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AGRICULTURAL COMMODITY PROTECTION BY PHOSPHINE FUMIGATION PROGRAMMATIC ENVIRONMENTAL ASSESSMENT SUPPLEMENTAL INFORMATION ANNEX



NOVEMBER 2013

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Cover photos: Phosphine fumigation monitoring equipment (top left), DIMEGSA Pest Control staff in Guatemala (top right), USAID food commodities stored in a warehouse (bottom).

COMMODITY PROTECTION BY PHOSPHINE FUMIGATION IN USAID FOOD AID PROGRAMS

PROGRAMMATIC ENVIRONMENTAL ASSESSMENT SUPPLEMENTAL INFORMATION ANNEX

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ANNEX A. IN-TRANSIT FUMIGATION OF VESSELS WITH ALUMINUM/MAGNESIUM PHOSPHIDE FORMULATIONS

As a precautionary measure to disinfest commodities prior to shipment overseas, food aid is usually fumigated prior to arriving at a US port or once it arrives at the US port. Fumigants may include methyl bromide or sulfuryl fluoride; it is illegal to use them, however, for in-transit fumigation of vessels. In-transit fumigation of vessels is allowed only with aluminum/magnesium phosphide formulations. This treatment may not always guarantee an insect-free commodity when food aid arrives at a port in the receiving country. Since 1975, FGIS, in cooperation with the USDA's ARS and the grain, fumigant, and maritime industries, has been involved in research studies to develop safe, effective, and economical fumigation methods for bulk grain loaded aboard oceangoing vessels. Based on the data obtained from these studies, ARS has provided FGIS with recommendations for the safe and effective in-transit fumigation of bulk grain aboard several types of vessels. Accordingly, for bulk grain aboard certain carriers, FGIS has issued policies and procedures for in-transit fumigation with aluminum phosphide formulations.

- Fumigation of bulk grains in land carriers is authorized by section 800.84 (b) (3) of the regulations under the United States Grain Standards Act, as amended.
- The fumigation of bulk rice in land carriers is approved under the provisions of the 1946 Agricultural Marketing Act. Land carriers used for transporting bulk grains and rice (paddy, brown, or milled rice) include boxcars, hopper cars with covered tops that can be closed and secured, containers, and trucks with permanently enclosed tops. Grains in these carriers can be fumigated only if the carriers are stationary during the fumigation and aeration period. Boxcars are not approved for in-transit fumigation. Hatch and trough type hopper cars, and trucks, trailers, and containers with enclosed tops, sides, and bottoms are approved for in-transit fumigation if they are transported by rail within the US.
- Section 800.86(d)(1) of the regulations under the United States Grain Standards Act, and applicable provisions of the Agricultural Marketing Act of 1946, as amended, govern in-transit fumigation of bulk grain (barley, canola, corn, flaxseed, mixed grain, oats, rye, sorghum, soybeans, sunflower seed, triticale, and wheat) and rice in vessels.
- These Acts stipulate that for in-transit fumigation, only US EPA registered aluminum phosphide formulations may be used and must be applied by certified applicators or under the supervision of certified applicators. A certified applicator is any individual who is certified to use or supervise the use of RUPs covered by the certification (40 CFR 171.2 (h)).
- The certified applicator must inspect the vessel and verify that it is suitable for fumigation, and that no gas will leak into areas occupied by ship personnel.
- The applicators provide a written statement on company letterhead to FGIS or the agency requesting the fumigation regarding which tanks or holds are suitable for fumigation; reason for unsuitability must be clearly articulated. Both the certified applicator and the vessel's officer-in-charge sign the statement. The applicator will have a prefumigation conference with the vessel's officer-in-charge in the presence of FGIS or agency personnel and provide each party with an EPA-approved aluminum phosphide label.
- Additional signed written statement by the applicator on company's letterhead must include the identification of the tanks or holds to be fumigated; cubic capacity and depth of each hold or tank; date of fumigation; expected time to reach destination; the method of fumigant application; safety

precautions to be followed by the vessel's crew during the voyage; symptoms of exposure to the fumigant, and first-hand aid procedures in case of accidental exposure; determine if appropriate respiratory protection equipment and gas detection equipment are on board the vessel and at least two crew members knowledgeable in their use; a listing of vessel areas judged safe and unsafe areas during the fumigation; a listing of areas to be monitored daily for gas leakage; instructions for aerating the holds or tanks (tanks or holds should not be aerated at sea); and instructions for the retrieval and disposal of fumigant formulation residue and its accompanying packaging such as sachets, bag blankets, or sleeves upon arrival at the destination port.

- In accordance with EPA-registered label requirements for aluminum phosphide formulations and US Coast Guard regulations for shipboard fumigation (46 CFR 147A) and any applicable state and local laws, packaged aluminum phosphide formulations or systems to retain residual fumigant dust should be used after loading of the tank or hold is completed.
- The fumigated tanks or holds must remain closed and sealed for the entire voyage and should not be opened unless there is an emergency such as structural damage or fire.
- Warning placards must be placed on all entrances to the fumigated tanks or holds and on the outside of each manway. Each placard must show the skull and crossbones symbol and include the fumigation date, fumigant formulation used, and that the fumigated holds and tanks should not be aerated until arrival at the destination port. Placards must be in English or in the principal language of the vessel's crew.
- Typical time for vessel fumigation varies with the fumigant application method and commodity depth and may range from 3-18 days. FGIS officials must verify accuracy of information provided by the certified applicator, and attach a copy of all fumigation related documents to the Inspection Log (form FGIS-921) to have on file.
- Commodities such as bagged rice or grain, bagged commodities, or soybean meal that do not qualify for in-transit fumigation, but are fumigated in land carriers (as mentioned above) require an FGIS observer to witness the fumigation but not its efficacy against insects.
- If bulk grain or rough or brown rice for processing is infested, fumigation in accordance with procedures in the USDA's Fumigation Handbook must be followed. Once fumigated, an FGIS certificate will be issued as if the "infested" designation had never been issued. However, the US Sample Grade designation for milled rice with live or dead insects will remain in place.
- When fumigation is a quarantine requirement, it should be undertaken in accordance with the Fumigation Handbook procedures and the USDA's Animal and Plant Health Inspection Service (APHIS) will issue a phytosanitary certificate denoting that the commodity was fumigated. More information about the APHIS-FGIS Cooperative Agreement can be found in FGIS Directive 9180.35.

ANNEX B. AN ILLUSTRATION OF TITLE II FOOD AID COMMODITY SUPPLY CHAIN FROM EXPORT TO IMPORT COUNTRY

EXPORT COUNTRY (USA)					
STAGES IN THE SUPPLY CHAIN OF FOOD AID	1. PROCUREMENT OF FOOD AID	2. HANDLING	3. STORAGE OF FOOD AID AWAITING SHIPMENT	4. HANDLING	5. SHIPPING
<p>LIKELY ACTIVITIES AT EACH STAGE</p>	<ul style="list-style-type: none"> ▪ Determination of availability and amounts of surplus food commodity ▪ Design and development of emergency food aid programs and multi-year assistance programs specific for target countries needs ▪ Procurement of food aid 	<ul style="list-style-type: none"> ▪ Transfer of procured food aid commodity from a transportation carrier to a storage area ▪ Removal of cargo from carriers arriving at the warehouse or silo ▪ Tallying of received food commodity ▪ Segregation of any damaged or suspect units for further treatment ▪ Stacking of all sound units ▪ Inspection of all suspect units ▪ Salvage and reconstitution of 	<ul style="list-style-type: none"> ▪ Before stocking food aid commodity in storage facilities, the following have to be ensured: <ul style="list-style-type: none"> - Storage area is cleaned and dry - Application of contact pesticides ▪ Stored food commodity in grain silos, ware houses or other storage facility have to undergo the following: <ul style="list-style-type: none"> - Proper staking as required - Fumigated (pre-shipment fumigation) - Stock rotation - Frequent 	<ul style="list-style-type: none"> ▪ Transfer (receiving from, stacking, and loading into a transport carrier) of sound units of stored food aid commodity to a transportation carrier, in this case, a ship. ▪ Tallying of goods received from the storage facility and that loaded onto a ship for onward delivery, including noting of any unsound/damaged units 	<ul style="list-style-type: none"> ▪ Transportation of food aid commodity from export country port to import country port

		<p>any damaged units</p> <ul style="list-style-type: none"> Disposal of any commodities certified as unfit for human consumption 	<p>inspection of stock</p>		
<p>LIKELY STAKEHOLDERS AND INTERESTED PARTIES AT EACH STAGE</p>	<ul style="list-style-type: none"> United States (US) department of Agriculture USAID/DCHR/FFP USAID country Missions USAID Cooperating Sponsors with interest in the “import” country e.g. WFP 	<ul style="list-style-type: none"> Transportation company Survey company/firm or commodity brokers (acting on behalf of USAID/ DCHR/FFP, Cooperating Sponsors e.g. WFP) Silo and ware house managers Handling company managers and workers 	<ul style="list-style-type: none"> Survey company/firm or commodity brokers (acting on behalf of USAID/ DCHR/FFP, Cooperating Sponsors) Silo and ware house managers Silo and ware house workers Fumigation companies (fumigation workers) Fumigation training and certification companies USA Federal Grain Inspection Service (FGIS) official Public housing (nearby residents) in close proximity to fumigation sites of food 	<ul style="list-style-type: none"> Survey company/firm or commodity brokers (acting on behalf of USAID/ DCHR/FFP, Cooperating Sponsors e.g. WFP) Silo and ware house managers Handling company managers and workers Long- haul shipping company or vessel representative 	<ul style="list-style-type: none"> Long haul shipping company or vessel representative Survey company/firm or commodity brokers (acting on behalf of USAID/ DCHR/FFP, Cooperating Sponsors e.g. WFP)

IMPORT/RECIPIENT COUNTRY

STAGES IN THE SUPPLY CHAIN OF FOOD AID	6. RECEIPT OF FOOD AID AT IMPORT COUNTRY PORT	7. HANDLING	8. PRIMARY STORAGE FACILITY	9. HANDLING	10. SECONDARY STORAGE FACILITY OR TRANSFER TO A DISTRIBUTION CENTRE
<p>LIKELY ACTIVITIES AT EACH STAGE</p>	<ul style="list-style-type: none"> ▪ Inspection and clearance of food aid commodity by recipient country's customs official(s), or ▪ Transfer of the food aid commodity to a bonded warehouse awaiting inspection and clearance by import country custom's official (s), government agency or health department representative 	<ul style="list-style-type: none"> ▪ Transfer of food aid commodity from a transportation carrier (ship vessel) to a primary storage area ▪ Tallying of goods received ▪ Segregation of any damaged or suspect units for further treatment ▪ Stacking of all sound units ▪ Inspection of all suspect units ▪ Salvage and reconstitution of any damaged units ▪ Disposal of any commodities 	<ul style="list-style-type: none"> ▪ Before stocking food aid in storage facilities, the following have to be ensured: <ul style="list-style-type: none"> - Storage area is cleaned and dry - Application of contact pesticides ▪ Stored food commodity in grain silos, warehouses or other storage facility have to be: <ul style="list-style-type: none"> - Accounted/ documented - Staked as stipulated - Fumigated - Stock rotation - Frequent inspection of stock 	<ul style="list-style-type: none"> ▪ Transfer (receiving from, stacking, and loading out on to transport) of stored food commodity to a transportation carrier. ▪ Tallying of goods received from the storage facility and that loaded onto a transportation carrier for onward delivery, including noting of any unsound/damaged units 	<ul style="list-style-type: none"> ▪ If, a secondary storage facility further inland or at a regional hub at the recipient country, the activities and stakeholders for this stage are likely similar to that of stage 8. ▪ If, a distribution centre, activities are likely to be: <ul style="list-style-type: none"> - Tallying of goods received - Segregation of any damaged or suspect units for further treatment - Stacking of all sound units - Inspection of all

		certified as unfit for human			<ul style="list-style-type: none"> - suspect units - Salvage and reconstitution of any damaged units - Disposal of any commodities certified as unfit for human consumption - Distribution of quality food aid to recipients
<p>LIKELY STAKEHOLDERS AND INTERESTED PARTIES AT EACH STAGE</p>	<ul style="list-style-type: none"> ▪ Survey company/firm or commodity brokers (acting on behalf of USAID/ DCHR/FFP, Cooperating Sponsors) ▪ Recipient country customs, government agency or health department representative 	<ul style="list-style-type: none"> ▪ Survey company/firm or commodity brokers (acting on behalf of USAID/ DCHR/FFP, Cooperating Sponsors) ▪ Silo and ware house managers ▪ Transportation company ▪ Handling company managers and workers ▪ Recipient country 	<ul style="list-style-type: none"> ▪ Survey company/firm or commodity brokers (acting on behalf of USAID/ DCHR/FFP, Cooperating Sponsors) ▪ Silo and ware house managers ▪ Silo and ware house workers ▪ Fumigation companies (fumigation workers) ▪ Recipient country's grain inspection service official ▪ Public housing in close proximity to fumigation 	<ul style="list-style-type: none"> ▪ Survey company/firm or commodity brokers (acting on behalf of USAID/ DCHR/FFP, Cooperating Sponsors) ▪ Silo and ware house managers ▪ Handling company managers and workers ▪ Transportation company 	<ul style="list-style-type: none"> ▪ USAID/ DCHR/FFP, Cooperating Sponsors staff ▪ Distribution site temporary storage facility manager(s) and workers ▪ Recipient community

		customs <ul style="list-style-type: none"> ▪ Recipient country's grain inspection service official (s) 	sites of food commodity		
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Constructed with reference to:

Food for the Hungry, Inc. 2010. Commodity Management Manual- Level 300 Freight. Phoenix, Arizona.

Hale, H., and Franciscovich, W., (ed). 1999. Commodity management enhancement project- Food Aid Logistics Operational Handbook. CARE, USA

USAID. 2011. Scoping statement for programmatic environmental assessment (PEA) for Title II Food Aid Commodity Protection and Fumigation, Environmentally Sound Design and Management Capacity-building in Africa (ENCAP).

ANNEX C. SCOPING STATEMENT (EXCERPTS)

The environmental regulations (22 Code of Federal Regulations, Part 216) of the United States Agency for International Development (USAID) commonly referred to as Reg. 216, establish the conditions and procedures for the environmental review of activities funded with Agency resources.

This Scoping Statement is being developed to guide a Programmatic Environmental Assessment (PEA) of the current activities associated with the protection and management of food aid commodities from procurement to distribution and with particular attention to fumigation practices.

As part of the effort to both prepare this Scoping Statement and lay the groundwork for the eventual PEA, the FFP Office mandate to the contractor called for the establishment and operationalization of a Sharepoint site (<http://encap.sharepoint.afr-usd.org/envofficers/fumigationpea/default.aspx?>).

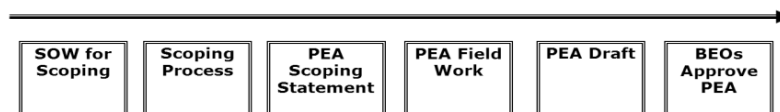


Figure 1 – Logic pathway for scoping and completion of PEA including stakeholder consultation and fieldwork as primary data gathering methodologies.

The USAID Food For Peace (FFP) office, through funding provided by the 2008 Farm Bill, 207(f) Oversight Authority under the Food for Peace Act, Public Law 480, Title II, makes agricultural commodity donations to Cooperating Sponsors [CSs: Private Voluntary Organizations (PVOs) or Non-Governmental Organizations (NGOs), Cooperatives, and Public International Organization Agencies, e.g., the UN’s World Food Program (WFP)] to address food security in both development and emergency food assistance programs. This distinction between emergency and non-emergency food aid is of interest here because traditionally emergency food aid is procured, transported and distributed more quickly than development program food aid, thus minimizing its exposure to pests and the need for protection/fumigation. In many instances, some emergency food aid commodities are “pre-positioned” at USAID run warehouses strategically located around the world. These commodities, as a matter of policy, are only stored for two months before being rotated out and restocked (personal communication, 2011, G. Olson/USAID/FFP).

Programs that Title II supports include but are not limited to direct commodity distribution, Food for Work (e.g., road rehabilitation), and commodity monetization to support an array of development activities (e.g., maternal-child health, agriculture, water/sanitation). Most of these commodities (with the exception of tinned food aid commodities such as vegetable oil) are fumigated with pesticides as they are made ready for shipment from the US or during transit. Primary warehouses where Title II commodity is discharged off shipping vessels and title transferred are found in all four regions where USAID operates. Table - List of Title II Development and Emergency Discharge Ports Worldwide

COUNTRY	DISCHARGE PORT	COUNTRY	DISCHARGE PORT
Africa Region			
Burkina Faso	Lome, Tema	Burundi	Dar es Salaam
CAR	Doula	Chad	Benghasi, Doula
Cote D’Ivoire	Abidjan	Ethiopia	Djibouti
Ghana	Tema	Guinea	Conakry
Kenya	Mombasa	Lesotho	Durban (SA)

Liberia	Monrovia	Madagascar	Toliara, Toamasina
Mali	Lome	Mauritania	Nouakchott
Malawi	Beira (Moz), Nacala (Moz), Durban (SA)	Mozambique	Beira, Maputo
Niger	Cotonou	Rwanda	Mombasa, Kigali
Sudan	Mombasa, Djibouti, Port Sudan	South Africa	Durban
Somalia	Mombasa	Senegal	Dakar
Swaziland	Durban (SA), Maputo (Moz)	Zambia	Durban (SA), Beira (Moz)
Zimbabwe	Durban (SA), Beira (Moz)		
Europe & Eurasia Region			
Afghanistan	Qasim	Tajikistan	Dushambe
Asia-Near East Region			
East Timor	Dili	Nepal	Calcutta
Bangladesh	Chittagong	India	Mumbai, Calcutta
Indonesia	Atapupu		
Latin America & the Caribbean Region			
Colombia	Barranquilla	Haiti	Gonaives, Callao, Port au Prince
Honduras	Puerto Cortes	Peru	Callao

Source: USAID/FFP



Photo - Food aid commodity infested with insects on arrival in-country. Evidence of boring damage and egg deposition apparent.

The **issue of fumigation** for USG food aid commodities has never been properly investigated by USAID, other donors, the UN or NGOs. The present USAID guidelines, as found in the Commodities Reference Guide (http://www.usaid.gov/our_work/humanitarian_assistance/ffp/crg/sec4.htm) are somewhat vague and variable. Different partners are using different approaches with varying degrees of sophistication that are not fully effective in ridding the food aid of insect pests. There is also a concern that some commodities may be exposed to "too many" fumigation cycles although it is unclear if this practice is dangerous or not.

Furthermore, USDA and FFP partners have had to destroy many hundreds of MT of commodity in recent times due to infestation. Disposing of large quantities of spoiled or contaminated food aid is an environmental management challenge itself. The PEA will set standards and provide guidelines as to what is and is not allowed for fumigation. Further, there should be a system that tries to identify where the infestation occurred and what measures should be undertaken to minimize future episodes.

Integrated Pest Management—USAID Best Practices: In addition to these pesticides, there is a range of closely associated integrated pest management and commodity management practices which when well executed serve to decrease the incidence of pest infestations and safeguard the quality of food aid resources. The interplay between these practices and the use of fumigants should also be considered here as part of due diligence of best practices. Both IPM and fumigation practices may also take on more importance as local procurement of food aid commodities becomes more commonplace and food safety and quality challenges have to be met in country.

PURPOSE OF THE PEA

The official review and approval of this PEA will precipitate a careful implementation which is expected to allow those involved in the program, whether representing USAID or its Cooperating Sponsor partners, to achieve a series of objectives, to wit:

- The PEA will bring the PL 480, Title II program into overall compliance under the precepts of the Agency's environmental regulations;
- The PEA will identify the potential for adverse human health and environmental impacts and recommend mitigation and monitoring measure to counter them;
- In doing the above, the PEA will develop tools and guidance that will lead to safer fumigation procedures and thus safeguard food aid quality, protect human health and ensure against adverse environmental impacts; and
- Build capacity for best management practices related to food aid protection and fumigation among the full array of stakeholders involved in Title II food aid.



Photo – Storage facilities for food aid commodities are expensive infrastructure investments, even some of the temporary facilities such as the Rubb Hall storage warehouse. Clean and neat facilities and properly stacked commodities are the start of sound storage practices and key to integrated pest management.

OUTCOME OF THE SCOPING EXERCISE

Scoping Exercise Methodology

The Scoping Exercise has been largely undertaken by an ENCAP consultant, Thomas Catterson from IRG, with direction and insight also provided by Dr. Erika Clesceri, DCHA Bureau Environment Officer, USAID, and participation from Dr. Walter Knausenberger, Bureau Environment Advisor, AFR/SD (please see their brief biographical sketches in **Annex D**).

Literature Review—a Sharepoint Site: Following the guidance outlined for scoping environmental assessments in USAID’s environmental procedures (Reg. 216), this Scoping Exercise methodology was simple and straight-forward. To begin with, a special effort has been made to identify and compile the most relevant literature related to the protection and fumigation of food aid commodities. There is actually some very good information available and as it started to accumulate, FFP suggested that a “Community of Practice” Sharepoint site be established as a means for making it available to a wider audience and ensuring that it remained intact ready for the actual PEA which will take place later this year. The intention is to eventually share this site with a wider stakeholder audience (<http://encap.sharepoint.af-sd.org/envofficers/fumigationpea/default.aspx?>). Please contact Erika Clesceri, DCHA/BEO to request access. A primary reference list drawn from the Sharepoint site is included here as Annex T-10.

Consultation—the Key to Environmental Assessment in the

US: The most important methodology for this Scoping Exercise, and something that will also feature prominently during the PEA itself, was consultation with the stakeholders. This began with consultations with in-house USAID staff in Washington involved in food aid programs. The Scoping Team was also favored by support from the staff of the FFP Advisory Support Project based at AMEX International who graciously assisted in organizing meetings with the Working Groups of the Food Aid Consultative Group. Member of three of the Working Groups—1) Packaging, 2) Food Aid Safety and 3) Quality Assurance, and Transportation—came together in Washington for half-days discussions with the Scoping Team during the week of April 18-22, 2011. The names and positions of the staff participating in these consultations can be found in Annex F.

These consultations took place in Washington and were so useful that the Scoping Team decided to widen its reach and sent out a follow-up questionnaire to all member organizations of the FACG and to USAID Mission FFP and Environment Staff. The list of those who responded is provided in Annex F and the questionnaire itself as sent can be seen in Annex G.

Draft Statement circulated for review: This document was circulated in draft for review and the comments and suggestions received have been incorporated into this final version. As is required, it is being submitted for official review and approval in anticipation of the scheduling of the actual Programmatic Environmental Assessment (PEA) later this year.

THE POTENTIAL FOR ADVERSE ENVIRONMENTAL IMPACTS

A careful consideration of the interplay between the announced activities being planned and the environmental sensitivities found at a given site where food aid commodities are stored and fumigated was made to develop a preliminary list of the potential adverse impacts. This analysis will consider environmental impacts to in potential impacts to both natural resources and the humans. This analysis also builds upon the issues raised during the consultations and in reviewing the relevant literature. The following issues were

Food Aid Tonnage (in million metric tonnes) by Fiscal Year:	
Fiscal Year	Total Million Metric Tons
2002	2.834
2003	3.716
2004	1.504
2005	1.647
2006	1.653
2007	1.372
2008	N/A
2009	N/A
2010	N/A
2011	0.949

Source: USDA/USAID Global Humanitarian Food Aid Risk Assessment Summary (FY 2007) & USAID/FFP Data Base Printouts.

identified and are considered central to a well-focused programmatic environmental assessment (PEA) of food aid protection and fumigation activities as currently practiced within the Title II Program.

- **Human health impacts from direct exposure to toxic or poisonous gases:** Fumigation gases affecting warehouse facility workers, fumigant applicators and/or cumulative effects of gases escaping to affect neighbors of the warehouse?
- **Contamination of food aid with pesticides or negative impacts on food aid quality and safety:** Is there such a thing as too much fumigation (especially of concern is aluminum phosphide) of food aid commodities? Does grain or food aid lose quality or become contaminated with hazardous chemical residues if fumigated too many times? Are some food aid commodities more sensitive to quality losses as a result of either pest infestations or repeated fumigation? What about the direct application of Actellic (Perimiphos-Methyl) dust into grain commodity, which is often proposed for controlling post-harvest storage loss of local farm produce?
- **Issues of human health risk assessment for vulnerable populations:** Are vulnerable populations that Title II program serve such as lactating women, children under two, chronically malnourished more susceptible to neurological or immunological impacts of exposure to pesticide residues associated with commodity protection? What about bioconcentration of pesticides in mother's breast milk and exposure infants through exclusive breast feeding? Issues of concern with dose-response curves for under twos vs full sized adults, given body burden per mass is higher?
- **Confusion about pesticides intended for use in sanitizing warehouse facilities and grounds:** Pyrethroids are commonly applied for crack, crevice, and spot spray treatment in and around the empty warehouse. However, some Deltamethrin or Cypermethrin synthetic pyrethroids, are being applied improperly on food aid commodities and contaminating them.
- **Pesticides inadvertently dispersal from the warehouse site:** Pesticide residues affecting people and/or the environment and how...what pathways? Pesticide residues tracked out of warehouse from normal in/egress or from sweeping residues out the doors of commodity storage area? Contamination of ground waters associated with dissolution of water-soluble pesticide residues in rainfall runoff?
- **Dangerous solid wastes mis-managed:** Other treatment residues—contaminated/toxic residues or solid wastes associated with fumigation and how to dispose of them? Disposal of empty containers or sachets?
- **Dangers associated with other kinds of pesticide use associated with food aid commodity protection:** How do rodenticides differ, are we considering them here, what about the disposal of the rats killed due to pesticide exposure? Insecticides used to rid the warehouse space of potential pests; what precautions and are these residues coming in contact with food?
- **Fumigation may not be enough or ineffective:** Is fumigation fully effective for the intended target pests or are some insect pests or food aid quality issues not being satisfactorily addressed? What about the effectiveness of phosphine gas on control of fungal contamination mycotoxin (i.e., aflatoxin, etc.) contamination of food aid commodities?

ISSUES EXCLUDED FROM FURTHER CONSIDERATION

- Inappropriate risks associated with pesticide use: Are they using banned pesticides for fumigation purposes and if so, why? This matter is not considered significant because it is understood that the use of Methyl Bromide, now prohibited because of its negative impacts on the ozone layer, has been banned from fumigation programs worldwide.
- Post Harvest Storage loss in FFP Development Programs is a related topic but beyond the scope of the present PEA. FFP may wish to consider working with the Bureau for Food Security to address post harvest loss, either as a separate PEA or general program study in the context of the broader Feed the Future (FtF) initiative.

- Disposal of Spoiled Food Aid Commodities is another closely related issue but one that will require separate and concerted attention beyond the means of the planned PEA.
- Food Aid Quality as a broader issue will not be considered here because pest infestation is only a small part of the wide range of characteristics currently being considered as part of an effort to enhance food aid quality. See for example the May 2011 GAO Food Aid Quality report.

A CONSIDERATION OF ALTERNATIVES

The provision of safe and quality food aid commodities to people in need around the world does not brook any compromises about infestation. Safe food is a basic human right. At the same time, however, it is USAID policy and regulation to protect the environment which provides goods and services for basic human needs and ecosystem function and also to use pesticides only in the context of an integrated approach to pest management. Anything that can increase the provision of clean, dry storage will go a long way to reducing the propensity for pest infestations. Several alternatives to reduce fumigation using toxic pesticides are being considered and studied, both in terms of cost and effectiveness, focusing on those approaches that could either be used immediately or feasibly commercialized within 3-5 years; they include:

- **Tiered pesticide application approach:** Lower toxicity pesticides applied first as a preventative measure, with higher toxicity pesticides like aluminum phosphide applied only if needed based upon observation and data collected, not simply as a matter of routine and time schedule.
- **Entolation of milled wheat** practice prior to shipment, (USAID OAA, Denise Scherl, communication).
- The use of **hermetically sealed bags** for shipping food aid commodities to ensure that they are not subject to attacks by pests once bagged. (USAID FFP, Judy Canahuati, communication) Add Nigeria and Purdue Univ study.
- **Diatomaceous earth** as grain protectants at community food aid distribution points for relatively inexpensive and safe method of storage insect control.
- Use of **naturally-occurring products** for protection such as black pepper, coconut oil¹
- Application of non-solid phase or liquid chemical, **alternative treatment** such as heat treatments, irradiation, and inert gases like CO₂.
- Greater use of **genetically modified organism (GMO)** commodity which would be more resistant to insect infestation of food commodities due to a greater durability of grain germ reducing opportunities for infection by pest agents.

