a site plan from the inventory data. Complete the TBRA and prioritize the order in which each product at the site will be repackaged. Include all activities for Zones 1, 2 and 3.

Site 1:
Inventory:

- Dieldrin (25% ULV); 25 litre steel drums; 2000 litres total.
- Sumithion (95% ULV); 200 litre steel drums; 5000 litres total.

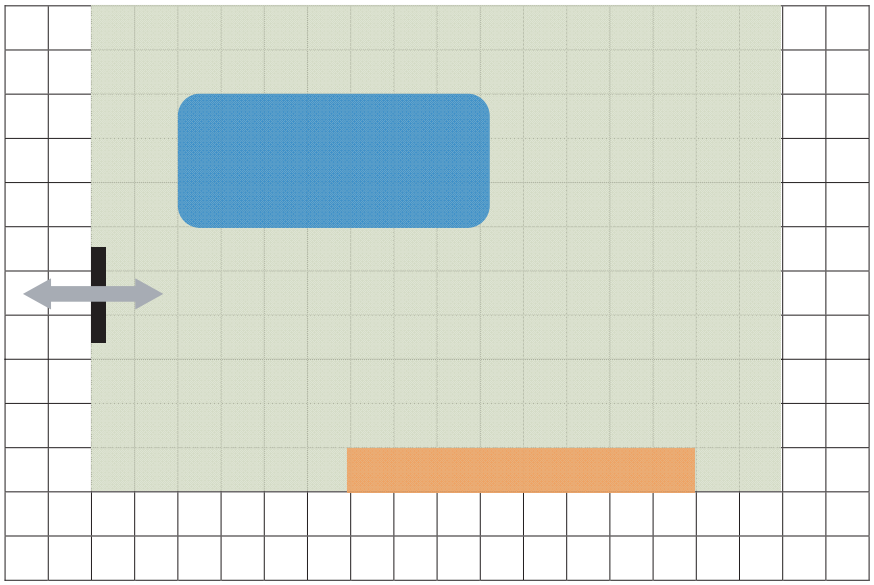
Photographs:

Product 1

Product 2

Store information and site plan:

Blue area indicates location of sumithion, orange area indicates location of dieldrin.



Site 2:

Inventory:

- Sevin (85% wettable powder formulation [WP]); 25 kg cartons in boxes; total 12 000 kg.
- Aldrin; 25 litre steel containers; leaking; total 100 litres.
- Queletox (600 ULV); 100 litre steel drums; total 300 litres.
- Calliherbe (2,4-D amine salt as a WP); 1 litre plastic bottles; 100 bottles total.

Photographs:

Sevin

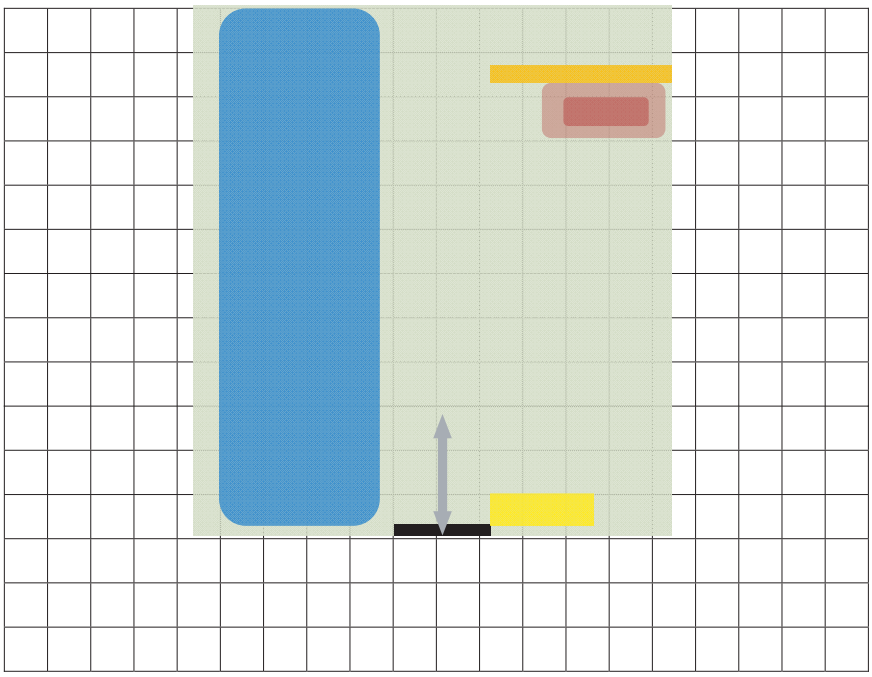
Aldrin

Queletox

Calliherbe

Store information and site plan:

Blue shading indicates location of sevin, yellow indicates location of queletox, orange indicates location of 2,4-D and brown indicates location of aldrin and associated halo of leaked products.



Site plan

Site 3:

Inventory:

- Lindane (90% ULV); 200 litre steel drums with significant leakage and contamination of floor area; total of 120 drums with approx. 50% leakage.
- Malathion (50% emulsifiable concentrate [EC]); 200 litre steel drums; total of 2 drums immediately next to the entrance to the store away from leakage.
- DDT (5% dusting powder); 25 kg sacks; total of 1000 kg of ripped sacks with spread of loose dust over rear of store area.

Photographs:

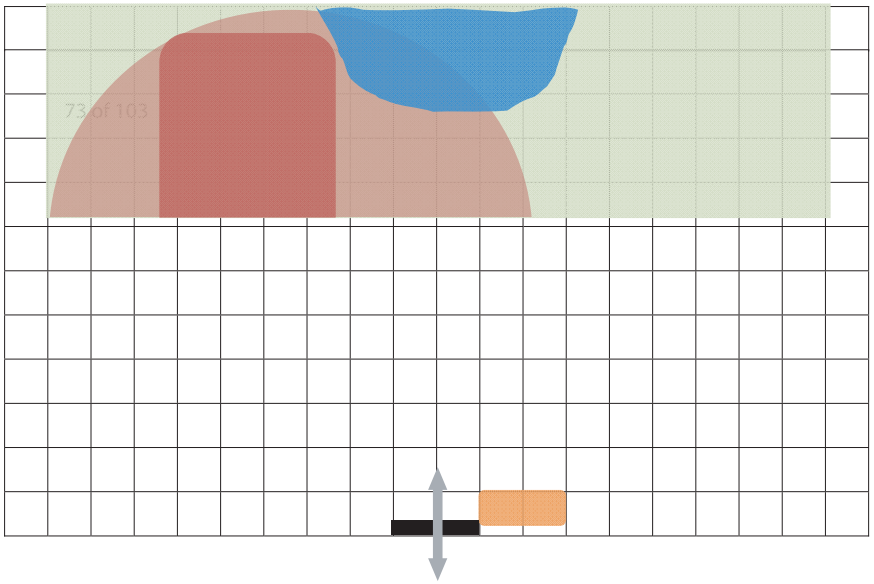
Lindane

Malathion

DDT

Store information and site plan:

Solid brown indicates location of lindane drums; transparent brown indicates extent of leakage; blue area indicates location of sacks of DDT and orange location indicates location of malathion drums.



