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PALLETIZED UNIT LOAD SPRAY FACILITY, DESIGN & TEST

TECHNICAL REPORT
NO. 245

U.S. ARMY NATICK LABORATORIES
Natick, Massachusetts

CONTAINER DIVISION

Technical Report No. 245

Project:	Container Research and Development 1K6-43324-0587
Subproject:	Packaging and Containers for Unitized Loads
Subtask:	Design of Lightweight Expendable Cargo Containers
Problem:	Design of Test Facilities

Palletized Unit Load Spray Facility Design and Test

Interim Report

by

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SUMMARY

A palletized unit load spray facility was designed to provide approximately the equivalent exposure as prescribed for small boxes by ASTM D-951-51, except that clear area dimensions were expanded to accommodate specimens up to and including pallet size unit loads. Various sizes and types of nozzles were investigated to establish optimum spray pattern coverage and flow characteristics. Final design gave a clear space of approximately 10' x 9'4" x 8' high with sufficient maneuver room to bring in specimens up to and including full palletized unit loads and CONEX inserts. The completed unit was calibrated for flow versus pressure using a variable built-in line pressure regulator and a flow meter to approximate the ASTM requirement for 2 to 2-1/2 gallons/hour/square foot, which is approximately 4-1/3 inches per hour or a steady tropical rain, with the added provision for horizontal spray to simulate wind-blown rain. In view of the spray strike pattern and surface wetting characteristics obtained, the design is considered a successful compromise of all the factors and limitations involved for the purpose intended.

Objective

The basic requirement was to design a water spray exposure test for large containers which would be similar to and approximately equivalent in exposure characteristics to the standard ASTM D-951-51 test procedure normally used for small containers. An additional effect was desired which would simulate wind-blown rain.

Introduction

Controlled water spray is a widely used and universally accepted exposure test for containers, and a standard test procedure has been developed for this purpose by the American Society for Testing Materials. This standard test procedure is identified as "ASTM-D-951-51 Water Resistance of Containers by Spray Method". The procedure had been intended for small containers such as cases of canned subsistence, cases of clothing, and other similar items in the smaller size and weight range, and the spray cabinets so designed have worked well with satisfactory results.

However, the recent expansion in the use of larger supply units, especially in fiberboard, such as sheathed unit loads, large double-wall and triple-wall boxes, and other designs such as modular container unitized loads and CONEX inserts, has required the consideration of a spray test facility which would accommodate these larger containers. Since these containers may also be required to have outdoor storage capability, an effect to simulate wind-blown rain was desirable. No formal test had been designed for this purpose. Previous testing was of the indiscriminate fire-hose-spraying variety, with no real control over the test conditions. Hence, the requirement arose for a standardized test procedure for large containers approximately equivalent to ASTM-D-951-51 which would give reproducible results.

Design Considerations

The dimensional requirements are intended to cover principally the unit loads built on the 40" x 48" pallet, along with the other various large fiberboard boxes which are used as consolidation containers. The palletized load dimensions would be a normal maximum of 43" x 52" x 54"H. The only longer dimension which would possibly be considered would be the CONEX insert "A" at 58", and rarely some of the triple-wall configurations up to 75" in length.

A spray rate and coverage was desired which would approximate as far as possible the requirements and procedure of ASTM-D-951-51 within the limitations of the available facilities and space. Since the pallet loads require handling by mechanical means, it was not possible to utilize the conventional raised platform type of cabinet. This resulted in a compromise which eliminated the recirculating system for simplicity, and utilized an existing floor drain for water disposal.

The final design was that shown in Figure I, and the list of materials is shown in Table I.

Procedure

The primary problem in the design of the sprayer was in the selection of the nozzles to give the required flow and spray area characteristics. The actual dimensional layout is shown schematically in Figure I, and was designed to give best performance with the standard 40" x 48" unit load.

