MICROWAVE-VACUUM DRYING SYSTEM (MIVAC)

PROGRESS REPORT #5 (FINAL)

DOE CONTRACT NO. EY-76-C-02-2918

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1.0 INTRODUCTION

This progress report presents the activities performed in partial fulfillment of DOE Contract No. EY-76-C-02-2918 during the period June 1978 through December 1978. The accomplishments during this reporting period were:

- (1) The dryer was disassembled at the site of the functional checkout in Raleigh, North Carolina and shipped to the USDA Coastal Plain Research Station in Tifton, Georgia.
- (2) The dryer was reassembled and checked out on a construction site and supported by a structure provided by the USDA.
- (3) Performance verification tests were performed, and an operating procedure manual was prepared.
- (4) An open-house was held to acquaint potential customers, and interested parties from government, educational institutions and the press with the MIVAC system and its potential.
- (5) Preliminary operational data was developed on the following products:
 - (a) Long grain rough rice
 - (b) Short grain rough rice
 - (c) Runner peanuts
 - (d) Grain sorghum
 - (e) Corn
 - (f) Soybeans

2.0 ERECTION AND VERIFICATION

The dryer, and the parts for the support building supplied by the USDA were trucked to Tifton, Georgia; arriving about 1 July 1978. At Tifton, the dryer was assembled by USDA personnel with MCAIR personnel on-site providing technical assistance. Figure 1 shows the dryer, fully assembled inside the support structure. Figure 2 shows the finished installation with the protective enclosure surrounding the support structure. The small trailer to the left of the structure houses instruments for product measurement and analysis and provides work space for the test personnel. Figure 3 shows rice being dumped into the receiving hopper of the bucket elevator. The elevator transfers the product to the top of the dryer where it flows through a spout into the upper hopper of the dryer as shown in Figure 4. In Figure 5 the dried product is shown emerging from the lower hopper. The main control console and the two microwave power supplies can also be seen in this Figure.

In assembling the dryer, all power and instrumentation wiring were installed in accordance with applicable sections of the National Electrical Code.

When the installation was complete, it was vacuum leak checked. A pressure of 2.0 Torr was achieved with the unit dry and empty.

Rewetted corn was then placed into the dryer to serve as a microwave load. The unit was operated at progressively higher power levels until full output (12 kilowatts) was achieved. Microwave emission measurements were made at all potential leak sites. A typical emission survey form is shown in Appendix A. This complete survey is performed approximately once each month. Spot checks are made each time a component of the system is removed and replaced.

3.0 PUBLIC DEMONSTRATION AND OPEN-HOUSE

In keeping with DOE's policy of rapidly moving the results of conservation research into the market place, MCAIR sponsored a combination conference, demonstration and open-house at Tifton, Georgia on 29 August 1978. MCAIR was assisted by USDA personnel, DOE personnel and personnel of the Aeroglides Corporation in making the presentations and demonstrations. Fifty-three persons attended representing government (7 persons), industry (37), educational institutions (4), and the press (5). As a result of this event, considerable public awareness of this new technology was achieved. Figure 6 shows some of the DOE and USDA officials who attended the conference.

4.0 DRYING EXPERIENCE

During the 1978 harvest season we were able to obtain preliminary data on the drying characteristics of two types of rice, peanuts, corn, soybeans and grain sorghum.

4.1 LONG GRAIN ROUGH RICE. "Starbonnet" variety long-grain rough rice was dried from an initial moisture content of 19.4% (wet basis) to 12.9% (wet basis) in a single pass through the dryer. When dried at rates of 8.8 percent per hour, the milling yield was the same as that obtained from a control sample dried by the conventional heated-air dryer. In a conventional drying process, this amount of moisture reduction would require approximately 72 hours and require three passes through the dryer with a 24-hour storage period between each pass through the dryer.

When the drying rate was increased above the 8.8 percent per hour, the milling yield decreased. Limited time and sample precluded further testing to determine if further improvements could be obtained by rate reductions.

