Health & Safety Report

Worker Health and Safety Branch

HS-1849

An Overview of Closed System Use in California 2001-2002

HS-1849
June 2003

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Executive Summary

The California Department of Pesticide Regulation conducted a survey of sealed pesticide transfer devices (closed systems) in use between 2001 and 2002. Seven agricultural-intensive California counties were visited, with 43 closed system surveyed. The use of closed systems in California has been a regulatory requirement since the late 1970's. Since a standard design was not promulgated, there have been various attempts to fulfill the requirements set forth in the "Director's Criteria for Closed Systems." Defined in Title 3 CCR Section 6000 and in the referenced Director's Criteria, closed systems allow for the sealed transfer of liquid pesticides from their original container into mixing equipment, then into the final application equipment. According to the Section 6000 definition and the Director's Criteria, closed systems must have: appropriate hoses, couplers, piping, and tanks; protected sight gauges; adequate measuring systems; maximum operating pressures no greater that 25 psi; container-rinsable probes; adequate shut-offs; a container rinsing system; and instructions on operation/cleaning/maintenance. Additionally, appropriate PPE must be present.

Three major types of systems were identified: Suction Extraction, Container Breach, and Direct Drop/Gravity Feed). Suction Extraction systems depend on vacuum removal of container contents. Container Breach systems utilize slicing or spearing actions to puncture containers, allowing their contents to spill into a drain box. Direct Drop/Gravity Feed systems allow the container to be directly connected atop the mixing tank and use gravity to empty the pesticide into the system.

The closed systems were surveyed as to their compliance with the Director's Criteria. The system users were also queried as to problems encountered with operating these devices. Most of the systems surveyed were very capable of moving pesticides through their various hoses, pumps, couplings and manifolds, delivering properly mixed materials to the application equipment. However, there was a general set of problems identified that all closed system had at least one of. These problems were:

1. Non-standardized container interfaces
2. Problems with container rinsing
3. Measuring difficulties
4. System complexities

The non-standardized container interfaces and container rinsing problems are interrelated, since in both cases removal of either the concentrate or the pesticide-contaminated rinsate is accomplished by the same means. Fine measurement is likewise difficult, especially with Container Breach systems, which do not lend themselves to accurate measurement of partial use of a container's contents.

System complexity, in and of itself, is not necessarily a problem to the closed system users. The problems associated with complexity often arise from inadequately trained or untrained personnel (i.e. emergency response personnel arriving on a scene where the operator is incapacitated). Under these conditions, the lack of posted instructions and unidentified control and flow systems could result in improper and unsafe operation of the closed system.

A standard opening interface requirement may resolve many of the problems associated with multiple connection requirements and fine measurement. Better identification of hose contents, valve operation and the posting of emergency shutdown procedures could address the problems of conduit and valve identification and emergency shutdown.

Introduction

The United States Environmental Protection Agency (USEPA) commissioned a study of sealed pesticide transfer devices, known as closed systems, in use in California during the period of 2001 to 2002. The California Department of Pesticide Regulation (DPR) conducted this study in several counties in California, focusing on the major agricultural areas of the state. Forty-three closed system users (CSU) were surveyed. In several cases, users relied on more than one type of closed system. These systems were surveyed as to their compliance with the Department of Pesticide Regulation's "Director's Criteria for Closed Systems".

Methods to control health hazards fall into three categories: engineering controls, administrative controls and personal protective equipment. The preferred order of these controls are as listed; engineering controls should be the first line of defense whenever feasible (Plog, 1996). Closed systems are considered an engineering control method. They should be designed to prevent human exposure and should not require human intervention to eliminate exposure.

Use of closed systems is required by California regulations (Title 3, California Code of Regulations [CCR] Section 6746) when using a liquid or liquefied Category I material. Category I pesticides have the signal word "DANGER" (often accompanied by "POISON" for materials with systemic toxicity) and are usually considered extremely dangerous. These materials may be corrosive or have other hazardous properties beyond systemic toxicity. Pesticides in Categories II (signal word "WARNING") and III (signal word "CAUTION") are less toxic or hazardous than Category I materials and are not mandated by regulation to be loaded via closed system.