Several types of nozzles were tested, e.g., fog nozzles, oil burner atomizing nozzles, and water spray nozzles. Generally the problem was to obtain sufficient wetting over the required area without an excessive flow, considering the 2 to 2-1/2 gallons/hour/square foot requirement of ASTM-D-951-51.

Additional data checked included the manufacturer's spray characteristic tables (pressure-flow-pattern). Final selection was based on the manufacturer's data and on laboratory tests for spray pattern, area coverage, and flow characteristics.

The control system was assembled in one set as illustrated in Figure II, and the sprayer was assembled as shown in Figure III. The clear space is approximately 10' x 9'4" x 8' high, sufficient for specimens up to and including full palletized unit loads. A pipe union was used at the top, center section, which would permit folding the unit flat against a wall out of the way if necessary. The use of standard pipe and fittings permitted rapid disassembly into a small compact bundle of piping strapped together for shipment purposes.

After assembly and initial runs on a sample load to check the operation of the unit, a calibration operation was initiated to obtain data on performance for various inlet line pressures, regulated pressures, outlet pressures and flow rates. Both pressure gauges had been calibrated by means of the dead weight tester of the piston type.

Results

The calibration data obtained in the tests were plotted as the family of curves shown in Figure IV, and indicates the operating characteristics of the configuration used for this sprayer. It is apparent that a wide range of rate of flow may be obtained by controlling the inlet pressure and the setting of the variable pressure regulator. Characteristically, for each setting of the pressure regulator, a break point was obtained with increase of the inlet pressure. Above this pressure, flow was essentially constant with increasing pressure, while below this point, flow decreased with decreasing pressure. It was also found that the critical pressure point of these particular nozzles was about 8 psi. Above this pressure, spray coverage was good with good flow and wetting characteristics. Below this pressure, the strike pattern and coverage, especially from the side nozzles, was insufficient for satisfactory performance. Although the strike pattern did not cover the complete surface, it was found that a minute under the sprayer was sufficient to wet the entire surface of the load.

Conclusions

Considering all the factors involved, such as flow rate, wetted surface, strike pattern, controllability, and accessibility for specimens, the unitized load spray facility is considered a successful compromise of all the factors and limitations involved for the purposes intended. The sprayer fills a need at this installation for spray testing of palletized unit loads and large containers.

Recommendations

It is recommended that the sprayer as designed be utilized for water spray testing of unitized pallet loads and large containers, as required in performing the Container Division mission.

TABLE I

List of Materials for Unit Load Spray Facility:

1. (12) spray nozzles, type 1/8 GG-3 male connection. (Spraying Systems Company, Bellwood, Illinois.)

2. 1" diameter, nominal, water pipe, elbows, tee's, reducers, etc.

3. (1) Line Strainer.

4. (2) Pressure gauges. (0-50 p.s.i. or as required.)

5. (1) Gate valve.

6. (1) Adjustable automatic pressure regulator at inlet (0-50 p.s.i.)

7. (1) Flowmeter. (0-250 g.p.h.)

