DRIVER LOADED TERMINALS FOR ANHYDROUS AMMONIA

In addition to providing safe, efficient delivery of anhydrous ammonia, these driver operated terminals automatically supply a bill of lading after the truck is loaded.

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Five driver loaded anhydrous ammonia terminals located in Kansas, Nebraska, and Iowa, on the Mid-America Pipeline System, have been in operation since November 1968. During this time about 500,000 tons of anhydrous ammonia have been loaded without a single accident or serious malfunction of equipment.

Each terminal consists of one 63,000 gal. 250 lb./sq. in. gauge working pressure tank, and two 500 gal./min. truck loading docks. The two truck loading docks are capable of loading 100 or 110 transports per day. All terminals are supplied with ammonia from the pipeline. Deliveries of anhydrous ammonia to the terminals are regulated from a central traffic control center in Tulsa, Okla. This control center can regulate rates into each terminal up to 2,000 ton/day. Tank level indication in the control center provides information on terminal demand. With this information the dispatcher can increase or decrease rates to each terminal to keep up with loadings.

One man is located at each terminal. He is responsible for training, qualifying and certifying drivers; checking and transmitting daily reports; maintaining terminal equipment. He is normally at the terminal during daylight hours five days a week, however, he is subject to call out by the drivers in case of equipment failures.

The safety system

The safety and dependability of these terminals rests in the protective and measurement systems. Figure 1 shows the general arrangement of the loading dock. The flow is from the tank through a can-type loading pump, positive displacement meter (registering in pounds), and a two hose (liquid and vapor) loading arm.

The protective control system for the flow loop is shown in Figure 2. A solenoid operated reverse check valve located in the outlet of the storage tank confines the liquid to the tank in case of power failures or emergencies on the dock. The loading pump is protected with a low flow switch. Down stream of the meter is a pressure regulator equipped with two solenoid pilots; one pilot senses the vapor pressure in the tank and maintains 25 lb./sq. in. gauge plus pressure on the meter, and the second pilot is used to close the regulator when the pump is shut down or the truck pressure is too high. Another pressure regulator is located in the liquid line of the loading arm. As the pressure in the truck increases this regulator starts to close, allowing more flow to go into the vapor space of the truck.

Additional safeguards are provided in the data acquisition system shown in Figure 3. This system consists of a two position card reader, equipment status and pump control panel, a data acquisition cabinet, and electrical interlocks to insure safe operation. The interlocks tie the low tank level, the card reader, the meter pre-set and the ticket printer, together, so that the pump cannot be started unless all steps have been taken. The data acquisition system is set to shut down the loading operation when 50,000 lb. of ammonia have been metered, regardless of what the driver has done.

Two emergency shutdown stations, one located at the truck dock, and the other at the terminal building, can be used to shut down the entire terminal in case of an emergency. Actuation of these stations will result in closing the pressure regulator, shutting down the pump, closing the tank solenoid operated check valve, and closing the motor operated valve on the pipe line.

The measurement system

The measurement system includes a positive displacement meter and a pipe prover. The positive displacement meter has accessory equipment to link the data acquisition and the measurement systems. A straight through adjuster on top of the meter serves as a seal to prevent ammonia vapors from reaching the other parts of the meter stack up. A high frequency pulse generator is used to generate pulses during meter proving. A 1:1 adjuster is used to maintain a unity meter factor. A gear changer located above the 1:1 adjuster converts gallons to pounds. A dual adapter placed on top of the gear changer provides a gross counter (pounds), and a shaft for the net counter. An automatic temperature compensator is located next to the dual adapter. This compensator corrects flow conditions to 60° F and equilibrium vapor pressure. A slow speed pulser on top of the compensator provides a signal to actuate the data acquisition system. The quantity controller is used to set in the number of pounds that are to be loaded in any given transport. A net counter printer is the final piece of equipment, and is used to print net pounds on the bill of lading.

