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Low-Pressure Suspensions

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## Low-Pressure Suspensions

Low-pressure suspensions contain all nitrogen as ammonia and exhibit similar vapor pressures as aqua ammonia. Reasons supporting their production are the same as those which have characterized all suspension fertilizers: lower cost, versatility in raw materials, and increased concentration over solution fertilizers, with which they share handling and application advantages. Suspension manufacturers have often used off-specification and byproduct fertilizer materials to reduce costs. Suspensions are more tolerant of raw material purity than solutions and can utilize a wider range of particle size than bulk blends. In this light, low-pressure suspensions were developed to take advantages of lower cost ammoniacal nitrogen instead of urea ammonium nitrate (UAN) solution. Fertilizer dealers and TVA have cooperated to find ways to produce and handle low-pressure suspensions.

Typical suspensions are produced by ammoniating monoammonium phosphate (MAP) to an  $N:P_2O_5$  weight ratio of 0.33:1. Crystals present at this point are diammonium phosphate (DAP) which are easily suspended and have enough solubility to remain fluid. For mixed NPK grades, potash is added as potassium chloride (KCl) and where the  $N:P_2O_5$  weight ratio exceeds 0.33:1 supplemental nitrogen must be added as UAN. Many suspension grades can be produced this way. They do not exert a pressure and can be stored in an open tank without losing ammonia. Equipment needed to produce these suspension fertilizers as described is shown in figure 1.

An alternative method of producing suspensions with higher nitrogen concentrations than 1:3:X ratio products is to supply supplemental nitrogen as aqua ammonia. Although the suspensions have an ammonia odor they have

a low vapor pressure. The low pressure suspension fertilizers are also sometimes called "all ammonia nitrogen suspensions" since all of the nitrogen is ammoniacal. Because these mixtures evolve ammonia at atmospheric pressure they must be injected into the soil when applied. Although fluid, they must be kept in closed tanks or vented through a water trap to prevent volatilization of ammonia. However, a specially designed pressure tank is not necessary for safe storage of the suspensions.

#### Bench Scale Tests

Low pressure suspensions are cold blended with base grade phosphate materials. Originally TVA laboratory tests were made using aqua ammonia (23-0-0), TVA ammonium polyphosphate suspension (9-32-0-2C), and potash (0-0-62). All supplemental nitrogen was supplied as aqua ammonia instead of UAN solution. After 1 month of storage at room temperature (75<sup>o</sup>F) these mixtures had low viscosity and high pourability. Grades tested included 18-6-6, 16-8-8, 12-12-12, 15-5-15, 14-7-14, 14-7-11, and 15-5-5. Other laboratory tests were made from phosphate base grades such as 10-30-0 produced from MAP. Laboratory results indicate that these suspensions are easily mixed from 10-30-0 and their vapor pressures may be slightly less than those reported when 9-32-0 was used. Low pressure suspensions containing ammonium polyphosphate generally have better storage characteristics than those using only orthophosphate material. Similar results were found in suspensions made from TVA 9-32-0 and those made from orthophosphate 10-30-0 and containing some ammonium polyphosphate from 10-34-0. These suspensions do not settle as much and are more easily pumped. Also there is some indication that if low-pressure suspensions produced from 10-30-0 are not agitated, a hard layer of settled solids will form which

is difficult to resuspend. The suspension of settled solids was not a problem in those suspensions containing some polyphosphate material. There was some settling, however. MAP base phosphate sources can be used if the product is agitated in the applicator and applied soon after production.

Vapor pressures of several different grades at 75<sup>o</sup>F and 100<sup>o</sup>F are given in table 1. From these data, pressure tanks would not be required for typical summer storage in most agricultural areas of the U.S. As mentioned, vapor pressures were slightly higher when TVA 9-32-0 was used for the phosphate base rather than 10-30-0. Curves showing vapor pressure versus temperature for three grades using TVA 9-32-0 or 10-30-0 are given in figures 2 through 4.

#### Plant Scale Demonstrations

Plant-scale production and application demonstrations were made by a Canadian company during June 1984. A 19-9-0 grade was produced and applied the following day. This material pumped well from the mix tank to applicator nursing equipment and was applied easily the next day. The application device was tractor drawn and was modified from an existing anhydrous ammonia applicator. There were no unexpected problems with either production or application and the material is expected to fit well into the increasingly popular banding or strip application techniques. The company predicts that 80 percent of low-pressure nitrogen suspensions produced by their plant will be farmer applied. Since these materials were produced from 10-30-0 there is some concern that the settling evident in the mixed material will present problems to farmer-stored suspensions. Laboratory work is continuing at TVA to find suspending techniques to minimize this problem.