Annex 2: Example of activity-specific standard operating procedure

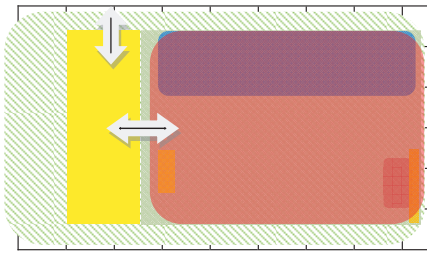
Activity-specific SOP #1	**Repackaging of bulk liquids (25 litres and above) using a flameproof pump At Site 1 in Annex 1 above**
Prepared by: Joe Bloggs	Approved by: Jane Doe
Section 1: Background	Sumithion (95% ULV) in steel drums – active ingredient fenitrothion 5000 litres (25 of 200 litre drums) WHO toxicity category 4 (GHS classification) plus flammable solvent hazard Frequency: 25 operations taking approx. 10 minutes each = 4 working hours (half a day)
Section 2: Aims	Transfer of expired sumithion from existing containers to new UN-approved steel closed-head drums mounted directly on the transport vehicle.
Section 3: Equipment	Packaging materials: 25 new UN-approved tight-head drums plus 1 open-head drum for site waste and contaminated materials (PPE and hose). 110 V flameproof pump (flam hazard) fitted with cut-off foot valve to prevent siphoning of liquid when pump is switched off. Double-layer polyethylene reinforced hose with valve closures and double-jubilee-clip fixtures. Steel drip tray on back of truck housing new drums in case of spillage. Polythene floor covering to prevent contamination in case of pump failure of hose rupture. Hot zone demarcation using three-stage decon unit and existing building structure. PPE: Type 3 coveralls, nitrile gloves, chemical-resistant boots, organic/particulate disposable half mask, safety spectacles. Optional PVC apron for workers at the pump. Two-person team at pump and one person at filling point on the back of the vehicle immediately adjacent to the store entrance.
Section 4: Environmental protection	**Zone 1:** entire internal area of the store plus back of truck immediately adjacent to store entrance. Steel containment tray on rear of vehicle at filling point and all internal floor surfaces in store covered by protective membrane. Three-stage decon unit at entrance to store – no entry to store without full PPE. **Zone 2:** once all pumping operations are complete, the rear of the truck is Zone 2, where labelling can be completed. Reduced PPE needed for this activity provided no spillage during pumping. **Zone 3:** new drums can be stored in the building as there is sufficient clean floor area. No requirement for storage of filled drums on-site as pumped directly onto truck for transport to collection point.
Section 5: Worker protection	Health surveillance records checked before departure to site (organo phosphate [OP] pesticide risk of cholinesterase inhibition). Worker briefing on TBRA and site-specific SOP completed prior to operations starting. Check adequate number of appropriate PPE for each team member (3 people plus driver). If using national counterpart staff, check training and experience records.

Section 6: Detailed activities	**Step 1:** put on PPE and enter into hot zone. Set up zoning and three-stage decon. **Step 2:** inspect materials and check inventory data. If as recorded, proceed. If any variation, seek advice from supervisor/management before proceeding. **Step 3:** set up pump and ensure good clear communications between pumping and filling ends of the line. Clear line of sight should be the aim. If not, set up a communications protocol to indicate when drums are full or, if pump should be stopped for emergency, needs to be in place. Liquid pumped from old containers directly into new drums on back of transport fitted with drip tray. Once empty, old drums should be rinsed and closed (see separate SOP), outer surfaces should be checked for contamination prior to removal from the hot zone and loading onto transport. **Step 4:** labelling for transport according to GHS requirements (completed once all drums are filled and pumping activities are finished). **Step 5:** demobilize zoning and packaging of contaminated materials (PPE, old hoses, contaminated polythene sheeting, etc.) into drums earmarked for site waste.
Section 7: Special instructions	All new drums to be electrically earthed to the side of the vehicle whilst being filled (static). Pump valve to be close before filling valve to avoid pressure build up and blowing of hose line. Filling valve to be opened before pump is started/restarted to avoid pressure build up. Valve and hose to be fitted with double jubilee clips at all junctions/joints. Drums may be moved to entrance to hot zone to facilitate line of sight communication.
Section 8: Reference data	Pump manual; rinsing of containers SOP; three-stage decon SOP.

Annex 3: Example of site-specific standard operating procedures

Site-specific standard operating procedure (SOP)

Site 2 in Annex 1

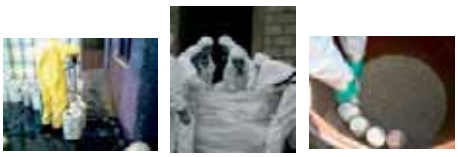


Site description and zones

Zone 1: Red area on diagram contained within building. Three-stage decon unit set up at entrance. Floor area covered with heavy-duty polythene. Emergency equipment set up in decon unit.

Zone 2: Yellow area on diagram adjacent to entry to Zone 1. Area defined by reflective barrier mesh. Storage of clothing.

Zone 3: Green shaded area entry from Zone 2 as shown.



Main activities

Zone 1: repackaging of packets/boxes of sevin; pumping of liquid pesticides (queletox and aldrin); packaging of bottles into open-head drums (2,4-D) – activity SOPs needed.

Zone 2: labelling of repacked items; storage of new packaging.

Zone 3: loading of items onto vehicles for transport (forklift).

Personal protective equipment (PPE)

	Zone 1	Zone 2	Zone 3
Overalls	Type 3 (Orange)	Type 5 (White)	Cotton
Gloves	Nitrile (Green)	Leather	Leather
Respiratory	Full-face vapour mask and half mask	Nil Safety boots	Nil Safety boots
Eyes	If no full-face vapour mask then specs	Specs	Specs

Packaging materials

Bags: FIBC for sevin.

Steel drum (open head) [200 litres]: for bottles of 2,4-D.

Steel drum (closed head) [200 litres]: for queletox and lindane.

HDPE drum (open head) [insert drum volume]: nil.

Other equipment

Electrical: transformer and cables.

Handling: drum pump, vacuum.

Site set-up: reflective mesh, polythene, spillage kit (site and vehicle).

Other: steel drip tray for truck, drum trolley.

[Insert photograph of emergency contact on-site (paramedic nurse and/or site supervisor) and highlight location of emergency shower, first-aid equipment and fire-fighting equipment on the main site diagram.]

Emergency procedures

On-site:	[nominated person and contact]
	[emergency actions to be carried out]
Hospital:	[insert telephone and contact]
Fire service:	[insert telephone and contact]
Local administration:	[insert telephone and contact]

Annex 4: Equipment
Personal protective equipment (use Table A.1 and Box A.4.1)

Personal protective equipment (PPE)[19] should be considered as the last line of defence when dealing with hazards and risk. In reality, the safeguarding of obsolete pesticides will require personnel coming into direct contact with hazardous materials. It is necessary, therefore, to provide project staff with appropriate PPE based on the type of hazard from the substance (pesticide) and level of potential exposure during repackaging, transportation and storage of the materials. As stated in tools J and K, obsolete pesticide projects largely use disposable PPE rather than reusable items. There are pros and cons associated with both types of PPE. These are presented in Table A4.1. Subsequent sections of Annex 4 will deal with PPE which provides protection from both physical (crush, impact, etc.) and chemicals hazards (toxicity, corrosive materials, etc.).