Data collected during these tests is summarized in Table 1.

4.2 SHORT GRAIN ROUGH RICE. "NATO" and "NORTAI" varieties of short-grain rough (or paddy) rice were obtained from Arkansas for testing. The data obtained is summarized in Table 2. No samples of conventionally dried rice of this lot were available for comparison. However, the milling yield of the rice dried at less than 5 percent per hour was nearly identical to that for the samples dried with moving ambient air. The rice was dried in a single pass through the dryer.

4.3 RUNNER PEANUTS. Runner peanuts were dried in the MIVAC dryer at rates from 4 to 35 times as fast as conventionally dried peanuts. At all drying rates there was no detectable change in the taste of the peanuts. However, the rate had to be held to no more than 4 times the conventional rate (0.5 percent per hour) to produce peanuts that met all the Federal and State grading specifications. Data from these tests are shown in Table 3.

4.4 GRAIN SORGHUM, CORN AND SOYBEANS. Grain sorghum was dried at rates from 4.7 to 10.5 percent per hour. All the samples met market standards.

Samples of corn and soybeans were dried for demonstration purposes only. The 1978 harvest season for both these products had passed by the time the dryer was installed. As a consequence only grain already at storage moisture content or below was available. Both dried readily and showed no deterioration. Drying data on these crops will be obtained in the 1979 crop season.

FIGURE 1 - MIVAC DRYER - PRIOR TO INSTALLATION OF SIDING

C35-589-2

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FIGURE 1

FIGURE 2 - COMPLETED MIVAC TEST INSTALLATION TIFTON GEORGIA

C35-588-13

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FIGURE 2

FIGURE 3 - DUMPING GRAIN INTO RECEIVING HOPPER OF BUCKET ELEVATOR

FIGURE 4 - GRAIN TRANSFERRING FROM BUCKET ELEVATOR UNTO THE UPPER HOPPER OF THE DRYER

C12-8163-2

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FIGURE 4

FIGURE 5 - DRIED GRAIN BEING REMOVED FROM THE DRYER

C12-8163-3

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FIGURE 5

FIGURE 6 - DEPARTMENT OF ENERGY AND DEPARTMENT OF AGRICULTURE OFFICIALS AT MIVAC "OPEN HOUSE"

C35-611-3

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FIGURE 6

TABLE 1 - SUMMARY OF DRYING DATA "STARBONNET" LONG GRAIN ROUGH RICE

Drying Method	Drying Time (Minutes)	Drying Rate (%/Hr)**	Initial Moisture Content	Final Moisture Content	Milling Yield	
			% Wet Basis	% Wet Basis	Total %	Head %
Air Dried Control Samples	4320*	.0002*	19.4	11.4	68.0	60.0
Conventionally Dried	4320*	.0002*	19.4	11.4	67.8	57.0
MIVAC Dried	45	8.8	19.4	12.9	68	57.0
MIVAC Dried	34	8.7	19.4	14.5	66	56.7
MIVAC Dried	14	18.0	18.6	14.4	64.6	54.5
MIVAC Dried	12	24.5	18.6	13.7	64.5	54.5

*The actual time required to dry the conventionally dried sample was not reported by the rice mill which made the quality analyses. The number reported here reflects the normal practice of removing about two percent of moisture (in about 2 hours) then storing the grain for 24 hours to allow moisture to equilibrate, then repeating the cycle until the desired moisture content is achieved.

