# COMBAT RATION ADVANCED MANUFACTURING TECHNOLOGY DEMONSTRATION (CRAMTD)

## "Design and Development of a Horizontal Form/Fill/Seal Machine for an Automated Combat Ration Manufacturing Facility"

Short Term Project #8



**FINAL REPORT**
**STP Results and Accomplishments (October 1989 to September 1991)**
**Report No. CRAMTD STP #8 - FTR 2.0**
**CDRL Sequence A004**
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To satisfy requirements for productivity, versatility and flexibility, the horizontal form/fill/seal machine was specified and developed (based on the Tiromat 3000) to provide MRE pouch packaging rates of 100 per minute and for integration into the Combat Ration Advanced Manufacturing Technology Demonstration. Over 45,000 pouches have been produced during the test runs (including debugging) at rates up to 102 per minute demonstrated with residual gas levels below 10cc and meeting the other MIL specifications. Performance of the F/F/S machine was enhanced by Rutgers developing a unique method of measurement and analysis of interrelated operations. The method uses a computer based data acquisition system and the existing Tiromat sensors. Cycle (production) rates, quality of packages and control of product slosh were improved. This technique is useful during equipment installation, measuring equipment performance and monitoring package quality. A new version of laminated film was developed by Reynolds Metal that can be formed, sealed to specification and does not delaminate after retorting. Earlier performance will be verified by acceptance testing and NRDEC approval of this alternate pouch production method.

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# 1.0 CRAMTD STP #8

## 1.1 Introduction and Background

DLA expressed a requirement to develop, test and demonstrate the horizontal form/fill/seal machine because it was considered the most modern and versatile of all current pouch machines.

STP#8 was begun in early October 1989 based on the proposal submitted to the DLA on August 1,1989 and revised on August 29, 1989 after detailed review with the DLA. The overall STP objective is to design, develop and fabricate a Horizontal Form/Fill/Seal Machine for MRE pouches. This unique machine is to be designed for accommodating future automated ingredient feeding devices and for integration into an advanced computer control system within the CRAMTD process automation Computer Integrated Manufacturing (CIM) strategy. This machine is intended to provide much higher packaging rates-up to 100 pouches per minute-than achieved by current MRE producers.

After a through study on developing a continuous motion pouch machine, it was decided, after a review with the COTR, to redirect efforts and focus on developing an indexing (intermittent) motion machine. The main reasons (Appendix 4.3) for the decision are that of the two designs, a continuous motion machine is mechanically much more complex, more capital intensive and will require an extensive shake-down period. This would take time and effort away from addressing potentially critical operating problems, e.g. delamination of packaging material during retorting that has been reported can occur due to stresses developed at the printed color layer interface during the pouch forming step and also some wrinkles may occur.

## 1.2 Progress Summary

- The STP was started in October 1989 with incremental funding.
- A review of current technology was completed in December 1989 including visits to potential subcontractors and workshop discussions with coalition members.
- Based on the technology review, specifications (Appendix 4.4) for a horizontal Form/Fill/Seal Machine were prepared.
- Requests for proposals were issued to three potential subcontractors on February 7, 1990 and a pre-bid conference was held by CRAMTD/Rutgers Purchasing Department on February 16, 1990.
- Proposals to fabricate a prototype Horizontal Form/Fill/Seal packaging machine for MRE pouch production were received from three potential subcontractors (Mutli-Vac, Mahaffy/Harder and T.W.Kutter) on March 3, 1990.
- The proposals were each analyzed based on the previously established criteria for evaluation in order to identify a recommended subcontractor. (Appendix 4.5 & 4.6).
- A prototype bench-top forming device was fabricated and tests started in March 1990 to study the forming characteristics of available aluminum/plastic laminates. (Appendix 4.9)
- A recommended subcontractor T.W.Kutter representing Kramer & Grebe (Tiromat 3000) was identified and all appropriate subcontracting documents were forwarded to the DLA for review and funding authorization in April 1990.
- The technique for bench-scale pouch formation and evaluation was demonstrated at the April 11, 1990 Coalition Meeting.

- Following DLA approval T.W.Kutter was awarded a subcontract on June 27, 1990 to provide a prototype Horizontal Form/Fill/Seal machine based on the Tiromat 3000. A prototype mold design was developed (Appendix 4.10) and sent to T.W.Kutter on August 20, 1990 for manufacturing. The machine was built by Kramer & Grebe in Waterloo, Ontario, Canada.
- A Technical Working Paper (TWP #19) was issued addressing the control strategy of the Horizontal Form/Fill/Seal Machine. (Appendix 4.13)
- T.W.Kutter provided the layout drawings of the machine in both plan and elevation views. (Appendix 4.8)
- The Horizontal Form/Fill/Seal Machine was delivered to the CRAMTD Pilot Plant on December 5, 1990. Installation was completed in January 1991 and preliminary runs were made during the debugging of the Machine.
- In collaboration with Reynolds Metals Co. and Lord Corp. (laminating adhesives experts) a better forming film was achieved with no apparent delamination during the month of September 1991. (Appendix 4.16 and 4.18)
- A documentation/demonstration run was made on September 26, 1991 that included a demonstration of a computer data acquisition system that optimized the Tiromat controls so that sloshing of water in the pouch was eliminated. This completed the STP (Short Term Project) (Appendix 4.23).

## 1.3 Results

The Tiromat 3000-400 produced over 45,000 pouches during the test runs. A large portion of these pouches were produced during the debugging phase. At the completion of the debugging process we were able to produce pouches at rates up to 102 per minute (17 indexes & 6 pouches per cycle) with residual gas levels below 10cc and meet the other MIL Specification requirements. (Appendix 4.14).

Performance of the CRAMTD Tiromat 3000 Horizontal Form/Fill/Seal Machine was enhanced by Rutgers developing a unique method of measurement and analysis of interrelated operations. The method uses a computer based data acquisition system and the existing Tiromat sensors. Cycle (production) rates, quality of packages and control of product slosh were improved. This technique is useful during equipment installation, measuring equipment performance and monitoring package quality. (Appendix 4.21).

A new version of the laminated film was developed in conjunction with Reynolds that can be formed, sealed to pass MIL Specifications and does not delaminate after retorting. (Appendix 4.16).

Working closely with Reynolds to develop the film the material cost of the bottom formed foil laminate has been reduced by 30% due to mixing the ink color with the adhesive thereby saving a process step. Reynolds is now investigating if this can be done with the lidding material. If so the existing co-packers will be able to profit from our work with Reynolds.

The total equipment cost was $327,345 and the project was completed in 24 months. This cost includes the ability to produce not only MRE foil laminate pouches but the large institutional pouch (12"x15") and semi-rigid plastic trays.

The machine is now installed at the demonstration site and is being used in other development projects and demonstrations. Interested persons are requested to contact the author or the CAFT Center.

## 1.4 Conclusions

1. The Tiromat 3000-400 at Rutgers is a customized packaging system with special features developed from Rutgers specifications that include numerous options and

unique design enhancements. These additional features, not offered by other vendors, provide unsurpassed flexibility and performance in horizontal form-fill-seal machinery:

- MRE pouch tooling in a 2 by 3 pattern are oriented in transverse direction to reduce slosh. Six pouches per index increase productivity. Tooling has adjustable depth for variable pouch volume. Tooling is cooled for producing thermoformed containers as well as cold forming of foil.
- Machine width increased to 440 millimeters to accommodate special tooling and provide greater packaging flexibility.
- Unique beaded seal form produces consistent and strong pouch seals. The design is more tolerant of particle contamination than flat jaw sealers. Several seal rubber durometers are provided for optimum seal width. Control and monitor of seal pressure, seal time and seal temperature assure uniform seal strength.
- Package evacuation by several unique modes:
  - High Speed Nozzle (patented) - eliminates the possibility of product coming in contact with the hot seal frame. A likely occurrence when running hot fluid products due to the need to remove air very quickly in order to attain 100+ packages per minute. This high-air movement plus the possibility of the vacuum level going below the vaporization point of the gravy and causing it to boil onto seals make this an important feature for trouble-free operation.
  - Infrared Sensor - for detecting temperature of the product (in real time) and send it to the control system. It then evaluates it in relation to a standard presuure-vaporization table and controls the vacuum level automatically.
- SMART (System Monitoring and Reporting Tiromat) System 5600/Allen-Bradley 2/17 Programmable Logic Controller is a proprietary state-of-the-art process control, data acquisition/archiving system developed for vertical plant integration. The system is composed of industry standard hardware such as Allen-Bradley PLC, Digital Equipment (DEC) Micro-PDP-11 computer and Setra transducers to provide precise process control. Key features include; audit trail, automatic diagnostic/testing, preventative maintenance prompting, statistical analyses, Tiromat control functions (individual functions and complete operating programs), equipment utilization reporting and network capability.

2. The Tiromat 3000 Horizontal Form/Fill/Seal Machine can produce MRE pouches at rates up to 102 per minute and meet MIL Specifications. This conclusion is based on limited short duration production runs and filling solid products manually. All of our tests were made with beef stew Specification MIL-B-44059C. The gravy was filled using a Raque Piston Filler. Due to the lack of filling equipment only one pouch was filled per cycle.
3. The machine is very flexible and can produce civilian products besides the MRE pouch. It can be adapted to produce a wide variety of packages such as; refrigerated cold cuts, boil in bag and trays for refrigerated and frozen products. By changing the tooling which is very easy to do, (Appendix 4.22) an almost infinite number of package configuration are possible. Flexibility on this type of machine is not limited to only changing the package but it also provides for flexibility in filling. Placeables such as ham slices and smokey franks can be manually or automatically filled on this machine easier than on existing vertical pouch machines used for MRE production.
4. When producing a product with a liquid with a low viscosity the machine should be ordered with an electronically adjustable three-phase drive instead of the standard Tiromat drive with only two speeds. This is an important feature that is needed to prevent product from sloshing and getting on the seal areas. The Rutgers machine has an Allen-Bradley Variable Speed Drive that was reprogrammed (Appendix 4.21) to

accelerate/deccelarate slower to demonstrate the ability of the machine to package a low viscosity liquid product without sloshing. This slowed down the cycle to 14 per minute. For beef stew it is not necessary to slow the index speed and the machine can run at its maximum rate of 17 cycles per minute. Reprogramming the variable speed drive is not difficult and can be done by the plant electrician with the aid of the excellent Allen-Bradley Instruction Manual (Appendix 4.17). The ability to reprogram the machine drive is important. It provides for flexibility in being able to run various products on the machine without getting product on the seal areas.

5. The need to remove residual air in the pouch down to 10 cc or lower requires combat ration products containing liquids to be filled using the MIL specification cold fill method (below 40oF) in order to prevent flashing of product and possible seal contamination. (Appendix 4.15)
6. The majority of the machine operations are controlled by air cylinders and therefore an adequate supply of plant compressed air is critical if cycle rates of 17 per minute are to be achieved. Our testing has determined that the compressed air required is greater than T.W.Kutter's recommendation. Air pressure needed is 110 psi and 100 CFM.
7. Due to the limitations in forming laminated aluminum film beyond 1" in depth, (this is based on the MRE pouch size), and the volume of product required in the pouch, the beef stew has to be filled "thawed" so that it can be pressed down below the top of the formed pouch. The pressing can be done manually using a plate slightly smaller than the pouch or automatically using a plate operated with an air cylinder and configurated to the pattern of the 6 pouches. Pressing or compacting the product will not be necessary for all products.
8. Forming a MRE pouch at 17 cycles per minute and meeting the residual air requirements of less that 10 cc requires that individual machine functions be optimized (Appendix 4.21) such as; forming, raising/lowering tooling, evacuation, sealing and punching. Some functions of the system are determined by trial and error, for instance vacuum level that varies for each product and seal temperature that varies for a particular film. Therefore it is important that machine operators and maintenance personnel be trained. T.W. Kutter supplied the machine with excellent manuals (Appendix 4.17) and gave five days of training in our facility. Additional training included a four day school at their facility in Avon, MA. (Appendix 4.5)
9. The cost savings per pouch using a horizontal form/fill/seal machine that forms a pouch from roll stock compared to using a pre-formed pouch is approximately 30%. (Appendix 4.19). This is due to the material vendor having to make the pre-formed pouches. These comparison costs are based on a four million pouch order. Therefore the savings on that order would be about $128,000.

## 1.5 Recommendations

1. Based on the conclusions in Section 1.4 it is our recommendation that packaged food manufacturers should seriously consider using this machine to produce the MRE pouch. This type of machine provides the flexibility to produce other civilian food packages besides the MRE pouch. The machine can be adapted to produce a wide variety of packages such as plastic semi-rigid and rigid trays for refrigerated and frozen food products. By changing the cutting tooling, an almost infinite number of package configurations are possible; round, oval and irregular contours. Flexibility on this machine is not limited to changing the package but it also provides flexibility in filling. Placeables such as smokey franks and ham slices can be filled easier on this machine than the existing vertical pouch machines that use pre-formed pouches with

three sides sealed and only the top open for filling. There are other features that add to its flexibility. The machine can be equipped for modified atmosphere packaging, pouch or tray forming can be made by the use of air, vacuum, plug assist or any combination of the three. With a major modification it is even feasible to run pre-formed trays on the machine. (Appendix 4.12)

2. The MIL Specifications for the MRE pouch could be modified to include this method of manufacture as an alternative to the existing method of using pre-formed pouches. The requirement is that a producer offer products made in this manner for acceptance testing and approval by US Army Natick, the agency that would modify the specifications. Sometimes pouches wrinkle and the modification could allow one side of the pouch to have wrinkles provided there are no fold overs. It is the intention of the management of this CRAMTD program to qualify the process by producing rations for Army acceptance.

# 2.0 Program Management

This STP was proposed as a five phase work activity as illustrated on the "CRAMTD STP#8-Form/Fill/Seal-Projected Time & Events and Milestones" (Appendix 4.1). These phases cover the following:

**Phase I** Technology reviews that lead to detailed design specifications for the machine and identification of the proper foil laminate to form MRE pouches.

**Phase II** The selected subcontractor will prepare machine drawings for acceptance and approval by Rutgers.

**Phase III** Fabrication (including operability demonstration) of the new machine by the subcontractor at his site.

**Phase IV** Installation, demonstrations and modification of the machine as required.

**Phase V** Testing and operational demonstration of the new machine at the CRAMTD pilot plant site by the subcontractor.

Detailed objectives, statement of work and CRAMTD personnel responsibilities are described in the Technical and Cost Proposals for STP #8. The CRAMTD organization is shown on Appendix 4.2.

# 3.0 Short Term Project Activities

## 3.1 Technology Review - Foil Laminates (Phase I)

The technical report "Evaluation of Aluminum/Plastic Laminates for Retortable MRE Pouches", Appendix 4.9 summarized bench tcp activities evaluating foil laminate pouch forming characteristics. Activity direction evolved from evaluating current technology and included ideas offered at coalition workshop meetings.

Foil work continued on the bench scale level. The technique used to form the pouch packet was demonstrated to coalition members at the April 11, 1990 Coalition Meeting. Plans were made to work with the successful subcontractor to fabricate a packaging machine mold to form pouches using candidate foil laminates.

Based on experiments conducted at T.W. Kutter, the military specifications and predicted performance, a preliminary mold design was developed. This design was sent to T. W. Kutter for fabrication. Aluminum foil materials of three different thicknesses were received from Reynolds Metals, a producer of foil for the industry and a Coalition member of CRAMTD.

Tests were made using foil laminate film from Reynolds and Allusuisse. Initial results on formability, sealing and retorting were positive with the Alusuisse film. The Reynolds film experienced tearing in the forming operation. Reynolds made several visits to Rutgers to discuss the problem and finally shipped film that corrected the problem.(Appendix 4.18).

Tests were made on the new improved foil film. The improvements included a new thermoset adhesive incorporating pigment and a new oriented polypropylene outer layer that increased formability while acting as a support for the aluminum foil. Results showed excellent formability.

## 3.2 Technology Review - Design Specifications (Phase I)

The decision (Appendix 4.3) to have a prototype intermittent motion machine instead of a continuous motion horizontal form/fill/seal pouch machine fabricated was made based on a review/evaluation of current technology (MTIAC literature search and NRDEC project work, interviews with packaging film converters, potential machine subcontractors) and included considerations offered at coalition meetings on July 6, 1989 and October 26-27, 1989.

Detailed design and performance specifications were prepared based on a review of current technology (Appendix 4.7). Potential subcontractors were visited to evaluate their performance capabilities.

## 3.3 Preliminary Engineering - Phase I

Machine specifications were developed based on STP #8 objectives, MIL specifications for the MRE pouch, findings from the review of current technology (Appendix 4.7) and initial foil laminate tests. (Appendix 4.11).

## 3.4 Decision Milestone - Phase I

A progress review of STP #8 activities (preliminary engineering and foil laminate test findings) was held on December 15, 1989 in conjunction with the Monthly COTR Review. It was agreed to proceed with the preparation of a RFP for fabrication of an Intermittent Horizontal Form/Fill/Seal Machine.

A Request for Proposal to fabricate the pouch machine was sent to three potential subcontractors on February 7, 1990 and reviewed at a pre-bid conference held on February 20 at the demonstration site by Rutgers Purchasing. Proposals were received March 9th. They were evaluated and T.W.Kutter was selected as the subcontractor. (Appendix 4.5 &4.6).

## 3.5 Feasibility Study - Rigid Trays - Phase I

Preliminary discussions were held with T.W. Kutter regarding a feasibility study on running pre-formed trays on the Horizontal Form/Fill/Seal Machine. T.W. Kutter proposed a three step feasibility study to design and engineer the incorporation of pre-formed tray sealing on this machine. (Appendix 4.12) Decision to proceed with this study has been postponed to Phase II of the CRAMTD Program.

## 3.6 Design/Development Drawings - Phase II

Based on Rutgers' evaluation of the expertise of the potential subcontractors identified, the complexity and proprietary nature of the machine design details, it was concluded it would be more efficient (cost and design time expended) to have the successful subcontractor prepare any necessary drawings. As part of the subcontractor specifications, T.W. Kutter provided lay-out drawings of the machine in both plan and elevation views showing special features. (Appendix 4.8).

## 3.7 Decision Milestone - Phase II

Based on competitive evaluation of proposals (Appendix 4.5) T.W. Kutter was awarded a subcontract to provide a Horizontal Form/Fill/Seal machine. A special feature is the system monitoring and reporting technology (SMART).The machine, a Tiromat 3000, was built by Kramer & Grebe in Waterloo, Ontario. Delivery was scheduled for November 15, 1990 and received December 10, 1990.

## 3.8 Fabrication/Assembling/Monitoring - Phase III

Several visits were made to T.W. Kutter to review the SMART System that monitors all the machine functions as related to Level 1 and Level 2 CIM architecture. During the same trip a visit to NRDEC assisted in defining mold design and foil specifications.

CRAMTD personnel (Jack Rossen, CRAMTD Director and Ted Descovich, Manager, Equipment Design and Engineering) visited Kramer & Grebe at the Waterloo, Ontario plant on October 5, 1990 to review status.

Sal Cimino, CRAMTD Pilot Plant Supervisor and Ted Descovich attended the T.W. Kutter four day Training School on the Tiromat 3000 on November 12-15th, 1990. Further training (5 days) was provided on-site after machine installation.

## 3.9 Installation at CRAMTD Site - Phase IV

A drawing (Appendix 4.8) was provided by T. W. Kutter that facilitated installation by locating all the utilities required; electrical, vacuum, compressed air and water. The machine was installed by Kutter's servicemen and preliminary tests made. The initial runs indicated that additional compressed air was required to operate all of the machine's air cylinders. The incoming air lines were increased from 3/4" to 1 1/4" and T.W. Kutter installed larger air regulators on the machine. During our tests with product, it was determined that a slightly deeper pouch was required to accommodate the specified volume. The mold was returned to T.W. Kutter for rework.

## 3.10 Testing/Modifying Pouch Tests - Phase V

During testing and debugging of the machine, foil laminate, sealing and retorting tests were made. Approximately 42,000 pouches were produced. The pouches contained 8 oz. of a viscous starch solution and beef stew. The pouches were filled by hand. Pouch bottoms were formed from Reynolds film and sealed with a top film also from Reynolds. The machine was run at speeds up to 102 pouches per minute and sample pouches were thermoprocessed and examined for compliance to military specifications. Pouch dimensions, minimum net weight, residual gas, internal pressure and fluorescence dye tests were found to be within the tolerance limits and in compliance with the MIL-P-44073C specifications. (Appendix 4.14).

## 3.11 Demonstration Runs

A documentation/demonstration run (Appendix 4.23) was made on September 26 that completed the STP. Three runs were made by CRAMTD staff personnel who had been trained by T. W. Kutter. The runs were:

**Run #1** No product at 17.7 cycles per minute (6 pouches per cycle for 106 pouches per minute) for five minutes with no vacuum, sealing only.

**Run #2** Eight ounces of corn starch at 17.7 cycles per minute (106 pouches per minute) with the viscosity of gravy for two minutes with vacuum. Also several pouches were filled with water and the acceleration/deceleration rate changed on the AC variable speed drive to show the ability of the machine to fill a low viscosity product without sloshing product on the seal area. The cycle rate was 13.8 per minute for an output of 83 pouches per minute.

**Run #3** Two minutes with product (beef stew) manually filling one pouch per cycle at 17.7 cycles per minute.

The features of the SMART system that monitors all the functions of the machine was also demonstrated during these runs. Typical data sheets for control and management are shown in Appendix 4.23.

## 3.12 Qualification of the Process

As a result of this project a qualification plan has been developed so that a horizontal form/fill/seal machine can be accepted by Natick and an amendment made to the MIL specifications. The amendment would authorize this type of machine as well as the existing machines to produce the MRE pouch.

Pouches will be tested at Rutgers for compliance to the MIL specifications and then shipped to Natick for laboratory, ASTM shipping and field tests.

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# 4.0 Appendix

**4.1 Projected Time & Events and Milestones**
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**4.3 Rationale for Change in Design Strategy**
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**4.13 Technical Working Paper (TWP) 19**
**4.14 Status Report 7/9/91 Package Development**

Appendix 4.1

**Fig. 1 - CRAMTD Short Term Project #8**
**Form/Fill/Seal**
**Projected Time & Events and Milestones**

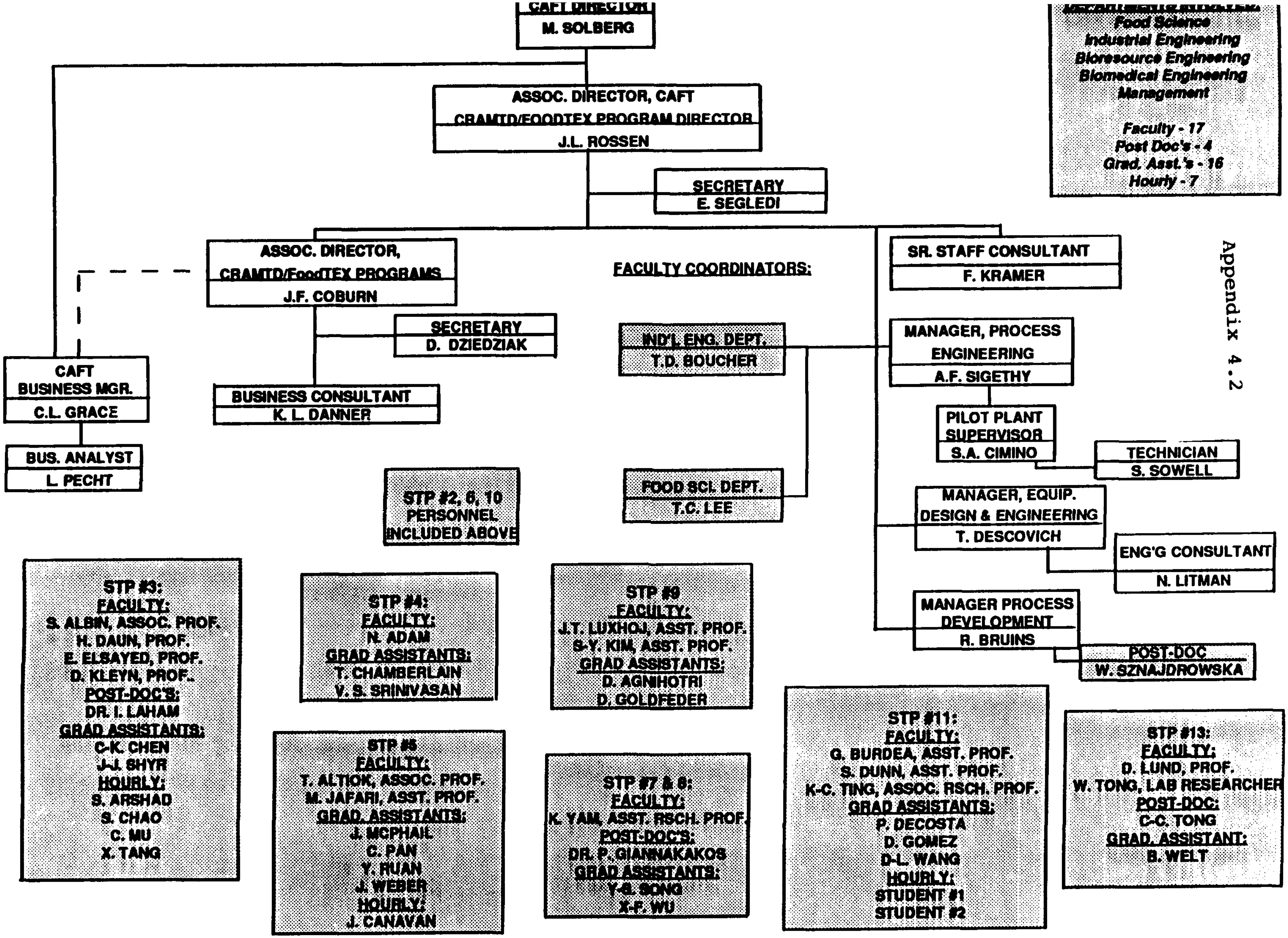
| Phase | Description of Specific Task | Section Ref. # | 1989 | | | 1990 | | | | | | | | | | | | 1991 | | | | | | | | | Cost Allocation $(000) | Actual Cost $(000) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | | |
| I | Foil Laminate/Rheology Tests | 3.3.1.1 | ↑ | | | | | | | | | | | | | | | | | | | | | | ↓ | | 422.2 | 359.7 |
| | Review Current Technology | 3.3.1.2 | ↑ | ↓ | | | | | | | | | | | | | | | | | | | | | | | | |
| | Preliminary Engineering | 3.3.1.3 | ↑ | | ↓ | | | | | | | | | | | | | | | | | | | | | | | |
| | Decision Milestone | 3.3.1.4 | | *1 | | | | | | | | ↓ | | | | | | | | | | | | | | | | |
| | Feasibility Study-Rigid Trays | 3.3.1.5 | | | ↑ | | | | | | | | | | ↓ | | | | | | | | | | | | | |
| | Technical Review | 3.3.1.6 | | | | | | | | ↑ | ↓ | | | | | | | | | | | | | | | | | |
| II | Design/Development Drawings-Monitoring | 3.3.2.1 | | | ↑ | | | | | | | | | | | ↓ | | | | | | | | | | | 529.4 | 337.2 |
| | Decision Milestone | 3.3.2.2 | | | | | | *2 | | | | | ↓ | | | | | | | | | | | | | | | |
| III | Fabrication/Assembly/Monitoring | 3.3.3.1 | | | | | | | | | | | ↑ | | | | ↓ | | | | | | | | | | 53.7 | 54.8 |
| | Testing/Debugging (Vendor) | 3.3.3.2 | | | | | | | | | | | | | | ↑ | | ↓ | | | | | | | | | | |
| IV | Installation (at Site) | 3.3.4.1 | | | | | | | | | | | | | | | | ↑ | | | | | | | ↓ | | 57.7 | 59.5 |
| | Decision Milestone | 3.3.4.2 | | | | | | | | | | | | | | | | | | *3 | | | | | | | | |
| V | Testing/Modifying Pouch Tests & Demonstration Runs | 3.3.5.1 | | | | | | | | | | | | | | | | | ↑ | | | | | | | ↓ | 565.3 | 239.3 |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | 1628.3 | 1050.5 |

Decision Milestone
*1 = Place order for machine
*2 = Start fabrication
*3 = Accept machine

**Legend:**
↑ = start
⇧ = projected start
↓ = completed
⇩ = projected completion

Appendix 4.1

Appendix 4.2




February 1992

CRAMTD / FoodTEX Organization

10/21/89
JLR

App. 4.3

cc Reer

**ɪRM/FILL/SEAL MACHINE:**

**ᴛHANGE IN DESIGN STRATEGY**

· for change in design strategy for
F/F/S packaging machine. This is
similar document prepared by Frank

·, —, —·

New Strategy: Design an intermittent motion (change from continuous motion) horizontal F/F/S machine capable of producing both civilian (all plastic and microwavable) in a variety of sizes and MRE pouches.

Key Points/Background/Justification:

1. Why Horizontal F/F/S rather than Vertical Machine with pre-formed pouches? The horizontal F/F/S machine has definite advantages over the Bartelt or Mitsubishi-type vertical machine. Advantages of and rationale for developing a flexible horizontal F/F/S machine for both MRE and civilian products were addressed earlier on. The advantages are reiterated here.

The horizontal F/F/S machine will overcome some pronounced problems encountered with the vertical machine. These include:

- poor seal integrity due to food contamination of the sealing area of the film

- difficulty in automatically feeding into the vertical pouch

- limited flexibility in terms of package types

- vertical machine has inherently limited speed.

- difficult to incorporate Modified Atmospheric Packaging (MAP) in vertical machine.

So far, the horizontal F/F/S machine has not been used successfully to make MRE pouches, and such a machine capable of producing both MRE and civilian pouches would be an important step forward.

2. MRE Pouch Integrity Problems with Horizontal Machines

Several companies report that attempts to make MRE pouches on an intermittent motion horizontal (IM)-F/F/S machine have resulted in package integrity problems. This is believed to be due to: a) delamination between printed color and the adhesive/foil layer. This is a soluble problem, but one that needs to be solved before a successful horizontal F/F/S process can be demonstrated; b) development of cracks in the foil when the laminated film is stretched. The approach to solving this problem would be use of different Al alloys and/or increased Al film thickness - within Mil Specs.

3. Intermittent Motion vs Continuous Motion

If this problem persists with a standard IM-F/F/S machine it will be more complex with a new continuous motion (CM)-F/F/S unit since some unpredictable problems of new design have a good probability of interacting with the delamination and sealing problems.

Although IM-F/F/S machines are commercial, an experimental IM-F/F/S unit is needed that has sufficient R&D flexibility to define and make necessary operational and design changes to achieve some major innovations. It is projected that the resulting IM-F/F/S Demonstration Unit (after development work is done) would offer small and large producers the following capability:

1. Twice the capacity - at equivalent cost - of a vertical machine that handles pre-formed pouches. Note: A 4-lane 17 cycle IM-F/F/S machine makes 136 pouches/min; a Mitsubishi makes about 60 pouches/min; both cost about $250M.

2. Can produce MRE, civilian, and Institutional size pouches.

3. Can produce in-line formed semi-rigid trays.

4. Possibly, with minimum re-tooling, will be able to fill and seal pre-formed rigid trays.

5. Have variable ramping (controlled deceleration and acceleration to accomodate filling and sealing)

6. would allow use of M.A.P. (modified atmos. packaging)

7. Computer control and diagnostics and capable of being integrated into continuous process for Phase 2.

A comparison of projected capabilities of IM-F/F/S and CM-F/F/S Demonstration Units is shown below:

COMPARISON OF IM-F/F/S AND CM-F/F/S MACHINES

| Attributes | IM-F/F/S | CM-F/F/S |
|---|---|---|
| 1. High speed | 34/min/lane | 120/min/lane |
| 2. Cost/Delivery Time | ?<br>6 mos. | > $600K<br>1 yr. |
| 3. Ablility to make MRE, inst'l and civilian pouches | YES<br>(see note below) | YES |

Note: However, solving the MRE pouch seal/delamination problem will be more difficult and time consuming with the Cont.-F/F/S route.

| | | |
|---|---|---|
| 4. Produce in-line rigid and semi-rigid trays with flat sealing area | YES | YES |
| 5. F/S capability for pre-formed rigid trays with complex shaped sealing area with minimum retooling | YES<br>(lower rate) | NO |
| 6. Minimized sloshing | GOOD | VERY GOOD |
| 7. Start-up snd Shut-down | OK | CONCERNS |
| 8. Use of MAP | YES | YES |
| 9. Computer control and Diagnostics | YES | YES |

After reviewing the above and other considerations, the following advantages accrue in going with the IM-F/F/S route as compared with the CM-F/F/S route:

- allows diversion of more funding to research activity

- much better chance of solving MRE pouch problem and in less time.

- More acceptable to small and large producers of combat rations and civilian products because of price and flexibility.

- Automatic ingredient feeding of particulates will be no more difficult with IH than with continuous.

- Shorter delivery time helps CRAMTD's contract obligations and credibility.

- Shake-down time will be considerably less for IM than for continuous unit.

- Lower linear velocity permits easier introduction of new recipes requiring hand placement initially.

- Greater value as a demonstration unit for both FoodTEX and CRAMTD - because it is more flexible and lower linear velocity.

The State University of New Jersey
RUTGERS

Cook College - Center for Advanced Food Technology

CRAMTD Program

# Specifications

for

# INTERMITTENT MOTION HORIZONTAL FORM-FILL-SEAL POUCH MACHINE

This specification covers the requirements for an intermittent motion (I.M.) form-fill-seal pouch machine that will be used for the CRAMTD Program as well as future civilian applications. The following areas are covered in this specification.

1. Basis for Proposal Reply
2. Performance Requirements
3. Product Information
4. Packaging Information
5. Design Requirements
   - 5.1 Mechanical
   - 5.2 Electrical
6. General
7. Acceptance
8. Shipping and Installation

## 1.0 BASIS FOR PROPOSAL

1.1 You are requested to supply a proposal for a Prototype Horizontal I.M. Form-Fill-Seal Pouch Machine per these specifications.

1.2 The machine will be used for the CRAMTD program demonstratio site and for research and development of new packaging methods and materials.

1.3 Copies of your proposal should be sent to the following:

**Rutgers — The State University of New Jersey**
**University Procurement & Contracting**
**Admin. Services Annex Bldg./Rm. 101**
**Davidson Road/Busch Campus**
**P.O. Box 6999**
**Piscataway, NJ 08855-6999**

## 2.0 PERFORMANCE REQUIREMENTS

### 2.1 Operational Duty

2.1.1 This equipment must be designed to operate under a continuous duty of 365 days per year in a three shift operation with a minimum mechanical efficiency of 99.5%.

2.1.2 This equipment must operate in a typical washdown area in a food processing plant and must withstand the use of detergent cleaning compounds.

2.1.3 Cleaning time will be provided daily as required by regulatory agencies, ie. FDA, USDA. Where regulations don't exist, cleaning time will be provided at least once per day.

2.1.4 The machine must be guaranteed to meet all specifications for 1 year.

### 2.2 Thruput Speed

The guaranteed production rate shall be 100 retort pouches per minute with minimum cycle rates of 2 per minute and a maximum rate of 25 cycles per minute.

### 2.3 Pouch (Formability, Seals & Size Changeover)

2.3.1 The machine must be designed to allow changeovers from one size pouch to another. The two specific outside pouch dimensions are as follows:

4 3/4" x 8 1/8" x 5/8" deep (3/8" seals)
[redacted] x 2" deep (3/8" seals)
10" x 12"

2.3.2 The machine must be able to form thermoprocessed fil[l] and the pouch must pass all quality assurance tests for retorting, per MIL Specification #P-44073B.

2.3.3 The machine sealing station must produce seals to pass all standard tests for retort pouches (internal burst, tensile, etc.). The seals must withstand normal retort conditions (Time/Temperature) and pass MIL Specification #P-44073B

3.0 FOOD PRODUCT INFORMATION

3.1 Although the specifications for this machine do not require the supply of filling machines, it is intended that the filling area of the machine will be used for the following types of products:

3.1.1 Sauces with meat, poultry, seafood and/or vegetables.

3.1.2 Sauces

3.1.3 Meats

3.1.4 Vegetables

3.1.5 Fruits

3.1.6 Soups

3.1.7 Bakery Items, such as crackers, meal, etc.

4.0 PACKAGE INFORMATION

4.1 The retort pouch packages shall be formed from a flexible film foil laminate that has been evaluated and developed to mee[t] MIL Specification #P-44073B for M.R.E. pouches.

4.2 With special tooling and change parts the machine shall be able to produce semi-rigid and rigid trays and have the potenti[al] to run preformed rigid trays.

4.3 The machine shall be able to produce pouches from a variet[y] of pouch stock material, non-retortable, as well as retortable.

4.4 The machine shall have the ability to form a variety of sizes, types and shapes of packages.

4.5 The machine shall be adaptable for use of research and development of improved packages, e.g. - microwaveable and acceptable to the military.

## 5.0 DESIGN REQUIREMENTS

### 5.1 Mechanical

5.1.1 The machine construction will be designed to meet all USDA regulations.

5.1.2 The machine will be of an indexing motion type with smooth acceleration and deceleration and ability to advance rate of acceleration/deceleration from 10% to 100% in 1% increments.

5.1.3 The machine will be modular in construction so that components can be added as needed.

5.1.4 The machine will be provided with a sealing station, evacuation chamber, gas flush system and additional features to improve seal reliability.

5.1.5 The working height of the machine shall be 36" +/- 3" to the top of the sealing area.

5.1.6 Machine safety guarding, electrical installation and other applicable OSHA requirements shall be fully met.

5.1.7 Machine shall be equipped with pressure-form, thermoform, plug-assist hardware and able to pressure form and thermoform packages with or without plug-assist.

5.1.8 The machine shall provide for 15' of product filling area clear of any obstructions on both sides of the machine. Capability will be provided to increase this area if required in the future.

5.1.9 A top and bottom web feed system shall be provided.

### 5.2 Electrical

5.2.1 All electrical wiring, connections, control boxes and components shall conform to NEMA 4 standards.

5.2.2 The drive system shall be of a solid state variable speed type. Digital speed indication will be provided at the primary operator station.

5.2.3 The machine is to be supplied with an advanced state-of-the-art microprocessor to control all functions and provide diagnostic capabilities for both production and research and development activities.

5.2.4 Provision will incorporate control for synchronization of filling equipment so that if there is no pouch or tray in position under the filling nozzles there will be no fill.

5.2.5 The machine functions that are controlled by a microprocessor shall be capable of being upgraded to communicate with external process controls.

## 6.0 GENERAL

6.1 A layout drawing of this machine shall be provided in both plan and elevation views showing special features.

6.2 A project engineering and delivery schedule shall be provided indicating the following milestones of the project.

6.2.1 Duration of engineering design.

6.2.2 Fabrication start and completion.

6.2.3 Start and completion of testing.

6.2.4 Date and definition of specific information that is required from Rutgers, CAFT/CRAMTD.

## 7.0 ACCEPTANCE

The machine shall be given an acceptance test with no product in a production mode for 1 hour at 80% of maximum speed producing pouches at the minimum efficiencies of 99.5%.

## 8.0 SHIPPING AND INSTALLATION

8.1 The machine to be shipped F.O.B., Rutgers University Food Science Building, CAFT, Cook College, New Brunswick, NJ 08903.

8.2 Supervision of installation and a minimum of three days training at Rutgers facility will be provided by supplier.

REQUEST FOR QUOTATION
THIS IS NOT AN ORDER

RUTGERS—THE STATE UNIVERSITY OF NEW JERSEY
UNIVERSITY PROCUREMENT AND CONTRACTING
P.O. BOX 6999
PISCATAWAY, NJ 08855-6999

THE RFQ NUMBER MUST APPEAR ON ALL CORRESPONDENCE REGARDING THIS QUOTATION

**R.F.Q.** 0-2-7-1

1. ... SIGNED QUOTATION IN A SEALED ENVELOPE. SHOW ... ON OUTSIDE OF ENVELOPE.
2. IN EVENT OF THIS BID BEING ACCEPTED, A PURCHASE ORDER WILL BE SENT.
3. SEE REVERSE SIDE FOR TERMS & CONDITIONS.
4. ANY EXPENSE INCURRED BY THE BIDDER IN CONNECTION WITH THIS QUOTATION IS THE SOLE RESPONSIBILITY OF THE BIDDER.
5. IF QUOTE IS NOT F.O.B. DESTINATION, YOU MUST SHOW COST OF FREIGHT AS A SEPARATE ITEM.

T.W. KUTTER
ATTN: ALAN MAIS JR.
91 WALES AVE.
AVON, MA 02322

Appendix 4.5

| DATE | THIS BID WILL BE OPENED: | | BY |
|---|---|---|---|
| 2/7/90 | SEALED PROPOSAL DUE FEB. 23, 1990 | TIME: 2:00 PM | DIRECTOR OF PURCHASES GEORGE THORN, JR. |

PLEASE QUOTE THE FOLLOWING F.O.B. DESTINATION

RUTGERS-THE STATE UNIVERSITY OF N.J., requests proposals for the supply and installation of an Intermittent Motion Horizontal Form-Fill-Seal Pouch Machine, in accordance with the attached specifications and the following notes:

A. MANDATORY PRE-BID CONFERENCE
IT IS MANDATORY THAT ALL PROSPECTIVE VENDORS ATTEND THIS PRE-BID CONFERENCE IN ORDER TO CLARIFY ANY SPECIFICATIONS/DETAILS AND ACQUAINT THEMSELVES WITH THE PROPOSAL TO BE SUBMITTED. EACH VENDOR MUST SIGN THE REGISTER TO VERIFY HIS/HER ATTENDANCE. FAILURE TO ATTEND THIS PRE-BID CONFERENCE WILL RESULT IN DISQUALIFICATION OF YOUR PROPOSAL.

