*Technical Report #10*

# Bulk Handling of PVC

## Introduction

Domestic consumption of plastic materials is increasing yearly and, as a result, fast, efficient and economical methods of handling these materials are needed. Currently, bulk railcars and bulk trucks are used for delivery of resins and compounds. Movement of the products from railcars to storage and subsequently, to processing equipment, requires new types of equipment and technology.

Most bulk handling equipment manufacturers are able to evaluate and test practically any new commodity in a pilot operation and develop a handling system. Empirical formulas cannot be used to satisfy every situation. Most manufacturers rely on experience and pilot operation results to design the most efficient bulk system for individual installations. Requirements for a bulk conveying system should be developed in detail so a manufacturer can more readily determine its ability to fulfill the system's requirements.

Presented in this bulletin are several factors which should be considered when designing a bulk handling system. The equipment investment required to install a facility for handling bulk general purpose and mass resins is large. Companies usually need to have a volume of 3 – 4 million pounds to justify the cost. For those in or above this volume, significant savings can be gained by purchasing PVC resin in bulk. Some of these savings follow.

### Lower Product Cost

Direct cost savings for plastic materials packaging can be realized. Bulk railcar and bulk truck purchases are normally lower than bag pricing. Indirect savings result from the elimination of bag spillage, broken bags and housekeeping cost. Up to 1% of the product can be lost in bag handling. The cost of contamination from paper, etc., will be reduced.

### Lower Labor Cost

A fully automatic receiving, storage, and in-plant delivery system can be operated by one man. The filling of hoppers, bag removal and disposal, and moving of material by forklift trucks can be reduced or eliminated. Inventories and process material consumption can be electronically monitored.

### Floor Space Savings

Warehouse space normally assigned to bag and Gaylord container storage can be used for finished product storage or for production space. Bulk silos and conveying equipment can be placed on the exterior of a building with hoppers and pipelines servicing in-plant use points located in ceiling areas, or buried in accessible ducts below floor level.

### Safety and Housekeeping

Self-cleaning, non-contaminating, totally enclosed dust collection and recovery systems can be employed for a cleaner plant. Reduced in-plant movement and less general congestion will make for a safer workplace.

### Automated Integration with Production

The entire process of unloading, storage, delivery and metering of material into production equipment will eliminate costly distribution problems and delays. The mixing operation will no longer be limited to 50 lb. increments, allowing full use of the capacity of mixing equipment.

### Pneumatic Bulk Material Handling

PVC resin in dry bulk is classed as a free-flowing material. Reliable systems can be designed and are available from a number of suppliers for railcar and truck, bulk unloading and in-plant handling. All bulk material handling systems utilize air to convey individual particles of plastic material in a given volume and simultaneously move the resin and air at high velocity through an enclosed pipe system. Described are three types of systems available for handling PVC in a pneumatic conveying system.

### Vacuum System

A choice for conveying PVC resin or compound from several places to a single point is the negative pressure conveying system (vacuum system, Figure 1), which uses a high velocity air stream. The ambient air enters the suction side of a positive displacement blower. The pulled air passes through material and draws it into the air stream. The material and air is separated by a filter receiver at the terminal point of the system. A rotary valve can be used to meter the material out of the receiver into the silo, hopper, etc.

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**Pressure System**

Another choice for conveying PVC resin or compound from one point to several points is the pressure system (or positive pressure, Figure 2), which uses compressed air. The product is introduced to the air through a sealing device on the discharge side of a positive displacement blower. The air and product are moved by the action of pressure to a vented filter receiving bin.

**Vacuum Pressure System**

The vacuum pressure system (Figure 3) moves PVC resin and compound from several points to several destinations.

Generally the positive pressure conveying system is most efficient. More pounds of material per pound of air can be handled due to the higher air density system.

Reliable bulk systems for handling PVC resin/compound should meet the following design criteria:

1.Linear velocity of 5,000 ft./min. average.

2.Filter area ratio should be 5.5 scfm/ft. $^2$ for suspension resin and 4.0 scfm/ft. $^2$