One complaint from project personnel is that "PPE is designed for use in temperate climates and is not suitable for use in tropical conditions". This is not true. PPE is designed to provide a barrier between the hazardous substance and the person wearing the PPE. It is an expected side effect that the barrier results in heat retention and discomfort to the wearer. The fact that PPE is not breathable allowing the exit of heat sweat (and hence comfortable to wear in hot climatic conditions) is a good indication that it is also preventing the entry of harmful materials.

Table A4.1
Comparison of reusable and disposable personal protective equipment (PPE)

Reusable PPE	Disposable PPE
Readily available. Relatively cheap (on the long term). Needs to be cleaned and maintained. Risk of taking the hazard home. May not be suitable for all materials. May be cumbersome and hot.	No maintenance. No cleaning. Can be selected based on actual hazard. Many different suppliers. May have to be imported. Can be expensive in the long term (but cheap singly). Only used once or for a specific time.

BOX A4.1
Factors influencing PPE selection

In order to select the PPE to be used, the user must:

- identify the type of hazard;
- establish the level of hazard (WHO class);
- identify effects on the body;
- identify the potential route(s) into the body;
- assess the likelihood and possible duration of exposure (risk).

The user must then consider other factors such as:

- work rate of project personnel;
- wear time;
- non-wear time (important for masks where filters degrade over time);
- medical fitness of wearer;
- need for communication between personnel wearing PPE;
- mobility and flexibility;
- work environment (confined space, hot/humid conditions, etc.);
- sweating and heat exhaustion;
- contamination;
- compatibility (with other PPE).

[19] See also EMTK 3, Annex 3.

The specifications for disposable PPE are derived from strenuous testing by both the manufacturing and independent testing institutes prior to the award of an internationally recognized certification mark. In the European Union, products are tested and certified to comply with a European Norm (EN). The European guidance on PPE is set out in the PPE Directive 89/686/EEC. The compliance of a specific item of PPE to the appropriate European Norm results with the award of the CE mark. Similar systems are operational in other regions including the US-based American Society for Standards and Materials (ASTM: for more information, visit www.astm.org). It is important when supplying PPE and other essential equipment from different regions that the testing procedures are compared to ensure that similar standards of protection and overall specification are provided.

Table A4.2 can be used to assist teams in the identification of the most appropriate PPE for each activity listed in the TBRA.

Table A4.2
Selection of personal protective equipment (PPE)

Chemical	WHO (AI*)	% AI	WHO (form.**)	Exposure route	Potential for exposure	Other factors	PPE

* AI: active ingredient

** form.: formulation

The data from this table may be annexed to the TBRA as required.

Item descriptions

Coveralls/overalls/work wear (all terms for the same item)

Coveralls are designed to provide a barrier from skin contact with hazardous materials. It is therefore critical when completing the TBRA (tool L) that the exposure route and likelihood of contact with hazardous materials (e.g. degree of leakage) are assessed adequately. The type of hazard and potential for contact should have a strong influence on the *type* of coverall selected for a specific activity.

Coveralls are usually assigned a *type* or *class*. The actual terminology can differ depending on the specific manufacturer but in general terms the following definitions can be applied.

- **Type 1:** fully enclosed gas-tight.
- **Type 2:** gas-tight for use with airline breathing apparatus (BA).
- **Type 3:** liquid-proof (typically used when handling WHO class Ia/Ib/II liquid pesticides).
- **Type 4:** splash resistant (typically used when handling WHO class III and U liquid pesticides and some solid pesticides which are also irritants or corrosive).
- **Type 5:** particulate resistant (suitable for use when handling most solid pesticides but may be compromised by sweat. Welded seams may also be needed for ultra-fine particles).
- **Type 6:** limited protection against splashes and particles (typically used when not coming into direct contact with pesticides).

FIGURE A4.1
Examples of coveralls commonly used for safeguarding

Fully enclosed Type 1

Airline gas tight Type 2

Liquid-proof Type 3

Splash resistant Type 4

Particulate resistant Type 5

It is vital to identify accurately the hazard associated with handling a specific pesticide at the store (from the inventory, ERA, TBRA and SOP), the potential for exposure (the amount of leakage), the mechanical strength requirements related to the activity (e.g. the physical lifting of contaminated containers compared to the passive pumping of materials from clean containers) and the amount of material to be handled. All could influence the selection of coveralls at a specific location.

Disposable coveralls made from synthetic non-woven polymers are designed to prevent chemical contamination of the worker. The selection of the polymer will provide specific protection to a variety of contaminants.

There are a number of general rules related to the use of coveralls. These include:

- Before putting the coverall on:
  - check the specification;
  - check for tears/rips, elasticated cuffs;
  - check the manufacture date (shelf-life).
- It should not be tight.
- It should allow free movement (bending, stretching, etc.).
- It should not be too big.

It is also important to monitor the use of coveralls:

- Is the wearer too hot?
- Is perspiration compromising the effectiveness of the coverall?
- Are there any tears/rips and is this a common problem associated with a specific activity or individual?

As a general rule, if the integrity of the coverall has been compromised:

- Stop work.
- Leave the working area.
- Carefully remove your damaged coverall.
- Put on a new coverall.

If there is a recurrent problem, it is important to reconsider the selection of the type of coverall, based on feedback from the project team.

When removing the coveralls there are a number of general rules which need to be considered:

- Assume the outer surfaces are contaminated.
- Remove gross contamination with the assistance of a dresser if available.
- Do not touch outer surfaces unless you have gloves on.

Box A4.2 outlines a general sequence for the safe removal of coveralls, which can be presented as part of FAO training.

BOX A4.2
Sequence for safe removal of contaminated coveralls

Following the removal of gross contamination, it is important to follow the sequence outlined below.

Remove zip cover if present.

Loosen both gloves and remove one.

Undo zip and remove the ungloved arm.

Shake off the other glove.

Reach inside the coverall towards the shoulder with the free arm.

Touching only the inside of the coverall, free the other arm.

The top half of the coverall has now been removed without touching the outer surface.

Pull down the coverall to the ankles.

Take care to touch only the inside surfaces of the coverall.

Step out of the coverall.

Fold the coverall into a ball so that the contaminated surfaces face inwards.

Used coveralls are waste.

Assume that they are contaminated;

Do not underestimate the value of the coverall or its components:

zips can be removed and sold;

wearing coveralls outside the workplace can be seen as a status symbol.

Package and label for disposal as waste.

Many of the coverall types listed above are available in a variety of colours. Colour can be used as an effective indicator to determine if workers are using the correct coveralls for a specific activity and to ensure that workers change coveralls when passing from one work area to another (e.g. from the hot zone to a buffer zone). The cost implication of colour options should also be considered when placing your order.

Gloves

Selecting an appropriate glove is very important when considering worker protection. Handling contaminated containers means direct contact of the hand area with the hazardous chemical to be repackaged. There is a need, therefore, to consider carefully not only the chemical resistance of the glove to the pesticide and any solvent carrier but also the mechanical strength of the glove when handling old corroded containers with an associated cut hazard. As with all PPE, gloves must be "fit for the intended purpose".

