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To: F. L. Culler

Date: February 11, 1954

From: W. T. McDuffee

Subject: THOREX PROCESS: Demonstration of Feasibility of Use of Steam Jets in Internal Decontamination of Vessels

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1.0 INTRODUCTION

The purpose of these tests was to determine the feasibility of using steam jets for lifting liquid under pressure to one or more spray nozzles to distribute liquid around the interior of a vessel. A method based on the use of these would be a simple way of recirculating minimum volumes of solution used for internal decontamination of radiochemical processing vessels.

2.0 SUMMARY

Preliminary testing, using readily available equipment, indicated that steam jets can be used to supply liquid under pressure to one or more spray nozzles. The presence of 27% dissolved solids, 0.2% undissolved soft solids, and/or 0.1% detergent did not appreciably alter the performance of the system tested. There was very little foaming when detergent was used. The steam jets tested exhibited different operating characteristics for one set of conditions. On the basis of their operability with the steam supply pressure available at the header and using "on-off" practice, it is recommended that Schutte and Koerting No. 217 jets, 0.5-in., be used in the decontamination assemblies to be purchased for the Thorex pilot plant.

3.0 DESCRIPTION OF EQUIPMENT AND TEST

3.1 Equipment

The details of the tank simulating a vessel to be decontaminated and the jet-and-nozzle assembly are shown in Figs. 1 and 2. The spray nozzles used were Delavan WSS20, which have a minimum orifice opening of 1/16 in. The steam jets used, all 1/2 in., were Penberthy 21A-XL-96, Penberthy 1A-XL-96, and Schutte and Koerting No. 217.