RECOMMENDATIONS AND DRAFT SOW FOR THE PEA

Engaging the Stakeholders

The Programmatic Environmental Assessment (PEA) being planned here to examine the potential for adverse human health and environmental impacts from food aid commodity protection and fumigation should have a profound effect on these activities over the years to come. Given the magnitude of the Title II Program, it is recommended that a small working group within FFP (and possibly including other USAID Bureaus) be assembled to sponsor, monitor and to work in support of the Bureau Environment Officer (BEO) of DCHA to eventually act upon the findings of the PEA.

It has also been suggested that this Scoping Statement be presented to the Executive Committee of the Food Aid Consultative Group at their upcoming (Oct. 2011) meeting for their consideration and to raise the profile and support for this important environmental management undertaking.

¹ Swella G.B., Mushobozy D.M.K. (2007): **Evaluation of the efficacy of protectants against cowpea bruchids (*Callosobruchus maculatus* (F.)) on cowpea seeds (*Vigna unguiculata* (L.) Walp.)**. Plant Protect. Sci., **43**:

68–72. <http://journals.uzpi.cz/publicFiles/00299.pdf>

PEA Team Configuration – Recruitment and Contracting of a Multi-disciplinary Environmental Assessment Team

This Scoping Statement would propose an EA team made up of the following positions/disciplines:

- **Team Leader/Environmental Review Specialist:** The overall duties of the Team Leader will be to oversee the design and implementation of the EA, participate in the detailed planning of the EA and, as possible, the selection of the candidates for other team positions, and coordinate the roles and inputs required of the other members of the Team. Additionally, the Team Leader will be the person responsible for interactions and communications with both USAID/FFP, any USAID Missions to be visited and the representatives of the Cooperating Sponsors. Finally, the Team Leader will be responsible for compiling and editing the report to be prepared by the team members as a result of this PEA (estimated LOE: 58 person-days).
- **Food Aid Commodities Management Specialist:** As noted elsewhere, the protection and fumigation activities are and should be part of a larger whole, a systematic process to deliver quality food assistance to those in need around the world. The complexities, process and rhythm of that process can easily affect how commodities are safeguarded and whether they need additional treatments. The role of this specialist will be to provide a sound explanation of the system and advise his/her team colleagues on the practicalities being recommended as mitigation and monitoring measures (estimated LOE: 50 person-days).
- **Food Grain Protection Specialist:** A full understanding of the proposed design and the range of activities entailed in safeguarding the quality and safety of food aid commodities will be critical to identifying cause and effect as concerns the potential for adverse environmental impacts, whether direct or indirect. This individual will work in close collaboration with the Team Leader to assess the potential for adverse impacts and to suggest mitigation and monitoring measures where required (estimated LOE: 50 person-days).
- **Experienced Fumigation Specialist:** Given the critical nature of the use of these toxic chemicals and pesticides as part of protection efforts, the PEA Team must be able to draw on the experience of someone who has had extensive real exposure and involvement in fumigating food aid commodities in different settings around the world (estimated LOE: 50 person-days).
- **Social and Environmental Impacts Analyst:** The basic premises of these food aid programs are that they will help to alleviate food security needs and opportunities in the area where they work and improve the nutritional status of the beneficiary community. Testing the social hypothesis that people are satisfied with the food aid programs from the perspective of food safety and quality will be essential to fulfilling the community dimensions of its sustainable design. This consultant will interview both community leaders and local stakeholders (staff of the CSs/NGOs and host government agencies) and the beneficiaries themselves about the premises of the food aid programs in which they are involved (estimated LOE: 50 person-days).
- **Mycotoxin/Alfatoxin Specialist:** It is usually assumed that fumigation is ineffective in dealing with mold and putative related mycotoxins², however additional evidence suggests phosphine gas as an alternative for controlling fungal growth and subsequent mycotoxin production³. This PEA represents a good opportunity to look at this issue and propose measures for increasing the understanding about it and how to mitigate it (estimated LOE: 10 person-days).

IMPLEMENTATION PLANNING AND EXECUTION – SOME PRACTICALITIES

Organizing an Effective and Efficient Series of Field Visits: Because of the almost global breadth of the Title II Program, a selected set of field visits must be carefully chosen to ensure that a fulsome range of the

² **Commodity Reference Guide, Section IV: Controlling Damage to Food Commodities, January 2006,** http://www.usaid.gov/our_work/humanitarian_assistance/ffp/crg/sec4.htm

³ Castro M, Mills K. Phosphine: an alternative for controlling fungal growth and to avoid mycotoxin production in high-moisture stored grains. [serial online]. 2003; Available from: CAB Abstracts 1990-Present, Ipswich, MA. Accessed June 24, 2011.

activities and circumstances under which they take place are included in the data collection and analysis. The PEA Team should visit country programs including both relatively small and well organized program countries and also some of the more difficult circumstances under which food aid is stored up-country. Then too, two or three visits to select pre-positioning warehouse facilities are also foreseen.

It is tentatively proposed that two country program visits in Eastern and Southern Sub-Saharan Africa (possibly Kenya and Zimbabwe) including from primary warehouse (Mombasa) to community distribution points. In addition, travel to the port of Jacinto (Houston) may be involved. Finally, if time and resources allow, a visit to the port of Chittagong in Bangladesh and/or to the FFP program in Haiti may also be programmed. The duration of each country/pre-positioning site visit will depend on the extent of the travel required to see the targeted warehouse and food aid handling sites. Six day work weeks while on TDY are foreseen although typically the sixth day may be used by the Team itself for either travel or for internal discussions and analysis of the data and information they have collected.

Consultations with Local Stakeholders, USAID Missions and the Cooperating Sponsors:

As has been noted throughout this Scoping exercise, the PEA is not a critical evaluation of current practices but

rather an effort to obtain a current overview of the state of the art/practice globally, and to learn from existing practices and practitioners and make suggestions and prepare guidance for ensuring the continuing safety and quality of food aid commodities within the system. It is foreseen that the FFP Office in Washington will ask its staff in the field to explain the objectives of the PEA Team mission to the USAID/Mission, Host Government personnel who may be involved and the Cooperating Sponsors and their local NGO partners. These FFP Staff in-country will organize the field visits so as to be able to see both primary and secondary storage facilities, consult with staff responsible for food aid commodity management and some representatives of the beneficiary community.

PEA IS NOT AN EVALUATION

The PEA is not critical evaluation of current practices but an effort to obtain a current overview of the state of the art and practice globally. Key outcome is to learn from practices and prepare guidance for ensuring the continuing safety and quality of food aid commodities within the system.

The Team Leader will develop a protocol providing a structured format for in-country data and information collection which allows all team members to address the areas of their specific interest while still facilitating effective interchange and reporting.

Proposed Timing and Dates of the PEA: The following parameters for the PEA are foreseen:

- The present plan assumes a start date for the PEA in October 2011 with a total duration of approximately 10 weeks depending on Mission and CS concurrence for visits.
- The PEA Team will assemble and carry out a virtual team building exercise under the direction of the Team Leader and the BEO/DCHA over a three week time period, with an approximate total LOE for the team building of one person week per team member.
- Once the countries and programs to be visited have been determined, the PEA Team will engage in a one week preparatory desk study and review of the Scoping Statement for each country. Two country visits in Sub-Saharan Africa are foreseen.
- The PEA Team will undertake a two week tdy to each selected country, one each in Eastern and Southern Africa, and visit food aid storage facilities from primary warehouses to up-country community oriented storage.
- Upon completion of the country visits, the PEA Team will spend three weeks each synthesizing and reporting on their findings, following the annotated outline of the PEA Final Report, in close collaboration and communication with the PEA Team Leader.

Pre-Departure Preliminary Debriefing: The PEA Team will be expected to provide a pre-departure debriefing for USAID and representatives of the Cooperating Sponsors to present their preliminary observations about the findings in the targeted country, and to seek comment and clarification as necessary.

Preparation of an Annotated Outline of the PEA Report: At some point along the way, the Team Leader will conference with his/her team members to develop an annotated outline of the eventual PEA Report. This outline will adhere to the guidance provided in Reg. 216 about the required elements of an EA Report although it is likely that additional guidance and tools will be developed in the course of this PEA.

The draft Annotated Outline will be circulated to the FFP Officer in charge of the PEA and any other USAID colleagues who she/he may designate to review it. The intention is to conclude the field visits with an agreed annotated outline in hand with specific drafting responsibilities understood and assigned to different team members. The Team Leader will work with the other team members to establish a rational timetable for the presentation of draft sections of the PEA Report.

Preparation and Review of the Final Report of the PEA: The following steps and timing are foreseen for the preparation and review of the Final Report of the PEA:

- The first draft will be due one month after the end of field visits, to be submitted by the PEA Team Leader to the BEO/DCHA.
- After preliminary scrutiny by the BEO, the draft will be circulated for review among members of the staff of FFP, the Regional Bureau BEOs and the BEO of the Bureau of Food Security.
- Cooperating Sponsors and WFP staff designated as stakeholders as part of the PEA process will receive a copy of the amended draft two weeks after the internal USAID review sessions are completed.
- The final timing of the production of the PEA Report is foreseen for the month of January 2012 noting that there may be a bit of a hiatus during the holiday season.

ANNEX D. BIOSKETCHES OF CORE PEA TEAM MEMBERS

Karen Menczer served as Team Leader/Environmental Review Specialist. She has a B.S. in Biology and an M.S. in Ecology, and did research for a Ph.D. (ABD) in Galapagos, Ecuador. Currently she is an independent consultant, focusing on environmental impact assessment and biodiversity conservation for USAID and its partners. From 1991-1997, she worked in USAID/Latin America and Caribbean Bureau as Natural Resources Advisor and also served as the Bureau Environmental Advisor. From 1997-2007, she lived in Uganda, Jamaica, Botswana, and Ghana, first working directly for USAID/Uganda as a Natural Resources Advisor and Mission Environmental Officer, and later working as an independent consultant. Upon returning to the US, she worked for The Cadmus Group, preparing EIA guidance, course material, and conducting environmental reviews for USAID/Washington and USAID missions. She has served as Team Leader on several USAID EAs and PEAs; and as Deputy Team Leader of the Millennium Challenge Corporation Strategic EA for its Namibia Compact, overseeing the work of a 22-person team.

Dr. Bhadriraju Subramanyam served on the PEA Team as the Food Grain Protection and Fumigation Specialist. He has M.S. and Ph.D. degrees from the University of Minnesota, and is currently the Don Wilbur Sr. Professor of Postharvest Protection in the Department of Grain Science and Industry, Kansas State University, Manhattan, Kansas. His area of emphasis for 30 years has been on protecting food and feed products from insect infestation throughout the supply chain using chemical and alternatives. He developed pest management programs for the food and feed industries, and helped companies develop insect resistant packing. In addition to stored-product protection, he teaches courses in food laws and food safety. As a member of the PEA Team, he interviewed stakeholders, inspected warehouses, provided information for human health risk evaluator's desk study, and wrote many sections of the PEA document on health and environmental risks associated with phosphine and alternatives.

Maureen A. Babu served as the Participatory Stakeholder Analyst and NGO Liaison in the PEA Team. She is trained as a Biologist and Urban Environmental & Infrastructure Manager (B.S. in Biology, The University of Nairobi, Kenya and an M.S. in Urban Management and Development, Erasmus University, The Netherlands). Additionally, she has training in strategic, environmental and social impact assessments. Since 2009, she has been working as an independent consultant on assignments ranging from policy review and regional framework development on environmental/social management, monitoring and evaluation of programs, program development and management to research. One of her current assignments includes working as part of a Team to develop an EIA framework for the IGAD member states. Prior to working as an Independent Consultant, she worked for amongst others (2003 to 2007), IUCN- International Union for Conservation of Nature, Eastern and Southern Africa as a Program Officer.

ANNEX E. PEA SCOPE OF WORK (EXCERPTS)

Attachment B: Detailed SOW

Scope of Work

Programmatic Environmental Assessment (PEA) for Title II food aid commodity protection and fumigation

Under the Global Environmental Support Project (GEMS)

I. Background. USAID’s Bureau for Democracy, Conflict and Humanitarian Assistance (DCHA) has tasked the GEMS project with undertaking a programmatic environmental assessment (PEA) for Title II food aid commodity protection and fumigation

Overall Technical approach/process. The PEA will fulfill the requirements of 22 CFR 216, with particular, but not exclusive emphasis on 216.3(5) and 216.6. It will, with the exception of the below-specified changes, be guided by the attached **PEA Scoping Statement** for Title II food aid commodity protection and fumigation, including important references and materials. (This scoping statement and other important references which may be useful in PEA preparation are also available on the Bureau for Africa SharePoint site at <http://encap.sharepoint.afr-sd.org/envofficers/fumigationpea/default.aspx>).

The exceptions and changes to the scoping statement are as follows:

- The PEA team and attendant LOE envisioned by the scoping statement has been revised
- A “Screening Human Health Risk Assessment on the Use of the Fumigant Phosphine Gas and its Primary Precursor Aluminum Phosphide” (HHRA) is being commissioned as part of the PEA.
- Timeline and travel/site visits have been revised as set out in this SoW.

II. . Specific Objectives of the Assessment. Once reviewed and approved, this PEA will guide those involved in food assistance, whether representing USAID or its Cooperating Sponsor (CS) partners, to achieve a series of objectives. It will:

- bring the PL 480, Title II program into overall compliance under the precepts of the Agency’s environmental regulations;
- identify the potential for adverse human health and environmental impacts and recommend mitigation and monitoring measure to counter them;
- In doing the above, develop tools and guidance that will lead to safer fumigation procedures and thus safeguard food aid quality, protect human health and ensure against adverse environmental impacts; and
- build capacity for best management practices related to food aid protection and fumigation among the full array of stakeholders involved in Title II food aid.

III. Revised Team Composition.

Team Leader: To achieve the specific objectives above the Team Leader will:

- A. oversee the design and implementation of the PEA
- B. ensure all team members have carefully reviewed the Scoping Statement for the PEA, including the issues to be addressed and those to be excluded from consideration

- C. identify, and where feasible, seek to provide coverage for gaps in data or analysis, and revise team member SoWs, where appropriate.
- D. lead and coordinate interactions and communications with USAID/FFP, any USAID Missions to be visited, representatives of the Cooperating Sponsors, fumigation companies, and other stakeholders
- E. summarize concisely key impacts and programmatic recommendations and measures to mitigate adverse impacts and prepare the PEA environmental mitigation and monitoring plan
- F. provide a standalone summary document that will serve as guidance to CS's, USAID FFP staff, and other stakeholders on best practices in Food Aid protection and fumigation and IPM alternatives
- G. compile and edit the report sections prepared by the team members to ensure quality, completeness and uniformity in the draft and final PEA document
- H. lead the detailed planning of the PEA and coordinate the roles and inputs required of the other members of the Team.

Food Grain Protection and Fumigation/IPM Specialist: The specialist must have a full understanding of the proposed design and the range of activities entailed in safeguarding the quality and safety of food aid commodities and will identify potential adverse environmental and health impacts, whether direct or indirect; propose appropriate mitigation measures; and develop key elements of a programmatic environmental mitigation and monitoring plan. The specialist must be fully familiar with the state of the art literature on fumigation and IPM alternatives. The specialist will write key sections of the PEA on these impact and mitigation measures under the direction of the Team Leader. Given the use of toxic chemicals and pesticides as part of protection efforts, this specialist must have extensive real exposure and involvement in fumigating food aid commodities in different settings around the world. The specialist will also confer with and provide advice to the specialists preparing a separate Human Health Risk Assessment which is being conducted as separate desk study supplement to the PEA. In addition, fumigation is generally assumed to be ineffective in dealing with mold and putative related mycotoxins[1], however additional evidence suggests phosphine gas as an alternative for controlling fungal growth and subsequent mycotoxin production[2]. The specialist will look at this issue as well, and propose measures for increasing understanding and potential mitigation.

Participatory Stakeholder Analyst and NGO Liaison (PSA): The Participatory Stakeholder Analyst (PSA) and NGO Liaison (PSA) will be responsible for obtaining stakeholder views on potential social/health and gender impacts and their thoughts and recommendations on how to mitigate (minimize or avoid) those impacts. Under the direction of the Team Leader and in regular consultation with the Senior Social Impact Assessment (SIA) specialist, the PSA will: a) Identify and review the most current and appropriate literature on potential social/health and gender impacts and mitigation and monitoring measures related to food aid protection and fumigation; b) develop and apply a participatory stakeholder survey instrument for different stakeholder groups, including, but not limited to Cooperating Sponsors (CS's), community beneficiaries, FFP officers and staff, fumigation staff and fumigation company representatives; d) be responsible for writing key sections of the PEA on both the potential social/health and gender impacts and mitigation measures and the PEA environmental mitigation and monitoring plan; d) In addition to looking at impacts associated with current practice, help assess traditional methods for providing grain storage insect protection; e) be responsible for liaison with NGO's involved in food distribution and fumigation and for providing some logistic coordination for the team; f) seek regular advice and counsel from the SIA specialist throughout the PEA process; g) other tasks as defined by the Team Leader.

[1] Commodity Reference Guide, Section IV: Controlling Damage to Food Commodities, January 2006, [HTTP://WWW.USAID.GOV/OUR_WORK/HUMANITARIAN_ASSISTANCE/FFP/CRG/SEC4.HTM](http://www.usaid.gov/our_work/humanitarian_assistance/ffp/crg/sec4.htm)

[2] Castro M, Mills K. Phosphine: an alternative for controlling fungal growth and to avoid mycotoxin production in high-moisture stored grains. [serial online]. 2003; Available from: CAB Abstracts 1990-Present, Ipswich, MA. Accessed June 24, 2011.

Senior Social Impact Assessment (SIA) Specialist: The SIA Specialist will have a background in social/health and gender impact assessment and will mentor the PSA specialist on a regular basis throughout the PEA process, with special emphasis on helping guide the PSA to the most current and appropriate literature on potential social/health and gender impacts and mitigation and monitoring measures related to food aid protection and fumigation; b) help the SIA specialist and TL develop and apply a participatory stakeholder survey instrument for different stakeholder groups, including, but not limited to Cooperating Sponsors (CS's), community beneficiaries, FFP officers and staff, fumigation staff and fumigation company representatives; and review and comment on the SIA's written products.

Technical Quality Assurance/Quality Control Specialist: Pesticides/IPM and PERSUAP expert for QA/QC review.

IV. . Screening Human Health Risk Assessment (HHRA). A “Screening Human Health Risk Assessment on the Use of the Fumigant Phosphine Gas and its Primary Precursor Aluminum Phosphide” (HHRA) is being commissioned as part of the PEA. This is a desk study with a separate SoW and LoE that will be initiated prior to the Team site visits and completed shortly after submission of the site visit report. Findings will feed into draft and final PEA results, recommendation and guidance.

VI. Implementation Planning and Execution

Organizing an Effective and Efficient Series of Field Visits: Because of the almost global breadth of the Title II Program, selected site visits will be undertaken to ensure that information collected through literature reviews and remote interviews are corroborated and supplemented by on-site assessment and stakeholder interviews and incorporated in the data collection and analysis process. The PEA Team will visit country programs including both relatively small and well organized program countries and also some of the more difficult circumstances under which food aid is stored up-country. Also foreseen are two or three visits to selected pre-positioning warehouse facilities.

Two country program visits in Eastern and Southern Sub-Saharan Africa (possibly Kenya and Zimbabwe) are proposed including from primary warehouse (Mombasa) to community distribution points. The duration of each country/pre-positioning site visit will be limited to one week for Kenya and one week for the Southern African location and will also depend on the extent of the travel required to see the targeted warehouse and food aid handling sites. Six day work weeks while on TDY are foreseen although typically the sixth day may be used by the Team itself for either travel or for internal discussions and analysis of the data and information they have collected.

Consultations with Local Stakeholders, USAID Missions and the Cooperating Sponsors: As has been noted throughout the Scoping exercise, the PEA is not a critical evaluation of current practices but rather an effort to obtain a current overview of the state of the art/practice

PEA IS NOT AN EVALUATION

The PEA is not critical evaluation of current practices but an effort to obtain a current overview of the state of the art and practice globally. Key outcome is to learn from practices and prepare guidance for ensuring the continuing safety and quality of food aid commodities within the system

globally, to learn from existing practices and practitioners, and to make suggestions and prepare guidance for ensuring the continuing safety and quality of food aid commodities within the system. It is foreseen that the FFP Office in Washington will ask its staff in the field to explain the objectives of the PEA Team mission to the USAID/Mission, Host Government personnel who may be involved and the Cooperating Sponsors and their local NGO partners. These FFP Staff in-country will organize the field visits so as to be able to see both primary and secondary storage facilities, consult with staff responsible for food aid commodity management and some representatives of the beneficiary community.

The Team Leader with the PSA Analyst and the senior SIA Social Specialist will develop a protocol providing a structured format for in-country data and information collection which allows all team members to address the areas of their specific interest while still facilitating effective interchange and reporting.

VII. Proposed Timing and Dates of the PEA: The following parameters for the PEA are foreseen:

- The present plan assumes a **start date** for the PEA in December 2011 with a total duration of approximately 5 months depending on Mission and CS concurrence for visits.
- A one day **virtual team orientation** will occur in late December under the direction of the Team Leader and the BEO/DCHA. Two days of **preparatory desk study** and review of the Scoping Statement will occur prior to the team orientation and another two after the team has discussed the PEA Scope, for an approximate LoE of four person days per core team member for preparatory desk work and team building. The Food Aid Protection and Fumigation/IPM Specialist will submit a state of the art literature review to the TL prior to the late December team orientation.
- The PEA Team will undertake a **one week tdy to each selected country**, one each in Eastern Africa (Kenya) and Southern Africa (tbd), and visit food aid storage facilities from primary warehouses to up-country community oriented storage. The Team will be expected to provide pre-departure debriefings for USAID and representatives of the Cooperating Sponsors to present their preliminary observations about the findings in the targeted country, and to seek comment and clarification as necessary.
- Upon completion of the country visits, the PEA Core Team (TL, Food Protection/Fumigation Specialist and Participatory Stakeholder Analyst and NGO Liaison (PSA) will spend approximately three weeks each **synthesizing and reporting on their findings**, following the annotated outline of the PEA Final Report, in close collaboration and communication with the PEA Team Leader.
- **Preparation of an Annotated Outline of the PEA Report:** Within 4 weeks of startup, the Team Leader will conference with his/her team members to develop an annotated outline of the eventual PEA Report. This outline will adhere to the guidance provided in Reg. 216 about the required elements of an EA Report although it is likely that additional guidance and tools will be developed in the course of this PEA.
- **The draft Annotated Outline** will be circulated to the FFP Officer in charge of the PEA and any other USAID colleagues who she/he may designate to review it by **December 22nd**, 2011. The intention is to carry out the field visits with an agreed annotated outline in hand with specific drafting responsibilities understood and assigned to different team members. The Team Leader will work with the other team members to establish a rational timetable for the presentation of draft sections of the PEA Report.
- **Preparation and Review of the Final Report of the PEA:** The following steps and timing are foreseen for the preparation and review of the Final Report of the PEA:
 - The first draft will be due one month after the end of field visits, to be submitted by the PEA Team Leader to the BEO/DCHA.
 - After preliminary scrutiny by the BEO, the draft will be circulated for review among members of the staff of FFP, the Regional Bureau BEOs and the BEO for the Bureau of Food Security.
 - Cooperating Sponsors and WFP staff designated as stakeholders as part of the PEA process will receive a copy of the amended draft two weeks after the internal USAID review sessions are completed.
 - The core team will retain an additional one week to address and incorporate suggested revisions to the final document.

- The final timing of the production of the PEA Report is foreseen for the month of March 2012, noting that there may be delay as a result of the holiday season.

DCHA, Mission and Cooperating Sponsor (CS) Support. Successful execution of this SOW will require DCHA, mission and Implementing Partner support, as noted in the discussion of tasks above.

The nature and extent of mission and CS support will be determined in close consultation with DCHA and the Cadmus home office.

Locations: U.S., Kenya and Southern Africa.

Duration and Timing: 45 working days in total November to March 31, 2012, with site visits to Kenya and Southern Africa (9-23 January 2012.)

Total LOE: 45 days (5 days prep, 5 days transit, 12 working days on site visits, 18 days draft report preparation; 5 days integration of comments and final report preparation).

VIII. deliverables: (1) prior to December 22nd, (1) a detailed draft PEA Outline, a draft site visit itinerary and team member responsibilities; (2) draft site visit report (within 5 days of return from site visits); (3) draft PEA report by 19 February 2012 and final PEA (within 10 days of receipt of final comments or 31 March 2012).

ANNEX F: LIST OF CONTACTS

Name	Organization	Title	Email address	Phone(s)
Manhattan, Kansas Study Tour, January 2012				
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USAID/Washington Stakeholder Consultations, January 2012				
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Larry Sprague	Kelley Bean Co.	Senior Merchandiser	lsprague@kelleybean.com	989-288-7477
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Stephen Moody	USAID/FFP	Senior Advisor for Food Technology	smoody@usaid.gov	202-712-0768
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David Haysmith		Independent Consultant	davehaysmith@hotmail.com	
Rachel Vas	USAID/DCHA/FFP	Program Operations Specialist	rvas@usaid.gov	202-712-1666

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16 th April 2012- USAID briefing				
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17th April 2012- meeting with CSs in Addis Ababa and warehouse visits in Adama, Nazareth

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18th April 2012- warehouse visits, CSs and community beneficiaries representatives interviews in Adama (Nazareth)

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19th April 2012- meeting with pest management/fumigation and transport companies at Save the Children/ USA, Addis Ababa

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19th April 2012- Debrief session at CRS , Addis Ababa

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20th April 2012- Debrief at USAID with ALT Office (food commodity monitors), Addis Ababa

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20th April 2012- Meeting with WFP fumigation experts at the Hilton, Addis Ababa				
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DJIBOUTI: Discussions conducted by Karen, Subi and Maureen. Hany Elabe of USAID Djibouti attended all the meetings				
23rd April 2012- Warehouse visits, meeting with CS, surveyors, fumigation companies and the Djibouti Port (grain and fertilizer terminal) officials				
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24th April 2012- Warehouse visit, meeting with surveyors and transport company				
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ANNEX G. PEA RESEARCH QUESTIONNAIRE FOR FIELD WORK, APRIL 2012

a) Cooperating sponsors

1. At what point does your organization take responsibility for/control of the food aid commodity?
 - What type of food commodity do you receive?
 - What criteria do you use to release food aid commodity before accepting/receiving it?
 - Have you had any issues with the food consignment when it arrives (*i.e. the condition of the commodity*)?
 - o What actions did you take to address these issues?
 - From the time you receive the food aid commodity, how long does it take before it is distributed to the beneficiaries?
2. Where is the food aid commodity warehoused once you receive it?
 - How long does it stay at the primary warehouse?
 - Who is responsible for monitoring the condition of the food commodity at the warehouse?
 - o How is the monitoring done?
 - What happens if you find out that food commodity is infested?
 - What do you do to prevent infestation for food commodity? (*Describe the typical Integrated Pest Management (IPM) practice that your organization uses for food aid commodity protection*)
 - Of the pest insects, rodents, birds and moulds, which is your biggest problem?
 - If you have a problem, who makes the decision that food commodity is fumigated and how is this decision reached/made?
 - What criteria do you use to select the fumigation service providers? (e.g. trained, licensed to operate etc) (*request for a copy of the service contract*)
 - Do you have your own staff on site to monitor the fumigation process?
3. How do you transport the food commodity from the primary warehouse to the secondary and tertiary warehouses?
 - Do you rent or own the transport carriers?
 - Do you inspect the trucks before food commodity is loaded?
 - o What inspection criteria do you use (do you have a standard operating procedure (SOP) for inspection)
 - Do you practice in-transit fumigation?
 - o How is this conducted?
4. What concerns do you have about:
 - (a.) fumigation ?
 - (b.) the fumigated commodity?
5. What concerns do your beneficiaries have with regards to food aid commodity?
6. Do you know what happens before the food commodity arrives at the discharge port?
7. Do you have any suggestions for improving food aid commodity protection?

b) Warehouse/silo/ food storage facilities workers and their supervisors

1. Describe your food aid commodity receiving practices (*inspections at port or warehouse etc*)
 - By what mode of transport does food commodity arrive at the warehouse?
 - How do you manage your inventory?