Many different plastic polymers are used to manufacture gloves. Different polymers offer differing levels of chemical resistance, and careful consideration should be taken when selecting the correct glove polymer for the safeguarding of specific pesticides. Gloves are generally tested via the breakthrough time of chemicals following immersion of the glove. The properties of the polymer plus the thickness of the glove will affect the breakthrough time. This can be obtained from the supplier of the equipment.

Remember these additional points when selecting gloves:

- What is the exposure route (dermal)?
- What is the hazard – WHO hazard class?
- What are the characteristics of the materials to be handled?
- What is the likelihood of contact?
- What is the likely duration of contact?
- Are there any carriers present that may affect the selection?
- Carriers may increase the real risk (formulations may enhance skin absorption).

Box A 4.3 provides some additional advice on selection of gloves.

BOX A4.3

Choosing the right glove for the job

Hands at work are extremely vulnerable to a wide range of hazards, which included cuts, blows, chemical attack and temperature extremes. The extent of protection which will be provided depends on the type of glove selected, how it is made and what it is made of. Inevitably, there will be a mixture of features which are desirable and in the end a compromise choice is often the result.

FIGURE A4.2.
Examples of gloves commonly used for safeguarding exercises

Leather "rigger" glove *PVC* *Cut-resistant nitrile* *Nitrile-rubber* *Nitrile surgical style* *Cut resistant Kevlar*

Maintenance

Contaminated and worn gloves may fail to protect the hands from the very hazard they were designed for. Effective protection is maintained by regular replacement of the gloves. Check the condition of the gloves, inside and out.

European standards

The presence of the CE mark on the glove packaging implies that the gloves comply with the basic requirements laid down by the EEC directive on personal protection equipment.

Simple design (Category 1)

For areas of 'minimal risk' where the effects of not wearing a glove are easily reversible or superficial. Such products are self-certified.

Intermediate design (Category 2)

For areas of specific risk (i.e. mechanical risks). Such products will have been EC type tested against European test methods and certified by a notified body.

Complex design (Category 3)

For areas/applications that can seriously or irreversibly harm the health. Such products, in addition to the CE type test, will also have to be either produced under an approved quality system or be type tested on an annual basis.

Complete a Web search for "*breakthrough times for glove polymers*" for further details on breakthrough times for common solvents with the various polymers used in glove manufacture. There is a wealth of advice freely available from glove suppliers as to the most appropriate glove polymer for handling a specific solvent-based pesticide formulation safely.

The increased potential for exposure and the need to handle pesticide containers will require a material with chemical resistance and mechanical strength. Teams may therefore wish to select a combination of gloves, such as an inner chemically resistant polymer glove with an outer mechanically strong leather/Kevlar glove. However, while this offers the best of both worlds in terms of protecting the wearer, it may impede the ability of the worker to handle and operate equipment.

Comfort is a final aspect to consider. Working in hot and humid environments can make gloves especially uncomfortable. To counteract this, thin, sweat-absorbent cotton glove liners may be used under thick polymer gloves to allow the wearer to work for longer in relative comfort.

Footwear

The entry of safeguarding teams into pesticide stores will result in the contamination of footwear. Teams must therefore make adequate provision to ensure that contaminated footwear is either fully decontaminated (in the case of reusable footwear) or safely discarded (in the case of disposable foot protection).

As with all PPE selection, it is important to consider the risks when selecting the correct footwear for an activity. For a safeguarding project, the principle risks are (i) crush injuries from falling containers and (ii) chemical contamination from leaking containers and spillages on floors in a store. Boot covers are generally used by personnel involved in the recording of inventory data and supervision of safeguarding activities and are not involved in the movement of contaminated packages. The boot covers offer nominal protection from low-level spills of chemicals in the store but offer no protection from crush injuries. Personnel involved with the movement of heavy packages should wear safety footwear with a protective toe cap and midsole. The boots should be made from chemically resistant material. The most commonly used footwear of this type is the *wellington-style* safety boot.

The completion of safeguarding activities may require an increase to the number of options for safety footwear. Personnel involved in the repackaging and handling of pesticides should wear wellington safety boots when working in the *hot* or *dirty zone*. These boots will need to be removed and decontaminated as workers leave the work area. It is therefore recommended that workers also be supplied with additional safety footwear for use outside the dirty zone in the form of *rigger-style* boots. The boots selected should not have laces and should include a protective toe cap. These items should be used for general manual work outside the dirty zone. The selection of a different style of boot also provides a simple visual supervision tool as with the colour coding of coveralls. Site rules at the pesticide store will need to stipulate that workers use wellington-style boots only in the dirty zone and rigger-style boots elsewhere on the site. Managers will therefore be able to ensure that potentially contaminated boots are restricted to the contaminated area of the workplace. As an alternative, workers may be provided with boot covers to wear over wellington boots in the dirty zone, which are discarded as waste each time the worker passes into other areas of the sites. Workers may also be supplied with a second pair of wellington-style boots, which are marked with spray paint to indicate where they can be worn. In all cases, the strategy for footwear which is adopted will affect the number and type of items supplied.

Projects should also consider the likelihood of visitors to work sites. Control of contamination remains a primary consideration and disposable shoe covers offer a cheap and easily usable alternative to the supply of additional boots or the supply of relatively expensive boot covers.

Figure A4.3.
Examples of safety footwear commonly used during safeguarding

Wellington safety boot *Rigger safety boot* *Disposable boot cover* *Disposable shoe covers*

Eye protection

The inventory and safeguarding of obsolete pesticides poses a risk of contaminated debris or chemicals entering the eye. It is important that all personnel involved in the completion of the inventory or safeguarding process be supplied with the correct type of eye protection for the activity to be completed.

As a minimum, personnel involved in the inventory of stocks should wear safety spectacles every time they enter a pesticide store or contaminated site. The glasses should be certified to comply with the appropriate European standard (or equivalent) and bear the CE mark. It is recommended that only polycarbonate, scratch-resistant lenses be selected. The style of safety spectacle chosen also needs to take into account the comfort of the wearer and fit at the bridge of the nose and ears.

Where there is a risk of chemical spill into the eye, workers are advised to use, as a minimum, safety goggles. Goggles offer an enhanced level of protection for workers but may be prone to misting and so interfere with the vision of staff, posing an additional risk. Every attempt should therefore be made to select anti-mist goggles and to monitor their use to ensure that the vision of the wearer is not impeded during work. Again, it is advised that polycarbonate, scratch-resistant lenses be chosen.

Safeguarding activities involving the pumping or decanting of liquid pesticides pose a more significant risk of contamination entering the eye. In such cases, workers should wear a protective face shield. The face shield should be made of scratch-resistant polycarbonate and offer all-round face protection. As an alternative, workers may be required to wear a full-face vapour mask (see below). The mask offers total eye and face protection and no additional glasses or goggles are required.

