Executive Summary

Closed Loop Fumigation (CLF) is one of the most environmentally friendly and human safety method of safe use of phosphine fumigants in pellet, tablet, liquid, or gaseous forms. OSU has been the leader in the U.S. in developing the use of recirculation fumigation or CLF in sealed storages to improve efficacy while reducing fumigant usage and human risk. CLF with an external release method as proposed in this study, can further reduce the risk to grain workers of OK by eliminating the need for worker entry into confined space.

The traditional method of fumigation of grain in storage bins, silos and flat storages by elevator grain workers and producers in OK has been by entering the storage unit, probing, “walking-in” or scattering phosphine pellets at relatively high dosage levels on the grain surface in storages. This entry into confined space, now heavily restricted by OSHA Regulation for grain elevators and mills in OK and the U.S. is very risky. Pellets in warm moist grain atmosphere can begin to release gas soon after removal from sealed canisters. Phosphine gas levels inside grain bins often reach levels requiring a face mask and respirator before workers finish the dosage process.

One method to eliminate this risk of exposure to toxic phosphine fumes and vapors is to develop a method of releasing the gas outside the storage units as part of the CLF system design. Conventional methods of dosage always result in a time delay of several hours to days before gas penetrates to all parts of a storage. Even use of automatic pellet dispensers in concrete silos often results in fumigation failure because of high upward movement of the gas plume moved by convection air currents induced by high winds across the tops of unsealed silos and bins. To compensate for poor distribution, dosages often exceed maximum label rates. As a result, peak gas levels may reach 6-8,000 ppm near the grain surface, and yet be less than 20-30 ppm at the base of storage units.

CLF resolves this problem by immediate recirculation of gas to all parts of the grain mass by low level (compared to aeration) airflow. An external gas chamber can allow much lower initial dosage, and the addition of more pellets and gas when and as needed periodically through out the fumigation.

Sealing of storage structure, a required part of CLF installations ensures that gas leakage is minimal compared to conventional fumigation. By upgrading CLF systems with external gas release methods, the future use of phosphine, the only remaining grain fumigant, will be greatly enhanced and the release of phosphine to atmosphere during the ventilation of gas at the end of the fumigation will be much safer, due to lower levels of phosphine gas used.

Final Report
FY 2002

This report reviews the work and accomplishments related to the project objectives listed above.
Fulfillment of Objectives 1-3.

The following information is submitted as fulfilling the Final Report obligation. The CLF hard plumbing was completed on the 8,000 bu. and 18,000 bu bins during the Summer 2002 Oklahoma Fumigation Workshops at SPREC, August 13-15, 2002. Most of the CLF plumbing for the sixteen 500-bu bins were completed just before the Fumigation workshop in early August, 2002.

Workshop students were involved directly in installing the CLF systems on the 8,000 and 18,000 bu bins and sealing the centrifugal fans to prevent leakage of gas around the direct drive motor shaft clearance hole.

Workshop students also assisted in sealing the sidewall/concrete base junction on the 500 bu bins to prevent gas leakage from the bins during fumigation as part of the CLF installation process.

Three sizes of Hoffman electrical cabinets were purchased to use in building phosphine gas release cabinets (PGRC). One PGRC was completed and demonstrated at the Fumigation workshops. A second, advanced stage design of the PGRC concept was built in September, 2002. These two cabinets will be leak tested and evaluated in January-March, 2003.

To demonstrate the ideal or model method of storing pesticides and fumigants at SPREC, two weather tight surplus electrical cabinets were purchased and installed outdoors in the grain center at SPREC. These cabinets were installed in early August, 2002 and were inspected and approved by the Hazardous Materials Staff, OSU Physical Plant, prior to authorizing and applying the correct signage for the storage units. The appropriate hazardous materials signs were provided by OSU and were installed prior to the Fumigation Workshop. These cabinets were demonstrated to all of our Fumigation Workshop students. Many students expressed interest in purchasing identical government surplus cabinets (at $100/cabinet) from the supplier at Okarche, OK. Training on safe storage of fumigants is considered part of CLF systems training.

The CLF plumbing of the sixteen 500 bu bins is a unique, multi-purpose design. The CLF suction pipe to pull phosphine gas from the headspace is inside the bin, from the headspace to the plenum. It also serves as the conduit for 3/16 inch ID gas sampling tubes to pull gas samples from the bin at 5 levels: Headspace (above grain surface), 1/4, 1/2, 3/4 depths and from the sub-floor plenum chamber.

We still have to develop the manifold system to connect a CLF fan inlet and outlet to one or more of the bins. I will design the CLF manifold and fan system so we can connect one to 16 fans and them fumigate simultaneously.

I've designed a similar system for the twelve hopper bins, but have not installed that system yet. The CLF for the twelve 450 bu hopper bins will incorporate a similar piping system for testing gas readings at multiple levels like the 500 bu bins.
Five of the twelve 170 bu bins have CLF plumbing. We did not have enough funds to complete the CLF for these small bins at this time.

Live fumigant was demonstrated in some of the 500 bu bins during the August Fumigation Workshops. We demonstrated probing technology with and without proper sealing of the bin fill cap. We added pellets to four bins the day before the workshop started. On bins with no sealing of the fill caps, gas levels were lower than readings in the tightly sealed bins on Day 1. All gas had dissipated from the bins with unsealed roof caps by Day 2 of the workshop. In bins that were properly sealed, gas levels were continuing to build on Day 3.

One important function that has begun at SPREC is "Practical or Hands-On Testing" qualification of people applying for their OK Fumigators License, either Commercial or Private. Several people who registered for the Fumigation Workshop received their complete certification for Category 7C during the three-day Fumigation Workshop. Approximately 60 people from OK, TX and KS attended the three fumigation workshops at SPREC.

The CLF/ERC or CLF/PGRC technology was transported to and demonstrated at the 6th National Stored Product IPM Training Conference at Manhattan, KS, August 19-22, 2002 to concurrent training groups containing 60-70 people from the U.S. and other countries in the Fumigation Application Section of the Grain Track of the conference.

**Fulfillment of Objectives 4.**

The CLF/ERC or PGRC design is complex and testing is still in progress.