- How do you manage the discharge of food aid commodity from the warehouse? (e.g. FIFO practice at the warehouse)
 - How do you store bagged food aid commodity in the warehouse? (e.g. stacked on pallets lined underneath with plastic paper)
 - What is the maximum height of the bagged food commodity stacks?
 - How do you store the different types of food commodities (e.g. segregation by commodity, risk of infestation)
 - How do you maintain cleanliness of the warehouse (sanitation practices)?
 - Who makes the decision on commodity protection? How is the decision made? (what is it based on?)
2. What is the turnover rate of food commodity in the warehouse?
 3. Who is responsible for monitoring the condition of the food commodity at the warehouse?
 - How is the monitoring done?
 - What steps do you take for commodity protection? (What are your IPM methods used?)
 4. Do you have your own warehouse staff trained in pest identification and management?
 - Do you self-apply pesticides?
 - What safety procedures are observed? (e.g. Personal Protective Clothing)
 - What are the specific training and certification requirements that you adhere to?
 - Is any staff trained and certified to apply fumigants?
 - Do you store any chemicals on site?
 - What are your chemical storage procedures?
 5. If fumigation is done, describe the fumigation process/practice adopted by the warehouse (request for a printed protocol)
 - How do you fumigate food aid commodity? (e.g. entire stack in the warehouse or a portion)
 - Once you open a flask of tablets do you use all of it?
 - What fumigant formulation is applied? (Request for a copy of the label, Material Safety Data Sheet)
 - What dosage is applied and what guides the decision on amount, time for the fumigation process etc to be considered?
 - Do you monitor the fumigation process when in progress?
 - How do you monitor gas concentrations?
 - What safety precautions do you take during fumigation?
 - How do you know when to fumigate or use other pesticides?
 - What are your major pests of concern?
 - Do you use rodent bait stations?
 - What rodent baits do you use?
 - How do you dispose off dead rodents?
 - Do you have issues with moulds in food aid commodities?
 - What actions do you take to address this?
 - What difficulties have you noticed with respect to food aid commodities
 6. Which of the commodities is more susceptible to infestation by insects and/or rodents?

c) Fumigation companies: workers and supervisor

1. Where is your work based? (In the city or elsewhere)
2. How were you selected as a contractor to conduct fumigation?
 - How many people perform a fumigation operation?
 - What does each individual do?

- How long does it take to cover stacks with sheets and put sandbags?
 - How many times per month (or per year) is fumigation performed?
 - For how long are commodities typically fumigated?
 - Do workers enter the structure as fumigation is on-going?
 - How many years have the workers been conducting fumigation?
 - For how many years do workers generally perform fumigation?
 - o Do fumigation workers also apply other pesticides?
 - What training is offered to workers? (*Qualifications and continued education*)
 - What risks are you concerned about during fumigation?
 - Have there been any incidences while using fumigants?
3. What services do you provide during your warehouse visits?
4. What products are used by your organization for fumigation? *-(Request for a copy of the label, Material Safety Data Sheet)*
- How do you know when to fumigate or use other pesticides?
 - What are the other pesticides used? (*label and MSDS*)
 - Do you apply any pesticides to warehouse floors and walls?
 - Do you apply pesticides to surfaces of bags on pallets?
 - How are the stacks to be fumigated prepared before fumigation?
 - o What is the fumigation dosage that is applied? (*2-3 tablets/ton or 1-1.5 g/m³*)
 - Do you fumigate all the food stacks in the warehouse or a portion of it?
 - o If a portion is treated, is the warehouse open for workers to enter to perform cleaning or maintenance work?
 - What safety measures are taken during fumigation?
 - o How is this communicated to the (illiterate) employees?
 - Describe your adopted fumigation process/practice (Before, during and after). Is there a standard operating procedure or practices that you follow?*-request for a written protocol*
 - What is the typical fumigation length in days?
 - How do you measure gas concentrations (during and after a fumigation)?
 - How do you determine gas tightness of the commodity under tarps? (*Do you do a pressure test?*)
 - How do you know you have a gastight enclosure during fumigation?
 - What smell gives you an indication of gas leakage through tarps?
 - Describe your fumigant residue retrieval and disposal practice? (*do you deactivate residue in water or do you bury it in the ground?*)
 - o If you bury the residues, how far from the warehouse do you bury it and how deep?
 - How do you dispose off pesticide's packaging/container and expired pesticides specifically fumigants?
 - How long is the aeration or fumigant clearance period after fumigation?
 - How many hours are spent by the fumigation worker in the structure as ventilation is being prepared (removal of tarpaulins, etc.)?
 - How do you know when it is safe to re-enter the warehouse after ventilation?
5. What constitutes an effective fumigation process?
- How long does it take before the next fumigation assignment at the same warehouse?

d) Transportation companies

1. What modes of transportation do you provide? (*railcars, trucks, other means*)
 - Do you own or lease transportation carriers?
2. How do you prepare the carrier prior to loading food aid commodity? (*Disinfestations procedures, if any---request of the company's written procedures*).

3. Do you inspect food commodity to check for infestation before loading?
 - Where do you look for infestation (*floor-wall junctions*)
 - What actions do you take if infestation is noted?
 4. Do you also use your trucks to transport non-food commodities?
 - o Please indicate the non-food commodities?
 5. During transportation, how do you protect the food aid commodity from weather conditions (e.g. rain)?
 6. When transporting food aid commodity, do you carry other non-food materials along?
 7. What is the average time taken for transportation of food aid commodity?
 8. What issues have you faced while transporting food aid commodity?
 9. What is your opinion on in-transit fumigation, if it is practiced?
- e) **Community beneficiaries**
1. What types of food aid commodity do you receive?
 2. From where do you collect the food aid commodity?
 3. Describe the general condition of the received food aid commodity (*e.g. clean, dry, smelly, moldy, infested etc.*)
 4. Are you satisfied with the quality of the food commodity? (*from the useability standpoint*)
 5. Describe any incidences where the food commodity may have been of poor condition
 - What actions did you take?
 - How was this communicated back to the distributors?

ANNEX H: US REQUIREMENTS TO OBTAIN CERTIFICATION TO USE RESTRICTED USE PESTICIDES

The following information is revised from:

<http://www.epa.gov/agriculture/lfra.html#Restricted%20Use%20Classification%20and%20Certification%20of%20Applicators>;

<http://www.ag.ndsu.nodak.edu/aginfo/pesticide/subpages/guidePesticideCertification.htm>

Pesticide certification is required by the United States Environmental Protection Agency (US EPA) for people selling, purchasing, or using restricted use pesticides (RUPs). The regulation is under the 1947 Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) Part 171. Requirements listed in Part 171 are intended as a minimum and set a federal standard from which US states can develop their own. Many states have incorporated stricter regulations than the federal.

Under FIFRA, registrations and product labeling may restrict uses of pesticides. Each registration specifies the crops/sites on which it may be applied, target pests, which the product is meant to control, and each use must be supported by research data (although such data are not required for US EPA registration). As a part of the pesticide registration, US EPA must classify the product or some uses of the product as “general use” where certification or training is not needed, and as “restricted use” where training and certification is needed, because these pesticides cause unreasonable adverse health and environmental effects when they are used inconsistent with the labeling.

Restricted use pesticides are limited to use by pesticide applicators, who are certified by an accredited body (in the US, this is the state’s Department of Agriculture), or to people under the supervision of a certified applicator. Under FIFRA, US states and tribes that choose to certify pesticide applicators submit a state/tribal plan to the US EPA Administrator. The Administrator approves the plan if it meets a number of conditions contained in [FIFRA Section 11\(a\)\(2\)](#), and the power to administer the certification is relegated to the state’s Department of Agriculture.

Certification and training regulations require pesticide applicators to meet certain training requirements before they apply pesticides labeled “for restricted use.” The purpose is to ensure that US federal regulations are being used when using pesticides at the US state level.

Certification Standards

Certification means a person has met the certification standards established by the Pesticide Control Board or other authorizing body of the applicable US state (or if the certification is not administered by the US state, the US EPA retains authority). Certification standards are in the form of a written examination. A person seeking certification has to pass a written test administered by the state’s Department of Agriculture. The test is offered in a “category of interest” (there are many categories of certified applicators). After passing the written test, the applicator can renew the license every year to every three years, as mandated by state regulations. License renewal is obtained by attending a Pesticide Applicator Training Program held jointly by a state university in cooperation with a state’s Department of Agriculture.

Pesticide applicators can also earn continuing education credits (CUEs) on pesticide application by attending several private and public training sessions that are pre-approved by states prior to the training

ANNEX I.

TRADITIONAL METHODS OF PROTECTION AGAINST PESTS OF STORED FOOD

UNDER

THE USAID PROGRAMMATIC ENVIRONMENTAL ASSESSMENT (PEA) FOR
TITLE II FOOD AID COMMODITY PROTECTION AND FUMIGATION

Prepared for:

The PEA Team

Prepared by:

Maureen Babu (Participatory Stakeholder Analyst and NGO Liaison)

March, 2012

INTRODUCTION

In Africa, the bulk of grain is produced by small scale farmers (Blum and Bekele, 2000). Nukenine (2010) further explains that agriculture in Africa is largely traditional and grains constitute the bulk of food production. Sorghum, maize, rice, wheat and millet for cereals and cowpeas, dry beans, groundnut, chickpea and bambara groundnut for pulses, are most common. In India, out of the total grain production, approximately 70% remain in the villages and is stored in traditional structures, the remaining 30% which is surplus destined for the market, is handled by traders and governments (UNESCO).

Agricultural production in these areas is seasonal while the demands for agricultural commodities are more evenly spread throughout the year. Therefore, grain storage becomes a particularly important agricultural activity. Grain storage is done on-farm, peasant farmers' residences (family granaries), community stores and large warehouses. Since most of the grains produced are destined for human consumption, storage in family granaries predominates.

Food security for these farmers, and especially in famine prone countries, depends on their success to grow and store their staple food that they need for their families. This is done while ensuring a minimum loss of quantity and quality, with the use of an effective and affordable storage method. They must be able to keep the stored produce until the next successful harvest, and this might be more than a year, in the case of crop failure. Even in developing countries which have central storage facilities, farmers in peripheral regions find it difficult to procure the needed grains in times of famine, unless they can rely on their own food stores. Purposes for on-farm storage can be summarized as follows: for household food consumption; future cash reserves especially if better prices are expected in the long run; use as seeds in the next planting season; coping strategy in the event of drought; collateral against bank loans.

TRADITIONAL POST HARVEST MANAGEMENT

The time of harvesting varies slightly throughout the agro-climatological zones. Farmers may tend to wait until later in the year for harvesting, more specifically, when the moisture content of the grain is thought to be lower. This factor is considered as the most crucial when deciding on the optimal time for harvesting, especially when the grain will be stored (Nukenine, 2010). Farmers decide when to harvest by experience, examples include: how hard the seeds feel when placed between their teeth and cracked, based on the seed color and according to the coloring of the stem just below the grain head (Blum and Bekele, 2000).

The harvested products are dried even further after threshing and shelling to separate the grains from the cob, pod or ear; winnowing the grain to separate good from damaged grain and debris; and before the eventual storage. Seed drying is mostly done by exposure to the sun rays for a certain period of time and the duration for exposure is dependent on the type of grain. For example, grains that are considered to have high moisture content are exposed to the sun drying method for a longer period. Sun drying is carried out while ensuring that abrupt or over drying of the grains does not occur, as these will reduce the nutrient content or germination capacity of the grains. However, if weather conditions are too cloudy, humid or even wet, then the crop may not be sufficiently dried and post harvest losses could be high.

TRADITIONAL GRAIN STORAGE METHODS

While preparing grain for storage there are three important practices that should be followed: keeping the produce dry, cool and insect free. In tropical climates, the ability to store seeds for an extended period is often limited due to adverse climatic conditions such as heat and humidity. In general, factors influencing grain storage are both scientific and socio-economic in nature. The scientific factors include physical, biological, zoological, chemical and engineering factors, whereas the socio-economic factors are finance, marketing, methods of farming and technical know-how (UNESCO). Examples of scientific factors include pests, rodents, birds and micro-organisms. Their activities result in not only a considerable loss in quantity but also result in qualitative deterioration.

Deterioration of stored grains is described as resulting from the interactions among defective or unfavorable physical, chemical and biological variables that exist in the system. For grain storage facilities including traditional systems, to be considered effective and efficient, the following functional and structural requirements must be met: adequate capacity and strength; ability to withstand all weather conditions; protection from rodents; insulation efficiency; loading and unloading arrangements; economics of the structure.

The length of storage depends on the agro-ecological zone, ethnic group, the quantity of commodity stored, the storage condition, the crop variety stored, etc. Grain is kept longer in the higher altitudes such as in temperate regions where the cooling effect is unfavorable to pest development. Across Africa, grain storage periods generally range between 3 to 12 months. Storage period amongst small and marginal farmers in India vary from 6 to 12 months.

The use of traditional stored product protection methods is very popular among small-scale farmers. The methods are numerous, diverse and widespread across the continents, with regional and country particularities. Those with the ability to store grains without compromising the quality of the stored commodity, protect grain from pest infestation and attack by moulds, thus ensuring that application of fumigants such as aluminium phosphide is rarely or hardly required, shall be explored in the subsequent sections.

Hermetic storage: Hermetic storage (gas tight) is an ancient way of storing grains in clay pots, underground pits or mud-plastered structures. Grain stored under hermetic conditions creates an atmosphere high in carbon dioxide and low in oxygen, thus protecting the stored seeds from insect infestation as these conditions are not conducive for insect production and survival. The low and controlled internal humidity levels in this storage system further provides an environment not conducive for pest infestation or mould growth. Insects' presence has direct influence on grains by creating hot-spots within the stored commodity, in addition to direct destruction of grains through feeding and reproduction (Nukenine, 2010). Hot-spots are areas that experience an increase in grain temperature and moisture contents, which lead to an increase in respiration and consequently loss in quantity and quality of the grain.

This ancient storage principle has been further elaborated and developed into modern storage bags, which have a much better ability to retain the gases produced by the grains and prevent changes in humidity. This is further strengthened by the ability of the hermetic

storage facility to create a gas barrier thus disabling entry of oxygen or humidity from the external environment of the storage facility (Bruin; Feed Technology Update, 2006).

- a) **Underground granaries/ pits:** These are commonly found in areas where the water table is low (FAO, 1997; Nukenine, 2010). The underground pit may be round or square in shape. Grain stored in pits is especially prone to attack by fungus. Therefore, to isolate the grain from the surrounding soil, lining of the pit becomes an important issue. Different materials can be used for lining such as straw, grass, plastic, dung and cement. Many farmers use more than one material to line the underground pits. In India, the underground pits, referred to as *gudana* have their walls and the floor plastered with cow dung and the floor covered with a fine layer of sand (UNESCO). From experimental research findings, Blum and Bekele (2000) further indicates that grains in pits with plastic lining remain cooler and drier, and lost less dry weight and seed germination rate, compared to grain in pits with grass or cement lining, or none at all. However, the price of plastic is still prohibitive for most small farmers in developing countries.

Usually, after loading the grains into the pit, the mouth of the pit is covered. For example in some regions in Nigeria, a stone slab is used and tree stems placed on top, across the pit, which is then covered with polyethylene or metal sheet etc (Adejumo and Ruji, 2007). The surrounding areas of underground pits are kept free from grass to discourage possible habitation by rodents and hibernation by weevils. Cats are also kept by farmers to keep off rodents.

Overall, it is believed that grains stored in these plastered underground structures are protected against insect attack because of reduced internal oxygen level. Incidences of theft, especially during a scarcity season are believed to be reduced when these underground structures are used.

- b) **Earthen pots:** Pots are made of burnt clay. The shape and sizes differ with the locality. Grains stored in earthen pots are known to retain their viability. Also these structures are considered not to be susceptible to attacks by rodents.
- c) **Off-the-ground mud/dung plastered structures:** Cow dung or mud coated on the floor and the sides of traditional storage structures prevent entry of insects into the stored grains, including providing airtight conditions within the storage structure.

In Ethiopia, there is the *gotera*, which is a large basket woven from wood, mud and cow dung, with a lid made from the same materials. *Goteras* are located in a cool place that is protected from direct sunshine. The surrounding area is kept free from grass to discourage possible habitation by rodents and hibernation by weevils. Cats are also kept by farmers to keep off rodents. Farmers can store wheat for one year up to five years or more in a *gotera*. Occasionally, farmers store sorghum mixed with *tef*, which is a very small grain and helps to make the content of the *Gotera* airtight and to keep it cool. It also obstructs the movements of insects.

In India, paddy is packed tightly in hay to keep it airtight during storage in cow dung wall plastered structures referred to as *ganaja*. These are temporary structures that are constructed after every harvest. The problem of contamination or infestation of

fresh stocks from instances where a permanent storage facility is not thoroughly cleaned is believed not to occur in the case of *ganaja*, as they are constructed afresh after each harvest.

To protect stored grains against pests such as termites, water or smoke is let into the holes, in the termite hills. Termites are also known to attack timber, and this may include the timber support frame of many traditional storage structures. A project conducted in Zimbabwe in 1996 to 1999, has successfully addressed this problem by modifying traditional storage structures by using PVC pipes filled with concrete as the support frame, totally excluding rodents and termites (Research into Use, 2012).

Botanical pest control agents: The high costs and the erratic supply of chemical pesticides in developing countries have stimulated a renewed interest in traditional botanical pest control agents used in the above traditional grain storage structures. The use of plants and also their local names changes from place to place. Chilli pepper and Finger Euphorbia are among the most commonly used biological pest control agents in most countries in Africa.

When grain is stored for seeds like in some parts of Tanzania, farmers sometimes sprinkle urine from a cow or goat or salt over the grain, for preservation. This is done two days before putting the grain into storage to ensure that it is dry. When salt is only used, the grain can be stored directly after dressing. Farmers in Uganda use banana juice, pepper, Mexican marigold and eucalyptus leaves, for pest control in stored grains (FAO, 1997; Nukenine, 2010). In India, neem leaves are mixed along with ragi, a staple food crop for Hunsur region to, keep it free of pests. Additionally, when rice is stored "Umi or Husk" is mixed with it in order to keep it free from pests (UNESCO).

Practically when botanical pesticides are used, farmers place leaves of the local plants, which are assumed to have repellent and protective effects against insects, between grain layers and on top of the stock within the storage system. Additionally, seeds from the fruits of these botanical pest control plants are ground, mixed with water and the mixture applied to the stored grain (Blum and Bekele, 2000).

CONCLUSION

Traditional storage structures are numerous and diverse, but only those with some hermetic characteristics were considered in this review. Though possessing some hermetic abilities, these traditional storage structures may still be prone to biotic and/or abiotic factors. For example, underground granaries may be susceptible during floods. Off-the-ground cow dung or mud plastered structures may eventually develop cracks which could be entry points for pests, rodents and external air & humidity. Additionally, the storage system frame, if made of wood, may be susceptible to termite attacks and favor other sources of infestation. There is also the concern that the actual effect of traditional botanical pesticides is yet to be experimentally demonstrated, though there are indigenous reports of success.

Interestingly, the hermetic characteristics have been improved and scaled upwards into modern storage facilities such as Cocoons, which allows for bulk storage like in the case of food aid. These have been used in Rwanda, Philippines and Thailand to mention but a few. Cocoons are described as hermetically sealed "silos." Herein, bagged grains are stored under

modified atmospheric conditions, insulated from ambient atmosphere by means of a special fabric that serves as a gas barrier. The metabolism of any organisms or insects that may have made its way into the stored products creates a modified atmosphere that is low in oxygen and high in carbon dioxide. The low permeability, flexible PVC material used in the Cocoons both prevent changes in humidity and protects the stored grains from rodents. The modified atmosphere controls the proliferation of pests, prevents growth of fungi and slows down oxidation. Bruin and Feed Technology Update (2006) further state that with the use of Cocoons, all the quality aspects of the stored grains are protected without the need of aeration or fumigation. Whereas in non hermetic conditions, stored grains are exposed to atmospheric oxygen and external humidity, and therefore insect infestation cannot be controlled without the use of toxic pesticides.

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ANNEX J PICTURES OF FOOD AID COMMODITY STORED IN WAREHOUSES IN UGANDA, ETHIOPIA, AND DJIBOUTI

(All pictures were taken during the PEA Team's fieldwork, and were taken by PEA Team members.)



Photo no. 1: ACDI/VOCA Warehouses with Cats. (Animals should be prevented from entering the warehouse)



Photo no. 4: Polypropylene Bag with Wheat Showing Gaps Near the Stitches. (Insects can easily enter through these openings (Adama, Ethiopia)



Photo no. 2: ACDI/VOCA Warehouse with Open Doors (This will let birds, rodents, and insects easily gain access into the warehouse)



Photo no. 5: Gaps near Seams Large Enough for Insect Entry (Adama, Ethiopia)



Photo no. 3: Save the Children Warehouse in Adama, Ethiopia showing gaps underneath the door



Photo no. 6: Poorly Lit Warehouse Interior (WFP, Adama, Ethiopia). A Handheld Machine for Stitching Torn Bags



Photo no. 7: Spillage of Wheat on Rubber Pallets (WFP, Adama, Ethiopia)



Photo no. 10: Torn Corn Soy Blend Being Rebagged(Catholic Relief Services, Adama, Ethiopia)



Photo no. 8: Bird Fecal Material on Corn Soy Blend (Catholic Relief Services Warehouse, Adama, Ethiopia)



Photo no. 11: Pesticide (includes AIP) Storage Shed with permanently open meshed windows (WFP, Adama, Ethiopia)



Photo no. 9: Tents Used for Food Aid Commodity Storage (Catholic Relief Services, Adama, Ethiopia)



Photo no. 12: Dust Masks Used During Phosphine Fumigation (WFP, Adama, Ethiopia)



Photo no. 13: Sand Snakes Used to Hold Down Fumigation Sheets (WFP, Adama, Ethiopia)



Photo no. 16: Bulk Wheat Being Bagged and Stitched at Djibouti Port



Photo no. 14: Fumigation Sheets in Storage (WFP, Adama, Ethiopia)



Photo no. 17: Bagged Wheat in Temporary Storage at Djibouti Port



Photo no. 15: Grain Being Pneumatically Unloaded From a Ship Hold. Note Birds (circled in red) Inside The Hold (Djibouti Port)



Photo no. 18: Spillage underneath Pallets at a Warehouse in the Free Zone (Djibouti)



Photo no. 19: Corn Soy Blend Spillage with Insect Trails in a Djibouti Warehouse in the Free Zone



Photo no. 21: Nail Sticking Out of a Pallet. Note Spillage of Corn Soy Blend (Warehouse in Free Zone, Djibouti)



Photo no. 20: Birds Roosting on a Light Fixture Warehouse in the Free Zone in Djibouti



Photo no. 22: Pit Used to Dispose Empty Phosphine Containers (WPF, Adama, Ethiopia)

PEA TOOLS

ANNEX T-I. ECONOMICALLY IMPORTANT STORED-PRODUCT INSECT SPECIES ASSOCIATED WITH GRAIN AND GRAIN PRODUCTS

Order	Family name	Scientific name	Common name
Major or Primary Insect Pests			
Coleoptera	Bostrichidae	<i>Prostephanus truncatus</i> (Horn)	Larger grain borer
		<i>Rhyzopertha dominica</i> (F.)	Lesser grain borer
	Curculionidae	<i>Sitophilus granarius</i> (L.)	Granary weevil
		<i>Sitophilus oryzae</i> (L.)	Rice weevil
		<i>Sitophilus zeamais</i> (Mots.)	Maize weevil
	Laemophloeidae	<i>Cryptolestes ferrugineus</i> (Stephens)	Rusty grain beetle
		<i>Cryptolestes pusillus</i> (Schönherr)	Flat grain beetle
		<i>Cryptolestes turcicus</i> (Grouvelle)	Turkish grain beetle
beetle	Tenebrionidae	<i>Tribolium castaneum</i> (Herbst)	Red flour beetle
		<i>Tribolium confusum</i> (Jacquelin Du Val)	Confused flour
weevil	Bruchidae	<i>Callosobruchus chinensis</i> (L.)	Southern cowpea
		<i>Callosobruchus maculatus</i> (F.) <i>Acanthoscelides obtectus</i> (Say)	Cowpea weevil Bean weevil
	Anobiidae	<i>Lasioderma serricorne</i> (F.)	Cigarette beetle
	Dermestidae	<i>Trogoderma granarium</i> Everts	Khapra beetle
		<i>Trogoderma variabile</i> Ballion	Warehouse beetle
beetle	Silvanidae	<i>Oryzaephilus surinamensis</i> (Fauvel)	Sawtoothed grain
		<i>Oryzaephilus mercator</i> (L.)	Merchantgrain
moth	Pyralidae	<i>Cadra cautella</i> (Walker)	Almond moth
		<i>Plodia interpunctella</i> (Hübner)	Indianmeal moth
		<i>Corcyra cephalonica</i> (Stainton)	Rice moth
		<i>Ephestia kuehniella</i> (Zeller)	Mediterranean flour
moth	Gelechiidae	<i>Sitotroga cerealella</i> (Olivier)	Angoumois grain

A brief illustration of the adult stages of the insects is provided below. Generally adults stages are easy to identify.



Prostebhanus truncatus (Horn)



Rhyzopertha dominica (F.)



Sitophilus granarius (L.)



Sitophilus oryzae (L.)



Sitophilus zeamais (Motschulsky)



Cryptolestes ferrugineus (Stephens)
(Gourville)



Cryptolestes pusillus (Schönerr)



Cryptolestes turcicus



Tribolium castaneum (Herbst)
(L.)



Tribolium confusum (Jacquelin du Val)



Callosobruchus chinensis



Callosobruchus maculatus (F.)



Acanthoscelides obtectus (Say)



Lasioderma serricorne (F.)



Trogoderma granarium Evert
(Fauvel)



Trogoderma variabile Ballion



Oryzaephilus surinamensis



Oryzaephilus mercator (L.)
(Hübner)



Cadra cautella (Walker)



Plodia interpunctella



Coryra cephalonica (Stainton)
(Olivier)



Ephestia kuehniella (Zeller)



Sitotroga cerealella

There are several insect species associated with stored products. For a comprehensive list see Hagstrum, D. W., and Bh. Subramanyam (2009). Stored-Product Insect Resource. American Association Of Cereal Chemists, St. Paul, Minnesota. Illustrations from: Hagstrum, D. W., T. Klejdysz, Bh. Subramanyam, and J. Nawrot. 2012. Atlas of Stored-Product Insects and Mites. American Association of Cereal Chemists, St. Paul, Minnesota (in press).

ANNEX T-2 GUIDE FOR DEVELOPING A FUMIGATION MANAGEMENT PLAN

THESE ADDITIONAL ANNEX PIECES ARE PDF FILES THAT WILL NEED TO BE ADDED TO FINAL DOCUMENT

THIS ANNEX CONTAINS:

- 1) GUIDANCE FOR DEVELOPING A FUMIGATION MANAGEMENT PLAN**
- 2) TWO FMP TEMPLATES**
- 3) ONE COMPLETE FMP**

In the US, all new phosphine labels require anyone fumigating commodities or structures to develop a Fumigation Management Plan (FMP) for each fumigated storage site. Fumigation service providers or Cooperating Sponsors responsible for fumigating food aid commodities with phosphine should develop an FMP as part of fumigation good practice. An FMP is a written documentation that provides specific logistical, performance, and contact information to help "characterize" the fumigation of a commodity storage site. An FMP is written to ensure the safety of the applicators, the storage facility employees, the surrounding community, and the environment. It is also designed to ensure a legal and effective fumigation.