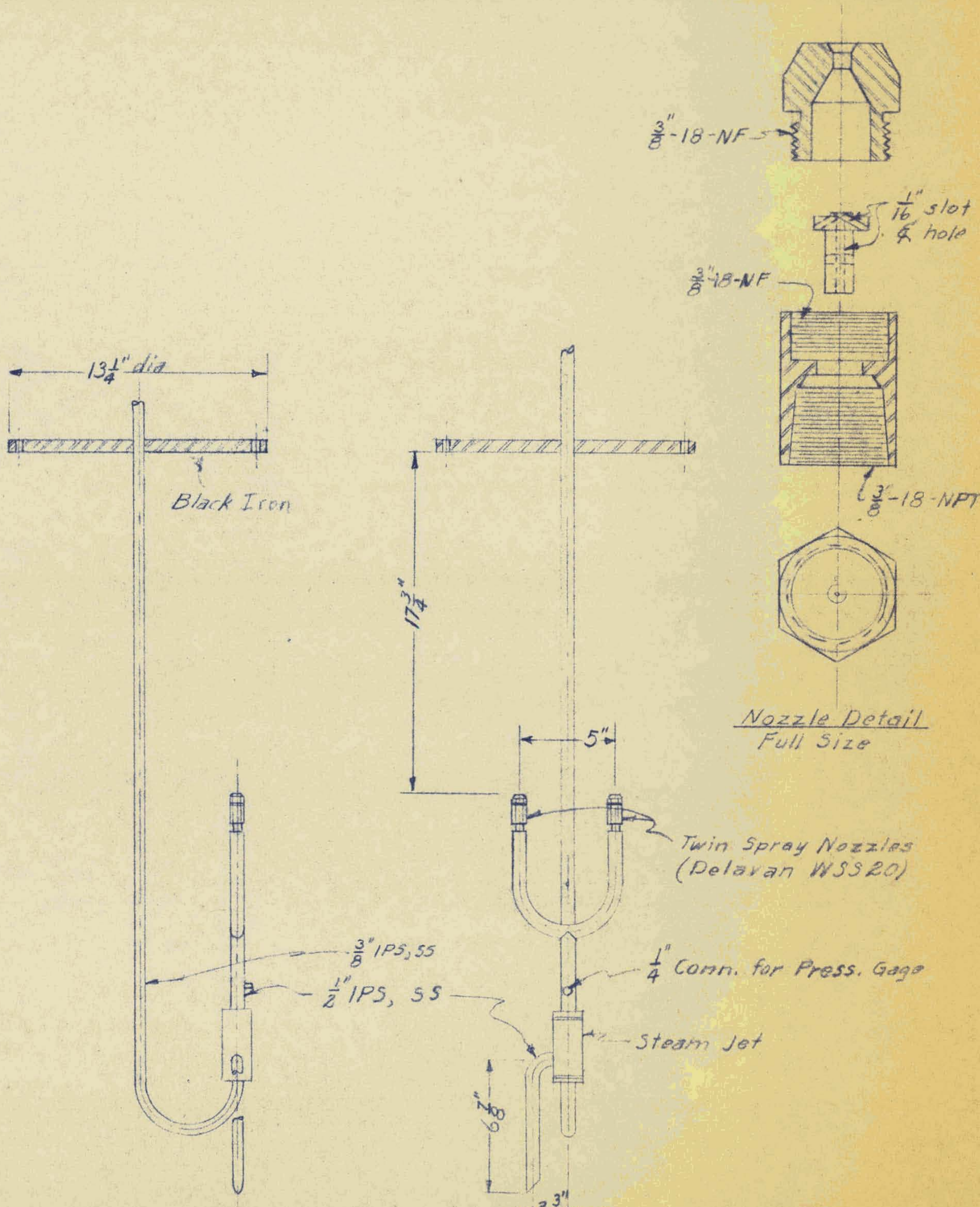

FIG. 1 JET & NOZZLE ASSEMBLY & NOZZLE DETAIL
Decontamination Test Facility, Oct 53.