### Design of Mix Plant

For the plant test, low pressure suspensions were produced in an open air, uncovered mix tank. As expected, ammonia fumes were very strong downwind of the mixing area and neighbor complaints were received during previous tests. Although ammonia concentrations are never high enough to cause injuries, modifications to eliminate ammonia fumes will be made before production is begun. Figure 5 is a sketch of a mix tank especially designed for production of low-pressure suspension. The mix tank will be fitted with a cover or shroud to direct ammonia fumes to a water scrubber containing plastic packing. The scrubber water containing ammonia can be used in subsequent grades. Piping should be designed so that storage tanks for low-pressure suspensions can be isolated and the packing can be flushed. Excess ammonia could cause problems if mixed with phosphate base grades and allowed to stand in plant piping. Conventional mix tanks can be used if they are covered and the specifications are the same as with production of conventional suspension. Material handling equipment such as the potash screw conveyor must be closely fitted into the tank cover to prevent ammonia leakage. Storage tanks should be equipped for agitation by recirculation of fluid in the tank. Air sparging of material will contribute to ammonia leakage. Pumping tests have shown that recirculation of material can generally remove all suspension from storage tanks. With proper agitation low-pressure suspensions will remain fluid and pourable. The storage tanks should be equipped with a pressure-vacuum release valve set to relieve at 5 psig pressure and 5 ounces of vacuum. A water trap fitted after the pressure-vacuum release valve would trap any ammonia that should leak from the storage tank.

### Mixing Procedures

TVA laboratory tests were made with the following order of addition: water, aqua ammonia, clay, phosphate base, and potash. In the 19-9-0 suspension production tests, aqua ammonia was added last because of the uncovered mix tank. In all cases the material should be mixed for several minutes to allow complete reaction and gelling of the clay.

Although low-pressure suspensions are easily handled they have significant vapor pressure, which increases with rise in temperature. Also, it is not surprising that the pressure increase is greater as the relative amount of nitrogen increases because more ammonia has been added. Using predispersed fluid clay should make mixing more efficient. The pH of these materials is between 10 and 10.5; solidification temperature is below 20<sup>o</sup>F.

### Application

Applicators for low-pressure suspensions are similar to those used to apply aqua ammonia. Both pull-type and self-propelled applicators have been used. Figure 6 shows a typical applicator. A pull-type applicator with high flotation tires is equipped with a 30-foot tool bar to which twelve equally spaced injection knives are attached. The knife design is shown in figure 7. Usually a one-half inch pipe is welded to the back of a standard ammonia application knife. The low-pressure suspension is pumped from the tank by a piston, diaphragm, or centrifugal pump to a manifold located in a low position so that it is completely full during application. Hoses from the manifold to the two flow dividers are of equal length. The flow dividers consist of hollow cone (swirl chamber) nozzles mounted in the top of a pot. The pots have six equally sized compartments each of which drains into a single line. Pots with more outlets are available for larger rigs. Since

the compartments drain faster than they are filled, equal length lines are not required. Continuous fall in the lines, however, is required to ensure good drainage. Different flow dividers are commercially available that can be used to uniformly distribute low-pressure suspensions.

When a centrifugal pump is used, part of the suspension is recirculated to the applicator tank and the pressure on the manifold is controlled by the amount of suspension recirculated to the tank. Sometimes a coulter is installed in front of each knife to keep the knife from becoming fouled by ground trash. Application of low-pressure nitrogen suspensions is the same as aqua ammonia, 4 inches deep as compared to 8 or more inches depth for the application of anhydrous ammonia. This requires less horsepower and saves fuel. It is estimated that a high speed applicator applying low-pressure nitrogen suspensions can cover about 0.5 acre of land per minute. Farmer owned anhydrous ammonia application equipment can be modified to apply low-pressure nitrogen suspensions thereby reducing the need for high flotation equipment to the dealer and reducing application charges to the farmer.

#### Cost Comparisons

Aqua ammonia represents the lowest cost production step for converting anhydrous ammonia--the basic unit of nitrogen fertilizers. While reducing the plant nutrient concentration of anhydrous ammonia, aqua ammonia is easier and safer to handle. It does not require the production investment that urea and ammonium nitrate require; therefore, aqua ammonia is a lower cost nitrogen product than is UAN solution. Low-pressure nitrogen suspensions are less expensive than suspensions containing UAN solution since aqua ammonia is a lower cost source of nitrogen. As might be expected, price differentials

increase for high nitrogen grades. Significant savings can be realized for 3:1:0 and 3:1:1 ratio products by substituting aqua ammonia for UAN solution as a source of supplemental nitrogen. A material cost comparison of suspension grades made from both of these materials is shown in tables 2 and 3. These data show that there is a saving of about 29 and 32 cents per unit of plant food when a 12-12-12 grade is produced as low-pressure nitrogen suspensions from TVA 9-32-0 and 10-30-0, respectively, instead of the conventional nonpressure solutions. However, with the 15-5-5 grade the saving increases to 66 and 79 cents per unit; and with the 18-9-0 grade it is 70 and 80 cents. More savings can be made from the lower horsepower requirement from low-pressure nitrogen suspension application and investment costs can be saved by the dealer if farmer owned equipment is modified and used to apply these materials. Farmers also save money because of lower horsepower requirements and freedom from application charges if they apply their own fertilizer.