Prior to writing a FMP, carefully read and review both the label and the Applicator's Manual for the fumigant product to be used. Assemble and organize all of the information needed to develop a FMP. The phosphine Applicator's Manual also lists all items to be considered when developing a FMP. Preparation is the key of any successful fumigation. Once the FMP has been written, a copy of this information must be given to the appropriate company officials (supervisors, foreman, safety officer, etc.) in charge of the site.

The guidance provided here is specific, yet allows flexibility for addressing a wide range of potential fumigation sites. Each item in the list below must be considered. However, each fumigation is different and not all items will be necessary to record for each fumigation site.

Checklist for Developing a FMP

- A. Preliminary Planning Facility and Commodity Details
 1. Determine the purpose of the fumigation (elimination of insect infestation, elimination of vertebrate pests, plant pest quarantine).
 2. Determine the type of fumigation (space, vehicle, container, vessel, etc.).
 3. Fully acquaint yourself with the structure and commodity to be fumigated to determine its suitability for fumigation, including:
 - a. The general structure layout, construction (materials, design, age, maintenance), fire or combustibility hazards, connecting structures and escape routes, above and below ground, and other unique hazards or structural characteristics. Prepare, with the owner/operator/person in charge, a drawing or sketch of structure to be fumigated, delineating features, hazards, and other structural characteristics.

- b. The number and identification of persons who routinely enter the area to be fumigated (i.e., employees, visitors, customers, etc.).
- c. The specific commodity to be fumigated, its mode of storage, and its condition.
- d. The previous treatment history of the commodity, if available.
- e. Accessibility of utility service connections.
- f. Nearest telephone or other means of communication. Mark the location of these items on the drawing/sketch.
- g. Emergency shut-off stations for electricity, water, and gas. Mark the location of these items on the drawing/sketch.
- h. Current emergency telephone numbers of local Health, Fire, Police, Hospital, and Physician responders.
- i. Name and phone number (both day and night) of appropriate company officials.
- j. Check, mark, and prepare the points of fumigant application locations if the job involves entry into the structure for fumigation.
- k. Exposure time considerations:
 - i. Minimum fumigation period, as defined and described by the label use directions.
 - ii. Down time required to be available.
 - iii. Aeration requirements.
 - iv. Cleanup requirements, including dry or wet deactivation methods, equipment, and personnel needs, if necessary.
 - v. Measured and recorded commodity temperature and moisture.
- l. Determination of dosage:
 - i. Cubic footage or other appropriate space/location calculations.
 - ii. Structure sealing capability and methods.
 - iii. Label recommendations.
 - iv. Past history of fumigation of structure.

B. Personnel - Training and Notification

- 1. Confirm in writing that all personnel in and around the structure and/or area (bystanders and neighbors) to be fumigated have been notified prior to application of the fumigant. Consider using a checklist that each employee initials indicating they have been notified.
- 2. Instruct all fumigation personnel to read the Applicator's Manual concerning the hazards that may be encountered and the selection of personal protection devices, including detection equipment.
- 3. Confirm that all personnel are aware of and know how to proceed in case of an emergency situation.
- 4. Instruct all personnel on how to report any accident and/or incidents related to fumigant exposure. Provide a telephone number for emergency response reporting.
- 5. Establish a meeting area for all personnel in case of an emergency.

C. Notification of Authorities

- 1. Confirm the appropriate local authorities (fire departments, police departments, etc.) have been notified as per label instructions, local ordinances, or instructions of the client.
- 2. Prepare written procedure ("Emergency Response Plan") which contains explicit instructions, names, and telephone numbers so as to be able to notify local authorities if phosphine levels are exceeded in an area that could be dangerous to bystanders and/or domestic animals.

3. Confirm that the receiver of in transit vehicles under fumigation have been notified and are trained according to the Application Manual.

D. Sealing Procedures

1. Sealing must be adequate to retain gas for the longest duration (7 days) to control the pests. Care should be taken to insure that sealing materials would remain intact until the fumigation is complete.
2. If the structure has been fumigated before, review the previous FMP for previous sealing information.
3. Make sure that construction/remodeling has not changed the building in a manner that will result in loss of the fumigant or affect bystanders.
4. Warning placards must be placed on every possible entrance (all sides) to the fumigation structure. Confirm the placement of placards.

E. Application Procedures and Fumigation Period

1. Confirm the required safety equipment is in place and the necessary manpower is available to complete a safe and effective fumigation.
2. When entering into the area under fumigation, always work with two or more people under the direct supervision of a certified applicator wearing appropriate respirators.
3. Provide watchmen when the possibility of entry into the fumigation site by unauthorized person cannot otherwise be assured.
4. When entering structure, always follow safety rules for confined spaces (two people, rope and harnesses).
5. Turn off any electric lights in the fumigated area of the structure as well as all nonessential electrical motors.

F. Monitoring

1. Safety
 - a. Monitoring of phosphine concentrations must be conducted to confirm that nearby workers and bystanders are not exposed to levels above the allowed limits. Document where monitoring will occur.
 - b. Keep a log or manual of monitoring records for each fumigation structure and/or area. This log must at a minimum contain the timing, number of readings taken, and level of concentration found at each location.
 - c. When monitoring, document (even if there is no phosphine present above the safe levels).
 - d. Monitoring must be conducted during aeration and corrective action must be taken if gas levels exceed the allowed levels in an area where bystanders and/or nearby residents or domestic animals may be exposed.
2. Efficacy
 - a. Phosphine readings should be taken from within the fumigated structure to insure proper gas concentrations for effective insect kills (200 ppm for 5-7 days). If the phosphine concentrations have fallen below the targeted level (200 ppm), the fumigators may reenter the structure with proper respiratory equipment, following proper entry procedures, and add additional product.
 - b. All phosphine readings should be documented.

G. Post-Application Operations

1. Provide watchmen when the fumigation structure cannot be secured from entry by unauthorized persons during the aeration process.
2. Aerate or ventilate in accordance with structural limitations (forced air delivered by fans can be used to facilitate in ventilation).

3. Consider temperature when aerating.
4. Turn on ventilating or aeration fans where appropriate.
5. Use a suitable gas detector before reentry into a fumigated structure to determine fumigant concentration.
6. Keep written records of monitoring to document completion of aeration.
7. Ensure that aeration is complete before moving a treated vehicle onto public roads.
8. Remove warning placards when aeration is complete.
9. Inform business/client that employees/other person may return to work or otherwise be allowed to reenter the aerated structure.

These factors must be considered in putting a FMP together. Some plans will be more comprehensive than others.

Source: <http://www.agr.state.ne.us/pesticide/fmp.html>.

ANNEX T-3 PHOSPHINE GAS MONITORING EQUIPMENT, RESPIRATORY PROTECTION, AND FIRST AID

The following information is included in this annex:

- Proper use of the required phosphine gas monitoring equipment;
- Where and when to monitor phosphine gas;
- Types of gas monitoring equipment;
- Proper use of respiratory equipment; and
- First aid in case of phosphine poisoning.

The short-term exposure limit (STEL) for phosphine is one ppm. Workers must not be continuously exposed to one ppm of phosphine for 15 minutes four times a day with at least one hour between such 15-minute exposures. Workers must not be exposed to 0.3 ppm of phosphine (threshold limit value or TLV) for more than eight hours a day or 40 hours a week.

The odor threshold for phosphine (in those who can detect it), is two ppm, which is higher than the established (STEL or TLV) safe levels. Odor should not be used to determine if the atmosphere is safe. Safety levels can only be ascertained by monitoring for phosphine gas. Monitoring is also important to determine if phosphine levels have been maintained within an enclosure to effectively kill insects.

There are three basic types of units available in the market place—the electrochemical, photo ionization, and tube types. The electronic monitors use an electrochemical sensor in which the change in current across the sensor is proportional to the phosphine concentration in the atmosphere. The purchase price ranges from about US\$800-2,000. The photo ionization detectors directly measure the wavelength of a certain gas. The tube type devices are approximately 10 cm long and 0.5 cm in diameter with a white reactive powder inside the tube which changes color when air containing phosphine is drawn through the tube with the aid of a handheld or mechanical pump. Tubes, with a scale in ppm of phosphine, are available for low and high range of phosphine (0.01 to 10,000 ppm), and the change in color is proportional to the phosphine concentration. Tube type devices cost about US\$200. The electrochemical and photo ionization detectors provide continuous measurement of phosphine, whereas the tube type provides non-continuous measurement.

ELECTRO-CHEMICAL/PHOTO IONIZATION UNITS

Advantages

- Readings are presented on a digital screen.
- Alarms, both audible and visual, alert applicators that they are in an environment that exceeds the TLV for phosphine.
- If used as intended, the cost of operation is the least expensive.
- Multi-gas units can be and should be used in confined spaces; this will preclude the need for multiple monitors to check a variety of atmospheric gases.
- Replacement sensors, as well as calibration gases, are widely available (depending on the brand purchased).
- Power requirements can be as basic as multiple AA batteries.
- Readings are provided in a matter of seconds and are continuous.

Disadvantages

- A separate unit must be used if checking for high range readings in the fumigated area during the exposure period.
- The units must be calibrated every six months; the unit can be tested with a known concentration of the gas or sent back to the manufacturer for calibration.
- If the unit is to be used infrequently (no more than three fumigations/year), the purchase price and use cost may exceed that of colorimetric tubes.
- For servicing, a trained service person must be available.

COLORIMETRIC TUBES

Advantages

- Tubes can be acquired for the intended gas monitoring range (high and low range tubes)
- If only sporadic fumigations are to be done annually, this is an inexpensive alternative to electro-chemical units
- Purchase price of the pump and tubes are less than the other option

Disadvantages

- It may take several minutes to adequately characterize a specific area depending on the tube used
- Can only obtain one reading per tube, and the tube should be discarded after use
- The tubes have a defined expiration date printed on each box
- Some discoloration stains in the tube make it difficult to read
- Operators must be able to read to ensure that they are using the correct tube for the intended job

WHERE AND WHEN TO MONITOR

- Reading must be taken frequently while applying gas and when working around the site under fumigation. These reading should be taken in the workers' "breathing zone."
- In areas that are prone to high bystander traffic, monitoring should be done to ensure the safety of those present. Any and all areas that are connected to or are in close proximity to the fumigated site should also be monitored. This helps ensure that there is no gas leakage.
- The fumigated site should be monitored with high range sensing devices during the exposure period. Sensors capable of reading concentration levels at or above 500 ppm should be used. Monitoring lines must be placed in the fumigated area prior to the release of the fumigant. These lines should be placed or positioned in different areas or depths in the space and/or the commodity being fumigated. A reading should be taken at least every 12 hours in order to verify that the desired amount of phosphine gas is present. This information aids in determining the effectiveness of the seals as well as determining the effectiveness of the fumigation.

The table below should be consulted for determining the appropriate type of phosphine gas monitoring equipment for the particular situation. In addition to the below criteria, CSs and fumigation service providers should determine whether the manufacturer is able to provide timely maintenance and parts in the host country.

Parameter	Criteria
Simplicity of operation	Ease of set-up and maintenance. If not easy to use, will employees actually use it, or will the unit stay on a shelf? Is calibration required, and if so, can it be easily completed?
Reliability	Ruggedness of unit. Can it withstand impact from a fall and typical field use?
Performance features and maintenance requirements	Will it give repeatable gas readings? Operation temperature range Response time Warranty Sensor life Battery life Approvals and certifications (such as by UL ^a) Auto zero Calibration frequency Calibration gas requirements
Options and accessories	Internal or external sampling pump Computer downloading Calibration and/or alarm check gas Remote sampling hose and/or probe
Support and service	What is the manufacturer's track record in responding to technical questions or repair work? Can training on the unit be provided on-site, or is audio/visual material available?

^aUnited Laboratories, St. Charles, Illinois
(http://www.unitedlabsinc.com/usa/content/contact_us.asp).

Source: Walter, V. 2006. Commodity and Space Fumigation in the Food Industry, pp. 183-198. In Insect Management for Food Storage and Processing, Second Edition, Heaps, J. W. (ed.). American Association of Cereal Chemists International, St. Paul, Minnesota, St. Paul, Minnesota.

TYPES OF GAS MONITORING EQUIPMENT



PortaSens Phosphine Monitor
(Photo Ionization Detector)



Dräger Pac III Phosphine Monitor
(Electrochemical)



Phosphine Detector Tubes



Handheld Air Pump with Detector Tubes



Gas Monitoring Lines



Gas Monitoring Line Connected to
a Detector Tube

RESPIRATORY EQUIPMENT

Cartridge and canister type respirators or supplied air respirators with self-contained breathing apparatus (SCBA) must be used in situations where workers may be exposed to phosphine. A full face mask must be used with both these types of respirators. Canister type respirators are much more favorable from a safety perspective than cartridge type of respirators, which should be avoided, if possible. Canister gas masks are the least expensive option. The full face mask fit should be verified following manufacturer's instructions.

If a canister is used, it must indicate that it will protect against or can be used to filter out phosphine gas. Most, if not all, manufactures print an expiration date on each canister. Canisters, even if new and unused, must be discarded if they are expired. Canisters may be reused; however they must be sealed and stored away from air contaminants, including phosphine gas. If, during normal use, phosphine gas odor is noticed, the canister should be discarded immediately and new one installed.

The following should be considered for personnel who will be involved in fumigation and required to wear respiratory equipment:

- (1) The individual must be adequately trained in the donning and doffing the mask unit.
- (2) The individual must be adequately trained in detecting leaks around the face piece.
- (3) The individual must not have facial hair that would prohibit an adequate mask seal.
- (4) The individual must be able to read and recognize the proper canister to be used as well as identifying the expiration date on the canister.

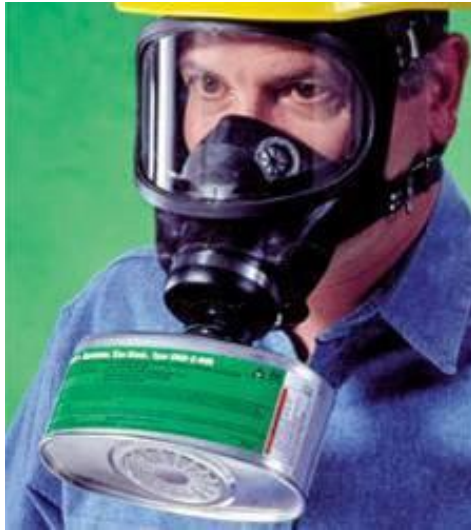
The US National Institute for Occupational Safety and Health (NIOSH) recommends the following respiratory protection at different phosphine concentrations:

0.3–3 ppm	Supplied-air respirator
7.5 ppm or less	Supplied-air respirator operated in a continuous-flow mode
15 ppm or less	Self-contained breathing apparatus with a full facepiece, or Supplied-air respirator with a full facepiece, or Air-purifying, full-facepiece respirator (gas masks) with a chin-style front- or back-mounted canister
50 ppm or less	Supplied-air respirator equipped with a full facepiece and operated in a pressure-demand mode, or Self-contained breathing apparatus equipped with a full facepiece and operated in a pressure-demand mode
Oxygen-limited atmospheres	Supplied-air respirator equipped with a full facepiece and operated in a pressure-demand or other positive-pressure mode, or Self-contained breathing apparatus equipped with a full facepiece and operated in a pressure-demand or other positive-pressure mode
Phosphine concentration, Unknown	Self-contained breathing apparatus

TYPES OF RESPIRATORY PROTECTION



Canister Type Respirators
With a Full Face Mask



Canister Type Respirator Without a Hose



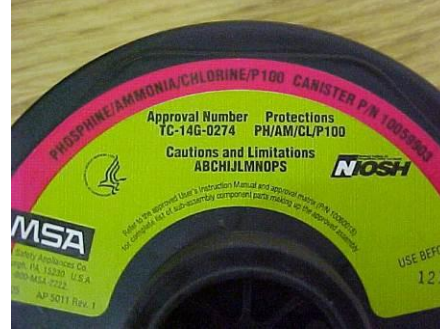
Cartridge Type Respirator with a
Nose Piece



Cartridge Type Respirator with
Full Face Mask



Fit Test for Cartridges to Determine Tight Fit



Read Information on Cartridges/Canisters



Self-Contained Breathing Apparatus



Face Mask Connected to SCBA

OTHER PERSONAL PROTECTIVE EQUIPMENT FOR FUMIGATION

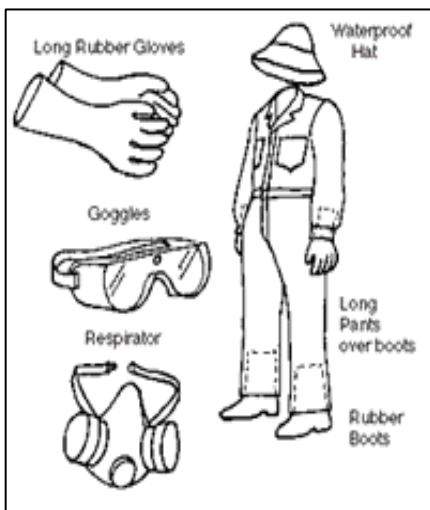


Figure 1: An assortment of personal protective clothing and

Dry cotton (or any other material) gloves, should always be worn by fumigant applicants when handling or in contact with aluminum phosphide pellets. Note that the gloves should remain dry during use. Additionally, fumigant applicators should wear rubber boots, eye goggles, and liquid-tight protective coveralls that are long sleeved, over full length pants and long-sleeved shirts. Hands should be washed thoroughly after using aluminum phosphide. The fumigant applicant should also shower with soap as soon as possible and before changing into clean clothes. The gloves and any other protective gear/clothing should be aerated in a well ventilated area before laundering.

Some Useful Sources for PPE Information:

- Ministry of Agriculture, British Columbia http://www.al.gov.bc.ca/pesticides/d_1.htm
- Photos courtesy of Kansas State University, Department of Grain Science and Technology from Lecture 9, Part 2 on *Fumigation Safety Considerations* by Thadd Bigler, Central States Enterprises, USA
- United Phosphorous, Inc. Rev 4/10. Applicators Manual for Aluminum Phosphide Fumigant- Tablets, Pellets and Gas Bags. s.n. USA

SYMPTOMS OF POISONING AND RESPONSE

First Aid in Case of Phosphine Poisoning (<http://www.fao.org/docrep/x5042e/x5042E0a.htm>)

According to the amount of phosphine inhaled, symptoms may occur immediately or several hours after exposure.

Slight or mild poisoning may give a feeling of fatigue, ringing in the ears, nausea, pressure in the chest and uneasiness. Wear Self-Contained Breathing Apparatus and move person to fresh air. Medical attention is important even in mild cases of poisoning.

Greater quantities will quickly lead to general fatigue, nausea, gastrointestinal symptoms with vomiting, stomach ache, diarrhea, disturbance of equilibrium, strong pains in the chest and dyspnea (difficulty in breathing).

Very high concentrations rapidly result in strong dyspnea, cyanosis (bluish-purple skin color), agitation, ataxia (difficulty in walking or reaching), anoxia (subnormal blood oxygen content), unconsciousness and death. Death can be immediate or occur several days later due to edema and collapse of the lungs, paralysis of the respiratory system or edema of the brain. Disturbances of kidney and liver functions (hematuria, proteinuria, uremia, jaundice) and cardiac arrhythmia may occur.

There is no specific antidote for phosphine poisoning, and treatment is symptomatic.

Do not administer milk, butter or castor oil, and alcohol to affected person.

If breathing stops or shows signs of failing, resuscitation must commence immediately.

Develop an emergency action plan to know what needs to be in case of poisoning.

ADVICE TO THE PHYSICIAN

The following measures are suggested by the manufacturer for use by the physician.

In its milder forms, symptoms of poisoning may take some time (up to 24 hours) to make their appearance, and the following measures are suggested:

1. Complete rest for one or two days, during which the patient is kept quiet and warm.

2. Should the patient suffer from vomiting or increased blood sugar, appropriate intravenous solutions should be administered. Treatment with oxygen breathing equipment is recommended as is the administration of cardiac and circulatory stimulants.

In cases of severe poisoning intensive care in a hospital is recommended:

1. Where pulmonary edema is observed, steroid therapy should be considered and close medical supervision is recommended. Blood transfusions may be necessary.

2. In case of manifest pulmonary edema, venesection should be performed under vein pressure control, and intravenous administration of glycosides (in case of hemoconcentration, venesection may result in shock). On progressive edema of the lungs, perform immediate incubation with constant removal of edema fluid and establishment of oxygen positive pressure respiration, as well as any measures required for shock treatment. In Case of kidney failure, extracorporeal hemodialysis is necessary. There is no specific antidote known for this poison.

3. Suicide may be attempted by taking solid phosphides by mouth. In such a case, empty the stomach by inducing vomiting and flush it with a dilute potassium permanganate solution or a solution of magnesium peroxide until the flushing liquid ceases to smell of carbide. Thereafter, administer medicinal charcoal.

4. Scientific research has shown that phosphine poisoning is not chronic; the action of phosphine is reversible and symptoms will disappear by themselves.

EXAMPLES OF DIFFERENT FIRST AID PROCEDURES INCASE OF ACCIDENTS
RESULTING FROM ALUMINUM PHOSPHIDE OR PHOSPHINE GAS

IF INHALED



1. Move person to fresh air.
2. If person is not breathing, call 911 or an ambulance, then give artificial respiration immediately, preferably by mouth-to-mouth if possible.
3. Keep warm and make sure person can breathe freely.
4. Call a poison control center or doctor for further treatment advice.

IF ON SKIN OR CLOTHING

1. Brush or shake material off clothes and shoes in a well-ventilated area.
2. Allow clothes to aerate in a ventilated area prior to laundering.
3. Do not leave contaminated clothing in occupied and/or confined areas such as automobiles, vans, motel rooms, etc.
4. Wash contaminated skin thoroughly with soap and water.

IF SWALLOWED

1. Call a poison control center or doctor immediately for treatment advice.
2. Have person drink one or two glasses of water, **Do not induce vomiting unless told by a poison control center or doctor.**
3. Do not give anything by mouth to an unconscious person.



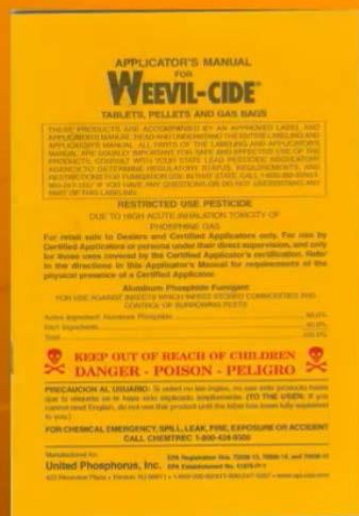
IF IN EYES



1. Hold eye open and rinse slowly and gently with water for 15 – 20 minutes.
2. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye.
3. Call poison control center or doctor for further treatment advice.

Have a copy of the Applicator's Manual with you.

- ◆ If you have to take someone for medical attention. Make sure you take a current copy of the brand of aluminum phosphide you are using with you for the doctor or medical attendant.



Source:

- Photo and Illustrations courtesy of Kansas State University, Department of Grain Science and Technology from Lecture 9, Part 1 on *Fumigation Safety Considerations* by Brayn Giroux, Central States Enterprises, USA
- United Phosphorous, Inc. Rev 4/10. Applicators Manual for Aluminum Phosphide Fumigant- Tablets, Pellets and Gas Bags. s.n. USA

ANNEX T-4 BEST PRACTICES: FUMIGATION AND SPRAYING CONTACT PESTICIDES

This annex contains the following best practice recommendations, including two sets of best practices revised from WFP's Commodity Management Standard Operating Procedure:

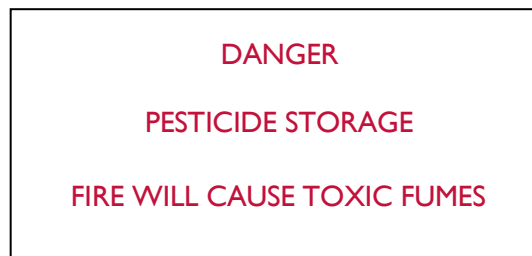
- Storage and disposal of pesticide containers (including fumigants)
- Transport of pesticides (including fumigants)
- Determining when to fumigate
- Fumigation of stacks with aluminum phosphide (modified from WFP SOP)
- Specifications and care of fumigation sheets/tarps
- Spraying empty warehouses & surroundings with contact pesticides (modified from WFP SOP)

Besides the below procedures, see Annex T-2, Fumigation Management Plan, for preparing the fumigation procedure, Annex T-3 Respiratory and Monitoring Equipment and First Aid, and Annex T-9 Warehouse Checklist for additional best practices in commodity protection.

PROPER STORAGE OF PESTICIDE CONTAINERS (INCLUDING FUMIGANTS)

Proper storage of pesticides is essential to protect human health and well-being and to protect against environmental contamination. Proper storage will also extend the shelf life of pesticides.

- A separate, isolated building should be dedicated for pesticide storage. The entrance to the storage area should be labeled/placarded as shown below in English and local language(s).



- The storage building should be constructed of fire-resistant material and should contain a portable fire extinguisher and a sprinkler system, if feasible.
- Make sure the storage area is not leaky and does not get wet during rain. Vents should be closed in case of rain.
- The storage area should be well ventilated. High temperatures may cause some pesticide drum heads to bulge and leak. High temperatures may also cause emission of toxic fumes.
- All pesticides must be stored in their original, labeled containers. Pesticides must never be stored in food, feed, or beverage containers.
- Keep similar pesticides together, and separate them from other types of pesticides.
- The lids of pesticide containers must be closed when they are not being used.
- Place liquid containers on pallets to avoid corrosion of flooring.
- Protect pesticide dusts from humidity to prevent caking.
- Check containers periodically (at least monthly) for leaks or tears.
- Make an inventory of all pesticides and keep records of use.

- Do not store pesticide solutions in sprayers in the storehouse; use all of the mixed formulation.
- In the case of phosphine, use all of the tablets/pellets in a container.
- Do not store food, feed, water, or beverages in the pesticide storage area.
- Do not store clothes, respirators, or other protective equipment in the pesticide storage area.
- The storage area should have plenty of water and soap and an eye station in case of an accidental spill on hands or eyes.
- Do not store pesticides for more than one year as they lose their activity.

PESTICIDE CONTAINER DISPOSAL (INCLUDING FUMIGANT PACKAGING)

Human/animal poisonings and environmental contamination may occur if pesticides and pesticide containers are not disposed of properly. In some countries, unused pesticide solutions can be taken to a designated collection place for incineration or disposal. In countries receiving food aid, such a facility may not exist. Therefore, all of the mixed chemical in a sprayer or a duster should be completely used. In the case of phosphine, all tablets/pellets in an opened container should be used for fumigation.

- In the case of liquid pesticides, the empty container should be drained vertically for 30 seconds.
- Triple rinse the container, each time using 1 liter of water for a sprayer of 3.84 L capacity. Allow 30 seconds for draining each time. The rinse water should be collected into a container and disposed of in an area away from any surface or ground water, following local and state ordinances.
- Crush or break the container and dispose it in an approved manner, and do not reuse the container.
- After all of the phosphine tablets/pellets are used, the empty container should be crushed and disposed as mentioned above.

Modified from: Bohmont, B. L. 1996. The Standard Pesticide User's Guide, Fourth Edition. Prentice Hall, New Jersey.

TRANSPORTING PESTICIDES INCLUDING FUMIGANTS

Transporting Aluminum Phosphide Packages

In the US, the US Department of Transportation (DOT) classifies aluminum phosphide as "Dangerous When Wet" material and it must be transported in accordance with DOT regulations. While these regulations do not apply to Title II programs in USAID host countries, they can provide a framework for implementation of safeguards when transporting aluminum phosphide packages. The US regulations are modified below so they can be applied to Title II situations.

Packaging

No unsealed pouches may be transported. The completed outer packaging containing a combination of canisters and pouches should not exceed 21 kg.

Operational Controls

1. No more than 21 kg of aluminum phosphide may be transported by motor vehicles at any one time.

2. The complete packages must be stowed in metal boxes or compartments on the motor vehicle.
3. Only licensed pest control operators may transport the packages.
4. Each canister or foil pouch and the outré packaging must be labeled POISON and DANGEROUS WHEN WET (see below); vehicles need not display DANGEROUS WHEN WET PLACARDS. Miniature placards (2 cm by 2 cm) are can be used for inner canisters and pouches.