Figure A4.4.
Examples of commonly used eye protection

Safety spectacles

Safety goggles

Face shield

Respiratory protection equipment/masks

Completion of inventory and safeguarding projects will result in exposure to respiratory hazards. Pesticides are produced in a variety of formulation types, including dusts, powders, liquid formulations with volatile organic solvents and water-based liquid formulations. Personnel involved in an inventory could potentially be exposed to a combination of inhalation and ingestion risks from obsolete pesticides. These hazards coupled with the poor storage situations and high levels of leaking or spilled products in many pesticide stores make the risk of contamination potentially high and hence the selection of appropriate respiratory protection is of critical importance to worker safety. During safeguarding operations the potential for exposure to respiratory hazards is far greater and so an enhanced level of respiratory protection equipment (RPE) will generally be selected, based on the site-specific/chemical-specific risks as defined in the TBRA and SOPs.

The shape and size of faces varies greatly. This can result in masks not fitting properly and so not offering the required level of protection to the wearer. It is essential, therefore, that all personnel complete a *fit test* for the assigned mask type to verify that it provides the adequate level of protection before starting work in a hazardous environment with respiratory risk. Workers

should be tested for a variety of mask types and styles from different suppliers to determine which mask type provides protection from dusts, organic vapour and so on. The results of the test must be recorded, and workers should only be assigned masks of types that have passed the fit test.

Figure A4.5.
Fit test apparatus; fitting of mask to worker; completion of fit test

Masks and test kit

Fitting of mask

Use of test hood to determine fit

The variety of mask types, specifications and EC standards for the selection of masks is provided in Box A4.4. For inventory and safeguarding work performed by national teams, the options for respiratory protection are generally limited to *air-filtering* equipment. Air-supply equipment such as airline and self-contained breathing apparatus require specific user training and are not typically needed in projects of this type. If the level of risk does warrant use of this elevated level of protection, it is recommended that specialist hazardous-waste contractors experienced in using this equipment be contracted to complete the activities.

As a minimum, personnel involved in inventory projects should be supplied with dust masks. It is recommended that a combination of high protection factor (FFP3 and FFP2) disposable dust masks be available from more than one manufacturer to account for fit-test results which often demonstrate that masks from a single supplier do not fit all workers. Reuse of these items should only be considered when there is no contamination of the outer surfaces of the mask and where the level of dust in the work area was minimal. Masks should always be discarded as contaminated waste in all other cases.

Dust masks do not generally offer an adequate level of protection to workers in stores where liquid pesticides have been spilt and where there is an associated vapour hazard. In such cases personnel should be provided with a combined particulate/organic vapour half mask. Reusable and disposable options are available.

Both disposable and reusable half masks offer equivalent levels of worker protection provided that the correct filters are used with the reusable option. There are pros and cons to the use of both options. In general terms the reusable options should be supplied to workers who will be repeatedly using this type of mask as part of their everyday work. Personnel should be assigned a mask (after fit test) and be held responsible for the maintenance and cleaning of the mask as part of a regular programme that is recorded and monitored. Personnel will require training in this area, which is offered by many suppliers in the workplace through the local supply network. Adequate and appropriate filter cartridges are needed to provide dust and vapour filtration to the highest available standard (A2P3).

For less frequent users, it is often more cost effective and less onerous in terms of maintenance to supply disposable half masks. Local government support staff and store keepers assisting the principal inventory team may therefore be supplied with a mask that is used for a limited period and then cleaned for reuse by the team at the next store. Again, A2P3-level protection should be set as a minimum standard.

While both levels of mask (dust and half mask) are commonly used for safeguarding activities, higher levels of protection may sometimes be needed. A full-face vapour mask (FFVM) fitted

either with a filter or with powered systems provides high levels of worker protection and generally meets the needs of most safeguarding activities. Using and maintaining FFVMs requires training from a specialist, and personnel should be assigned a specific mask for which they are held responsible. A management, maintenance and inspection system for masks is essential to ensure that they continue to offer the required level of protection. A poorly maintained mask will not protect the wearer and so result in exposure and contamination.

For comfort during extended periods of use, it is recommended that a powered air-filtering system is used. Such systems use a battery-powered backpack to draw air through three filters housed on a belt. The purified air is fed to the FFVM through a hose which connects to the front of the mask. The air flow has a cooling effect on the wearer and the three-filter system extends the effective air-filtration time. Maintenance of the system is important with special care of the hose from the filter system to the mask being necessary. Systems such as this remove the weight of the cartridge from the front of the mask. Systems that fit the cartridge directly to the front of the mask can cause fatigue and neck strain over prolonged working periods.

FIGURE A4.6.
Examples of commonly used RPE

Examples of particulate (dust) masks

Examples of reusable and disposable combinations of half masks

Example of full-face mask with cartridge

Example of full-face vapour mask with belt-mounted filter unit

BOX A4.4

Respiratory protection selection guide

The selection of respiratory protection follows as a basic four-step method:[20]
1. **Identify the hazards:** dust, metal fume, gas, vapour.
2. **Access the hazards:** measure the hazard level/other protection – skin and eye.
3. **Select the proper respirator:** disposable, half mask, full face, powered, airline.
4. **Train in fitting and use:** to optimize respiratory protection.

Respiratory hazards

Dusts: produced when solid materials are broken down into finer particles, the longer the dust remains in the air the easier it is to inhale.
Mists: tiny liquid droplets formed by atomization and condensation processes such as spraying. Mists are often combinations of several hazardous ingredients.
Metal fumes: occur when metals are vaporized under high heat. The vapour is cooled quickly and condenses into very fine particles that float in the air.
Gases: airborne at room temperature. Able to diffuse or spread freely, they can travel very far, very quickly.
Vapours: gaseous state of substances that are liquids or solids at room temperature. Formed when substances evaporate in the way water vapour evaporates from water.

Respiratory terminology

Occupational exposure limits (OEL): there are two types of OELs: occupational exposure standards (OESs) and maximum exposure limits (MELs) listed in EH40/2000[21].
Maximum exposure limits (MELs): to comply with COSHH,[22] exposure should be reduced as far below the MEL as is reasonably practicable and should not exceed the MEL when averaged over the specified reference period.
OEL reference periods: there are two reference periods for which OELs may be set: eight-hour time-weighted average (TWA) and 15-minute short-term exposure limit (STEL). A substance may be assigned OELs at either one or both reference periods.
Eight-hour TWA: some adverse health effects can occur after prolonged or accumulated exposure. The eight-hour TWA is set to restrict the total intake by inhalation over one or more shifts.
15-minute STEL: some adverse health effects may be seen after short exposures. The 15-minute STEL may be applied to control these effects. For a substance assigned a 15-minute STEL MEL, this level of exposure should never be exceeded.
Immediately dangerous to life or health (IDLH): the IDLH concentration of a substance is defined as one "that poses a threat of exposure to airborne contaminants when that exposure is likely to cause death or immediate or delayed permanent adverse health effects or prevent escape from such an environment". The IDLS value represents a maximum concentration from which a worker would escape within 30 minutes without any impairing symptoms or irreversible health effects.
Odour threshold: the concentration of a substance at which the majority of individuals can smell or taste it.

[20] Reproduced with permission of Greenham Ltd. For original source data follow the link www.greenham.com.
[21] United Kingdom Health and Safety Executive (HSE), EH40/2002 – Occupational Exposure Limits 2002. EH40 lists all the current United Kingdom occupational exposure limits (OELs) for hazardous substances that are potential contaminants in workplace air (see www.hse.gov.uk).
[22] For regulation on the control of substances hazardous to health (COSHH), see the United Kingdom Health and Safety Executive (HSE) website on COSHH www.hse.gov.uk/coshh//

Protection factors

The updated British Standard BS4275 *Guide to Implementing an Effective Respiratory Device Programme* incorporates the latest information available on respiratory usage and is regarded by the Health and Safety Executive (HSE) as illustrating the current best practice in this area.