3. Hopper cone angle is recommended to be 60°, but not below 45°.

4. Bulk density of the material between 30 and 40 lbs./ft.$^3$.

5. Filter type should be pulse jet, continuous cleaning.

6. Storage capacity is two times bulk carrier capacity.

7. Air sources are positive displacement blowers (oil-free).

8. Storage silos are bolted or welded, epoxy-coating carbon steel, aluminum, or stainless steel.

9. Level switches are paddle wheels or capacitance.

10. Conveying lines are light weight (Schedule 5 or 10) aluminum or stainless steel.

11. Elbows should be long sweep stainless steel.

12. Rotary valves should be stainless steel.

13. Dust filter frames should be epoxy-coated carbon steel or stainless steel.

**Figure 1**
**Negative Pressure Conveying System**

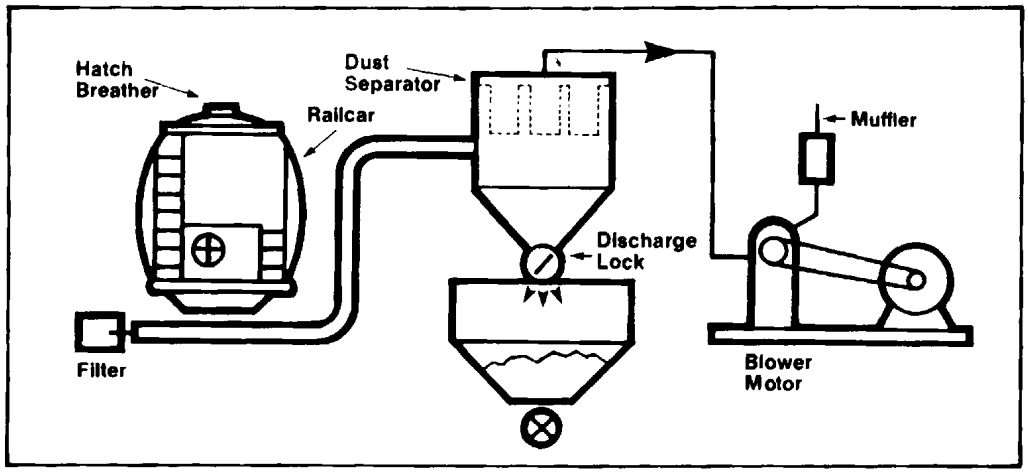



**Figure 2**
**Positive Pressure Conveying System**

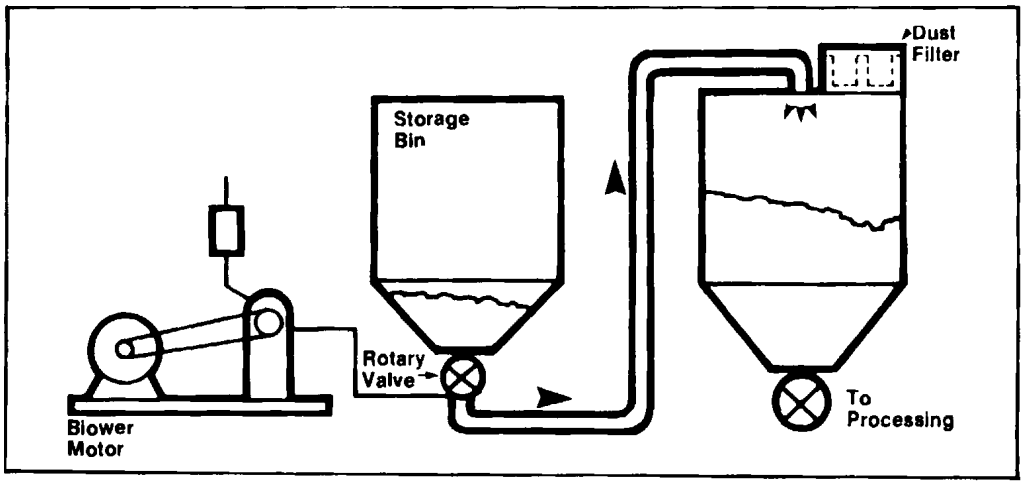
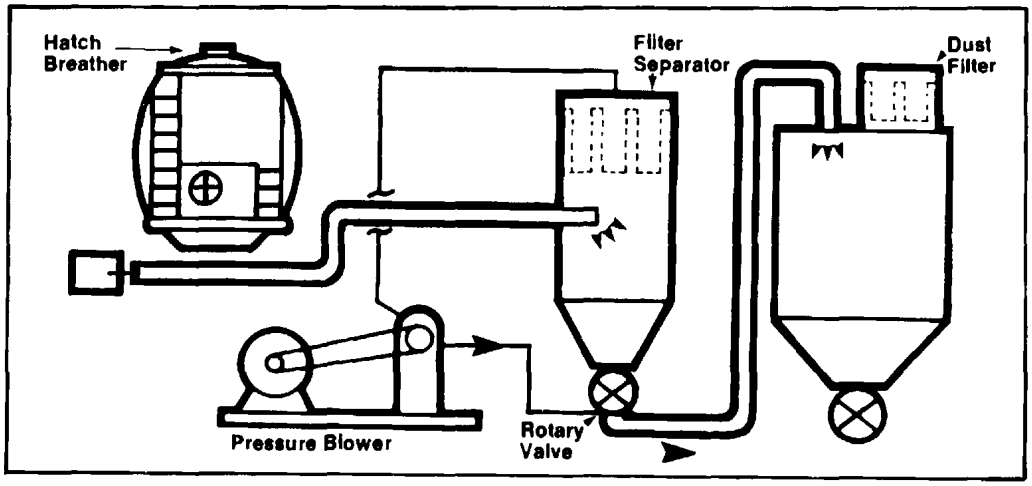



**Figure 3**
**Vacuum Pressure System**



14. Filter bags should be made of 1602 Dacron polyester.

Rotary valves shown in this report must be monitored for preventive maintenance. The close tolerances must be maintained or resin particles will get between the two surfaces and build-up excessive frictional heat that will cause the resin to fuse. This milled resin will flake off into the product stream and cause plugging of the bulk system.