Closed systems essential properties include removal of material from the original container; rinsing and collection of the rinsate from the original container; moving the pesticide and its rinsate into appropriate mixing/holding tanks; agitating or otherwise mixing materials when appropriate; and finally moving the pesticide, its rinsate, its diluents (largely water) and any other added materials (adjuvants, non-Category I pesticides, etc.) into the application equipment. Ideally, all this is to be accomplished without any potential for worker exposure. Even the hose disconnections are allowed to leak only trivial amount of material (according to the Director's Criteria, two milliliters of drippage from a coupler is allowed, per each disconnect). This approach would be considered an engineering control of worker exposure to hazardous materials. Other types of engineering controls available for pesticide mixing and loading include the use of water soluble packets and the substitution of less hazardous (Category II or III) materials.

The use of a closed system allows for reduction in the personal protective equipment (PPE) ensemble that would normally be required when handling Category I pesticides. According to DPR regulations concerning PPE and closed systems (Title 3, CCR Section 6738 [i]):

(i) The following exceptions and substitutions to personal protective equipment required by pesticide product labeling or regulations are permitted:

(1) Persons using a closed system to handle pesticide products with the signal word "DANGER" or "WARNING" may substitute coveralls, chemical resistant gloves, and a chemical resistant apron for personal protective equipment required by pesticide product labeling;

(2) Persons using a closed system to handle pesticide products with the signal word "CAUTION" may substitute work clothing for personal protective equipment required by pesticide product labeling;

(3) Persons using a closed system that operates under positive pressure shall wear protective eyewear in addition to the personal protective equipment listed in (1) or (2). Persons using any closed system shall have all personal protective equipment required by pesticide product labeling immediately available for use in an emergency.

Regulations only require the use of closed systems for Category I liquids, but as noted above, PPE exemptions are also granted with Category II and III pesticides when using a closed system. The exemption from certain PPE is considered an incentive to use closed systems, inasmuch as PPE can be uncomfortable to wear (respiratory protection) and also cause thermal discomfort (chemical resistant coveralls). Use of engineering controls also avoids the constellation of problems associated with PPE (heat stress, decreased mobility, physical stress, lack of fine motor skill, false sense of security).

In California, closed systems are defined by regulation (Title 3 CCR, Section 6000) and required under certain conditions (Title 3, CCR Section 6746). Both of these sections require that “The system's design and construction shall meet the director's closed-system criteria.” These criteria are found in a DPR document called Director’s Criteria Document (last revision January 2, 1998). The essential components of a closed system acceptable to DPR are:

1. Must meet the Title 3, CCR Section 6000 Definition: *"Closed system" means a procedure for removing a pesticide from its original container, rinsing the emptied container and transferring the pesticide product, mixtures and dilutions and rinse solution through connecting hoses, pipes and couplings that are sufficiently tight to prevent exposure of any person to the pesticide or rinse solution. Rinsing is not required when the pesticide is used without dilution. The system's design and construction shall meet the director's closed system criteria*.
2. Must use appropriate hoses, couplers, piping, and tanks.
3. Must have protected sight gauges.
4. Measuring system adequate to accurately measure the smallest unit used.
5. If it is pressurized, it must be no greater that 25 psi.
6. Probes must be rinsable in the container or some other method of precluding worker exposure.
7. There must be shut-offs or other anti-leak devices (i.e. dry disconnects) for hose ends.
8. A container rinsing system must be incorporated.
9. Instructions on operation/cleaning/maintenance must be available
10. Maintenance must be performed on regular basis.