#### Summary

Suspensions have always been versatile in terms of the raw materials that can be used in them. Fertilizer dealers are able to capitalize on that fact by using low cost material to reduce the production cost. One company expects to save their farmers 10 percent on nitrogen costs because low-pressure nitrogen suspensions made from a lower cost nitrogen source can be made more cheaply than a UAN solution for the same grade. These materials can be produced, stored, and handled safely. They can be applied beneath the soil which makes them ideal for banding or strip application. Although certain precautions and modifications may be necessary, raw material savings are too great for suspension fertilizer dealers to ignore low-pressure nitrogen suspensions.

Acknowledgement

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Table 1

Vapor Pressure of Low-Pressure Suspensions<sup>a</sup>

<u>Grade</u>	<u>Pressure Above Suspension, psig</u>		<u>Volume Tested, cm<sup>3</sup></u>
	<u>At 75 F</u>	<u>At 100 F</u>	
12-12-12	1.2	2.2	100
19-8-0	1.0	2.5	100
18-6-6	2.2	4.8	100
14-7-14	1.2	3.6	100
16-8-8	1.0	3.9	100
15-10-5	1.7	3.2	100
20-4-0	1.2	5.0	100

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a. Stainless steel vapor pressure bomb, Whitey 150 cc

Table 2  
Relative Cost Comparison<sup>a</sup>

Ratio	Aqua Suspension (1.5% Clay)			Conventional Suspension		
	Grade (N-P-K)	Cost (\$/Ton)	Cost (\$/Unit of Nutrients)	Grade (N-P-K)	Cost (\$/Ton)	Cost (\$/Unit of Nutrients)
1:1:1	12-12-12	116.65	3.24	12-12-12	127.15	3.53
2:1:0	18-9-0	95.78	3.55	18-9-0	114.70	4.25
2:1:1	16-8-8	100.78	3.15	16-8-8	117.51	3.67
3:1:0	18-6-0	81.23	3.39	18-6-0	101.05	4.21
3:1:1	15-5-5	77.70	3.11	15-5-5	94.25	3.77

a. Raw Material Costs for Eastern Iowa

Aqua ammonia (25% N)	\$ 64.40/Ton
31-0-0-2C	127.00
9-32-0-2C	182.35
0-0-62	120.00
Dry clay	120.00
Water	0.0

Table 3  
Relative Cost Comparison<sup>a</sup>

Ratio	Aqua Suspension (1.5% Clay)			Conventional Suspension		
	Grade (N-P-K)	Cost (\$/Ton)	Cost (\$/Unit of Nutrients)	Grade (N-P-K)	Cost (\$/Ton)	Cost (\$/Unit of Nutrients)
1:1:1	12-12-12	99.99	2.78	12-12-12	111.64	3.10
2:1:0	18-9-0	81.28	3.01	18-9-0	102.97	3.81
2:1:1	16-8-8	87.90	2.75	16-8-8	107.23	3.35
3:1:0	18-6-0	70.20	2.93	18-6-0	93.35	3.89
3:1:1	15-5-5	66.84	2.67	15-5-5	86.39	3.46

a. Raw Material Costs for Eastern Iowa

Aqua ammonia (25% N)	\$ 64.40/Ton
31-0-0-2C	127.00
10-30-0-1.5C	127.11
10-34-0	218.00
0-0-62	120.00
Dry clay	120.00
Water	0.0