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TABLE 1

TABLE 2 - SUMMARY OF DRYING DATA "NATO" AND "NORTAI" SHORT GRAIN ROUGH RICE

<u>Drying Method</u>	<u>Drying Rate (Points/Hr)*</u>	<u>Initial Moisture Content (% Wet Basis)</u>	<u>Final Moisture Content (% Wet Basis)</u>	<u>Milling Yield</u>	
				<u>Total %</u>	<u>Head %</u>
NATO RICE					
MIVAC	7.0	18.3	12.4	62.0	49.7
Air Dried Control Sample	.0002	18.3	12.3	62.0	58.2
NORTAI RICE					
MIVAC (Run 1)	2.6	16.0	13.4	73.2	60.7
MIVAC (Run 2)	3.7	16.0	13.4		
Air Dried Control	.0002	16.0	12.5	72.5	60.4

TABLE 3 - SUMMARY OF DRYING DATA RUNNER PEANUTS

<u>Drying Method</u>	<u>Drying Rate (Percent/Hr)</u>	<u>Initial Moisture Content % Wet Basis</u>	<u>Final Moisture Content % Wet Basis</u>	<u>Percentage of Sound Splits (Federal-State Grading Test)</u>
MIVAC	2.2	14.2	9.3	5.2
MIVAC	6.9	13.0	8.1	17.6
MIVAC	17.8	25.9	10.9	12.6
Air Dried Control Samples	0.4	16.8	7.8	5.0

TABLE 3

APPENDIX A

PROCEDURE FOR CHECKING
THE MICROWAVE EMISSION OF
THE MIVAC CROP DRYER IN
TIFTON, GEORGIA

Inclusive pages: 16 - 23

PROCEDURE FOR CHECKING
THE MICROWAVE EMISSION OF
THE MIVAC CROP DRYER IN
TIFTON, GEORGIA

1.0 MICROWAVE EMISSION LEVELS

- 1.1 The frequency of the microwave energy used in the MIVAC crop dryer is 2450 megahertz (MHz). It is essential that surveys for microwave emission be conducted with a microwave detection device calibrated for 2450 MHz. The band width of the detection device must also be sufficiently broad to encompass the band width of the microwave magnetron, typically about 50 MHz.
- 1.2 The current maximum allowed level of microwave power that may be emitted from a microwave oven in the USA is 5.0 milliwatts per square centimeter (mWcm^{-2}) at a distance of 5.0 centimeters or more from the external surface of the oven, after acquisition by the purchaser. Prior to acquisition, the maximum allowed level is 1.0 mWcm^{-2} at a distance of 5.0 cm or more from the external surface of the oven. (Reference 1).
- 1.3 The MIVAC crop dryer is designed to emit less power than this standard. The maximum level of microwave power emission that is considered to be acceptable is 0.5 mWcm^{-2} at a distance of 5 cm or more from the external surface of the MIVAC dryer.
- 1.4 Periodic surveys of the microwave emission of the MIVAC dryer will enable potential leaks to be identified and their cause corrected before the official U.S. microwave emission standard is exceeded. It is recommended that a microwave emission survey be conducted at least once per month during routine operation of the dryer, according to the procedure described in the following sections.

2.0 MICROWAVE EMISSION SURVEY POINTS

2.1 The locations to be checked for microwave emission are indicated in Figures A1 and A2.

3.0 MICROWAVE EMISSION SURVEY RECORDS

3.1 Records of the microwave emission survey should be kept on the record sheet illustrated in Figure A3. If a level of microwave emission higher than the MIVAC dryer standard (Paragraph 1.3) is detected, its approximate location and magnitude should be indicated on the record sheet. If the level of microwave emission is equal to or less than the MIVAC dryer standard, this is indicated by writing "OK" in the "Leak Status" column (Figure 3). If for any reason a given survey area is not tested for microwave emissions during a microwave emission survey, indicate this and the reason for not testing it on the survey record sheet.

"OK" WRITTEN ON THE MICROWAVE EMISSION SURVEY RECORD SHEET FOR A GIVEN SURVEY AREA INDICATES THAT MICROWAVE EMISSION FROM THIS AREA IS LESS THAN OR EQUAL TO 0.5 mW/cm^2 AT A DISTANCE OF 5 cm OR MORE FROM THE SURVEY AREA.