11. Appropriate PPE must be present (and eye protection must be worn for systems operating under pressure).

The flexibility of these criteria have allowed for multiple approaches to the manufacture of closed systems. Various pumping systems, piping/manifold configurations and tank set-ups have been designed, some which allow for non-pesticide related side-use. These side-use set-ups include routing fresh water supply tanks for use in dust-suppression road watering.

The American Society of Agricultural Engineers (ASAE) has a proposed Standard for Closed Chemical Transfer for In-Field Handling of Pesticide Products (Draft Standard X-550). Work on this Standard was started in the early 90's, though there has been no known recent progress since 1998.

The essentials of all closed systems are the following:

1. A method for removing the pesticide from its original container (EXTRACTION)
2. A transfer system to move the pesticide though the appropriate hoses, tanks and pumps, often involving the dilution of the pesticide with water (TRANSFER/MIXING)
3. A delivery system to place the finished mix into the application equipment (LOADING).

Though CSUs had differing material transport/mixing apparatus, and either one of two types of loading interfaces (dry couplers or quick release couplers with integral shut-off valves), the types of chemical extraction devices could be classified into three major approaches:

Suction Extraction (SE): A sufficiently long tube is introduced into the pesticide container. The tube is connected to a pump by a flexible hose. Suction is applied through the hose and tube, drawing the pesticide out of the container and into the transfer/mixing section of the closed system. Inasmuch as rinsing is also required, these extraction tubes are usually part of a two-tube system, the secondary tube jacketing the primary extraction tube. The secondary tube supplies water, spraying out of ports on the side of the tube, for container rinsing. The extraction tube also suctions the resulting rinsate out. Examples of this class include the Chemprobe®, Chemeasure® and ColFab® and are shown in Figures One and Two and Three, respectively.

Figure One: Chemprobe®

Figure Two: Chemeasure®

Figure Three: Col-Fab® Probes

Container Breach (CB): The pesticide container is placed within a larger container that is plumbed into the transfer/mixing system (primarily by drains in the bottom of the encasing container). This enclosing container is then sealed by closing the access opening through which the pesticide container was introduced. A container-breaching device is then activated. This device (a sharp edge cutter, a spike or a pointed ram) compromises the container integrity, allowing the pesticide to flow out of its original container and be directed by the drains into the transfer/mixing section. Rinse water injectors, strategically positioned to spray water into the destroyed container, ensure compliance with rinsing requirements. The drains for transfer/mixing also collect this rinsate. This class includes Goodwin Boxes®, Captain Crunch® and Goodwin-type boxes. A Goodwin box is shown in Figure Four.

Figure Four: Goodwin® Box

Direct Drop/Gravity Feed (DD/GF): The pesticide container is connected to an adaptor. The adaptor connects to the top of the mix tank. The adaptor is activated, releasing the material directly into the mix tank. Integrated into the adaptor is an internal spray nozzle that sprays water up into the pesticide container, which also drains into the mix tank. A key aspect of this system is that the adaptor, even after being placed on the pour spout of the pesticide container, maintains a seal until it is locked onto the mix tank and then activated. Sotera® adaptors, shown in Figure Five, are the only example in this class.

Figure Five: Sotera® Adaptor

Of these three system types, the basic design of both SE and CB has been used since the middle of the 1970's (Brazelton, 1978). The DD/GF design was presented to DPR in the mid 1990's (author's personal communication).

Other minor variations include large (+30 gallons) pre-probed containers, proprietary systems for dry formulations (TEMIK LOCK 'N LOAD®) and off-loading systems for bulk and mini-bulk containers. However, in terms of liquid Category I pesticides, the three previously mentioned systems constitute the majority of systems surveyed, and presumably used, in California.

The design of pesticide containers is the province of the USEPA under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA). Under FIFRA Section 19 (e) Container Design:

(1) Procedures:

(A) Not later than 3 years after the effective date of this subsection, the Administrator shall, in consultation with the heads of other interested Federal agencies, promulgate regulations for the design of pesticide containers that will promote the safe storage and disposal of pesticides.