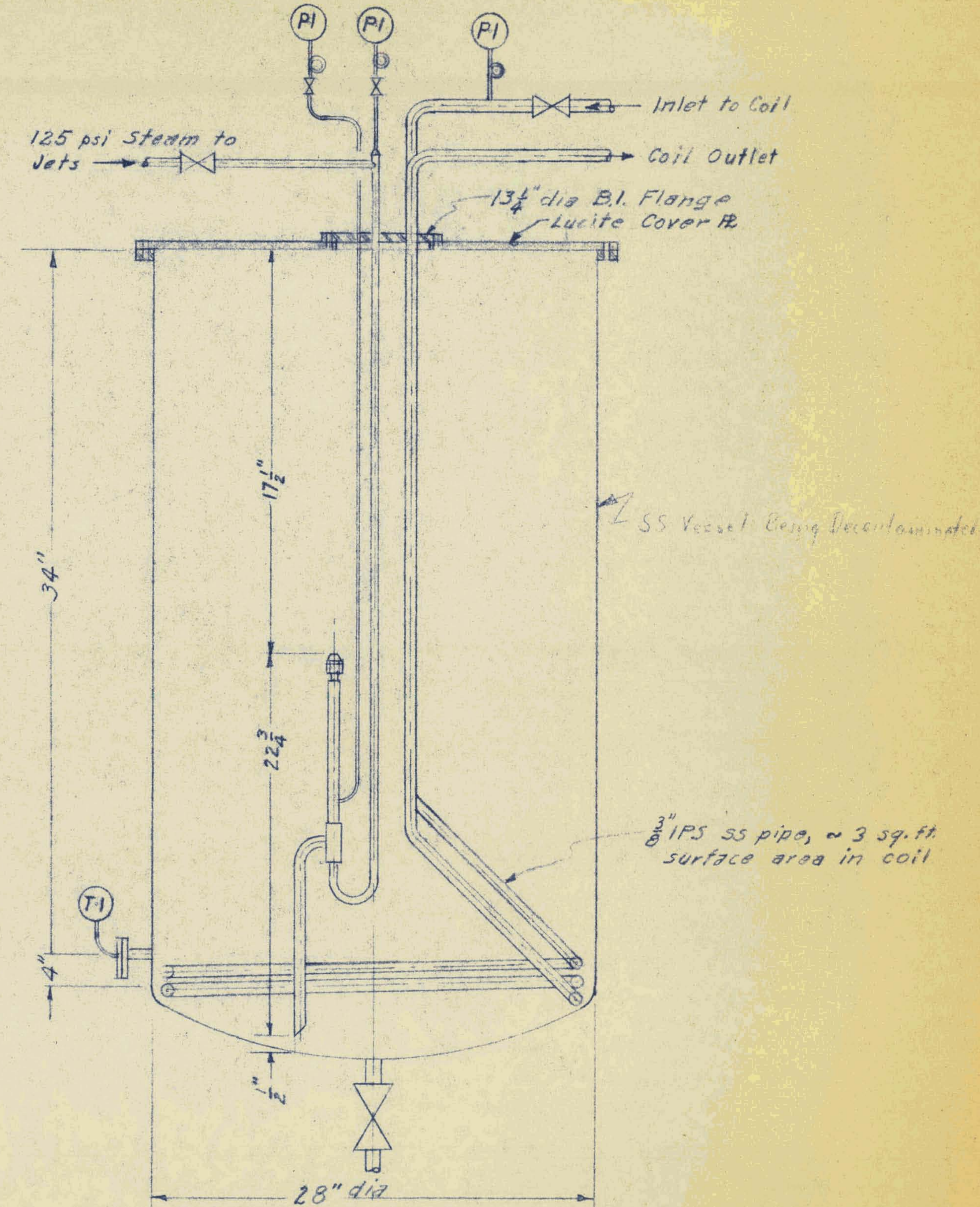

Fig. 2 - Tank & Jet Assembly
Decontamination Test Facility

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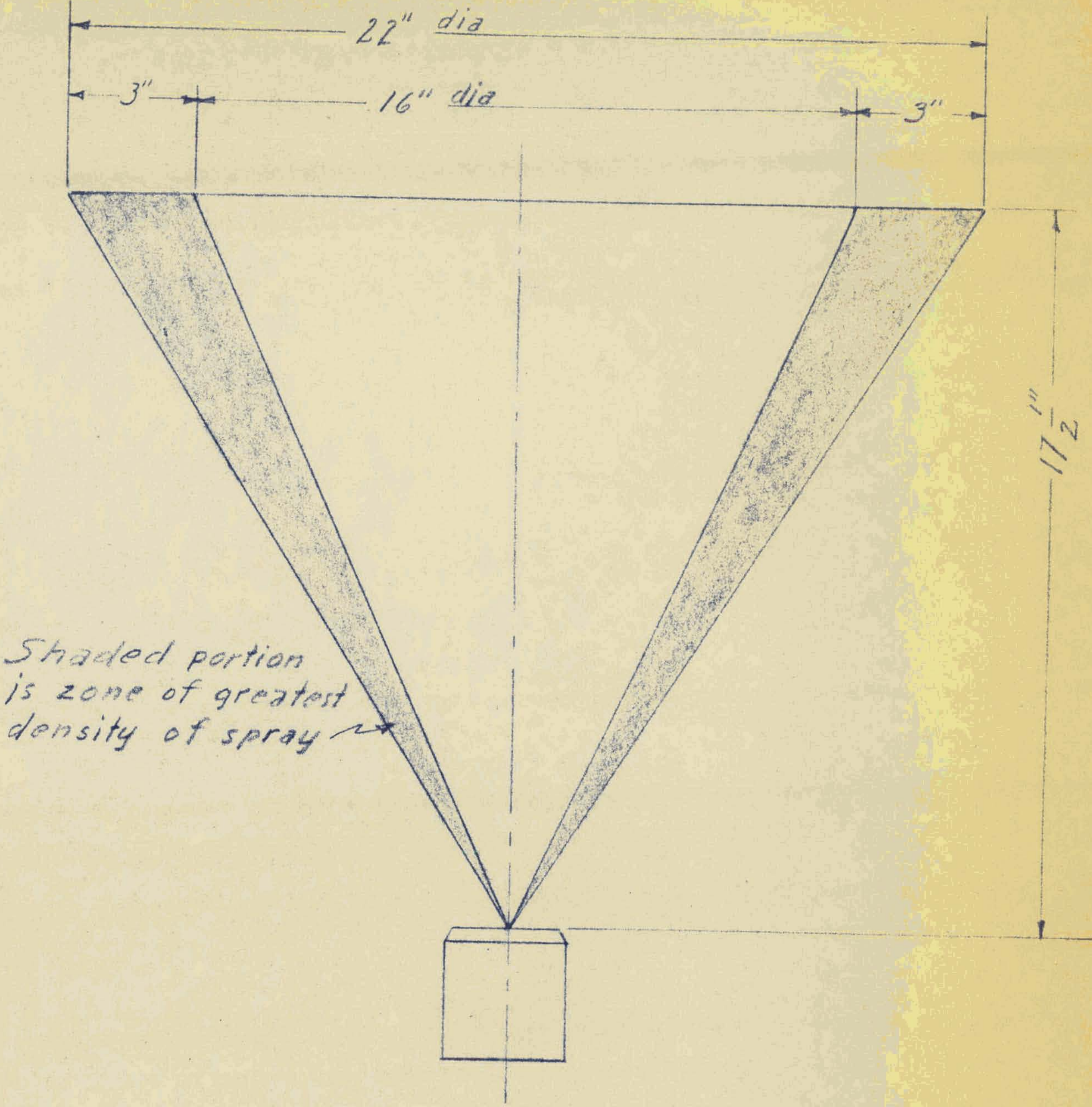

FIG 3
SPRAY PATTERN
DeLAVAN WSSF-20 SPRAY NOZZLES

3.2 Test Conditions

The working volume of the liquid being studied was initially 12 gal, which barely covered the cooling coils. As the test progressed, the volume increased owing to the accumulation of condensed steam, from operation of the jets, in the tank. The suction lift initially was approximately 6 in. and decreased to 0.0 in. as the test progressed and the volume increased. The equilibrium temperature of the liquid was observed to be about 75 to 80°C.