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UNIT LOAD SPRAY FACILITY
QMF & CIAF, CHICAGO, ILL.
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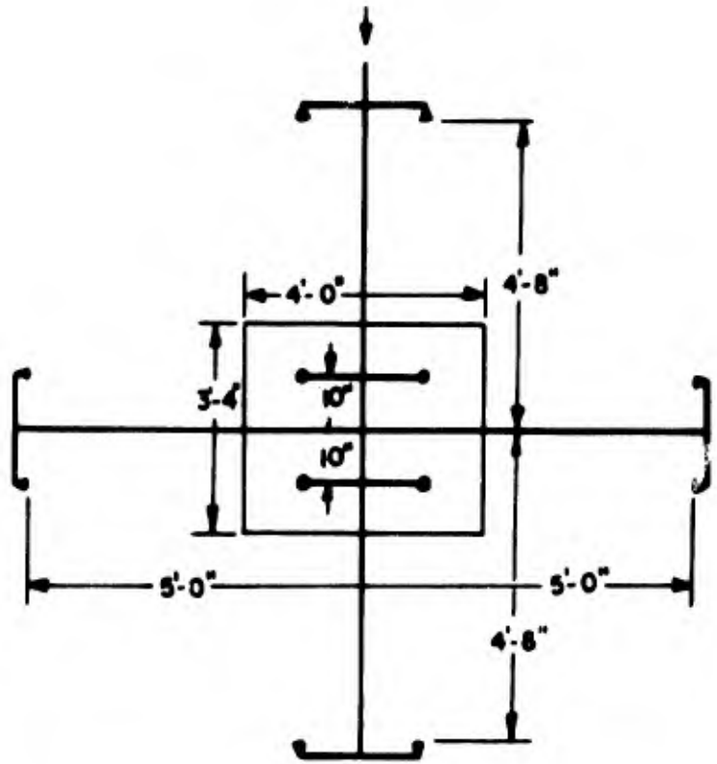