(B) The regulations shall ensure, to the fullest extent practicable, that the containers-

(i) accommodate procedures used for the removal of pesticides from the containers and the rinsing of the containers;

(ii) facilitate the safe use of the containers, including elimination of splash and leakage of pesticides from the containers;

Container design is an integral facet of the closed system process and must be considered part of a holistic approach to ensuring a functional closed system. However, as illustrated by the numerous EXTRACTION schemes, consideration of the interface between the container and the EXTRACTION device does not appear to have been adequately addressed.

Methods

DPR's Worker Health and Safety Branch contacted the County Agricultural Commissioners (CAC) in seven California counties. These were Kern, Imperial, San Diego, Fresno, Monterey, Kings and Glenn counties. The CAC in turn, contacted local users of closed systems, both custom applicators and growers.

A questionnaire was developed to assist in the on-site survey. This form identified the operator, any identifiers of the actual system (e.g. Truck #123A), the county in which the system was observed and any comments the CSU may have concerning specific problems or attributes of their particular system. Additionally, a checklist of properties that the closed system should have, based on the Director's Criteria Document, was also included. The form is shown in Figure Six.

Closed System Survey Form

Operator Identification: ______________________________ Date ___/___/___

System Identification: ____

County: ___________________________ Inspecting IH: ___________________________

Primary Checklist (explain all deficiencies)

Any observed stains/discoloration?	YES	NO
Are container-to-system connections tight-fitting?	YES	NO
Are transfers lines of appropriate type?	YES	NO
If present, are sight gauges protected against damage?	YES	NO
If present, are any sight gauges damaged?	YES	NO
Are there adequate shut-off valves in appropriate positions?	YES	NO
Do transfer lines appear to have functional integrity?	YES	NO
Does rinsing system perform as required?	YES	NO
Are pressure gauges present?	Water / Conc. / Mix	
Are instructions present on the system?	YES	NO
Are there any obvious leaks?	YES	NO

What is the smallest unit of measurement: ________________

Capacity of Containers It Can Accommodate

ALL	One Gallon Only	Up to Five Gallon
One to 30 Gallon	One to 50 Gallon	Five to 50 Gallon
30 and 55 Gallon	15 Gallon Mini Bulk	30 Gallon and Larger

Container Compatibility Problems:____

Restrictions

NO GLASS	CAN USE WP/WSB	Destroys Closure
Cannot Remove Partial	Destroys Container	Can use Undiluted

Does it use dry couplers or probe rinse: ______________ Operative? ______________

How is the maintenance schedule documented? ________________________________

Comments:(interface/rinsing/measuring/complexity)

Figure Six: Closed System Survey Form

With the assistance of CAC's staff, CSUs were visited and a survey form was completed. In two cases, the complete closed system was not seen, only the extraction portion (in one case a Chemprobe®, in the other a Chemeasure®). The CSU was also interviewed (often the company owner/operator) and comments were solicited concerning their experiences using the closed system. Digital photos were also taken for future reference.

A "walk-around" of the equipment was performed, looking for any unusual or novel approaches to design or technology. In several cases, the equipment was in actual operation during the examination and the operating procedures could be observed.

Conditions of system function that could have resulted in worker exposure were noted (i.e. interface problems).

Results

From August of 2001 to June of 2002, forty-three CSUs were surveyed for their use of closed systems. The types of systems encountered were of the following:

Suction Extraction: 24 examples
Container Breach: 18 examples
Direct Drop/Gravity Feed: 5 examples

In a few cases, CSUs would have more than one type of system. For example, a CSU may have a Goodwin® box for use when using the total contents of a 2.5-gallon plastic container and use a Chemeasure® when only drawing a partial amount from the same size container.