The Pre-Bid Conference will be held:
DATE: February 16, 1990
TIME: 1:30 PM
LOCATION: Rutgers University Food Science Bldg, C.A.F.T., Cook College, corner of College Farm & Dudley Roads, Conference Rm # 120A, New Brunswick, N.J. 08903

B. Technical questions pertaining to specifications are directed to Mr. Theodore Descovich at (201) 932-8307. Questions pertaining to proposal procedures are directed to Mr. Michael Dunn at (201) 932-5070.

C. The following areas must be addressed in detail with each proposal and will be considered in the evaluation of this proposal. Delivery, Production Rate, Engineering Features, Cost, Service, Training.

D. Prices are to be F.O.B., Rutgers University Food Science Bldg, CAFT, Cook College, New Brunswick, N.J. 08903.

E. A certificate of compliance in regards to MIL-Spec P-44073B must be included with the delivery of the unit.

| | |
|---|---|
| COST OF MACHINE & INSTALLATION | $ 199,990.00 *aam* |
| ENGINEERING COSTS | $ 0.00 |
| TRAINING COSTS | $ 0.00 |
| TOTAL | $ 199,990.00 *aam* |

DELIVERY & INSTALLATION 16-20 Wks. days ARO

**************************************************************************************

1. Please note additional Terms & Conditions on reverse side of this sheet.
2. It is the bidders responsibility to see that their proposal arrives at the University Procurement & Contracting Office before the proposal opening date and time.

REFER ALL QUESTIONS REGARDING THIS REQUEST TO: DUNN/M/932-5070

NOTE: SHOW ALL TAXES AS SEPARATE ITEM

GRAND TOTAL →

THIS SPACE TO BE FILLED IN BY BIDDER

PAYMENT CAN BE MADE IN ______ DAYS FROM RECEIPT OF ORDER

FOB

TERMS

We quote you as above subject to the terms and Conditions on the reverse.

SIGNATURE: *[signature]*

PRINT NAME AND TITLE: Alan A. Mais, Jr./Sr. Applic. Spec.
PHONE NUMBER: 508-588-2600



S-002 Rev 6/88

REQUEST FOR QUOTATION
THIS IS NOT AN ORDER

RUTGERS — THE STATE UNIVERSITY OF NEW JERSEY
UNIVERSITY PROCUREMENT AND CONTRACTING
P.O. BOX 6999
PISCATAWAY, NJ 08855-6999

THE RFQ NUMBER MUST APPEAR ON ALL CORRESPONDENCE REGARDING THIS QUOTATION

R.F.Q. 0-2-7-1

1. [illegible] SIGNED QUOTATION IN A SEALED ENVELOPE. SHOW [illegible] ON OUTSIDE OF ENVELOPE.
2. IN EVENT OF THIS BID BEING ACCEPTED, A PURCHASE ORDER WILL BE SENT.
3. SEE REVERSE SIDE FOR TERMS & CONDITIONS.
4. ANY EXPENSE INCURRED BY THE BIDDER IN CONNECTION WITH THIS QUOTATION IS THE SOLE RESPONSIBILITY OF THE BIDDER.
5. IF QUOTE IS NOT F.O.B. DESTINATION, YOU MUST SHOW COST OF FREIGHT AS A SEPARATE ITEM.

T.W. KUTTER
ATTN: ALAN MAIS JR.
91 WALES AVE.
AVON, MA 02322

| DATE | THIS BID WILL BE OPENED: | | BY |
|---|---|---|---|
| 2/7/90 | SEALED PROPOSAL DUE FEB. 23, 1990 | TIME: 2:00 PM | GEORGE THORN, JR. DIRECTOR OF PURCHASES |

PLEASE QUOTE THE FOLLOWING F.O.B. DESTINATION

3. Proposals delivered in person or by express service should be to our actual location. This location is: RUTGERS -THE STATE UNIVERSITY of New Jersey
University Procurement & Contracting
Administrative Services Annex Building/Room 101,
Davidson Road/Busch Campus
PO Box 6999
Piscataway, NJ 08855-6999

4. All cash discount terms will be acceptable, however, terms less than 3%-30 days will not be considered in the proposal award.

5. Proposals should be returned in the enclosed Yellow Envelope or attach the Yellow envelope to the outside of a large envelope, if necessary. Telegraphic and facsimile proposals are not acceptable. Bidders must submit sealed proposals only. Any communication such as (facsimile transmittal) which reveals the contents of a sealed proposal will result in disqualification of entire proposal.

6. Proposal documents submitted with price alterations ie. whiteouts, crossouts, erasures etc. must be initialed otherwise proposal will be rejected. (See number 17, terms & conditions)

7. ATTENTION BIDDERS
THIS ORIGINAL (LEGAL SIZE SHEET) REQUEST FOR PROPOSAL FORM "MUST" BE SIGNED AT THE BOTTOM AND RETURNED WITH PROPOSAL SHEET(S). YOUR ENTIRE PROPOSAL SUBMITTAL WILL BE REJECTED AND DISQUALIFIED IF THIS FORM IS "NOT" SIGNED AND RETURNED ON OR BEFORE THE PROPOSAL DUE DATE AND TIME.
FURTHERMORE BIDDERS WHO WISH TO REMAIN ON OUR "QUALIFIED" BIDDERS LIST SHOULD ALSO SIGN AND RETURN THIS PROPOSAL FORM INDICATING A REASON FOR NOT SUBMITTING A PROPOSAL.

8. Any addendums to this Request for Proposal must be acknowledged. Failure to comply will result in rejection of proposal. Please sign below for each addendum received.
ADDENDUM: #1 [signature] (Signature)
#2 [signature] (Signature)
#3 ______ (Signature)

9. Bidders must comply with all proposal enclosures and must return certain enclosures with proposal form. Failure to comply will result in rejection of proposal. They are:
(1) Affidavit
(2) Bid Security
(3) Non-Collusion Statement NCS-1

A. Requirement to be provided by successful bidder after proposal award is made.
(1) Performance Bond within ten (10) days after award
(2) Insurance, after award and prior to start of work
(3) PL 1975 C.127 within seven (7) days after receipt of purchase order
Note: Bidders are required to comply with the requirements of PL 1975 C.127.
(4) PL 1977 C.33 within seven (7) days after receipt of purchase order

B. Supplemental Terms & Conditions, form STC-1 is a notice of requirement for compliance by bidder to whom an award is made and is to be retained by bidder.
Additional enclosures are: Did You Sheet/Specifications/Map

| REFER ALL QUESTIONS REGARDING THIS REQUEST TO: | NOTE: SHOW ALL TAXES AS SEPARATE ITEM | GRAND TOTAL |
|---|---|---|
| [illegible] DUNN/M/932-5070 | Not to be collected by T W Kutter in NJ | $199,990.00 |

THIS SPACE TO BE FILLED IN BY BIDDER

SHIPMENT CAN BE MADE IN ______ DAYS FROM RECEIPT OF ORDER

FOB

TERMS

"We quote you as above subject to the Terms and Conditions on the reverse"

SIGNATURE: [signature]

PRINT NAME AND TITLE: Alan A. Mais, Jr. Sr. Application Specialist

PHONE NUMBER: 508-588-2600



5-009 Rev 8/88

**RUTGERS-THE STATE UNIVERSITY OF N.J.**
**UNIVERSITY PROCUREMENT & CONTRACTING**
**PROPOSAL SHEET**
**RFP #0-2-7-1**

COMPANY NAME T W KUTTER, INC.

SIGNATURE ____________

| | |
|---|---|
| Cost of Machine and Installation | $ 199,990.00 |
| Engineering Costs | $ N/C |
| Training Costs | $ N/C |
| Total | $ 199,990.00 |

OPTIONS

| | | |
|---|---|---|
| 1. | Mound Detector | $ 375.00 |
| 2. | Loading Grid/Spill Covers | $ 3,460.00 |
| 3. | Vacuum Pump | $ 13,660.00 |
| 4. | Vibrating Unit | $ 7,450.00 |
| 5. | Outfeed Conveyor (approx. 2') | $ 4,325.00 |
| 6. | Trim Removal System | $ 2,665.00 |
| 7. | Tear Notch - "C" Notch | $ 4,950.00 |
| 8. | Ink Code Dating | $ 10,233.00 |
| 9. | Microprocessor Controller (PLC) | $ 12,690.00 |
| 10. | Spare Parts (recommended) | $ 5,173.89 |
| 11. | Complete set of tooling | $ 35,800.00 |

THE STATE UNIVERSITY OF NEW JERSEY
RUTGERS

UNIVERSITY PROCUREMENT AND CONTRACTING · P.O.BOX 6999 · PISCATAWAY, NEW JERSEY 08855-6999 · (201)932-3000

February 16, 1990

LETTER SENT TO: MULTI-VAC: MAHAFFY AND HARDER: T. W. KUTTER

SUBJECT: Addendum #1 to RFP #0-2-7-1
Intermittent Motion Horizontal Form-Fill-Seal Pouch Machine

Dear Sir:

The information contained herein revises, supplements and/or supercedes the specific parts of the documents referred to as Request for Proposal Number 0-2-7-1. Except as herein modified, all other provisions of the proposal request shall remain in full force as originally set forth.

The date of the mandatory pre-bid meeting is hereby rescheduled for February 20, 1990. The time and place remain the same.

Sincerely,

Michael Dunn
Buyer

c: T. Descovich/CAFT-Cook College
G. Thorn, Jr.

THE STATE UNIVERSITY OF NEW JERSEY
RUTGERS

UNIVERSITY PROCUREMENT AND CONTRACTING · P.O. BOX 6999 · PISCATAWAY · NEW JERSEY 08855-6999
201/932-3000 · FAX: 201/932-4712

February 22, 1990

LETTER SENT TO: MULTI-VAC: MAHAFFY AND HARDER: T. W. KUTTER

SUBJECT: Addendum #2 to RFP #0-2-7-1
Intermittent Motion Horizontal Form-Fill-Seal Pouch Machine

Gentlemen:

The information contained herein revises, supplements and/or supercedes the specific parts of the documents referred to as Request for Proposal number 0-2-7-1. Except as herein modified, all other provisions of the proposal request shall remain in full force as originally set forth.

1. The date of the proposal opening is hereby changed to March 9, 1990. The time and place of the opening remain the same.

2. The requirements for a Proposal Security and Performance Bond are hereby waived.

3. The requirement for a certificate of compliance is hereby waived.

4. Delete section 2.1.1 of the proposal specifications.

5. Section 6 of the proposal specifications is to be supplied by the successful contractor.

6. Contractors are to use the attached proposal sheet when submitting prices with your proposal. Included are options that will be considered in the evaluation process.

7. Section 4.2 of the proposal specifications is not mandatory and will not be weighed heavily in the evaluation process.

8. M.R.E. pouch to be round corner in accordance to MIL-SPEC P-44073B.

9. The PLC must be able to interface with an Allen Bradley Data Highway System. List any other manufacturers that would be compatable with your proposed system. The size of the PLC is left to the discretion of the designer.

10. All addendums received must be acknowledged by signing page 2, Section 8 of the proposal document.

Sincerely,

Michael Dunn

Michael Dunn
Buyer

encl. Proposal Sheet

c: T. Descovich/CAFT/Cook College
G. Thorn, Jr.

# A PROPOSAL FOR RUTGERS UNIVERSITY FOR PACKAGING

## CRAMTD

TW KUTTER INC
91 Wales Ave., P.O. Box 7, Avon, MA 02322 (508) 588-2600

March 7, 1990

Mr. Ted Descovich
**RUTGERS UNIVERSITY**
Cook College
C. C. A. F. T.
P.O. Box 231
New Brunswick, NJ 08903

Dear Mr. Descovich:

The Allen-Bradley PLC 2/17 is the control system that Kutter has used as a replacement more than 100 times. Kutter's name for this family of controls is "SMART System". There are three (3) systems built using the Allen-Bradley: SMART 1000, SMART 3600 and SMART 5600.

The SMART 3600 and 5600 are of value to you in this retort type of packaging, because they have the capability of monitoring all of the packaging parameters through sensors that look at seal temperature, seal pressure and seal time.

The system will see that one of the sealing parameters have changed beyond the known safe value, either alert the operator, stop the machine or just make a record of the event, depending on how far out the tolerance is.

The SMART 3600 and 5600 will also do this monitoring for all other packaging functions including forming parameters.

During a material evaluation it would keep very accurate documentation automatically of all packaging events and provide printouts for comparisons. More detailed information is attached for your information. (See Smart System Functionality.)

The patented High-Ŝpeed Evacuation Nozzel System eliminates the possibility of product coming in contact with the hot seal frame. A likely occurrence when running hot fluid products due to the need to remove the air very quickly in order to attain the 100+ packages per minute. This high-air movement plus the possibility of the vacuum level going below the vaporization point of the hot gravey and causing it to boil onto seals, make this a must for a trouble-free operation. (See Drawing #4.)

We have a system using an infra-red temperature sensor that senses the temperature of the product (in real time) and send it to the control system. It then evaluates it in relation to a standard pressure/vaporization chart and controls the vacuum level automatically for that particular temperature. (See Drawing #5.)

This was not called for in the RFQ. I feel that it is an absolute necessity in retort packaging, whether it be in flexible films (CRAMTD) or sterilization of rigid polypropylene trays. I have included the costs for the additional hardware for your information.

The type of forming system that you need to form without heat the retort grade of aluminum lamination consists of high-air pressure forming. The expansion of the aluminum, as compared to the plastic components in the lamination, will cause delamination when heat is applied.

This is not called for on your RFQ, but our experience has shown that this type of operation cannot be successful without having a complete seal maks with a crowned sealing surface. (See Drawing #1.)

This will reduce the finish seal to about 1/8". This is different than what you request in the RFQ, but it will pass the test mentioned in the MIL-P-44073B.

Your future projects of thermoforming rigid polypropylene do require heating. I have included the costs for the additional hardware for your information. Regarding the possibility to convert this machine to run a preform tray, we see no major problems providing this option.

The price for the Coder shown on the "Proposal Sheet" is for a BellMark Three-Stop Ink Code Dating System. It is a contact coder system using base-lock type.

For a non-contact coder, we have worked with both Vidiojet and Control Print in the past. Their prices to code (as shown in Drawing #2) are:

| | |
|---|---|
| Vidiojet | $28,305.00 |
| Control Print | $16,995.00 |

Due to the modular design of the 3000 Tiromat, it is very easy to add these devices in the future in your facility. I have included a section describing the Tiromat Modular Design System.

Since our last meeting T W Kutter has been purchased by Alfa-Laval. They also own Kramer & Grebe who is the manufacturer of the Tiromat, and a variety of companies which supply machinery to the food industry. A brochure is included for you.

This will give Kutter and our customers access to the research & development information they have for food processing, i.e. Aceptics, Microwave Pasteurization, Filling, etc.

Kutter also has an Automated Systems Division which many times compliments our food packaging group by providing automation and turnkey production lines. This may be of interest to you when you get to phase two. (See Section VII.)

We currently have a system in our facility in Avon that is a fully automated line for packaging syringes. Our Systems and Automation Division integrated all of the hardware and developed all the software in house. You or any of your colleagues are welcome to see it in operation while it is here. (A video is enclosed.)

Sincerely yours,

Alan A. Mais, Jr.
Sr. Application Specialist

AAM:jcd
Enclosures

C: Jim Ryan
Steve Tennis
Dave Andronico

T W Kutter, Inc. 91 Wales Avenue, P.O. Box 7, Avon, Massachusetts 02322

March 6, 1990


RUTGERS UNIVERSITY

## AUTOVAC TIROMAT 3000/440

**Maximum Package Size: 31.5" L x 15.8" W x 3.1" D**

**Standard Equipment Consists Of:**

- Stainless Steel Cladding
- Patented Wide Tolerance Film Infeed System (U.S. Patent #3,738,556)
- Patented 5/8" Tongue and Groove Clip Chain, nickel-plated to prevent rusting
- Plated to Prevent Rusting
- Loading area of 1850 mm
- Safety covers for all operating devices
- Visual display indicating all covers are in place, support rail up to four (4) tracks
- Quad Air Cylinder Drive for sealing pressure for polypropylene
- Exit Conveyor 750 mm long, easily adjustable through the full depth of the machine
- Vacuum Trim Removal System and Suction Tube for edge trim
- AC Drive Motor, with encoder for digital index length control
- Six-inch Expandable Mandrel System for forming
- Six-inch Expandable Mandrel System for non-forming

**BASE MACHINE PRICE:** **$90,400.00** √

RUTGERS UNIVERSITY

| QUANTITY | DESCRIPTION | PRICE |
|---|---|---|
| 1 | Tiromat Formset Number 348-1.1 Divided to 104-2.3 to package Beef Cube in Gravey using retort grade aluminum polypropylene material | |

Includes:

Maximum Draw Depth 80mm
Forming Mold 104-2.3 cooled, dividable to 104-2.3
Deep Draw Lid (without heating plate) Format 104-2.3
Sealing Form, Format 104-2.3 (without seal support frame)
Seal Support Frame, Format 104-2.3 with insert for package support
Profiled Seal Plate, Format 104-2.3
Seal Chamber Lid for Format 104-2.3
Product Support Rails

**TOTAL FORMSET:** **$29,950.00** ✓

| | | |
|---|---|---|
| Pocket Size: | 104.6 x 188 | |
| Package Size: | 121.6 x 205 | (4.78" x 8.07") |
| Number of Pockets: | 6 | |
| Depth of Draw: | 25 | |
| Cut-Off: | 365 | |

RUTGERS UNIVERSITY

## ADDITIONAL HARDWARE

| QUANTITY | DESCRIPTION | PRICE |
|---|---|---|
| 1 | Allen-Bradley Variable Speed 1333 Drive with ramping for use with fluid products | $3,400.00 |
| 1 | Allen-Bradley PLC-2/17 PLC Controls Enables machine functions to be finely tuned to establish optimal time relationships. Provides digital diagnostic on-site trouble-shooting. Full documentation and service provided by Kutter or Allen-Bradley | 12,690.00 |
| 1 | Busch RA-400 Vacuum Pump | 13,660.00 |
| 1 | Infra-red Temperature Sensing System to sense the product temperature and automatically set the maximum vacuum level attainable in the packages | 15,000.00 |
| 1 | Vibrating Station in the loading area to settle the meat cubes | 7,450.00 |
| 3 | KG-87 Cross Punch for round corners & "C" style tear notch | 55,875.00 |
| 1 | Loading Area Extension to 15' | 9,235.00 |
| 1 | High-speed Nozzle Evacuation System with moisture trap to protect vacuum valves and the seal plate from contamination by the product | 4,275.00 |
| 1 | Set Loading Grid/Spill Cover for seal protection with lifting | 3,460.00 |
| 1 | High Product/Mound Detector | 375.00 |
| | **TOTAL ADDITIONAL HARDWARE** | **$125,420.00** |

RUTGERS UNIVERSITY

**OPTIONAL FOR THERMOFORMING** (Up to 50 mm polypropylene at 10 cpm)

| | | |
|---|---|---|
| 1 | Uniform System with compressed air assist | $8,850.00 ✓ |
| 2 | Sandwich Preheat Assembly for top and bottom preheating for use in forming 50 mm polypropylene films into rigid trays for auto cleaving | 19,700.00 |
| 4 | Sandwich Preheat Plates | 7,000.00 |

**TOTAL OPTIONAL HARDWARE $35,550.00**

## TOTALS PAGE

| | |
|---|---|
| TOTAL PAGE 1 | $90,400.00 |
| TOTAL PAGE 2 | 29,950.00 |
| TOTAL PAGE 3 | 125,420.00 |
| TOTAL MACHINE PRICE | $245,770.00 |
| LESS DISCOUNT FOR TEACHING INSTITUTE | -45,780.00 |
| **TOTAL COST** | **$199,990.00** |
| TOTAL PAGE 4 (OPTIONS) | $35,550.00 |

## PRODUCTION RATE

Packages per Minute: 102

## UTILITIES REQUIRED

| | | |
|---|---|---|
| 1. | Electrical | 220 Volts, 3 Phase, 60 Cycle, 35 amps |
| 2. | Compressed Air | 100 PSI @ 50 CFM Dry Air |
| 3. | Water | 45 Liters per Hour/12 Gallons per Hour |
| 4. | Vacuum Pump | Requires separate three-phase connection |

## FILM DIMENSIONS

| | |
|---|---|
| Forming Web | 440mm +2mm -0mm |
| Non-forming Web | 430mm +2mm -0mm |
| Core Size | 6" (3" on request) |
| Roll Size | 19" O.D. sealant wound in |

## TERMS

The terms of purchase for equipment as quoted are 30% down payment with the order, 60% payment upon delivery of the equipment to your plant and prior to the installation, and 10% balance due 30 days after delivery of the equipment to your plant, or 3% - 30 days.

## DELIVERY

Approximate shipping date of equipment quoted is 16 to 20 weeks from the date of receipt of order, receipt of down payment and finalization of all technical details including die specifications.

**NOTE:** Prices quoted are valid for a period of thirty (30) days from the above date. All prices are F.O.B. Piscataway, NJ, unless otherwise specified.

## RECOMMENDED SPARE PARTS FOR TIROMAT 3000/440

| Quantity | Part # | Description | Unit Price |
|---|---|---|---|
| 1 | VPM-571203 | Magnetic Safety Switch | $46.36 |
| 1 | VPM-571204 | Magnet | 15.90 |
| 1 | VPM-323242 | Solid State Relay | 70.40 |
| 1 | VPM-X321-60S3 | Solid State Relay | 30.73 |
| 1 | VPM-X383-1 | Thermosensing Element | 139.68 |
| 1 | VPM-322034 | Temp Controller | 509.44 |
| 1 | VPM-526000 | Wachendorf Counter | 1,484.80 |
| 1 | VPM-700A149 | Brake for Film Mandrel | 54.10 |
| 2 | FST-4527 | 24 Volt Coil for Valves | 68.56 |
| 10 | VPM-210A19D | Mushroom Clamp | 39.50 |
| 10 | VPM-X130-4 | Spring | 1.00 |
| 10 | VPM-408501 | Seeger Ring | 1.50 |
| 2 | 827384 | O' Ring | 1.48 |
| 1 | VPM-523000 | Namur Module | 107.84 |
| 1 | VPM-570021 | Namur Module P&F | 335.40 |
| 1 | FST-12468 | Proximity Switch | 104.80 |
| 1 | KST-12478 | Proximity Switch | 117.25 |
| 1 | VPM-321106 | Emergency Stop Push Button | 107.65 |
| 1 | VPM-SK41 | Silicone Glue | 32.00 |
| 3mt | VPM-X327-14 | 5mm Dia. Silicone String | 12.66 |
| 2mt | VPM-X327-15 | 3mm Dia. Silicone String | 3.84 |
| 1 | VPM-X318-1 | PG9 Fitting | 4.19 |
| 1 | VPM-X354-29 | Socket | 13.60 |
| 1 | VPM-X354-30 | Plug | 12.54 |
| 1mt | VPM-X317-165 | 7 Lead Silicone Cable | 9.38 |
| 50 | VPM-X332-2 | Silicone Bushings | 15.00 |
| 2 | VPM-365076 | O'Ring 53x5 | .44 |
| 2 | VPM-365078 | O'Ring 238x | 66.90 |
| 5 | | Contour Seal Masks for 104-2.3 | 1,133.33 |
| 1 | VPM-X172-25 | Suction Cup | 25.35 |
| 1 | VPM-Gloves | Gloves | 28.83 |
| 1 | VPM-451280 | Hook Spanner | 36.6 |
| 1 | VPM-365004 | O'Ring | 1.58 |
| 1 | 827316 | O'Ring | 1.00 |
| 1 | 827359 | O'Ring | .54 |
| 1 | 827362 | O'Ring | .51 |
| 1 | VPM-X172-013 | Bellow With Needle | 32.00 |
| 2 | VPM-700A145 | Round Knife | 248.20 |
| 1 | VPM-500B62 | Air Bladder | 130.05 |
| 6' | VPM-X156-25 | 1" Vacuum Hose | 42.84 |
| 2mt | VPM-X156-45 | 1 3/4" Vacuum Hose | 41.70 |
| 1 | VPM-323316 | Relay | 44.42 |

**PRICE ON RECOMMENDED SPARE PARTS** **$5,173.89**

# TRAINING

Training consists of five (5) consecutive days in your facility during the installation period.

The Tiromat should be placed and all utilities connected prior to our technician's arrival.

You should plan to be ready to run production the afternoon of the first day. That will give our technician the maximum time to spend with your personnel during the five days.

Additional training includes a three-day school at our Avon facility for two people. This is at no charge. (See KUTTER SCHOOL SCHEDULE.)

## KUTTER SCHOOL SCHEDULE - January — March 1990

(Effective 2/1/90)

| | SCHOOL DATES | COURSE | LOCATION | APPLICABLE NOTES |
|---|---|---|---|---|
| **January 90:** | | | | |
| | 1/ 8 - 11 | TIROMAT-3000 | Chicago, IL | #1, #4 |
| **February 90:** | | | | |
| | ---- | VF-20 | Avon, MA | #3, #4 |
| | 2/ 12 - 15 | TIROMAT-3000 | Avon, MA | #1, #4 |
| **March 90:** | | | | |
| | ---- | VF-20 | Avon, MA | #3, #4 |
| | 3/5 - 7 | VA-TIROMAT | Avon, MA | #2, #4 |
| | 3/ 19 - 21 | HANDTMANN VF-200/300 | Avon, MA | #2, #4 |

.... A VF-20 School is not currently scheduled due to lack of a VF-20 machine in Avon, MA. If a machine suddenly becomes available a training school will be conducted on an unscheduled basis. Students for this school will be selected from a list identifying those companies who have requested schooling for this equipment. Contact Ms. Sandy Vaughn in Avon to place name(s) on this school waiting list.

NOTE #1: Tuition charge of $350.00 per-person.
NOTE #2: Tuition charge of $200.00 per-person.
NOTE #3: Tuition charge of $150.00 per-person.
NOTE #4: Course will be cancelled if less than five (5) students enroll.
NOTE #5: Private School. Not open for general student enrollment.
NOTE #6: A second school may commence immediately upon completion of this school if number of students warrants.

Tuition charge will be waived for up to two (2) individuals providing the training school is for equipment purchased by them or their employer, and has been delivered and installed within six (6) months of school commencement date.

Enrollment of students prior to receipt of equipment covered by course is strongly discouraged. Some exposure to course equipment is strongly advised before enrolling a student into any KUTTER course.

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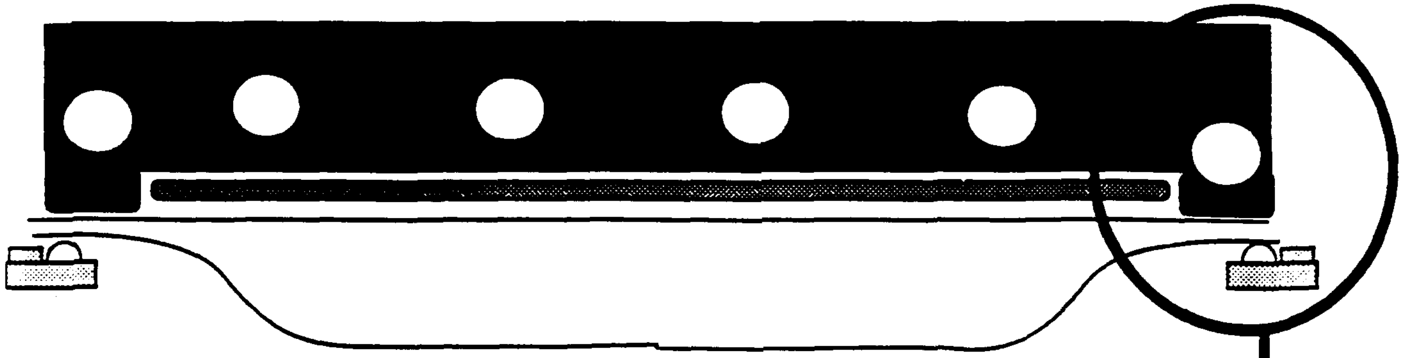
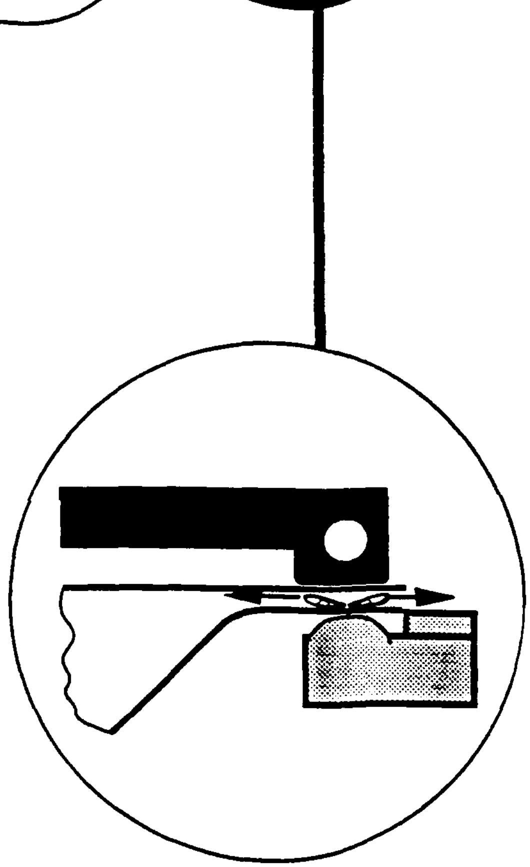
All monetary transactions associated with KUTTER training will be handled via advance Purchase Order prior to scheduled training course commencement date.

KUTTER will provide training materials required for each course free of charge. KUTTER will provide free daily student transportation (via company van) between one (1) selected hotel/motel and schooling site. KUTTER will provide free lunch each school day.

All other expenses will be borne by the student or their employer.

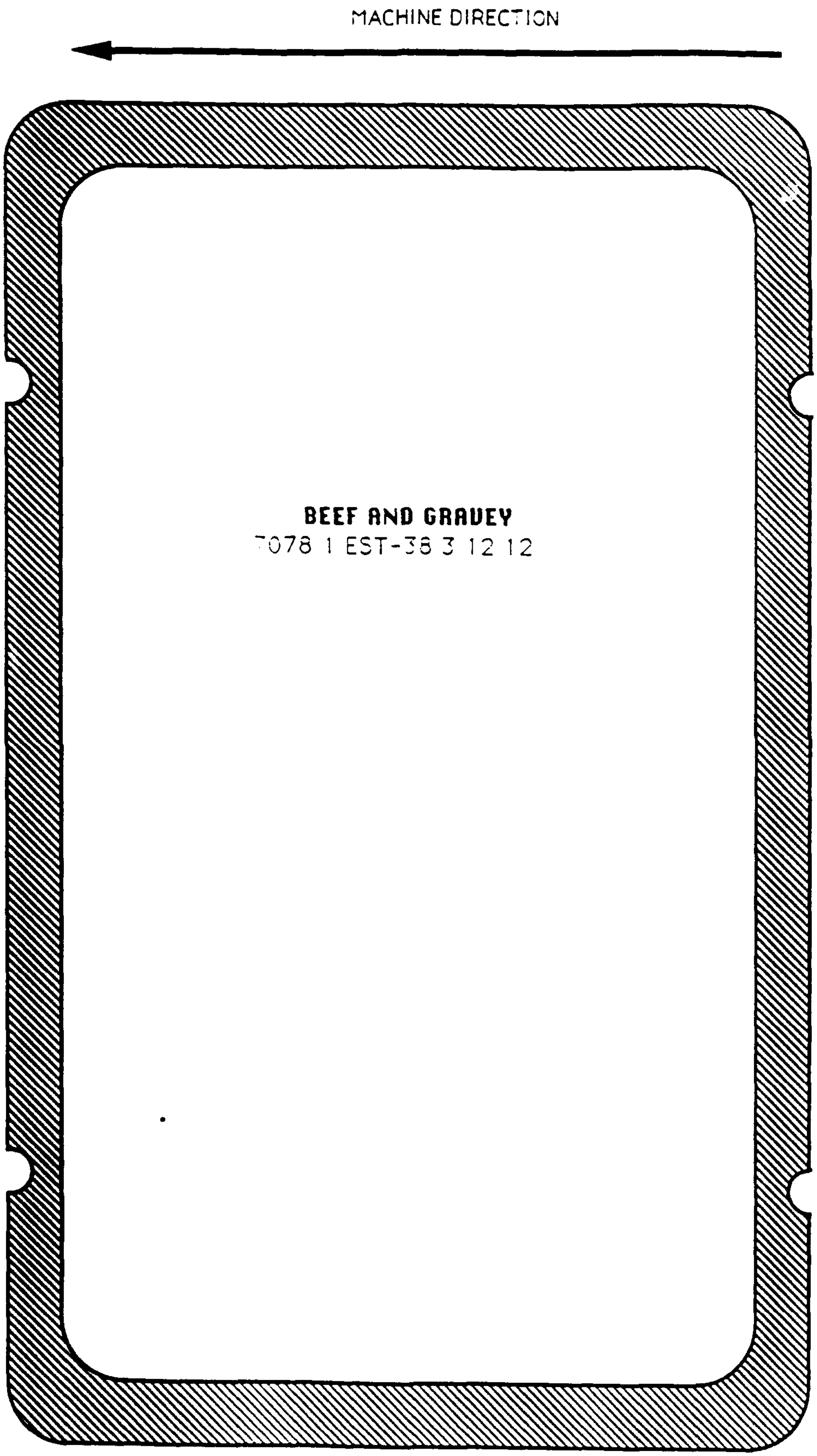
# BEADED SEAL RUBBER





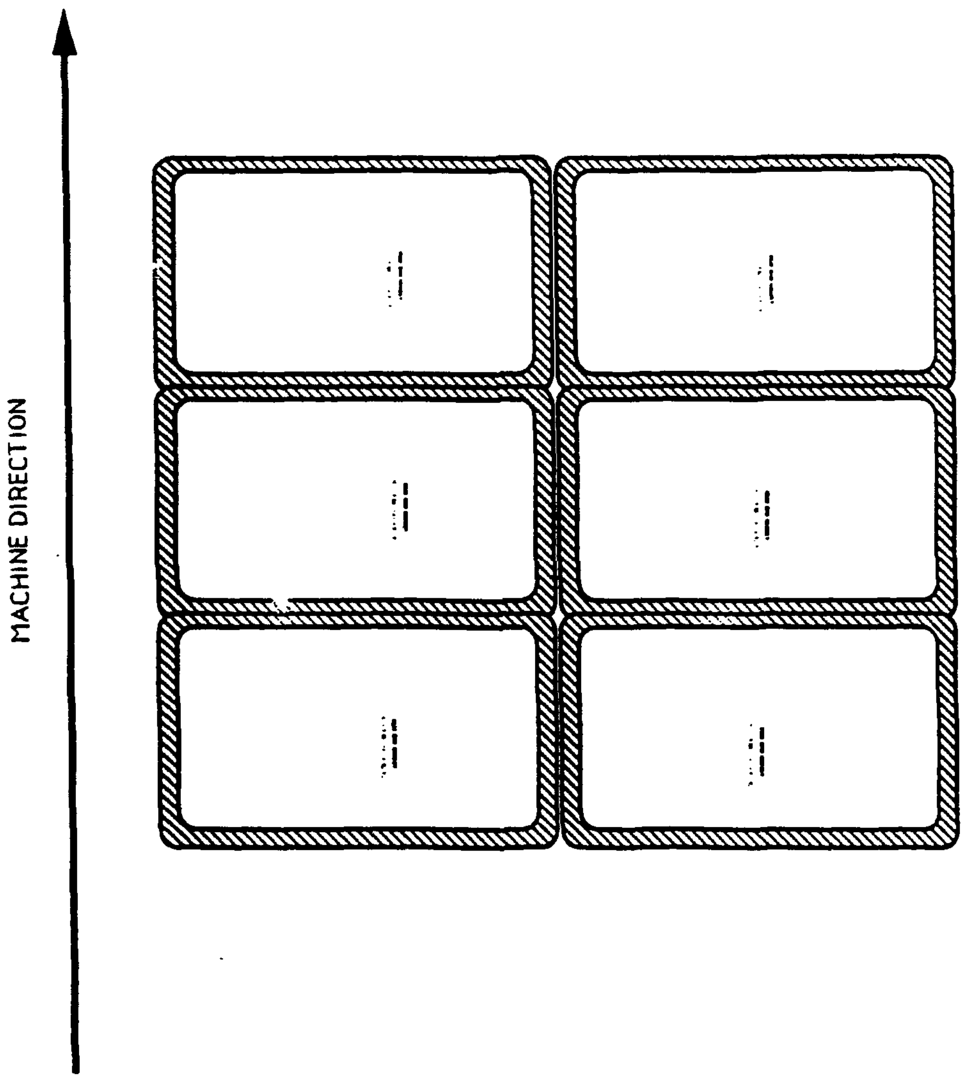
By using a silcone rubber seal mask with a bead when contamination accures it will be pushed out of the way during compression of the bead.