The meter prover is a calibrated piece of pipe with two

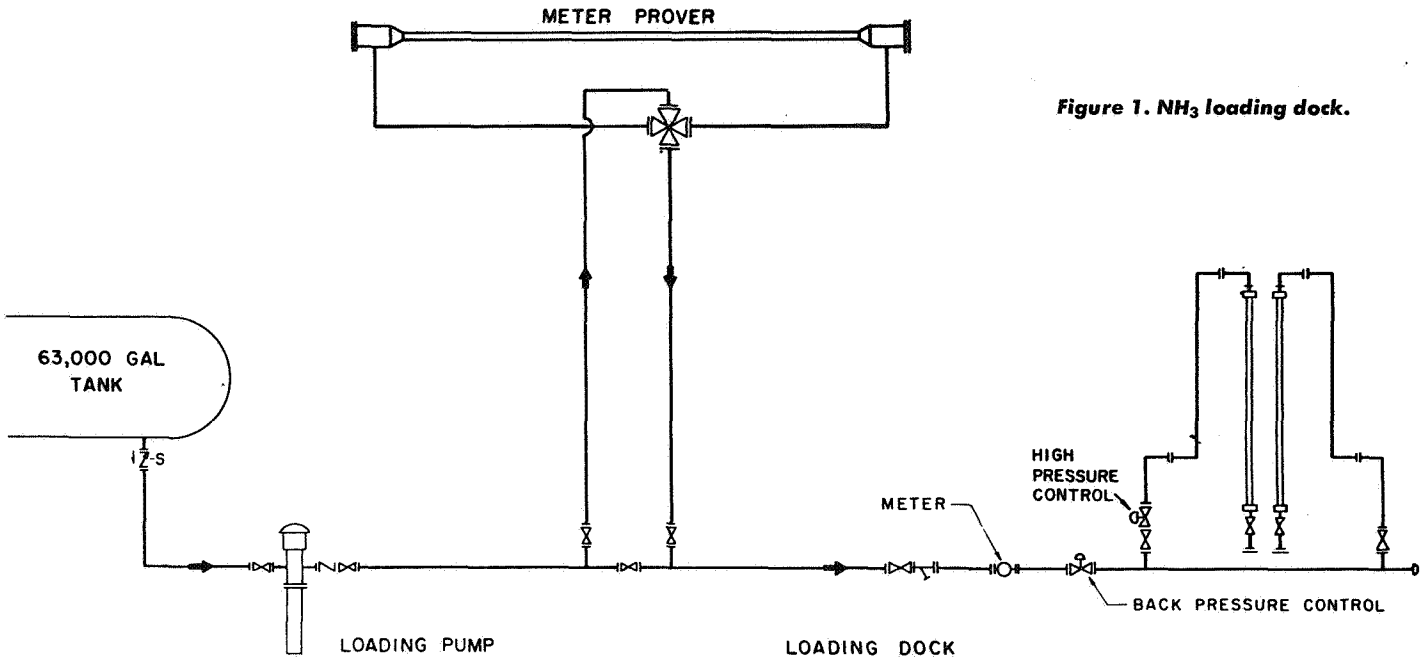

Figure 1. NH_3 loading dock.

detector switches. These switches start and stop a counter registering the pulses from the meter during the proving operation. A four-way diverter valve is used to change the direction of flow into the prover.

To prove the meter, a high resolution counter is connected to the high frequency pulse generator on the meter, and the detector switches on the meter prover. The stream is then diverted to the prover and back to the meter. As the ball in the meter prover passes one detector switch the counter is started. When the ball has travelled the length of the calibrated section, the detector switch on the other end is actuated, stopping the counter. The process is then reversed. A total of 10 double runs are made for each proving. The volume counted by the meter is then compared to the calibrated volume in the prover.

The loading operation

To initiate a loading operation the driver spots his truck, connects the two loading hoses to the cargo tank, and opens all hose and cargo tank valves. The bill of lading is then inserted into the meter counter printer, and the number of pounds to be loaded set into the quantity controller. He then inserts a shipper and trucker card into the card reader. As these steps are performed, green lights on the equipment status board come on. Only after he has performed these operations and all lights show green can he start the loading pump. If any of these steps are missed, pushing the start button on the loading pump will do nothing.

When the pre-set quantity has been delivered to the truck the system automatically shuts down. The driver then closes off all hoses, disconnects, and removes bill of lading from the ticket printer head. He then leaves and the dock is ready for the next truck.

Custody transfer of all product is based on volumes at 60° F and equilibrium vapor pressures. PVT data used for volume corrections was obtained from a MAPCO sponsored research project at the University of Tulsa. This data covers a temperature range from -20- to 120° F, and pressures from equilibrium vapor pressure to 1,500 lb./sq. in. gauge.