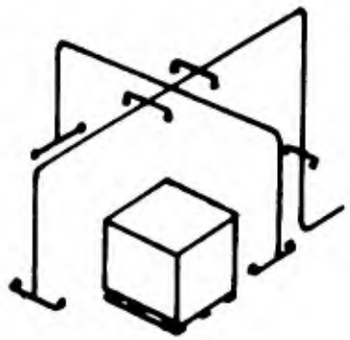

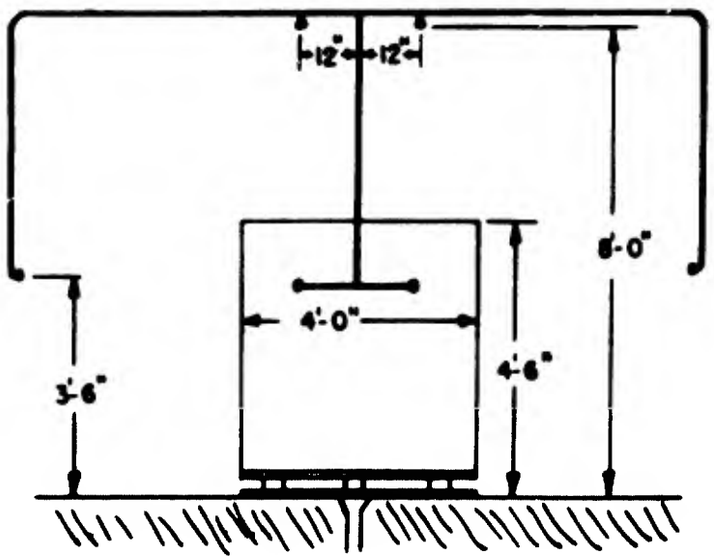

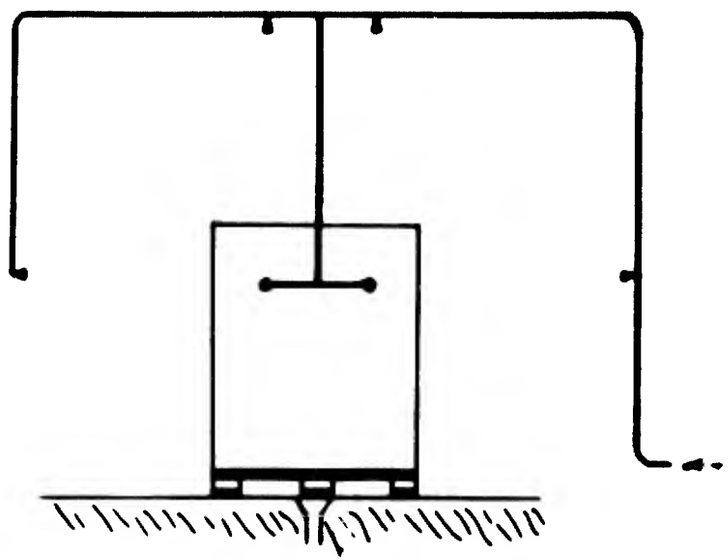

FIGURE 1

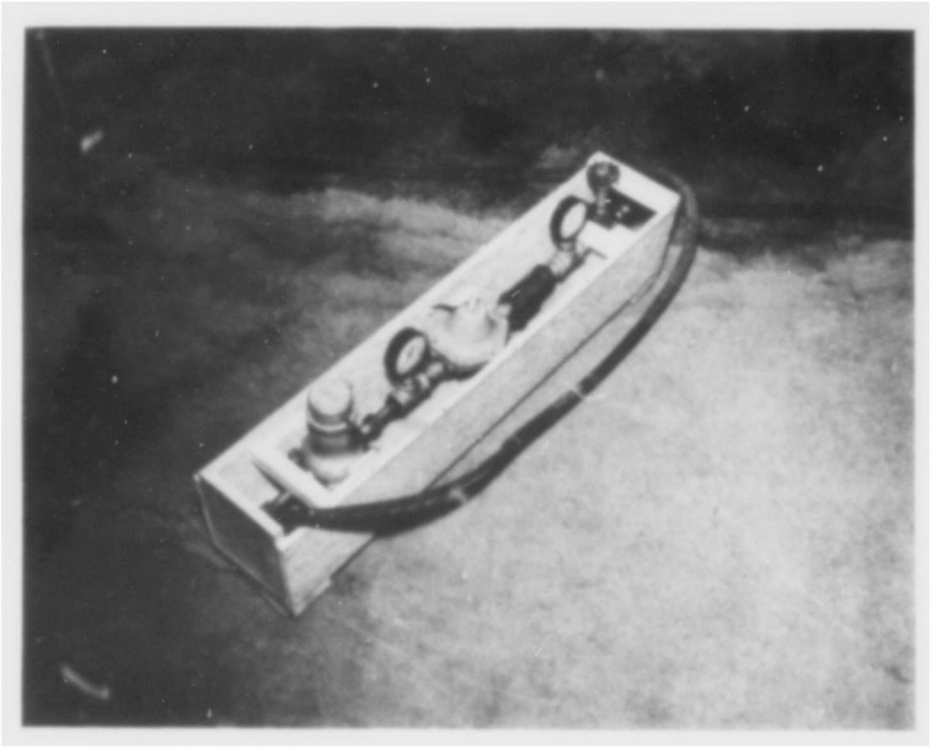

Figure II - Photo of assembled control case. From left to right, the parts are: flow meter, pressure gauge for regulated pressure, adjustable automatic pressure regulator, line strainer, pressure gauge for line pressure, and inlet valve.