DRAWING ONE



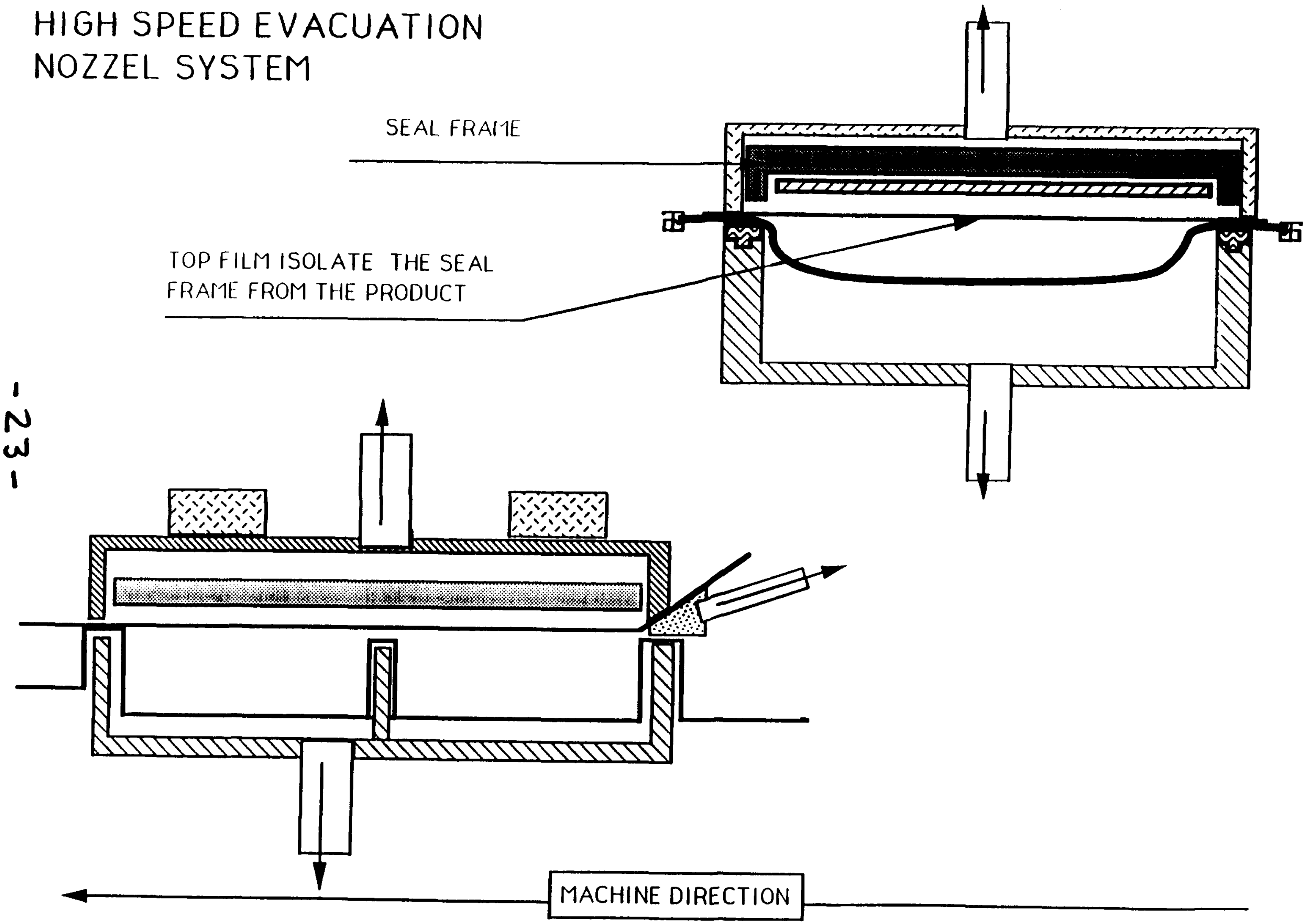

DRAWING TWO

PACKAGE LAYOUT




DRAWING THREE

# HIGH SPEED EVACUATION NOZZEL SYSTEM

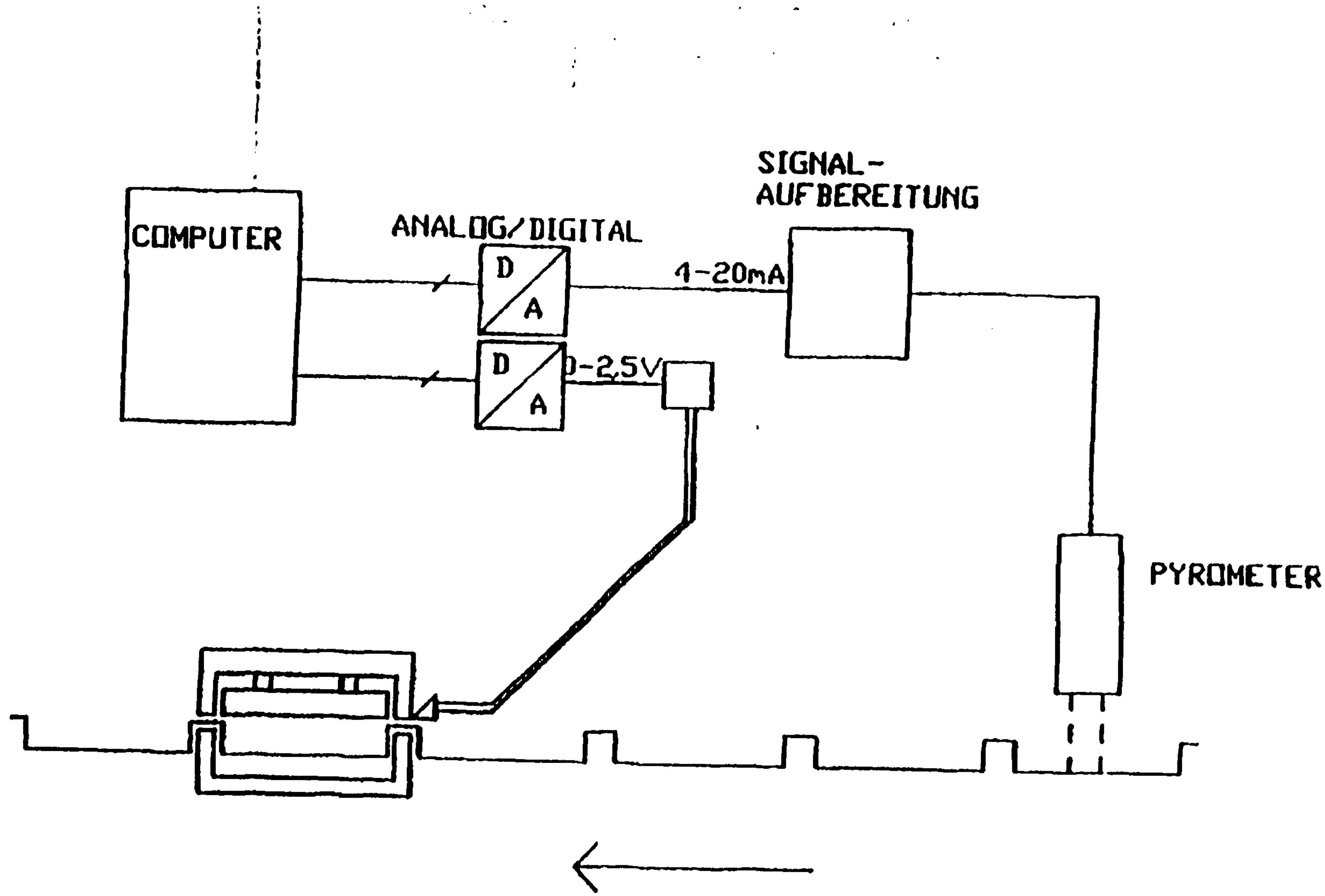



DRAWING FOUR

# INFRA-RED
# TEMPERATURE SENSOR

REFER TO DRAWING 5. SENSOR SENSES THE TEMPERATURE OF THE PRODUCT (IN REAL TIME) AND SENDS IT TO THE CONTROL SYSTEM. IT THEN EVALUATES IT IN RELATION TO A STANDARD PRESSURE/VAPORIZATION CHART AND CONTROLS THE VACUUM LEVEL AUTOMATICALLY FOR THAT PARTICULAR TEMPERATURE.

DRAWING #5


COMPUTER
ANALOG/DIGITAL
D
A
D
A
4-20mA
0-2,5V
SIGNAL-
AUFBEREITUNG
PYROMETER

# SMART System Functionality

Implemented with the Tiromat 3000 Form-Fill-Seal machine, the SMART System 5600 is a state-of-the-art process control, data acquisition / archiving system developed with vertical integration in mind.

Industry standard hardware such as an Allen-Bradley 2/17 Programmable Logic Controller, DEC (Digital Equipment Corporation) µPDP-11 mini computer, Setra and Rochester Instruments transducers, provide precise process control, with proven reliability backed by a network of World-wide distributors along with Kutter's extensive parts inventory and knowledgeable technicians based in locations around North America.

For integration with our line of packaging equipment, over the past 8 years Kutter has developed a proprietary software package second to none. The SMART System application software is user-friendly, menu driven, and is password protected (up to 50 users, each with individual levels of access). The SMART System allows quick, repeatable set-up of process variables while maintaining an "Audit Trail" of all events which occur during the manufacturing / packaging process. The SMART System also provides Maintenance and Diagnostic routines which help retain maximum efficiency .

A few of the key features found in the SMART 5600 are following:

| | |
|---|---|
| **Audit Trail** | • Maintains record of all changes made to process controls with time/date/password stamp.<br>* Allows tracking of personnel interaction.<br>• Stores snapshots (check point records) of all critical parameters during production on an ongoing basis.<br>* Allows review of all parameters during specified time period or relating to a combination of selected criteria.<br>• Keeps record of any occurrence of "out of tolerance" (may force production halt if desired).<br>* Allows tracking of incidents of parameters not being maintained. |

| | |
|---|---|
| **Automatic Device Testing** | • On start up each day, executes static evacuation check<br>* Ensures integrity of evacuation chamber for consistent evacuation & gas levels.<br>• On start up each day, executes heater current check.<br>* Ensures integrity of heaters to prevent hot/cold spots effecting forming and sealing.<br>• On start up each day, executes X-cut bladder check.<br>* Ensures integrity of Cross Cut bladders to provide consistent cutting. |
| **Automatic P.M. Prompting** | • On start-up each day, provides a printed listing of preventative maintainance scheduled to be performed.<br>Maintains record of work performed and rolls over work defered.<br>* Improves performance and life of equipment. |
| **Up / Down Time Statistical Analyses** | • Forces the operator to select a reason (from a menu displayed) for shutting down prior to re-starting the Tiromat.<br>* Provides detailed breakdown of time the Tiromat is not generating packages. |
| **Machine Control Functions** | • All devices (primary and ancillary) may be manually activated from the SMART keyboard.<br>*Provides assistance in maintenance procedures as well as troubleshooting. |
| **Film Utilization Reports** | • Data base of material usage<br>* Provides information on material utilization while tracking production with film lot codes and roll numbers. |

**Network Compatibility**

• Production data and set-up information is compatible for exchange over many networks utilizing most common protocols.

* Set up parameters may be exchanged between the SMART System and other intelligent devices *ie*; vision systems, robots, etc.

* Plant networks may access Tiromat data for production tracking and system status.

# TIROMAT

# MODULAR

# DESIGN

FILM CONVEYOR CHAIN

Previously film transport chains were ½" links. A 5/8" nickel-plated chain is installed as standard which has a greater holding force. The 5/8" chain doesn't stretch.

FORMING STATION

A newly-developed lifting mechanism that is maintenance free. This new lifting is heavy duty and can take pressures up to fourteen (14) tons. Film composites, such as aluminum and poly-propylene require high forming pressures.

Cylinder lifting is standard. Optional is gear-motor lifting.

There are four different lifting graduations which are:

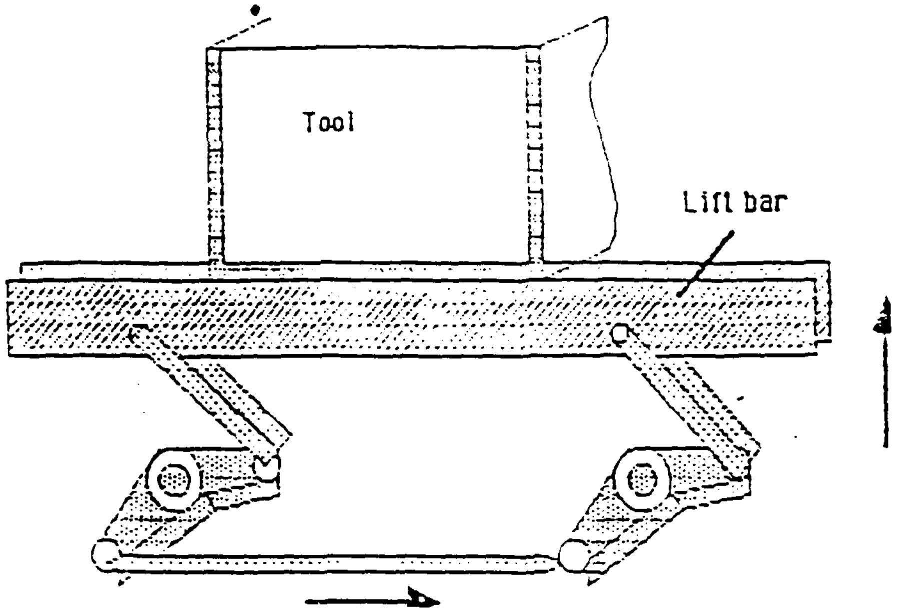
1. Lift 210mm/190mm draw depth
2. Lift 150mm/130mm draw depth
3. Lift 120mm/100mm draw depth
4. Lift 80mm/ 60mm draw depth

Depth conversions are possible by traversing the lifting rails. For example, by traversing the lifting rails the maximum depth of draw can change from 130mm to 190mm. Also, the lifting cylinder must be changed.

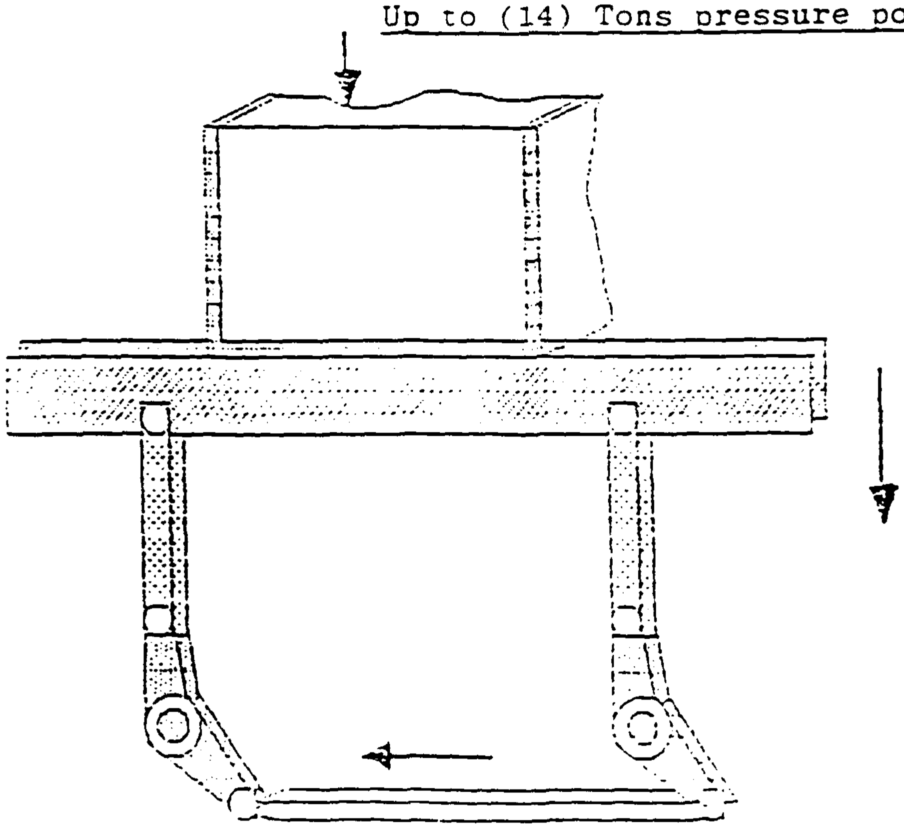
All TIROMAT 3000 have independent lifting.

SKETCH OF THE LIFT DRIVE

Tool at rest



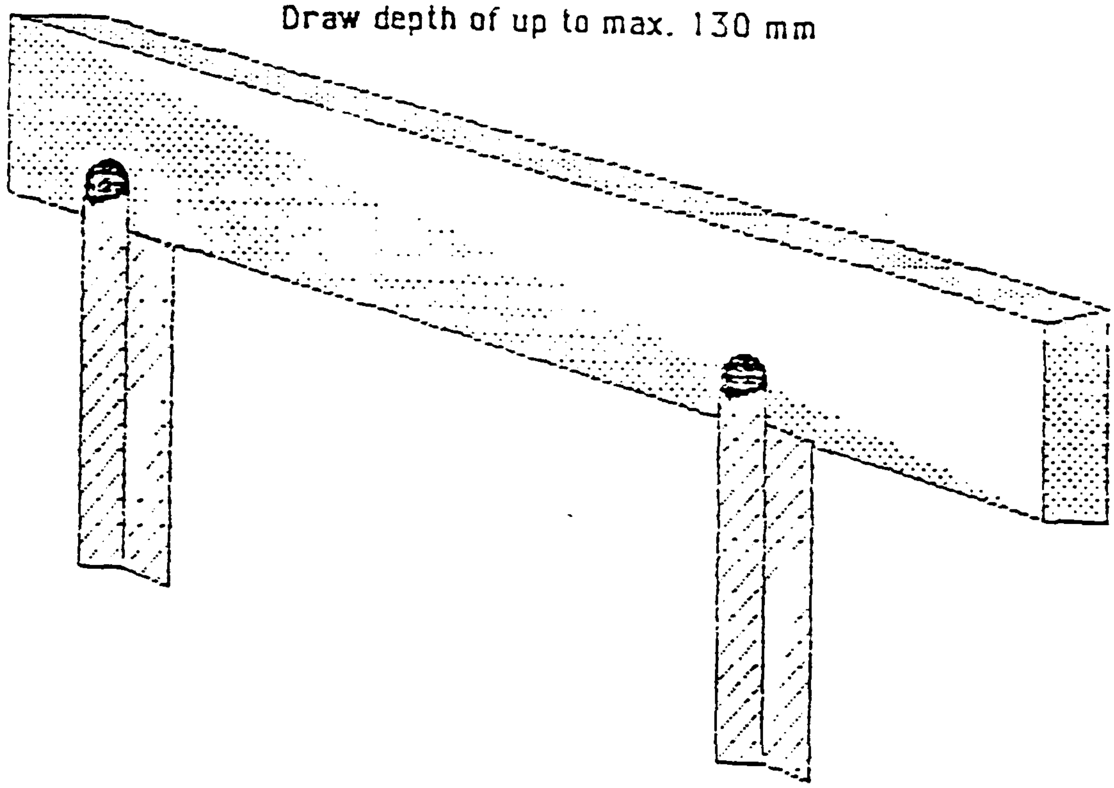

Up to (14) Tons pressure possible



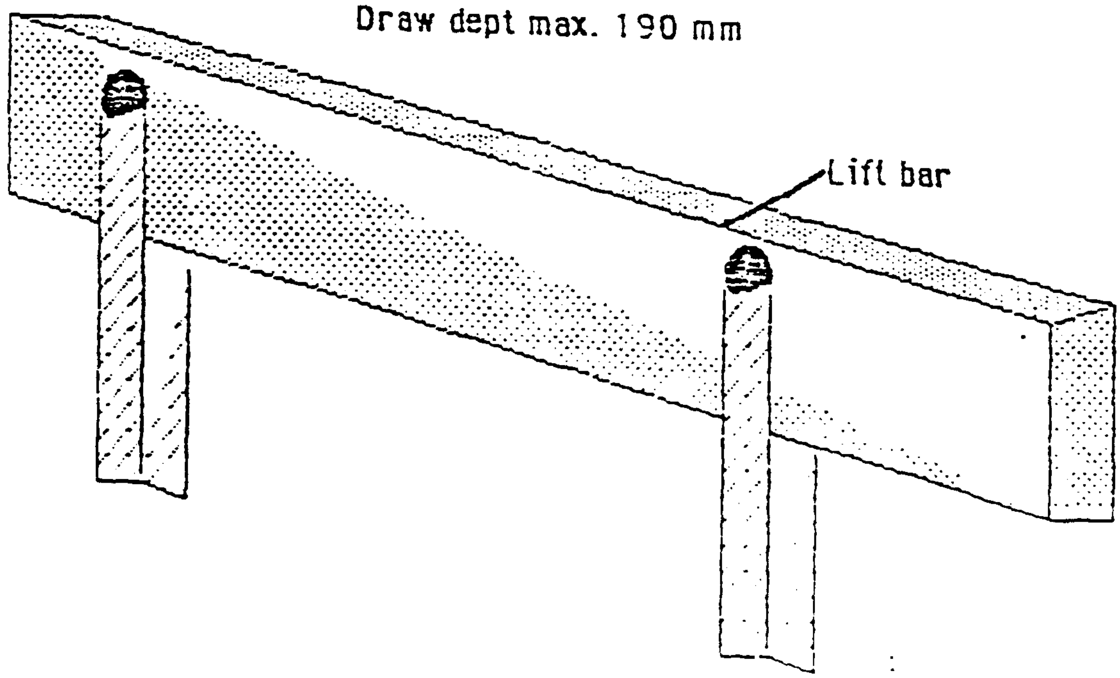
Tool in locked position

Infinitely-adjustable lift limitation is still provided

Draw depth of up to max. 130 mm

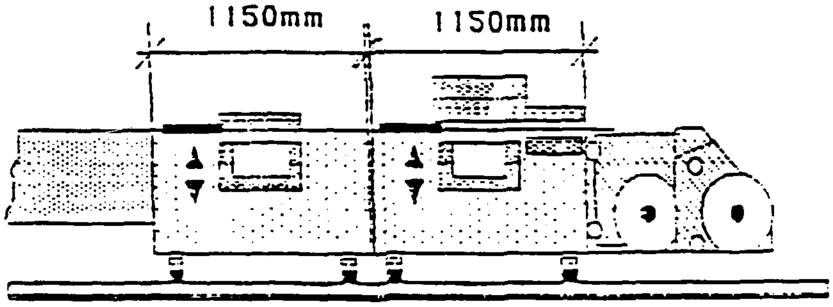


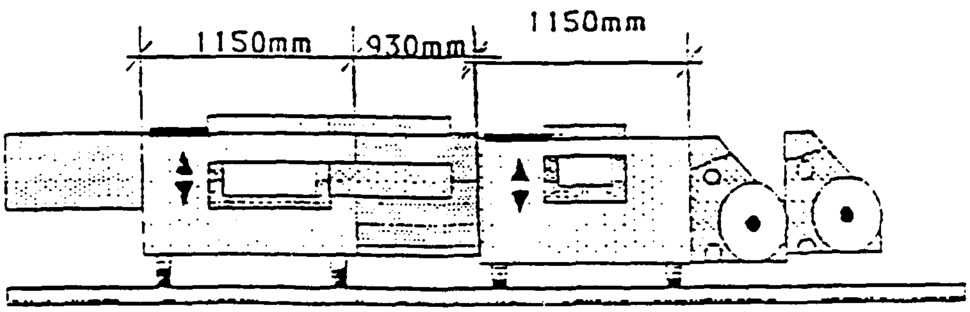
Draw dept max. 190 mm



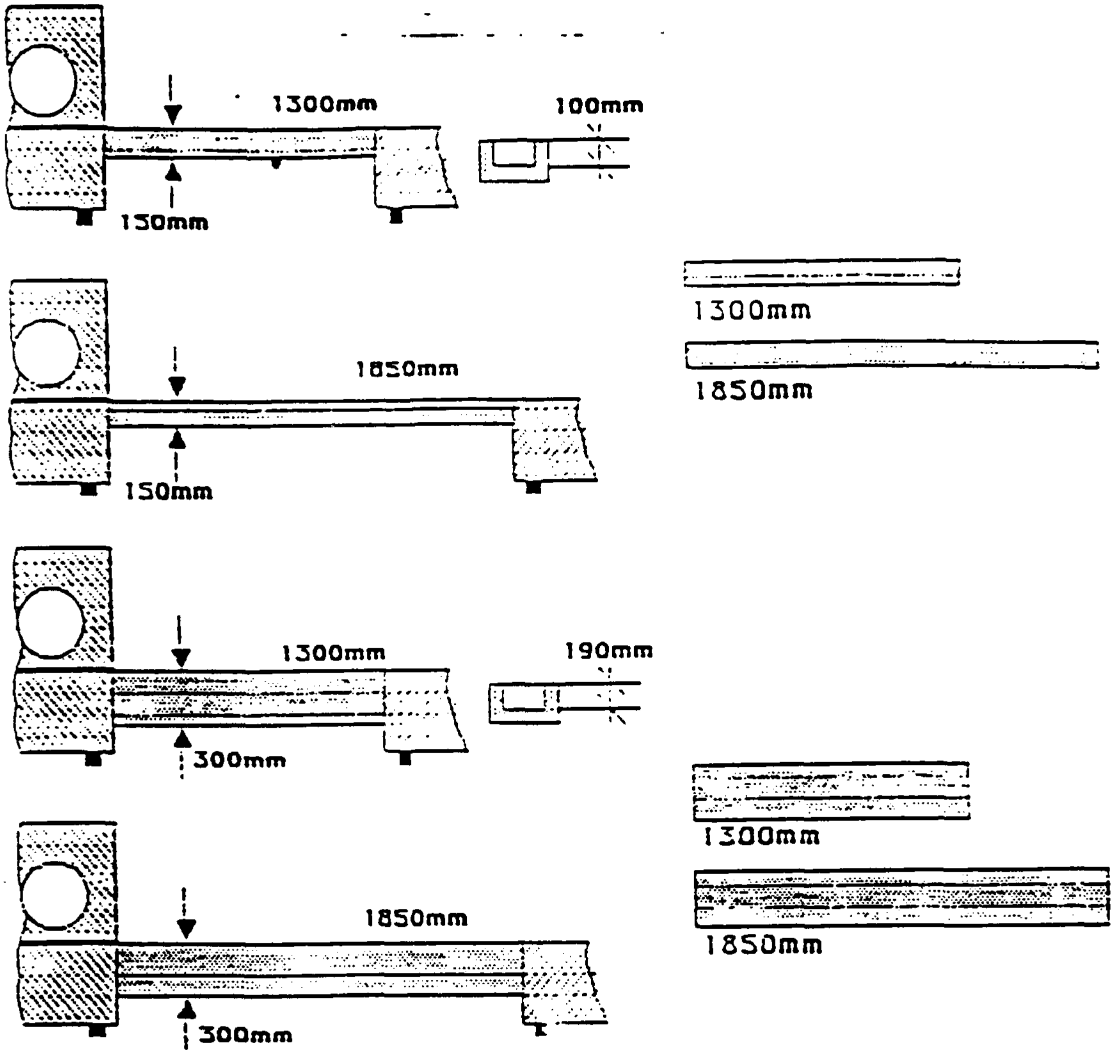
The standard forming station is 1150mm long and allows a maximum index of 800mm without preheating and 450mm with preheating. A 930mm extension is available for a 800mm maximum advance with preheater.

To produce difficult packages is much easier because two or more forming stations can be added and this produces a tremendous flexibility in the packages. Double mandrels may be also be added.

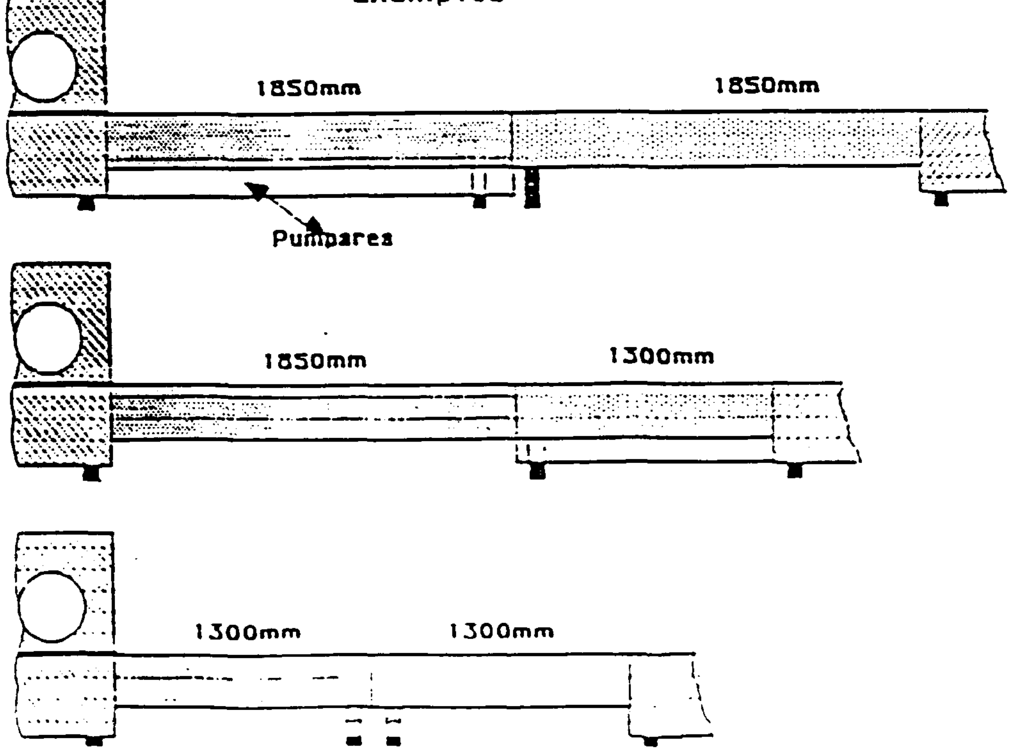


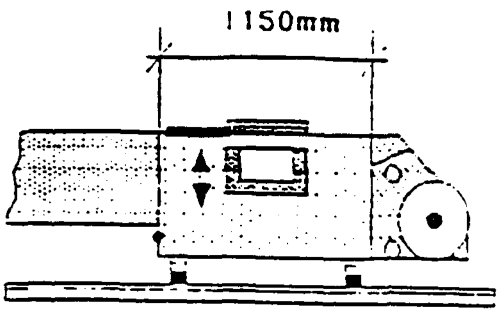



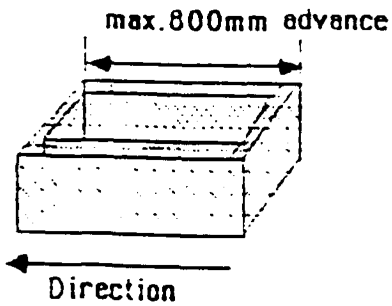
# LOADING AREA

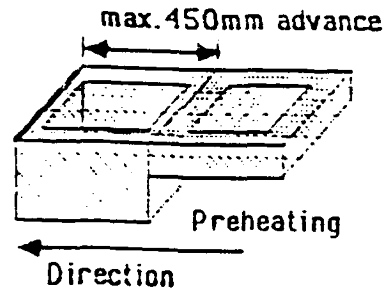


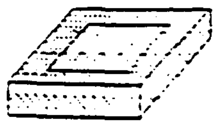

Examples



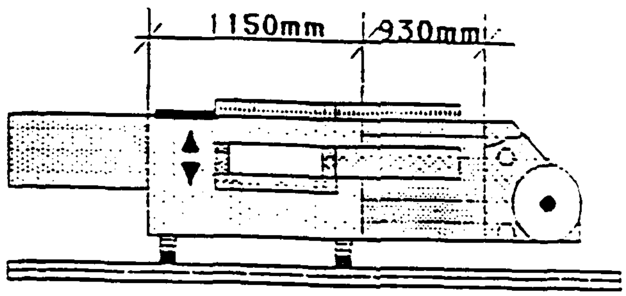


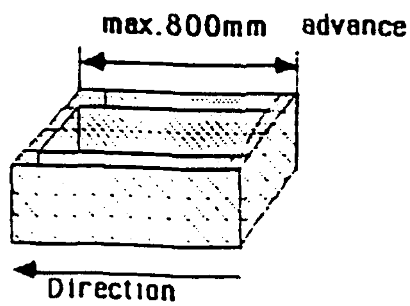



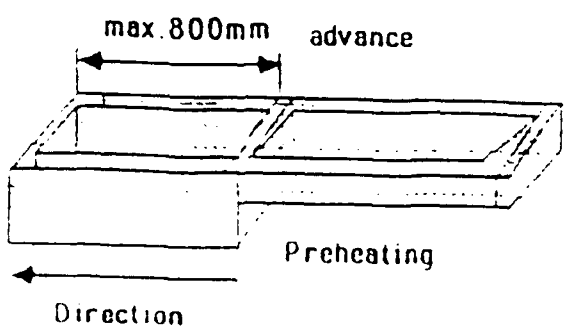



Doeble preheating possible
depending on format



## LOADING AREA

Standard loading extensions are 1300mm and 1850mm long.

Standard heights are 150mm and 300mm.

The limitations in depth and index are as follows:

| Ext. length - height in mm | | Max. draw depth in mm | Max transport advance in mm |
|---|---|---|---|
| 1300 | 150 | 100 | 350 |
| 1300 | 300 | 190 | 350 |
| 1850 | 150 | 100 | 800 |
| 1850 | 300 | 190 | 800 |

A channel runs on the cabinet side of the machine to the forming station for all utilities. This can be serviced from the outside of the Tiromat.

## SEAL STATION

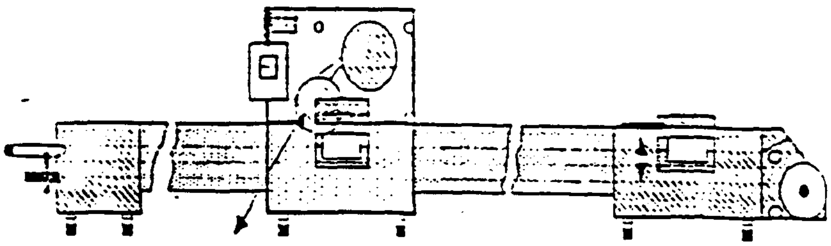
In order to facilitate faster evacuation of the seal chamber, the bridge has two 1½" cross-sections. Standard is an adjustable seal bridge. Previously 100mm diameter cylinders were used, now 125mm diameter are used. All bridges are reinforced.

2, 4, or 6 cylinder bridges are used which is determined by index length. Tandem cylinders are available.

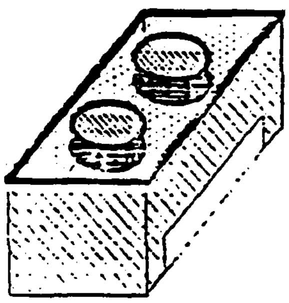
Per cylinder - 125mm diameter @ 90 PSI = 1390 pounds of pressure buildup

Per tandem cylinder - 125mm diameter @ 90 PSI = 2781 pounds of pressure buildup

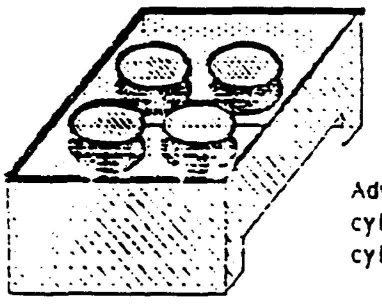
The different variables of bridges are as follows:



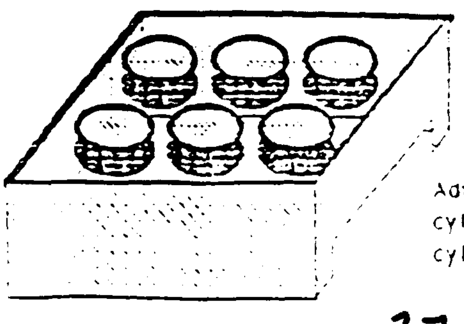
Sealing bridge in different variants



Up to 350 mm advance
2 welding cylinders, with
2 tandem cylinders, up to
350 mm advance



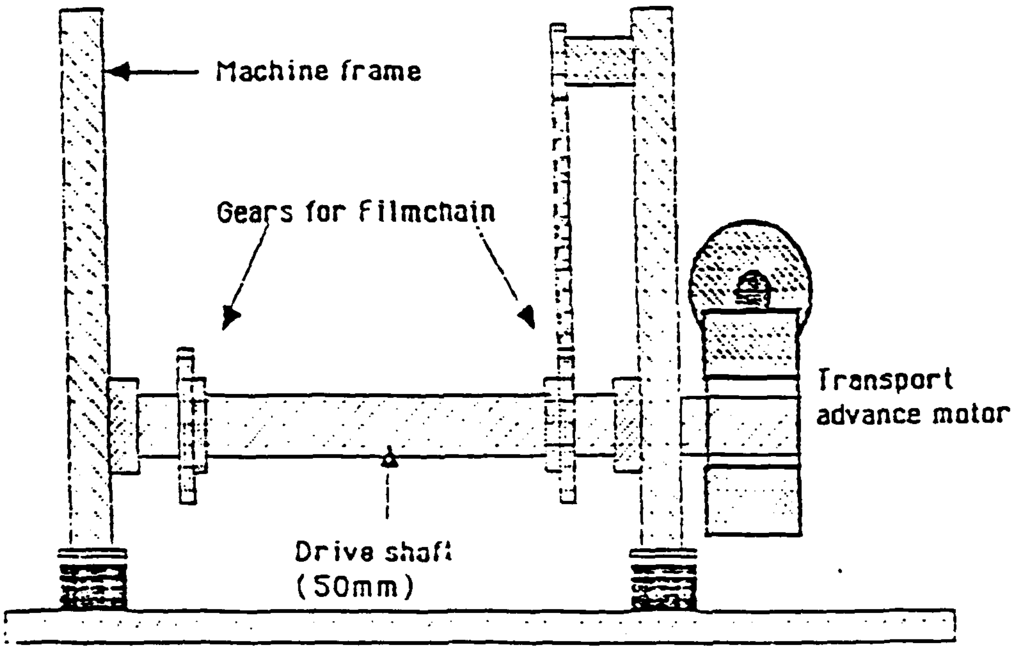
Advance 450 mm 4 welding
cylinders, with 4 tandem
cylinders, advance 450 mm



Advance 800 mm 6 welding
cylinder, with 6 tandem
cylinder advance 800 mm

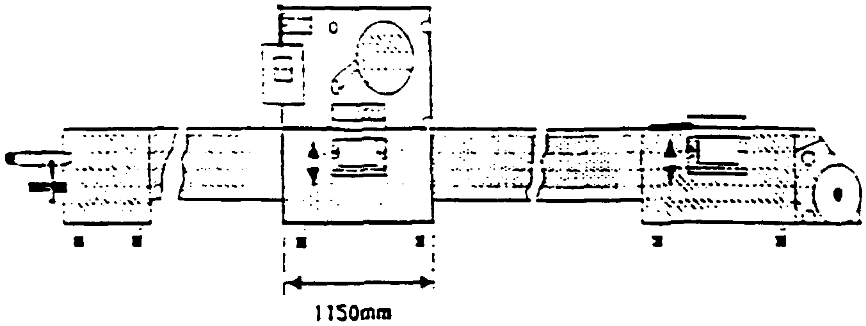
## DRIVE SYSTEM

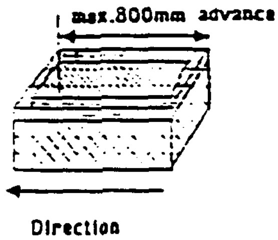
The standard drive is a 2-speed AC motor. Optional is a RF-control motor by Lenze. Both units, drive the transport chains directly. Index is adjustable in 1/10 mm adjustments.



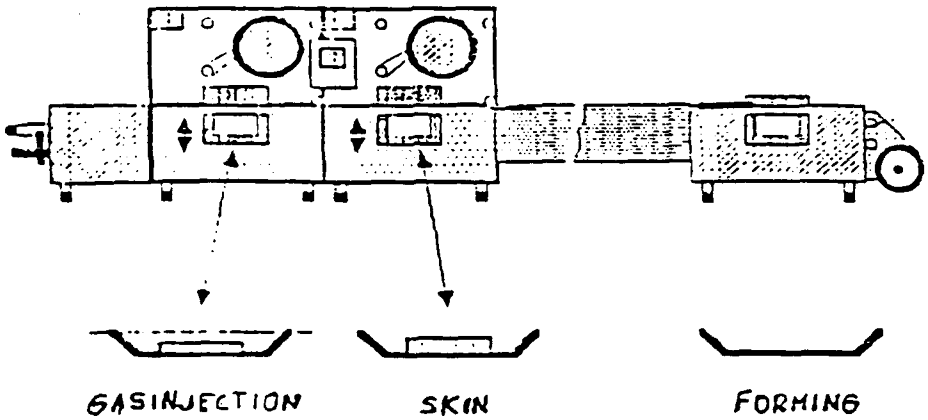
## SEALING STATION

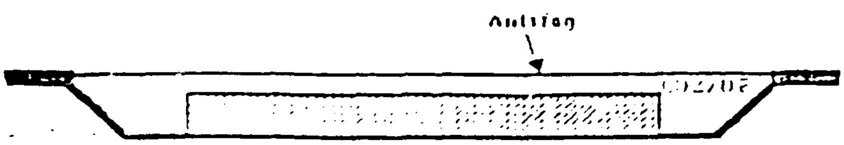
The standard length is 1150mm which is designed for an 800mm index and still have adjustments.



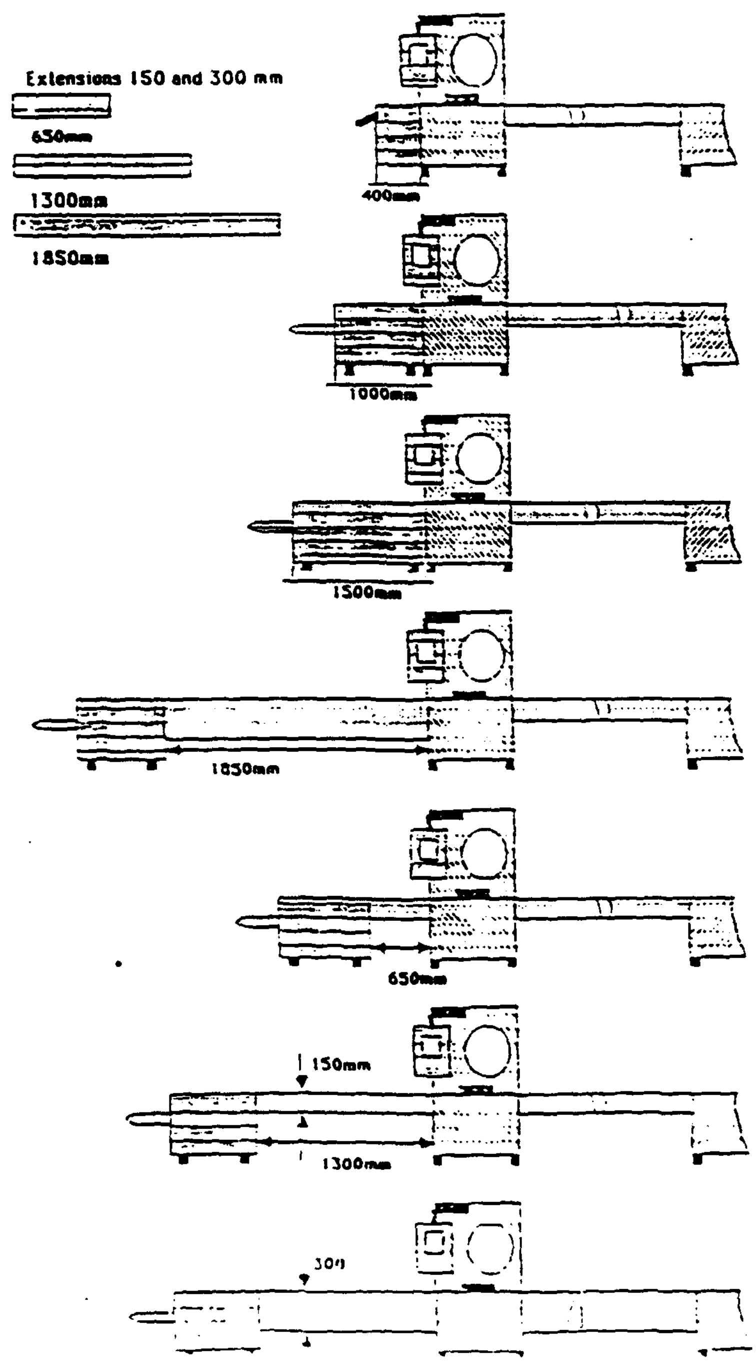

The Tiromat 3000 is able to have 2 or 3 sealing stations. This now makes it possible to make SKIN/CAP PACKAGES.



## CUTTING AREA

The versatility of, the TIROMAT 3000 allows a large number of accessories. Cutting modules are 400mm, 1000mm, and 1500mm long. Examples of the versatility are as follows:



## DISCHARGE

There are two standard length discharge conveyors. They are 750mm and 1200mm. Either synchronous or adjustable compressed air motor drives are available. A large hand wheel is used to adjust heights.