When matching the *Performance of Respiratory* protection to the measure respiratory hazard level, the *assigned protection factor* should now be used in the calculation, in place of the nominal protection factor.

Nominal protection factor (NPF): derived for the performance categories of the European Standards to which all respirators are tested.

Assigned protection factor (APF): based on workplace protection factor studies and listed in BS4275. The figure is used for calculation of selection.

Generally, it is only after a full RPE programme has been implemented that the APF is likely to be achieved by the majority of users in the workplace.

Guide for OEL

The measured airborne concentration of a respiratory hazard is established by workplace monitoring. The value has to be compared to a reference figure to determine whether actions are required to reduce exposure. The reference figure is usually the relevant OEL.

If the respiratory hazard is above the OEL, various control measures should be considered.

For example: if products containing the solvent toluene were in use, the exposure to toluene vapour would need to be established by monitoring. Toluene is listed in EH 40 with an occupational exposure limit of 50 ppm (parts per million). If the measured level at the workplace were to be above 50 ppm, control measure would need to be used to adequately reduce the exposure to the toluene vapour. The control measures could include improving general ventilation, extraction systems and respiratory protective equipment.

Calculation for the RPE selection

Air monitoring is required to measure the respiratory hazard level in the workplace. The hazard level is then compared to the OEL to determine the required respirator performance.

Example: Woodworking

1. Measured respiratory hazard level (wood dust) = 60 mg/m^2
2. Occupational exposure limit (OEL) = 5 mg/m^3

Divide 1 by 2: 60/5 = 12 × OEL.

Respiratory hazard level = 12 times OEL.

Assuming all other control measures have been considered, select a respirator with an APF greater than 12 × OEL.

e.g. 3M 9332 respirator

EN 149 FFP3S – APF: 20 × OEL.

European standards

Respirators are tested to the relevant European standards and CE mark. All respirators carry the CE mark plus the European standard and performance category markings.

EN 149 Filtering face piece particulate respirators.

EN 405 Valved-filtering half-mask respirators for gases and particulates.

EN 140 Half-mask face pieces.

EN 136 Full-face pieces.

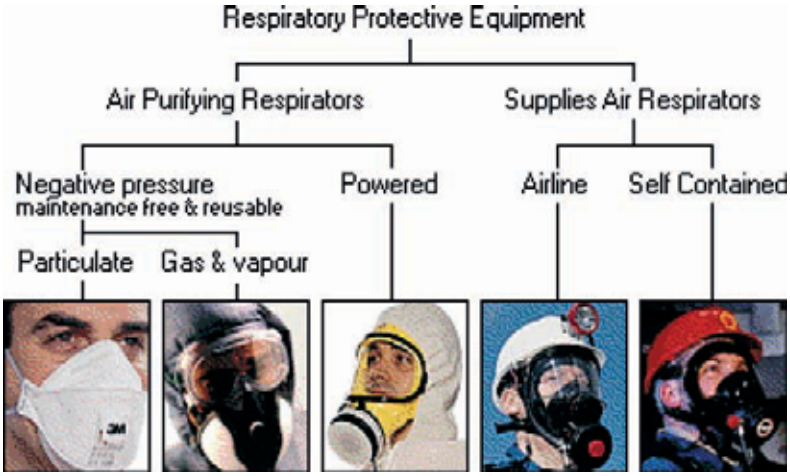
EN 141 Gas and vapour filters.

EN 143 Particulate filters.

EN 146 Powered respirators – hoods and helmets.
EN 147 Powered – full-face masks.
EN 270 Heavy-duty supplied air.
EN 371 Gas and/or combined filters for use against low-boiling organic compounds.
EN 1835 Light-duty supplied air.
EN 12941 Powered respirators – hoods and helmets (as EN 146 revised but also requires a low flow indicator).
EN 12942 Powered respirator full-face masks.

Types of respirator

Each type of RPE has specific limitations which dictate the types of application for which it may be used. RPE is tested to relevant European standards which determines the product performance.



Filters markings

For use against	Filter Type	Colour Code	Main Applications
Gas & Vapour (EN 141 & EN 405)	A	Brown	Organic vapours with boiling point greater than 65°C
	B	Grey	Inorganic gases and vapours e.g. chlorine (not carbon monoxide)
	E	Yellow	Acid gases and vapours, e.g. sulphur dioxide, hydrogen chloride
	K	Green	Ammonia and organic ammonia derivative
	P	White	Particulate
Particles (EN 143 & EN 149)	P1	White	Protection against particulates in concentrations up to 4 × OEL
	P2	White	Protection against particulates in concentrations up to 10 × OEL
	P3	White	Protection against particulates in concentrations up to 20 × OEL
Gas & Vapour (EN 371)	AX	Brown	Certain organic compounds with boiling points less than 65°C

A guidance booklet from the UK Health and Safety Executive EN 40 listing occupational exposure limits is available for further information.

Repackaging equipment

Specialist equipment is needed to transfer obsolete pesticides to new packages. For liquid pesticides the most common form of equipment used is a pump. For solid wastes, especially powders, waste is often transferred by manual means with the use of vacuum equipment to remove traces of contamination during safeguarding and for removal of final residual amounts of powder once the operations are complete.

As with packaging and PPE, the types and numbers of pumps and vacuums needed by the project will be defined by the inventory. In cases where the country decides on direct purchase of equipment, the PMU will need to analyse the data and decide how many of each type of pump and vacuum will be needed. In most cases, these items will be imported into a country prior to the start of the safeguarding phase of the project. It is important not to oversupply on items not needed as these items are expensive and the lead time for supply can be many weeks or months.

It is also possible to supply the inventory data as part of the safeguarding and disposal tender and therefore pass the responsibility for supplying adequate pumps and vacuum equipment of the appropriate type to the bidder. The risk of selecting the correct units and possible oversupply then passes to the contractor. The organization of delivery also passes to the contractor.

Safeguarding and disposal projects typically require the use of one or all of the following types of pumps and vacuums: pumps; vacuums and other electrical equipment, plant equipment, general site equipment, container-handling equipment, safety equipment and packaging materials. As mentioned above, the final selection of the number and type of pumps and vacuum equipment needed for a specific country can only be carried out once the inventory is complete. The project EMP and site-specific HSE plans for the higher-risk sites will also provide some data on the equipment needs for implementation.

As a general rule, all equipment supplied for the safeguarding of obsolete pesticides should be classed as *flameproof to Zone 0* as set out in the EU Directives 99/92/EC and 94/9/EC concerned with the use of electrical equipment in flammable environments.