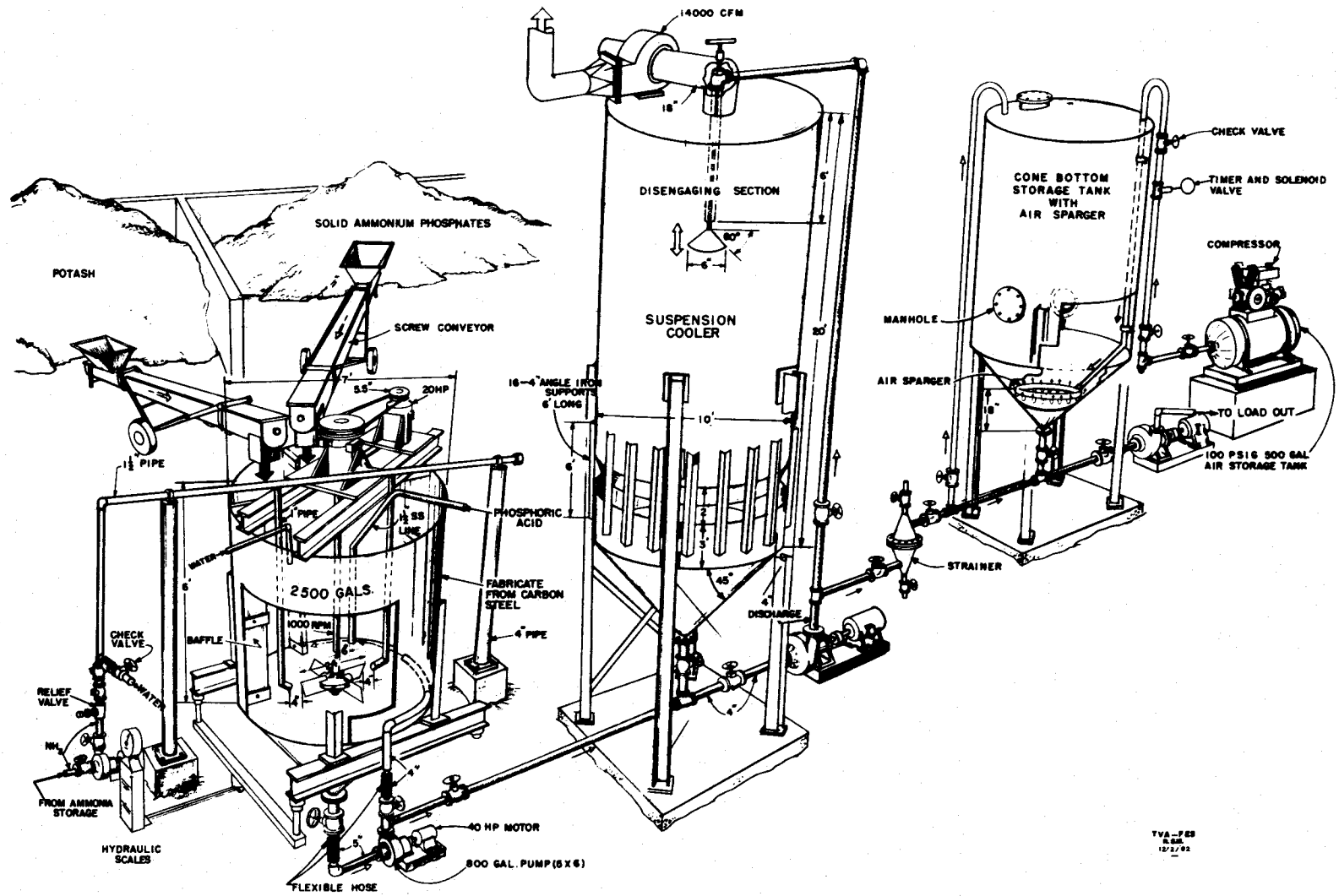