## MACHINE WIDTHS

The TIROMAT 3000 is offered in three basic frames. They are 325mm, 430mm, and 560mm. Other widths are easily available because of the new film chain shafts. For example, a 430mm frame is adjustable to 350mm.

## VACUUM TRIM REMOVAL

Kramer & Grebe now offers a Venturi Style Nozzle for trim removal. A cutting device is also offered.

## CUTTING EQUIPMENT

The cutting equipment was completely revised, with special attention being paid to costs, flexibility, safety, and passage heights.
The cutting area of 400 mm includes only longitudinal cutting and simple cross-cutting. Cross-cutting is done by a moving knife driven by a cylinder.(system used by Buddig)

Cross-cutters (guillotine system) have a new stroke drive. The bed knife is powered by a locking cylinder, and cutting is done only in the final position. Closing pressure is 15 kg, which means that even if a hand gets between the knives it will not be injured.
A product height of 190 mm is provided for.

Transverse punches were previously limited in passage height as well as in terms of pressure. A distinction was made between 6 and 9 metric-ton punches.

The new bed knife is likewise powered by means of a locking cylinder, giving a passage height of 210 mm. Cutting pressure is applied by tandem cylinders reaching 600 kg per segment. On each side, sufficient segments are built up to reach 4.5 metric tons pressure, so that a 9 metric ton transverse punch is available on the standard machine.

Since there is no mechanical lift system, there is no lubrication system. The cutting lines for separating hard films are bedded in high-density wood or in plexiglass.

CENTER FOR
ADVANCED
FOOD
TECHNOLOGY

Appendix 4.6

March 19, 1990

TO: M. Dunn, Buyer
University Procurement &
Contracting Services

FROM: A. Sigethy/T. Descovich
Combat Ration Advanced Manufacturing Technology
Demonstration (CRAMTD)

RE: Short Term Project #8 (STP #8) - DLA Contract
DLA 900-88-D-0383

This documents our selection of T. W. Kutter as the subcontractor of choice to fabricate an intermittent motion form/fill/seal packaging machine for CRAMTD STP #8 "Design and Development of a Horizontal Form/Fill/Seal Machine for an Automated Combat Ration Manufacturing Facility".

All proposals were evaluated based on delivery, production rate, engineering features, cost, service and training. Based on these criteria, T. W. Kutter was selected as the subcontractor for this project. They were the low bidder, had the shortest delivery time and were rated no lower than equivalent in the other areas of evaluation.

dd

Nabisco Advanced
Food Technology Institute
Cook College
P.O. Box 231
New Brunswick, NJ 08903 0231
201/932 8306

RUTGERS

## Vendor Evaluations RE: R.F.Q. 0-2-7-1

| Evaluation Criteria | % Weight | Mahaffy & Harder | | T.W. Kutter | | Multi-Vac | |
|---|---|---|---|---|---|---|---|
| | | Score | Rationale | Score | Rationale | Score | Rationale |
| Delivery | 10 | 5 | 27 weeks | 10 | 16-20 weeks | 5 | 28 weeks |
| Product Rate | 15 | 15 | 110 pouch/min | 12 | 102 pouch/min | 12 | 102 pouch/min |
| Engng Features | 35 | 25 | • Have not run retort pouch in production<br>• no unique features;<br>• no test lab<br>• can run preformed trays | 35 | • retort pouch experience<br>• product temp. sensor avail.<br>• SMART diagnostic sys. avail.<br>• Lab/pilot plant available<br>• can run preformed trays | 33 | • retort pouch experience<br>• Lab/pilot plant available<br>• no mention of feasibility to run preformed trays |
| Cost* | 10 | 10 | $297,480.00 | 10 | $294,622** | 5 | $357,803.00 |
| Service | 15 | 10 | • adequate but has limited service people due to number of machines in industry | 12 | • Now part of Alfa Laval organization<br>• Tiromat smaller than Multi-Vac | 15 | • largest number of F/F/S machines in U.S.; considered industry standard |
| Training | 15 | 10 | • on-site training only | 15 | • formal classroom training program | 15 | • formal classroom training program |
| TOTAL | 100 | 75 | | 94 | | 85 | |

* = Cost is based on equivalent technical content for all proposals and includes Options 1 - 11

** = $300,772 Total cost Item E ($199,990) of RFQ plus Options 1 -11 ($100,782)
- 15,000 Product Temperature Sensor Option listed in Item E (not offered by other bidders)
+ 8,850 Plug assist listed by other bidders in total cost Item E (refer to T.W. Kutter proposal, pg. 4 of 6)
$294,622



3/19/90

THE STATE UNIVERSITY OF NEW JERSEY
RUTGERS

Interdepartmental Communication

CRAMTD

June 8, 1990

TO: Files

FROM: A. Sigethy

RE: Literature Search - Combat Rations (Horizontal Form/Fill/Seal Machine)

A search for information relative to combat ration production was made via MTIAC and NRDEC.

MTIAC identified a total of 57 references. Of these, none were pertinent to the horizontal form/fill/seal machine. NRDEC provided 2 references. Of these, the following one (summary below) was pertinent to the subject.

"Preliminary Draft Report of Horizontal Form-Fill-Seal Retort Pouch Production Using the Tiromat CS-VA-430 LTH Machine", J.J. Clayton, Sept. 1987

Summary: The Tiromat CS-VA-430LTH Horizontal Form-Fill-Seal packaging machine was designed and built to package solid materials. In this use we found the machine to be an effective performer but in need of improvement for use with foil laminates.

For packaging flowable food materials in flexible, retortable pouches machine performance was far from acceptable. Pouch forming operations are based on incorrect assumptions about how pouches made from aluminum foil containing laminates are actually formed. As a consequence of this, pouch volumes were less than predicted, and even worse, of variable volume depending on location. In addition, and for some unexplained reason, pouch volumes were found to be related to dwell time in the sealing chamber.

Pouch configuration and modes of movement and handling make it virtually impossible to effectively use a high percentage of the available volume for product. Spillage of low viscosity materials was a problem in virtually all parts of the transport and sealing phases of the operation. Reliable, predictable, effective sealing of properly made pouches - even pouches containing highly viscous materials - was virtually unachievable because of the inclusion of product in seal areas due to the location of the ambient air evacuation nozzle with respect to the product in pouches being evacuated.

Unsupported and sagging pouches, prior to the sealing operation: (1) may be the cause of seal contamination due to flow from the pocket onto seal areas; and (2) cause blockage and improper operation of the slitting knives used to singulate pouches following sealing.

Both of the laminates used were deficient. One of them could not be drawn into pouches of sufficient volume (rupture occurred first) and the other, when evacuated at even modest vacuum levels gave rise to wrinkles that caused poor seals and "standing seams" that when folded over apprereared to be possible sites for flex cracks.

Although some good appearing pouches with well fused seals were made and subjected to retorting without failure, it is likely that they contained excess air and were, therefore, of unacceptable quality.

Literature Search
Combat Rations - Horizontal Form/Fill/Seal Machine

MTIAC

| AD Number | Title | Date |
|---|---|---|
| D440506 | Coextrusion Blow Molding of Barrier Structures for Rigid Containers with Polycarbonate Resins. | May, 1986 |
| D439233 | High-Barrier Packaging - What are the Options. | Mar, 1985 |
| D438630 | Properties of a New Biaxially Oriented Nylon 66 Film. | Apr 30, 1984 |
| D438432 | Permeability of Polymeric Membrane Lining Materials, | 1984 |
| D437664 | FoodPlas 83/84 | Jan 18, 1984 |
| D437173 | Physical Testing of Transparent Films in the Laboratory and its Relationship with Packaging Performance. | Sep 15, 1963 |
| D437171 | A Chromatographic Method for Measuring the Gas Permeability of Packages. | Sep 15, 1963 |
| D437159 | Evaluation of Package Performance. | Sep 15, 1963 |
| D433849 | Polypropylene Film. | Sep 11, 1960 |
| D433154 | A Practical Gas Permeation Test for Plastic Containers. | Mar 7, 1966 |
| D432189 | Macro-encapsulation of PCM. | Aug, 1978 |
| D430578 | Plastics Packaging in the Space Program. | Nov 19, 1963 |
| D430577 | Progress in Films, Laminations and Coatings. | Nov 19, 1963 |

| | | |
|---|---|---|
| D429837 | Research and Development Associates Inc., Activities Report, V. 21, No. 1. | 1969 |
| D429836 | Research and Development Associates Inc., Activities Report, V. 20, No. 1. | 1968 |
| D429835 | Research and Development Associates Inc., Activities Report, V. 19, N.2. | Apr 11, 1967 |
| D429822 | Effective High Speed Gas Packaging. | Dec, 1961 |
| D429818 | Conventional Retorting and Flexibly Packaged Products. | Dec, 1961 |
| D429817 | Problems in Assuring Sterility in Thermally Preserved Flexibly Packaged Foods. | Dec, 1961 |
| D429814 | Quartermaster Food and Container Inst for the Armed Forces, Activities Report, V.13, No.4. | Dec, 1961 |
| D428224 | Stability of Tomato Pastes Packaged in Plastic Laminated Pouches. | Aug 19, 1979 |
| D428212 | Oxidized Polyethylene Flavor: Source, Measurement and Characterization in Food Packaging Systems. | Aug 19, 1979 |
| D428211 | The Direct Measurement of Respiration of Natural Cheese in Polymeric Film Package. | Aug 19, 1979 |
| D426608 | Package Integrity and Performance. | Nov 17, 1964 |
| D426606 | Convenience Foods. | Nov 17, 1964 |
| D425406 | Retort Pouch Earns 1978 IFT Food Technology Indistrial Achievement Award. | Jun, 1978 |
| D425365 | Microbial Recontamination in Flexible Films. | 1967 |
| D425361 | Conference on Food from the Sea. | 1967 |

| | | |
|---|---|---|
| D424718 | Approaches to Mechanical Sealing Problems. | Feb 2, 1976 |
| D423926 | Testing Procedures for Retortable Pouches. | - |
| D423925 | Meeting on Retortable Pouches. | Jun 6, 1975 |
| D423715 | The Reliability of Flexible Packages. | 1968 |
| D423223 | Retort (Processable) Pouches (II) Outline Specification for Retort Pouches, Polyester/Aluminum Foil/ Polyolefin. | Feb, 1975 |
| D423221 | Integrity Aspects of Package Seals. | Feb 2, 1976 |
| D423220 | Approaches to Mechanical Sealing Problems. | Feb 2, 1976 |
| D423219 | Heat Seal Characteristics of Polyolefin Materials. | Feb 2, 1976 |
| D423218 | Ultrasonic Sealing of Thin Film Thermoplastics. | Feb 2, 1976 |
| D423217 | Laser Welding of Thin Plastic Sheets. | Feb 2, 1976 |
| D423138 | New Opportunities in Manufacturing Formed Containers Using the Scrapless Forming Process. | Jun 14, 1977 |
| D422506 | An Overview of the Retort Pouch in the U.S. | Feb, 1976 |
| D422505 | Performance and Integrity of Retort Pouch Seals. | Feb, 1976 |
| D407098 | Flexible Packages Now Withstand Heat-Processing Temperatures of Foods. | Mar, 1962 |
| D405798 | Resolving the Retort Pouch Ruckus. | Mar, 1975 |
| B063877 | Investigation of the Suitability of 6 Packing Tray Models with Respect to Long Range Storage and Transport. | Jun 15, 1981 |

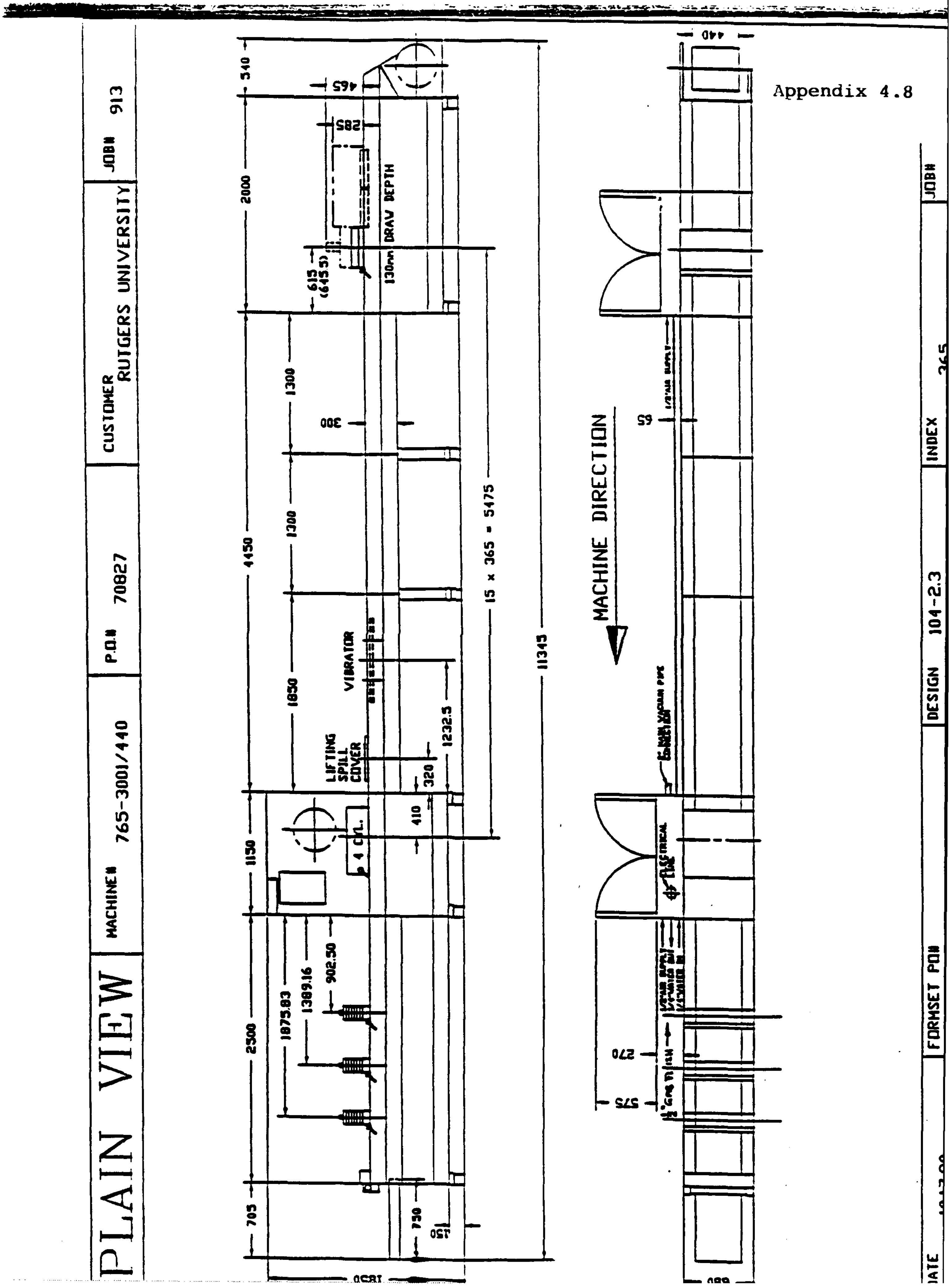
PROJECT WORK

Combat Rations - Horizontal Form/Fill/Seal Machine

NRDEC

| Contact No. | Title | Date |
|---|---|---|
| DAAG17-69-C-0160 | Reliability of Flexible Packaging for Thermoprocessed Foods Under Production Condition. Phase I: Feasibility | July 1970 |
| ---------- | Preliminary Draft Report of Horizontal Form-Fill-Seal Retort Pouch Production Using the Tiromat CS-VA-430 LTH Machine | Sept. 1987 |

Appendix 4.8



PLAIN VIEW
MACHINE# 765-3001/440
P.O.# 70827
CUSTOMER RUTGERS UNIVERSITY
JOB# 913
540
465
285
2000
DRAW DEPTH
615
(645.5)
130mm
1300
300
1300
4450
15 x 365 = 5475
11345
VIBRATOR
1850
1232.5
LIFTING SPILL COVER
320
410
1150
4 CYL.
2500
1875.83
1389.16
902.50
705
750
150
440
65
MACHINE DIRECTION
ELECTRICAL LINE
270
575
JOB#
INDEX 365
DESIGN 104-2.3
FORMSET PO#

# Evaluation of Aluminum/Plastic Laminates for Retortable MRE Pouches

**Kit L. Yam, Ph.D.**
*Co-Principal Investigator*

**Panos Giannakakos, Ph.D.**
*Post-Doctoral Fellow*

**Yoon-Seok Song**
*Graduate Assistant*

**Food Science Department**
**Cook College**
**Rutgers University**

**March 27, 1990**

## I. SUMMARY

This work is a part of the CRAMTD STP-8 project which deals with the package development of MRE pouches on a horizontal form/seal/seal machine. Present work is being conducted on evaluating the proper kind of foil laminate and the optimum sealing conditions. A prototype has been constructed to study the forming characteristics of the laminates. Also being constructed is apparatus for evaluation the performance of the pouches such as pinholes, seal integrity, and burst strength.

## II. OBJECTIVES

Here are some of the major objectives:

1. Evaluate and characterize commercially available aluminum/plastic laminates as candidates for forming retortable MRE pouches.
2. Study the forming characteristics of these laminates.
3. Study the heat sealing characteristics of these laminates.
4. Identify and study the process parameters for the forming and heat sealing.
5. Use existing methods or develop new methods to test the performance of these laminates.

## III. IDENTIFIED PROBLEMS

Based on literature review and personal contacts, the followings have been identified as potential obstacles which demand further research:

1. Very little information is available in the literature on forming aluminum-plastic laminates. For example, it is still not known what kind of laminate are formable, and a plug assist should be used in the forming process.
2. The choices of aluminum-plastic laminates are rather limited because only a few companies manufacture them.
3. The existing MRE pouch film may not be formable due to delamination and severe flex cracking.

4. There is a concern that foil laminates with a printing layer may cause delamination after formed into pouches and then retorted. This may be due to chemical incompatible between the printing layer and its adjacent layers.
5. Based on a recent study by Dr. Elsayed A. Elsayed, the major causes for the rejection of MRE pouches are residual gas, internal pressure, and seals of packaged pouches.
6. The dimension of pouch must be properly designed to minimize sloshing problem during filling.

## IV. PREVIOUS PROGRESS

1 Reviewed literature on forming techniques, especially those pertaining to foil/plastic laminates.

2.. Visited with Mahaffy & Harder, Du Pont, and Natick to discuss STP-8.

3. Obtained foil/plastic laminates of various thickness and composition from Reynolds and Alusingen for evaulation.

4. Measured tensile properties of the above foil/plastics laminates.

5. Conducted preliminary study on forming pouches from the above foil/plastics laminates at Mahaffy & Harder.

6. Measured the thickness distribution of formed pouches.

7. Retorted filled pouches and examined defects.

6. Designed and constructed a prototype mold for forming pouches with foil/plastic laminates. This is a refined mold compared to the one made by Mahaffy & Harder.

8. Studied the heat sealing conditions of foil/plastics laminates. Process variables were dwell time, temperature, pressure.

## V. NEAR FUTURE WORK

1. Measure the seal strength of laminates before and after the retort process.

2. Form pouches with our prototype mold.

3.. Refine the prototype mold design as needed

4. Construct equipment to measure or conduct
   a. residual volume
   b. internal pressure test
   c. fluroescein dye test

5. Visit with pouch machine vendor to conduct more tests on forming foil laminates.

## VI. RECOMMENDATIONS

From our preliminary study, the Reynolds RND #8 is a potential laminate for forming the pouches. More work should be conducted to determine the relationship between the various laminate materials, mold design, forming conditions and the performance of the pouches. The mold should be designed to minimize the sloshing problem, and filled pouches should be tested to more severe retort conditions to evaluate its performance and survivability.

## VII. BRIEF TECHNICAL STATUS REPORT

### A. Sample Films

In addition to the existing MRE laminate, we have also obtained several foil laminates from Reynolds Company and Alusingen. The thicknesses of aluminum for these laminates vary from 0.4 to 2.0 mils (Figure 1).

Obtained from Reynolds Company are two sets of foil laminates. Both sets use a very tough, non-oriented polypropylene copolymer film as the sealable surface.

The first set consists of oriented polypropylene/adhesive/aluminum foil/adhesive/non-oriented polypropylene, from outside to inside. The oriented polyproylene (from Hercules, Inc.) is a standard film in the packaging industry, standing second only to low-density polyethylene. It has good mechanical strength, barrier properties, and flex crack resistance. The second set consists of polyester/adhesive/aluminum foil/adhesive/non-oriented polypropylene, from outside to inside. The polyester is PET (from Du Pont) which has very good chemical resistance and usable temperatures range from -70 °C to 150 °C with minimum shrinkage and loss of strength. One of the laminates in this set has a printed layer.

Obtained from Alusingen are two formable foil laminates. However these laminates are currently not manufactured in the United States.

## B. Tensile Properties

Mechanical properties such as tensile strength and elongation at break for the above films were measured with an Instron Universal Tester. These properties are useful for evaluating the forming characteristics of the laminates. The samples for tensile testing were strips (1" wide) of the laminates, and the cross-head speed was set at 5 in/min. Figures 2 and 3 show representative results obtained.

Preliminary evaluations suggest that the laminate coded RND-8 (consists of 1.2 mil OPP/1.5 Al/3.0 mil PP) has good tensile properties and can be used as bottom stock material. Candidate laminates for lid-stock are RND-1 and RND-6 which consist of 1.2 mil PP/0.7 mil Al/3.0 mil PP and 0.5 mil PET/0.7 mil Al/3.0 mil PP, respectively.

## C. Thickness Distribution

During the cold forming process, the web is stretched to take the shape of the mold. Such process often causes thinning of the laminate. Excessive thinning is undesirable because it will adversely affect the mechanical and physical performance of the pouch.

The thickness profile of the formed pouch can provide useful information. First, it can be used to evaluate the film itself. The formed pouches should have somewhat uniform thickness profile, without thin or weak spots. Second, it can be used to evaluate the performance of the cavity shape. Excessive thinning indicates that toc much stress is applied as a result of sh-p corners or non-tapered walls. The thickness profile can be obtained by . 'ing the formed pouches into small grids, and measuring the average thickness of each grid with a micrometer. Thus the smaller the grid, the more accurate the result.

Figures 4 through 6 show the thickness of formed pouches using the present MRE laminates, RND-6, and RND-8. All the formed pouches have a comparable thickness profile with minimum thickness being 79 % of the initial thickness. (The forming were performed with a female mold constructed by Mahaffy & Harder. The mold is a parabolic shape cavity with smooth edges and round corners. Such a shape, however, tends to cause more sloshing problem.)

## D. Retort tests

Several pouches were prepared with the Mahaffy & Harder mold and then filled with water. They were tested in a retort at 250 °C for at a minimum of ten minutes. (Both printed and non-printed laminates were used to form these pouches.) After retort, visual inspection did not reveal any defects or failure neither on the seals nor the laminates. This observation disagrees with the concern that the printed laminates can't be used for formable retortable pouches. It appears that the survivability of the pouches depends strongly on the forming process—the forming process employed by Mahaffy & Harder is relatively gentle due to the mold design, which results in good survivability rate.

## E. Heat Sealing Conditions

Preliminary experiments were performed with a band heat seal to optimize the sealing conditions for three laminate combinations:

| Top | Bottom |
|---|---|
| RND #6 | RND #3 |
| RND #6 | RND #8 |
| AS #2 | AS #1 |

The heat sealing parameters studied were temperature, dwell time, and effective jaw pressure. At that time of sealing, our Instron Universal Tensile Tester was temporary out of service, and thus the seals were only evaluated visually. Two characteristics were used to evaluate the sealing condition—resistance to heat and control of seal width. Since our heat sealer had only the upper band heated, we concluded that if the bottom web showed signs of melting, it had too low resistance to heating. We also inspected the edge of the seal, and a good seal should have clear seal edge. Currently we are measuring the seal strength with an Instron Universal Tensile Tester.

Our preliminary results suggest that optimum operating conditions are

| | |
|---|---|
| Jaw temperature: | 240 - 250 °C |
| Dwell time: | 1 sec |
| Jaw pressure: | 50 psi |

## F. Prototype Mold

A preliminary design and construction of a prototype mold is underway (Figure 10). The final construction will accept a 6" x 9" flat sheet and be able to cold form foil laminate into a selected pocket shape.

Two die configurations were designed. One design has a 4" x 7 3/8" x 9/16" pocket which has the desired dimensions for an 8 fl. oz. MRE package. The calculated volume is approximately 7.9 fl. oz. The other design has the same dimensions but double depth (1 1/8'). The second design allows stretching the laminates to a higher degree for finding the limiting conditions in the cold forming process.

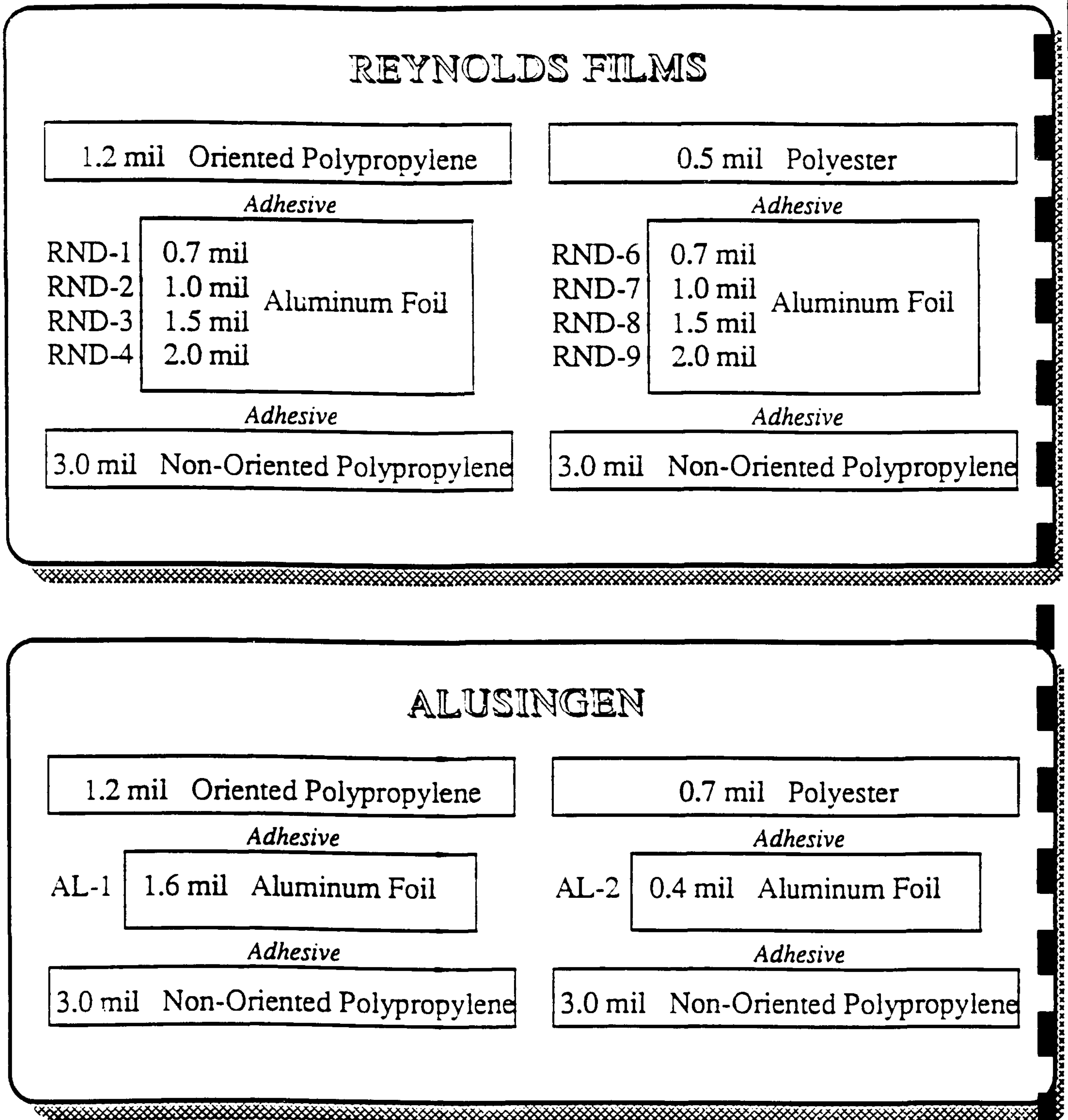



Figure 1. Construction of Available Laminates (Named by Codes)

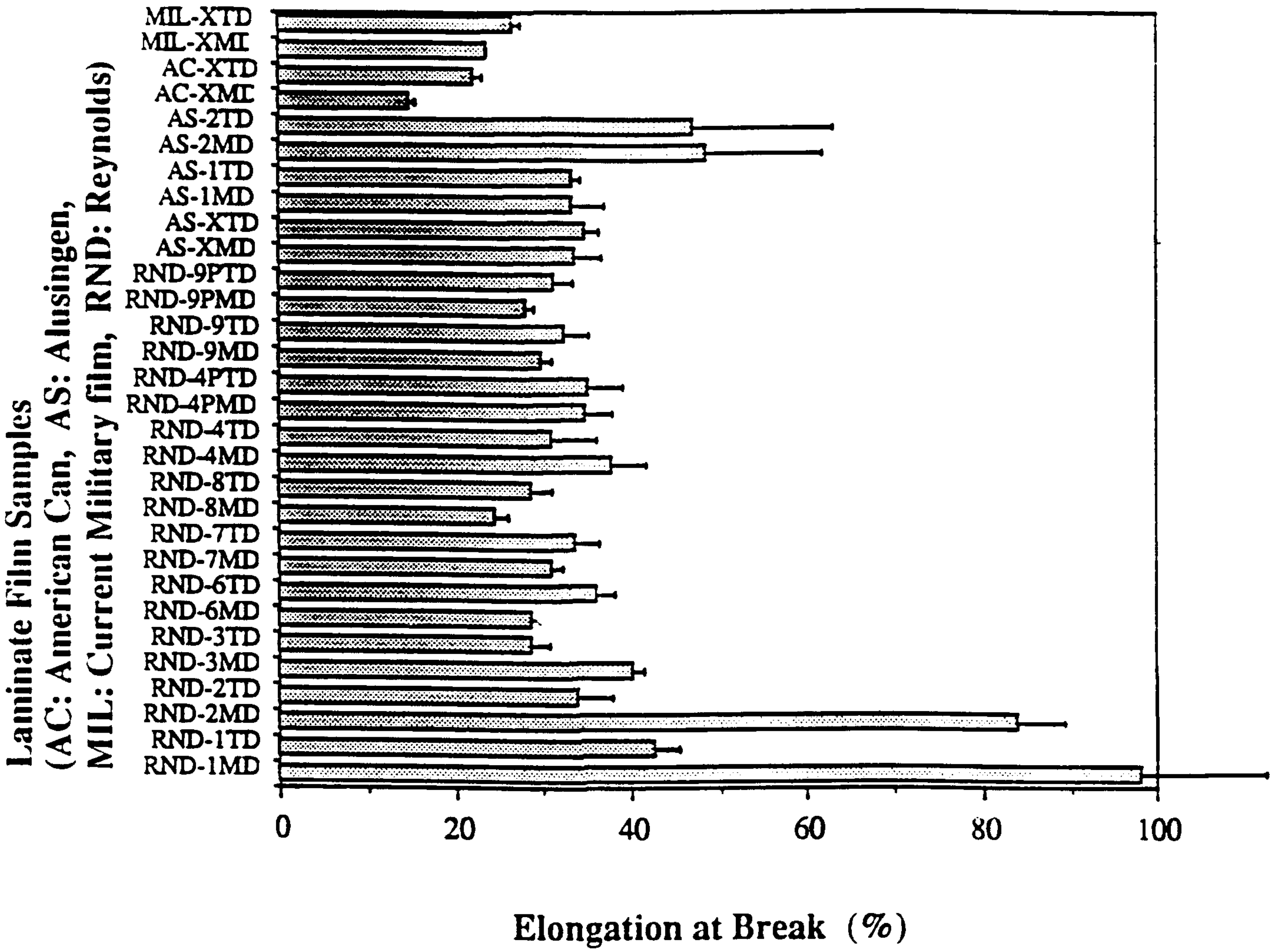



Figure 2. Elongation at break of various laminates

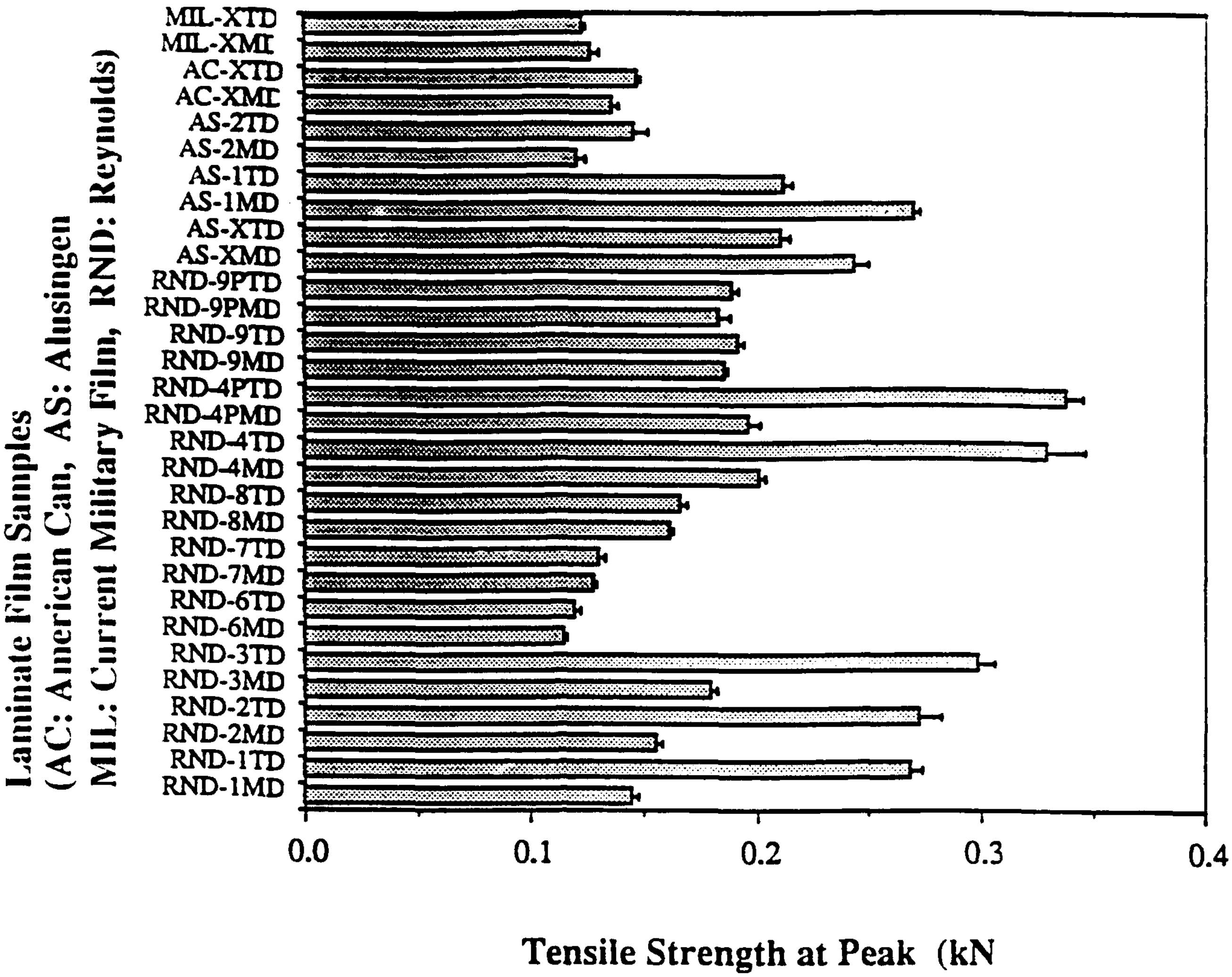



Figure 3. Tensile strength of various laminates

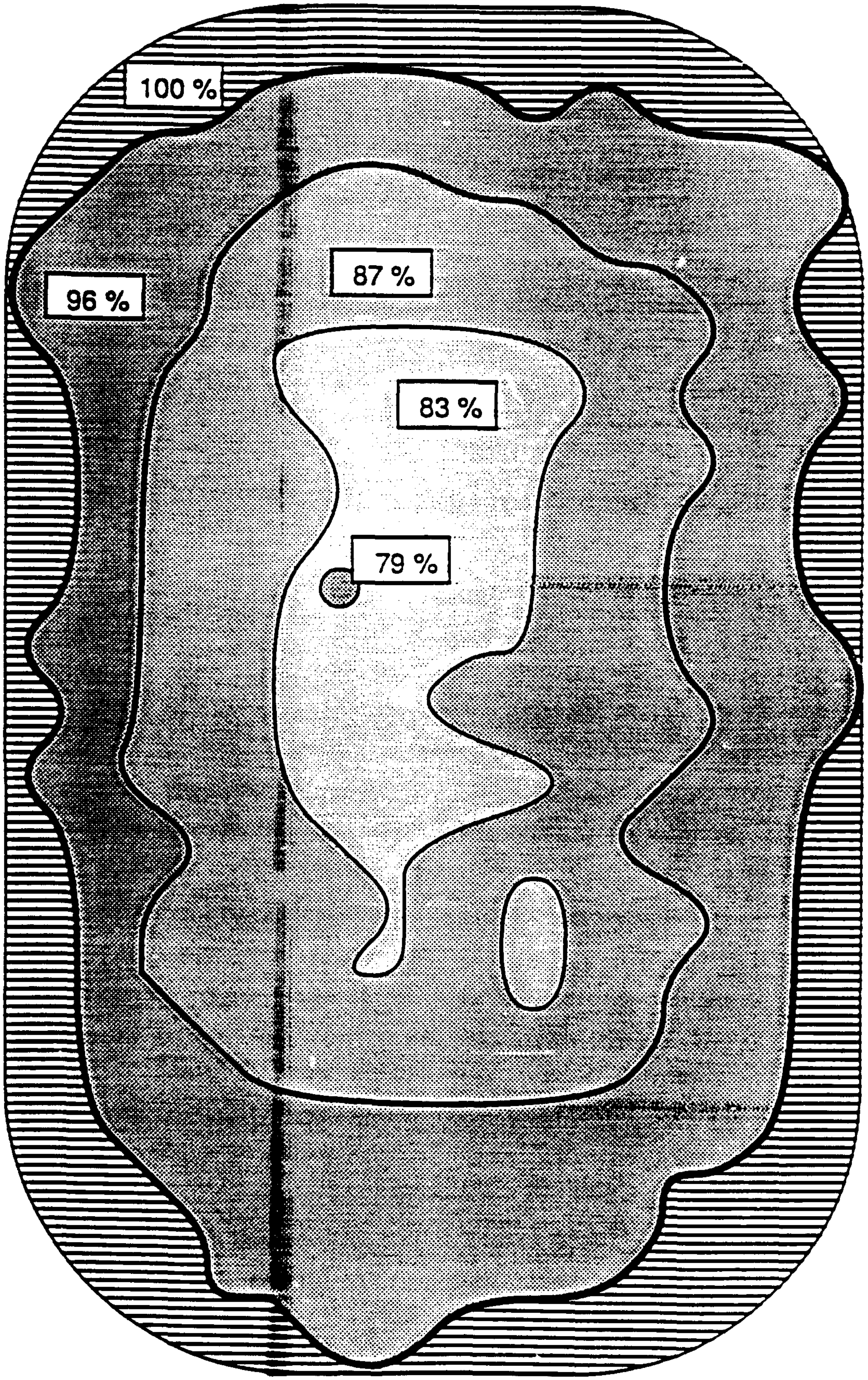



Figure 4. Thickness profile of a formed cavity of the presently used MRE laminates