Some companies use fluidized "pressure vessel" conveying systems that have no rotating parts in the product stream. Following are other advantages offered by pressure vessel conveying:

1. Two or more weighed ingredients in the same vessel impart some mixing action.
2. Flexibility to convey two dissimilar materials in separate batches without having to change rotary lock gearing or speed.
3. Conveying at higher pressures, which use smaller lines and denser flow patterns than rotary locks.

Figures 4, 5 and 6 illustrate pressure vessel conveying and its adaptability to the accepted pressure and combination pneumatic conveying system.

**Operation**: Vessel is filled to level control or weight limit. Fill and vent valves close and the vessel is pressurized. Material and air flow to receiver.

**Bulk Shipping Equipment**

OxyVinyls offers bulk shipments of general purpose resin in both railcars and trucks. The railcars are specifically designed for pneumatic bulk unloading; interiors are lined with a special non-toxic, non-contaminating material to protect the vinyl products. Rigorous and exacting standards are maintained for inspection, cleaning and loading of each car.

**Figure 4**
**Vacuum/Pressure System Using Pressure Vessel**

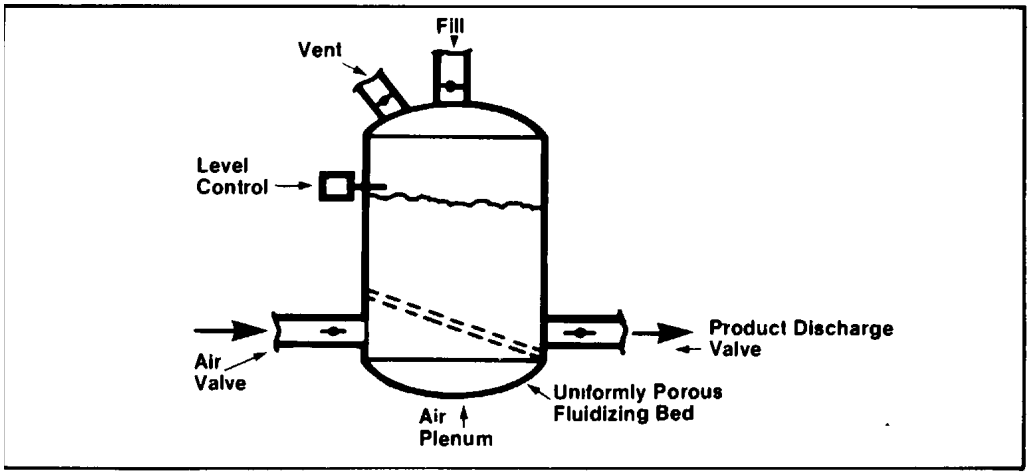



**Figure 5**
**Combination System**

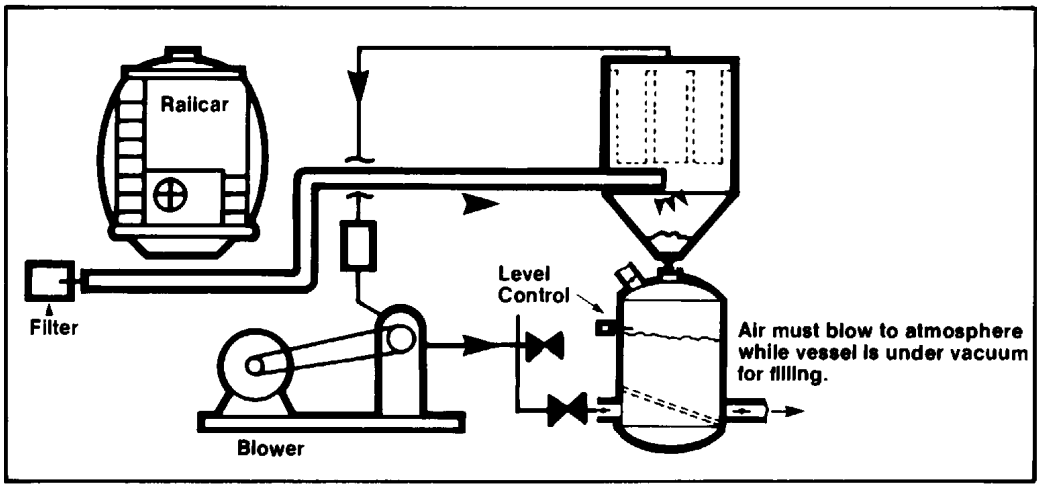



**Figure 6**
**Complete Vacuum/Pressure System Using Pressure Vessel**

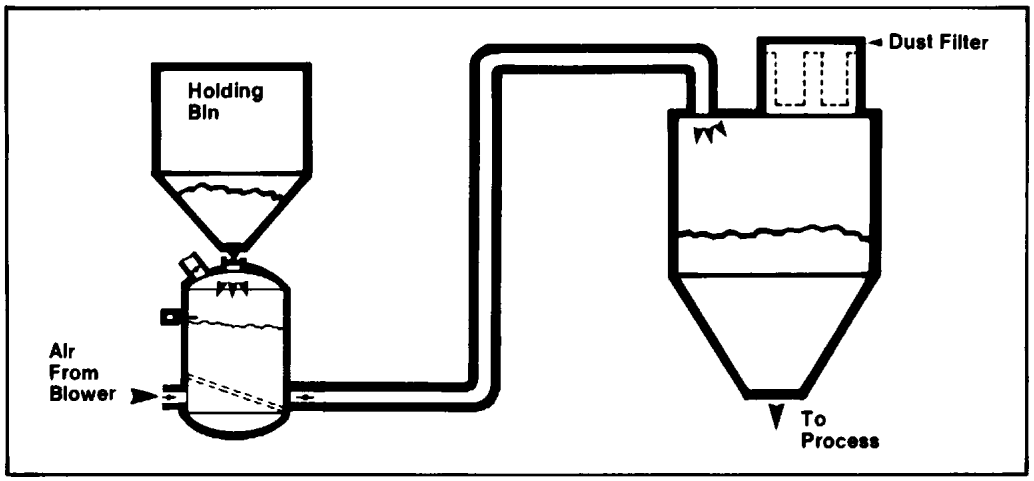


**Figure 7**
**Resin/Powder Bulk Handling System**

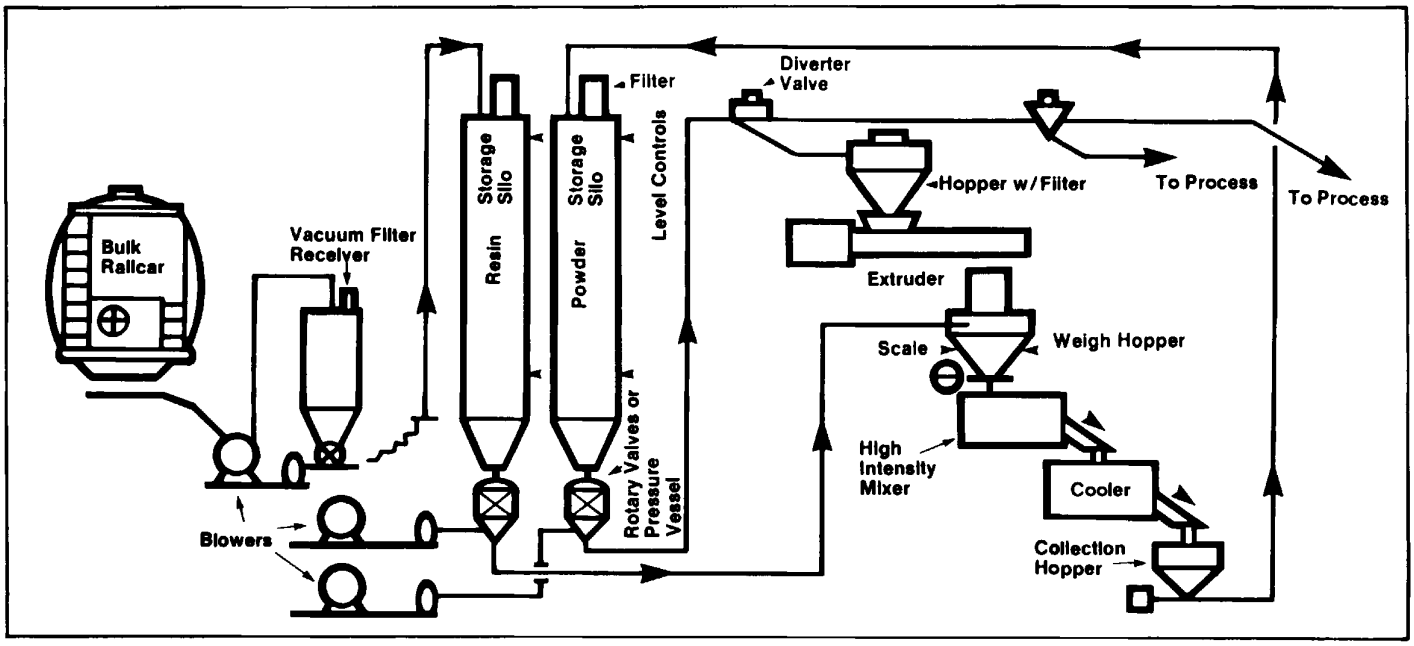
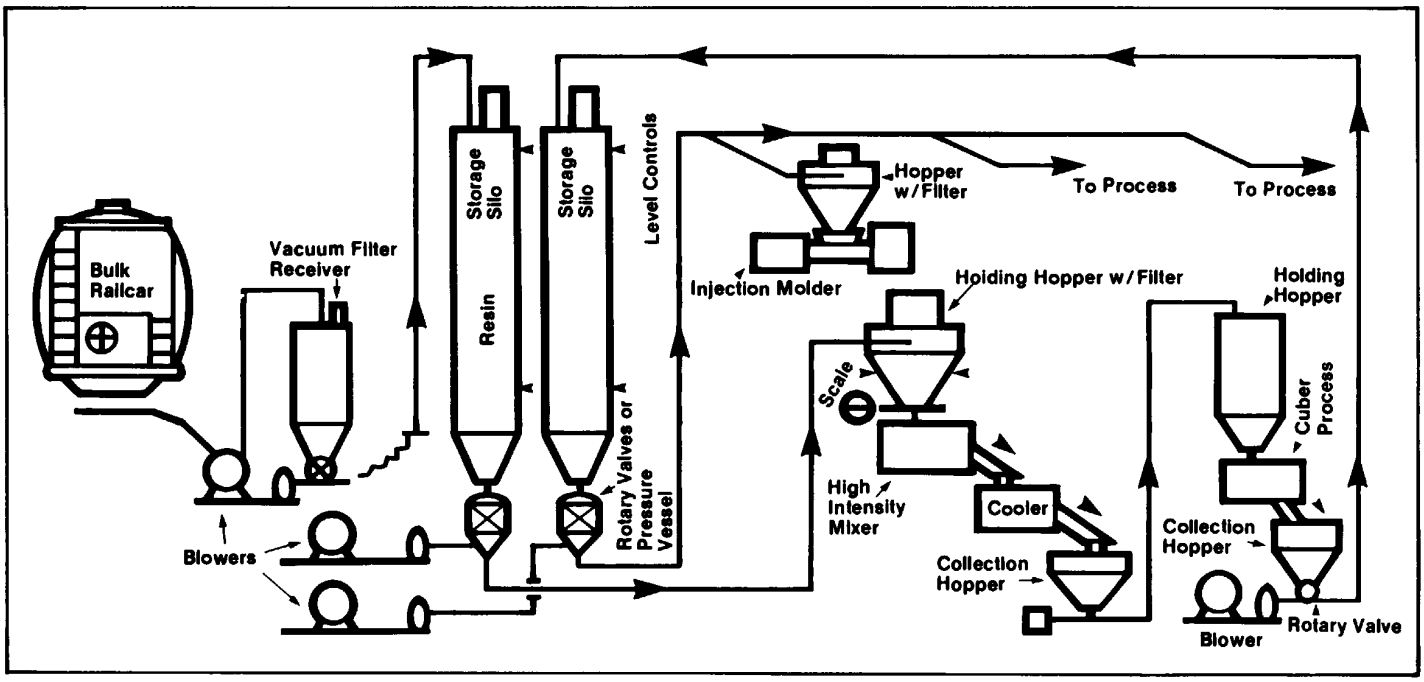