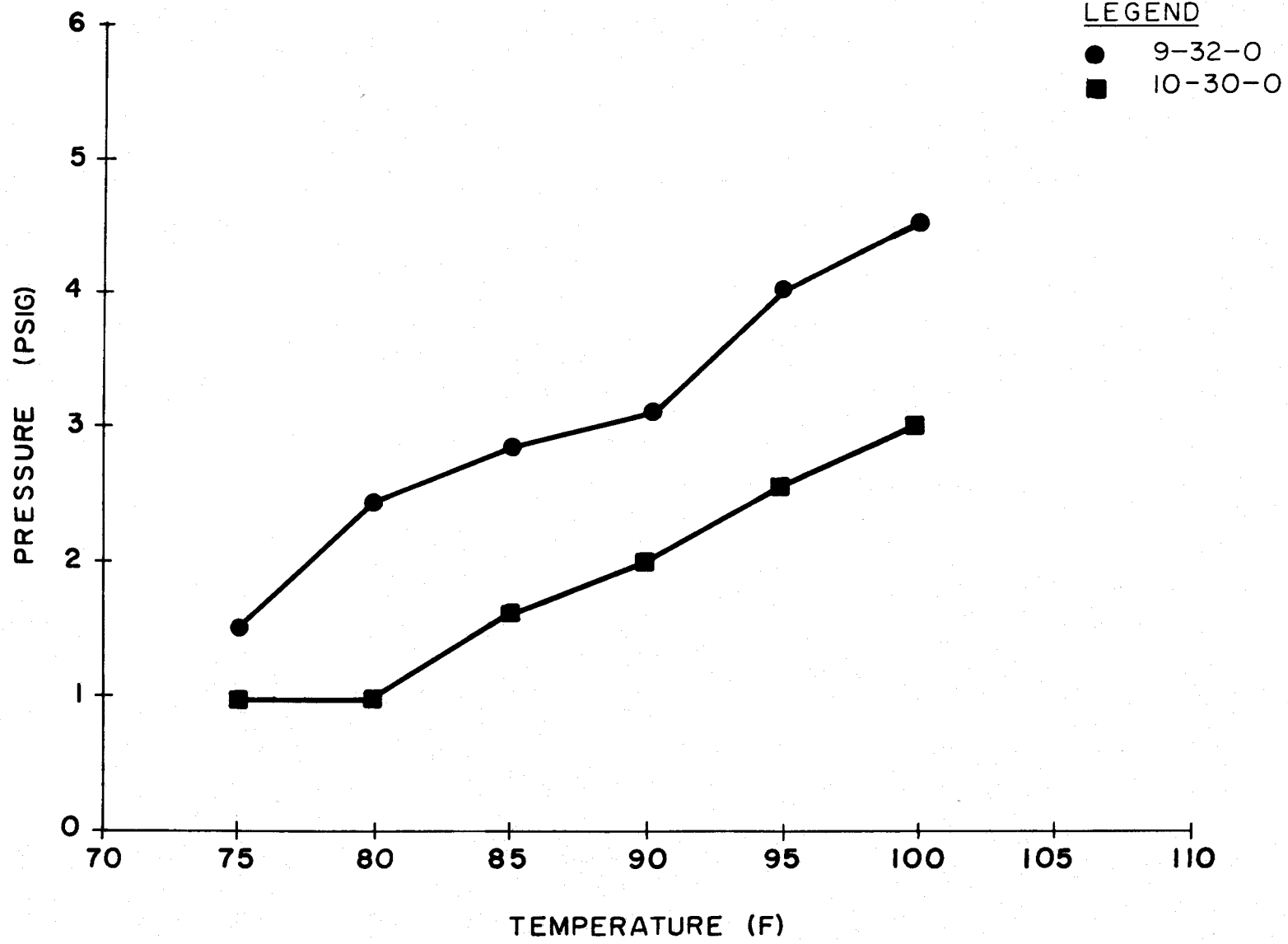