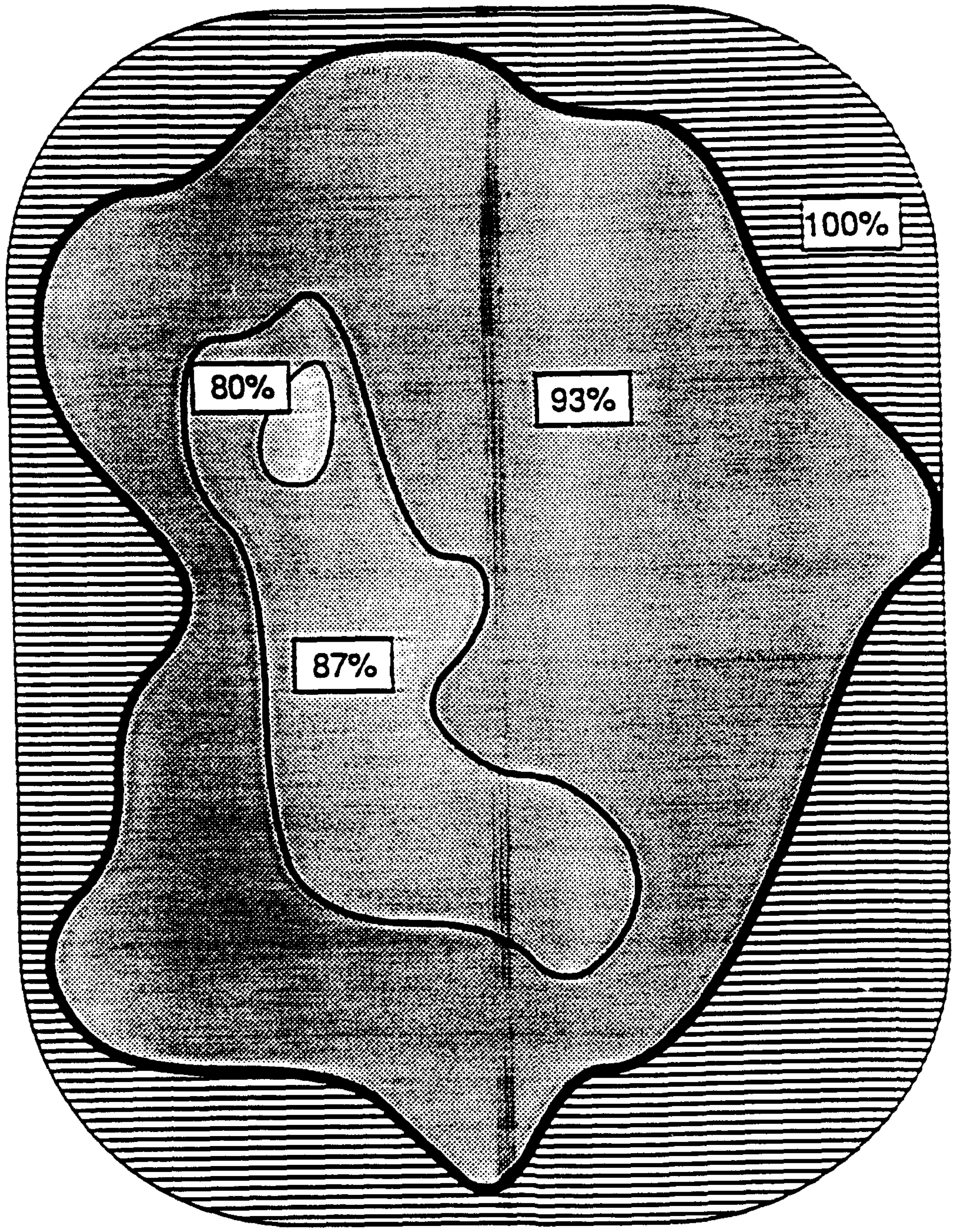



Figure 5. Thickness profile of a formed cavity of RND #6

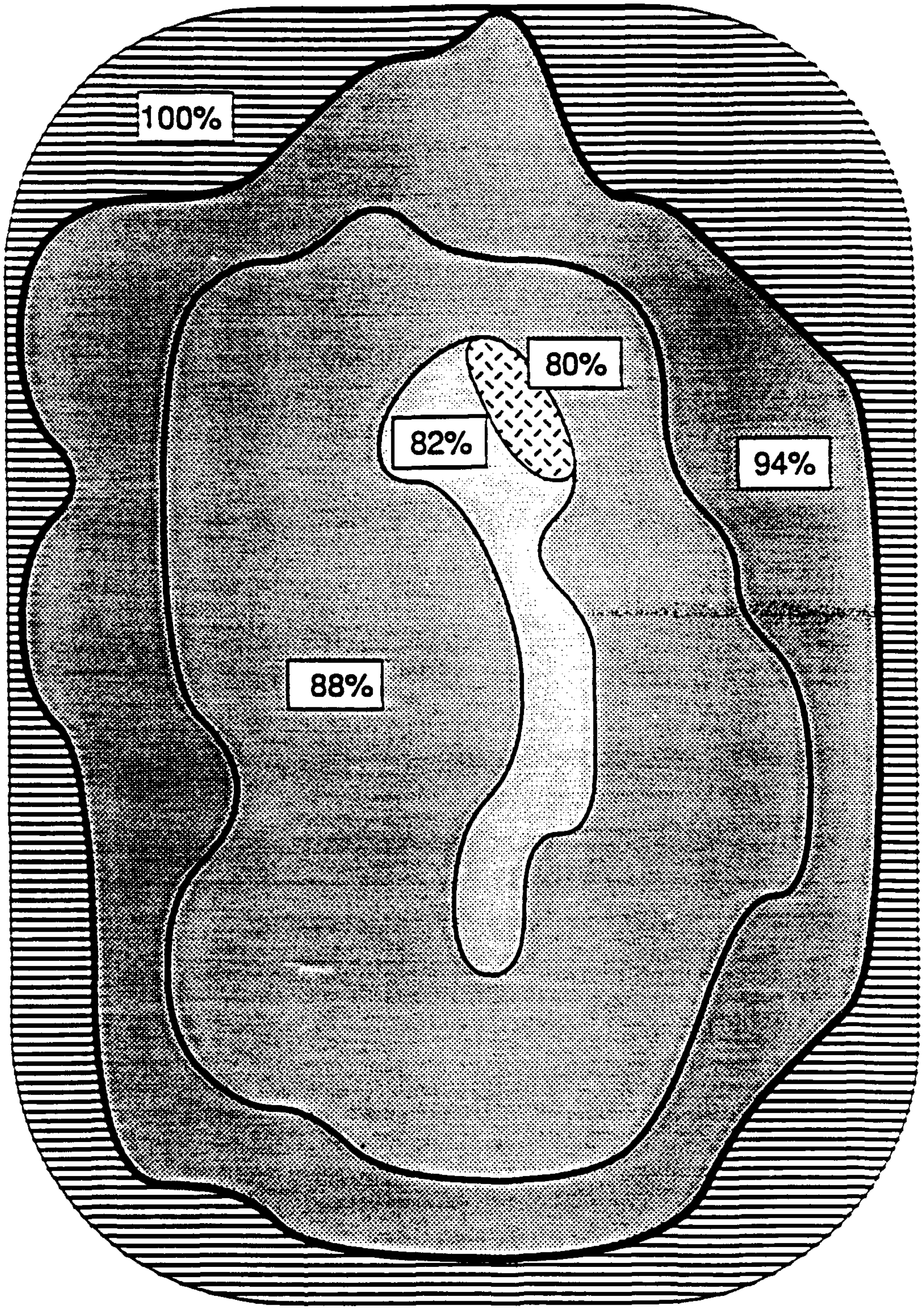



Figure 6. Thickness profile of a formed cavity of RND #8

| Temp (°C) | Char. \ Time (Sec) | 0.5 | 1.0 | 1.5 | 2.0 |
|---|---|---|---|---|---|
| 230 | Resist to heat | G | G | B | B |
| | Ctr. of S.Wdth | G* | G* | G* | N* |
| 240 | Resist to heat | G | N | B | B |
| | Ctr. of S.Wdth | G* | G* | N* | B* |
| 250 | Resist to heat | G | B | B | B |
| | Ctr. of S.Wdth | G* | N* | B* | B* |
| 260 | Resist to heat | N | B | B | B |
| | Ctr. of S.Wdth | G* | N* | B* | B* |
| 270 | Resist to heat | B | B | B | B |
| | Ctr. of S.Wdth | G* | N* | B* | B* |

Resistance to heat

G: Bottom film is not melted
N: Bottom film is about to melted
B: Bottom film is melted

Control of seal width

G*: Edge of seal is clear
N*: Edge of seal is partly clear
B*: Edge of seal is not clear

Figure 7. Heat Sealing Characteristics
(RND# 6 as top web , RND #3 as bottom web)

| Temp (°C) | Char. \ Time (Sec) | | | | |
|---|---|---|---|---|---|
| 230 | Resist to heat | G | G | G | G |
| | Ctr. of S.Wdth | G* | G* | N* | B* |
| 240 | Resist to heat | G | G | N | B |
| | Ctr. of S.Wdth | G* | G* | N* | B* |
| 250 | Resist to heat | G | G | B | B |
| | Ctr. of S.Wdth | G* | G* | B* | B* |
| 260 | Resist to heat | G | B | B | B |
| | Ctr. of S.Wdth | G* | N* | B* | B* |
| 270 | Resist to heat | B | B | B | B |
| | Ctr. of S.Wdth | G* | B* | B* | B* |

Resistance to heat

G: Bottom film is not melted
N: Bottom film is about to melted
B: Bottom film is melted

Control of seal width

G*: Edge of seal is clear
N*: Edge of seal is partly clear
B*: Edge of seal is not clear

Figure 8. Heat Sealing Characteristics
(RND# 6 as top web , RND #8 as bottom web)

| Temp ('C) | Time (Sec) / Char. | | | | |
|---|---|---|---|---|---|
| 230 | Resist to heat | G | G | N | B |
| | Ctr. of S.Wdth | G* | G* | G* | G* |
| 240 | Resist to heat | G | N | B | B |
| | Ctr. of S.Wdth | G* | G* | G* | N* |
| 250 | Resist to heat | G | N | B | B |
| | Ctr. of S.Wdth | G* | G* | N* | B* |
| 260 | Resist to heat | G | B | B | B |
| | Ctr. of S.Wdth | G* | N* | B* | B* |
| 270 | Resist to heat | N | B | B | B |
| | Ctr. of S.Wdth | G* | N* | B* | B* |

Resistance to heat

G: Bottom film is not melted
N: Bottom film is about to melted
B: Bottom film is melted

Control of seal width

G*: Edge of seal is clear
N*: Edge of seal is partly clear
B*: Edge of seal is not clear

Figure 9. Heat Sealing Characteristics
(AS #2 as top web , AS #1 as bottom web)

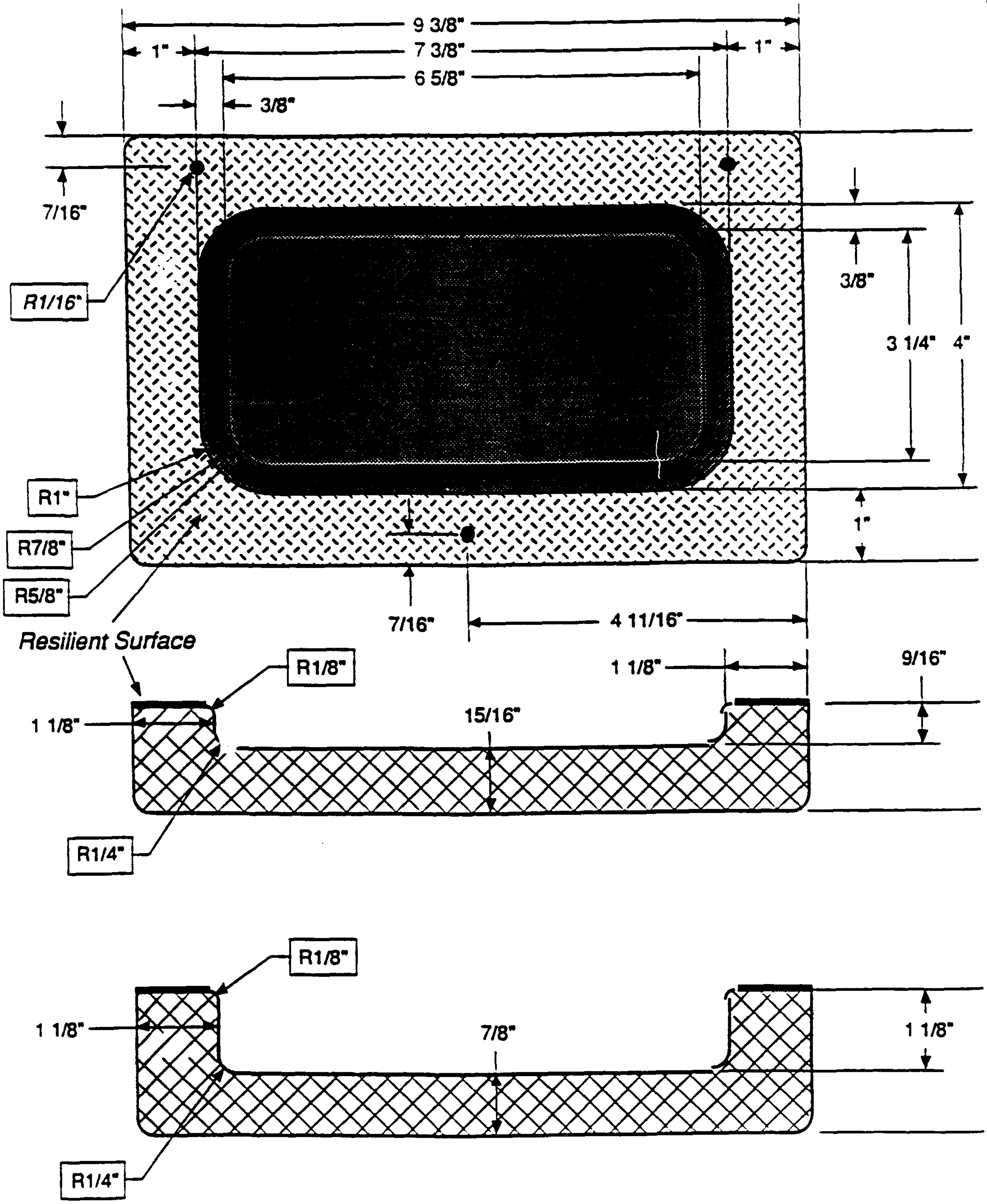
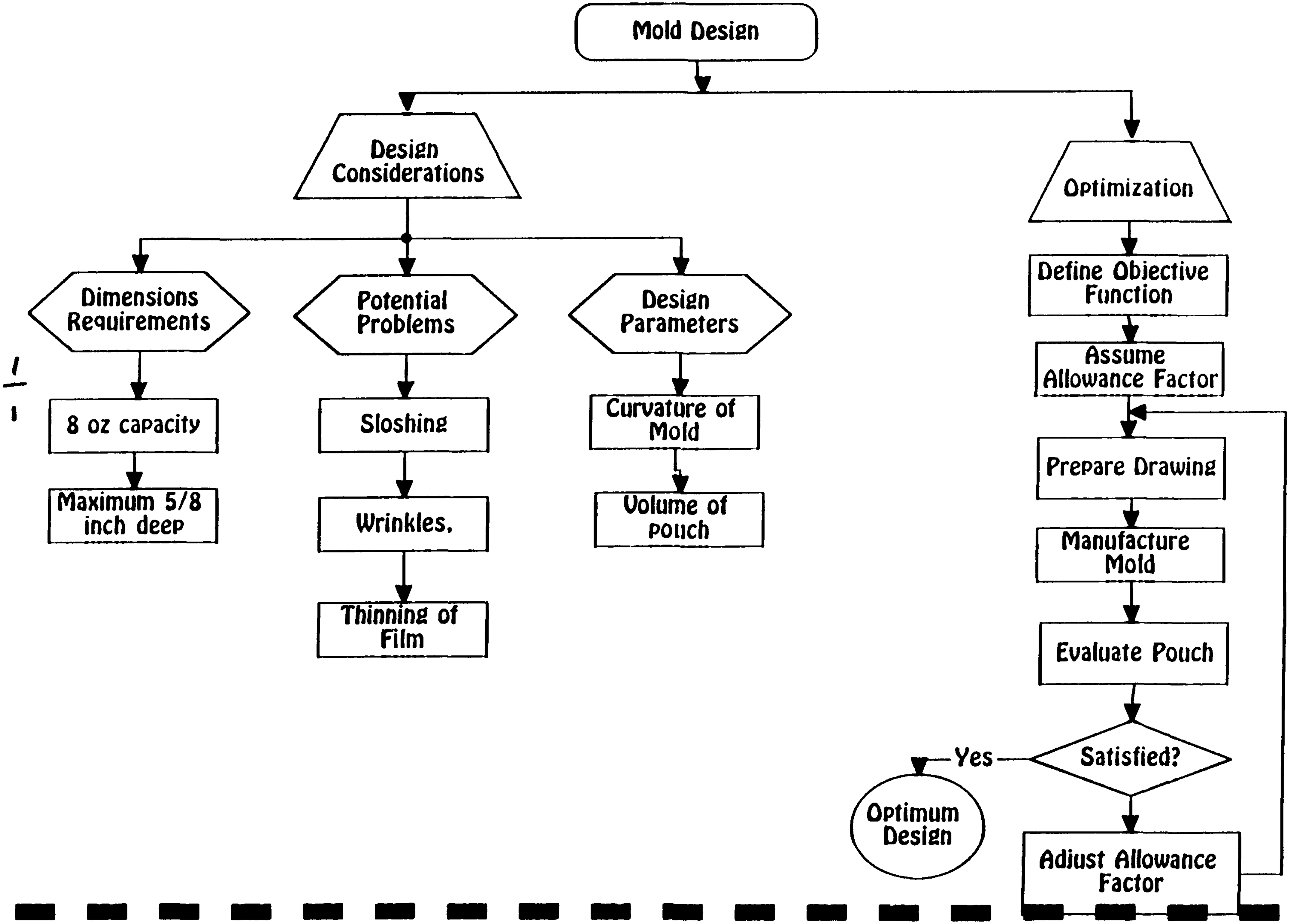
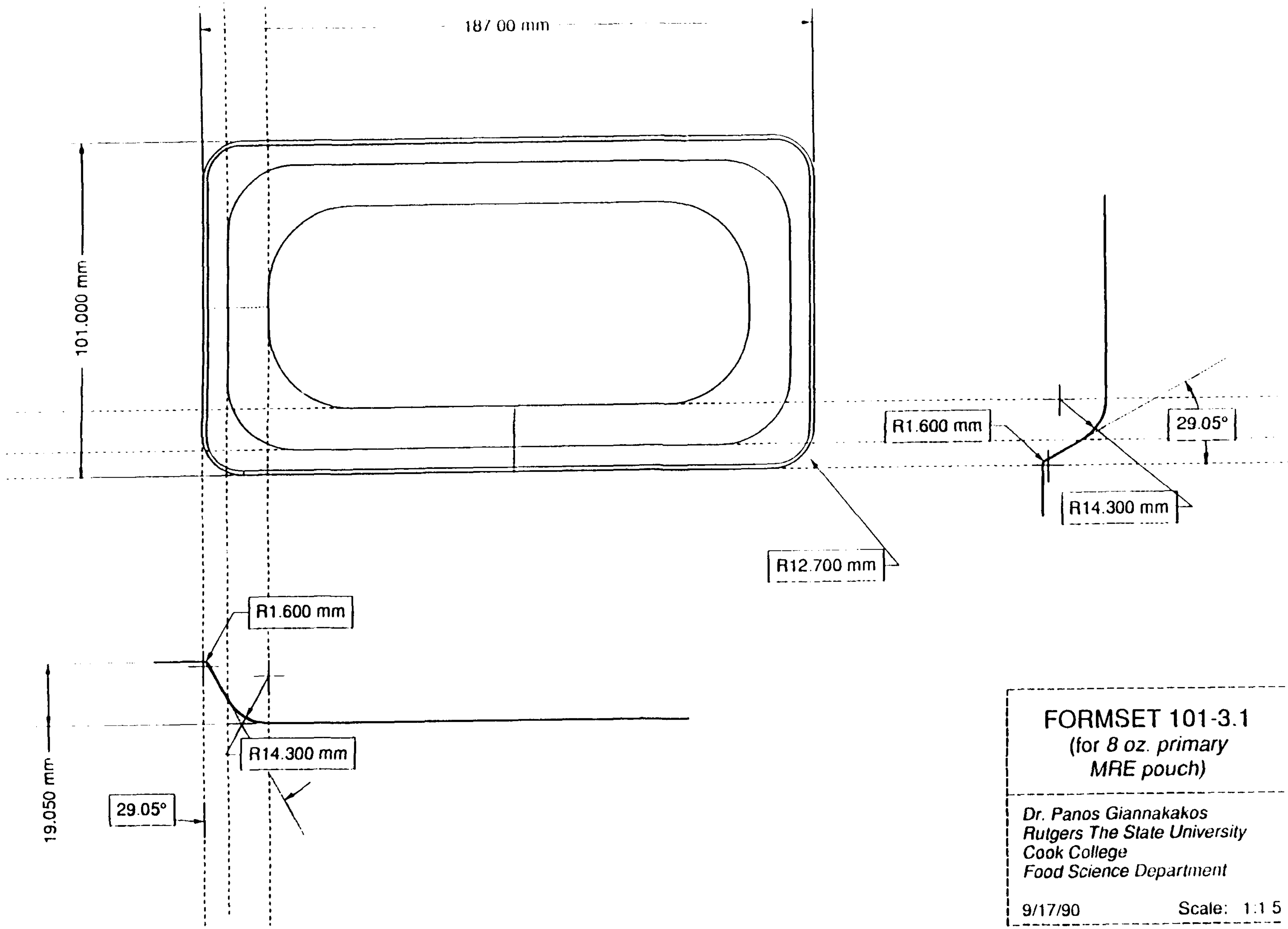



Figure 10. Prototype dies for cold forming of aluminum foil laminates

CRAMTD Mon, Aug 20, 1990 12:40 PM



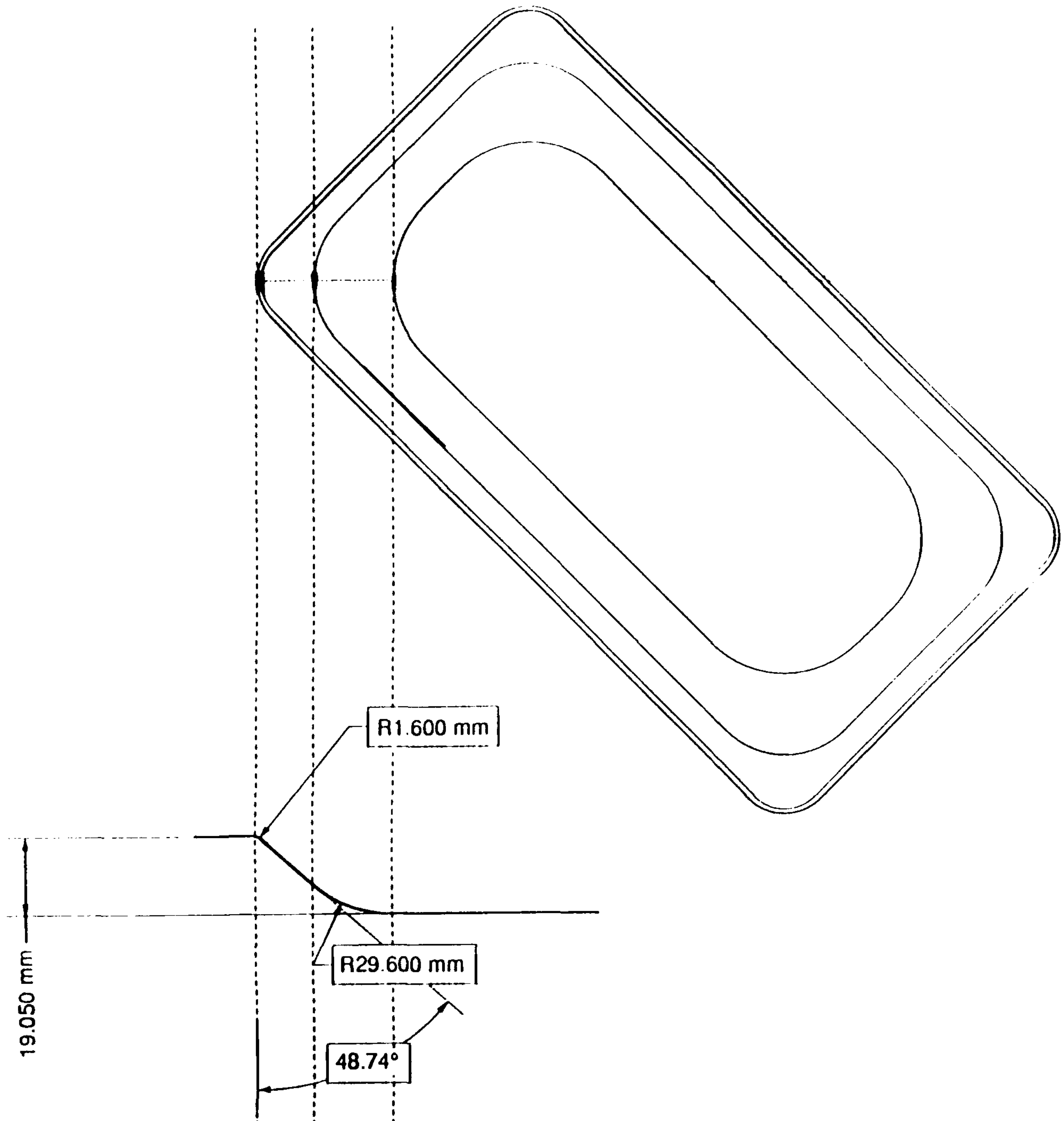



FORMSET 101-3.1
(for *8 oz. primary MRE pouch)*

*Dr. Panos Giannakakos*
*Rutgers The State University*
*Cook College*
*Food Science Department*

9/17/90 Scale: 1:1 5

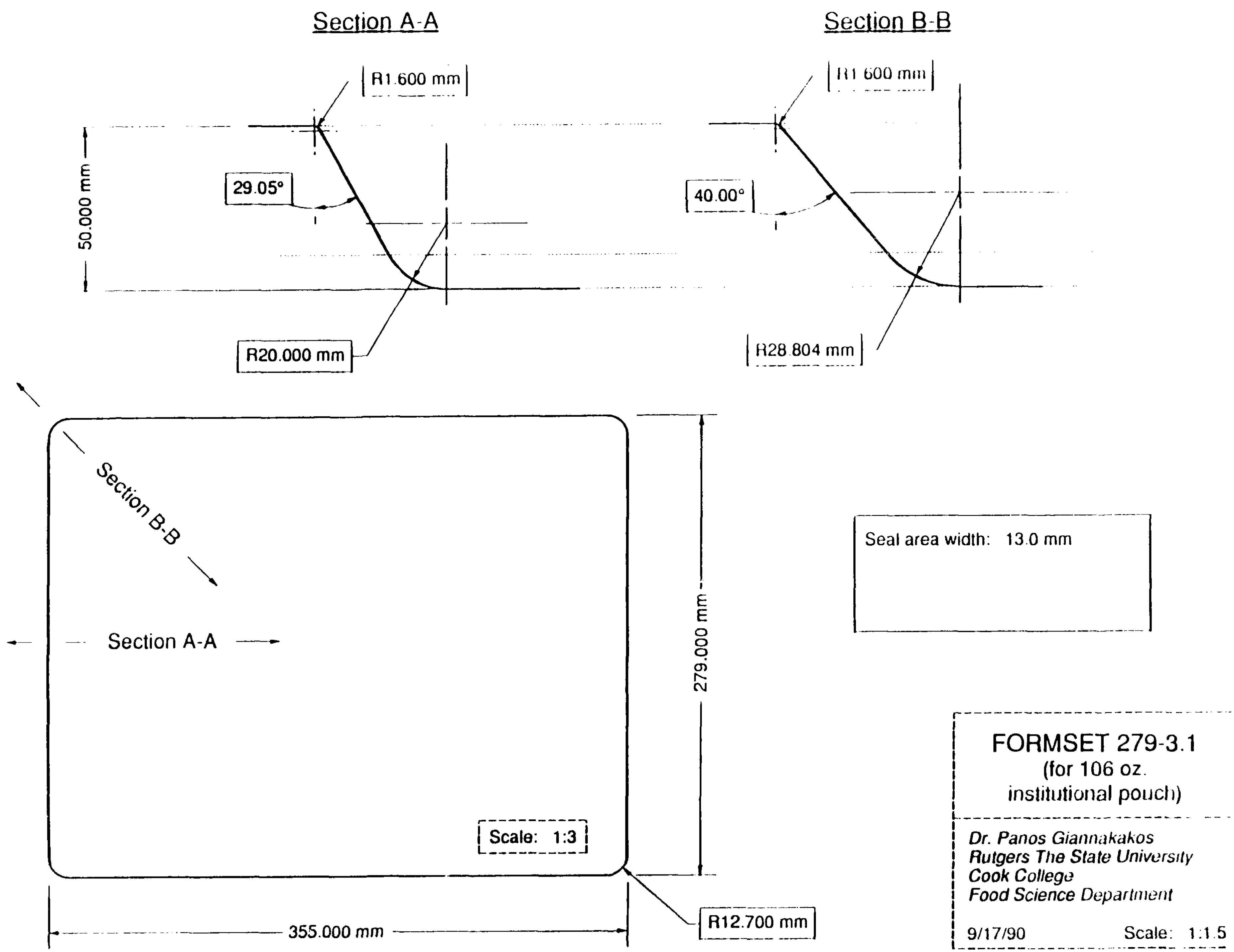
1 of 2




FORMSET 101-3.1
*(for 8 oz. primary MRE pouch)*

*Dr. Panos Giannakakos*
*Rutgers The State University*
*Cook College*
*Food Science Department*

9/17/90 Scale: 1:1.5


Section A-A
R1.600 mm
29.05°
50.000 mm
R20.000 mm
Section B-B
R1.600 mm
40.00°
R28.804 mm
Section B-B
Section A-A
Scale: 1:3
279.000 mm
355.000 mm
R12.700 mm
Seal area width: 13.0 mm
FORMSET 279-3.1
(for 106 oz.
institutional pouch)
Dr. Panos Giannakakos
Rutgers The State University
Cook College
Food Science Department
9/17/90
Scale: 1:1.5

# Progress Report
# CRAMTD STP-8

**Kit L. Yam, Ph.D.**
*Co-Principal Investigator*
**Panos N. Giannakakos, Ph.D.**
*Post-Doctoral Fellow*
**Yoon-Seok Song**
*Graduate Assistant*

September 11, 1990

## I. Summary

This work is a part of the CRAMTD STP-8 project which deals with the package development and performance of MRE pouches on a horizontal form/fill/seal machine. A study is being conducted on evaluating aluminum/plastic laminates, being stretched formed, to be used for MRE pouches. To identify suitable laminates, several commercial and custom made laminates have been obtained and their performance are being evaluated and compared.

Present work is being conducted on determining suitable dimensions / shape of the prototype mold. An array of films with varying aluminum thicknesses has been ordered to be used in the prototype HFFS machine.

## II. Objectives

Here are some of the major objectives:

1. Evaluate and characterize aluminum/plastic laminates suitable for stretch-forming, to be used for retortable MRE pouches.
2. Identify or develop test methods to evaluate the performance of these laminates.
3. Identify and study the process parameters for stretch-forming of laminate films into molds.
4. Design the forming mold for the prototype HFFS machine.
5. Study the influences of process parameters and the pouch dimensions on the extent of product sloshing.
6. Evaluate the mechanical strength and seal integrity of the pouches produced by the prototype machine.

## III. Progress Update

### A. Prototype mold

From preliminary results obtained with the use of the bench-top prototype was concluded that a depth of 6/8" should be adequate. The military specifications for the final pouch width is 5/8". If the formed pocket has depth less than 6/8" should not adequately accommodates the product at the feeding station. Deeper pockets should result in excess wrinkle when the pouches are evacuated before the sealing stage.

Preliminary test runs where made at T. W. Kutter's (Inc.) Avon headquarters. It has been used a Tiromat, model 3000, HFFS machine running the AS-1 film (by Alusingen of West Germany) (see figure 1 for description of the film). The first set of formed pockets had approximately a depth of 6/8". The sides took a "natural" shape by applying compressed air at 30 psi for one second. A thickness profile diagram of formed pockets is shown in figure 2. The maximum thickness reduction measured is about 25% of the original gauge. Unfortunately the orientation of the mold was not the proper one since the longest side was aligned at the traverse direction of the film. After an engineering of a mold and a reoptimization, a third set of formed pockets was made. This last set was properly oriented and was satisfactory as far as total volume capacity was concerned. The thickness profile is shown in figure 3. It is interesting to note that a critical thinning is along the longer side of the pocket. Further ahead, in order to standardize a most desirable pocket shape, an initial engineering draft was made and sent to T. W. Kutter (figure 4).

A crucial forming parameter is the deepening ratio which denotes the relation of the narrow inner side of the package to the depth of the package. The smaller the deepening ratio the greater the extent of stretching or elongation of the film required. Alusingen suggests a minimum ratio of 4 with a lateral angle of the pocket not lower than 30 degrees. Smaller angles can be obtained with higher deepening ratios or in other words with lower depths of the pocket. In our design (figure 4) we have a ratio of 4"/0.75" or 5.3 and a lateral angle of 29°. It is obvious that the mold design can permit the use of a laminate with thinner gauge of aluminum foil than the one that AS-1 film incorporates.

### B. Purchase of laminate films

### C. Bond strength

A typical three layer laminate film suitable for retortable pouches consists, from outside to inside, of polyester / adhesive / aluminum foil / adhesive / polyolefin. A seal strength will be critically determined from either the strength of the inner sealable layer or the interlaminar bond strength between the inner layer and the aluminum foil. In all the laminate films examined, the inner layer consists of non-oriented polypropylene. This film is highly elastic with maximum elongation ability reaching about 600%. The two outer layers do not have as much elasticity. Thus the observable seal strength should depend greatly on the polypropylene - aluminum foil bond strength.

We attempted to measure the interlaminar bond strength in few of the examined cold-formable laminate films. However we should note that the measurement method (ASTM, F 904-84) includes the force required to bend the separated layers, in addition to that required to separate them. Also, conditioning the specimens, by pre-stretching and/or retorting, it affects the elastic modulus of the plies as well along with the strength of the adhesive, and it should be reflected in the bond strength measurement. In any way, table 1 summarizes the measured bond strengths from various films and treatments.

Table 1: Bond strength for various films and treatments (MD strips, 1" width)

| Film | As is | After 20% elongation | After 20% elongation and retorting |
|---|---|---|---|
| | [ N/m (lbf/in) ] | | |
| AS-1 | 476 (2.720) | 258 (1.472) | -- |
| AS-2 | 808 (4.615) | 759 (4.332) | 876 (5.002) |
| RND-3 | 1714 (9.786) | 1032 (5.892) | -- |
| RND-6 | 1065 (6.079) | -- | -- |
| RND-8 | 1761 (10.058) | 1045 (5.966) | -- |

With some reserved skepticism we can draw a pattern from the above data. The initial elongation of the strips by 20% serves as a model for the actual stretch forming of the film. It is very difficult to measure experimentally the bond strength of film strips cut from an actual formed pocket. The data (from table 1) show that stretched strips show a decreased bond strength while after retorting the bond strength seems to recover. Not all the films were able to evaluated due to increased stiffness, presumably, of the adhesive.

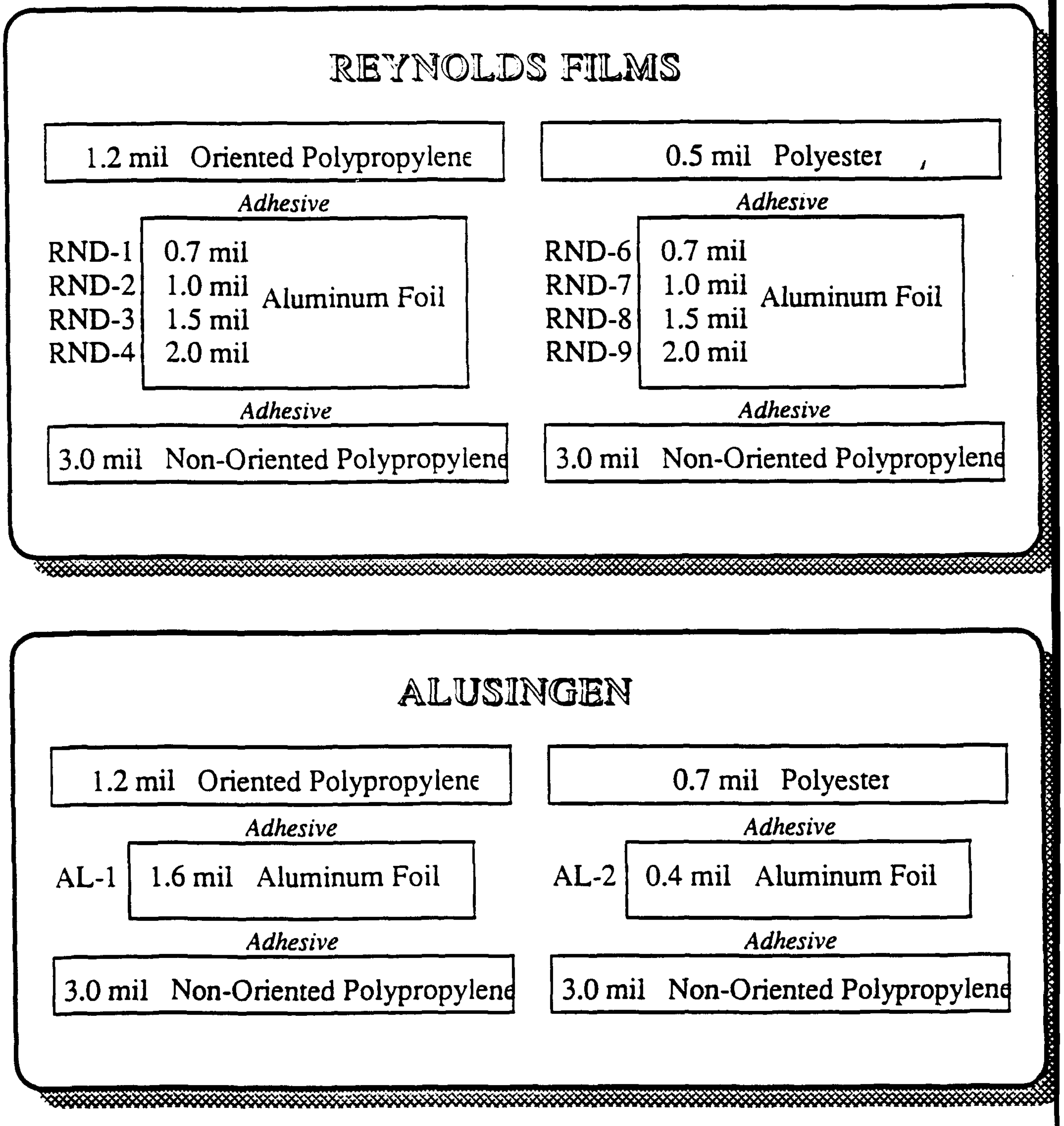



Figure 1. Construction of Available Laminates (Named by Codes)

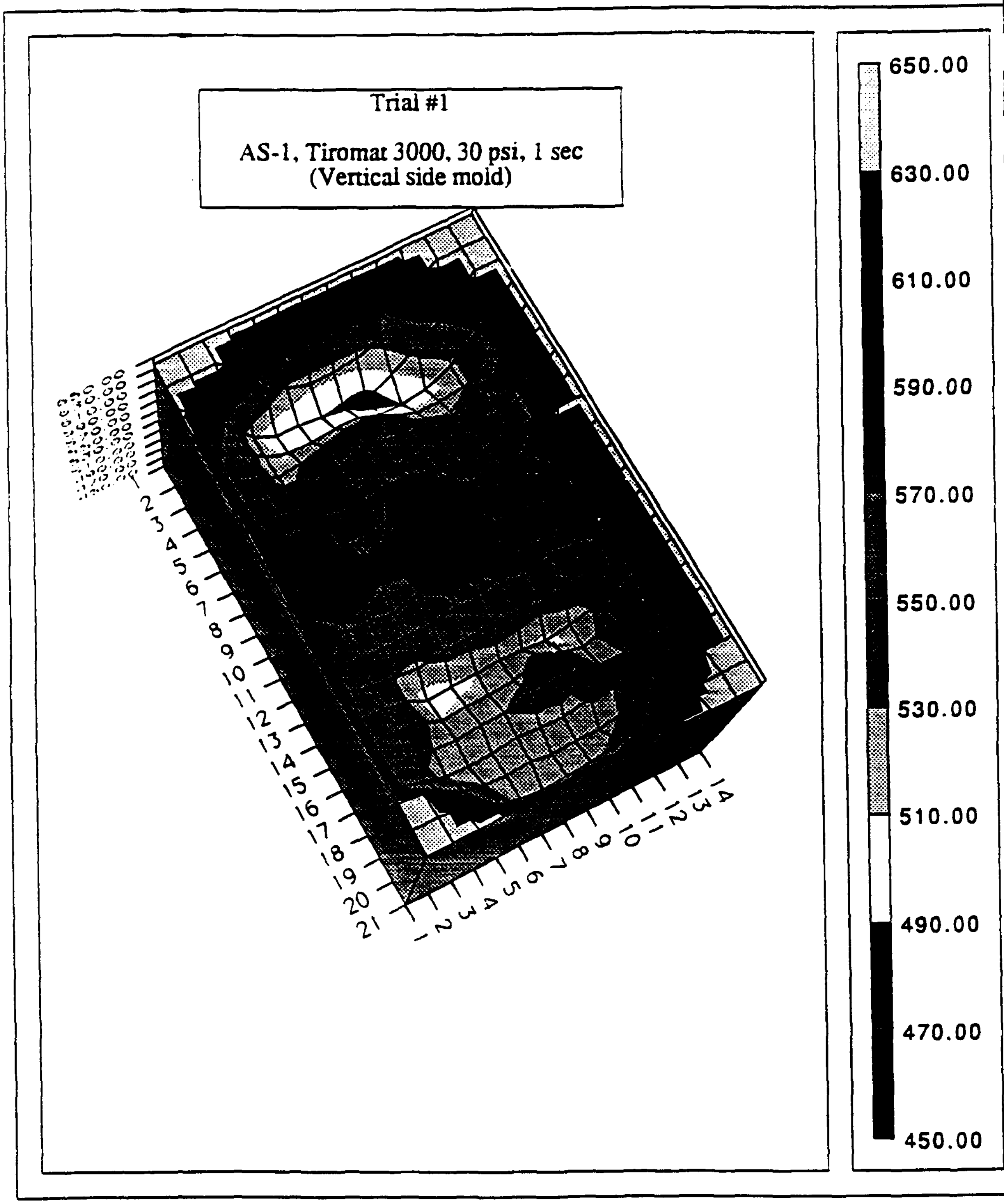



Figure 2: Thickness profile of formed pocket from 1st trial at Kutter Inc. using AS-1 film