There are two 40,000 ton atmospheric pressure storage tanks at Early, Iowa. Ammonia from these tanks is heated in a direct fired heater and is supplied to the terminal and to main line pumps for pumping into the pipeline with flow in either direction.

The system is capable of delivering 6,000 tons/day and did operate at 5500 tons/day for several consecutive days.

There are two meters in each terminal. With trained personnel, each meter can load three trucks per hour, or a possible 150 trucks/day. At the Early terminal, which is supplied from storage and is not pipeline limited, more than 100 trucks have been loaded in one day. Terminals south of Early are limited by total system capacity. The Garner terminal to the north is limited by a pipeline capacity of 1800 tons/day.

There has been a general question and it has been asked here, "What happens if a truck comes in that is supposed to be empty, but in fact contains a lot of ammonia?" The trucks are equipped with a level indicator. Assume that this is not working. The driver sets the meter to deliver 36,000 lbs. of ammonia. When the truck is full, the pressure will start to rise and the terminal delivery pump will shut down on over-pressure. If the driver restarts the pump, it will again shut down on over-pressure. It is unlikely that the truck relief valve will open since it is set at 265 lb./sq. in. while the shutdown switch in the terminal controls is set at 275 lb./sq. in. The meter will correctly indicate the total weight of ammonia delivered.

The meters have a repetitive accuracy when checked with a moving ball prover of 0.1% error. During the 1969 season there were cases of error in the meter at Borger. The meters were not exactly the same as those in the other terminals and there were other problems. Meter stack-ups were changed so that they were the same in all terminals before the 1970 season. During 1970 some complaints were again received at Borger. The customer was asked to keep records of weights received. After a period of time, the customers agreed that they were getting the amount billed and the complaints were withdrawn.

I think that from the safety standpoint, the pipeline has demonstrated a higher order of safety than any other form of transportation. Many questions regarding safety were raised during the right-of-way acquisition period. The actual record of the line is very good. Certainly the overall safety of handling ammonia is improved simply because the distances that it must be transported by truck or rail are reduced. There have been no failures in 1970. The only failure of the line attributed to a problem with the line occurred during 1969 and Mr. Gil Rohleder reported on it at the last meeting here. The failure occurred a few miles from Borger and was caused by a slag inclusion in the line.

MAPCO was paralleling the line in 1969 and there were two or three instances where power diggers pierced the line. In one case, they essentially cut the line in two. Still the driver was able to get off the digging tool and get away. There were no injuries.

There has been one comment on the type of safety equipment—the air breathing equipment, and perhaps Gil Rohleder could comment on this. The cannister masks do not have sufficient capacity for prolonged use in the area. As long as you have pumps, relief valves, and power diggers; you are going to have malfunctions and throw ammonia to atmosphere. When this occurs, you need breathing equipment with a reasonable length of time of assured oxygen supply.