3.3 Effect of Temperature on Steam Jet Operation

The steam jet ceased to function at the temperature at which the liquid entering the orifice of the jet flashed off sufficiently that the jet was essentially operating on vapor. Those jets designed to operate on liquids, the Penberthy 1A and the Schutte and Koerting No. 217, do not "vapor-bind" at such low temperatures as those designed to operate on vapors. The Penberthy 21A, designed to operate on vapors, "vapor-binds" at 60 to 65°C. The presence of dissolved substances did not alter the range of temperatures in which unstable operation occurred.

3.4 Performance of Jets and Nozzles When Operated on Water Alone

The data assembled for the three jets tested indicate that the Penberthy 21A is less effective at steam pressures below 60 psig, but both the Penberthy 1A and the S & K Fig. 217 perform satisfactorily in this range. The latter two, however, retain the advantage of higher discharge pressures in the range of 70 to 80 psig pressure, with perhaps the Schutte and Koerting possessing a slight advantage under the service conditions simulated in this test (see Table 1).

3.5 Effect of Dissolved Solids in Liquid on Performance of Jet and Nozzles

There was no observable difference in the performance of the jet and nozzles whether operating with water or with aqueous solution of density 1.3, under the same conditions of steam pressure and temperature of the liquid (see Table 2).

Table 1

Discharge Pressures of the Jets Tested under Various Steam Pressures

Liquid: water only
Temperature: Approximately 75°C

Steam Pressure (psig)	Discharge Pressure (psig)		
	21A	1A	S & K
30	---	---	7.0
35	---	9.0	9.5
50	---	14.5	13.5
60	7.5	17.0	16.0
70	9.0	---	17.0
80	11.0	17.0	18.0
90	13.0	---	19.0
100	14.5	---	---

Table 2

Effect of Dissolved and Undissolved Solids and Detergent in Liquid on Discharge Pressure

Liquid: (A) 27% Na_2CO_3 solution, density 1.3 g/ml at 20°C
(B) Solution A containing also approximately 0.2% $Al(OH)_3$
(C) Solution B containing also 0.1% PAX

Jet: Penberthy 21A-XL-96

Temperature: Approximately 75°C

Steam Pressure (psig)	Discharge Pressure (psig)			
	Water Only	Solution A	Solution B	Solution C
60	7.5	---	7.5	---
70	9.0	10.0	8.5	10.0
80	11.0	11.5	11.0	---
90	13.0	---	13.0	---
100	14.5	---	14.5	---

3.6 Effect of Undissolved Solids on Performance of Jet and Nozzles

There was no observable difference in the performance of the jet and nozzles whether using clear aqueous solution or the same solution containing about 0.2% undissolved soft solids, i.e., aluminum hydroxide (see Table 2). No evidence of an accumulation of solids in any part of the equipment was observed.

3.7 Effect of Detergent in Liquid on Performance of Jet and Nozzles

There was no observable effect of the presence of detergent in the solution on the performance of the jet and nozzles whether operating with water alone or with an aqueous solution of density approximately 1.3 containing approximately 0.2% solids and 0.1% PAX* (see Table 2).

3.8 Spray Pattern

The spray pattern for a single nozzle is shown in Fig. 3. The use of two nozzles eliminated "blind" spots in the overall pattern, but the two patterns interfered with each other to some extent. The entire inner surface of the tank was wetted by spray impinging on it, although there were zones of varying density of spray, as shown in Fig. 3.

3.9 Steam Consumption

The steam consumption of the jet supplied with steam at 60 psig and liquid at 70°C was 60 to 65 lb/hr, which agrees with the data supplied by the manufacturer for the Penberthy 21A-XL-96. Similar data for the Penberthy IA and the S & K Fig. 217 were not collected.

*Composition unknown. This material is a commercial detergent sold under the trade name "PAX."

1 - 8

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