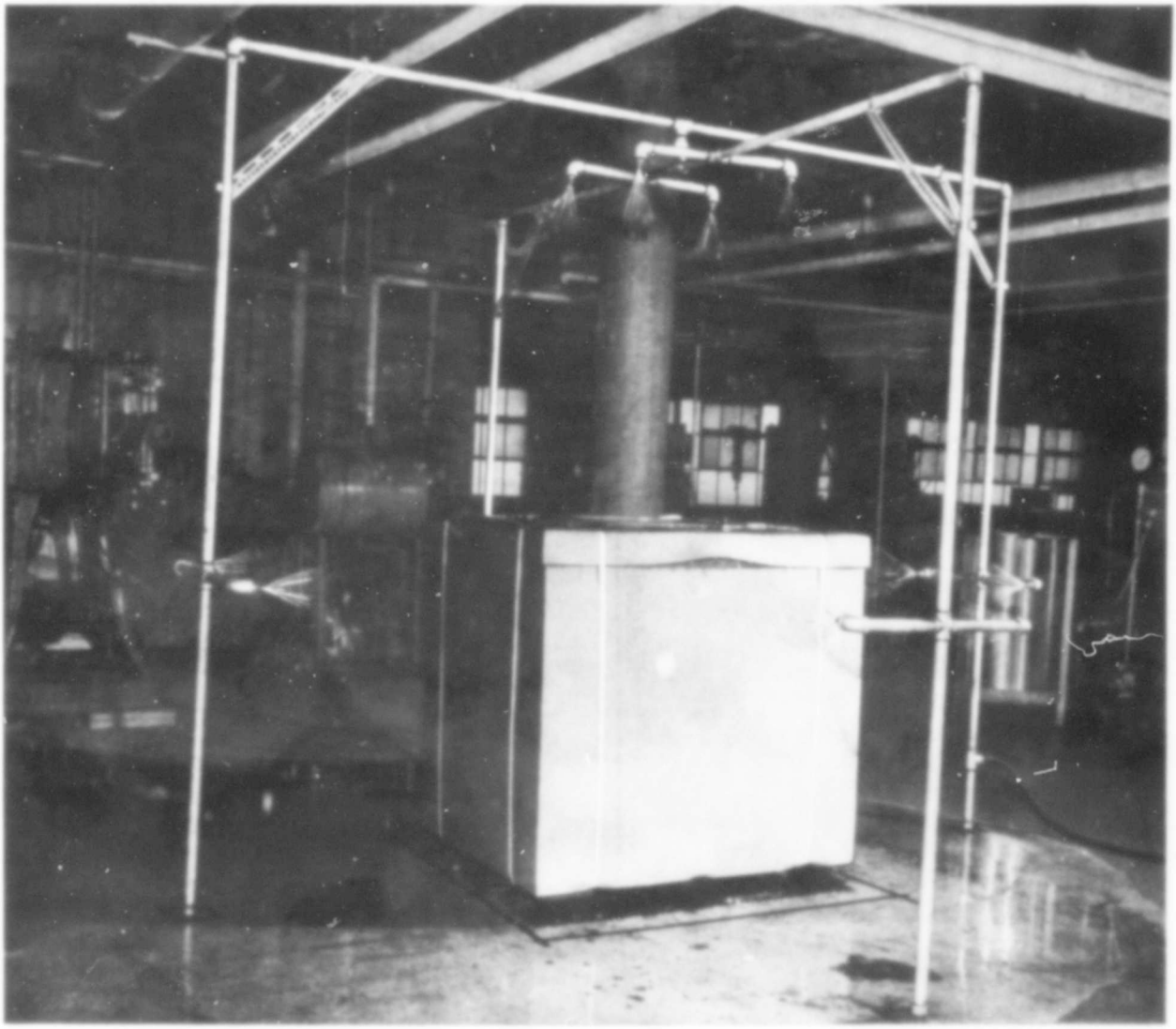

Figure III - Photo illustrates the sprayer in operation with a specimen under the spray. This load is the largest to be expected, and is well covered by the spray characteristics of the spraying pattern as designed. Even though the "strike" pattern does not cover the complete surface, a few moments under the sprayer is sufficient to wet the entire surface of the load, and the design can be considered a successful compromise of all the factors and limitations involved. The water dripping from the lower edge illustrates the excellent performance of the sheath as a rain shed. Of interest also is the utility of the wood pallet as dunnage for protection against ground water.