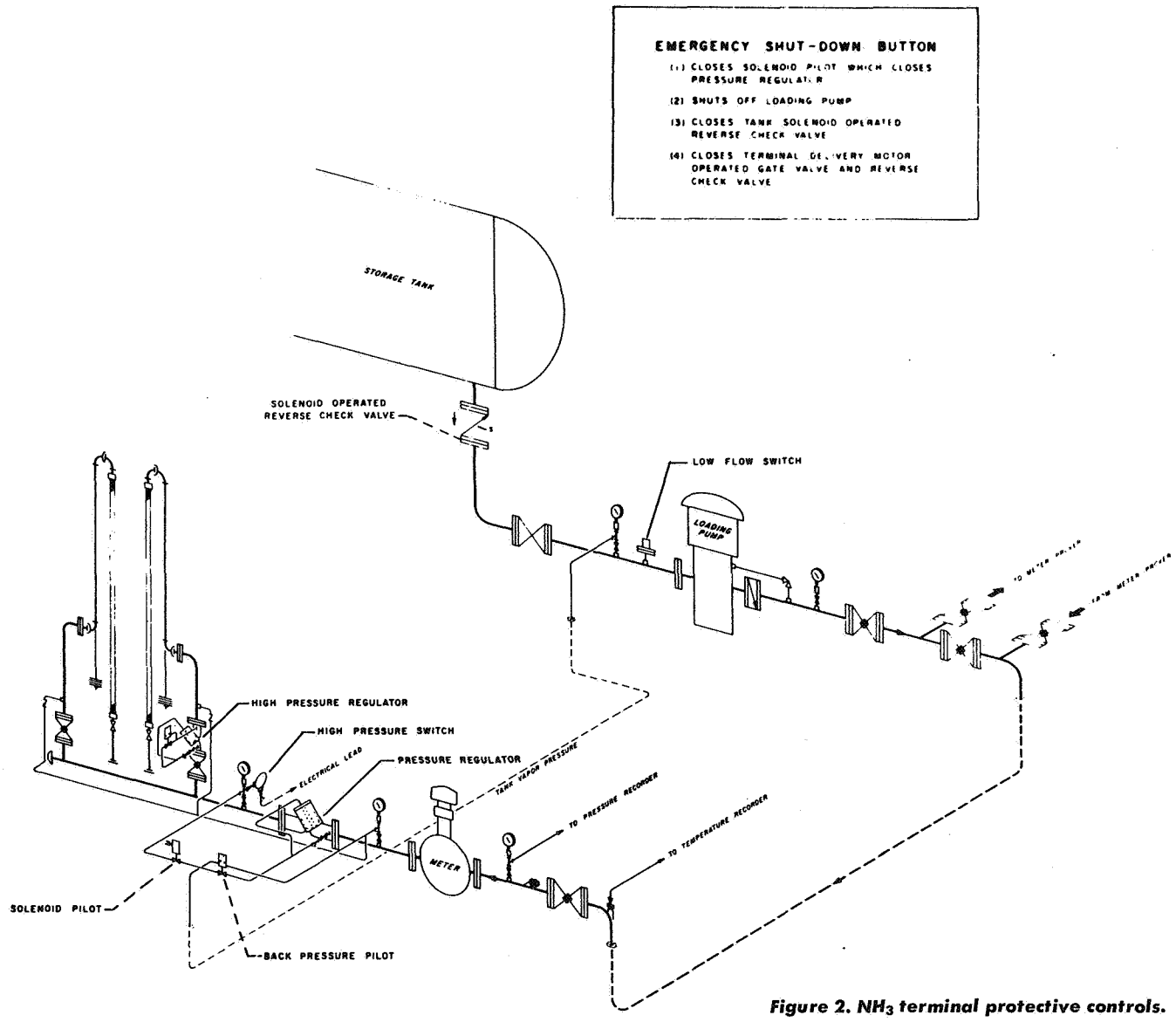

Figure 2. NH_3 terminal protective controls.

ROHLEDER: I want to add one thing on the safety equipment. We found that the canister type masks; in fact, we've thrown all of ours away, and we're staying with Scott Airpacks. The type of clothing that we've been getting is not to our satisfaction, and we at the present time have a local firm in Tulsa trying to redesign some equipment for us that we think we need to adequately handle ammonia emergencies.

We've had goggles fogging up on welders' masks, so we are now trying to get somebody to take our ideas and design us some safety equipment. We'll make that available, if we get some.