The answers to the primary checklist questions of the survey form (Figure Six) were unremarkable. For the most part, systems were clean and well maintained (no observed stains that could be associated with leaks and no obvious leaks of pesticidal material were noted), material and engineering were adequate (appropriate hoses and transfer lines; sight gauges shielded or break resistant; integrated rinsing systems; heavy duty valves) and operating systems appeared to function as designed. Three systems were deficient in that the mixing tank was open, though material was not poured into the system by this opening. The CSUs were advised by the CAC to add tank closures to these systems.

The only consistent problem noted on the checklist was the question concerning the instructions being present on the system. In the majority of surveyed systems, instructions were not present. Only 8 systems had instructions "…in a prominent location on the systems" as required by the Director's Criteria Item 9(a).

Of all the systems surveyed, none seem to display any deficiencies (except the cover problem noted above) concerning the TRANSFER/MIXING (T/M) portion. This is to be expected, since the T/M section is essentially a plumbing system. Plumbing is a mature technology, with generally recognized procedures and proven materials. Thus the confined movement of liquids, barring equipment failure from wear, is easily accomplished. Inadequate design would make itself apparent very rapidly, with evidence of leakage or other inappropriate release of liquid.

Likewise, the LOADING systems did not appear to have any major deficiencies regarding worker safety. However, several systems did not appear to have dry couplers as their shut-off device for the loading end of the system. Many used simple ball valves, not equipped for anti-drip decoupling. Evaluation of the effectiveness of the dry coupling was not performed, though cursory observation of systems in actual use did not disclose any puddle or other leakage evidence at the coupler when it was placed on the ground after decoupling from an application rig loading. Many of the crews mentioned that normal procedure is to load an incompletely diluted pesticide mix into the application tank and follow up with the remaining water to reach application strength in the application tank. This procedure supposedly ensures that any drippage after decoupling was largely dilution water, with only minimal levels of pesticide available for exposure. One CSU stated that they flushed the loading lines with compressed air before decoupling from the application rig. It is not clear if the lack of a dry coupler could be a source of pesticide exposure to handlers. Likewise, the Director's Criteria specification for less than 2 ml of drippage per disconnect may be not relevant to handler exposure if the material is essentially water.

The EXTRACTION portion of closed systems is the weak point of most closed systems. Inasmuch as container openings are of manifold differing configurations, no single type of device is suitable for all types of containers. The interface between the container and the extraction system is usually not designed for a "perfect" fit. The most extreme case of this is the container breaching approach, where the customary interface (the container cap and spout assembly) is disregarded and destruction of the container integrity is the method for material removal. Figure Seven shows how complete the destruction of container integrity is achieved in a Goodwin® Box. This approach, though functional, does not appear to be exactly the concept envisioned within the Director's Criteria, which addressed probes as the apparent route of material removal. That is not to say that container breaching is an illegitimate method, just one that may have been unconventional in its initial deployment.

Figure Seven: Container Opened by Goodwin® Box

Since the interface is often not designed with closed system probes in mind, it is difficult to establish a single universal fit device that can extract the material through the spout. A probe that is tight fitting on one container may be too loose (or too tight) on another. CSUs have attempted to overcome this shortcoming by the use of flanges, auxiliary seals to enclose the probe/spout interface or, in the case of one CSU, the use of multiple probe diameters. Figures Eight and Nine illustrate some of these devices. However, if a perfect seal is achieved, a second problem may be introduced from the vacuum placed on the plastic container as the material is removed. As the container is evacuated, atmospheric pressure causes it to collapse. If the CSU is attempting to use a portion of the container, the distorting container interferes with attempts to judge the portion removed. This problem was noted by 5 CSUs. One CSU attempted to overcome this problem by incorporating a vacuum release valve on the flange assembly.

Figure Eight: Plastic Interface Adaptors

Figure Nine: Metal Interface Adaptor

The difficulties inherent in the EXTRACTION process not only apply to the removal of the pesticide from the container but also bear on the rinsing of the container interior. In the process of rinsing the containers, the rinsate must necessarily become contaminated with pesticide residue and be removed from the container (to normally be added to the total amount of material in the mix tank). Once again, the same problems of initial pesticide removal are found in the removal of rinsate. Three CSUs noted they had encountered problems rinsing containers that had held viscous or batter-like materials, especially in the handle portion of the container. The rinse water ejection pattern of suction extraction probes was problematic, incapable of rinsing up into the small channel of the handle interior.