Special Provisions

1. Drivers must have been instructed as to necessary safeguards and proper procedures in the event of unusual delay, fire, or accident.
2. The person performing the transportation tasks must receive training on the requirements and conditions herein.

Reporting Requirements

Notification in writing, of any incident involving a package, shipment, or operation shall be made to the designated contracting authority within 24 hours.



DECISION-MAKING: WHEN TO FUMIGATE WITH PHOSPHINE

In hot, humid climates, fumigation with phosphine is typically the preferred method to eliminate stored product infestations. Fumigation must be undertaken only if trained operators are available, the enclosure in which fumigation is carried out can be sealed adequately, all people can be reliably excluded from the treated area, and the fumigant can be safely ventilated from the enclosure after the fumigation.

The need for fumigation is influenced by three factors:

(1) Acceptability of observed insect pest levels. The acceptable level of insect pests is based on standards established for infested grain. For example, in the US wheat with two or more live insects, on average, is considered infested. The goal for grain managers is to maintain levels below this acceptable level. “On average” is determined by the sampler taking 10 to 30 samples to determine if the average insect density is two live insects or above. If a decision to fumigate will be threshold-based, such thresholds must be developed for all food aid commodities. To develop threshold-based approaches for decision making data must be collected from bags over a period of one to two years and analyzed using established statistics (Subramanyam and Hagstrum, 1996, cited in the PEA).

(2) Suitability of the environment for pest multiplication. Stored-product insects are cold blooded and develop faster at warmer temperatures. The optimum for rapid development (egg-to-adult, one generation) and reproduction is 28-32°C. Most countries that receive food aid have temperatures close to or greater than this optimum. Temperatures above 50°C are lethal to insects but, depending on the species, insects can do well at temperatures as high as 40°C. Under these conditions insects complete one generation in four to six weeks. Under tropical conditions, stored-product insects multiply 50-fold every six weeks, resulting in a build-up of large populations. Therefore, fumigation on a calendar basis may be the optimum to prevent pest populations from exploding. In this case, depending on site-specific warehouse situations, fumigation may be needed as often as every four to six weeks.

(3) The length of time the commodity is stored before it is shipped to beneficiaries. Commodities stored for longer than four to six weeks can incur damage from multiplying insect populations. Therefore, quick turnover of commodities will provide less opportunity for insects to survive and thrive.

Another consideration is that sampling-based decision-making is useful when only a portion of the total storage structure will be fumigated. If the entire structure is to be fumigated, sampling adds additional costs for storehouse managers; in this case, it is more cost-effective to use a calendar-basis fumigation schedule.

The following guidelines can be used to decide when to fumigate food aid commodities.

- (1) Since tropical climates are conducive to year-round infestation by stored-product insects, commodities should be fumigated soon after receipt into a primary warehouse.
- (2) If instead, the CS prefers to base a fumigation decision on sampling, the best point to sample is at the time of unloading from a container or truck near a primary warehouse or a port warehouse. The warehouse personnel and the CS should decide the best method of sampling.

(3) There are two types of sampling. One, a “destructive” method, requires probes to be inserted into the opened bag or bags; a handful of commodity is sampled from each. Sampling is based on examining seed slots for quality factors; insects are not sampled. If this method is used, the bagged commodity must be re-bagged and this will take time away from unloading and loading. Table 1 shows the number of bags to be sampled based on the original number of bags.

(4) Another approach is to conduct a visual inspection for insect infestation, primarily checking the seams of bags and the outside of bags. The number of bags to be sampled should be based on the time it takes to unload a container/truck divided by the time it takes to inspect one bag. This assumes that the inspector is trained in quickly identifying a stored-product insect from a non-stored product insect. If eggs are present inside the commodity, they can never be sampled or detected visually. Bags may be sampled at specified intervals (e.g., every 10th or 20th bag unloaded).

(5) Alternatively bags can be pre-selected at time of unloading and later opened, sampled with probe, or by hand for determining infestation. This type of sampling gives a presence or absence type of information and is not threshold based. In other words, if one or more live insects are found in or on many bags, the entire lot should be fumigated upon receipt.

THRESHOLD-BASED DECISION-MAKING

The relationship between the probability of detecting an infestation or the chance of finding an infestation (P), is influenced by the number of samples (bags) observed (n) and the frequency of infestation (f). Frequency of infestation is simply the number of bags out of total unloaded that contained or had one or more live insects, inside (if it is the destructive method of sampling) or outside (if it is a non-destructive type of sampling). For example if 5 bags out of 100 had live insects the frequency of infestation is 5/100 or 0.05. The probability P ranges from 0 to 1 or 0 to 100%. These 3 variables are related as follows:

$$P(x > 0) = 1 - (1 - f)^n \quad \text{Equation 1}$$

where, P is the probability detecting 1 or more live insects (x).

In bags received recently one can expect that there may be only a few bags with live insects—inside or outside. Therefore, f may be low. In the absence of information one can assume f to be 0.01 (1 bag out of 100 has live insects), 0.05 (5 out of 100 bags has live insects) and so on. Let us assume in this example that we have $f = 5\%$ or 0.05, and $n = 30$. What is our probability of finding that infestation given 2 of the 3 variables. These calculations can be easily done in Microsoft Excel®. At any given frequency one can see the effect of taking samples (n) anywhere from 1 to 300.

$$P = 1 - (1 - 0.05)^{30}$$

$$P = 0.785 \text{ or } 78.5\%.$$

Figure 1 below shows how P changes at different f values. Generally, as the frequency of infestation is greater (more bags have insects), one would need only a few bags to inspect or have greater confidence or probability. Conversely, the graphs can also be used to set a confidence level or probability at 0.95 or 95% and determine how many samples are needed to be sure that you are able to detect insects at a certain f .

The number of samples to be taken is based on time available for the sampler and a method highlighted in bold above. Time and resources are always limited so one cannot sample all the bags. Equation 1 above can be rearranged to find n for a given P and f and f for a given P and n . These will be illustrated below.

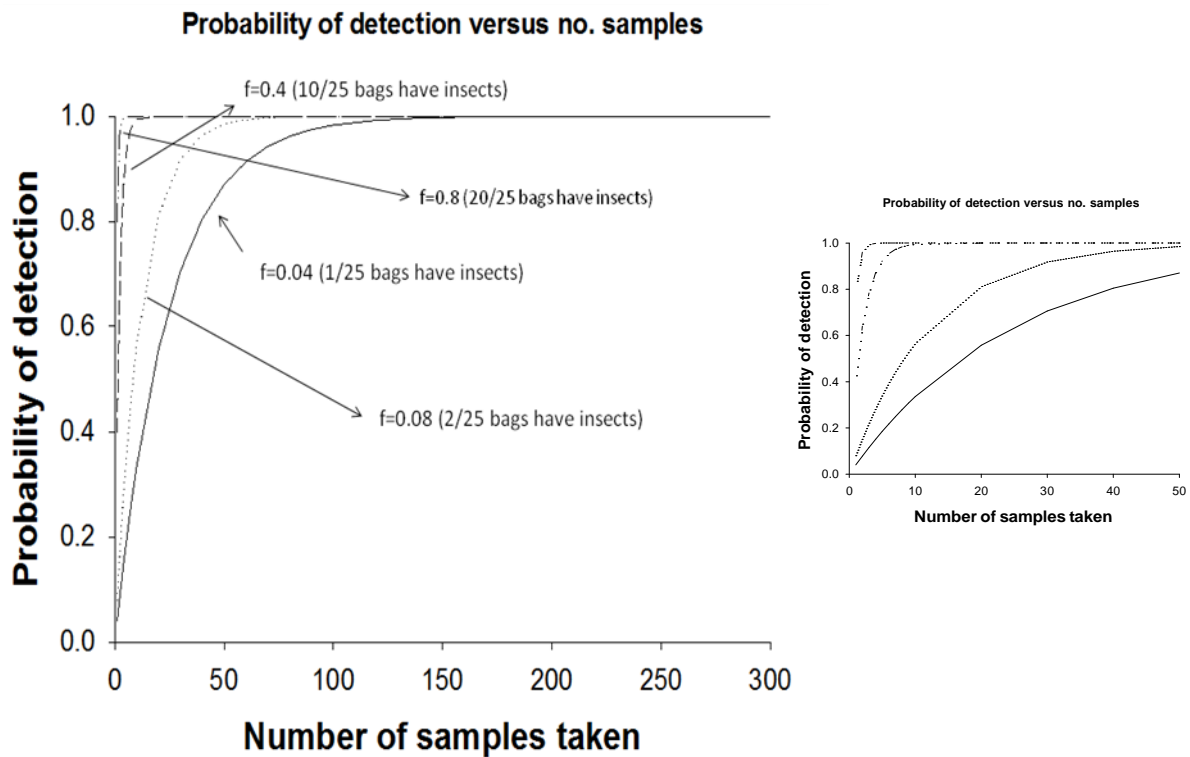


Figure 1. Relationship between Probability of Detection, Number of Samples, and Frequency of Infestation. The Inset Graph Shows the Same Four Lines Over 0 to 50 Samples.

Equation 1 can be rearranged to find how many samples are needed (n) given P and f . Assume that you want to be 95% sure ($P = 0.95$) that you want to detect an infestation rate of 5% ($f = 0.05$). How many samples or bags should be inspected?

$$n = \frac{\ln[1 - P]}{\ln[1 - f]} \quad \text{Equation 2}$$

$$n = \frac{\ln[1 - 0.95]}{\ln[1 - 0.05]} = 58.4 \text{ or } 58 \text{ samples/bags}$$

If your warehouse has a policy to inspect only a certain number of bags, we can determine what level of infestation frequency (f) you will be able to find. Let us assume for this exercise that your $P = 0.95$, and n is 30 bags.

$$\text{Rearranging Equation 1 then yields, } f = 1 - [1 - P]^{1/n} \quad \text{Equation 3}$$

$$f = 1 - [1 - 0.95]^{1/30} = 0.095 \text{ or } 0.095 \times 100 = 9.5\% \text{ or approximately } 10\%. \text{ This value is the maximum infestation frequency (} f_{\text{max}} \text{) I should have in order to be 95\% sure that if I take 30 bags I will find an infestation. The true frequency may lie anywhere between } >0 \text{ to } 9.5\%!$$

These same calculations can also be used when visually inspecting or sampling bags after the bags are placed in stacks over pallets. However, it is important to realize that only the bags on the exterior and top can be sampled and not those inside or inaccessible. One can also use the same techniques when inspecting various portions of a warehouse. In order to use these equations for warehouse inspections one has to define different zones of the warehouse or divide it into a certain number of equal quadrats or zones. The number of zones with a live insect should then be recorded. Irrespective of whether bags are sampled or floors or underneath pallets are examined, the number of locations out of total examined with a live insect should be recorded to use the above equations.

The frequency of infestation may also vary by month. The tools above provide some quantitative basis to make a decision to fumigate.

Sometimes visual inspections or sampling can be deceptive, because insects may not be active at the time the inspector is sampling. In such situations, the use of devices such as food-baited and pheromone traps for various stored-product insects is best. These devices work 24 hours a day, 7 days a week and work on insect behavior.

Insects are attracted to the traps and are captured in the traps. It is also possible for these traps to detect insects that may be attracted from the outside. The food-baited traps are for crawling insects (Figure 2) while traps with pheromones with sticky bottoms (Figure 3) are for flying insects.

Since these traps work on insect behavior, absence of insects does not mean that insects are absent; all it means is that insects failed to come to the trap and be captured. Fast moving insects are likely to be captured more than slow moving insects. The fact that these devices sample continuously 24 hours a day, 7 days a week helps increase the probability of detecting insects.

How can one use trap data to make a decision to fumigate? The warehouse manager or CS must place 30-40 traps in each warehouse and examine them on a weekly basis. All captured stored-product insects should be sorted by species and counted. If a few traps out of the total deployed have insects then it can be assumed that the infestation is not severe.

On the contrary, if every trap has an insect then there is a widespread problem. Managers can set an arbitrary threshold to fumigate when 10, 20, or 30 percent of traps have insects. Also, the traps can be used after fumigation to determine the degree and duration of control achieved or the need for the next fumigation.

The trap data should be correlated with visual inspection data. The only limitation of traps is that the food baits and lures should be replaced at monthly intervals.

There is no simple answer to know when to fumigate. It can be done on a calendar basis, every 4-6 weeks as a precautionary measure, or through visual inspections, or sampling using insect traps and some arbitrarily set threshold of one or more live insects or percentage of traps with insects. It is always important to accumulate any visual and trap information for review and refinement of pest management decisions.

Table 1: Recommended Sampling Intensity for Seed in Bags^a.

1 to 6.....*	95 to 104.... 15	195 to 204..... 25
7 to 14.....6	105 to 114.... 16	205 to 214..... 26
15 to 24.....7	115 to 124.... 17	215 to 224..... 27
25 to 34.....8	125 to 134.... 18	225 to 234..... 28
35 to 44.....9	135 to 144.... 19	235 to 244..... 29
45 to 54.....10	145 to 154.... 20	245 to 254..... 30
55 to 64.....11	155 to 164.... 21	255 or more.... 30
65 to 74.....12	165 to 174.... 22	
75 to 84.....13	175 to 184.... 23	
85 to 94.....14	185 to 194.... 24	

* For lots of 1 to 6 bags, sample each bag and take a total of at least 5 cores or handfuls.

^aSource: Knapp, A. D., T. J. Gutormson, and M. K. Misra. 1991. Seed Lot Sampling. North Central Regional Extension Publication 403, July 1991. North Dakota State University, Fargo, North Dakota. <http://www.ag.ndsu.edu/pubs/plantsci/smgrains/ncr403w.htm>.



Figure 2. Food-Baited Traps with Oil and Lures for Three Insect Species For Capturing Crawling Insect Species (Photo: Bh. Subramanyam). These Traps Should be Placed in a Grid Fashion Throughout the Warehouse. They Can Also be Placed Outdoors.

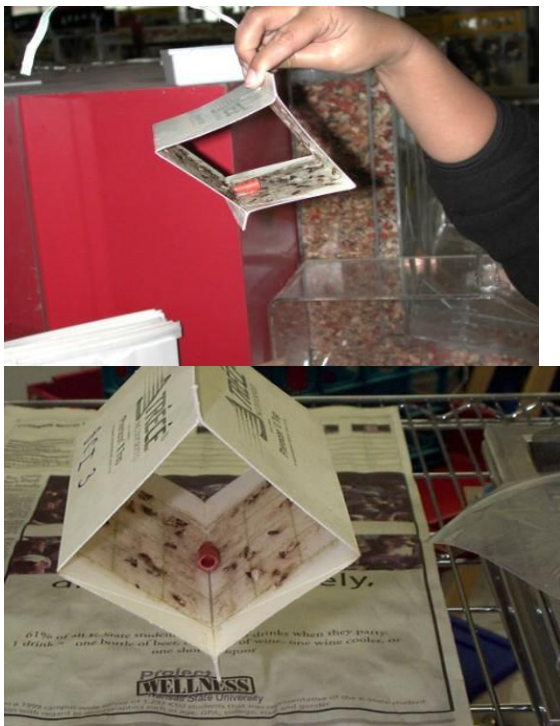


Figure 3. Sticky Traps with a Lure (Red Rubber Septum) for Capturing Flying Insects. These Traps Should be Hung at Eye Level to a Suitable Structure in a Warehouse. They Can Also be Used Outdoors.

FUMIGATION OF STACKS USING ALUMINUM PHOSPHIDE (ALP)

At temperatures of 25°C or above a minimum exposure time of 7 to 10 days is necessary to control phosphine-tolerant insect stages. The fumigation should be planned for a time period that will allow for this length of fumigation. The following steps, modified from WFP's SOPs) should be followed for a proper fumigation.

1. Initial Preparations

- Calculate the amount of food to be fumigated to decide the quantity of fumigant required (general recommendation is dosage rate at 3 ALP tablets /metric ton but will vary with commodity and temperature). A dosage of 6 tables/metric ton may be needed for high sorptive commodities, such as paddy rice, brown rice, and pulses.
- Inspect and prepare the safety respiratory equipment, warning signs (placards), and cotton gloves.
- Decide on the number of fumigation sheets needed and check for holes. Repair as necessary. (For information on gas sheet specifications see below.)
- Calculate the number of sand snakes required (two rows should be used) to place around the stack to be fumigated. In the absence of sand snakes, use other bagged commodities.
- Calculate the number of trays for ALP tablets/pellets required and make sure enough trays are available.
- Examine the conditions of the warehouse (the floor for cracks and holes; the stability and form of the stack; the cleanliness of the floor, walls and stack sides; the roof for leakage, etc.). Seal all floor cracks or the gas will be lost through the gaps.
- Identify the time when the fumigation can be performed taking warehouse operations into consideration (need 7 to 10 days).
- Ensure that the contracted service provider or CS fumigation staff are well trained and experienced in the fumigation process; and that they have adequate supplies and protective equipment, especially in case of an emergency.
- Consider the need to spray contact pesticides prior to fumigation, such as spraying the store structure and stack surfaces (see below).
- In accordance with CS procedures, notify appropriate CS staff, including warehouse managers, workers and other employees about the fumigation and its duration, including safety precautions to be followed; notify neighbors if they are within 100 meters of the fumigated warehouse; and have phone numbers of physicians, police, and fire department in case of an accident or emergency.

2. Sheeting the Stack

- Unfold the sheets towards the stack – always carry the sheet, never drag it over the ground.
- Place the sheet over the stack and position with 1meter of sheet lying on the ground.
- Unroll the sheet to cover the entire stack.
- Take care when climbing on stacks or up ladders while covering the stacks to avoid falling over the edge.
- Smooth out any wrinkles and folds in the sheets before placing sand snakes on them.
- If more than one sheet is used, join the sheets or clip the joints.
- Place two rows of sand snakes on the sheets along the sides of the stack. Ensure that a good seal is achieved along the whole length and take special care at the corners.
- Place two monitoring lines from the top and one from the bottom of each stack to determine if phosphine concentration of 200-300 ppm is maintained for the duration of exposure. Cut small holes to insert tubes and seal holes in gas sheets with tape.
- Gas monitoring lines should be placed outside of treated area. Place duct tape over the free tube ends, except when measuring gas concentrations with electrochemical or tube type gas monitoring equipment.

3. Apply the Fumigant and Seal the Stack

- Decide on each person's responsibility. Several people may be needed to place trays with ALP under all stacks.
- Lay out the trays for ALP tablets/pellets around the stack. Remove the sand snakes next to the trays that hold down the sheets.
- Place warning signs on the outside of all warehouse doors and on all sides of the warehouse.
- All people who are not going to be involved with the fumigation activity should leave the warehouse.
- Position ALP tablets/pellets in a single layer on each tray. To avoid fire risk, do not pile tablets or pellets. Slide trays under the sheets and replace the sand snakes (two rows). To minimize worker exposure to gas being released, placement of trays should be completed within 15 minutes.
- Leave the warehouse and lock the doors to prevent access to unauthorized people for the whole exposure period (minimum of 7 to 10 days).

4. Spray Contact Pesticides (optional)

- Consider spraying the empty warehouse (floor, walls, roofs, etc.) and surrounding areas before receipt of food commodities to kill any live insects. The perimeter of the warehouse on the outside should be sprayed, as described below. The aim is to kill insects that might escape the fumigation.

5. Open and Aerate Warehouse

After fumigation (7 to 10 days):

- Check gas readings under the sheets (check the monitoring lines).
- If gas readings are above 0.3 ppm, no one should enter the warehouse without wearing an appropriate respirator, preferably a self-contained breathing apparatus or a canister mask.
- Open all doors and ventilators, preferably one-half day before starting aeration of the warehouse.
- Remove sand snakes from one or both ends of the stack.
- Pull the corners of the sheet up on to the top of the stack using a rope and leave the warehouse immediately.
- Allow gas to leave the stack and warehouse for approximately one-half to one day.
- To further aerate, remove all sheets covering the stacks.
- Check gas readings in the warehouse and within bags. If gas readings are 0.3 ppm or less, it is safe for workers to enter the warehouse.
- Remove warning signs and placards.

6. Dispose of Spent Aluminum Phosphide Residue

The below is from: van Someran Graver, J. E. 2004. Guide to Fumigation Under Gas-Proof Sheets. Food and Agriculture Organization of the United Nations. Produced by the Australian Centre for International Agricultural Research, Canberra, Australia.

All phosphine-generating formulations used during fumigation must be collected and disposed of in a safe manner. This is important because "spent residues" still contain 3-5% of unreacted aluminum/magnesium phosphide, which can be a safety hazard. The steps below provide guidance

for safe disposal of the spent residues. Handlers of spent residues should wear respirators with appropriate filters and wear personal protective clothing to avoid contact with the dust.

- Do not breathe the dust of the residue
- Prevent contact with eyes and skin
- Collect the residue in a bucket or drum
- Take the residue outdoors to a safe area
- Mix the residue (ash) slowly with water and detergent
- Slowly stir the water to mix the powder. The mixer must stand upwind to avoid any phosphine exposure that is released during this process.
- After any reaction that may occur has ended, the mixture must be disposed of in a 0.5 m deep hole dug in the soil, which is then filled in. The location of the disposal pit should be at least 100 meters away from warehouse structures, where there is no possibility of anyone being exposed to phosphine that may be released.
- Never dispose of unused tablets and pellets using the process above. Always try to use all of the materials in the container, even if the 3 tablets/ton rate has been used. Adding more tablets is allowed by the label.
- Never place unused tablets/pellets in a drum with or without detergent water as a fire or explosion may occur.

7. Dispose of empty phosphine containers

The following is modified from: Bohmont, B. L. 1996. The Standard Pesticide User's Guide, Fourth Edition. Prentice Hall, New Jersey.

- After all phosphine tablets/pellets are used, the empty container should be crushed and disposed of in an approved manner (in accordance with CS procedures and host country regulations).
- Do not reuse the container.

8. Notify Appropriate Authorities after the Fumigation is Complete

- After the fumigation, as required by CS procedures, report the type and quantity of commodity treated and the quantity of pesticides used (fumigants and liquid insecticides) to appropriate CS authorities along with any monitoring data.

9. Dispose of Dead Rodents and Birds Following Fumigation

The below is modified from: Proper Disposal of Animal Carcasses in Michigan: An Industry Guide to the Bodies of Dead Animals Act. Michigan Department of Agriculture, Lansing, Michigan.

Available at: http://www.michigan.gov/documents/MDA_BODA_80099_7.pdf.

Rodent Control: How to Use Rodent Traps and Bait Stations. Public Health Seattle & King County. Environmental Health Services, Seattle, Washington. Available at :

www.kingcounty.gov/healthservices/health/ehs/~/_/.../RatTraps.ashx.

Dead Animal Disposal. Indiana State Board of Animal Health. Available at

<http://www.in.gov/boah/2369.htm>.

Rodents and birds gain entry into food aid warehouses through structural gaps in the building. Entry is more likely in temporary tent-type structures that store food. Fumigation to kill stored-product

insect pests will also kill rodents and birds. After fumigation, the warehouse must be inspected to locate all dead rodents and birds and they must be promptly disposed of (24 hours). The rate of decomposition is faster in tropical and sub-tropical climates than in colder climates. If not promptly disposed of, odor and disease transmission are concerns. In addition, secondary infestations of flesh flies, carrion beetles, blow flies, carpet beetles, and cockroaches could result. Dead animals must be disposed of within 24 hours after fumigation is complete to avoid these issues. The information below provides simple guidelines for carcass disposal.

- With a flashlight (torch) thoroughly inspect all areas of the warehouse, including under the pallets, to locate all dead rodents. Overhead areas may need to be inspected for dead birds.
- Do not touch dead animals with bare hands. Wear disposable gloves, if available, to pick up dead animals. If gloves are unavailable use the inside of a plastic bag or a shovel to pick up the carcasses. Wrap the dead animals in newspaper or preferably in plastic bags before burying in an area and at a depth that will not be disturbed. Dead animals should be buried 0.6 – 1.2 m (2 - 4 ft) below the surface of the soil, and 61 m (200 ft) from a groundwater well or surface water.
- As an alternative, carcasses can be burned.. Burning must be done where it will not cause public nuisance, and in accordance with local laws. The burnt residues must be later buried..
- Wash hands thoroughly with soap and warm water after disposing dead animals.

SPECIFICATIONS FOR FUMIGATIONS (GAS-PROOF) SHEETS OR TARPS AND PROPER CARE OF SHEETS

Sources for fumigation sheets:

Elastec American Marine, Innovative Environmental Products.

<http://www.elastec.com/fumigationtarps/>

Reef Industries, Inc. <http://www.reefindustries.com/prodsite.php?pid=19>

Specifications:

- Fumigation sheets are generally made of unsupported polyvinyl chloride (PVC), woven polythene, PVC laminate, PVC on a nylon or terylene scrim, or multi-layered thin-film laminates.
- Annealed polypropylene sheets and thinly coated and widely woven materials must not be used as fumigation sheets.
- Sheets should be resistant to ultraviolet light. They should be resistant to tearing and impermeable to phosphine (gas loss should be less than 1 mg/day/m²).
- Sheets must be of 18 x 12 m size, 250 microns thick (1 micron = 1/1000 of a mm), and light weight (200-250 g/m²).

Care of Sheets:

- To prevent tears, sheets should not be pulled or dragged over rough ground or walked on. .
- Sheets should be stored in a place where they will not be damaged by rodents.
- Prior to each use, hang sheets on long supports and inspect against light for any holes. Seal holes or tears with duct tape or PVC solvent glue.

- If two or more sheets are needed to cover a large stack of bags, place one sheet over the other and pull back (fold) the first sheet and place sand snakes to seal the sheets.
- Two rows of sand snakes should be used to seal the sheets to the floor. The use of tape, if the floor is smooth, might be a better option (see picture below).



SPRAYING WAREHOUSE STRUCTURES (EMPTY WAREHOUSE AND SURROUNDING AREAS)

Most fumigations involve spraying a contact pesticide before a fumigation, as mentioned above. Spraying is important prior to fumigating a stack to kill any insects escaping the fumigation. Although CSs must submit a PERSUAP to USAID that requests specific pesticides and delineates safe practices to be implemented, the following steps are provided herein since pre-fumigation spraying is usually an integral part of the fumigation process. The following has been modified from WFP's SOPs.

- Clean empty warehouse of all food grains and debris. This will increase insecticide effectiveness.
- Ensure spray equipment is well maintained and make repairs prior to spraying.
- Give prior notice of the spraying to warehouse staff whose work is likely to be disrupted.
- Calculate the area to be sprayed (recommended rate is two to five liters of water/100 square meters) and provide sufficient insecticide (recommended dosage rate 2% active ingredient in the solution or as recommended by the label). Ensure adequate water and sprayers are available, and that protective clothing and washing water and soap is available.
- Protective clothing, including boots, long sleeve shirts, pants, disposable gloves, goggles, and coveralls should be worn by applicators. In some cases, cartridge type of masks should be worn to protect against inhaling spray droplets. Check label for respiratory protection needed.
- Calibrate sprayer by adjusting volume of water needed to cover a known amount of floor area.
- Provide clear instructions to applicators as to the parts of the warehouse to be treated and an estimate of the area to be covered with one knapsack sprayer of pesticide.
- Give special instructions, for example, about applying heavier than normal dosages of spray to places where insects might be concentrated (i.e., cracks and crevices in walls and floors).