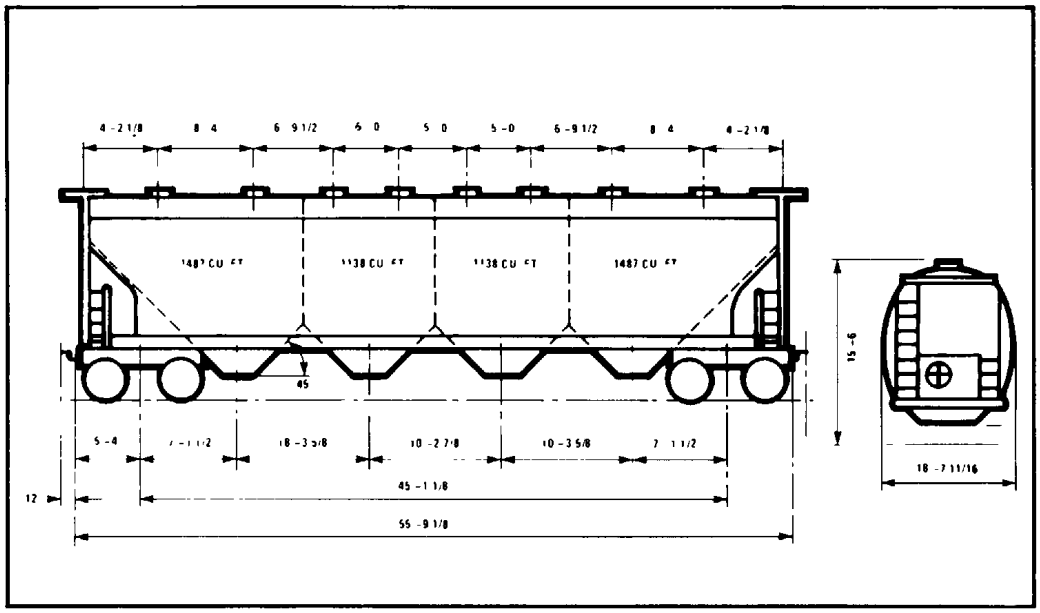

**Figure 8**
**Resin/Cube Bulk Handling System**



**Preparatory Steps for Unloading**

1. Open at least one hatch on the hopper being unloaded to avoid risk of collapsing bulkheads. If filtered air is required, a filter must be applied to the open hatches.
2. Remove the caps from both sides of outlet and secure on cap hangers. The valve cannot be rotated for operation unless both caps are removed. If filtered air is required, apply filter to the nozzle opposite the one used for vacuum connection.
3. Connect pneumatic line to the outlet nozzle using a sliding joint which will allow rotation of the control valve during unloading.
4. Support the pneumatic line adjacent to the nozzle connection to avoid excess friction when the control valve is rotated. If a large, heavy air filter is used on the opposite side, this should be supported also.
5. Start the pneumatic system.

**Figure 9**
**ACF Center Flow Car, ACF Industries, Inc., St. Charles, Missouri**



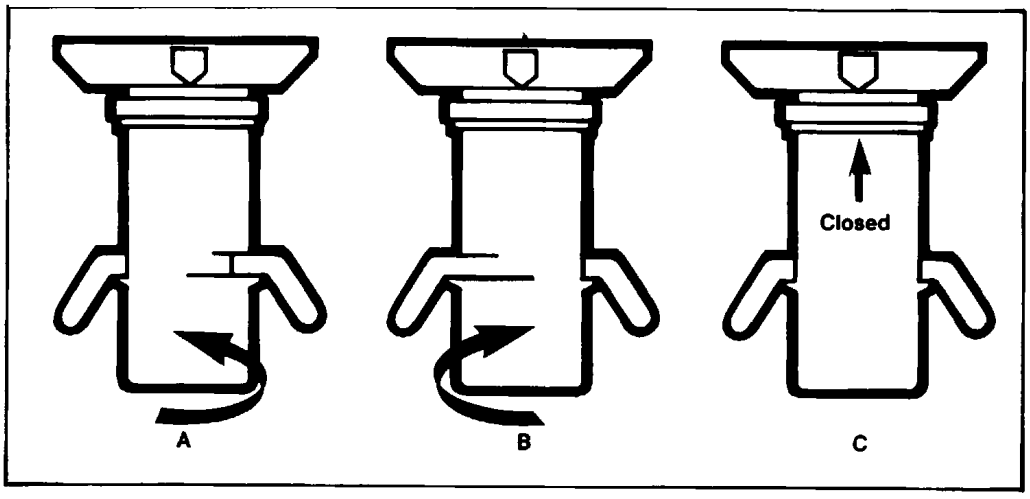

**Unloading Operations**

1. Initially the outlet nozzle will be in the closed position with the center arrow in line with the position indicator.
2. Rotate the control handle in counterclockwise direction until desired flow rate is achieved. Most of the lading in the compartment will be unloaded with the valve in this position.

**Clean-Out Operations**

1. After the flow of material stops (indicated by a sharp decrease in vacuum), rotate the control handle counterclockwise until material flow starts again. continue operation until material flow ceases (Figure 10A)
2. Rotate the control handle clockwise until material flow starts. Continue the clockwise rotation until desired material-to-air ratio is achieved. This is best determined by listening for the proper sound of material flow (Figure 10B).
3. When material flow ceases, rotate control handle clockwise a bit further.
4. To complete cleanout, rotate the control handle wide open alternately clockwise and counterclockwise several times, pausing several seconds each time at closed position so vacuum will clear tube.
5. Return control handle to closed position (Figure 10C).