Another problem of the extraction is potential incompatibility with containers less than 2.5 gallons. CB units may not be able to accommodate small (pint to quart) containers within their holding brackets, making it impossible to open the container. Suction systems, using probes, experience difficulty in both maintaining stability of the small container (center of gravity migrates up the heavier probe) and in measuring out small amounts of material from these containers. Furthermore, direct drop/gravity feed systems may not fit the undersized (less than 64 mm diameter) openings of the smaller containers.

Of systems that were in operation during the survey, there were no obvious conditions of normal operation of the T/M equipment that could have resulted in worker exposure. All observed hoses and tubing were in adequate condition. No overt leaks of pesticides were noted on any operating system. Connections on all systems appeared to be tight and there were no signs of hose or connection deterioration. Several systems had obviated the need for hose replacement by using metal tubing whenever possible, especially on the T/M section of the equipment. When queried about system maintenance, most CSUs either stated they did annual teardown and replacement of worn parts or that they replace hoses on an as-needed basis.

Additionally, systems in operation during the survey did not show any signs of causing exposure to the handlers from either the EXTRACTION or LOADING activities. It would appear that CSUs have developed operating strategies with their respective equipment that generally result in minimal exposure to the operator. One CSU who used SE units had designed retention cages, shown in Figure Ten, for 2.5-gallon containers. These cages would ensure the container remained stable and did not tip if the operator had to remove his hand from the SE probe.

Figure Ten: Container Stabilizer

Discussion

The use of closed systems in California has been a regulatory requirement since the late 1970's. Since a standard design was not promulgated, there have been various attempts to fulfill the requirements set forth in the Director's Criteria document. Most designs appear to fulfill these requirements, though there are some problems associated with the SE approach. However, there does seem to be a general set of problems, which every system type has at least one, though not necessarily all types of systems have all these difficulties. These problems are:

1. Non-standardized container interfaces
2. Problems with container rinsing
3. Measuring difficulties
4. System complexities

These problems are not of recent origin. Previous work from 1982 had cited "…cost of systems, lack of efficiency, lack of versatility to handle different containers and dry materials, equipment problems and operational complexity." (Jacobs, 1987).

The first and second problems are interrelated, since in both cases removal of either the concentrate or the pesticide-contaminated rinsate is accomplished by the same means. Difficulties in measuring are also partially related to the methods of EXTRACTION, since fine measurement is often difficult with a SE system (though somewhat easier with the Chemeasure®) and virtually impossible with a CB system. The DD/GF system presently available can meter out small amounts, but once again is dependant on a standardized interface to function properly.
These problems had been noted in closed system design from the outset. Early work on closed systems revealed "[W]hile there may be some improvement, general comment from users continues to indicate that the wide variety of pesticide containers continues to be a major impediment to wide-spread closed system use, particularly with commercial users." (Rutz, 1987). This comment was written in 1987 and it appears that very little improvement has occurred in terms of the containers.

System complexity, in and of itself, is not necessarily a problem to the CSUs. It was noted that several of the systems did not have operating instructions posted on the rig, as required by the Director's Criteria Document. A properly and comprehensively trained CSU could probably operate the closed system without instruction explicitly posted on the equipment they are operating. For a well-trained CSU, this would be akin to posting the instruction manual for starting and driving a vehicle on the dashboard of a car. Properly trained personnel can safely operate systems of amazing complexity, as for example, a nuclear submarine. Likewise, the complexity of a system may be masked, yet still under the control of the operator, such as driving an automobile. The problems associated with complexity often arise from inadequately trained or untrained personnel. In the instance of closed systems, there could be three major conditions where such personnel could interact with the closed system: genuinely incompetent operators, panicked operators, or persons thrust into attempting to immediately understand the system without prior knowledge, i.e. emergency response personnel arriving on a scene where the operator is incapacitated. Under these conditions, the lack of posted instructions could result in improper and unsafe operation of the closed system.