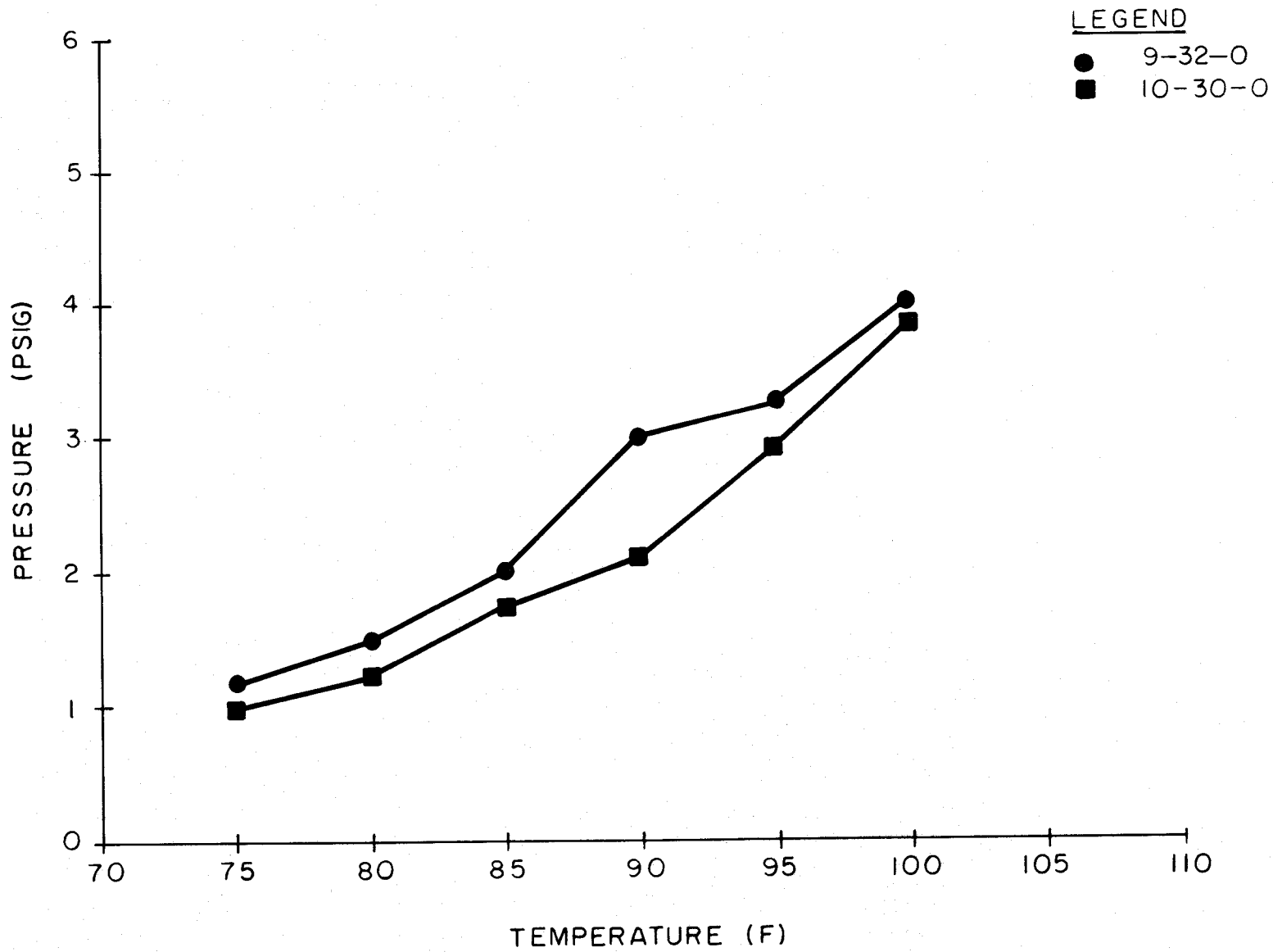
FIGURE 1

SUSPENSION PLANT—10-TON BATCH TYPE—FROM GRANULAR AMMONIUM PHOSPHATES