3.2 If excessive microwave emission is detected from a survey area, its position should be described by locating the survey reference mark and indicating the position as on a clock face. The reference mark corresponds to the 12 o'clock position.

4.0 MICROWAVE EMISSION SURVEY FOLLOWING INITIAL ERECTION OF THE MIVAC DRYER

4.1 After the initial erection of the MIVAC dryer, a microwave emission survey must be conducted, including every test area identified in Figures A1 and A2, and including any areas subsequently identified as areas of potential microwave leakage.

- 4.5 Set the microwave power supplies to deliver 5000W each to the dryer. Conduct a microwave emission survey including every survey area (Figures A1 and A2) and record the results. Repair any causes of excessive microwave emission and retest. The dryer is now fully tested for excessive microwave emission.
- 4.6 At this point it may be possible to eliminate certain survey areas from the routine survey (Section 5). If no microwave emission has been detected from the knife gate valves K-1 and K-2 (Figure A2) at the end of paragraph 4.5, then leak survey areas K-1, S, K-2, V-8, and V-9, may be eliminated from the routine survey subject to the instruction in Section 5.

5.0 MICROWAVE EMISSION SURVEY FOLLOWING MODIFICATIONS TO THE DRYER

- 5.1 Following modifications to the dryer which alter or potentially alter the continuity of the microwave seals in the MIVAC dryer, the area(s) in question must be surveyed for excessive microwave emission before drying is resumed. This survey must be conducted as described in Section 4.

6.0 ROUTINE MICROWAVE EMISSION SURVEY

- 6.1 The MIVAC dryer should be surveyed on a regular basis for excessive microwave emission. It is recommended that a routine survey (described below) be conducted when the dryer is started up at the beginning of a period of use, and then at least once every two weeks thereafter. A complete microwave emission survey should be conducted as described in Section 4 once during each month of operation.

(NOT TO SCALE)

**FIGURE A1 - MICROWAVE EMISSION SURVEY AREAS FOR MICROWAVE POWER SUPPLIES AND WAVE-
GUIDE**

FIGURE A1

FIGURE A2 - MICROWAVE EMISSION SURVEY AREAS FOR THE VACUUM VESSEL. VIEW A IS THE DRYER ROTATED 90° TO THE RIGHT FROM VIEW B. VIEW C IS THE DRYER ROTATED 90° TO THE LEFT FROM VIEW B.

FIGURE A2

MIVAC DRYER MICROWAVE EMISSION SURVEY RECORD SHEET

DATE

Tifton, GA
DRYER LOCATION

Power Level:

Test Area	Leak Status	Location Notes
1W1		
1W2A		
1W2B		
1W3		
1W4		
1W5		
1W6		
1W7		
1W8		
T-1		
2W1		
2W2		
2W3		
2W4		
2W5		

Test Area	Leak Status	Location Notes
2W6		
T-2		
K-1		
V5		
V1		
V2		
V3		
V3B V3C		
S		
V4		
V5		
V6		
V7		
V8		
V9		
K-2		

Signature

FIGURE A3 - MICROWAVE EMISSION SURVEY DATA SHEET

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FIGURE A3

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FIGURE A4 - EXAMPLE OF THE LOCATION OF A REFERENCE MARK ON A WAVEGUIDE JOINT

FIGURE A4

6.2 Fill the product chute with a microwave-absorbing material. This may be the next product to be dried. Evacuate the vacuum vessel. Warm-up the microwave power supplies. Set the microwave power supplies to deliver 5000W each to the dryer. Conduct a complete microwave survey and record the results. Repair any excessive microwave emission and retest.

REFERENCE: "Regulations for the Administration and Enforcement of the Radiation Control for Health and Safety Act of 1968", September 1978, HEW Publication (FDA) 79-8035, § 1030.10(c)(1).