**Figure 10**
**Clean-Out Operations**




**Preparing the Car for Return Transit**

1. Shut off vacuum system.
2. Remove hatch filters, check inside of car to see that unloading is complete. Close the hatch and secure in closed position.
3. Disconnect conveying hose from discharge nozzle.
4. Remove the filter on side of car opposite vacuum connection.
5. After making certain that valve is in closed position, apply caps to both discharge nozzles and secure.

**Special Note – Interrupted Unloading**

If unloading is to be discontinued before the compartment is empty, rotate the end adaptor handles and control valve to the “closed” position. Allow the vacuum system to run for a short period (2 minutes) to clear all pellets and powder from the bottom of the control valve tube.

Adjustable pneumatic outlets (Figure 11) are designed to provide the following advantages: 1) easy and complete clean-out without disassembly; 2) optimum flow control for all pellets and powders; 3) easier operation because of reduced torque requirements; 4) improved locking device for the end cap; 5) new higher-strength handles; 6) the provision for product sampling from either side of the outlet.

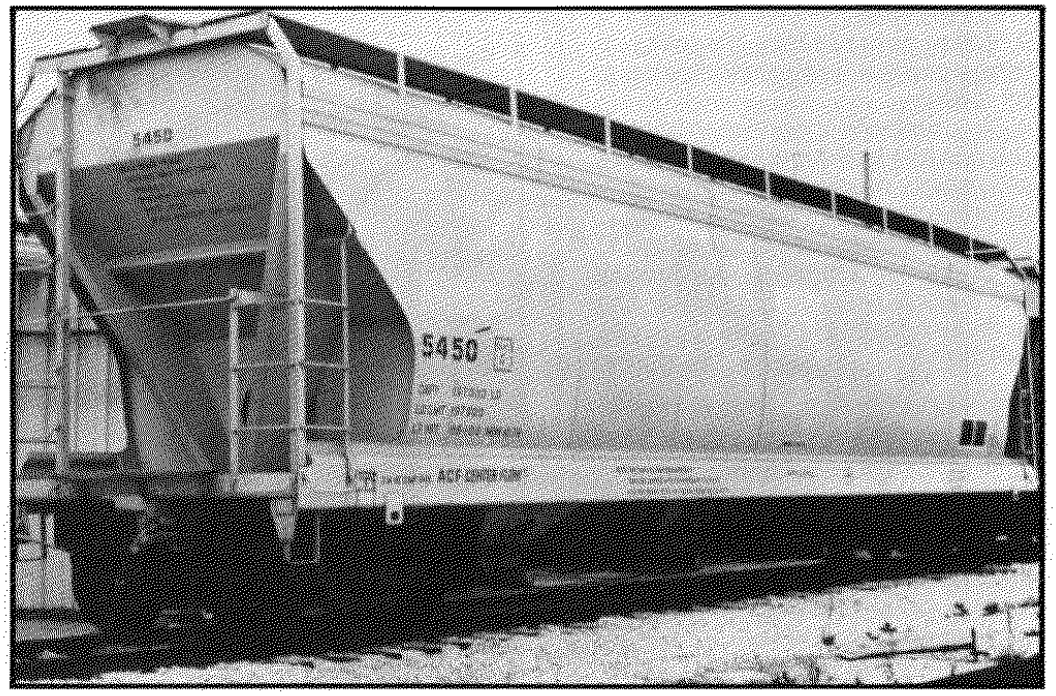
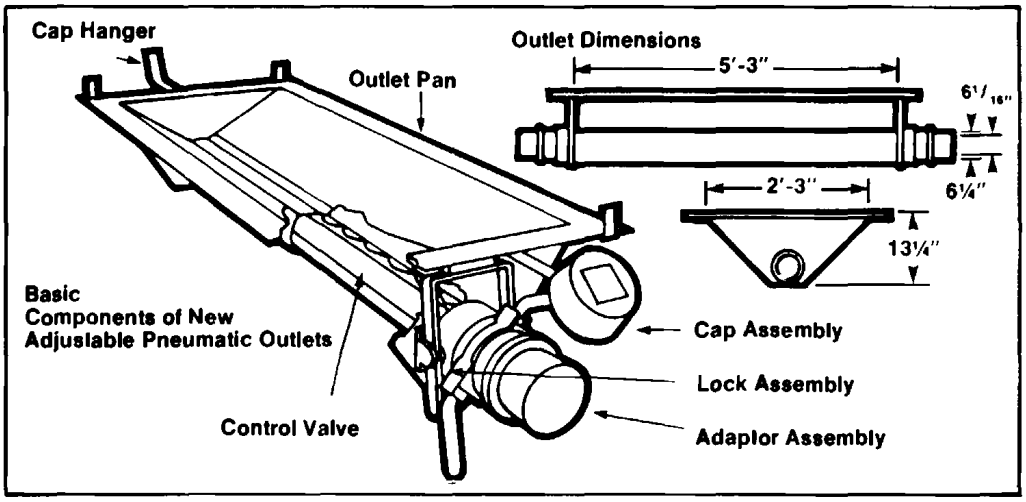



**Figure 11 — Adjustable Pneumatic Outlet, ACF Industries, Inc., St. Charles, Missouri**




**Covered Hopper Car Unloading**

Since many dry bulk commodities tend to compact in transit and may not flow freely at destination, mechanical assistance sometimes is required in unloading covered hopper cars such as the ACF Center Flow car. Various devices are available that assist unloading while protecting the car itself. Unloading personnel should be familiar with the various methods in order to prevent damage to the cars.