Genuinely incompetent operators are a failure of adequate training by the employer. This problem is addressed in Title 3 CCR, Section 6724: Handler Training. An incompetent operator is an inadequately trained operator and is a violation of existing regulations. A panicked operator may momentarily become confused because of a stressful condition (i.e. catastrophic hose failure) and may find even a rudimentary instruction posting valuable in re-establishing their proper responses to the stressful conditions. The more ominous situation of emergency responders cannot be addressed by better training of the handlers. In such situations, clear and understandable instructions on emergency shutdown procedures should be readily available and prominently displayed on the mix/load rig.

Along the same avenues of providing information to emergency responders or others not normally required to be trained to operate a closed system, better labeling of pipes, hoses and controls would provide rapid information as to whether a leaking valve or hose were water or some material of more concern. Given the almost Gordian Knot complexity of some systems surveyed, requiring simple identification of system contents, controls and tanks (e.g. hoses with "PESTICIDE" or "WATER" labels on them, valves with "OPEN", "CLOSED" tanks with "NON-POTABLE WATER" or "PESTICDE MIX TANK") could provide valuable information to emergency personnel untrained in the operation/construction of the closed system.

Recommendations

Problems inherent in the design of containers are beyond the regulatory scope of DPR. However, stabilization of the interface platform is a necessary first step in addressing the difficulties of closed system use in California. That is not to say that law or regulation should mandate the entire interface. The critical element of container design would be to mandate a specific opening/spout for the container capacity range of 0.5 liter (pint containers) to 40 liters (5 gallon pails). This capacity range is selected since it represents the normal size/weight range one could reasonably expect a mixer-loader to handle without mechanical assistance (approximately 20 kilograms). One of the most common container sizes in this range, the 2.5 gallon F-style jug, is usually equipped with a foil-enclosed 63 mm opening. However, there are no reasons smaller bottles or larger pails could not also be equipped with this size opening. If the container opening is standardized, closed system manufacturers could design connectors that are a perfect fit to the opening. In principal, stabilizing only the opening platform extends a mandated design only to the container fabricator, allowing for independent approaches for the connector design. CSU could then choose from the multitude of connector designs for the most appropriate for their pesticide handling operation. To accomplish this USEPA will need to establish a nationwide interface requirement.

There are actions that California may take to provide additional levels of safety that are not related to container design but are concerned with the mixing/loading equipment. As noted previously, some systems were fairly complex in construction and operation, with various hoses and pipes moving liquid compositions of an indeterminate nature to a person not familiar with the system. Labeling both the conduits and the controls would clarify the operation of the systems, especially to emergency responders. Conduit labeling could provide valuable information in an emergency situation, e.g. that a leaking hose is releasing water as opposed to a pesticide mixture. The labeling of conduit and controls would also be useful for the CSU, acting as a confirmation of action taken (i.e. moving the lever does turn "OFF" flow through the "PESTICIDE/WATER" hose).

A second potential regulatory requirement regarding safety would be the incorporation of an emergency shut off. On equipment built in the future, an integrated control could be made a regulatory requirement. Older equipment could require the posting of specific shutdown instructions near or on the closed system equipment. These instructions could be as simple as “Turn off the pump motor” or so detailed as requiring multiple sequential actions to occur, but at least a method for rapid shutdown would be posted and available in an emergency.

Finally, formalization of the Director’s Closed System Criteria into a regulatory requirement may help clarify the elements that DPR believes are most important in the design of a closed system. The present Criteria document is not generally available to the public. It may be more effective to reduce the document to a set of general regulatory requirements, without mandating any one specific technology.

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