- Notify applicators about hazards such as electrical equipment, dimly lit areas, and slippery floors.
- Mix pesticides in a well-ventilated area using disposable gloves and goggles. If a pest management service provider is used for spraying, pesticides should be mixed off-site before arriving on warehouse grounds. For additional guidance in mixing and handling pesticides, see below.
- Spray empty warehouse (floor, walls, roofs, etc.) and surrounding areas before receipt of food commodities to kill any live insects. The perimeter of the warehouse on the outside should be sprayed. Do not spray near waterways; spray at least 50 meters away from the edge of a surface water body. An approved contact pesticide must be used.
- Inspect immediately after spraying that all areas have been properly treated. Any surplus spray remaining in the sprayers should be applied to walls to use it up. Diluted water-based sprays should not be retained in the sprayer for longer than one day since the insecticide may deteriorate rapidly.
- Empty the sprayers and wash thoroughly with clean water. Dismantle and clean nozzles. Drain and dry spray tanks, hoses, and lances. Triple rinse sprayers and collect rinse water and dispose safely and securely, preferably in an area designated for this waste, in an area where it will not affect non-target organisms. Empty insecticide containers should be disposed of safely by crushing them and placed in a safe, secure pit/landfill, and covered.
- Applicators should wash hands thoroughly with soap and warm water. Clothes worn during application should be washed with soap and water. Do not reuse gloves. Goggles should be thoroughly washed in soap and water and dried.
- As required by CS procedures, report the area of a warehouse sprayed and the type and quantity of pesticides used.

ADDITIONAL INFORMATION ON PROPER HANDLING AND MIXING OF PESTICIDES

Spills and splashes can occur when mixing pesticides with water in sprayers. The following safety instructions should be observed during the mixing and loading of pesticides:

- After selecting a pesticide for spraying the warehouse, follow label directions for using correct amount of the pesticide and do not exceed label rates.
- Wear protective clothing and respirator as stated by the label, and have first aid equipment available.
- Never work alone when handling highly hazardous pesticides.
- Mix chemicals outside or in a well-ventilated area and not inside the warehouse.
- Do not mix chemicals near surface water. Mixing should occur at least 50 meters away from surface water.
- Always stand upwind when mixing or loading pesticides.
- The measuring containers should be thoroughly cleaned after each use.
- First add water to the spray tank, then add the pesticide and fill the spray tank to the desired level.
- Clean up spilled pesticides immediately. If the pesticide is accidentally spilled on skin, immediately wash it off with soap and water. Notify supervisor to ensure that appropriate procedures are taken to avoid injury.
- If the pesticide is spilled on clothing, change clothing as soon as possible and wash clothes before using them again.
- Protective gloves should be washed before removing them.

- Wear new gloves each time as the pesticide residues can be absorbed into the glove matrix. Discard gloves as above for pesticide containers.
- Persons mixing, handling, or applying pesticides should never smoke, eat, or drink until after they have thoroughly washed their hands with soap and water.
- Never use your mouth to siphon a pesticide from a container.

ANNEX 5. ALUMINUM PHOSPHIDE MSDS & PHOSPHINE FACTSHEET (US EPA)

The Phostoxin applicator manual (expanded label) can be accessed from:

<http://www.degeschamerica.com/docs/USA/Phostoxin%20Tablet-Pellet%20manual.pdf>



MATERIAL SAFETY DATA SHEET: ALUMINUM PHOSPHIDE

	<u>U.S. EPA Reg. No.</u>
PHOSTOXIN® TABLETS	72959-4
PHOSTOXIN® PELLETS	72959-5
PHOSTOXIN® TABLET PREPAC	72959-9
PHOSTOXIN® PREPAC ROPES	72959-8
DETIA® FUMEX BAGS, BELTS AND BLANKETS	72959-10
DETIAPHOS TABLETS	72959-4
DETIAPHOS PELLETS	72959-5

PROPER DOT SHIPPING NAME: UN1397 ALUMINUM PHOSPHIDE, 4.3 (6.1) PG-I DANGEROUS WHEN WET, POISON LABELS APPLY

SECTION I - PRODUCT INFORMATION

Manufacturer:

DEGESCH America, Inc.
153 Triangle Dr.
P. O. Box 116
Weyers Cave, VA 24486 USA

Telephone: (540) 234-9281 / 1-800-330-2525
Telefax: (540) 234-8225
Internet Address: www.degeschamerica.com
E-mail: degesch@degeschamerica.com

EMERGENCY TELEPHONE NOS.:

Emergency – Call PROSAR: 1-800-308-4856 for human or animal emergencies
Call Chemtrec: 1-800-424-9300 for all other chemical emergencies
Emergency and Information - DEGESCH America, Inc. (540) 234-9281 / 1-800-330-2525

Phostoxin and DetiaPhos are available as 0.6g pellets and 3.0g tablets. Tabletized Phostoxin is also available in gas permeable packages called Prepacs and Ropes. These products are packed in gas-tight containers. Detia® Fumex is available as 34g bags. Fumex is also packed as bag belts, each equivalent to 4 bags and bag blankets, equivalent to 100 bags.

Date of Revision: April 2011

SECTION II - HAZARDOUS INGREDIENTS INFORMATION

Identity:

Phostoxin, Fumex, DetiaPhos and Aluminum Phosphide (AIP) - react with water to produce phosphine (Hydrogen phosphide, PH₃) as shown in Equation 1. Phostoxin and DetiaPhos is formulated with 55% aluminum phosphide and also contains ammonium carbamate (AC) and inert ingredients. Ammonium carbamate releases ammonia and carbon dioxide as shown in Equation 2. Detia Fumex bags do not contain ammonium carbamate.



AIP	CAS No. 20859-73-8
PH ₃	CAS No. 7803-51-2
Al(OH) ₃	CAS No. 21645-51-2

NH ₂ COONH ₄	CAS No. 1111-78-0
NH ₃	CAS No. 7664-41-7
CO ₂	CAS No. 124-38-9

NFPA Chemical Hazard Ratings:

Flammability Hazard 4
Health Hazard 4
Reactivity Hazard 2
Special Hazard ~~W~~

SARA Physical and Health Hazards:

Fire
Reactivity
Immediate (Acute)

Inhalation Exposure Limits:

Component	OSHA PEL	ACGIH TLV		NIOSH
	TWA (ppm)	TWA (ppm)	STEL (ppm)	IDLH (ppm)
Phosphine (Hydrogen Phosphide, PH ₃)	0.3	0.3	1.0	50
Ammonia	50	25	35	300
Carbon Dioxide	5,000	5,000	30,000	40,000

SECTION III - PHYSICAL CHARACTERISTICS

Boiling Point:

AIP	>1000°C
PH ₃	-87.7°C

Specific Gravity of Vapors (Air = 1):

AIP	N/A
PH ₃	1.17

Vapor Pressure:

AIP	0mm Hg
PH ₃	40mm Hg @-129.4°C
AC	100mmHg @26.7°C

Solubility in Water:

AIP	Insoluble, reacts
PH ₃	26cc in 100 ml water at 17°C
AC	Very soluble, reacts

Appearance and Odor:

The Phostoxin, DetiaPhos and Fumex formulations, and aluminum phosphide have a greenish-gray color and the hydrogen phosphide (phosphine, PH₃) gas produced by these chemicals has an odor described as similar to garlic, carbide or decaying fish.

Specific Gravity:

AIP 2.85

Melting Point:

AIP >1000°C
PH₃ -133.5°C

SECTION IV - FIRE AND EXPLOSION HAZARD DATA**Flash Point:**

Aluminum phosphide, Phostoxin, DetiaPhos and Fumex are not themselves flammable. However, they react readily with water to produce phosphine (hydrogen phosphide, PH₃) gas which may ignite spontaneously in air at concentrations above its LEL of 1.8% v/v (18,000 ppm). UEL of phosphine (hydrogen phosphide, PH₃) is not known.

Extinguishing Media:

Suffocate flames with sand, carbon dioxide or dry extinguishing chemicals.

Special Fire Fighting Procedures:

Do not use water on metal phosphide fires.

Respiratory Protection:

Wear NIOSH/MSHA approved SCBA or equivalent respiratory protection.

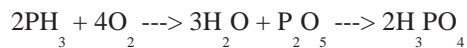
Protective Clothing:

Wear gloves when handling Phostoxin, and DetiaPhos tablets, pellets or dust.

Unusual Fire and Explosion Hazards:

Phosphine (hydrogen phosphide, PH₃)-air mixtures at concentrations above the lower flammable limit of 1.8% v/v (18,000 ppm), Phosphine (hydrogen phosphide, PH₃) may ignite spontaneously. Ignition of high concentrations of phosphine (hydrogen phosphide, PH₃) can produce a very energetic reaction. Explosions can occur under these conditions and may cause severe personal injury. Never allow the buildup of phosphine (hydrogen phosphide, PH₃) to exceed explosive concentrations. Open containers of metal phosphides in open air only and never in a flammable atmosphere. Do not confine spent or partially spent dust from metal phosphide fumigants as the slow release of phosphine (hydrogen phosphide, PH₃) from these materials may result in the formation of an explosive atmosphere. Spontaneous ignition may occur if large quantities of aluminum phosphide or magnesium phosphide are piled in contact with liquid water. This is particularly true if quantities of these materials are placed in an environment which can provide partial confinement of the hydrogen phosphide gas liberated by hydrolysis.

Fires containing phosphine (hydrogen phosphide, PH₃) or metal phosphides will produce phosphoric acid by the following reaction:

**SECTION V - REACTIVITY DATA****Stability:**

Phostoxin, DetiaPhos, Fumex and aluminum phosphide are stable to most chemical reactions, except for hydrolysis. They will react with moist air, liquid water, acids and some other liquids to produce toxic and flammable phosphine (hydrogen phosphide, PH₃) gas. Phosphine (hydrogen phosphide, PH₃) may react vigorously with oxygen and other oxidizing agents.

Incompatibility:

Avoid contact with water and oxidizing agents.

Corrosion:

Phosphine (hydrogen phosphide, PH₃) gas may react with certain metals and cause corrosion, especially at higher temperatures and relative humidities. Metals such as copper, brass and other copper alloys, and precious metals such as gold and silver are susceptible to corrosion by phosphine. Small electric motors, smoke detectors, brass sprinkler heads, batteries and battery chargers, fork lifts, temperature monitoring systems, switching gears, communication devices, computers, calculators and other electrical equipment may be damaged by this gas. Phosphine (hydrogen phosphide, PH₃) will also react with certain metallic salts and, therefore, sensitive items such as photographic film, some inorganic pigments, etc., should not be exposed.

Hazardous Polymerization:

Will not occur.

SECTION VI - HEALTH HAZARD INFORMATION**Routes of Entry:**

The dermal toxicity of aluminum phosphide is very low. The LD50 via the dermal route is estimated to be greater than 5,000 mg per kilogram for a 1-hour exposure. Primary routes of exposure are inhalation and ingestion.

Acute and Chronic Health Hazards:

Phostoxin, DetiaPhos and Fumex are highly acute toxic substances. The LC50 for phosphine (hydrogen phosphide, PH₃) gas is about 180 ppm for a one-hour inhalation exposure. The acute oral toxicity of the Phostoxin, DetiaPhos and Fumex formulations was found to be 11.5 mg/kg of body weight. Aluminum phosphide and phosphine (hydrogen phosphide, PH₃) do not cause chronic poisoning.

Carcinogenicity:

Aluminum phosphide and phosphine (hydrogen phosphide, PH₃) are not known to be carcinogenic and are not listed as such by NTP, IARC or OSHA.

Signs and Symptoms of Exposure:

Aluminum phosphide tablets, pellets, bags and dust react with moisture from the air, acids and many other liquids to release

phosphine (hydrogen phosphide, PH₃) gas. Mild exposure by inhalation causes malaise (indefinite feeling of sickness), ringing in the ears, fatigue, nausea and pressure in the chest which is relieved by removal to fresh air. Moderate poisoning causes weakness, vomiting, pain just above the stomach, chest pain, diarrhea and dyspnea (difficulty in breathing). Symptoms of severe poisoning may occur within a few hours to several days resulting in pulmonary edema (fluid in lungs) and may lead to dizziness, cyanosis (blue or purple skin color), unconsciousness, and death.

Emergency and First Aid Procedures:

Symptoms of overexposure are headache, dizziness, nausea, difficult breathing, vomiting, and diarrhea. In all cases of overexposure get medical attention immediately. Take victim to a doctor or emergency treatment facility.

If the gas or dust from aluminum phosphide is inhaled:

Get exposed person to fresh air. If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably by mouth to mouth, if possible. Contact a poison control center or doctor for treatment advice.

If aluminum phosphide pellets, tablets or powder are swallowed:

Call a poison control center or doctor immediately for treatment advice. Have person sip a glass of water if able to swallow. Do not give anything by mouth to an unconscious person. Do not induce vomiting unless told to by a poison control center or doctor.

If powder or granules of aluminum phosphide get on skin or clothing:

Take off contaminated clothing. Rinse skin immediately with plenty of water for 15-20 minutes. Call a poison control center or doctor for treatment advice.

If dust from pellets or tablets gets in eyes:

Hold eye open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. Call a poison control center or doctor for treatment advice.

HOTLINE NUMBER: Have the product container, label or applicator's manual with you when calling a poison control center, doctor, or when going for treatment. **CONTACT 1-800-308-4856 FOR ASSISTANCE WITH HUMAN OR ANIMAL MEDICAL EMERGENCIES.** You may also contact Degesch America, Inc..-540-234-9281/1-800-330-2525 OR CHEMTREC-1-800-424-9300 for all other chemical emergencies.

SECTION VII - PRECAUTIONS FOR SAFE HANDLING

Spill Cleanup Procedures:

If possible, dispose of spilled Phostoxin, DetiaPhos and Fumex by use according to label instructions. Freshly spilled material which has not been contaminated by water or foreign matter may be replaced into original containers. Punctured flasks or containers may be temporarily repaired using aluminum tape. If the age of the spill is unknown or if the product has been contaminated with soil, debris, water, etc., gather up the spillage in small open buckets having a capacity no larger than about 1 gallon. Do not add more than about 1 to 1.5kg (2 to 3 lbs.) to a bucket. If on-site wet deactivation is not feasible, transport the uncovered buckets in open vehicles to a suitable area. Wear gloves when handling Phostoxin tablets and pellets.

Respiratory protection may be required during cleanup of spilled material. If the concentration of phosphine (hydrogen phosphide, PH₃) is unknown, NIOSH/MSHA approved SCBA or its equivalent must be worn.

Small amounts of spillage, from about 4 to 8 kg (9 to 18 lbs.) may be spread out over the ground in an open area to be deactivated by atmospheric moisture. Alternatively, spilled Phostoxin and Fumex may be deactivated by the wet method as described in the following:

Wet Deactivation of Spilled Phostoxin and Fumex:

1. Deactivating solution is prepared by adding the appropriate amount of low sudsing detergent to water in a drum or other suitable container. A 2% solution or 4 cups of detergent in 30 gallons is suggested. The container should be filled with deactivating solution to within a few inches of the top.
2. The material is added slowly to the deactivating solution and stirred so as to thoroughly wet all of the product. This should be carried out in open air and respiratory protection may be required. At no time should the deactivation drum be covered.
3. No more than about 45 to 50 lbs. of Phostoxin, DetiaPhos or Fumex should be added to 15 gallons of water-detergent mixture. Prepacs, Ropes, and Fumex may ignite during wet deactivation if they are allowed to float to the surface. Add weights or otherwise ensure that Phostoxin and Fumex stay submerged until deactivation is completed.
4. Allow the mixture to stand, with occasional stirring, for about 36 hours. The resultant slurry of dust or packaged product will then be safe for disposal.
5. Dispose of the slurry of deactivated material, with or without preliminary decanting, at a sanitary landfill or other suitable site approved by local authorities. Where permissible, this slurry may be poured into a storm sewer or out onto the ground.

For Assistance:

Contact - DEGESCH America, Inc.
Telephone: (540) 234-9281 / 1-800-330-2525
Fax: (540) 234-8225
Internet address: www.degeschamerica.com
E-Mail: degensch@degeschamerica.com

or

Human or Animal Emergencies – PROSAR: 1-800-308-4856
All other chemical emergencies – CHEMTREC: 1-800-424-9300

Disposal of Spent Phostoxin, DetiaPhos and Fumex:

When being disposed of, spilled or partially reacted Phostoxin, DetiaPhos and Fumex are considered hazardous wastes under existing Federal Regulations. If properly exposed, the grayish-white residual dust after a fumigation will not be a hazardous waste and normally contains only a very small amount of unreacted aluminum phosphide. This waste will be safe for disposal. However, the spent residual dust from incompletely exposed Phostoxin, DetiaPhos or Fumex may require special care.

Triple rinse tablet and pellet flasks and stoppers with water. Then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, or by other procedures approved by state and local authorities. Rinsate may be disposed of in a storm sewer, sanitary landfill or by other approved procedures. Or, it is permissible to remove lids and expose empty flasks to atmospheric conditions until the residue in the flasks is reacted. Then puncture and dispose of in a sanitary landfill or other approved site, or by other procedures

approved by state and local authorities. Some local and state waste disposal regulations may vary from the following recommendations. Disposal procedures should be reviewed with appropriate authorities to ensure compliance with local regulations. Contact your State Pesticide or Environmental Control Agency or Hazardous Waste Specialist at the nearest EPA Regional Office for guidance.

1. Confinement of partially spent residual materials, as in a closed container, or collection and storage of large quantities of dust may result in a fire or explosion hazard. Small amounts of phosphine (hydrogen phosphide, PH_3) may be given off from unreacted aluminum phosphide, and confinement of the gas may result in a flash.
2. In open areas, small amounts of spent residual dust or spent packaged products may be disposed of on site by burial or by spreading over the land surface away from inhabited buildings.
3. Residual dust from Phostoxin, DetiaPhos and Fumex may also be collected and disposed of at a sanitary landfill, or other approved sites or by other procedures approved by Federal, State or Local authorities.
4. From 3 to 5 kg (7 to 10 lbs.) of spent dust from 2 to 3 flasks of Phostoxin or 80 to 130 Fumex bags may be collected for disposal in a 1-gallon bucket. Larger amounts, up to about one-half case, may be collected in burlap, cotton or other types of porous cloth bags for transportation in an open vehicle to the disposal site. Do not collect dust from more than 7 flasks of tablets, 10 flasks of pellets (about 11 kg or 25 lbs.) or 300 bags in a single bag. Do not pile cloth bags together. Do not use this method for partially spent or "green" dust. Caution: Do not collect dust in large drums, dumpsters, plastic bags or other containers where confinement may occur.

Deactivation of Partially Spent Phostoxin Prepacs and Ropes and Fumex Bags:

Packaged products, such as Phostoxin Prepacs, Ropes, and Fumex bags, which are only partially spent may be rendered inactive by either a "dry" or "wet" deactivation method. The "dry" method entails holding the Prepacs, Ropes and bags out of doors in locked, 30-gallon wire baskets which are available from DEGESCH America, Inc., or your supplier. Protect the partially spent Phostoxin and Fumex from rain. The deactivated Prepacs, Ropes, and Fumex may then be taken to an approved site for burial at periodic intervals or whenever the wire container is full. Caution: Storage of partially spent Prepacs and Ropes in closed containers may result in a fire hazard upon opening the container.

Alternatively, partially spent Prepacs, Ropes and bags and residual dust from phosphine (hydrogen phosphide, PH_3) fumigations may be treated by the "wet" deactivation method as follows:

1. Deactivating solution is prepared by adding the appropriate amount of low sudsing detergent or surface active agent to water in a drum or other suitable container. A 2% solution or 4 cups of detergent in 30 gallons is suggested. The container should be filled with deactivating solution to within a few inches of the top.
2. Immerse spent Prepacs, Ropes and Fumex or slowly pour residual dust into the deactivating solution while stirring so as to thoroughly wet all of the spent material. Keep immersed for about 36 hours. This should be done in the open air and not in the fumigated structure. Dust from Phostoxin tablets or pellets should be mixed into no less than about 10 gallons of water-detergent solution for each case of spent material.
3. Dispose of the deactivated Prepacs, Ropes, and Fumex or dust-water suspension, with or without preliminary decanting, at a sanitary landfill or other suitable site approved by local authorities. Where permissible, the slurry may be poured into a storm sewer or out onto the ground.
4. Caution: Respiratory protection may be required during wet deactivation. Do not cover the container at any time. Do not dispose of dust in a toilet. Do not allow quantities of dry, spent dust from Phostoxin to be collected or stored without deactivation.

Precautions to be Taken in Handling and Storage:

Store Phostoxin, DetiaPhos and Fumex products in a locked, dry, well-ventilated area away from heat. Post as a pesticide storage area. Do not store in buildings inhabited by humans or domestic animals.

Other Precautions:

1. Do not allow water or other liquids to contact Phostoxin, DetiaPhos or Fumex.
2. Do not pile up large quantities of Phostoxin, DetiaPhos or Fumex during fumigation or disposal.
3. Once exposed, do not confine Phostoxin, DetiaPhos or Fumex or otherwise allow hydrogen phosphide concentrations to exceed the LEL.
4. Open containers of Phostoxin, DetiaPhos or Fumex only in open air. Do not open in a flammable atmosphere. Hydrogen phosphide in the head space of containers may flash upon exposure to atmospheric oxygen.
5. Phostoxin, DetiaPhos and Fumex are restricted use pesticides due to acute inhalation toxicity of highly toxic phosphine (hydrogen phosphide, PH_3) gas. For retail sale to and use only by certified applicators or persons under their direct supervision and only for those uses covered by the certified applicator's certification.
6. See EPA approved labeling for additional precautions and directions for use.

SECTION VIII - CONTROL MEASURES

Respiratory Protection:

NIOSH/MSHA approved full-face gas mask with approved canister for phosphine (hydrogen phosphide, PH_3) may be worn at concentrations up to 15 ppm. At levels above this or when the phosphine (hydrogen phosphide, PH_3) concentration is unknown, NIOSH/MSHA approved SCBA or equivalent must be worn.

Protective Clothing:

Wear dry gloves when contact with aluminum phosphide tablets, pellets or dust is likely to occur.

Eye Protection:

None required.

Ventilation:

Local ventilation is generally adequate to reduce phosphine (hydrogen phosphide, PH_3) levels in fumigated areas to below the TLV/TWA. Exhaust fans may be used to speed the aeration of silos, warehouses, shipholds, containers, etc.

We believe the statements, technical information and recommendations contained herein are reliable, but they are given without warranty or guarantee of any kind, expressed or implied, and we assume no responsibility for any loss, damage, or expense, direct or consequential, arising out of their use.



USAID PROGRAMMATIC ENVIRONMENTAL ASSESSMENT (PEA) FOR PHOSPHINE FUMIGATION OF STORED AGRICULTURAL COMMODITY

SUMMARY:

Fumigation with the pesticide phosphine gas is a critical tool to assure protection of agricultural food commodities from waste and spoilage. It is also an intrinsically dangerous process: phosphine is deadly, flammable and corrosive. Failure to conduct fumigation properly poses serious risks to human health and of ineffective fumigation, posing both an immediate problem for commodity losses and contributing to phosphine pesticide resistance. In the worst case, resistance could lead to the loss of phosphine fumigation as an effective pest control.

In recognition of these risks and to develop clear guidance and tools, DCHA has undertaken a *Programmatic Environmental Assessment (PEA) for Phosphine Fumigation of Stored Agricultural Commodity* (i.e., “Fumigation PEA”) under the US Code of Federal Regulations, Title 22 for Foreign Relations, Chapter II, Part 216, Environmental Procedures (22 CFR 216). The PEA was informed by expertise in stored-product entomology, fumigation, environmental impact and human health risk assessment, as well as extensive inter- institutional stakeholder consultation across the food aid commodity chain from procurement to beneficiary distribution. Specific stakeholders included US Department of Agriculture, US Private Voluntary Organizations, United Nations World Food Program, US agricultural commodity shipping and supplier industries, warehouse operators and fumigation service providers in several countries in Africa.

The Fumigation PEA establishes a clear approach for USAID DCHA Food for Peace (FFP)¹ and other USAID Operating Unit programs (e.g., Regional and Functional Bureaus, field Missions) that plan to undertake phosphine fumigation. While the Fumigation PEA was developed with USAID FFP program and funding support, the findings are applicable to any phosphine gas fumigation of stored agricultural commodities implemented under USAID. (Full PEA and supporting Tools at: <http://www.usaidgems.org/fumigationpea.htm>).

Prepared by: Erika Clesceri, Arianne Neigh, Walter Knausenberger, Josh Habib, Mark Stoughton, Karen Menczer, Maureen Babu, Subramanyan Bhadriraju, John Martin, Tom Catterson (*contact information contained within*).

Point of Contact: GEMS@cadmusgroup.com

¹ Bureau for Democracy, Conflict and Humanitarian Assistance (DCHA), Office of Food for Peace (FFP)

PURPOSE OF PEA AND CONDITIONS FOR APPROVAL:

The purposes of this PEA are to:

1. Identify the potential for adverse human health and environmental impacts from fumigation of food aid and recommend mitigation and monitoring measures to counter;
2. Develop tools and guidance that will lead to safer and more effective fumigation procedures and thus safeguard food aid quality, protect human health, and mitigate adverse environmental impacts;
3. Build capacity for best management practices related to food aid protection via integrated pest management (IPM) and fumigation across the full array of stakeholders; and
4. Bring USAID projects into overall compliance under the precepts of the Agency's environmental regulations.

Through approval of the PEA, as documented by the signatures to this facesheet, the following requirements must become operational for activities in each of these areas with necessary attendant budgeting and technical support. The PEA provide all the necessary Tools to ensure effective implementation. The Tools Annexes² to the PEA provide compliance guidance and all needed templates and standard language. Partners that use the Tools provided and follow through on implementation and reporting, as specified therein, will be in compliance. The Tools - specifically the PERSUAP and FMP templates - can be effective training tools for USAID staff, IPs and fumigation service providers involved with phosphine fumigation.

Under the requirements established by the PEA, each program supporting phosphine fumigation must use the following PEA Tools:

1. PERSUAP: Adapt, and USAID must approve, the provided template³ for a fumigation Pesticide Evaluation Report and Safer Use Action Plan (PERSUAP). The PERSUAP describes the safe and effective approach for phosphine fumigation subject to the requirements established by the PEA.
2. FMP: Use of the template⁴ for the Fumigation Management Plan (FMP) for each fumigation event & adherence to its provisions. The FMP template provides a clear and easy process to ensure safe and effective fumigation.
3. Solicitations: Apply the recommended standard language⁵ for use in fumigation services solicitations and contracts that specify required safer and more effective practices.

² http://www.usaidgems.org/Documents/FumigationPEA/FumigPEAToolAnnexes_Dec%202013.pdf

³ http://www.usaidgems.org/Documents/FumigationPEA/PhosphineFumigPERSUAPtemplate_dec%202013.pdf

⁴ http://www.usaidgems.org/Documents/FumigationPEA/Phosphide_FumigMangmtPlan_Dec%202013.pdf

⁵ include link to exact language; language to put in fumigation service RFP.