Pumps

The transfer of liquids from one container to a new, typically 200 litre, drum requires specialist equipment. This is commonly called a *barrel* or *drum pump*. All pumps supplied for use in safeguarding projects for obsolete pesticides need to be capable of meeting a number of primary requirements:

- They must not generate any spark and so risk the ignition of flammable vapour.
- All parts of the pump should be chemically resistant to attack by solvents.
- They must be fitted with a non-return valve so as to prevent siphoning of liquid due to gravity when the pump is disengaged.
- They should be designed to remove all liquids from the original container with only small amounts of residue remaining.
- They should be well maintained or new with easy-to-follow maintenance and repair instructions.
- A number of critical spare parts should be supplied with all pumps.
- If used by inexperienced personnel, an activity-specific SOP and associated training module should be provided to ensure safe use.

The most commonly used type of pump is either air driven or one that uses an intrinsically safe electric motor. Both offer adequate flameproofing and are safe for use with flammable pesticide formulations. There are a number of international suppliers for such pumps. It is recommended that, if purchased by the country, that the procurement service complete a Web search for suppliers of "*flameproof barrel pumps*" to identify a wide range of suppliers. If the pump equipment is to be supplied as part of this bid proposal, it is important that all bidders provide the relevant information regarding the specification of any pumps to ensure that they meet the standards and specifications set out above.

Vacuums and other electrical equipment

All vacuum units operate by extracting air from a chamber, resulting in a pressure differential between the inside and outside of the container. The exhaust air which is extracted from the container will generally be in contact with the material being sucked into the unit and so will contain fine particles of dust. It is therefore important that all vacuum units filter the exhaust air so as to avoid the widespread dispersion of this fine particulate material and associated spread of contamination. The most commonly used system for filtration of vacuum air is the *high efficiency particulate air* (HEPA) filter. This system removes 99.97% of particulates in the 0.3 micron range. In addition to all vacuum equipment supplied under the tender meeting this requirement it is also important that:

- All units are supplied with wet and dry vacuum capability.
- All units are supplied as 110 V units or carry a certificate of electrical safety for use in wet environments.
- All units are compatible for use with a standard UN-approved 200 litre open-head steel drum or come as self-contained units with all necessary accessories.
- They should be well maintained or new with easy to follow maintenance and repair instructions.
- A number of critical spare parts should be supplied with all items.

If used by inexperienced personnel, an activity-specific SOP and detailed training module should be provided to ensure safe use.

A wide range of manufacturers and suppliers can be found on the Internet. If countries decide to purchase the equipment directly, they should complete a detailed Web search for suppliers of "*industrial HEPA vacuum systems*". If equipment is to be supplied as part of a bid proposal, it is important that all bidders provide the relevant information regarding the specification of any vacuum equipment to ensure that it meets the standards set above.

Important note: as with the supply of all electrical equipment, it is important to ensure that all associated extension cables, sockets and plugs, voltage transformers and other equipment are compatible. This responsibility is usually passed to the bidder but in cases where the country decides for direct procurement of these items, it is important that the correct supplementary items are sourced at the same time.

Plant equipment

The term *plant equipment* in this context refers to items such as forklift trucks (FLTs), cranes, mechanical excavators and other specialist equipment, including drum decontamination and crushing equipment. The supply of such equipment to a project has significant cost implications. The bid documents therefore need to specify if the government is able to provide any of this type of equipment for use by the contractor and under what terms – such as covering the operating costs, providing an experienced driver, wear and tear, and so on.

In cases where the government is unable to offer this equipment for use by the contractor, the contractors should be held responsible for either the purchase and delivery of the necessary equipment, or for the identification of suppliers of such equipment locally (they should list the suppliers in their bid submission). The relative merit of purchase of equipment versus rental locally through a subcontractor needs to be based on a commercial assessment and potential to maintain any equipment purchased under the contract under local conditions.

The detailed service and maintenance records of items such as FLTs and cranes are also important from a safety perspective. Only equipment that can demonstrate a fitness to complete the job at hand should be considered. This is especially true of any cranes used to load filled shipping cargo units of pesticide on or off trucks at collection points and/or the port area.

All such equipment requires an experienced operator who is licensed to operate the equipment. If contractor personnel are assigned to operate any equipment of this type, all licences

and test certificates should be provided before authorization to use the equipment is given by the PMU. This also applies to personnel responsible for fixing the crane to the item to be lifted. Only qualified "*slingers*" should be allowed to complete this role in the project and the bidder should again provide full qualifications of personnel responsible for completion of this activity. The need to provide experienced operators of machinery with the necessary licences must be spelled out in the bid documents.

For items such as hydraulic drums crushers and drum-rinsing equipment, it is important that all equipment is certified as flame/explosion proof in accordance with the EC Directives 99/92/EC and 94/9/EC (use of equipment in flammable environments). The installation of such equipment and the supply of the necessary power supply need also to be made clear in the bid documents as such equipment commonly requires a three-phase 450 V power supply.

General site equipment

A wide range of additional equipment will be needed for the safe implementation of a safeguarding and disposal project. The bid documents should therefore stipulate that all equipment to be provided by the contractor be listed and any specification for the items be provided. All equipment should be confirmed as being provided in good working order and, where necessary, work instructions need to be provided to ensure that all staff are familiar with the operation of the equipment. The bid should also ask for as much equipment as possible to be supplied locally and details of locally supplied items will need to be submitted by the bidder.

Figure A4.7.
Examples of protective membranes, warning tape and barrier mesh used to construct safe working areas

(a) Heavy-duty polythene sheeting *(b) Barrier tape* *(c) Barrier mesh*

BOX A4.5
Other equipment supplied locally

buckets and bowls
brooms and shovels
absorbent wipes
hose valve
first-aid kits (vehicle, store)
warning signs (printed and laminate)
pallets (as required)
scales (1000 kg)
chairs plus table
staple gun and staples
tool kit (spanners, hammer, etc.)

caps (one per worker)
T-shirt – (two per worker)
shorts – (two per worker)
towels, soap, etc. (per worker)
110 V transformer
cable tiles
plywood sheets
cloths hooks
plastic funnels
nails
heavy-duty adhesive tape
hand pump

Container-handling equipment

"Waste handling" includes activities related to the movement of containers within the store area plus the equipment necessary to load and offload items onto vehicles and cargo transport units (CTUs) for movement overseas for disposal.

The most widely used items are drum trolleys and hydraulic pallet trucks. Drum trolleys need to be suitable for the specific package size to be moved and should be fitted with an adjustable chime hook to help secure the drum on the trolley. The unit should be fitted with a kickstand to hold the truck upright when not in use. Wheels should ideally measure 30 cm × 5 cm to assist in movement over rough terrain. Load capacity is generally in the order of ± 300 kg (sufficient to allow movement of a filled 320 litre salvage drum). Various styles can be found, including versions which allow movement of items up and down stairs.

There is a wide variety of hand-operated pallet trucks on the market. Most warehouses will use this equipment to move pallets of materials. The items are simple to operate and should be certified to lift 1 metric tonne of cargo (approx. four filled 200 litre drums of liquid pesticide). Care is needed when purchasing/making pallets for use with this type of equipment as the spacing of the wooden staves can interfere with the lifting operation of the truck. Four-way pallets should be used if possible.

FIGURE A4.8.
Examples of commonly used container-handling equipment

(a) Drum trolley

(b) Drum trolley

(c) Pallet truck

Safety equipment

The PMU will need to provide adequate on-site emergency equipment to cope with accidental spillage, fire or injury to personnel. The following items will therefore be essential items to allow safe project implementation: fire extinguishers, spill-control materials and first-aid kits.