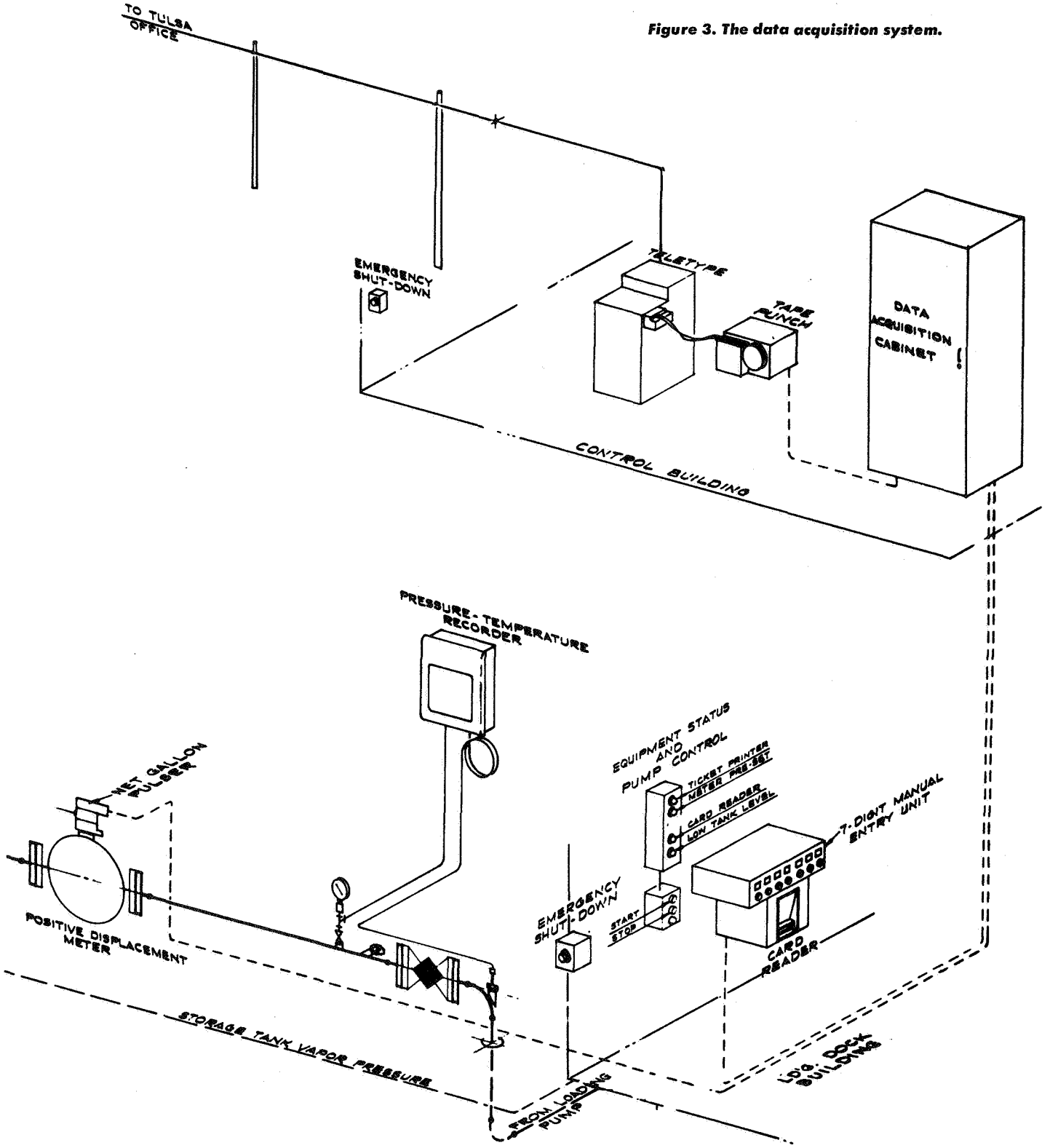

Figure 3. The data acquisition system.

DISCUSSION

Q. I have three questions. One: Could you tell us the brand of meter you use? Two: How fast do you load? And three: How often do you prove the meters?

ROHLEDER: The brand of meter is a Brodie meter, which is manufactured by a Rockwell Manufacturing Subsidiary. The loading rates average about 500 gal./min. In some trucks it will go higher than that—some trucks it will be a little slower. It depends on how the truck is equipped; if there is a full vapor line, he can probably load at about 550 gal./min. If he has a short, stubby vapor header, it's

down around 475, and again, as the cargo tank fills up, the rate slows down a little bit, but will average 500 gallons a minute.

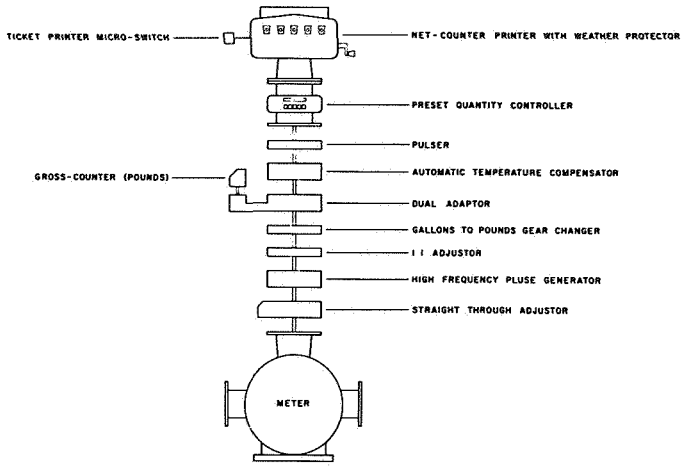

Figure 4. NH_3 meter stack-up.