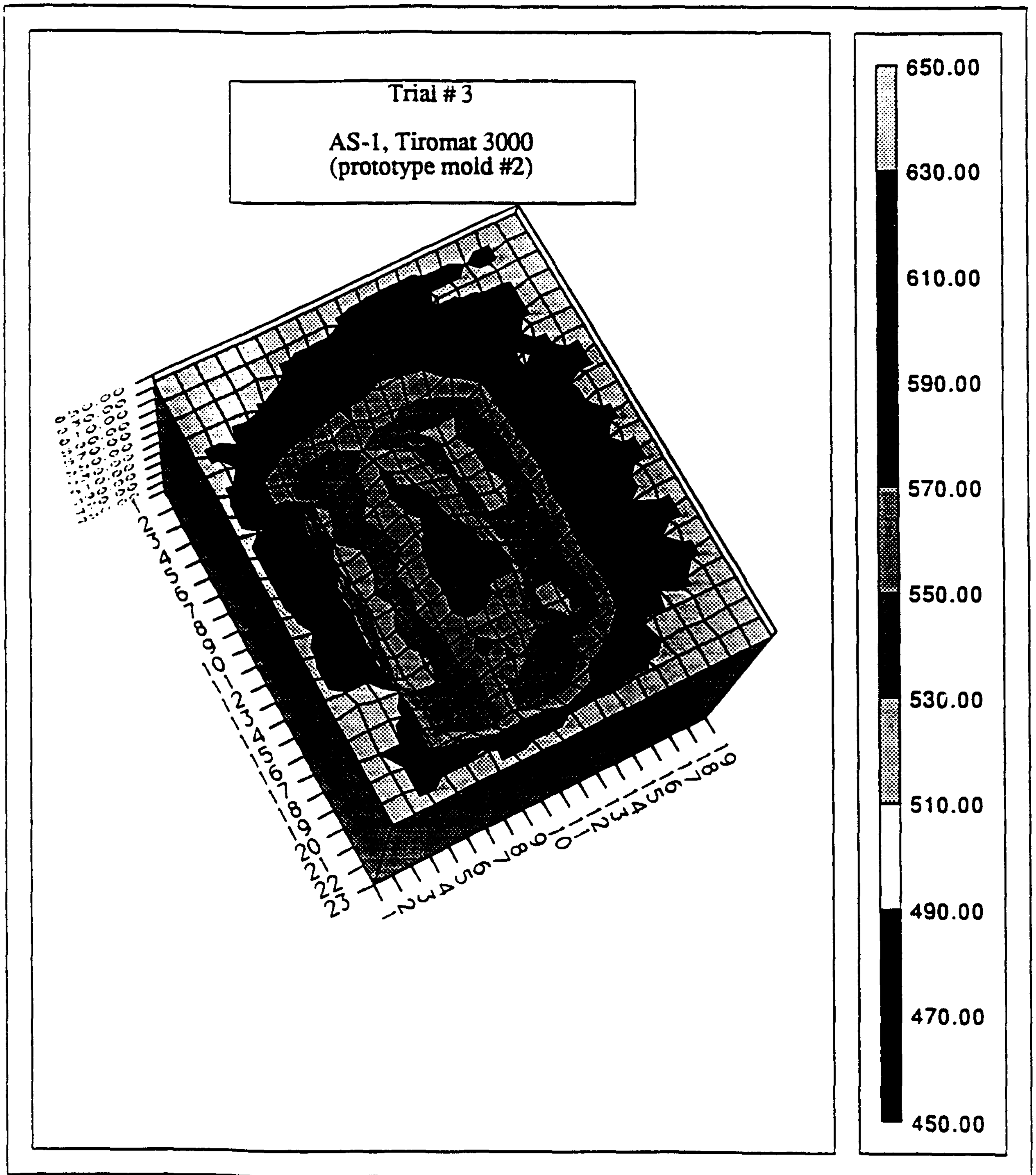



Figure 3: Thickness profile of formed pocket from 3rd trial at Kutter Inc. using AS-1 film

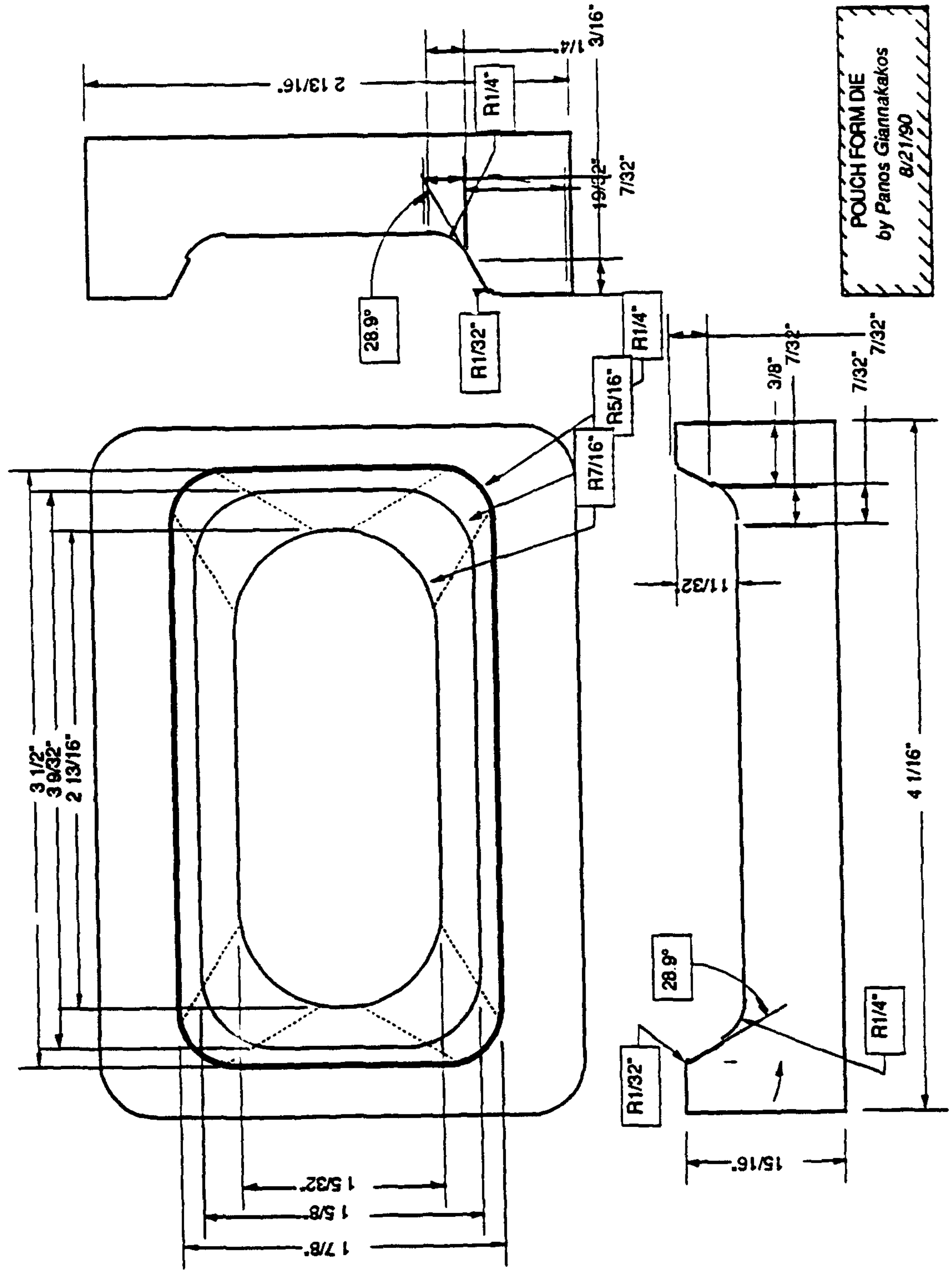



Figure 4: Mold design for the prototype machine

TWO KUTTER INC
91 Wales Ave., P.O. Box 7, Avon, MA 02322 (508) 588-2600



October 17, 1990

Quotation #: 00216

Mr. Ted Descovich
RUTGERS UNIVERSITY
Cook College
C.A.F.T.
P. O. Box 231
New Brunswick, NJ 08903

Dear Ted:

Regarding the feasibility study to determine how to incorporate tray sealing ability in the Tiromat 3000/440 for the 1/2 steam table tray, we propose that this feasibility study be in three steps.

## STEP 1

After the trays seal flange profile has been determined, we will supply:

Prototype hardware to seal the Half Steam Table Tray consisting of:

(1) Seal Mold with internal support
(1) Profiled Sealing Plate and upper vacuum chamber lid
(1) Seal Support Frame

**TOTAL $14,955.00**

These parts can be made to be used in your 3000/440. The filled trays would be feed by hand into the Tiromats seal station for vacuuming and sealing, and than removed by hand. This would give you the means to test a wide variety of preformed tray materials and shapes, through your retort process.

## STEP 2

We would that begin to determine what would be the best way to incorporate a tray sealing system into your 3000/440,taking into consideration the possibility to seal other size trays as well.

Design of the following station would be needed:

Tray De-nesting.

Transport of the tray thru the filling area.

Transfer of the filled trays into the vacuum and seal station.

T W Kutter, Inc. 91 Wales Avenue, P.O. Box 7, Avon, Massachusetts 02322

October 17, 1990 Quotation #: 00216

Mr. Ted Descovich
RUTGERS UNIVERSITY


**STEP 2 - Continued**

Transferring finished trays onto a transport system in the cross cutting section, for cutting and exiting the machine.

Development of a cutting device to cut the lidding material.

We would provide drawing that would show concepts after STEP 1, that will have established what tray will be technically, weight, material, lidding requirements, product to be handled and production speeds.

**TOTAL DESIGN ENGINEERING $ 40,000.00**

STEP 3

Would be to manufacture the needed hardware, modify the programme, and install and debug the system as needed.

**TOTAL FABRICATION AND DEBUGING $126,250.00**

Sincerely,

T W Kutter, Inc.

Alan A. Mais
Alan A. Mais, Jr. bjc
Sr. Application Specialist

AAM:bjc

Enc.

cc: D. Andronico
J. Balog
R. Merrill
P. Paquette
T. Pile

# COMBAT RATION ADVANCED MANUFACTURING TECHNOLOGY DEMONSTRATION (CRAMTD)

## Level 1 Automation Control Strategy for Horizontal Forming/Filling/Sealing Machine

Technical Working Paper (TWP) 19

T.O. Boucher, T. Descovich and E. Goldman
CRAMTD
Rutgers University
October, 1990

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THE CENTER FOR ADVANCED FOOD TECHNOLOGY*
Cook College
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TEL: 908-932-8306
FAX: 908-932-8690

# Level 1 Automation Control Strategy

# for

# Horizontal Forming/Filling/Sealing Machine

Thomas Boucher
Theodore Descovich
Ernest Goldman

CRAMTD
Technical Working Paper (TWP19)

10/18/90

## 1.0 Introduction

This report addresses in part program Item 4.5.1 of the CRAMTD Management Master Plan. This program item requires a control strategy plan in accordance with final process specifications for the CRAMTD pilot plant. This report will focus on the horizontal forming, filling, and sealing machine.

## 2.0 Machine Equipment Specification

Figure 1 illustrates the mechanical design of the pouch line. There are four major stations: Bottom Film Forming, Product Loading (Pouch Filling), Package Sealing, and Package Separation (cutting).

The bottom forming station consists of a mold which is raised until in contact with the film and a vacuum which pulls the film into the mold. The product loading station provides access to manual or automatic loading into the open pouches prior to sealing. The package sealing station is where the top and bottom films are heatsealed together to form the final package. The package separation station contains knives which separate and trim the pouches after sealing.

## 3.0 Equipment Operation

Figure 1 will be used to describe the general operation of the pouch line. Film and package transport is from right to left. Film to be formed into pouch bottoms is mounted on a roll at the extreme right and is pulled over guide rollers to open semi-circular grip-clips which firmly grip the outside edges of the film, stopping at each machine station. An AC drive motor with optical encoder for digital index length control provides precise incremental steps for proper package registration during forming, sealing, and separation.

A switch interrupts transport and operations in all sections when the bottom film roll is empty.

In the bottom film forming station the lower mold assembly is raised until a vacuum can draw the film into the mold for a programmed time period. Programmed controls are described in Section 4 of this report. Proximity switches using magnetic field measurements control the forming tool positioning in the up and down positions. When the forming is complete the mold is lowered in preparation for film advance (indexing) and the next package generation cycle. Indexing cannot occur until bottom forming is complete and the molds are down, again for a programmed time period.

Initial equipment capabilities also include preheating of film, plug assist forming, and compressed air which is applied from above, for possible use in future packages using various plastic materials. It is not anticipated that these will be required during initial operation. After bottom forming is complete, the indexing operation moves the pouches to subsequent stations for loading, sealing, and separation. However, in the steady-state condition forming, loading, sealing, and cutting take place simultaneously with the film stopped, between indexing. Product loading will be the subject of an upcoming STP and will not be described in this report.

Pouches which have been indexed to the package sealing station will already have been bottom formed and filled. The upper film roll is fed to the sealing station by guide rollers. As in the bottom forming station a switch will interrupt all operations when the upper film roll is empty. Positioning controls for the sealing operation are similar to the bottom forming station, with 2 proximity switches. An internal watchdog timer is also used as a safety measure.

When upper and lower film have been properly positioned for sealing, pneumatic cylinders provide uniform pressure to insure multitrack safety welds. Since this is a food product, pouch evacuation is required. A high speed nozzle evacuation system draws air out of the pouch just prior to sealing.

In the package separation station controls for solenoids provide exact timing for lift and cut operations while film is at rest. Longitudinal cutters require no controls.

Finally, elimination of waste, not shown in Figure 1, is controlled by the programmed setting of an output bit which opens a vacuum canister plugged into any vacuum port.

## 4.0 Horizontal Forming/Filling/Sealing Machine Control Strategy

Section 3.0 described the overall operation of the horizontal forming/filling/sealing machine. In this section we describe the control hardware and software configuration.

### 4.1 Control Hardware Configuration

The control hardware for the pouch forming/filling/sealing line is shown in Figure 2. All programmed automatic controls are contained in the "SMART" (System Monitoring and Reporting, Tiromat) system.

Major components in the SMART system are the programmable controller, PLC 2/17, manufactured by the Allen-Bradley Company, the LSI 11/23 computer with its associated display monitor, keyboard, and printer, and the communications module which provides interface ports between the two. Also a part of the SMART system, but not shown, are Input/Output modules for the PLC 2/17 which contain the necessary circuitry to connect both the input devices from the various sections of the pouch forming/filling/sealing line to the PLC and the output devices from the PLC to these same sections. Input devices provide the conditions in the line (positions, temperatures, etc); output devices react to action commands (turn on, turn off, increase temperature, etc.). Types of input/output modules will include:

(a) Digital Encoder/Counter Module: This counts and encodes into 12-bit binary numbers, pulses provided by the high-speed optical beam counter attached to the indexing motor, allowing decisions based on comparisons with specified values stored in the PLC. This is used to control the length of time the drive motor is allowed to run and the times at which speed will be changed, which in turn controls how far and how fast the bottom film is advanced each index.

(b) Master Analog Input Module: Up to 8 analog signal device sensors may be scanned. For each analog voltage of 0-5 volts the magnitude is converted to a 12-bit 3-digit binary coded decimal value which is stored until it can be transferred to PLC memory for use in making decisions about process control parameters. If more than 8 analog input device signal levels are required, an Expander Analog Input Module is used to provide seven additional inputs.

(c) 24-Volt DC Input Module: This provides interfacing between on/off voltage levels originating from up to eight switches such as limit, selector, push-button, and proximity switches. Three modules are used, providing 24 input points.

(d) 24-Volt DC output module: This outputs 0 or 24 volts DC to turn on or off up to 8 devices such as indicators or solenoids when enabled by the PLC 2/17 processor. Five are used, providing 40 output points.

The Allen-Bradley PLC 2/17 contains the programmable controller microprocessor and memory. It is capable of monitoring and controlling up to 128 input/output devices that may be wired to the Input/Output modules described above. The PLC (or processor) examines data from input devices via input modules, processes the data according to the program stored in its memory, and transmits data to control output devices via output modules.

The SMART system is controlled by a Digital Equipment Corporation (DEC) Micro/PDP-11 computer system containing an LSI 11/23 Central Processing Unit (CPU) and memory, a monochrone display monitor, a keyboard, and a line printer. This computer system is used to provide the PLC with the information that its program needs to control the actions and functions in the horizontal forming/filling/sealing machine. While the PLC operating program contains instructions which control indexing, raise and lower tooling, apply vacuum, seal the package, start and stop cutting, and check film rolls, it needs information as to whether the machine is configured for bottom or top and bottom forming, what type of forming tool is installed, whether a nozzle is being used for evacuation, what type of index drive motor is installed, what time periods will be used for each of the process steps, etc. The purpose of the PDP-11 computer system is to provide this information through the interaction of its operating program with the machine operator who uses its display monitor output and keyboard input. Operators can also monitor real-time critical package generation values, such as sealing and forming temperatures and pressures, voltage levels, and valve positions, and can make on-line adjustments of parameters. Examples of services and facilities provided to the user by the PDP-11 monitor and keyboard will be given later in this report.

The PDP-11 system also controls the printing of package identification upon top film roll prior to pouch sealing and separation. This is indicated in Figure 2 but is not shown in Figure 1.

### 4.2 Control Software

The flow chart in Figure 3 indicates the general structure of the control logic. This software is the responsibility of the subcontractor and is loaded into the PLC via the Programming Port shown in Figure 2. Figure 3 does not show all of the program steps just as Figure 2 does not contain all of the process control input and output devices, but we can step through the flow chart and relate each programmed step to the control hardware which provides input data and output actions in Figure 2.

In Figure 3 the PLC program is represented by programmed tests and decisions, indicated by diamond shapes, and PLC output signals, indicated by rectangles. Inputs signals to the PLC, provided by input devices such as process sensors, timers, and proximity switches, can be inferred from the labels in the diamond shaped decision symbols.

Referring to Figure 3, after we start the program running, the program tests whether all of the service lines are turned on. These services include vacuum, air supply, gas supply (if used), and electric power. If these have been turned on, input signals will have caused the PLC to write ones in a specific memory area called the Input Image Table. If these bit locations contain ones, the answer to the test is yes and the program proceeds to the next test. If the answer to the test is no, then the program will continue to make this test during repeated input/output scans, until the answer is yes.

The second test indicated is whether three manual switches are all turned off. The emergency switch is self-explanatory. The maintenance switch is turned on when any maintenance routines, scheduled or unscheduled, are performed. The tool change switch is turned on when tools such as the bottom forming mold are being changed.

In the third test shown in Figure 3, as stated in section 3.0, the program will prevent operation when the bottom fill roll is empty.

If we follow the YES outputs from these first three test/decision symbols we see that when all these conditions are satisfied the program will enter the first rectangle and enable the bottom forming tool to be raised. In this and other rectangles "enable" is used rather than a command such as "raise forming tool" because the complete program may require other conditions to be satisfied.

When the tool is in the proper position, detected by the bottom proximity switch, the program proceeds to enable the bottom forming operation (in this case the drawing down of the film into a mold by means of a vacuum) to take place.

During steady-state operation of the line, filling, sealing, and cross cutting may take place simultaneously with bottom forming because the film is not advancing (indexing). For this reason the flow chart shows that filling can be enabled as soon as bottom forming is enabled. The same is true of sealing providing the top proximity switch indicates that the sealing tools have been correctly positioned.

Inputs and tests which prevent filling and sealing during startup, before the first bottom-formed films have reached the filling and sealing sections, are not shown.

Cutting operations (lift and cut) and printing of identification data on the top film can also take place simultaneously with bottom forming. Subject to other conditions trim can be chopped and disposed, and data can be logged to the LSI 11/23 in accordance with its program.

Finally, when inputs to the PLC indicate that bottom forming has been completed, the indexing motor can be enabled to advance the film. Indexing can only take place when tools are down. After indexing, the control program loops back so that all safety and operating checks can be made again as the cycle repeats.

## 5.0 Operator Interface

Of the SMART system components shown in Figure 2, the monitor and keyboard provide the complete operator interface to the control hardware for the pouch forming/filling/sealing line, the role once held by PLC indicator lights, push buttons, dials, toggle switches, etc. Screen displays provide operators with detailed system and process information, features which may be changed or added, and choices which may be made. Through keyboard commands an operator may select different features, change parameters such as limit and set points, and input information. A typical display provides information and instructions to be followed. When an operator does not understand the display or does not know what to do, he can press the HELP key for guidance.

Like many software packages available today, the SMART system provides a menu driven display. Figure 4 illustrates the Master Menu which governs the choice of many specialized displays including more specialized menus. The "cursor" arrow in the left hand margin may be moved up and down by depressing appropriate keys (with arrows). The choice can then be activated by pressing the ENTER or RETURN key.

By selecting "Monitor Tiromat Operations" in Figure 4 an additional display is provided to allow the operator to examine critical parameters specified in the PLC program presently running, along with the actual values measured by the machine's sensors. Examples would be, for seal temperature, the setpoint in degrees celsius, the low limit, the actual temperature, and the high limit along with, for seal pressure, the setpoint in pounds per square inch, the low limit, the actual pressure, and the high limit. A second display may be selected for the state of the line's safety circuits, cooling water, overloads, low film, and emergency stop.

The SHIFT INFORMATION refers to the workshift and provides information on the operator's name, the product going through the line, the lot number, and the manufacturers of important supplies such as films, and the lot numbers of these supplies. Information provided by the operator using this display is recorded in Audit Trail records and included in Audit Trail reports.

Manual Film Infeed, Initial Film Seal, and Tooling Change are used to request special instructions to the operator, and to place the machine in a condition which inhibits all movements or operations. The special instructions to the operator include what switches to turn on, such as the Emergency Stop Switch, what switches to inspect, what specific steps to take and in what order, and how to return to normal operation.

Of the remaining Master Menu options, Create/Maintain Operating Programs allows many types of changes to be made to up to 50 different pouch producing operating parameter programs or to create a completely new program. The Password Information option allows the control of user access to SMART system features by creating a users access file for up to 20 users. Diagnostic/Maintenance provides detailed and lengthy step-by-step choices and procedures for finding the causes of malfunctions, including diagnostic testing which can be run and observed either when the line is running or when it is not running.

The Audit Trail Parameters option allows an operator to construct and define a detailed history relating such events as user access, out of tolerance conditions, time/date of occurrence, and record generation frequency. This can be helpful in reviewing past events for the purpose of improving future operations. The specialized Audit Trail Parameters Menu also allows the user to select a scratchpad option and to enter or read scratchpad messages to or from other system users. This feature is not related to audit trails but has been included here to avoid lengthening the master menu.

## 6.0 Summary

This document describes the control strategy for the horizontal forming/filling/sealing machine. It is meant to be used to inform individuals concerned with these developments and to serve as a working document for further enhancements.

The four figures provide a conceptual view of the physical line, the control hardware, the PLC program, and a user interface menu display. Sections 3.0 on the equipment operation, 4.1 on control hardware, 4.2 on control software, and 5.0 on the operator interface provide more detailed explanations of the illustrations and the role which the control hardware, software, and user interface have in the automation control strategy of the pouch forming/filling/sealing line.

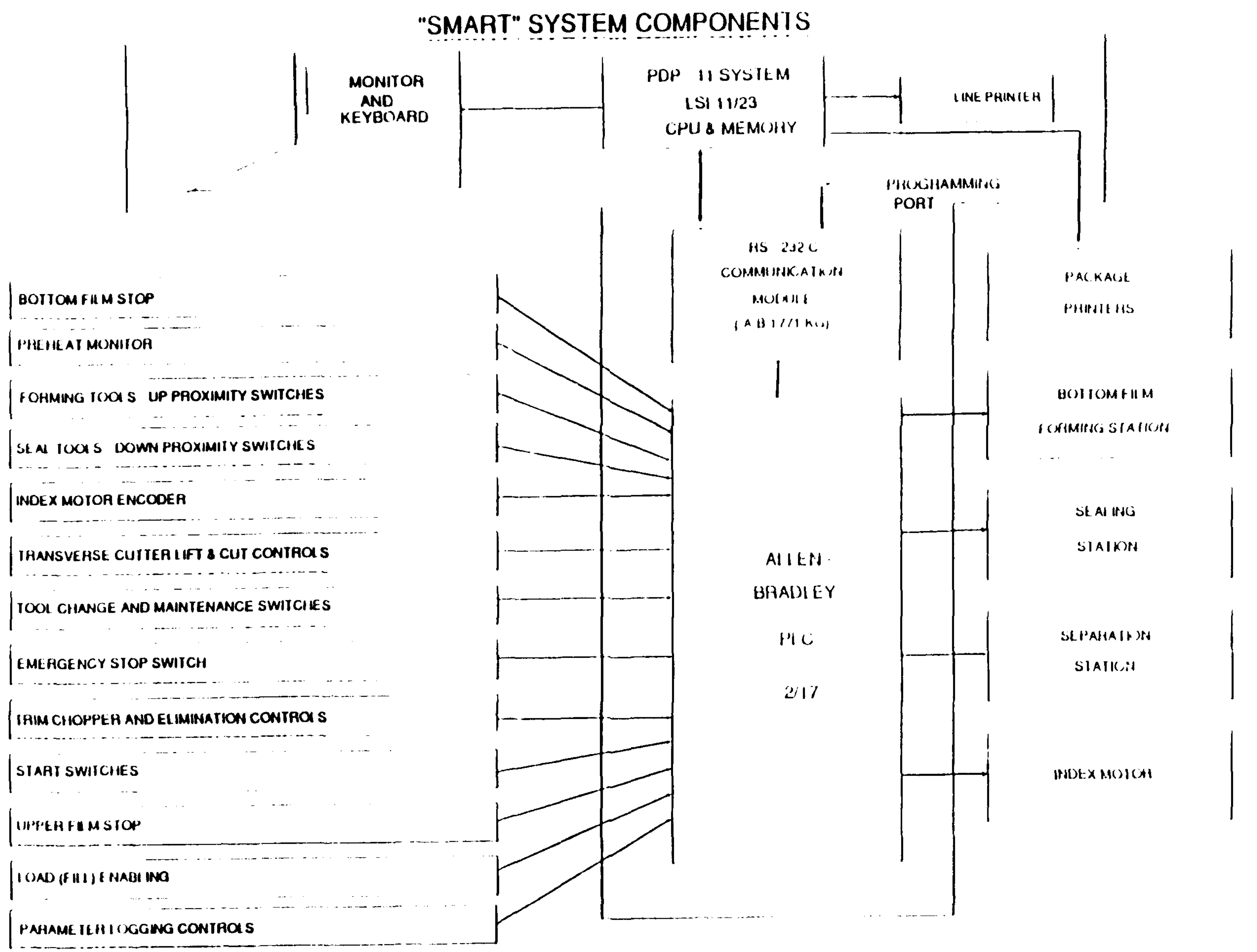
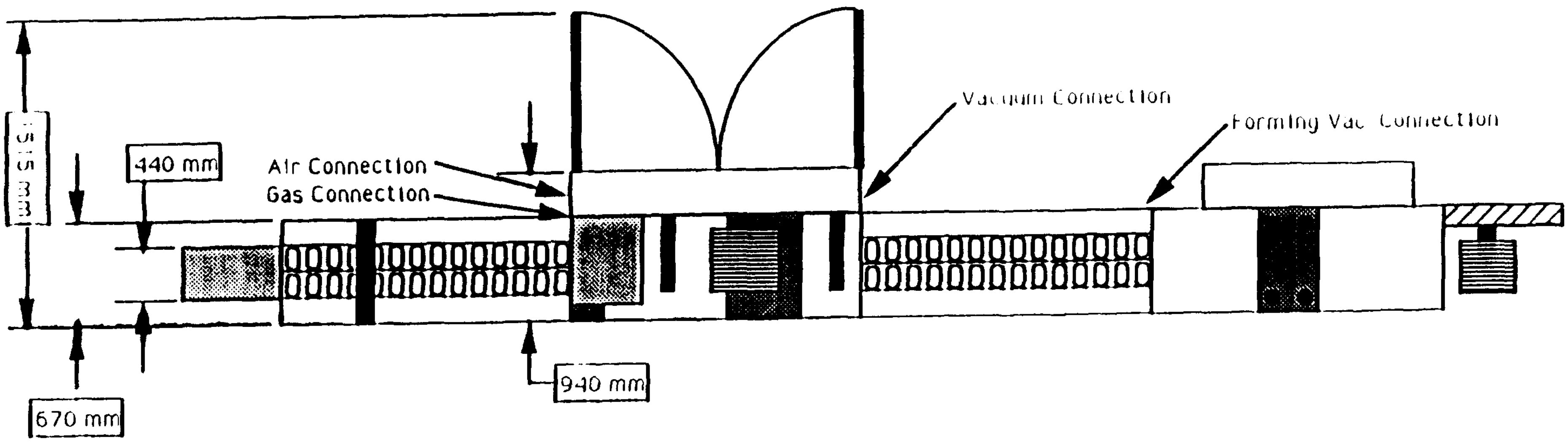
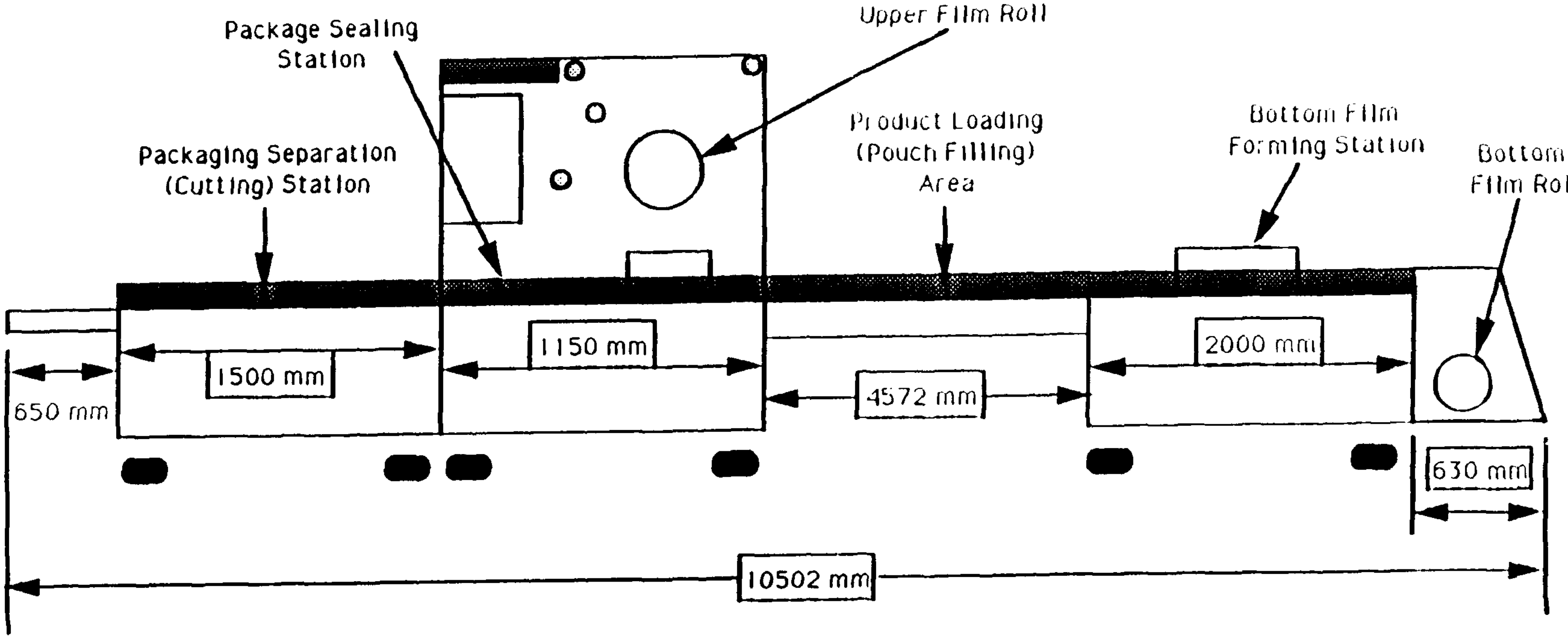



Fig. 2 · CONTROL HARDWARE FOR HORIZONTAL FORMING/FILLING/SEALING MACHINE

(a) TOP VIEW, WITH SERVICE CONNECTIONS




(b) SIDE VIEW




NO SCALE, Dimension Approximate

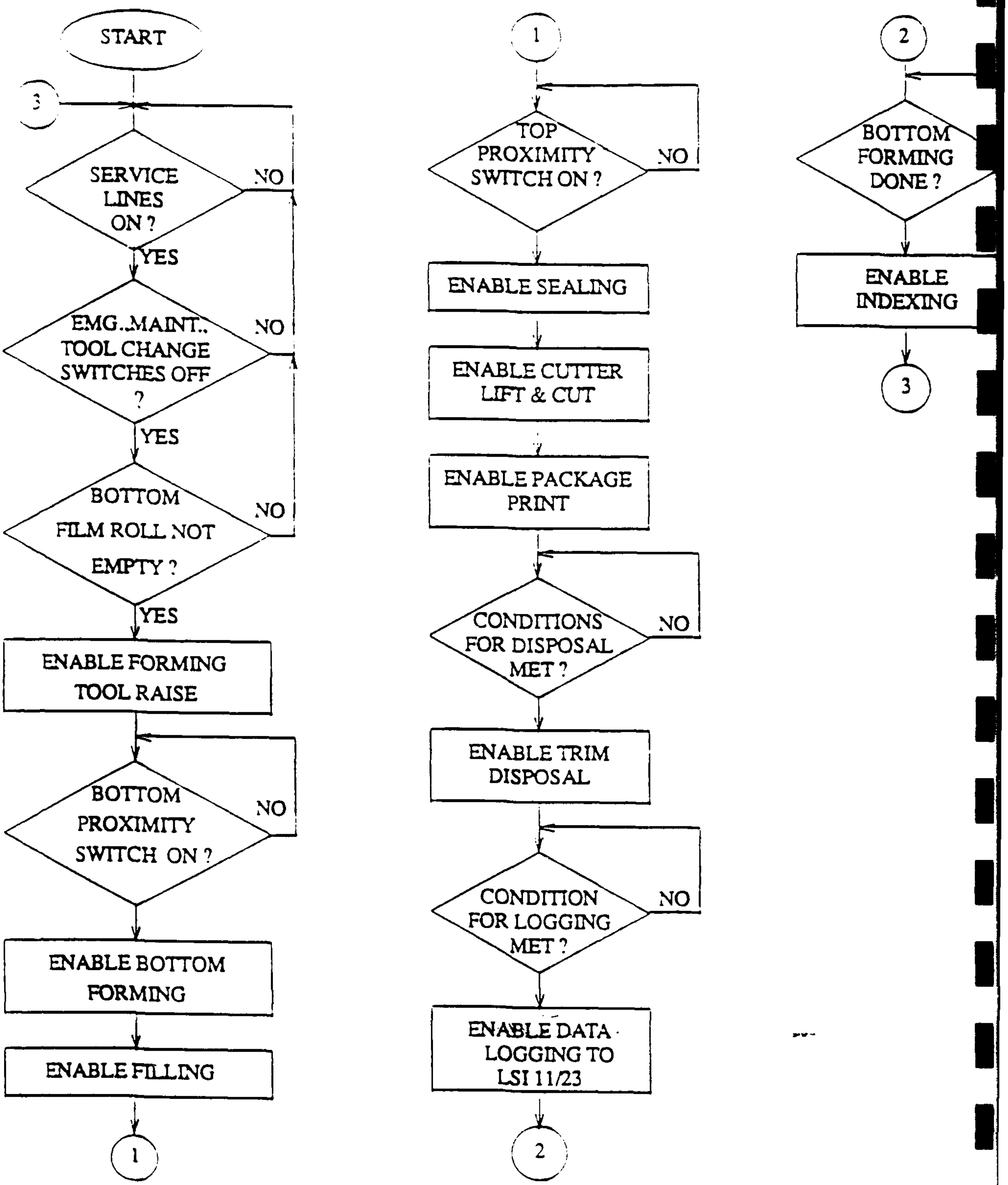



Fig 3 - FLOW CHART OF OVERALL PLC 2/17 LOGIC

SMART TIROMED SYSTEM

MASTER MENU

—> Monitor TIROMAT Operations

Shift Information

Load Operating Program

Manual Film Infeed

Initial Film Seal

Tooling Change

Create/Maintain Operating Programs

Password Information

Diagnostics/Maintenance

Audit Trail Parameters

Report Generation

System Shutdown

Select Option and press <RETURN>..

FIGURE 4 SMART SYSTEM "MASTER MENU" DISPLAY.

# Status Report
# CRAMTD STP-8

**Kit L. Yam, Ph.D.**
*Co-Principal Investigator*
**Panos N. Giannakakos, Ph.D.**
*Post-Doctoral Fellow*
**Xuan-Fei Wu**
*Graduate Assistant*

July 9, 1991

# I. Introduction

This work is a part of the CRAMTD STP-8 project which deals with the package development and performance of MRE pouches on a Horizontal Form/Fill/Seal (HFFS) machine. A study is being conducted on evaluating aluminum/plastic laminates, being stretched formed, to be used for MRE pouches.

The objective of the present work is to determine the status of MRE pouches produced in the HFFS Tiromat 3000 machine, identify and study the process parameters for stretch-forming, and evaluate the current forming mold.

A number of pouches were produced on the Tiromat using the correct amount of ingredients for beef stew MRE (MIL-B-44059C). The ingredients were pre-weighed and manually placed in the formed cavities. The machine was operated at 17 cycles per minute with Alussuise "Flexalcon" film (coded as AS-1 and AS-2 films). Finally, all the pouches were thermoprocessed.

The pouches were examined for compliance to military specification "Packaging and thermoprocessing of foods in flexible pouches" MIL-P-44073C.

# II. Results and Discussion

## A. Current mold

At 5/23/91 the depth of the cavities in the forming mold was 27.1 mm (1.07 in). Lateral angles are as designed.

## B. Pouch Preparation

(1) Composition of beef stew with dehydrofrozen potatoes (MIL-B-44059C)

| Ingredients | Weight (g) |
|---|---|
| Beef, diced | 92.4 |
| Sauce | 93.6 |
| Potatoes, diced | 17.0 |
| Carrots, diced | 17.0 |
| Peas | 6.7 |
| Total | 226.7 (8.0 oz) |

Eighteen out of twenty-eight pouches were weigh ed and the result is shown below. The mean net weight is a little lower than the required in the military specifications. The most possible cause may be that some sauce was stuck on the cup, while manually filling the formed cavities, so the weight of the transferred sauce and the net weight were reduced.

| Weight measured | Weight required |
|---|---|
| mean 7.9 oz | ≥ 8.0 oz |
| min. 7.8 oz | ≥ 7.5 oz |

(2) Sealing Process Conditions

| | |
|---|---|
| Temperature | 225 and 230 °C |
| Heating Time | 1 sec |
| Vacuum | -0.96 bar for 1 sec |

## C. Residual Gas Test

Non-Destructive Test (NDT) was conducted for all 28 pouches. The measured residual gas is as follows:

| | |
|---|---|
| Max. | 8.01 ml |
| Min. | 5.24 ml |
| Mean | 6.08 ml |

Destructive Test (DT) was conducted for five pouches. The pouches were opened under the surface of water and the collected residual gas was a little less compared to that of NDT (for detail see appendix). All the produced pouches were under the 10 ml maximum level of residual gas required in the military specifications.

## D. Seal Strength Test

(1) Sampling

Fin seal samples from five pouches were cut. Eight sample seals were taken from each pouch, two from the middle of each side. The width of specimen was 1 inch and the length was 2 inches in each side of the seal.

(2) Test Results

The results were compared with those obtained from the Sentinel laboratory sealer.

| Temperature (°C) | Seal Strength N/m (lb/in) Tiromat | Sentinel |
|---|---|---|
| 225 | 3752 (21.4) | 2909 (16.6) |
| 230 | 3846 (22.0) | 3047 (17.4) |

Both results show that the seal strength increases as the sealing temperature increases. The Tiromat pouch machine seems to be more effective than the Sentinel heat sealer. However, secondary sealed areas were detected, outside the normal sealing area, in the examined pouches. This might be objectionable from the DoD although is not mentioned as a defect in the military specifications.

## E. Burst Strength

Three of the pouches, sealed at 300°C, were tested for conformance to military specifications for internal pressure resistance (MIL-P-44073C) and were found to be within the tolerance limits. The pouches were restrained between two rigid plates spaced 0.5 inch apart, pressurized by air to 20 psig for 30 seconds, and then examined for separation or yield of the heat seals. Burst of the pouches, under these restrained conditions, were at pressures greater than 30 psig.