Fire extinguishers

The handling of liquid pesticide formulations will pose a potential fire risk. It is therefore essential that the work team have access to adequate fire-fighting equipment. It is recommended that, as a minimum, there be two 10 kg dry-powder extinguishers on-site plus additional 6 kg units kept in reserve. Each project vehicle should also be assigned a 6 kg unit as part of its operational equipment. The site-specific needs should be assessed as part of the site-specific SOP.

Spill-control materials

In the unlikely case of a spillage of pesticides during collection and repackaging operations, the safeguarding team must have access to specialist spill-control equipment. Each team and vehicle should be assigned a portable carry kit. Large spill-control kits for oils and aqueous materials should be placed at the main collection centre. Additional absorbent granules should also be kept in reserve in case of a serious incident. The exact type and quantity of spill-control materials should be detailed in the site-specific SOP.

There are a wide range of material suppliers. A Web search for "*spillage control materials*" should allow the PMU to identify locally based suppliers if needed. In projects where the supply of such items is passed to a contractor, the exact specification and quantities of the items supplied should be reviewed and approved by the PMU.

Figure A4.9.
Examples of commercially available chemical-spillage control kits[23]

(a) Large carry bag spill kit (100 litre) *(b) Medium spill kit (500 litre capacity)* *(c) Chemvac absorbent*

First-aid kits

The access to adequate first aid during site operations is essential. Field teams will need to be self-reliant in terms of access to emergency first-aid provision. As a minimum, a paramedic first-aid kit should be available at the main collection centres and higher-risk locations. In addition, each member of the safeguarding team should have their own first-aid kit which must be kept with them at all times during project implementation. Additional eyewash kits should also be available in all work locations.

[23] Photographs provided courtesy of Drizit South Africa.

Figure A4.10.
Example of paramedic first-aid kit used during safeguarding projects

Packaging materials

The selection and correct use of packaging is critical to the safe transport and storage of obsolete pesticides. The use of incorrect specifications can result in the catastrophic failure of packaging materials and the leakage of hazardous materials. The impact of such a failure may be compounded if the items are in transit to a storage facility (by road/rail) or disposal plant (by sea). The various packaging regulations for transport by road (ADR [International Carriage of Dangerous Goods by Road]), rail (RID [International Rule for Transport of Dangerous Substances by Railway]) and sea (IMDG [International Maritime Dangerous Goods]) all provide advice on the selection of appropriate packaging for safe transport. It is strongly recommended that the reader complete a training course on each/all of the above regulations to assist in the selection of the most appropriate packaging option, based on the project inventory data (online training for IMDG can be found at http://www.imdge-learning.com). It is important that the person selecting the packaging is familiar with the concept of *packing group* (PG) and understands the *packaging instructions* which may apply to individual chemicals as defined in the IMDG, as these relate to the risk posed by the material and are often linked to its concentration and hazards (flammability, corrosive ability, oxidizing capacity, etc.).

The section "Selection and use of packaging" in tool M refers to the *Certificate of Packaging Performance*. It is important that these be obtained from the packaging supplier for all types of package used in the project. If packaging is supplied as part of a safeguarding contract, then the contractor should provide proof that the packaging materials meet the requirements of the project and are compatible with the materials listed in the inventory data (usually supplied as part of the tendering process).

Most safeguarding projects will require the use of a combination of different container types. Examples of these are presented below in Box A4.5. It is again stressed that the particular package type used for a material listed in the inventory should be done on a case-by-case analysis of the hazards, chemical compatibility and physical characteristics of the waste.

BOX A4.5

Examples of packaging materials commonly used during safeguarding projects

Drum specification	Example
UN-approved, open-head plastic drums certified for PG I, II and III, fluorinated, UN code 1H2/X/…. UN certification mark stamped/embossed on body of drum.	 
UN-approved, closed- head plastic drums certified for PGs I, II and III, fluorinated, UN code 1H1/X/…. All plastic drums are stamped with date of manufacture and are valid for five years.	 
UN-approved, open-head steel drums certified for PGs I, II and III, epoxy phenolic lacquer lined, UN code 1A2/ X/... minimum 1.2 mm gauge.	  
UN-approved, closed- head steel drums certified for PGs I, II and III, epoxy phenolic lacquer lined, UN code 1A1/ X/... minimum 1.2 mm gauge steel with Trisure closures (two filling points). UN certification mark on drum side and base.	  
UN-approved, open-head steel salvage drums for PGs II and III liquids and solids, epoxy phenolic lacquer lined, UN code 1A2T/Y 320/….	 
UN-approved, woven polypropylene flexible intermediate bulk containers (FIBCs, i.e. Big Bags), certified for PG II and III dry granular solid powders, fitted with a sift-proof polythene liner bag, funnel top opening, UN code 13H3/Y/....	 

In addition to the examples presented above, some projects have used stainless steel ISO tanks for the transportation of liquid pesticides. While there is no technical reason why this is not allowed, this option can be expensive because of high rental charges and a general unwillingness by owners of the tanks to allow them to be used to carry hazardous-waste cargo such as obsolete pesticides. Similarly, the use of 1000 litre rigid *intermediate bulk containers* (IBCs) for the carriage of liquid wastes is technically feasible for some materials. In practice the handling and movement of filled items (weighing approx. 1000 kg) pose significant logistical problems and the general unwillingness of shipping companies to accept hazardous cargo in 1000 litre IBCs makes this option less attractive.

The national competent authorities for the IMDG are listed in the code. For a list of suppliers of UN-approved packaging, a simple Web search under "*UN approved containers*" will provide details of suppliers for the various categories of packaging presented above.

Annex 5: Example of reporting formats

Daily Progress Report	
Store name and number Briefing by:	Local counterparts and workers:
Planned activities for today	
Summary of work completed today	
Hours worked:	
Hours lost due to delays:	
Is the project on schedule:	
Any incidents/accidents/near misses (details):	
Planned operations for tomorrow	
Signed:	Position:

Daily Briefing Sheet		
Staff members present:	Absentees:	
Date & Time:		
Given by:		
Location:		
Previous day's progress		
Principal activities for day		
Activities:	Assigned personnel:	
Zone 1: Zone 2: Zone 3:		
TBRA and SOPs issued	Variations to TBRA & SOPs	PPE Requirements
		Zone 1: Zone 2: Zone 3:
Signed:	**Position:**	

Project Improvement Notice	
Completed by: Site number: Site name/Location (zone and region): Date:	
Deficiency in performance	
Corrective action required	
Time scale for implementation of corrective action	
Review of corrective action	
Improvement notice lifted	
Date:	Signed:
Failure to address improvements resulting in issue of prohibition notice	
Date:	Signed:

Project Prohibition Notice	
Completed by: Site number: Site name/Location (zone and region): Date:	
Deficiency in Performance	
Corrective action required	
Time scale for implementation of corrective action	
Review of corrective action	
Prohibition notice lifted	
Date:	Signed:
No Action taken: Project closed	
Date:	Signed:

Progress Report	
Date and time::	
Principal tasks	**Progress**
Safety issues	**Update risk assessment**
Variations	**Instruction issued**
Operations planned for next week	
Signed:	Position:

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