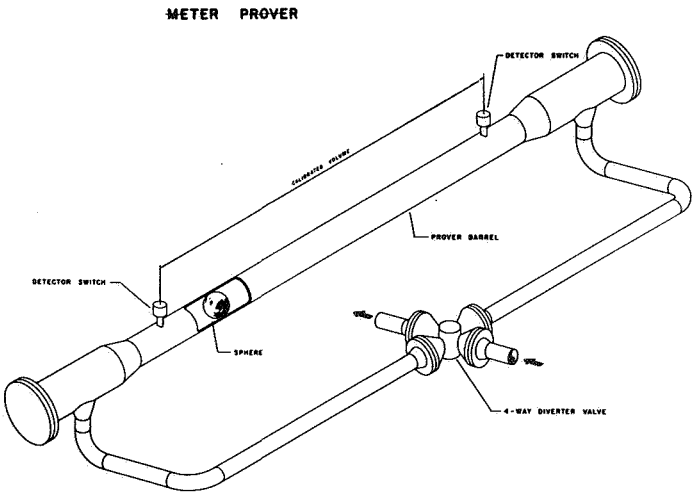

Figure 5. Meter prover.

As to the number of times we prove meters, we prove them at least once a week. During the peak season, that sometimes might be a little oftener than once a week, depending on what kind of mechanical problems we have had.

Q. What sort of experience have you had with the mechanical seals in your pumps?
ROHLEDER: It's been very good. We've had no trouble with mechanical seals.

Q. Whose pumps are they?
ROHLEDER: These are Johnson and Byron Jackson, and they are equipped with John Crane mechanical seals.

Q. What do you hook the vent hose to? Is it a stack, or some sort of vessel?
ROHLEDER: No. There is a little bit of space between the cargo tank valves and the valves on the end of our hoses, and most of the truckers have equipped their truck with a vent line up the back of their vessel, and we just blow to the atmosphere. Has been no problem.

Q. Are these in fairly remote locations?
ROHLEDER: No, some of them are only a mile from town.

Q. Do you require the drivers to wear any protective gear?
ROHLEDER: Well, we'd like for them to wear goggles, but that's been an impossible situation to enforce. But we do have a tank of water, a shower and fire extinguishers at each location.

Q. Does the driver compute his percent of water weight and calculate exactly how much he wants you to load, and have you ever overloaded anybody?
ROHLEDER: We make the trucker responsible for calculating and maintaining the maximum load. Now the Motorola data acquisition system will shut him down automatically if he tries to go over 50,000 pounds. It won't let him load any more than 50,000 pounds. Actually, it's 49,000 some odd hundred. If he tries to put any more than that in the vessel the system shuts down.

Q. Since this vents out to the atmosphere, have you thought of the possibility that the truck might come in half full, and therefore vent all over the place? Or pour liquid ammonia all over the place?
ROHLEDER: Well, we're assuming that first of all the driver closes his valves before he starts venting. If the driver errs, of course he can vent the whole truck to the atmosphere, but to date we have not had a driver that left his valves open.

HAYS MAYO, Hill Chemicals: Many people have asked questions about the ammonia pipeline, storage, and automatic terminal operation. I would like to review the basic design of the system and supplement what Gil Rholeder has said.

The MAPCO ammonia pipeline is approximately 800 miles long. It originates at Borger, Texas and terminates at Garner, Iowa. There is a 100% capacity main line pump and a 100% capacity standby pump at Borger. These are electric motor driven multi-stage, horizontally split centrifugal pumps with a suction pressure of approximately 200 lb./sq. in. at 60° F. and a discharge pressure of approximately 1500 lb./sq. in. There is an unspared booster pump at Conway, Kansas which also discharges at 1500 lb./sq. in. There is 1000 tons of storage at the Hill Chemical plant at Borger, Texas in the form of 250 lb./sq. in. pressure tanks.

—ROHLEDER