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MICROWAVE-VACUUM DRYING SYSTEM (MIVAC)*

PROGRESS REPORT #4

ERDA CONTRACT NO. E(11-1)-2918

Issue date 30 June 1978

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1.0 INTRODUCTION

This progress report presents the results of activities performed in partial fulfillment of ERDA Contract No. E(11-1)-2918 during the period September 1977 through May 1978. The goals during this period were as follows:

- (1) Redesign the dryer from the 48 kilowatt size to a 12 kilowatt size to make it compatible with the revised statement of work.
- (2) Procure, fabricate and check components for the dryer.
- (3) Assemble the dryer and perform functional tests of the dryer assembly.

2.0 DESIGN

The design drawing of the dryer is shown in McDonnell Drawing T-055718 (attached). The basic functional elements are the vacuum vessel, the product chute and metering assembly, the vacuum pumping and vapor removal system, the microwave generation and application system, and the product sampler system.

2.1 VACUUM VESSEL. The vacuum vessel is three feet in diameter and approximately twenty-five feet long. The volume of the upper and lower hoppers is approximately nineteen bushels each. Ten-inch diameter knife-gate valves are provided to admit grain to the upper hopper and remove it from the lower hopper. The nominal volume of the empty vessel is 150 cubic feet. The vessel is of welded construction and made of 5086 aluminum alloy. This material is a "marine" alloy commonly used for ships, tanks, trucks and other equipment exposed to corrosive environments.

2.2 PRODUCT CHUTE AND FEEDER ASSEMBLY. Three sizes of product chute have been provided. They are ten, six and four inches in diameter. The purpose of the three different sizes is to permit the flexibility to assess the effects of energy density and penetration depth on grain quality and drying uniformity. Two types of chute material are provided (polypropylene and polyester fabric) in each of the three sizes. This provides redundancy in the event of chute damage and allows some assessment of the relative merits of the different materials. The maximum and minimum nominal power density in the product for each of the chute sizes is shown in Table 1.

The product feeder assembly is a small section of a standard Aeroglide Corporation power discharge unit. The rotor is driven, through a rotary vacuum seal, by a variable D.C. motor drive.

The drive motor is smoothly variable from 0.1 to 3.0 rpm. This provides a product flow variation from 0.4 to 12 bushels per hour. This provides a residence time of each grain kernel in the microwave cavity that can be varied from 3.5 minutes to more than four hours.

The reason for this variability is to provide the capability to determine the optimum operating parameters for many different products. In general, the quality of the product is improved at low drying rates. However, the size of a dryer (and consequently its capital cost) is decreased by increasing the drying rate. The trade-off between the quality and cost factors can be explored using the built-in variability of this test device.

2.3 VACUUM PUMPING AND VAPOR REMOVAL SYSTEM. The vacuum pumping system is shown schematically on sheet 9 of T-055718. The Beech-Russ vacuum pump has a nominal volumetric capacity of fifty cubic feet per minute.

At this rate the pressure in the tank can be reduced to the operating pressure of 20 Torr in about 12 minutes.

The pump is expected to only remove the air from the vacuum vessel. The steam evolved from the grain is condensed on the inner wall of the vessel, runs down into a collection gutter and is then channeled down to the condensate collection tank. The condensate tank may be isolated from the main chamber by a valve, drained, and then returned to service without affecting the system operation.

The walls of the vacuum vessel are continuously cooled with water from a spray ring located at the top of the tank. The cooling water is collected in a channel at the bottom and piped away to a drain.

2.4 MICROWAVE GENERATION AND APPLICATION SYSTEM. Two identical microwave power supplies, Model S6-F, manufactured by Cober Electronics, Inc., are used to transform 480 volt electrical power into microwaves at 2450 ~~150~~ megahertz. The microwaves are then transmitted via waveguide into the interior of the vacuum vessel. A teflon window at the end of each waveguide allows the microwaves to be transmitted into the vacuum inside the vessel. The interior of the vacuum vessel functions as a cavity applicator for the microwave energy. The product travels through the cavity via the fabric chute which is positioned along the central axis of the cavity. The microwave radiation passes through the chute fabric and is absorbed by the moisture in the product. The water vapor evolved then passes out through the porous cloth and is condensed on the inside wall of the vacuum vessel.