## F. Food Inspection of Compressed Pouches

To achieve the acceptable width for these pouches, complying to the military specifications, few of the produced pouches were compressed before the retort process.

Five pouches, 3 compressed and 2 regular, were opened and the food was inspected. The beef chunks and the potato cubes in all of the pouches were found to be in good shape. The color of beef in the cutting-surface was acceptable.

| | | |
|---|---|---|
| Pouch # | 7 (Compr.): | About 30% of carrot and peas damaged. |
| | 8 (Compr.): | About 100% of carrot and peas damaged. |
| | 12 (Compr.): | About 50% of carrot and peas damaged. |
| | 21 (Reg.): | A little (<10%) carrot damaged. |
| | 22 (Reg.): | No damage at all. |

### G. Fluorescein Dye Test

Two pouches (# 9 and 27) were tested for presence of nonvisible leaks with the fluorescein dye test according to military specifications. No penetration through the seal or elsewhere was found.

### H. Thickness Measurement of Pouch Abdomen

One pouch abdomen was measured for thickness distribution. The unstretched film thickness was 6.79 mm and the minimum thickness measured was 4.95 mm (73 % of the initial thickness). The profile shows a rather even thinning across the bottom of the pouch, where the thinnest points of the formed cavity were also located.

## III. APPENDIX

| | |
|---|---|
| Test of residual gas for pouches | 1 page |
| Seal Strength test report | 3 pages |
| Data for thickness of pouch abdomen | 1 page |
| Thickness profile for pouches | 1 page |

TEST OF RESIDUAL GAS FOR POUCHES
May 29,1991

| Pouch No. | Wt. (g) | Mano. (mmHg) | Atm. (mmHg) | Gas(NDT) (ml) | Gas(DT) (ml) |
|---|---|---|---|---|---|
| 1 | 19.06 | 192 | 759 | 6.45 | 6.00 |
| 2 | 19.58 | 190 | 759 | 6.54 | 6.00 |
| 3 | 18.7 | 188 | 759 | 6.16 | |
| 4 | 19.48 | 178 | 759 | 5.97 | |
| 5 | 19.43 | 195 | 759 | 6.72 | |
| 6 | 18.34 | 218 | 759 | 7.39 | |
| 7 | 20.44 | 182 | 759 | 6.45 | |
| 8 | 20.12 | 170 | 759 | 5.81 | |
| 9 | 18.43 | 192 | 759 | 6.24 | |
| 10 | 20.66 | 185 | 759 | 6.66 | |
| 11 | 20.08 | 157 | 759 | 5.24 | |
| 12 | 20.52 | 160 | 759 | 5.48 | |
| 13 | 18.63 | 195 | 759 | 6.44 | |
| 14 | 17.96 | 234 | 759 | 8.01 | 7.50 |
| 15 | 19.35 | 181 | 759 | 6.06 | |
| 16 | 20.24 | 164 | 759 | 5.58 | |
| 17 | 20.2 | 166 | 759 | 5.65 | |
| 18 | 19.98 | 170 | 759 | 5.77 | |
| 19 | 18.89 | 185 | 759 | 6.09 | 5.80 |
| 20 | 18.93 | 179 | 759 | 5.84 | 5.40 |
| 21 | 20.91 | 162 | 759 | 5.67 | |
| 22 | 20.48 | 156 | 759 | 5.30 | |
| 23 | 20.24 | 159 | 759 | 5.36 | |
| 24 | 20.19 | 160 | 759 | 5.39 | |
| 25 | 19.21 | 180 | 759 | 5.97 | |
| 26 | 18.37 | 188 | 759 | 6.05 | |
| 27 | 19.09 | 184 | 759 | 6.11 | |
| 28 | 19.37 | 179 | 759 | 5.98 | |
| | | | Max | 8.01 | |
| | | | Min | 5.24 | |
| | | | Mean | 6.08 | |
| | | | Stdev | 0.61 | |

Rutgers University
Dept. of Food Science, Cook College
Packaging Laboratory

# **** SEAL STRENGTH TEST REPORT ****

Operator Name: Xuan-Fei Wu
High Initial Strain Rate Tensile Test - S.I.

Test Date: 6/4/91
Analysis Date: 6/6/91

| | | | |
|---|---|---|---|
| Instrument Type: | Instron 4201 | Film Name: | Pouch prod. |
| Crosshead Speed (mm/min): | 254 | Film Thickness (mm): | aprx. 0.1 |
| Gauge Length (mm): | 50.4 | Grip Distance (mm): | 50.4 |
| Temperature (°C): | aprx. 23 | Width (mm): | 25.4 |
| Humidity (%): | aprx. 50 | Sample Rate (pts/sec): | 10 |

| Sample ID | | Specimen Number | Displcment at Peak (mm) | % Strain at Peak (%) | Load at Peak (KN/IN) | Area to Yield Point (J) |
|---|---|---|---|---|---|---|
| SAS01-01 | | 1 | 11.88 | 23.39 | 0.0813 | 0.00045 |
| (Pouch#1) | | 2 | 18.12 | 35.67 | 0.0989 | 0.00009 |
| | | 3 | 13.89 | 27.34 | 0.0799 | 0.00139 |
| SEAL TEMP. | | 4 | 11.05 | 21.75 | 0.0944 | 0.00165 |
| 225°C | | 5 | 8.17 | 16.08 | 0.1062 | 0.00005 |
| | | 6 | 13.83 | 27.22 | 0.0910 | 0.00524 |
| | | 7 | 6.04 | 11.89 | 0.1169 | 0.00071 |
| | Average | | 11.85 | 23.34 | 0.0955 | 0.00137 |
| | Standard Deviation | | 3.69 | 7.26 | 0.0123 | 0.00168 |
| SAS01-02 | | 1 | 16.56 | 32.60 | 0.0983 | 0.00002 |
| (Pouch#2) | | 2 | 6.49 | 12.78 | 0.0907 | 0.00265 |
| | | 3 | 3.51 | 6.91 | 0.0976 | 0.00467 |
| SEAL TEMP. | | 4 | 5.64 | 11.10 | 0.0887 | 0.00363 |
| 225°C | | 5 | 5.29 | 10.41 | 0.0891 | 0.00343 |
| | | 6 | 6.29 | 12.38 | 0.1027 | 0.00118 |
| | | 7 | 4.54 | 8.94 | 0.0942 | 0.02093 |
| | | 8 | 5.82 | 11.46 | 0.0996 | 0.00037 |
| | Average | | 6.77 | 13.32 | 0.0951 | 0.00461 |
| | Standard Deviation | | 4.07 | 8.02 | 0.0052 | 0.00680 |

Rutgers University
Dept. of Food Science, Cook College
Packaging Laboratory

**** SEAL STRENGTH TEST REPORT ****

Operator Name: Xuan-Fei Wu
High Initial Strain Rate Tensile Test - S.I.

Test Date: 6/4/91
Analysis Date: 6/6/91

| | |
|---|---|
| Instrument Type: | Instron 4201 |
| Crosshead Speed (mm/min): | 254 |
| Gauge Length (mm): | 50.4 |
| Temperature (°C): | aprx. 23 |
| Humidity (%): | aprx. 50 |

| | |
|---|---|
| Film Name: | Pouch prod. |
| Film Thickness (mm): | aprx. 0.1 |
| Grip Distance (mm): | 50.4 |
| Width (mm): | 25.4 |
| Sample Rate (pts/sec): | 10 |

| Sample ID | | Specimen Number | Displcment at Peak (mm) | % Strain at Peak (%) | Load at Peak (KN/IN) | Area to Yield Point (J) |
|---|---|---|---|---|---|---|
| SAS01-14 (Poucn#14) | | 1 | 6.02 | 11.85 | 0.0922 | 0.01450 |
| | | 2 | 5.38 | 10.59 | 0.1199 | 0.00318 |
| SEAL TEMP. 230°C | | 3 | 5.60 | 11.02 | 0.0799 | 0.00002 |
| | | 4 | 7.75 | 15.26 | 0.1050 | 0.00175 |
| | | 5 | 5.34 | 10.51 | 0.0868 | 0.00090 |
| | | 6 | 5.19 | 10.22 | 0.1158 | 0.00125 |
| | | 7 | 7.00 | 13.78 | 0.0989 | 0.00202 |
| | | 8 | 7.04 | 13.86 | 0.0969 | 0.00001 |
| | Average | | 6.16 | 12.14 | 0.0994 | 0.00295 |
| | Standard Deviation | | 0.97 | 1.91 | 0.0137 | 0.00478 |
| SAS01-19 (Pouch#19) | | 1 | 8.19 | 16.12 | 0.1046 | 0.00248 |
| | | 2 | 7.05 | 13.88 | 0.1008 | 0.00000 |
| SEAL TEMP. 230°C | | 3 | 9.80 | 19.29 | 0.1032 | 0.01077 |
| | | 4 | 12.84 | 25.28 | 0.1089 | 0.00003 |
| | | 5 | 5.56 | 10.94 | 0.0925 | 0.00002 |
| | | 6 | 12.12 | 23.86 | 0.0882 | 0.00391 |
| | | 7 | 4.58 | 9.02 | 0.0890 | 0.00005 |
| | | 8 | 8.89 | 17.50 | 0.0860 | 0.02754 |
| | Average | | 8.63 | 16.99 | 0.0966 | 0.00560 |
| | Standard Deviation | | 2.92 | 5.76 | 0.0087 | 0.00960 |

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Packaging Laboratory

# **** SEAL STRENGTH TEST REPORT ****

Operator Name: Xuan-Fei Wu
High Initial Strain Rate Tensile Test - S.I.

Test Date: 6/4/91
Analysis Date: 6/6/91

Instrument Type: Instron 4201
Crosshead Speed (mm/min): 254
Gauge Length (mm): 50.4
Temperature (°C): aprx. 23
Humidity (%): aprx. 50

Film Name: Pouch prod.
Film Thickness (mm): aprx. 0.1
Grip Distance (mm): 50.4
Width (mm): 25.4
Sample Rate (pts/sec): 10

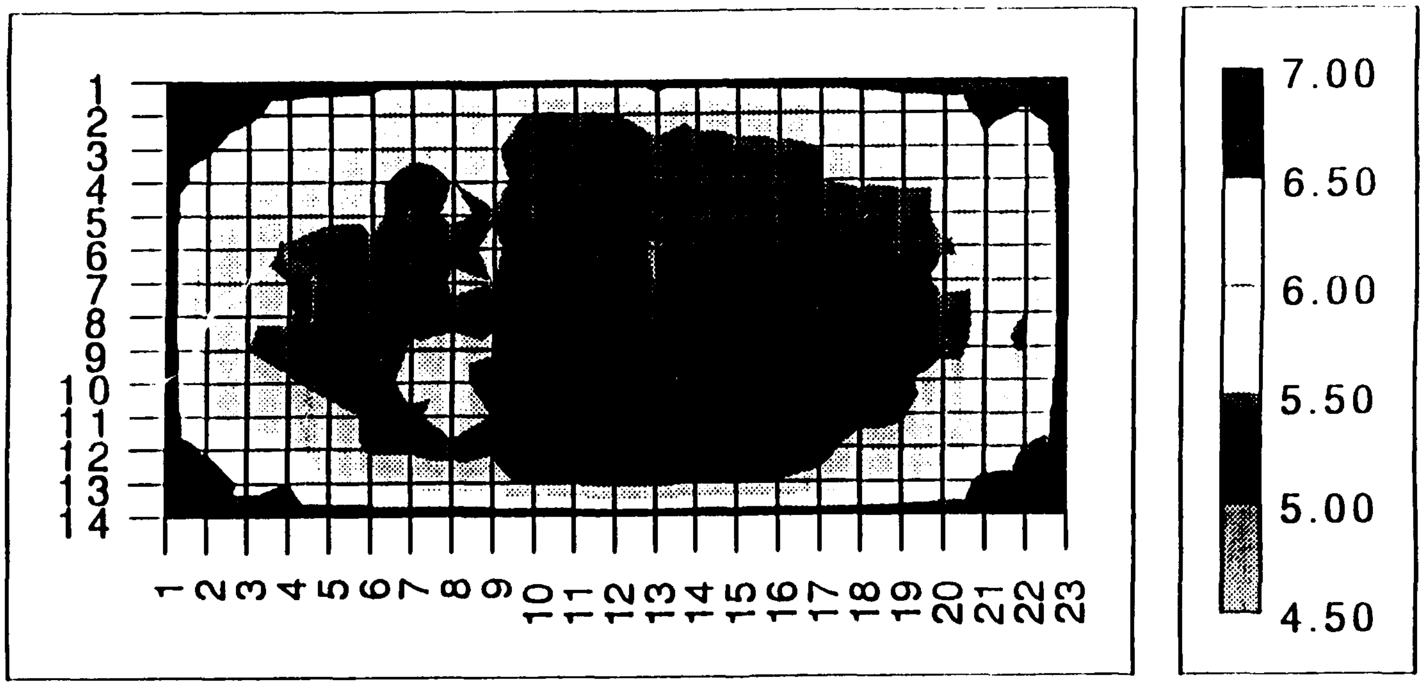
| Sample ID | Specimen Number | Displcment at Peak (mm) | % Strain at Peak (%) | Load at Peak (KN/IN) | Area to Yield Point (J) |
|---|---|---|---|---|---|
| (Pouch#20) | 1 | 5.73 | 11.28 | 0.1038 | 0.00043 |
| | 2 | 11.96 | 23.54 | 0.0899 | 0.00117 |
| SEAL TEMP. | 3 | 5.42 | 10.67 | 0.1150 | 0.00113 |
| 230°C | 4 | 5.82 | 11.46 | 0.1064 | 0.00312 |
| | 5 | 10.85 | 21.36 | 0.0919 | 0.00120 |
| | 6 | 10.43 | 20.53 | 0.0838 | 0.00002 |
| | 7 | 10.72 | 21.10 | 0.0885 | 0.00155 |
| Average | | 8.70 | 17.13 | 0.0970 | 0.00123 |
| Standard Deviation | | 2.68 | 5.27 | 0.0106 | 0.00091 |

DATA FOR THICKNESS OF POUCH ABDOMEN

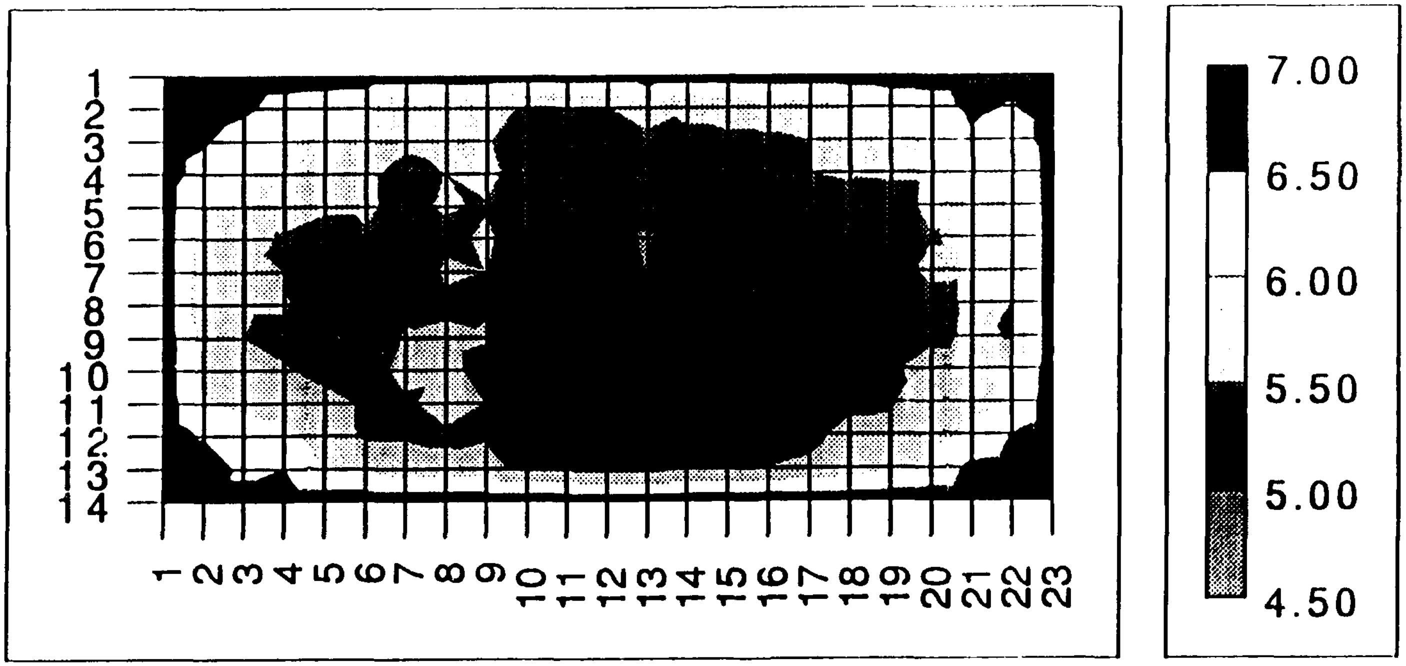
(X 0.001 in.)

| | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | | | | | | | | | |
| 6 | 6.79 | 6.79 | 6.79 | 6.79 | 6.79 | 6.79 | 6.79 | 6.79 | 6.79 | 6.79 | 6.79 | 6.79 | 6.79 | 6.79 | 6.79 | 6.79 | 6.79 | 6.79 | 6.79 | 6.79 | 6.79 | 6.79 | 6.79 |
| 7 | 6.79 | 6.80 | 6.60 | 6.25 | 6.15 | 6.05 | 5.55 | 5.65 | 5.75 | 5.40 | 5.45 | 5.45 | 5.95 | 5.60 | 5.70 | 5.85 | 5.80 | 6.00 | 6.15 | 6.20 | 6.65 | 6.45 | 6.79 |
| 8 | 6.79 | 6.55 | 6.20 | 6.05 | 5.90 | 5.95 | 5.55 | 5.60 | 5.55 | 5.25 | 5.25 | 5.25 | 5.25 | 5.40 | 5.40 | 5.40 | 5.50 | 5.70 | 5.80 | 5.65 | 6.40 | 6.10 | 6.79 |
| 9 | 6.79 | 6.25 | 6.05 | 5.70 | 5.50 | 5.55 | 5.40 | 5.50 | 5.65 | 5.25 | 5.35 | 5.25 | 5.25 | 5.40 | 5.40 | 5.35 | 5.50 | 5.55 | 5.60 | 5.60 | 6.00 | 5.80 | 6.79 |
| 10 | 6.79 | 5.85 | 5.65 | 5.65 | 5.55 | 5.55 | 5.40 | 5.55 | 5.45 | 5.05 | 5.25 | 5.15 | 5.25 | 5.30 | 5.40 | 5.35 | 5.35 | 5.35 | 5.20 | 5.65 | 5.65 | 5.65 | 6.79 |
| 11 | 6.79 | 5.70 | 5.65 | 5.45 | 5.35 | 5.45 | 5.40 | 5.35 | 5.60 | 5.15 | 5.05 | 5.15 | 4.95 | 5.30 | 5.30 | 5.25 | 5.20 | 5.20 | 5.20 | 5.45 | 5.65 | 5.50 | 6.79 |
| 12 | 6.79 | 5.65 | 5.55 | 5.50 | 5.10 | 5.35 | 5.00 | 5.60 | 5.50 | 5.20 | 5.05 | 5.15 | 5.00 | 5.40 | 5.30 | 5.30 | 5.10 | 5.15 | 5.20 | 5.65 | 5.60 | 5.50 | 6.79 |
| 13 | 6.79 | 5.65 | 5.55 | 5.55 | 5.25 | 5.25 | 5.40 | 5.35 | 5.45 | 5.30 | 5.30 | 5.25 | 5.25 | 5.40 | 5.35 | 5.25 | 5.15 | 5.10 | 5.20 | 5.30 | 5.60 | 5.50 | 6.79 |
| 14 | 6.79 | 5.85 | 5.50 | 5.35 | 5.30 | 6.05 | 5.55 | 5.65 | 5.55 | 5.20 | 5.00 | 5.25 | 5.25 | 5.40 | 5.30 | 5.20 | 5.10 | 5.15 | 5.20 | 5.25 | 5.65 | 5.45 | 6.79 |
| 15 | 6.79 | 5.85 | 5.75 | 5.55 | 5.35 | 6.15 | 5.75 | 5.65 | 5.30 | 5.10 | 5.05 | 5.15 | 5.15 | 5.30 | 5.25 | 5.20 | 5.15 | 5.20 | 5.30 | 5.90 | 5.80 | 5.75 | 6.79 |
| 16 | 6.79 | 6.05 | 5.90 | 5.80 | 5.65 | 5.45 | 5.35 | 5.85 | 5.50 | 5.10 | 5.05 | 5.25 | 5.15 | 5.30 | 5.20 | 5.30 | 5.30 | 5.40 | 5.45 | 5.75 | 5.85 | 6.00 | 6.79 |
| 17 | 6.79 | 6.45 | 6.20 | 6.15 | 5.80 | 5.45 | 5.45 | 5.35 | 5.45 | 5.05 | 5.05 | 5.20 | 5.35 | 5.40 | 5.35 | 5.45 | 5.40 | 5.60 | 5.60 | 5.80 | 6.10 | 6.50 | 6.79 |
| 18 | 6.79 | 6.90 | 6.35 | 6.50 | 6.00 | 5.95 | 5.75 | 5.75 | 5.70 | 5.35 | 5.35 | 5.25 | 5.25 | 5.45 | 5.45 | 5.50 | 5.55 | 5.70 | 5.90 | 6.10 | 6.60 | 6.65 | 6.79 |
| 19 | 6.79 | 6.79 | 6.79 | 6.79 | 6.79 | 6.79 | 6.79 | 6.79 | 6.79 | 6.79 | 6.79 | 6.79 | 6.79 | 6.79 | 6.79 | 6.79 | 6.79 | 6.79 | 6.79 | 6.79 | 6.79 | 6.79 | 6.79 |
| 20 | | | | | | | | | | | | | | | | | | | | | | | |
| 21 | Film mean thickness= | | | | 6.79 | | | | | | | | | | | | | | | | | | |
| 22 | Pouch abdomen thickness: | | | | | | | | | | | | | | | | | | | | | | |
| 23 | | | | Max= | 6.90 | | | | | | | | | | | | | | | | | | |
| 24 | | | | Min= | 4.95 | | | | | | | | | | | | | | | | | | |
| 25 | | | | Avg= | 5.54 | | | | | | | | | | | | | | | | | | |
| 26 | | | | | | | | | | | | | | | | | | | | | | | |

## Thickness Profile for Pouches (thickness x 0.001 in., grid in cm)



Thickness Profile for Pouches (thickness x 0.001 in., grid in cm)



**CRAMTD**

September 18, 1991

TO: Files

FROM: Neal Litman

RE: STP# 8 - Tiromat Pouch Sealing Tests

As a result of the pouch seal tests conducted on September 17, 1991, the flashing problem was investigated further. Pouches were filled with product at several temperatures. The results are as follows:

1. 6 pouches were filled with 8 ozs. of **Antifreeze** solution at **10F** and vacuumed to approximately 6cc residual gas level. Seal quality was very good. No evidence of flashing or splashing.

2. 6 pouches were filled with 8 ozs. of **water** at approximately **50F** and vacuumed to approximately 6 cc residual gas level. Seal quality was very good. No evidence of flashing or splashing.

3. 6 pouches were filled with 8 ozs. of **water** at approximately **120F** and vacuumed as above. Pouches exiting the seal chamber had water above the upper film. The pouches were not sealed.

4. 6 pouches were filled with 8 ozs. of beef stew, the **gravy** was approximately 40F with a viscosity of approximately 3500cp and filled **on top** of the particulates. The pouches were vacuumed as above with no visible signs of flashing. Upon careful examination of the pouches, it was discovered that gravy had been drawn onto the seal area, possibly by gasses entrapped between the solids or mounded gravy squeezed out in the seal chamber.

5. 6 pouches were filled with 8 ozs. of beef stew, the **gravy** was approximately 40F with a viscosity of approximately 3500cp and filled **below** the particulates. The pouches were vacuumed as above with no visible signs of flashing. Pouch seals were very good. The residual gas was approximately 6cc.

The conclusion from these experiments are; gravy temperatures must be below 40F (military cold fill method) to avoid flashing. Viscous gravy when filled on top of the meat and vegetables may contaminate the seal.

cc: T. Descovich
A. Sigethy
R. Bruins

# REPORT ON REYNOLDS FILMS

SEP 3, 1991

Retort No.: R911002B
Food in pouches: 8 oz. of beef stew

| Film Name | Pouch No. | Forming | Mold Depth (mm) | Vacuum * | Delamination. (spots) | | Res.Gas (ml) |
|---|---|---|---|---|---|---|---|
| | | | | | Before Retort ** | After Retort | |
| RND-22G (Item1) | 1V-1 | manual | 25 | yes | 0 | 0 | |
| | 1V-2 | manual | 25 | yes | 0 | 0 | 8.7 |
| | 1-1 | manual | 25 | no | 0 | 0 | |
| | 1-2 | manual | 25 | no | 0 | 0 | |
| | d1 | manual | 30 | yes | 0 | 8 | |
| RND-23 (Item2) | 2V-1 | manual | 25 | yes | 0 | 0 | |
| | 2V-2 | manual | 25 | yes | 0 | 0 | |
| | 2-1 | manual | 25 | no | 0 | 0 | |
| | 2-2 | manual | 25 | no | 0 | 0 | |
| | d2 | manual | 30 | yes | 0 | 2 | |
| RND-24G (Item3) | 3V-1 | manual | 25 | yes | 4 | same as before | |
| | 3V-2 | manual | 25 | yes | 0 | 0 | |
| | 3-1 | manual | 25 | no | 0 | 0 | |
| | 3-2 | manual | 25 | no | 0 | 0 | |
| | d3 | manual | 30 | yes | 0 | 1 | |
| RND-21G | G10 | Auto | 25 | no | 0 | >30 | |
| | G11 | Auto | 25 | no | 0 | >30 | |
| | G12 | Auto | 25 | yes | 0 | >30 | 8.4 |
| | G13 | Auto | 25 | yes | 0 | >30 | |

* Manually vaccumed
**Before retort but after forming and sealing

REPORT ON REYNOLDS FILMS

SEPT 17, 1991

Retort No.: R911016A
Food in pouches: 8 oz. of beef stew

| Film Name | Pouch No. | Forming | Mold Depth (mm) | Vacuum * | Delamination. (spots) | | Res.Gas (ml) |
|---|---|---|---|---|---|---|---|
| | | | | | Before Retort ** | After Retort | |
| RND-22G (Item1) | 1M-1 | manual | 25 | yes | 0 | 0 | |
| | 1M-2 | manual | 25 | yes | 0 | 0 | |
| | 1MD-1 | manual | 30 | yes | 0 | 0 | 16.77 |
| | 1MD-2 | manual | 30 | yes | 0 | 0 | |
| | 1T | manual | 25 | yes | 0 | 0 | |
| | 1TD | manual | 30 | yes | 0 | 0 | |
| RND-23 (Item2) | 2M-1 | manual | 25 | yes | 0 | 0 | 13.07 |
| | 2M-2 | manual | 25 | yes | 0 | 0 | |
| | 2MD-1 | manual | 30 | yes | 0 | 0 | |
| | 2MD-2 | manual | 30 | yes | 0 | 0 | |
| | 2T | manual | 25 | yes | 0 | 0 | |
| RND-24G (Item3) | 3M-1 | manual | 25 | yes | 0 | 0 | |
| | 3M-2 | manual | 25 | yes | 0 | 0 | 15.49 |
| | 3MD-1 | manual | 30 | yes | 0 | 0 | |
| | 3MD-2 | manual | 30 | yes | 0 | 0 | |
| | 3T | manual | 25 | yes | 0 | 0 | |
| | 3TD | manual | 30 | yes | 0 | 0 | |
| RND-21G | 21M-1 | manual | 25 | yes | 0 | >30 | |
| | 21M-2 | manual | 25 | yes | 0 | >30 | 5.99 |
| | 21MD-1 | manual | 30 | yes | 0 | >30 | |
| | 21MD-2 | manual | 30 | yes | 0 | >30 | |
| | 21T | manual | 25 | yes | 0 | >30 | |
| | 21TD | manual | 30 | yes | 0 | >30 | |

* Manually vaccumed
**Before retort but after forming and sealing

# TIROMAT 3000

# TRAINING

# MANUAL

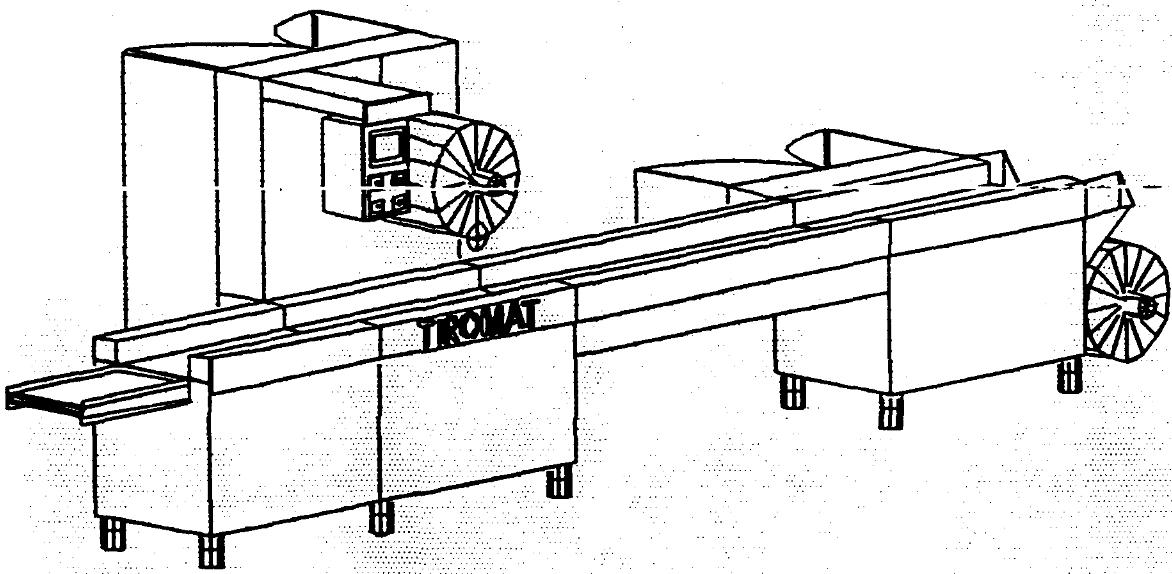
TWK590

TWO KUTTER INC

91 Wales Ave, P.O. Box J, Avon, MA 02322 (617) 588-2600

# TIROMAT

## tiromat / 3000




**machine number :**

## 765-3001 / 440

SUPPLEMENT TO
TIROMAT 3000 TRAINING MANUAL

# Electrical Diagrams

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# ac Motor Control

---

# Lenze Technical Specifications

TWK590

TWO KUTTER INC.
91 Wales Ave, P.O. Box 7, Avon, MA 02322 (617) 588-2600

# ALLEN - BRADLEY
# ADJUSTABLE
# FREQUENCY AC DRIVES
# INSTRUCTION MANUAL

Part No: UG-5600-101-001

SYSTEM MONITORING AND RECORDING TIROMAT

# SMART SYSTEM 5600

## USER GUIDE

ALFA-LAVAL

TW KUTTER

T.W. KUTTER, INC. 91 WALES AVENUE, P.O. BOX 7, AVON, MA 02322-9973

\+ STP-8 - SUMMARY FILM LAMINATES

*Packaging Lab*
*Food Science Dept.*
*Rutgers University*

- **Literature search provided very limited results**

\+ **Reynolds Metals Co. produced eight (8) experimental aluminum laminated films in their pilot plant**
  - Non-colored films
  - Aluminum thickness ranged from 0.7 to 2.0 mil
  - Two families of films: a) PET as outer layer
    b) OPP as outer layer

\+ **Alusuisse sent us their commercial film which has the trade name "Flexalcon" (AS-1, 2)**
  - Non-colored films
  - Formable bottom film has OPP as outer layer
  - Top film has PET as outer layer

\+ **Worked closely with Mahafffy & Harder Engineering Co.**
  - No significant progress

- **Films were evaluated with various techniques including tensile tests and thickness profiles**
- **Preliminary drawings of formed packages were made**
- **A bench-top forming unit was constructed**
- **Initial package designs were drawn**
- **Tiromat 3000 HFFS machine was selected**

\+ **Alusuisse sent us a four layer film intended for the institutional size package (AS-15)**
  - Non-colored film

- **In cooperation with T.W. Kutter mold designs were finalized**

\+ **Alusuisse produced two (2) experimental aluminum laminated films**
  \+ First film had coloring outside and was coated with a laquer as a protective layer
    - Tests showed that the color was not resistant enough to scratches during handling and retort

  \+ Second film had coloring incorporated inside the outer adhesive
    - Tests showed that the film was delaminating after retort

\+ **Reynolds Metals Co. produced three (3) experimental aluminum laminated films in their production plant (RND-11G, 12, 13G)**
  - One was non-colored while the other two were reverse printed

- Aluminum thickness ranged from 0.8 to 1.2 mil
- Extensible PET as outer layer
- Tests showed that the films were inadequate for high speed forming

- **Forming molds in Tiromat 3000 were modified so that the depth can be changed at will**

+ **Reynolds Metals Co. produced one (1) experimental aluminum laminated film in their production plant (RND-21G)**
  - A new laminating procedure was used
  - Coloring was incorporated inside the outer adhesive
  - Composition of the film: 1.2 mil OPP/colored adhesive/1.75 mil aluminum foil/adhesive/3.0 mil PP
  - Tests showed very good forming characteristics but there was some delamination after the sterilization procedure

+ **In collaboration with Reynolds Metals Co. and Lord Corporation, Erie, PA (laminating adhesives experts) we formulated a better performing film (RND-22G, 23, 24G) than the previous one (RND-21G)**
  - Tests showed that there was no apparent delamination in the pouches produced
  - Forming characteristics were very good (tested on the bench-top forming unit)

Appendix 4.19

## MRE MATERIAL POUCH COSTS

**Preformed 8 oz.pouch**

Cost = $113.57/1000 pouches

**Pouches from rollstock**

Top roll stock, cost = $591.84/1000 yds.

Bottom roll stock, cost = $629.68/1000 yds.
Total cost =$1221.52/1000 yds.

@ 15 pouches/yd. Cost = $81.43/1000 pouches
**Material Cost Savings =$32.14/1000 pouches**

Note: Costs supplied by Reynolds Metals Co.and are based on a four million pouch production order. Savings will vary depending on production order size and supplier.

**CRAMTD**

TO: T. Descovich

FROM: Neal Litman

RE: STP# 8 - Tiromat Final Pouch Run

MRE pouches were made to demonstrate Tiromat equipment capability for STP #8 Final Report. Beef Stew per MIL-B-44059C was manually filled in pouches using the cold fill method. The production rate was reduced to compensate for the in-house Food Science Building air compressor which does not provide sufficient quantities of air for maximum production rate. The Tiromat operating parameters and operating program are attached.

Results of pouch examination after retort are favorable:

1) Residual Gas was approximately 6.5cc per pouch which is less than the 10cc maximum specified.

2) Seals passed internal pressure test with several occurrences of minor seal creep. All pouches remained sealed after retort.

3) There was no evidence of product flashing from pouch evacuation.

4) Film delamination was observed on the formed web. Film used was Reynolds lot RND-21G-1 since film from later lots (RND-22G, 23G and 24G) were not available for this test run. [See Appendix 4.16]

5) Production rate was 40 pouches per minute. With a proper air supply the production rate would have been 88 pouches per minute. A production rate of 102 pouches per minute would be acheived by increasing the index velocity and shortening the vacuum timer setting.

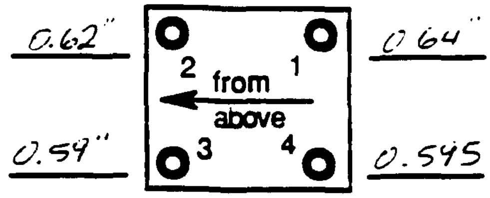
The production rate was less than the design rate because vacuum time was increased to assure very low residual gas levels. Seal contamination due to splash, slosh or flash was not observed. It is concluded that the Tiromat can produce MIL spec quality pouches with the exception of film delamination. Laboratory tests on a new Reynolds film were free of delamination.

Attachments: Tiromat Operating Paramters
SMART System Operating Program Listing: Process Capability
Instrumentation Chart: Final Pouch Test

## TIROMAT OPERATING PARAMETERS

**Date:** 12/11/91
**Tiromat Operating Program** (attach copy): PROCESS CAPABILITY
**Film:** Bottom Web (lot#): REYNOLDS RND-21G-1
Top Web (lot#): ALU SUISSE AS-2-4
**Forming Station:** AIR ASSIST
Station Position (distance from mark): 0.0"
Incoming Air Pressure Regulator: [Max] 101 psi
Forming Air Pressure (from SMART): 19 psi
Forming Mold Tooling: MRE 6 UP
Package Depth: 1.33"
Package Volume (approximate): 12 oz.