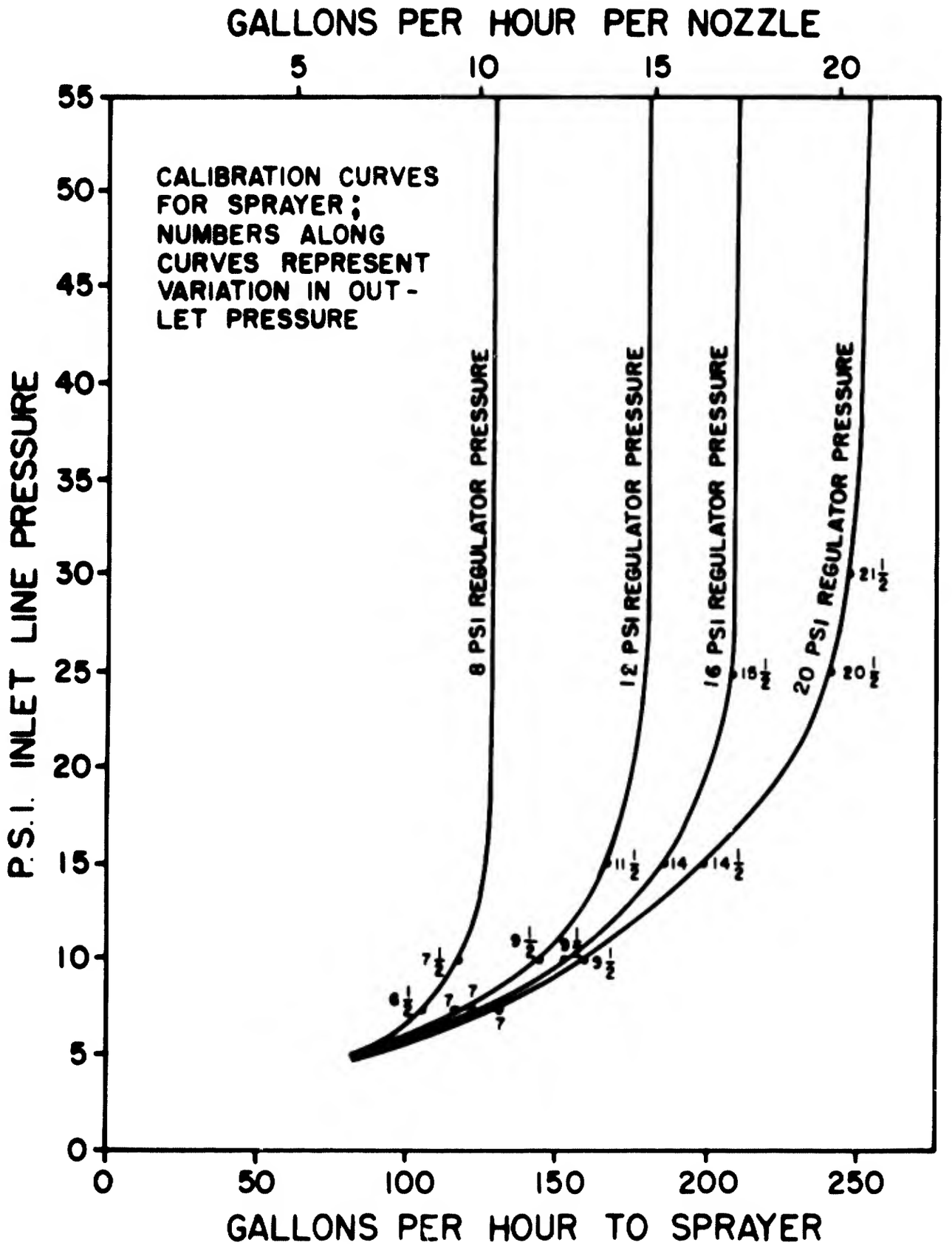
GALLONS PER HOUR PER NOZZLE
5
10
15
20
55
50
45
40
35
30
25
20
15
10
5
0
CALIBRATION CURVES FOR SPRAYER; NUMBERS ALONG CURVES REPRESENT VARIATION IN OUT-LET PRESSURE
8 PSI REGULATOR PRESSURE
12 PSI REGULATOR PRESSURE
16 PSI REGULATOR PRESSURE
20 PSI REGULATOR PRESSURE
P.S.I. INLET LINE PRESSURE
0
50
100
150
200
250
GALLONS PER HOUR TO SPRAYER

FIGURE 4