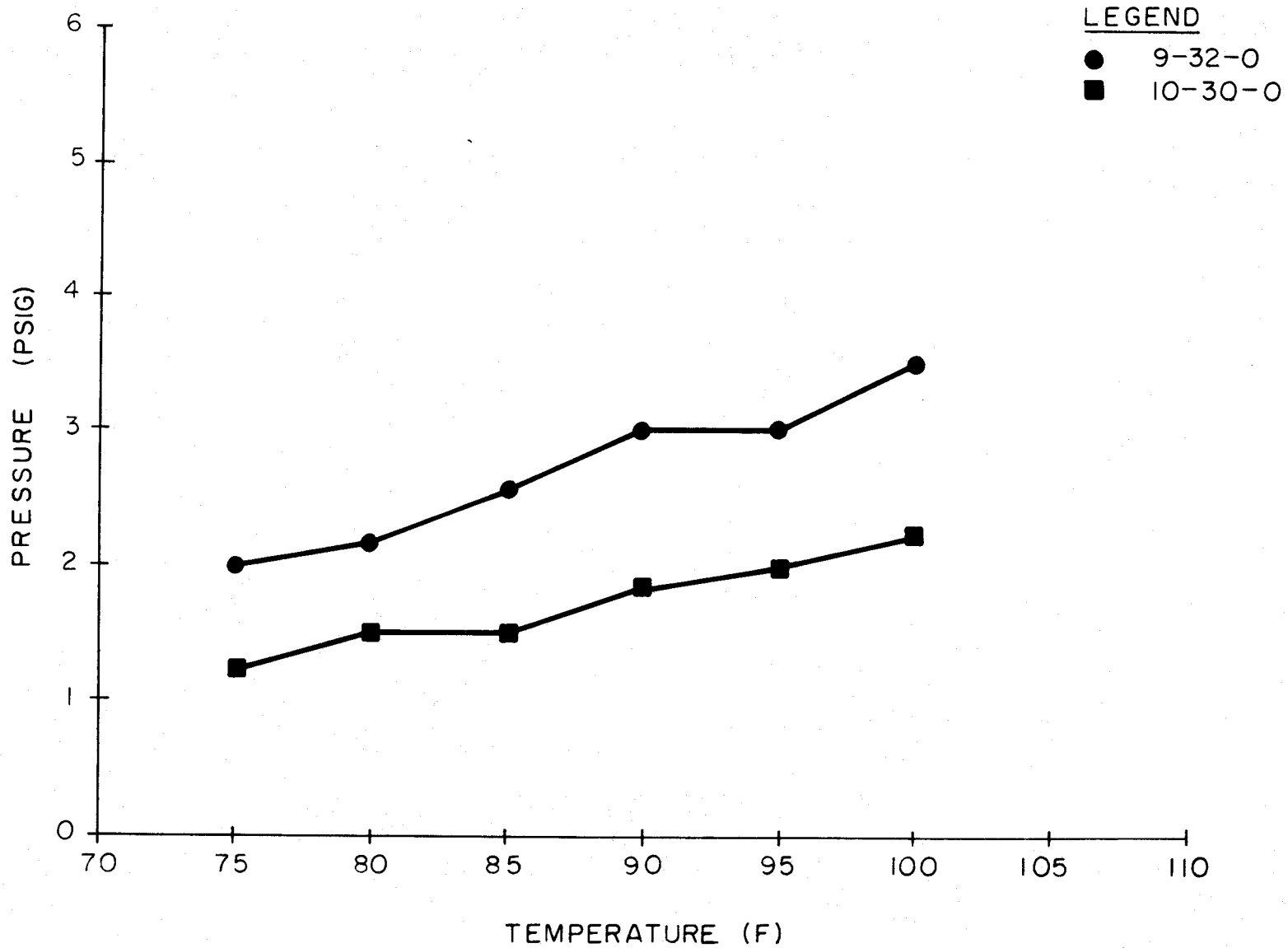
TVA-PES  
8.08  
12/2/52



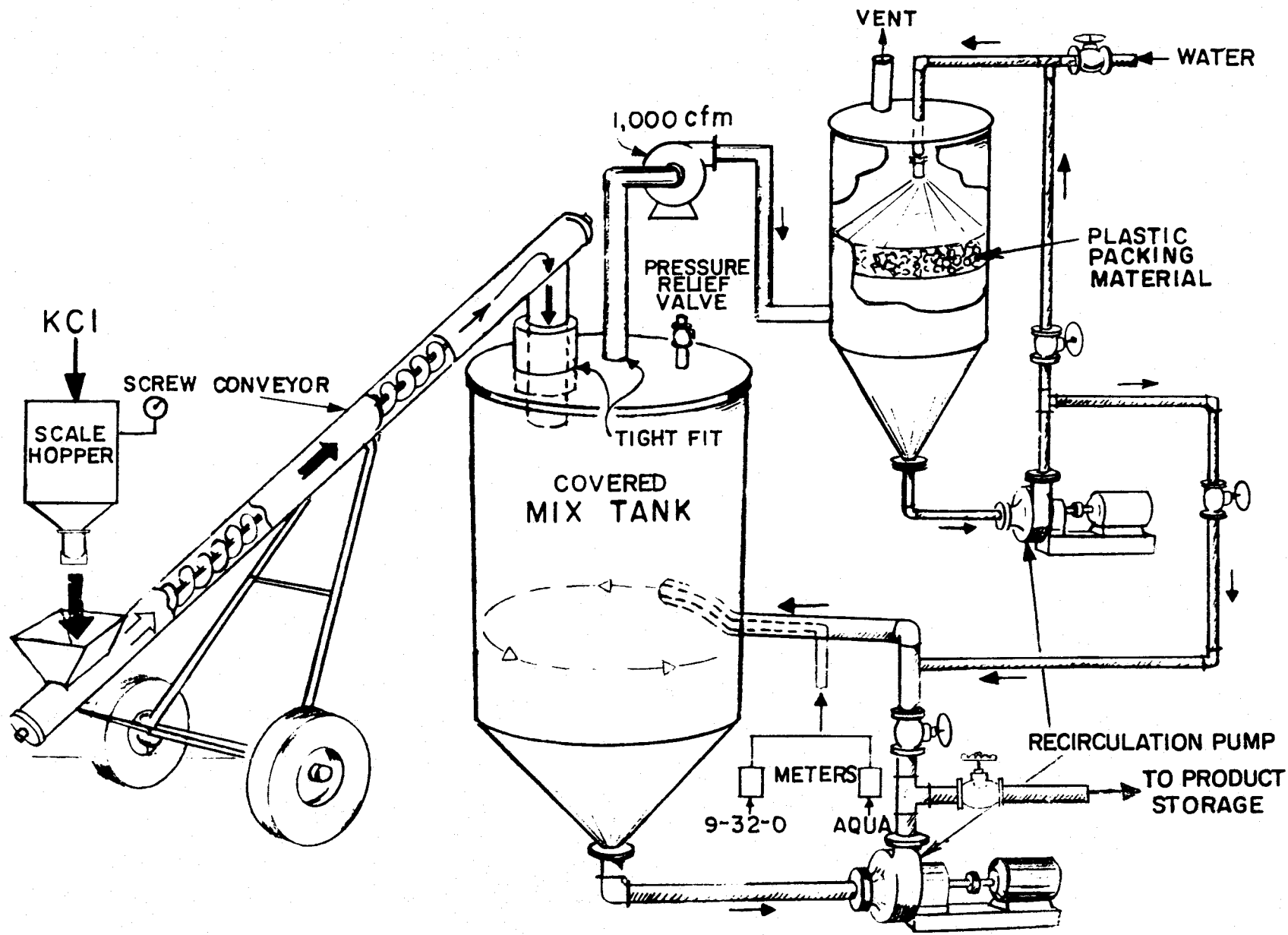
15-5-5 LOW PRESSURE SUSPENSION  
FIGURE 2