2.4.1 System Efficiency. As discussed in Progress Report Number 2, the anticipated efficiency of the power supplies selected for this apparatus is

47.5 percent. Figure 1 shows the anticipated losses in each part of the apparatus. The anticipated overall efficiency of this experimental unit is about 39%. As was pointed out in Progress Report Number 2, the equipment for this experimental unit was selected on the basis of compatibility with project scope and budget goals and its efficiency is not representative of projected commercial dryers.

3.0 FABRICATION AND ASSEMBLY

3.1 VACUUM VESSEL FABRICATION AND LEAK TESTING. The main shell was rolled and welded from 3/8 inch thick, four-foot by twelve-foot plates of 5086 aluminum alloy. The flanges were cut from 1.25 inch thick 5083 aluminum plate. The vacuum vessel was assembled by welding.

The vacuum vessel was tested for leaks using the pressure decay method. The test setup is shown schematically in Figure 2. The test was performed as per the specified leak test procedure T-055815. The pressure in the vessel increased less than 0.3 Torr (0.006 psi) in 24 hours. The corresponding leak rate was at least ten times lower than the specified acceptable rate (T-055759, paragraph 5).

3.2 COMPONENTS FABRICATION, ASSEMBLY AND ERECTION. The product feeder, the condensate collection cone, the upper hopper cone and the associated drive and instrument components were installed and functionally verified.

The support structure for the dryer was designed and fabricated by Aeroglides under contract to the USDA. This structure was erected at Aeroglides's facilities in Raleigh and the vessel installed in this structure. The microwave power supplies and the main control console were positioned and the waveguide and wiring were routed. The microwave windows and tuners were installed and the product chute was installed. Figure 3 shows the vessel as installed for functional testing.

4.0 FUNCTIONAL TESTING

The purpose of erecting the dryer at Raleigh was to optimize the arrangement of the equipment for the available space in the structure and to discover any problems while we had the manufacturing capability available to correct them.

Three separate tests were performed; (1) a batch test with corn, (2) a batch test with Vermiculite Insulation Material and (3) a continuous flow test with corn.

4.1 BATCH TEST WITH CORN. Only one microwave power supply was used for this preliminary test. Corn having a moisture content of approximately 15% was placed in the product chute. The chamber was evacuated to 20 Torr and the condenser cooling water was turned on. The one microwave power supply was turned on and the tuner adjusted for minimum power reflection. The power supply output was then increased to full output (6 kw) and maintained for 30 minutes. The reflected power when operating at full output was 20 to 50 watts. Drying of corn was evident in this test; however the moisture reduction achieved in this functional test was not analyzed.

4.2 BATCH TEST WITH VERMICULITE. Because of the low moisture of the corn available for these tests it was decided to use wet vermiculite for initial tests at full power. Four gallons of water were mixed into about seven (volumetric) bushels of vermiculite. The wet vermiculite was then used to fill the product chute. The dryer was evacuated to a pressure of 17 Torr and both power supplies were turned up to full power. These operating conditions were maintained throughout the forty-five minutes of the test. At the termination of this test the dry vermiculite was removed using the product feeder, and the water was drained from the condensate tank.

4.3 CONTINUOUS TEST WITH CORN. For this test the product chute and upper hopper were completely filled with corn. The measured moisture content of the corn varied from 13.5% to 18%. This variation was suitable for a functional test but the data cannot be used for performance evaluation.

The dryer was evacuated to 30 Torr, the condenser cooling water was turned on, the power supplies were adjusted to full output and the product feeder was operated at a rate equivalent to approximately ten bushels per hour. The dryer was operated a total of 70 minutes.