APPROVAL OF THE RECOMMENDED ACTION:

Clearance:

Office Director, DCHA Food for Peace (FFP)

Signed: _____ Date: _____
Dina Esposito

Concurrence:

DCHA Bureau Environmental Officer

Signed: _____ Date: _____
Erika J. Clesceri

Additional Clearances:

Africa Bureau Environmental Officer:

Signed: _____ Date: _____
Brian Hirsch

Asia Bureau Environmental Officer:

Signed: _____ Date: _____
Mary Melnyk

Middle East Bureau Environmental Officer:

Signed: _____ Date: _____
John Wilson

Economic Growth, Education
and Environment Bureau Environmental Officer:

Signed: _____ Date: _____
Teresa Bernhard

Europe and Eurasia Bureau Environmental Officer:

Signed: _____ Date: _____
Mark Kamiya

Food Security Bureau Environmental Officer:

Signed: _____ Date: _____
Ronald Greenberg

Global Health Bureau Environmental Officer:

Signed: _____ Date: _____
Rachel Dagovitz

Latin American and Caribbean
Bureau Environmental Officer:

Signed: _____ Date: _____
Victor Bullen

Policy, Program and Learning Bureau
Environmental Officer:

Signed: _____ Date: _____
Dennis Durbin

CC: Regional Environmental Advisors (REAs)

ANNEX 6. ANNOTATED TEMPLATE FOR PESTICIDE EVALUATION REPORT: REQUEST FOR PROCUREMENT AND/OR USE OF ALUMINUM PHOSPHIDE

The following is an annotated template for a Pesticide Evaluation Report (PER) for procurement/use of aluminum phosphide. A PER + SUAP (Safe Use Action Plan) is required to be submitted to USAID prior to procuring or using any pesticides in a USAID-funded program. CSs can modify this format and build on the template by referring to the USAID/DCHA PEA and by inserting country-specific, CS-specific, and project-specific conditions. Search the USAID database for samples of PERSUAPs that request approval for aluminum phosphide, as follows:

Step 1: click: <http://gemini.info.usaid.gov/egat/envcomp/>

Step 2: Click on the "Advanced Search" tab

Step 3: in the first field "Source Document Text Search" enter "aluminum phosphide" (for PERSUAPs that request AP)

Step 4: click on "PDF" to view the documents

USAID "Pesticide Procedures" Factors and Description (from 22 CFR 216, USAID's Environmental Procedures)	PERSUAP Factors 22 CFR 216.3(b)(1)(i)(a) through (l)
<p>(a) USEPA registration status of the proposed pesticide. Pesticides are registered in the U.S. by active ingredient and by formulation.</p> <p>A useful way of presenting the information required under this factor is in a table with columns: active ingredient requested in the PERSUAP, brand name(s) requested in the PERSUAP, USEPA Registration Status, USEPA Toxicity Level, WHO Toxicity Level, Registration Status in the host country, and commodities it will be used on.</p>	<p>In the PERSUAP: Identify the registration status in the U.S. and in the host country. Identify the formulated pesticide product to be used.</p> <p>Aluminum phosphide is an inorganic phosphide registered in the U.S under CAS Number 20859-73-8 with U.S. EPA PC Code 066501. <i>Aluminum phosphide</i> is a Restricted Use Pesticide (RUP) so may be purchased and used only by certified applicators. It is in EPA toxicity Class I and products containing it must bear the signal word DANGER. In contact with water, it produces a toxic gas <i>hydrogen phosphide</i>. <i>Aluminum phosphide</i> is used to control insects and rodents in a variety of settings.</p>

	<p>This PERSUAP requests approval to use aluminum phosphide as an indoor fumigant at storage facilities for the following commodities:</p> <p>This PERSUAP requests use of aluminum phosphide in both pellet and tablet formulations with 55-57% active ingredient.</p> <p>Aluminum phosphide is found in a variety of products: Celphos, Phostoxin, Detia-Gas-Ex-B, Phoxfinon 570 GE that will be used/procured by this project: http://www.pesticideinfo.org/Detail_Chemical.jsp?Rec_Id=PC34851 http://pmep.cce.cornell.edu/profiles/extoxnet/24d-captan/aluminum-phosphide-ext.html.</p> <p>Host country registration status:</p>
<p>(b) Basis for selection of the pesticide</p> <p>The information to the right should be modified and expanded on for the specific situation.</p>	<p>In the PERSUAP: <i>Explain the basis for selection of the fumigant to be used (active ingredient and formulation).</i></p> <p>The selection of aluminum phosphide is based on: efficacy against pests of stored grains, inexpensive cost, and availability in country, and registration in country. If used in accordance with safeguards, aluminum phosphide is not expected to have environmental impacts; this also was considered when selecting pesticides. The selection was also based on the availability of a qualified professional service provider for phosphine fumigation.</p>

<p>(c) Extent to which the proposed pesticide use is, or could be, part of an IPM program. USAID policy promotes the development and use of integrated approaches to pest management whenever possible. This section discusses the extent to which the proposed pesticide use is incorporated into an overall IPM strategy.</p> <p>The information to the right should be modified and expanded on for the specific situation.</p>	<p>In the PERSUAP: Describe the IPM practices that the CS has in place at the warehouse.</p> <p>IPM practices in place at the warehouse include: preventive measures such as daily sanitation of the warehouse and weekly clearing of warehouse surroundings of weeds; daily inspections for pests and strictly adhering to the first in first out (FIFO) rule to minimize the storage time of the commodities in the warehouse.</p> <p>When possible, least toxic pesticides are used first to prevent infestations.</p>
<p>(d) Proposed method or methods of application, including the availability of application and safety equipment.</p> <p>The information to the right should be modified and expanded on for the specific situation.</p>	<p>In the PERSUAP: As stated, describe in detail how aluminum phosphide will be applied and the measures to be taken to ensure its safe use.</p> <p>Aluminum phosphide will be used for indoor fumigation of warehoused commodities. As stated, aluminum phosphide is an RUP, which may be purchased and used only by certified applicators. The professional fumigation service provider, who will apply aluminum phosphide, is a trained technical agent specialized in the handling of stored food commodities, who has passed certification trainings in the US at..... He has taken follow-up courses for certification every three years for the last ten years.</p> <p>The fumigation process will be conducted as follows:</p> <p>First the warehouse will be cleaned and stacks dusted.</p> <p>Fumigation sheets will be used to tarp the stacks; sand snakes will be used for sealing.</p> <p>A contact pesticide will/will not be used (if one is used, this will require USAID approval</p>

	<p>of a PERSUAP).</p> <p>Application rates are 30 tablets or 75 pellets per square foot for fumigation of warehouses; formulations that will be used are tablets and pellets.</p> <p>Application will be in accordance with labeling. The MSDS for aluminum phosphide will be made available at the warehouse office.</p> <p>The following personal protective equipment will be available for fumigators:</p> <p>The phosphine gas monitoring equipment will be used as follows:</p> <p>The fumigation process, from tarping to aeration will take XX days.</p> <p>Aeration will be done as follows:</p> <p>Following fumigation, the warehouse will be inspected as follows:</p>
<p>(e) Any acute and long-term toxicological hazards, either human or environmental, associated with the proposed use, and measures available to minimize such hazards.</p> <p>A table with the following columns may be used to respond to this factor: acute effects</p>	<p>In the PERSUAP: Describe measures the program will take to reduce the potential for exposing humans and non-target organisms to aluminum phosphide.</p> <p>The potential toxicological effects of <i>aluminum phosphide</i> are well covered by EXTOKNET, and Extension Toxicology Network http://pmep.cce.cornell.edu/profiles/extoxnet/24d-captan/aluminum-phosphide-ext.html; the PEA includes details of acute human health exposure and potential impacts to fumigators, other on-site workers, visitors, nearby residents and beneficiaries.</p>

to humans, chronic effects to humans, effects on wildlife, surface and groundwater is often used as a way of illustrating the information required for this factor. See www.pesticideinfo.org for concise data.

Examples of information to be included in this section are: The main routes of exposure to *aluminum phosphide* are through inadvertent ingestion or inhalation during fumigation of the highly toxic gas. Symptoms of mild to moderate acute aluminum phosphide toxicity include nausea, abdominal pains, tightness in chest, excitement, restlessness, agitation and chills. Symptoms of more severe toxicity include diarrhea, cyanosis, difficulty in breathing, pulmonary edema, respiratory failure, tachycardia and hypotension, dizziness and or death.

The available evidence for reproductive effects in animals suggests that they are not likely in humans under normal conditions. No evidence is available to support teratogenic effects in humans or to support the ability of aluminum phosphide to cause mutations or increase mutation rates.

The USEPA has determined that uses of aluminum phosphide will not generally cause unreasonable adverse effects to humans or the environment if used in accordance with the approved use directions and revised precautionary statements prescribed by the registration standard. Requirements for acute toxicity data have been waived because of the well-known extreme inhalation toxicity of phosphine gas, which it generates. Accordingly, aluminum phosphide has been placed in toxicity category I, the highest toxicity category.

Tolerances have been established for raw agricultural commodities at a level of 0.1 ppm (40 CFR 180.225); processed foods 0.01 ppm (21 CFR 193.20); and animal feeds 0.1 ppm (40 CFR 561.40). Finished food and feed must be held 48 hours prior to being offered to the consumer; tobacco fumigated in hogsheads must be aerated 72 hours.

The following safeguards will be in place to minimize the potential health impacts to fumigators, others on-site at the warehouse, nearby residents, and beneficiaries, which according to the USAID/DCHA Fumigation PEA are

	<p>potentially the most at risk: (discuss PPE, monitoring phosphine gas, placarding, etc.)</p> <p>There is no evidence of aluminum phosphide having a negative impact on soil or ground water. It breaks down spontaneously in the presence of water to form a gaseous product, thus is non-persistent and non-mobile in soil and poses no risk to groundwater. For the same reasons, it is unlikely that aluminum phosphide or phosphine will contaminate surface waters.</p> <p>Disposal of packaging will be in accordance with labeling: (describe disposal pit and any other measures)</p>
<p>(f) Effectiveness of the requested pesticide for the proposed use.</p> <p>The information to the right should be modified and expanded on for the specific situation.</p>	<p>In the PERSUAP: <i>Explain evidence that suggests aluminum phosphide is effective for the proposed use.</i></p> <p>In-country experience has shown that this fumigant is very effective in killing the intended targets (note what these are) within the prescribed seven to ten day fumigation time. Aluminum Phosphide is registered as stored grain pesticide. It is considered the most effective method of controlling stored commodity pests, especially when used in an IPM framework, as described above in (c).</p> <p>Describe any reported resistance:</p>
<p>(g) Compatibility of the proposed pesticide use with target and non-target ecosystems. This factor may have been covered in response to (e), and if so, simply reference that section without repeating it.</p>	<p>In the PERSUAP: <i>Describe efforts that are being made to minimize environmental exposure from use of aluminum phosphide.</i></p>
<p>(h) Conditions under which the pesticide is</p>	<p>In the PERSUAP: <i>Describe the environmental conditions under which the</i></p>

<p>to be used, including climate, flora, fauna, geography, hydrology, and soils.</p>	<p><i>pesticide is to be used, identifying any environmental factors that might be particularly sensitive or subject to contamination.</i></p> <p>This factor requires site-specific information about the warehouse location with a focus on natural resources which may be affected by fumigation. Given that fumigation will be within the confines of the warehouse, it is unlikely that aluminum phosphide will contaminate surface or groundwater, or soil. In addition, it is unlikely there will be adverse effects on wildlife at the site. Items of interest for this factor will be the location of disposal of residue and packaging and the storage location.</p>
<p>(i) Availability of other pesticides or non-chemical control methods</p> <p>The information to the right should be modified and expanded on for the specific situation.</p>	<p>In the PERSUAP: <i>Describe other possible pest management options including IPM.</i></p> <p>Bagged commodities are sprayed prior to fumigating; other pesticides are available, and are used as part of fumigation. However, fumigation with aluminum phosphide is the most effective method to control stored grain pests.</p> <p>Other products, such as neem oil, may be used against pests, however at the scale required for Title II food aid, it is currently not practicable. Other organic and/or traditional practices that are effective on a smaller scale include the following:</p> <p>However, for Title II stored commodity, fumigation, along with IPM measures, and using a contact pesticide prior to fumigating, is the most efficacious method to control stored grain pests, while also the least toxic if used with appropriate safeguards.</p>
<p>(j) Host country's ability to regulate or control the distribution, storage, use, and disposal of the requested pesticide:</p>	<p>In the PERSUAP: <i>Summarize the host country's structure for the regulation of public health and agricultural pesticides with a focus on fumigation with aluminum phosphide. Identify the approval/registration status of the pesticide</i></p>

	<i>product in the host country. Evaluate the capacity of the host country to regulate quality of aluminum phosphide (i.e., to ensure against counterfeit products).</i>
(k) Provisions for training users and applicators	<p>In the PERSUAP: Describe the provisions made to train and educate those who will be using aluminum phosphide.</p> <p>Given that aluminum phosphide is an RUP, and required to be applied by a certified applicator, what are the fumigation service provider’s provisions for training their staff:</p>
<p>(l) Provision made for monitoring the use and effectiveness of this pesticide.</p> <p>The information to the right should be modified and expanded on for the specific situation.</p>	<p>In the PERSUAP: Describe monitoring to determine effectiveness of aluminum phosphide and potential resistance.</p> <p>Describe the warehouse monitoring activities, including post-fumigation inspections, and any information about insect resistance to phosphine. Describe actions to be taken to address resistance.</p>

SAFE USE ACTION PLAN

This plan should list the mitigation/best practices/safeguards that are needed to minimize potential human health and environmental impacts identified above in the PER. The SUAP lists mitigation measures, and then uses table format, as follows to detail how mitigation will be implemented.

Potential Impact	Mitigation Measure	Monitoring Indicator	Person Responsible for Monitoring/Frequency of Monitoring	Reporting Requirement/Frequency of Reportings

ANNEX T-7 PROGRAMMATIC ENVIRONMENTAL MITIGATION AND MONITORING PLAN

The Programmatic Environmental Mitigation and Monitoring Plan (PEMMP) describes mitigation measures to minimize the potential adverse impacts identified in the PEA (Issues 1 to 8, evaluated in Section 5.1). It identifies practical measures that USAID and CSs can implement to ensure that fumigation of Title II food aid commodities is conducted in an environmentally sound manner and that when fumigating, all practical precautions are taken to minimize potential impacts to human health.

Given the different roles of USAID and CSs in implementing the Title II food aid program, the PEMMP is presented in two parts: mitigation measures that are primarily USAID's responsibility; and mitigation measures that are primarily the CS's responsibility. It also includes topics that require follow-up study, as identified in Section 1.1.2 of the PEA.

The PEA is not a substitute for a Pesticide Evaluation Report-Safe Use Action Plan, which CSs are required to prepare prior to providing assistance for the procurement or use of aluminum/magnesium phosphide. As mentioned in the text, the PEA satisfies the Reg. 216 requirement, in the Pesticide Procedures, to conduct an evaluation of user hazard; it provides a foundation for preparing a project-specific PERSUAP; and it includes Annex T-6, an annotated template for a PERSUAP. The CS should integrate mitigation measures from the below PEMMP into their project-specific IEE and PERSUAP EMMP so that the CS has one EMMP to guide environmental mitigation, monitoring, and reporting.

PEMMP FOR FUMIGATION OF TITLE II FOOD AID: COOPERATING SPONSORS

Situation #1

- (1) If the CS has provided assistance for the procurement or use of aluminum/magnesium phosphide **without an approved PERSUAP (i.e., if the CS has fumigated or purchased fumigation services at their Title II warehouse, but has not received USAID/DCHA/Bureau Environmental Officer (BEO) approval of a PERSUAP which includes the fumigant)**, the CS shall make note of this in the next Environmental Status Report, and shall, as soon as possible, take corrective action by preparing a PERSUAP for procurement and/or use of the fumigant.
- (2) The PERSUAP (attached to an Initial Environmental Examination (IEE) Amendment) for procurement or use of aluminum/magnesium phosphide shall integrate mitigation measures (see #3 below) from the below PEMMP into the IEE/PERSUAP so that the CS has only one project-level EMMP to guide implementation, monitoring, and reporting on mitigation measures.
- (3) For integration into the PERSUAP, the PEA best practices (Annexes T-4 and 8, with supporting Annexes, T-2 and 3) may be modified to fit the country-, project-, and site-specific situation. However, the PEA BPs are standards that have been identified to minimize the potential for significant impacts to human health and the environment. The CS should justify the need for modifications, and should identify any additional measures the CS will take to monitor to ensure adverse impacts will not result from fumigation with aluminum/magnesium phosphide.
- (4) The CS shall report on implementation of mitigation (successes, issues, failures) in **Title II semi-annual progress reports** and in the annual ESR.
- (5) The CS shall identify a party responsible for ensuring that PEMMP mitigation is modified and incorporated into the PERSUAP EMMP, for overseeing implementation of mitigation measures and monitoring, and for reporting on the PEMMP/EMMP.

Situation #2

- (1) If the CS has an approved PERSUAP for aluminum/magnesium phosphide, the CS shall review the PERSUAP (and EMMP, if one is included) to determine whether modifications are needed to comply with the PEA and PEMMP.
- (2) As necessary, the CS shall submit an amendment to the IEE with an attached PERSUAP that includes mitigation measures from the PEMMP (with a revised EMMP).
- (3)) For integration into the PERSUAP, the PEA best practices (Annexes T-4 and 8, with supporting Annexes, T-2 and 3) may be modified to fit the country-, project-, and site-specific situation. However, the PEA BPs are standards that have been identified to minimize the potential for significant impacts to human health and the environment. The CS should justify the need for modifications, and should identify any additional measures the CS will take to monitor to ensure adverse impacts will not result from fumigation with aluminum/magnesium phosphide.
- (4) The CS shall report on implementation of mitigation (successes, issues, failures) in **Title II semi-annual progress reports** and in the annual ESR.
- (5) The CS shall identify a party responsible for ensuring that PEMMP mitigation is modified and incorporated into the PERSUAP EMMP, for overseeing implementation of mitigation measures and monitoring, and for reporting on the PEMMP/EMMP.

Potential Impact	Mitigation Measure	Monitoring Indicator/Requirement & Frequency Reporting Information
<p>Issues I through 7/Use of the fumigant, phosphine, can affect the health of applicators and other on-site workers and visitors; the health of nearby residents; food quality; the health of beneficiaries; and soil, water, and non-target organisms. Inappropriate practices in handling (transport, storage, and disposal) and in disposing of dead rodents and birds could result in adverse health and environmental</p>	<p>1) CS shall use Annex T-8, Model RFQ and Contract (or revised) when procuring fumigation services, which require that the fumigation service provider (FSP) complies with best practices (BPs), such as fumigation tarp specs, use of PPE, phosphine gas monitoring, securing the warehouse, notifications, safe disposal etc. (full details of BPs are in Annex T-4, with supporting material in Annexes T-2 and 3).</p> <p>CS shall evaluate proposals/quotes from pest management companies based on their ability to implement the BPs stipulated in the RFQ and Model Contract.</p>	<p><u>Monitor</u> proposals/quotes received: # with/#without capacity to implement best practices. [Frequency: each time an RFQ is released]</p> <p><u>Report</u> on ability/inability of pest management companies to comply, in their proposals, with the best practices (i.e., unavailability of monitoring equipment, PPE, good quality tarps, good disposal practices, etc.)</p>
	<p>2) If CS finds that FSPs are unable to comply with BPs and Model Contract in Annexes T-4 and T-8, CS shall take corrective actions, such as:</p>	<p><u>Monitor</u> corrective actions taken [Frequency: as often as necessary until adequate safeguards and project needs</p>

impacts.	<ul style="list-style-type: none"> • Sponsoring a meeting with FSPs to identify compliance concerns; • Procuring phosphine gas monitoring equipment; • Procuring PPE; • Procuring fumigation sheets; • Providing training for CS and/or FSP staff in use and maintenance of the above; and/or • Other measures that would address non-compliance issues. 	<p>for fumigation are met]</p> <p><u>Report</u> on type of corrective actions taken and outcomes</p>
	<p>3) Based on FSP’s ability to perform in accordance with BPs (and Model Contract), CSs shall discuss with USAID possible actions to take to strengthen capacity of FSPs and/or to modify the best practices, RFQ, and contract so that they are implementable, while also providing adequate safeguards.</p>	<p><u>Monitor</u> training needs of FSPs; and modifications needed to make the BPs, RFQ, and contract implementable [Frequency: as often as necessary until adequate safeguards and project-specific needs are met]</p> <p><u>Report</u> on above needs</p>
	<p>4) CS shall ensure that during fumigation, BPs are implemented by FSP, as stipulated in Annexes T-4 (Best Practices) and T-8, Model Contract, and as revised from #s 2 and 3 above.</p> <p>For individual CS PERSUAPs, the PEA BPs (with modifications), and monitoring and reporting requirements shall be described in the PERSUAP EMMP.</p>	<p><u>Monitor</u> prior to and during fumigation to ensure FSG implements the BPs (Annexes T-4 and T-8, with modifications). [Frequency: for each fumigation]</p> <p><u>Report</u> on shortcomings and successes in implementing BPs (as modified), including monitoring phosphine gas, using good quality PPE and tarps, good disposal practices, etc. (i.e., report on FSP’s ability to successfully implement the contract.)</p>
	<p>5) In consultation with the FSP, CS shall prepare a Fumigation Management Plan (FMP, Annex T-2) which shall provide guidance for the fumigation process.</p>	<p><u>Monitor</u> the preparation and implementation of FMPs [Frequency: each fumigation]</p>

<p>Each FMP shall be retained for two years in project files.</p>	<p><u>Report</u> on the # of FMPs prepared, and successes and shortcomings in preparing and implementing them.</p>
<p>6) If CS has fumigators on staff who serve as FSPs, the above mitigation measures 2 through 5 shall be followed. In addition, mitigation measures below specifically related to Issues 3 through 7 shall be followed.</p>	<p><u>Monitor</u> as above for 2 through 5; and as below for mitigation for issues 3 through 7.</p> <p><u>Report</u> as above for 2 through 5; and as below for mitigation for issues 3 through 7.</p>
<p>7) The CS shall retain the MSDS, label, and emergency/ first aid measures at the warehouse office or other nearby, convenient location (See Annexes T-2 and T-5). This information shall be made available to all staff, and if required, key sections should be translated to local language.</p>	<p><u>Monitor</u> information is available to staff and, if necessary, has been translated into local language [Frequency: as needed]</p> <p><u>Report</u> information is available and has been translated.</p>
<p>8) Prior to fumigating, if contact pesticides are to be used, CS shall ensure that spraying is done in accordance with USAID's Pesticide Procedures, which require that a PERSUAP be approved prior to using/procuring pesticides, and that they are used in an environmentally sound manner that reduces potential impacts to human health.</p>	<p><u>Monitor</u> that PERSUAP has been completed prior to procuring/using contact pesticides. [Frequency: for each fumigation]</p> <p><u>Report</u> PERSUAP does/does not cover proposed spraying of contract pesticides.</p>
<p>9) CS shall ensure that phosphine fumigation is implemented within an IPM framework that involves use of non-chemical measures (see warehouse checklist, Annex T-9), and the use of pesticides as a last resort control, using least toxic (i.e., IGRs, inert dust), efficacious, cost-effective pesticides before more toxic.</p>	<p><u>Monitor</u> Annex T-9 warehouse sanitation/checklist measures are being implemented [Frequency: semi-annual reports to USAID, or as requested; CS PERSUAP describes process for IPM/least toxic pesticide use prior to fumigation [Frequency: as required in CS PERSUAP].</p> <p><u>Report</u> successes/challenges in</p>

		implementing warehouse sanitation measures; and as required in PERSUAP.
	I 0) Based on Annex T-9, Warehouse Inspection Checklist, CS shall revise, as necessary, CS-specific warehouse sanitation and inspection procedures.	<u>Monitor</u> need to update/revise warehouse sanitation and inspection procedures [Frequency: as needed]. <u>Report</u> on completion of revisions/updates
	I 1) CS shall include warehouse infrastructure improvements in DFAP budget for Title II program (if allowable).	<u>Monitor</u> need for warehouse infrastructure improvements [Frequency: as needed] <u>Report</u> on implementation of repairs/improvements and limitations in ability to make repairs
Issue 2/Use of the fumigant, phosphine, can affect the health of residents nearby to the warehouse being fumigated.	In addition to the above: I) CS shall develop a plan for notification of nearby residents (see Annex T-4), which shall be implemented prior to conducting fumigation.	<u>Monitor</u> need for developing a plan (if there are nearby residents, see Annex T-4) [Frequency: on time]; and implementation of plan [Frequency: for each fumigation]. <u>Report</u> on need for and finalization of plan, and successes/constraints in implementing plan.
Issues 3 & 4/The quality of the food commodity may be compromised due to phosphine fumigation & Beneficiary populations may be at risk from inhalation, preparation, and ingestion of	In addition to the above: I) When procuring an FSP, CS shall use Annex T-8, Model RFQ and Contract (and see Annex T-4) to ensure BPs are implemented regarding placement of aluminum/magnesium phosphide under the stack.	<u>Monitor</u> that aluminum phosphide is placed under pallets and on plates or in envelopes to ensure no contact with commodities (i.e., monitor that contract is complied with [Frequency: during each fumigation]) <u>Report</u> BPs regarding placement of fumigant are complied with/any challenges

fumigated commodities.	2) When procuring an FSP, CS shall use Annex T-8, Model RFQ and Contract (and see Annex T-4) to ensure FSP provides an adequate aeration period.	in compliance <u>Monitor</u> that aeration period is adequate (as described in Annex T-4) [Frequency: during each fumigation] <u>Report</u> BPs regarding aeration are complied with/any challenges in compliance
Issues 5, 6, & 7/Phosphine fumigation can affect water quality, soil, and non-target organisms; poor handling (transport, storage, and disposal) of fumigants could have adverse impacts on human health and the environment; and Improper disposal practices of rodents and birds, etc. killed by the fumigant, phosphine, could affect human health.	In addition to the above: 1) When procuring an FSP, CS shall use Annex T-8, Model RFQ and Contract, to ensure that FSP implements proper transport, storage, and disposal practices, including disposal of dead rodents and birds.	<u>Monitor</u> that proper procedures are in place (as described in Annex T-4 before, during, and after fumigation [Frequency: on a regular basis, and during each fumigation] <u>Report</u> BPs regarding transport, storage, and disposal are complied with/any challenges in compliance
	2) CS shall ensure that on CS sites that fumigants are stored safely and securely to minimize potential impacts to human health and the environment; and that CS responsibilities in regard to transport and disposal are conducted in accordance with BPs (see Annex T-4).	<u>Monitor</u> transport, storage, and disposal practices conducted by CS staff <u>Report</u> compliance and challenges in CS staff implementation of transport, storage, and disposal BPs:
8/Phosphine may not be effective for the control of fungal contamination	Measures included in USAID PEMMP	
OTHER ISSUES OF CONCERN		
Follow on actions/research needed to fill data gaps	Measures included in USAID PEMMP	
Capacity of CS staff and FSPs may be inadequate to ensure successful	1) CS shall ensure that CS staff who review quotes/proposals from FSPs are trained to evaluate technical fumigation issues.	<u>Monitor and Report</u> on training needs, plans, and implementation

<p>implementation of BPs.</p>	<p>2) CS shall ensure that CS staff who supervise/oversee warehouse fumigation are trained to monitor fumigation in accordance with Annex T-4 and the supporting Annexes, T-2 and T-3.</p> <p>3) CS shall ensure that at least one CS staff is trained to inspect the warehouse post-fumigation to ensure a successful fumigation; and to identify key stored-product pests of the country/region (see below issue, resistance).</p> <p>3) CS shall ensure that warehouse staff are well trained in implementing warehouse sanitation procedures and inspections (see Annex T-9).</p> <p>4) CS shall identify and train at least one staff person who will be responsible for ensuring PEMMP is integrated into PERSUAP EMMP, and that the EMMP is implemented.</p> <p>5) For Applicator certification issues, see USAID PEMMP.</p> <p>6) For capacity strengthening of FSPs, see Mitigation Measure #2 under Issues #1 to 7.</p>	
<p>Due to implementation of poor fumigation practices (shorter than needed fumigation periods, leaky fumigation), insect resistance has become a significant challenge in many countries in which Title II programs operate.</p>	<p>In addition to measures above requiring implementation of BPs during fumigation (use of good quality tarps, airtight seals, and sufficient length of time for a fumigation), CS shall inspect warehouse post-fumigation and track fumigation successes and failures in ridding commodities of infestations.</p>	<p><u>Monitor and Report on successful and unsuccessful fumigations</u></p>

PEMMP FOR FUMIGATION OF TITLE II FOOD AID: USAID

ISSUE	USAID MISSION FFP PROGRAM IN CONSULTATION WITH DCHA/BEO SHALL....
<p>CS-specific PERSUAPs must be approved prior to providing assistance for the use or procurement of aluminum/magnesium phosphide.</p>	<ul style="list-style-type: none"> • Work with CSs to ensure they understand the need to submit a PERSUAP for fumigation. • Ensure that PEA mitigation measures and BPs are incorporated into the PERSUAP. • Provide timely review and approval of fumigation PERSUAPs.
<p>PEA BPs/mitigation measures may need to be modified to take into account country and project-specific situations.</p>	<ul style="list-style-type: none"> • Work with CSs to develop practical BPs for the specific country and/or CS project. • Ensure that modified BPs are integrated into the CS PERSUAP.
<p>The USEPA requires that only certified applicators use aluminum/magnesium phosphide, considered Restricted Use Pesticides.</p>	<ul style="list-style-type: none"> • Collaborate with CSs and FSPs to determine the need to support in-depth and recurrent training on proper fumigation practices (This could be provided through online services or by other means, see Annexes T-10; and could be funded through cost-sharing or other innovative means).
<p>Aluminum/magnesium phosphide does not control fungal contamination. The only reliable measure to protect against fungal growth is to purchase commodity that is at 13% or less moisture, and distribute it as quickly as possible so once it arrives in the host country, moisture level has no chance to increase to 14.5% or higher, a level that promotes mold growth.</p>	<ul style="list-style-type: none"> • Collaborate with USDA partners to ensure that purchased commodity complies with 13% or less moisture level.
<p>For control of infestation and to control fungal growth</p>	<ul style="list-style-type: none"> • Continue to promote “First In First Out” method of commodity management. • Promote web-based tracking systems that can help ensure commodity moves quickly through the Title II food aid commodity chain.
<p>Data gaps/research needs</p>	<p>Collaborate with USAID/Washington/FFP, private sector, other US and host country government agencies, and universities to determine measures to fill the following gaps:</p> <ul style="list-style-type: none"> • Health risks to nursing mothers/infants and health risk to all beneficiaries • Chronic health effects: The HHRE evaluated only

	<p>acute health effects of phosphine</p> <ul style="list-style-type: none">• Insect-resistant packaging: Further exploration is needed of improved packaging• Toxicity of inert ingredients• Use and commercialization of traditional practices, such as neem and hermetic storage: If promising, they could be promoted as potential environmentally sound, low impact means of stored-product pest management.• No information collected from nearby residential areas: Further exploration may be needed regarding potential health impacts experienced by nearby residents.
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ANNEX T-8 MODEL REQUEST FOR QUOTE TO PROCURE FOOD COMMODITY FUMIGATION SERVICES AND FUMIGATION SERVICE PROVIDER CONTRACT

MODEL RFQ

Dear Sir/Madam

Date:

[Organization Name] requests a quotation for fumigation of [weight] of [type of] food commodities.