**Vibrators**

The most commonly used device to assist unloading is the vibrator. It also is the safest if used correctly. However, vibrators can damage the car’s structure if improperly used. There are vibrators that are operated by air, electricity, hydraulic drives or internal combustion engines. Vibrators are fitted into a bracket or shoe found on the car’s side slope sheets. There are two types of vibrators in general use: piston and rotary. Because of the manner in which the loads are applied, the car’s structure can tolerate a larger force output from the piston type. In using a vibrator to help unload a Center Flow covered hopper car, the following precautions should be taken:

· Vibrators should be applied only to the vibrator bracket welded to the outlet slope sheets.

· They should be used only on the compartment being unloaded and should not be operated continuously – only intermittently to initiate flow.

· **They must be turned off as soon as the compartment is empty.** Continued operation may damage the car body since there is no lading to absorb the vibration shock. There are other less commonly used methods of unloading, some of which are not recommended. (See below)

The operating frequency and force output must not exceed those listed in Table 1.

A. Weight of vibrator plus adapter under 65 lbs. with maximum operating frequency of 2700 rev./min.
B. Weight of vibrator plus adapter under 95 lbs. with maximum operating frequency of 2400 rev./min.

**Table 1**
**Unloading Specifications**

| Vibrator | Piston Type | | Rotary Type | |
|---|---|---|---|---|
| Operating Frequency in Revolutions per Minute | Force in Pounds | | | |
| | A | B | A | B |
| 1000 | 4000 | 3800 | 2400 | 2300 |
| 1500 | 3400 | 3200 | 2150 | 1900 |
| 2000 | 2700 | 2200 | 1700 | 1305 |
| 2400 | 1900 | 1200 | 1200 | 800 |
| 2700 | 1300 | -- | 800 | -- |

**Pressurization**
Because they are not designed to withstand internal pressure, conventional center flow cars cannot be pressurized safely. Pressurization of such cars is strictly prohibited since it is extremely dangerous to the car and operating personnel.

**Vacuum Unloading**
If a car is being unloaded by a vacuum method, the compartment's hatch must be open or equipped with a vacuum relief device. Otherwise the car could collapse or implode since it cannot withstand negative pressure.

**Poling or Air Lancing**
Poles or air lances frequently are used by unloaders to dislodge hung-up cargo or assist its flow to the outlet area. (An air lance is metal or plastic pipe with holes through which air is introduced into the cargo to assist the poling operation.) When the poles or air lances are used in lined cars they should be fitted with rubber or plastic tips and extreme care should be exercised to make sure the car's lining is not damaged. If the car is equipped with fluidizing-type outlets, the poles or lances should never touch the fluidizing membranes.

**Sledge Hammering**
Using a sledge hammer (or any hammer) on the side of a car to help unloading is never recommended. Not only are the effects minimal in speeding up unloading, but it can damage the car's paint finish and interior lining. If it is believed that local hammering really will produce worthwhile results, a rubber mallet should be used carefully.

**Car Shakers**
Some unloading facilities utilize car shakers, which are powerful devices that are affixed to the top or side of the car. Do not use car shakers since the entire car's structure can be damaged.

**Bulk Trucks**
Bulk trucks are unloaded by pressurizing them with a positive displacement blower. The blower is normally part of the truck. These trucks can unload themselves. They blow PVC resin/powder into a vented silo or receiving bin.

**Conditions of Sale for Bulk Plastic Materials**
OxyVinyls provides certified weighing facilities for determining the lading of all bulk shipments in compliance with the rules and regulations set forth by the Interstate Commerce Commission.
Each car or truck is weighed after loading and the net weight resulting from using the marked tare of the car or truck is used for billing of the shipment.
I.C.C. states in its "National Code of Rules Governing the Weighing and Reweighing of Carload Freight" under Rule 3, Section G, that: "The marked tare should be used to arrive at the net weight of the load . . ." Rule 8, Section E. of I.C.C. regulations states: "The tolerance shall be one percent (1%) of the lading with a minimum of 500 pounds on all carloads, freight, including coal and coke . . ."

**Figure 12**
**Unloading Bulk Trucks**