During grain removal from the lower hopper following drying, it was noted that the amount of grain that had been fed through the chute was less than calculated for the selected feeder operating speed. Further investigation revealed that the combination of a nail in the grain and a loose set-screw on the feeder drive mechanism caused grain flow to stop during the run. As a consequence the grain remaining in the chute was dried more than intended. Some of the grain removed from the chute had a measured moisture content of as low as 8.2%. None of the grain, not even that which was

over-dried, showed any evidence of heat damage. One gallon of condensed water was removed from the condensate collection tank.

4.4 COMMENTS AND CONCLUSIONS. The functional tests performed give confidence that the unit will perform as expected when installed and tested under more controlled conditions at the USDA site in Tifton, Ga. The microwave power supplies successfully delivered their full output into a common cavity with minimum reflected power or mutual interference. The condensing system successfully absorbed the steam generated by full output from the power supplies. The condensing system performed acceptably even though only 60% of the design cooling water flow rate was available in this temporary setup. The waveguide and tuner section performed as expected. The teflon window worked well and showed no evidence of heating or deterioration.

The problem that caused the product to stop feeding is not uncommon in grain dryers but precautions must be built in to the dryer to prevent recurrence. Therefore we are investigating installation of a positive flow interlock system or implementation of operating procedure changes prior to routine operation in Tifton, Ga.

The MIVAC System and its support structure will be disassembled, the structure will be painted, the system parts labeled and shipped to the USDA Coastal Plain Research Station, Tifton, Ga. in June 1978. Total erection of the MIVAC system is scheduled to be completed during July 1978. System operational evaluation will follow completion of erection.

FIGURE 1 - SYSTEM EFFICIENCY ANALYSIS

FIGURE 2 - VESSEL LEAK TEST SETUP

FIGURE 2

FIGURE 3 - MIVAC DRYER AS INSTALLED FOR FUNCTIONAL
TESTING AT AEROGlide CORPORATION IN RALEIGH, NORTH CAROLINA

D4E-591538-1

FIGURE 3

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TABLE 1 - CHUTE SIZE VERSUS POWER DENSITY

	<u>Chute Size</u>		
	<u>10" Dia.</u>	<u>6" Dia.</u>	<u>4" Dia.</u>
Max. Power Density (watts/in ³)	1.3	3.7	8.4
Minimum Power Density (watts/in ³)	0.07	0.2	0.4

- 203 SAMPLE PORT DETAIL (1/2" FROM 14" STEEL)
- 209 GASKET (ONE FROM 14" HEADLINE)
- 111 DOOR (1/8" FROM 14" STEEL)

SAMPLING DEVICE (X₂ SCALE)
(THIS VIEW CORRESPONDS TO THAT SHOWN
IN FIG. 8-11 OF THE DRAWING)

-3 LOWER COMPARTMENT ASSEMBLY
SCALE = 1/4

THE NEW CARTRIDGES TO THE GUN IN BERT 7, ZONE C5.
IT SHOWS A -21 WHILE PREVIOUSLY TO THE -8. LONG ASSEMBLY

NAME	STC	CODE	PART NO	REPRESENTATIVE	STOCK	MAILING LIST	ORDERED BY	DATE
LAST	NO		DESCRIPTION	OR DESCRIPTION		NO	OR DESCRIPTION	
PRICE				QUANTITY				
			101	101				
			102	102				
			103	103				
			104	104				
			105	105				
			106	106				
			107	107				
			108	108				
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-I MICROWAVE VACUUM DEMONSTRATION DRYER
1/4 SCALE

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-35 FLANGE DETAILS
FULL SCALE
APPROXIMATE FROM 2013 ALUMINUM ALLOY

-33 TUBE DETAILS
FULL SCALE
APPROXIMATE FROM 2013 ALUMINUM ALLOY

-29 SAME AS -31 EXCEPT ONLY BOLT HOLES (1.625 I.D.)
-31 FLANGE DETAIL
APPROXIMATE FROM 2013 ALUMINUM ALLOY PLATE (1.625 I.D.)
SCALE - V8

[illegible]