**16-8-8 LOW PRESSURE SUSPENSION**  
FIGURE 3



**12-12-12 LOW PRESSURE SUSPENSION**  
**FIGURE 4**



**LOW PRESSURE SUSPENSION MIX TANK**  
**FIGURE 5**

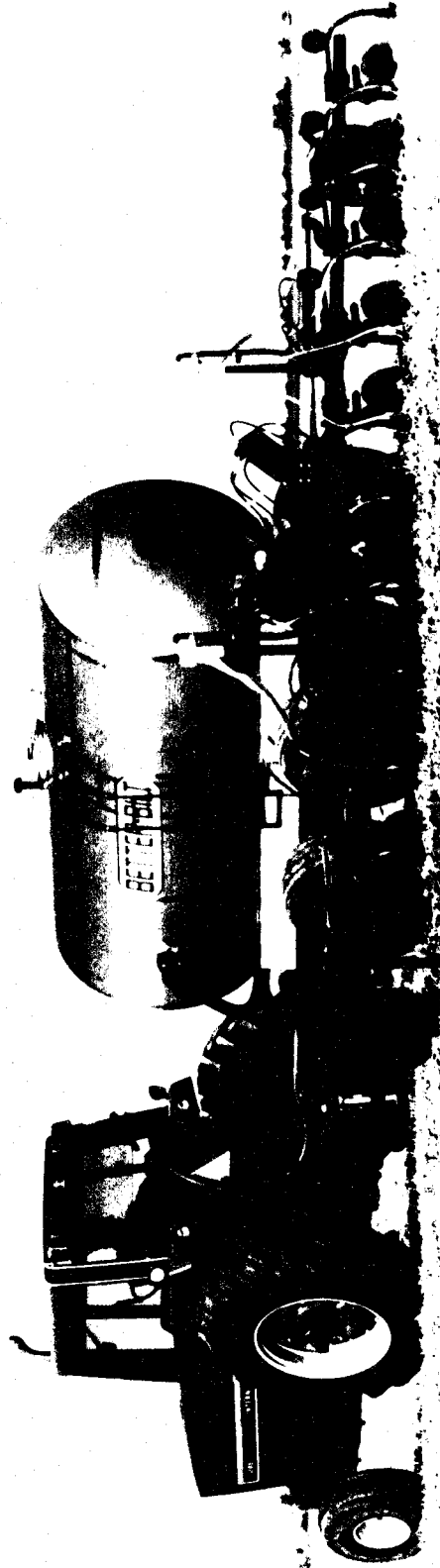


FIGURE 6

ALL-AMMONIA SUSPENSION PULL-TYPE APPLICATOR

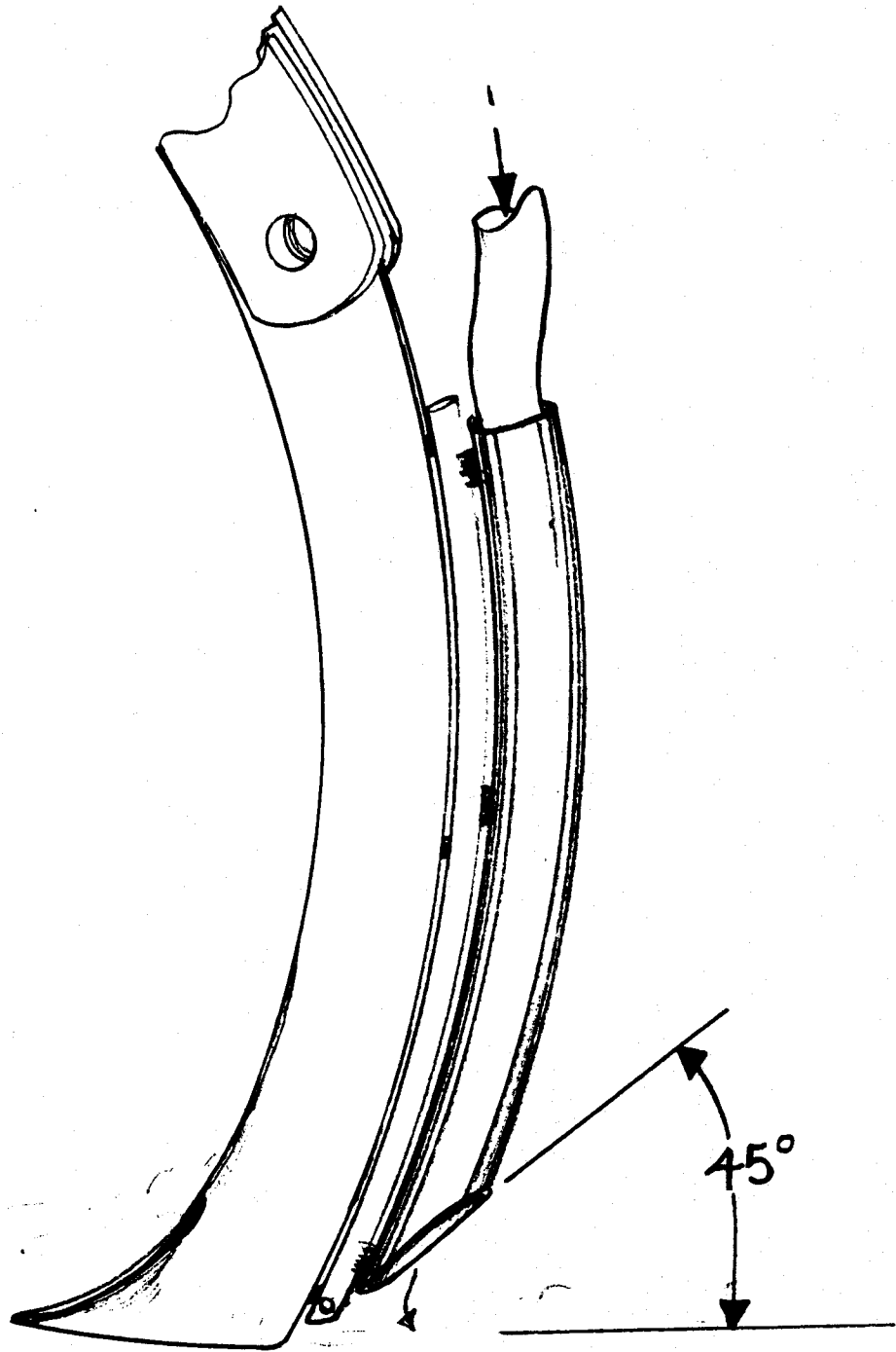


FIGURE 7

SUBSURFACE APPLICATION OF SUSPENSION