If this RFQ is for recurring fumigation services (versus one time fumigation) state as much information as possible about the types and amounts of commodity to be fumigated.

_____ This will be a full warehouse fumigation

_____ This will be a fumigation of [number] stacks

The location(s) of performance is/are:

[Name(s) of warehouse, city/village, district/parish, etc.]

The expected dates of performance are (If this is for recurring fumigation, state how often fumigation should be conducted):

Other requirements:

(a) Please submit the names of the key fumigation workers and the types and dates of fumigation training that they have received in the last five years (If this is for recurring fumigation, request this information for the first fumigation; updates can be requested at a later date.)

(b) Please submit a description of the type of safety equipment you intend to use during the fumigation. This should include personal protective equipment (PPE), equipment for monitoring phosphine gas, and supplies for placarding and sealing the warehouse during the fumigation.

(c) Please describe contact pesticides you intend to use, including the type of pesticide (product name, active ingredient), locations where you will spray, the application method, and the timeframe for spraying.

(d) Please advise on availability during the proposed timeframe, and the number of days required for the fumigation process, from tarping through aeration.

(e) Please note

You will be required to supply an:

(1) Adequate number and high quality fumigation sheets. The specs should meet the following:

- Fumigation sheets should be made of unsupported polyvinyl chloride (PVC), woven polythene, PVC laminate, PVC on a nylon or terylene scrim, or multi-layered thin-film laminates.
- Sheets should be resistant to ultraviolet light. They should be resistant to tearing and impermeable to phosphine (gas loss should be less than 1 mg/day/m²).
- Sheets must be of 18 x 12 m size, 250 microns thick (1 micron = 1/1000 of a mm), and light weight (200-250 g/m²).

(2) Adequate number of sand snakes or other method to secure tarps to the floor , with two rows of bags/sand snakes around each stack.

(f) No waste, including pesticide containers and fumigant packaging, shall be left on-site unless prior arrangements have been made with our office to safely dispose of the items.

Please quote your price for the above fumigation services.

MODEL CONTRACT FOR FUMIGATION SERVICES

The following is modified from a World Vision contract for fumigation services.

CONTRACT FOR FUMIGATION SERVICES

Between

[Name of CS Organization, location of organization]

And

[Name of Fumigation Service Provider (FSP), location]

Both parties hereby enter into an agreement which states the following:

This agreement covers fumigation services to be rendered by [Name of Fumigation Service Provider/contractor] at the following location(s):

- Warehouse name, location, capacity
- Warehouse name, location, capacity

If during the period of this contract, the number of warehouse locations will be revised (increased or decreased), [CS Organization] will notify contractor by letter. The floor

area/capacity of each warehouse is an estimate, and the contractor is encouraged to visit each site, prior to fumigating, to investigate specific situations.

Expected Date(s) of Services:

[if this is a re-current contract, state expected frequency (i.e., every four to six weeks; or other timeframe, as applicable); if services may also be needed based on CS's inspections (versus or in addition to a calendar-based schedule), state that additional services may be required, depending on warehouse inspections]

APPLICABLE TO ALL CONTRACTS

(1) [CS Organization] will impose a penalty of [amount of penalty in local currency/day] if the contractor fails to perform the requested services in a timely manner, if due to the contractor's negligence (i.e., workers unavailable, fumigant unavailable, etc)

(2) The contractor shall be responsible for re-fumigating at no cost to [CS Organization] should [CS Organization] deem the work was not done properly. Payment will be made only after satisfactory service has been rendered. This determination will be made by an authorized individual from [CS Organization].

(3) [CS Organization] will/will not provide transport and accommodation of contractor's personnel from point of origin to warehouse(s) and return.

(4) The contractor shall abide by all local and national regulations regarding use of pesticides, including fumigants.

(5) [Incorporate CS's indemnification, dispute, payment clauses, termination clauses, and other legal/contractual requirements.]

FUMIGATION

(1) Based on a written request from [CS Organization], the contractor will fumigate stored commodities]. [CS Organization] will notify contractor of the desired date of services, the type of commodity, and the approximate amount of commodity to be fumigated.

(2) Contractor must ensure that fumigation staff are well trained and experienced in the fumigation process; and that they have adequate supplies and protective equipment, especially in case of an emergency.

(3) Contractor is required to provide all safety equipment, including personal protective equipment (PPE), equipment for monitoring phosphine gas, and supplies for placarding and sealing the warehouse during the fumigation. PPE must be adequate to protect workers against inhaling phosphine gas. PPE must not be expired, and must be maintained as required by manufacturer.

(4) If a contact pesticide will be used, contractor must provide adequate PPE and ensure other safety procedures are in place so no environmental contamination results from use, including mixing, storing, applying, and disposing of contact pesticide.

(5) The contractor will abide by the best practices described herein (below, are Annex T-4 Best Practices for Phosphine Fumigation; some of the best practices may not be implementable in the specific situation/country, and should be modified, as needed):

At temperatures of 25°C or above a minimum exposure time of 7 to 10 days is necessary to control phosphine-tolerant insect stages. The fumigation should be planned for a time period that will allow for this length of fumigation. The following steps should be followed for a proper fumigation.

1. Initial Preparations

- Calculate the amount of food to be fumigated to decide the quantity of fumigant required (general recommendation is dosage rate at 3 ALP tablets /metric ton but will vary with commodity and temperature). A dosage of 6 tables/metric ton may be needed for high sorptive commodities, such as paddy rice, brown rice, and pulses.
- Inspect and prepare the safety respiratory equipment, warning signs (placards), and cotton gloves.
- Decide on the number of fumigation sheets needed and check for holes. Repair as necessary. (For information on gas sheet specifications see below.)
- Calculate the number of sand snakes required (two rows should be used) to place around the stack to be fumigated. In the absence of sand snakes, use other bagged commodities.
- Calculate the number of trays for ALP tablets/pellets required and make sure enough trays are available.
- Examine the conditions of the warehouse (the floor for cracks and holes; the stability and form of the stack; the cleanliness of the floor, walls and stack sides; the roof for leakage, etc.). Seal all floor cracks or the gas will be lost through the gaps (or notify the Cooperating Sponsor that cracks should be sealed).
- In accordance with CS procedures, notify appropriate CS staff, including warehouse managers, workers and other employees about the fumigation and its duration, including safety precautions to be followed. Notify the CS about neighbors that should be alerted to the fumigation (if they are within 100 meters of the fumigated warehouse); and have phone numbers of physicians, police, and fire department in case of an accident or emergency.

2. Sheeting the Stack

The following specs should be met for fumigation sheets:

Fumigation sheets should be made of unsupported polyvinyl chloride (PVC), woven polythene, PVC laminate, PVC on a nylon or terylene scrim, or multi-layered thin-film laminates; sheets should be resistant to ultraviolet light. They should be resistant to tearing and impermeable to phosphine (gas loss should be less than 1 mg/day/m²); and sheets must

be of 18 x 12 m size, 250 microns thick (1 micron = 1/1000 of a mm), and light weight (200-250 g/m²).

- Unfold the sheets towards the stack – always carry the sheet, never drag it over the ground.
- Place the sheet over the stack and position with 1 meter of sheet lying on the ground.
- Unroll the sheet to cover the entire stack.
- Take care when climbing on stacks or up ladders while covering the stacks to avoid falling over the edge.
- Smooth out any wrinkles and folds in the sheets before placing sand snakes on them.
- If more than one sheet is used, join the sheets or clip the joints.
- Place two rows of sand snakes on the sheets along the sides of the stack. Ensure that a good seal is achieved along the whole length and take special care at the corners.
- Place two monitoring lines from the top and one from the bottom of each stack to determine if phosphine concentration of 200-300 ppm is maintained for the duration of exposure. Cut small holes to insert tubes and seal holes in gas sheets with tape.
- Gas monitoring lines should be placed outside of treated area. Place duct tape over the free tube ends, except when measuring gas concentrations with electrochemical or tube type gas monitoring equipment.

3. Apply the Fumigant and Seal the Stack

- Decide on each person's responsibility. Several people may be needed to place trays with ALP under all stacks.
- Lay out the trays for ALP tablets/pellets around the stack. Remove the sand snakes next to the trays that hold down the sheets.
- Place warning signs on the outside of all warehouse doors and on all sides of the warehouse.
- All people who are not going to be involved with the fumigation activity should leave the warehouse.
- Position ALP tablets/pellets in a single layer on each tray. To avoid fire risk, do not pile tablets or pellets. Slide trays under the sheets and replace the sand snakes (two rows). To minimize worker exposure to gas being released, placement of trays should be completed within 15 minutes.
- Leave the warehouse and lock the doors to prevent access to unauthorized people for the whole exposure period (minimum of 7 to 10 days).

4. Spray Contact Pesticides (optional)

- Consider spraying the empty warehouse (floor, walls, roofs, etc.) and surrounding areas before receipt of food commodities to kill any live insects. The perimeter of the warehouse on the outside should be sprayed, as described below. The aim is to kill insects that might escape the fumigation.

5. Open and Aerate Warehouse

After fumigation (7 to 10 days):

- Check gas readings under the sheets (check the monitoring lines).
- If gas readings are above 0.3 ppm, no one should enter the warehouse without wearing an appropriate respirator, preferably a self-contained breathing apparatus or a canister mask.
- Open all doors and ventilators, preferably one-half day before starting aeration of the warehouse.
- Remove sand snakes from one or both ends of the stack.
- Pull the corners of the sheet up on to the top of the stack using a rope and leave the warehouse immediately.
- Allow gas to leave the stack and warehouse for approximately one-half to one day.
- To further aerate, remove all sheets covering the stacks.
- Check gas readings in the warehouse and within bags. If gas readings are 0.3 ppm or less, it is safe for workers to enter the warehouse.
- Remove warning signs and placards.

6. Dispose of Spent Aluminum Phosphide Residue

All phosphine-generating formulations used during fumigation must be collected and disposed of in a safe manner. This is important because “spent residues” still contain 3-5% of unreacted aluminum/magnesium phosphide, which can be a safety hazard. The steps below provide guidance for safe disposal of the spent residues. Handlers of spent residues should wear respirators with appropriate filters and wear personal protective clothing to avoid contact with the dust.

- Do not breathe the dust of the residue
- Prevent contact with eyes and skin
- Collect the residue in a bucket or drum
- Take the residue outdoors to a safe area
- Mix the residue (ash) slowly with water and detergent
- Slowly stir the water to mix the powder. The mixer must stand upwind to avoid any phosphine exposure that is released during this process.
- After any reaction that may occur has ended, the mixture must be disposed of in a 0.5 m deep hole dug in the soil, which is then filled in. The location of the disposal pit should be at least 100 meters away from warehouse structures, where there is no possibility of anyone being exposed to phosphine that may be released.
- Never dispose of unused tablets and pellets using the process above. Always try to use all of the materials in the container, even if the 3 tablets/ton rate has been used. Adding more tablets is allowed by the label.
- Never place unused tablets/pellets in a drum with or without detergent water as a fire or explosion may occur.

7. Dispose of empty phosphine containers

- Arrange with the Organization for safe disposal of any waste that will not be carried off-site.
- After all phosphine tablets/pellets are used, the empty container should be crushed and disposed of in an approved manner (in accordance with CS procedures and host country regulations).
- Do not reuse the container.

8. Notify Appropriate Authorities after the Fumigation is Complete

- After the fumigation, as required by CS procedures, report the type and quantity of commodity treated and the quantity of pesticides used (fumigants and liquid insecticides) to appropriate CS authorities along with any monitoring data.

9. Dispose of Dead Rodents and Birds Following Fumigation

- With a flashlight (torch) thoroughly inspect all areas of the warehouse, including under the pallets, to locate all dead rodents. Overhead areas may need to be inspected for dead birds.
- Do not touch dead animals with bare hands. Wear disposable gloves, if available, to pick up dead animals. If gloves are unavailable use the inside of a plastic bag or a shovel to pick up the carcasses. Wrap the dead animals in newspaper or preferably in plastic bags before burying in an area and at a depth that will not be disturbed. Dead animals should be buried 0.6 – 1.2 m (2 - 4 ft) below the surface of the soil, and 61 m (200 ft) from a groundwater well or surface water.
- As an alternative, carcasses can be burned.. Burning must be done where it will not cause public nuisance, and in accordance with local laws. The burnt residues must be later buried..
- Wash hands thoroughly with soap and warm water after disposing dead animals.

ANNEX T-9. CHECKLIST FOR INSPECTION OF COMMODITIES AND WAREHOUSE

In keeping with best practices in warehouse inspection, the PEA Team modified this Storage Inspection Checklist from the original found in the Food for Peace Commodity Reference Guide.⁴ The goal is to use inspections to help Title II CSs implement good warehouse practices; inspections should be a learning tool for warehouse staff. The checklist should be signed by a supervisor and then filed so that results of inspections are documented.

STORAGE INSPECTION CHECKLIST

Date: _____
Inspected by: _____
Warehouse: _____

A. Yard Area Surrounding Warehouse:

On at least a weekly basis:

- ___ 1. Inspect the yard for signs of rodents (i.e., fecal pellets, tracks, burrows in the ground, holes, signs of feeding).
- ___ 2. Check to see that conditions do not attract insects (i.e., spilled commodities or other edible materials, empty containers, shrubs and trees, bird nests, weeds, trash, piled or damaged packing materials).
- ___ 3. Remove trash and unnecessary equipment and supplies regularly.
- ___ 4. Check the general security of the yard area surrounding the warehouse.
- ___ 5. Remove weeds from the perimeter of the warehouse.
- ___ 6. Check if water ponds at the perimeter of the warehouse and along access roads. If water ponds after a rain, grade the area to prevent water accumulation.

B. Warehouse

For proper inspections, the warehouse should be well lit. Inspectors should conduct inspections using a flashlight (torch). Warehouse cleaning should be done daily; warehouse inspections should be carried out at least weekly.

- ___ 1. Check screens at the vents and other openings of the warehouse. If there are no screens, place screens at any openings into the warehouse. Use wire netting with mesh no larger than 6.35 mm or steel wool. Check for structural damage; use concrete to seal the opening.
- ___ 2. Check doors. Doors should be tightly fitting metal; make sure there are no gaps.
- ___ 3. Check for roof leaks.

⁴ Food for Peace Commodities Reference Guide, Section III, updated January 2006.
http://www.usaid.gov/our_work/humanitarian_assistance/ffp/crg/sec3.htm

- ___ 4. Check for holes in the walls.
- ___ 5. Ensure that the floor is sufficiently hard-packed to prevent burrowing by rodents.
- ___ 6. Check to see that the warehouse is well lit (as above, good lighting is required for proper inspections).
- ___ 7. Clean and service the anticoagulant and rodent bait stations regularly, and keep them filled with fresh bait (exterior use only). Bait stations should be tamper proof and secured to the ground with a concrete block and placed every 15-30 meters.
- ___ 8. Check rodent tracking powders (these should be placed on the exterior of the warehouse only).
- ___ 9. Check mousetraps (they should be emptied of dead mice **daily**). Only multiple-catch mouse traps, snap traps, and glue boards should be used in the interior of the warehouse. These should be placed every 15 meters along the floor wall junctions inside the warehouse and also underneath pallets if an infestation is suspected.
- ___ 10. Make sure that commodity stacks are positioned at least one meter from walls and other stacks to facilitate inspections.
- ___ 11. Ensure passageways are clean of spilled grain and debris.
- ___ 12. (For large and very large warehouses) Ensure three to four meters wide central aisles.
- ___ 13. Ensure stacks are at a reasonable height for ease of handling and to prevent damage to containers by crushing or falling from stacks.
- ___ 14. Ensure sides of stacks are flush.
- ___ 15. Ensure air spaces are provided between individual stacks.
- ___ 16. Ensure clean, unused packing material is neatly stacked.
- ___ 17. Ensure broken packing material is removed.
- ___ 18. Ensure the top of packing materials is covered to prevent spillage of food from damaged containers to ground or floor below.

C. During working hours, check that:

- ___ 1. Workers are lifting bags by the body instead of corners (to prevent tearing or weakening of the bag).
- ___ 2. Workers place bags on stacks, they do not throw bags.
- ___ 3 Workers clean empty bags and pallets thoroughly before they are reused and stack them neatly.
- ___ 4. When workers reconstitute/re-bag commodities from damaged container into good containers, they are adequately stitching the opening and weighing for correct quantity before stacking.
- ___ 5. Spilled commodity is not swept up into the reconstituted bag. This will help ensure that commodity will not be contaminated with pesticides that may have been sprayed in the empty warehouse.
- ___ 6. Warehouse doors and windows are kept closed to discourage entry of insects, birds, and rodents.

D. Commodities

On a daily basis check whether:

- ___ 1. Insects are present on damaged containers. Report presence of insects to warehouse supervisor.
- ___ 2. The exterior of stacked food containers is clean and free of mold, insects, rodents, and birds. Report presence of any of these to warehouse supervisor.
- ___ 4. Spoiled/infested food commodity is stored away from good commodity.
- ___ 5. Damaged commodities are removed promptly and rebagged. Use tape to seal small tears in paper bags.
- ___ 6. All floor sweepings are discarded and not re-bagged or otherwise used for human or animal consumption, as they may contain insecticide residue. If fumigating, discard all floor sweepings by placing them under fumigated tarps to kill any insects and discard after aeration.

At least on a weekly basis, inspect that:

- ___ 1. Individual commodities are stacked separately from one another.
- ___ 2. Food stacks are separated from non-food stocks.
- ___ 3. Records are current and adequate to document program of stock rotation (i.e., what is first in, is first out, or FIFO).
- ___ 4. Check to see that commodities are stacked on pallets to keep off the floor in both small and large warehouses.
- ___ 5. Pallets are not chipped nor are nails sticking out which could tear bags or injure workers.

Reviewed and Approved by: Name: _____ Signed:

Date: _____

ANNEX 10. TRAINING AND EDUCATIONAL MATERIALS ON PHOSPHINE FUMIGATION AND FOOD PROTECTION

PHOSPHINE FUMIGATION GUIDES

Suggested Recommendations for the Fumigation of Grain in the ASEAN Region. Part 1. Principles and General Practice. 1989. ASEAN Food Handling Bureau, Kuala Lumpur, Australian Centre for International Agricultural Research, Canberra, Australia.

Boye, J., S. Ignatowicz, H. Lange, O. Mück, D. K. Mueller, S. Navarro, and V. Sotiroudas. 2006. Training and Technical Support in Alternative Technologies to Methyl Bromide Fumigation for Post-Harvest Sector in CEIT Countries. United Nations Environmental Program, Training Manual. <http://jp1.estis.net/includes/file.asp?site=ecanetwork&file=8AA139BF-610D-4524-8BB1-8003850B52C1> (Excellent source of information on integrated pest management)

Fumigation Training Manual, University of Kentucky Cooperative Extension Service, Lexington, Kentucky. <http://pest.ca.uky.edu/PSEP/Manuals/7c-FumigationManual.pdf>

van Someren Graver, J. E. Guide to Fumigation Under Gas-Proof Sheets. 2004. Food and Agricultural Organization of the United Nations. Produced for FAO by the Australian Centre for International Agricultural Research, Canberra, Australia. <http://aciarc.gov.au/publication/CoP06>. The best resource for CS conducting fumigation.

Flander K., and S. Brown. 2005. Fumigating Agricultural Commodities with Phosphine, Alabama Cooperative Extension System, Auburn University, Alabama. <http://www.aces.edu/pubs/docs/A/ANR-1154/>

Warrick, C. 2011. A Grains Industry Guide: Fumigating with phosphine, other fumigants and controlled atmospheres. Grains Research and Development Corporation. GRDC Grain Storage and Extension Project, Australia. <http://www.chemcert.com.au/2012/PDF/National/Phosphine/GRDC%20Phos.pdf>

Manual of Fumigation for Insect Control. FAO Corporate Document Repository, Rome Italy. <http://www.fao.org/docrep/x5042e/x5042E0a.htm>

NIOSH Alert: Preventing Phosphine Poisoning and Explosions During Fumigation. 1999. Department of Health and Human Services (NIOSH) Publication No. 99-126, National Institute for Occupational Safety and Health Publications Dissemination, Cincinnati, Ohio. <http://www.cdc.gov/niosh/docs/99-126/>

Dangerous Phosphine Practices in West Africa. <http://www.pan-uk.org/pestnews/Issue/pn53/pn53p4.htm>

FUMIGATION TRAINING VIDEOS

Fumigation Management Plan Resources for Aluminum Phosphine. North Dakota State University Extension Service Pesticide Program, Fargo, North Dakota. http://www.ag.ndsu.nodak.edu/aginfo/pesticid/fum_resource.htm. This link has videos on phosphine fumigation.

PHOSPHINE GAS MONITORING DEVICES AND RESPIRATORY PROTECTION

Cardinal Professional Products, Woodland, California. Labels and MSDS of Pesticides for Insect and Vertebrates Pests, Gas Monitoring Equipment, Respiratory Protection, and Training in Fumigation. <http://www.cardinalproproducts.com/>

Ribble Enviro Ltd. Gas Detection Equipment. http://www.ribble-enviro.co.uk/product/drager-detection-tubes.htm?gclid=CNf_hM_b2LACFVPftgodvWEc2Q

DegeschAmerica, Inc. Weyeres Cave, Virginia. <http://www.degeschamerica.com/products.asp>

Uniphos Gas Detector Tube and Pump Accuracy. Technical Note 02, January 2, 2012. <http://www.factorydirectsafety.com/assets/tech-notes/TN-02-Detector-Tube-Accuracy.pdf>

Uniphos, United Phosphorus Limited, Maharashtra, India. <http://www.uniphos-she.com/>

Grainger. Gas Detection Equipment. <http://www.grainger.com/Grainger/gas-detection/safety/ecatalog/N-b0s>

ControlEquipment Private Limited, Australia. <http://www.contralequipment.com.au/>

Intrinsically Safe Personal Gas Detectors. SA Ex Instruments (Pty) Ltd., Wellington 7655, Western Cape, South Africa. <http://www.intrinsically-safe-instruments.com/gas-detectors.html>

Danley, R., B. Adam, J. Criswell, R. Noyes, and T. W. Phillips. 2005. How Accurate Are Phosphine Monitoring Devices? Journal of Pesticide Safety Education 7: 1-9. http://scholar.lib.vt.edu/ejournals/JPSE/v7/JPSEV7_1-9.pdf

National Pesticide Applicator Certification Core Manual. <http://www.nasda.org/workersafety/>. There are 12 Chapters. Chapter 6 is dedicated to Personal Protective Equipment.

Department of Labor, Occupational Safety, and Health Administration. <http://www.osha.gov/pls/publications/publication.AthruZ?pType=AthruZ#R>
Scroll down to Respiratory Protection Standard: Small Entity Compliance Guide

Airgas. Respiratory Protection Equipment Company. http://www.airgas.com/browse/category_list.aspx?catID=177&WT.svl=177&gclid=CJJDVuf_N2rACFSdeTAodbVGY0w

Respirator Protection Center. Respirators, Cartridges, and Filters. <http://www.respiratormaskprotection.com/index.html>

End-of-Service-Life Calculator for Cartridge and Canister Respirators. <http://northsafety.com/> Click on U.S. map. Then click on “Selection Guide for Respiratory and Hand Protection” on the left. Then click on “Cartridge Service Life Estimation” at top.

STORED-PRODUCT INSECTS

List of Stored Product Insect Websites.

http://www.ksre.ksu.edu/grsc_subi/Database/SPI_websites/Stored_product_insect_website1.htm

Kansas State University. Postharvest Protection Website. http://www.ksre.ksu.edu/grsc_subi. Has power point files on stored product insects and their management.

Primary Insect Species. Canadian Grain Commission. <http://www.grainscanada.gc.ca/storage-entrepouse/pip-irp/pip-irp-eng.htm>

USDA-ARS, Stored-Product Insect Images. http://bru.gmprc.ksu.edu/db/insect/search_results.asp

Stored-Product Insects. Cardinal Professional Products, Woodland, California. <http://cardinalproproducts.com/wp/stored-product-insects/>

Hagstrum, D. W., and Bh. Subramanyam. 2009. Stored-Product Insect Resource. American Association of Cereal Chemists International, St. Paul, Minnesota. <http://www.apsnet.org/apsstore/shopapspress/Pages/27663.aspx>

Reichmuth, C., M. Schöller, and C. Ulrichs. 2007. Stored Product Pests in Grain: Morphology, Biology, Damage, and Control. AgroConcept Verlagsgesellschaft, Bonn, Germany.

Hagstrum, D. W., and Bh. Subramanyam. 2006. Fundamentals of Stored-Product Entomology. American Association of Cereal Chemists International, St. Paul, Minnesota. <http://www.amazon.com/Fundamentals-Stored-Product-Entomology-David-Hagstrum/dp/1891127500>

Subramanyam, Bh., and D. W. Hagstrum (ed.). 2000. Alternatives to Pesticides in Stored Product IPM. Kluwer Academic Publishers, Boston, Massachusetts. <http://www.amazon.com/Alternatives-Pesticides-Stored-Product-Bhadriraju-Subramanyam/dp/0792379764>

Subramanyam, Bh., and D. W. Hagstrum. 1996. Integrated Management of Insects in Stored Products, Marcel Dekker, New York.

Dobie, P., and C. P. Haines. 1991. Insects and Arachnids of Tropical Stored Products, Second Edition. Natural Resources Institute, Chatham, U.K. <http://www.amazon.co.uk/Insects-Arachnids-Tropical-Stored-Products/dp/0859542823>

Sinha, R. N., and F. L. Watters. Insect Pests of Flour Mills, Grain Elevators, and Feed Mills and Their Control. 1985. Research Branch Agriculture Canada, Publication 1776. Canadian Government Publishing Centre, Ottawa, Canada.

DISTANCE EDUCATION COURSE ON MANAGING STORED GRAIN INSECTS

Grain Elevators and Processing Society (GEAPS) Distance Education Course on, “Management of Insect Pests in Stored Grains”. Offered in Spring Every Year. Limited to 30-40 participants. http://www.geaps.com/knowledge/dist_learn/course_525.cfm

STORED-PRODUCT INSECT MONITORING DEVICES (NOT FOR CONTROL)

AgriSense, South Wales, U.K. http://www.agrisense.co.uk/ProdRange_ipc.php
Click on Products and Select Traps for Stored-Product Beetles and Moths.

Trécé, Inc., Adair, Oklahoma. <http://www.trece.com/> The Company Has a Wide Range of Products for Monitoring Stored-Product Insects in Warehouses and Commodities.