Forming Station Shim (total leg height):

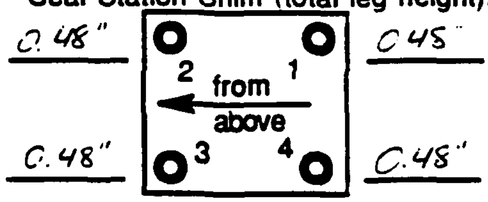



**Filling Station:**
Product Filled: BEEF STEW MIL-B-44059C
Product Formula:

| | Ingredient | Wt/Pkg | Temperature | Filler |
|---|---|---|---|---|
| 1. | PEAS IQF | 7 gm | 32°F | MANUAL, |
| 2. | CARROTS IQF | 17 | 32 | PREMEASU |
| 3. | POTATOES IQF | 34 | 32 | CUP |
| 4. | BEEF-CUBED PRECOOKED | 93 | 32 | ↓ |
| 5. | GRAVY w/ THERMTEX | 77 | 40 | |

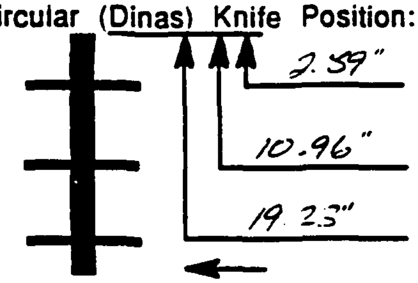
Tamping: [manual]
Vibrating Station Depth: 1.55"
**Sealing Station:**
Station Position (distance from mark): +0.10"
Incoming Air Pressure Regulator: [max] 101 psi
Seal Pressure (from SMART): 56 psi
Seal Rubber Design: ROUND BEAD
Seal Rubber Durometer: [70 white] BLUE 80
Upper Chamber Ball Valve: [4 open] 3½
Lower Chamber Ball Valve: [4 open] "
Vacuum Equilization Valve: [in (no equil)][out]
Evacuation Method: [standard][nozzle][nozzle/gas flush]
Vacuum Level Method: [timer][product temperature]
Target Residual Gas Level: 6 cc

Seal Station Shim (total leg height):




**Cutting and Punching:**
Punch #1 Position (from mark): 0.0" Pressure: 50 psi
Punch #2 Position (from mark): 0.0" Pressure: 48 psi
Punch #3 Position (from mark): -0.02" Pressure: 49 psi

Circular (Dinas) Knife Position:




**Index Motor Controller:**
Acceleration Time (mode 1): 0.1 sec
Deceleration Time (mode 3) 0.1 sec
Max. Speed (mode 6): 120 HZ
Stop Mode (mode 14): [0 Ramp to stop]
Speed (mode 18): 100 HZ
**Misc:** Air Compressor: FOOD SCIENCE BLDG (130 CFM)
Minimum Receiver Tank Pressure: 84 PSI
Maximum Air Flow Rate: 75 CFM
Tiromat Production Rate: 6.7 CYCLES/MIN (40 POUCHES/MIN)
Vacuum Pump Used: [Busch RA400]
Videojet Printer A Label: NOT USED
Videojet Printer B Label: NOT USED
Package Count: Filled: 14 Unfilled: 600

# SMART System
# Operating Program Listing
# Date: 11-Dec-91
# Time: 15:18:49



Operating Program Name: Process Capability
Program Creation Date: 18-Nov-91
Last Modification Date: 11-Dec-91
Operator For Modification: Generic Operator

## Operating Program Information

Program Description: Process Capability Testing
Reason For Update:

## Operating Program Configuration

| Y/N | Component | Y/N | Component |
|---|---|---|---|
| Y | BF1 - Installed | N | BF1 - Positive Forming System |
| N | BF1 - Positive Forming - Air Assist | Y | BF1 - Negative Forming System |
| Y | BF1 - Negative Forming - Air Assist | N | BF1 - Uniform Plug Installed |
| N | BF1 - Uniform Plug Locking Cylinder | Y | BF1 - Foil Forming System |
| N | BF1 - Lower Preheater #1 | N | BF1 - Upper Preheater #1 |
| N | BF1 - Independent Preheaters #1 | N | BF1 - Lower Preheater #2 |
| N | BF1 - Upper Preheater #2 | Y | BF1 - Vacuum Pressure Sensor |
| N | BF1 - Air Assist Below Valve | Y | BF1 - Air Assist Above Valve |
| Y | BF1 - Vacuum/Air Vent | Y | BF1 - Standard Forming Vacuum V |
| Y | SS1 - Installed | Y | SS1 - Evacution By Timer |
| N | SS1 - Evacution By Vacuum Level | N | SS1 - Gasflushing By Timer |
| N | SS1 - Nozzle | N | SS1 - Evacuate Via Nozzle |
| Y | Punch & Die #1 | Y | Punch & Die #2 |
| Y | Punch & Die #3 | Y | Onboard Vacuum Pump #1 |
| Y | Trim Removal Vacuum Device | Y | Air-Driven Exit Conveyor |
| Y | Conveyor Active During Index Cnl. | Y | Package Marking System |
| Y | Upper Dancer Arm | Y | Lower Dancer Arm |
| Y | SS - Upper Web Brake #1 | Y | BF - Lower Web Brake |
| Y | Stop Lamp | Y | Start Lamp |
| N | Product Dispensing Unit | N | Product Spill Protection Device |
| N | Product Vibrator | N | Product Temperature Sensor |
| N | Miscellaneous Device | Y | Video Jet Printer #1 |
| Y | Video Jet Printer #2 | | |

## Index Parameters

| Parameter Name | Value |
|---|---|
| Index Length (mm): | 364.0 mm |
| Index Correction Factor (mm): | .0 mm |
| Index Speed [L/H]: | H |
| Ramp-Up Distance From Start (mm): | 0 mm |
| Slow-Down Distance From End (mm): | 87 mm |
| Low-Speed Camera Enable Distance From End (mm): | 0 mm |
| High-Speed Camera Enable Distance From End (mm): | 0 mm |
| Ink Jet Distance (mm): | 0 mm |
| Packages Per Cycle: | 6 |
| Forming Tools Counter: | 1 |
| Sealing Tools Counter: | 1 |

# SMART System
# Operating Program Listing
## Date: 11-Dec-91
## Time: 15:18:49



## Timer Set Points

| Timer Description | Value |
|---|---|
| SF1 - Forming Time | 1.50 Secs. |
| BF1 - Air Assist Forming Time | 1.50 Secs. |
| SF1 - Forming Time | 1.50 Secs. |
| SS1 - Package Sealing Time | .75 Secs. |
| SS1 - Upper Chamber Evac Time | 1.00 Secs. |
| SS1 - Lower Chamber Evac Time | 1.00 Secs. |
| SS1 - Evac Chamber Vent Delay | .75 Secs. |
| 4S - Tool Separation Delay #1 | 4.00 Secs. |
| 4S - Tool Separation Delay #2 | .00 Secs. |
| 4S - Miscellaneous Timer | .00 Secs. |
| Video Jet Printer #1 Delay | .00 Secs. |
| Video Jet Printer #2 Delay | .00 Secs. |
| 4S - Ink Jet Timer | .00 Secs. |
| 4S - Start Warning Time | 3.00 Secs. |

## Temperature Set Points

| Temperature Description | Lower Limit | Set Point | Upper Limit |
|---|---|---|---|
| SS1 - Temperature | 210 (C) | 220 (C) | 235 (C) |

## Pressure Set Points

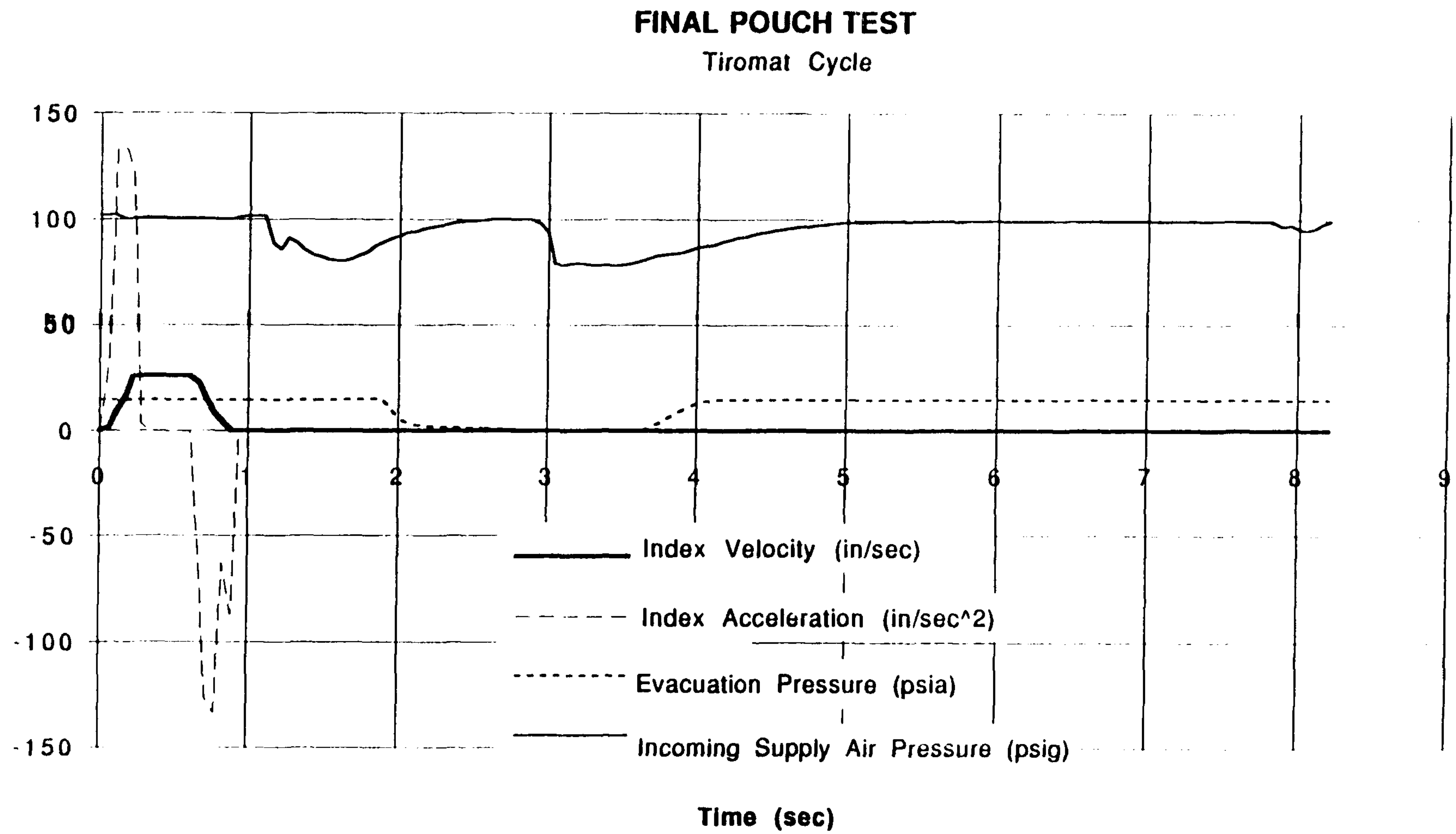
| Pressure Description | Lower Limit | Set Point | Upper Limit |
|---|---|---|---|
| 4S - Incoming Oiled Air Pressure | 2 PSI | 80 PSI | 120 PSI |
| SF1 - Air Assist Forming Pressure | 12 PSI | 21 PSI | 30 PSI |
| SS - Seal #1 Pressure | 40 PSI | 55 PSI | 65 PSI |

## Forming Vacuum Pressure Set Points

| Pressure Description | Lower Limit | Set Point | Upper Limit |
|---|---|---|---|
| SF1 - Forming Vacuum Pressure | 7.5 PSI | 11.0 PSI | 14.0 PSI |

## Heater PID Parameters

| Heater Name | Gain Factor | Integral Factor | Derivation Factor |
|---|---|---|---|
| SS1 - Heater | 60.00 | 1.00 | .25 |


FINAL POUCH TEST
Tiromat Cycle
150
100
50
0
-50
-100
-150
0
1
2
3
4
5
6
7
8
9
Index Velocity (in/sec)
Index Acceleration (in/sec^2)
Evacuation Pressure (psia)
Incoming Supply Air Pressure (psig)
Time (sec)

# Instrumentation Methods for Quantifying and Enhancing Packaging Equipment Capability

## I. Abstract

Performance of the CRAMTD Tiromat 3000 Horizontal Form-Fill-Seal packaging machine was enhanced by a method of measurement and analysis of interrelated operations. The method included a personal computer based data acquisition system and existing Tiromat sensors. Optimization and coordination of events within the system (numerous closely coupled operations) were made to both mechanical and electronic controls. Cycle (production) rates, quality of packages and control of product slosh (a problem for intermittent motion machinery) were improved. The techniques described have useful applications during equipment installation, measuring equipment performance and monitoring package quality.

## II. Objectives

Develop a method of electronically measuring operating conditions of a packaging line.

Improve equipment performance through optimization of operations.

Quantify performance and establish a baseline.

Aid the installation and de-bugging of new machinery.

Identify improvements to machinery design.

Develop methods that are effective for monitoring package quality.

## III. Summery

A computer base data acquisition system was sucessfully used to monitor equipment sensors. Incoming air pressure, vacuum level within the seal chamber and the index motor controller were measured in real time and recorded electronically on computer disk for analysis. The resolution and accuracy were adequate for detailing equipment capability. Scan rates up to 132 data records per second were acheived.

The indexing motion was optimized for 6 velocity ramps. The modes produce increasing acceleration/deceleration and a corresponding decrease production cycle time. Higher accelerations are suitable for solid materials. Slower motions are used for liquids or flowables since seal contamination must be avoided.

Pouch residual gas levels have been correlated to Evacuation Timer Settings.

The influence of compressed air suppy on equipment operation has been documented. The air requirements and system limitations have been measured. The in-house air compressor is inadequate for high production rates. There is a large pressure drop in the Tiromat air distribution manifold, possibly due to undersized piping.

Tiromat system performance has been quantified. This data is useful for calculating impact of an operational change, for calibrating performance of interrelated functions, and for diagnosing component problems. A comparison of the baseline operating mode to the original installation show a significant improvement in both package quality and production rate.

Instrumentation data has been exchanged with the equipment manufacturer. Potential design changes to the vacuum system, tool lift system and PLC programming have been identified.

The data acquisition system may be an alternative to the SMART (System Monitoring And Reporting Tiromat) System.

## IV. Background

The Tiromat was manufactured by Kramer & Grebe of Kitchener, Canada. Installation and service at the CRAMTD Pilot Plant Site was by T.W. Kutter of Avon MA. The Tiromat 3000 with the SMART process control system can produce a variety of packages including the MRE. Inherent with this flexible manufacturing system is the complexity of numerous integrated operations.

Installation time was significantly longer than planned. Minimum required operating speed was difficult to achieve due to problems with air supply, pneumatics, punch dies, package evacuation, tooling and PLC programming. The minimum production rate was reached but package quality was difficult to control. De-bugging problems were mis-diagnosed because the equipment manufacturer had not established a baseline of operating performance. Furthermore, break-in/adjustments for the machinery and having several operators added to the variability of equipment performance.

A data acquisition system was employed to gather data from several equipment sensors. The data system measures and records the electronic inputs; temperature, pressure, vacuum, proximity switch position, valve position and index motor speed. The electrical output of these sensors are measured with relatively high resolution allowing for analysis of individual equipment operations/events simultaneously.

The data acquisition system displays data in "real-time" as well as capturing data on disk for further analysis. As a practical tool, adjustments can be made to the equipment, and a clear result can be seen on the computer monitor. Improvements are typically measured in tenths of a second, too short for accurate human observation. Debugging time for equipment is greatly reduced since guess work is eliminated. Data collected is becomes an "electrocardiogram" that can be helpful in diagnosing machinery problems.

## V. Instrumentation Description

The instrumentation system is comprised of an IBM type (DOS) Personal Computer with an expansion slot available, a data acquisition Input/Output card, a terminal box, control software, sensors and wiring.

Computer
A Compaq LTE16S portable computer with a docking station was used along with an Epson dot matrix printer. System requirements include; MS DOS 3.0 or higher, 640K RAM, floppy disk drive, hard disk drive, Microsoft compatible mouse and a 16 bit expansion slot.

Data Acquisition Card
The data acquisition card used is an Analog Connection PC-16 (ACPC16-16). The card is a 16 channel high resolution acquisition board for the measurement and control of DC voltages, RTDs, strain gages, pressure sensors and analog signals up to 10 volts. The card can generate analog output for equipment control and digital output suitable for computer communications.

Control Software
The software was WorkBench PC Version 2.02 Data Acquisition & Control Software by Strawberry Tree Incorporated. WorkBench provides an easy to use graphical interface for interpreting the various input signals. A control file is shown in Appendix A. Boxes identified as AI are used to control analog inputs from the sensors. This function is used to assign data acquistion card channels, signal gain, sampling frequency, etc. Boxes identified with CA are used to perform arithmetic calculations on the input signal. These calculations are used to calibrate the signal (typically millivolts or milliamps) to useful units such as PSI or inch/second. The box identified as CH1 sets up charting functions. Data can be charted in real time, much like an oscilloscope (see Appendix B). Data stored on disk (box LO1) can easily be used at a later time with a spread sheet type program such as Excel or 1-2-3. The system has the capability of reading a sensor signal and logging to disk at the rate of typically 125 datum per second which is more than adequate.

Terminal Box
The sensor lead wires are attached to a Strawberry Tree Terminal Panel Model T11.

Sensors
Pressure transducers installed in the Tiromat have been utilized. These are the Setra 280E pressure transducer, producing a 0-5 volt output. The voltage value is calibrated and converted to pressure units (psia for vacuum or psig for pneumatic air pressure). The response time for these transducers are 1 millisecond.

A pressure transducer on the the air distributio manifold located at the main air inlet monitors supply pressure. This compressed air is used for approximately 32 pneumatic cylinders, pilot valves, valve operators and air assist package forming. A second pressure transducer is located on the vacuum system manifold block and measures absolute pressure during pouch evacuation.

Allen Bradley AC variable speed motor controller provides a current output (milli-amp) for speed monitoring, proportional to the index drive motor speed. A conversion calculation produces values in units of inches per second. Workbench has a capability to calculate the acceleration of the speed (the differential of velocity, dv/dt).

Wiring
Pressure transducers and the variable speed drive output are connected to the terminal box in "series". Three conductor shielded wiring is recommended.

Calibration of Sensors
The sensor electrical signals require calibration from an external source. Mechanical pressure gages were used to calibrate the vacuum and pressure transducers. The index speed was determined from videotaped indexes. The analog inputs are converted into useful units i.e. psi or inch/second by the linear relation: $y = mx + b$.

## VI. Experimental Procedure

The Tiromat operating parameters are shown in Appendix C. The experiment is broken down into runs which examine individual operations, summerized and charted in Appendix E. The logging function was used to capture data from three sensors; variable speed motor drive, a pressure tranducer at the vacuum manifold and a pressure transducer at the incoming supply air distribution manifold. See Appendix A for the WorkBench instrumentation set up. The logged data was then imported into Excel spreadsheet program to produce graphic charts. The charts represent machinery response for one index cycle.

Baseline Parameters
It was necessary to document the equipment response for the baseline operating settings. The baseline was developed specifically for manufacture of military MRE pouches at a rate greater than 102 pouches per minute. This baseline mode was used for the Equipment Acceptance Trials and Demonstration Runs for CRAMTD project sponsors.

Vacuum Timer Setting
Increasing vacuum time will decrease residual gas in the pouch. Residual gas will be determined for a a range of vacuum timer settings, from 0.4 seconds to 1.6 seconds. This parameter directly relates to residual gas in the sealed pouch. The vacuum timer was increased from the baseline to 1 second to determine affect on cycle time.

Seal Tooling Lift System
The seal tool counter setting adjusts the tool lift system depth. The purpose of this experiment is to measure production rate and air pressure for seal tool counter setting of 1 pin (baseline) versus 2 pins.

Supply Air Compressor
Installation and acceptance of the Tiromat was delayed due to problems associated with the supply of compressed air; insufficient air pressure and volume. Instrumentation helped to identify individual operations for which the supply pressure drops greatest. The experiment will compare Tiromat operation with two different air compressors; the Food Science building compressor (130 cfm @ 104 psi) and a portable construction type compressor (185 cfm @ 110 psi).

Transverse Punches
The transverse punches require large quantities of compressed air. This experiment will examine the affect of operating one, two and three punches on machine performance.

Optimization of Index Motions
An important feature of the CRAMTD Tiromat 3000 is the variable speed drive controller. This controller is used to adjust the speed profile when handling

liquid or flowable products that would otherwise slosh out of the pouch and contaminate the pouch seal.

The motor controller has a range of maximum speeds and "speed ramps" selectable. Optimum index modes are established by trial and error of motor controller parameters; maximum speed, time to accelerate, time to decelerate and distance from end of index to begin deceleration. Sloshing is principally a function of the liquid viscosity and the index motion acceleration/deceleration. Large accelerations occur whenever the speed changes abruptly, i.e. the slope of the velocity is steep.

Comparison of Standard Tiromat Performance with the Baseline
The baseline operating program has been significantly refined since the Tiromat was first installed at Rutgers. An analysis of the overall improvement was made.

## VII. Analysis of Data

Baseline Parameters
Producing pouches in accordance with the military specifications at production rate of 102 pouches per minute (6 pouches per index times 17 cycles per minute) was a requirement for the Tiromat. Reaching this production rate was achieved through optimization of the individual machine operations; raising/lowering tooling, punching, forming, evacuation and sealing. Many aspects of the system are determined by trial and error such vacuum level (varies for each product) and seal temperature (varies for particular film).

The "baseline" operation is characterized by the instrumentation chart found in Appendix D. This operating mode was used for the equipment acceptance trials and the STP#8 Final Demonstration.

The chart identifies in detail critical events within a machine cycle (the events are numbered sequentially). The total cycle time is 3.35 seconds, which meets the required minimum production rate of 17 indexes per minute.

From the chart, the time needed to lock tooling in the up position is taking 0.7 seconds and to lower tooling, about 0.5 seconds. Air pressure is dropping from 110 psi at the supply inlet to 78 psi (below the minimum operating pressure of 80 psi). Improvement in operating performance may be achieved through modifications to; a) the pneumatic sytem and b) the PLC sequence timing.

The very large pressure drop within the supply air distribution manifold suggests a severe restriction in the air flow. A larger diameter port and distribution manifold may reduce pressure drop and improve flow to the pneumatic cylinders. An improved tooling lift system that locks more quickly could be developed.

The PLC timing for raising anvils and punching could be postponed until after tooling has been locked. modifications to PLC programming are relatively easy.

Vacuum Timer Setting
Comparing Experimental Run Nos. 1 and 2, the total cycle time increases by the additional vacuum time (0.6 seconds) which has the effect of reducing the production rate to approximately 14.6 indexes per minute.

The residual gas in pouches filled with vegetables and gravy was determined at several timer settings. The results are plotted in Appendix F. Acceptable residual gas levels are reached within 0.4 seconds. These charts are useful to operators who must maintain the operating conditions within an process control program. It should be noted that the residual gas measured is only valid for the specific product, values must be developed for each product.

T.W. Kutter offers an enhancement to the vacuum system that includes a storage tank with valving that acts as a booster which can shorten vacuum times. CRAMTD is considering such a retrofit.

Seal Tool Counter
Experimental Run Nos. 2 and 3 demonstrate the additional time required to raise and lower tooling from and to a deeper position (0.5 seconds). Run No. 3 drops tooling one pin more than the baseline (the lower position would be used for deeper packages). The production rate drops to approximately 15.6 indexes per minute.

The tooling lift system has a significant impact on machine performance, proper operation and maintenance will be important factors. Design improvements to the pneumatic and control system are justified to decrease cycle times and manufacture better packages (so that longer vacuum and sealing times may be used).

Supply Air Compressor
Experimental Run Nos. 5 through 8 were made with the lower capacity in-house air compressor. The Tiromat shut down quickly during Run No. 8 due to insufficient air pressure.

Comparisons can be made with the baseline, Run No. 2 and No. 8; the large drop of the maximum air supply pressure with the in-house compressor indicates inadequate volume of air. The overall effect on production is a slightly longer cycle time but unless the air is distributed more quickly within the the Tiromat, the line shuts down.

The higher supply pressure and volume is needed for sucessful operation at high speed.

Transverse Punches
When punching is not used, the in-house compressor is adequate for maintaining the target production rate. The effect of one, two and three punches operating can be observed in Run Nos. 6, 7 and 8 by the decrease in air pressure. Production rate is not impacted with one or two punches operating.

Optimization of Index Motions for Control Slosh
Experimental Run Nos. 2, 9, 10 and 11 demonstrate the capability of the variable speed motor controller. The index motions are optimizes by trial and error to find the highest velocity and best "Distance to Slow Speed" for each velocity ramp. This distance parameter is used to begin the deceleration. A low setting will produce high accelerations due to the use of the motor brake at high speed. A high setting will begin the deceleration to low speed opration too early causing a longer index motion (see Comparison of Standard Tiromat Operating Program in the next section). Each run uses a progressively lower velocity ramp to accomplish the index motion. The results can be seen in the charted velocities and accelerations. The lower velocity ramp produces the lower accelerations, however greatly impact cycle time. The index motion

shown in Run No. 10 will transport water without sloshing onto the seal area at a production rate of 15 indexes per minute, or 88% of design production.

The instrumentation system was indispensible for analyzing the index motion, it would not be possible to "see" accelerations by any other method.

For solid products or highly viscous gravy, the baseline index motion is acceptable. For thin gravies, a slower motion must be used with only minor loss of production speed.

Comparison of Baseline to Standard Kutter Operating Program

The significant difference between these runs is the improvement in time to index. A reduction of approximately 0.5 seconds per cycle yield an improvement of 14 pouches per minute. Analysis of the incoming air pressure sensor suggest that further speed improvement may be made by changes to the timing seuences of the pnuematic operations. For example, delay of punching operations may allow for tooling to reach the "locked up" position faster. This type of optimization can be accomplished through PLC programming by the manufacturer T. W. Kutter.

## VIII. Conclusions and Recommendations

Pressure transducers are needed to measure upper and lower vacuum chambers for actual pouch vacuum level and pressure differential above and below the lower pouch web, .

Need large capacity air compressor.

Need to reduce pressure drop within air distribution manifold through redesign (larger ports) and modification of PLC programming (timing of punching operation).

Need to evacuate pouches faster through redesign. T.W. Kutter has suggested adding a booster system. Kutter has also developed a high speed machine that places vacuum valving closer to the vacuum chamber.

TIme to move tooling is approximately 1.2 seconds or 35% of the total cycle time for the baseline operation. Need to increase speed of tooling lift system.

Need to establish performance benchmarks for the equipment.

Need to incorporate instrumentation methods into a complete diagnostic and maintenance procedure for the Tiromat packaging line.

Instrumentation methods may be useful for other production processes, especially process that are linked (integrated manufacture). Equipment capability can be quantified.

Instrumentation methods may be useful in quality control applications.

T.W. Kutter should evaluate CRAMTD intrumentation data, comment on these conclusions, incorporate knowledge gained into the Tiromat design.

**Appendices**

A. Work Bench Control Diagram

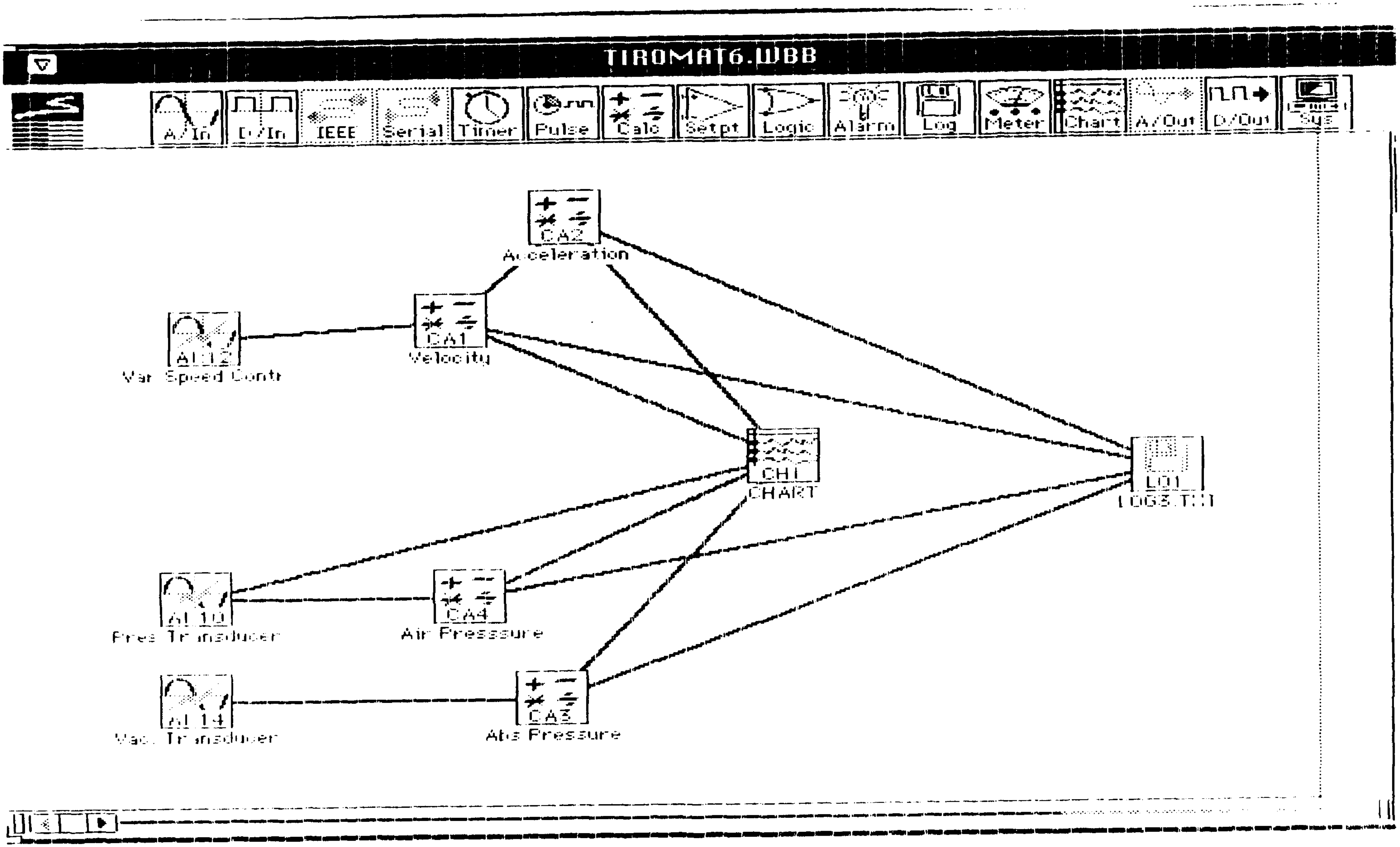
B. Real-Time Computer Display

C. Tiromat Operating Parameters

D. Baseline (instrumentation chart)

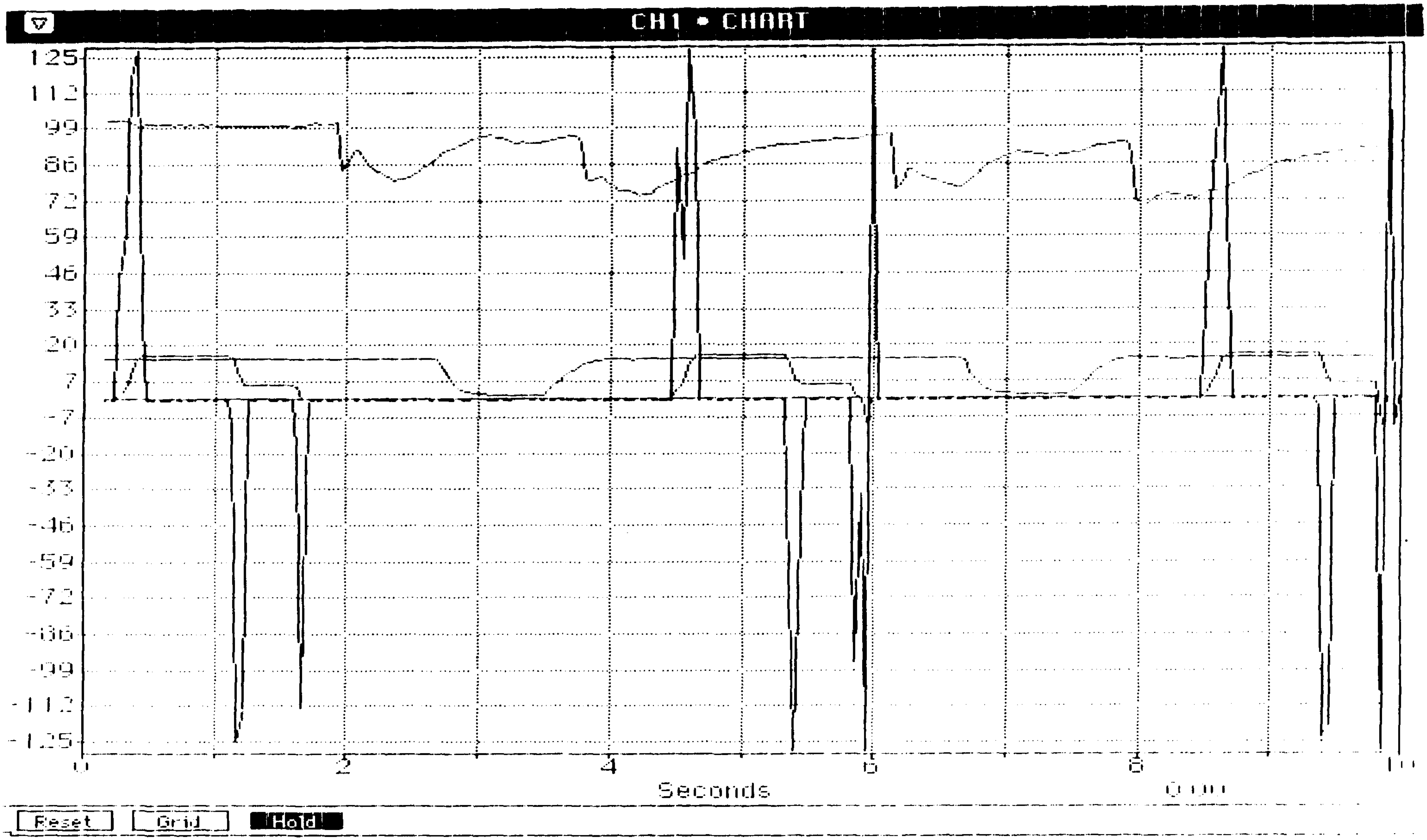
E. Experiment Runs 1 through 12 (instrumentation charts)

F. Evacuation and Residual Gas vs. Vacuum Timer Chart




**Work Bench Control File**

**Appendix 4.21 - A - Page 9**




**Real-Time Computer Display**

# SMART System
# Operating Program Listing
## Date: 24-Oct-91
## Time: 10:31:33



Operating Program Name: Baseline - Beef Stew
Program Creation Date: [illegible]-Sep-91
Last Modification Date: [illegible]-Oct-91
Operator For Modification: Generic Operator

## Operating Program Information

Program Description: Beef Stew at 17 cycles/min.
Reason For Update: Production run

## Operating Program Configuration

| Y/N | Component | Y/N | Component |
|---|---|---|---|
| [illegible] | BF1 - Installed | [illegible] | BF1 - Positive Forming System |
| [illegible] | BF1 - Positive Forming - Air Assist | [illegible] | BF1 - Negative Forming System |
| [illegible] | BF1 - Negative Forming - Air Assist | [illegible] | BF1 - Uniform Plug Installed |
| N | BF1 - Uniform Plug Locking Cylinder | [illegible] | BF1 - Foil Forming System |
| N | BF1 - Lower Preheater #1 | N | BF1 - Upper Preheater #1 |
| N | BF1 - Independent Preheaters #1 | N | BF1 - Lower Preheater #2 |
| N | BF1 - Upper Preheater #2 | Y | BF1 - Vacuum Pressure Sensor |
| N | BF1 - Air Assist Below Valve | Y | BF1 - Air Assist Above Valve |
| Y | BF1 - Vacuum/Air Vent | [illegible] | BF1 - Standard Forming Vacuum valve |
| Y | SS1 - Installed | Y | SS1 - Evacution By Timer |
| N | SS1 - Evacution By vacuum Level | N | SS1 - Gasflushing By Timer |
| N | SS1 - Nozzle | N | SS1 - Evacuate Via Nozzle |
| Y | Punch & Die #1 | Y | Punch & Die #2 |
| Y | Punch & Die #3 | Y | Onboard Vacuum Pump #1 |
| Y | Trim Removal Vacuum Device | Y | Air-Driven Exit Conveyor |
| Y | Conveyor Active During Index Only | [illegible] | Package Marking System |
| Y | Upper Dancer Arm | Y | Lower Dancer Arm |
| Y | SS - Upper Web Brake #1 | Y | SS - Lower Web Brake |
| [illegible] | Stop Lamp | [illegible] | Start Lamp |
| Y | Product Dispensing Unit | N | Product Spill Protection Device |
| N | Product Vibrator | N | Product Temperature Sensor |
| [illegible] | Miscellaneous Device | Y | Video Jet Printer #1 |
| Y | Video Jet Printer #2 | | |

## Index Parameters

| Parameter Name | Value |
|---|---|
| Index Length (mm): | 364.0 mm |
| Index Correction Factor (mm): | .0 mm |
| Index Speed (L/H): | H |
| Ramp-Up Distance From Start (mm): | 0 mm |
| Slow-Down Distance From End (mm): | 37 mm |
| Low-Speed Camera Enable Distance From End (mm): | 0 mm |
| High-Speed Camera Enable Distance From End (mm): | 0 mm |
| Ink Jet Distance (mm) | 0 mm |
| Packages Per Cycle: | [illegible] |
| Forming Cycle Counter: | [illegible] |
| Sealing Cycle Counter: | 1 |

# Timer Set Points

| Timer Description | Value |
|---|---|
| SF1 - Forming Time | 1.00 Secs. |
| SF1 - Air Assist Forming Time | 1.00 Secs. |
| SF1 - Forming Time | 1.00 Secs. |
| SS1 - Package Sealing Time | .75 Secs. |
| SS1 - Upper Chamber Evac Time | .40 Secs. |
| SS1 - Lower Chamber Evac Time | .40 Secs. |
| SS1 - Evac Chamber Vent Delay | .40 Secs. |
| AS - Tool Separation Delay #1 | .00 Secs. |
| AS - Tool Separation Delay #2 | .00 Secs. |
| AS - Miscellaneous Timer | .00 Secs. |
| Video Jet Printer #1 Delay | .00 Secs. |
| Video Jet Printer #2 Delay | .[illegible] Secs. |
| AS - Ink Jet Timer | .10 Secs. |
| AS - Start Warning Time | 2.00 Secs. |

# Temperature Set Points

| Temperature Description | Lower Limit | Set Point | Upper Limit |
|---|---|---|---|
| SS1 - Temperature | 210 (C) | 220 (C) | 235 (C) |

# Pressure Set Points

| Pressure Description | Lower Limit | Set Point | Upper Limit |
|---|---|---|---|
| AS - Incoming Oiled Air Pressure | 60 PSI | 80 PSI | 120 PSI |
| SF1 - Air Assist Forming Pressure | 12 PSI | 21 PSI | 30 PSI |
| SS - Seal #1 Pressure | 40 PSI | 55 PSI | 65 PSI |

# Forming Vacuum Pressure Set Points

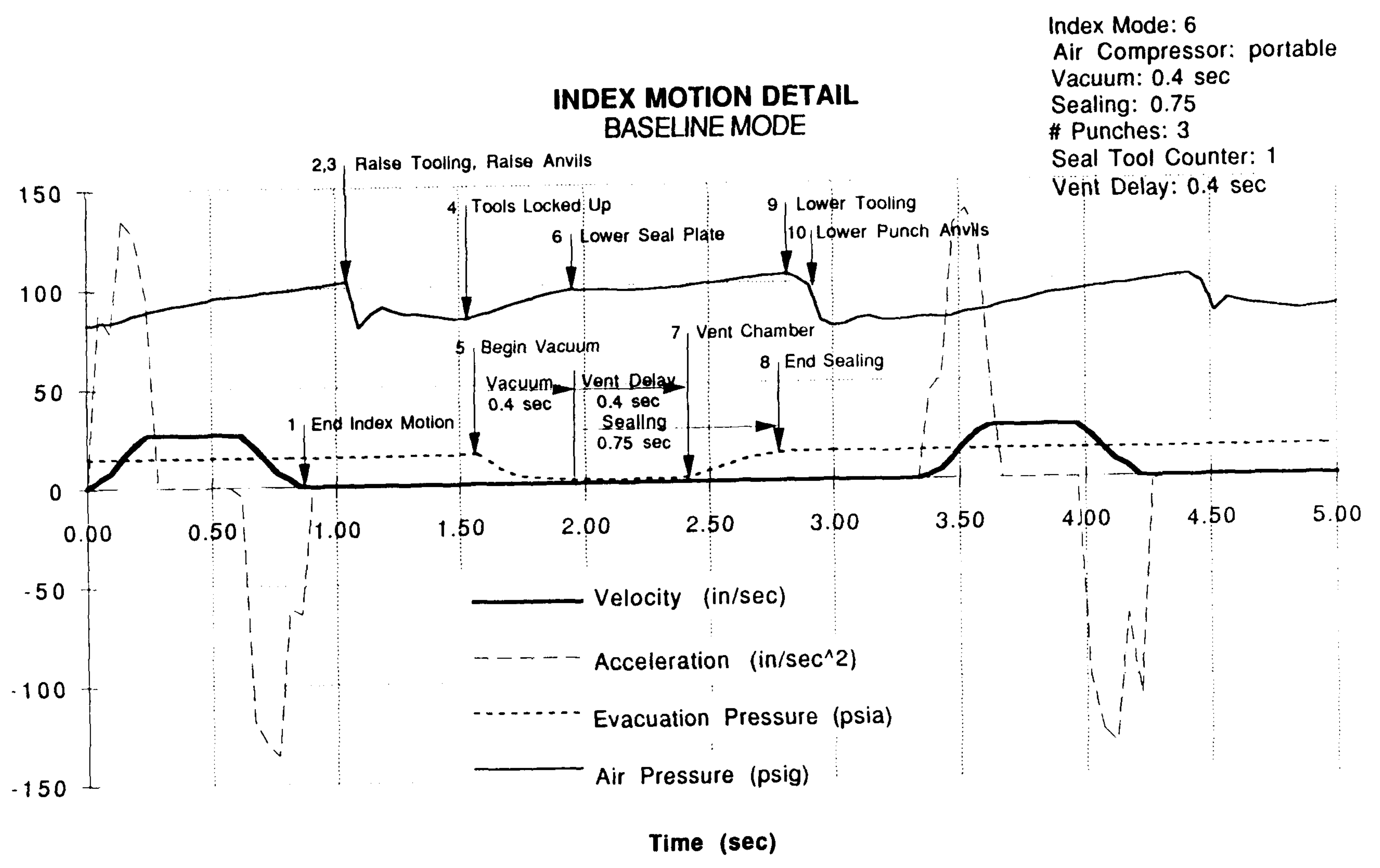
| Pressure Description | Lower Limit | Set Point | Upper Limit |
|---|---|---|---|
| SF1 - Forming Vacuum Pressure | 7.5 PSI | 11.0 PSI | 14.0 PSI |

# Heater PID Parameters

| Heater Name | Gain Factor | Integral Factor | Derivative Factor |
|---|---|---|---|
| SS1 - Heater | 60.00 | .00 | .25 |

## Tiromat Motion Parameters

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | INDEX MODE | | | | | |
| | | | | | | |
| | 1 | 2 | 3 | 4 | 5 | 6 |
| **Tiromat Parameters** | | | | | | |
| | | | | | | |
| **Variable Speed Motor** | | | | | | |
| **Drive Setting (MODE):** | | | | | | |
| Accel Time (1) | 5 | 2 | 1 | 0.5 | 0.2 | 0.1 |
| Decel Time (3) | 5 | 2 | 1 | 0.5 | 0.2 | 0.1 |
| Max Freq (18) | 25 | 40 | 55 | 70 | 90 | 100 |
| | | | | | | |
| **PLC Settings:** | | | | | | |
| Forming Time (sec) | 1 | ----> | | | | |
| Air Assist Time (sec) | 1 | ----> | | | | |
| Sealing Time (sec) | 0.75 | ----> | | | | |
| Evacuation Time (sec) | 0.2 | ----> | | | | |
| Slow Down Dist (mm) | 158 | 172 | 165 | 140 | 122 | 87 |



INDEX MOTION DETAIL
BASELINE MODE
Index Mode: 6
Air Compressor: portable
Vacuum: 0.4 sec
Sealing: 0.75
# Punches: 3
Seal Tool Counter: 1
Vent Delay: 0.4 sec
2,3 Raise Tooling, Raise Anvils
4 Tools Locked Up
6 Lower Seal Plate
9 Lower Tooling
10 Lower Punch Anvils
5 Begin Vacuum
7 Vent Chamber
8 End Sealing
1 End Index Motion
Vacuum 0.4 sec
Vent Delay 0.4 sec
Sealing 0.75 sec
150
100
50
0
-50
-100
-150
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00
4.50
5.00
Velocity (in/sec)
Acceleration (in/sec^2)
Evacuation Pressure (psia)
Air Pressure (psig)
Time (sec)

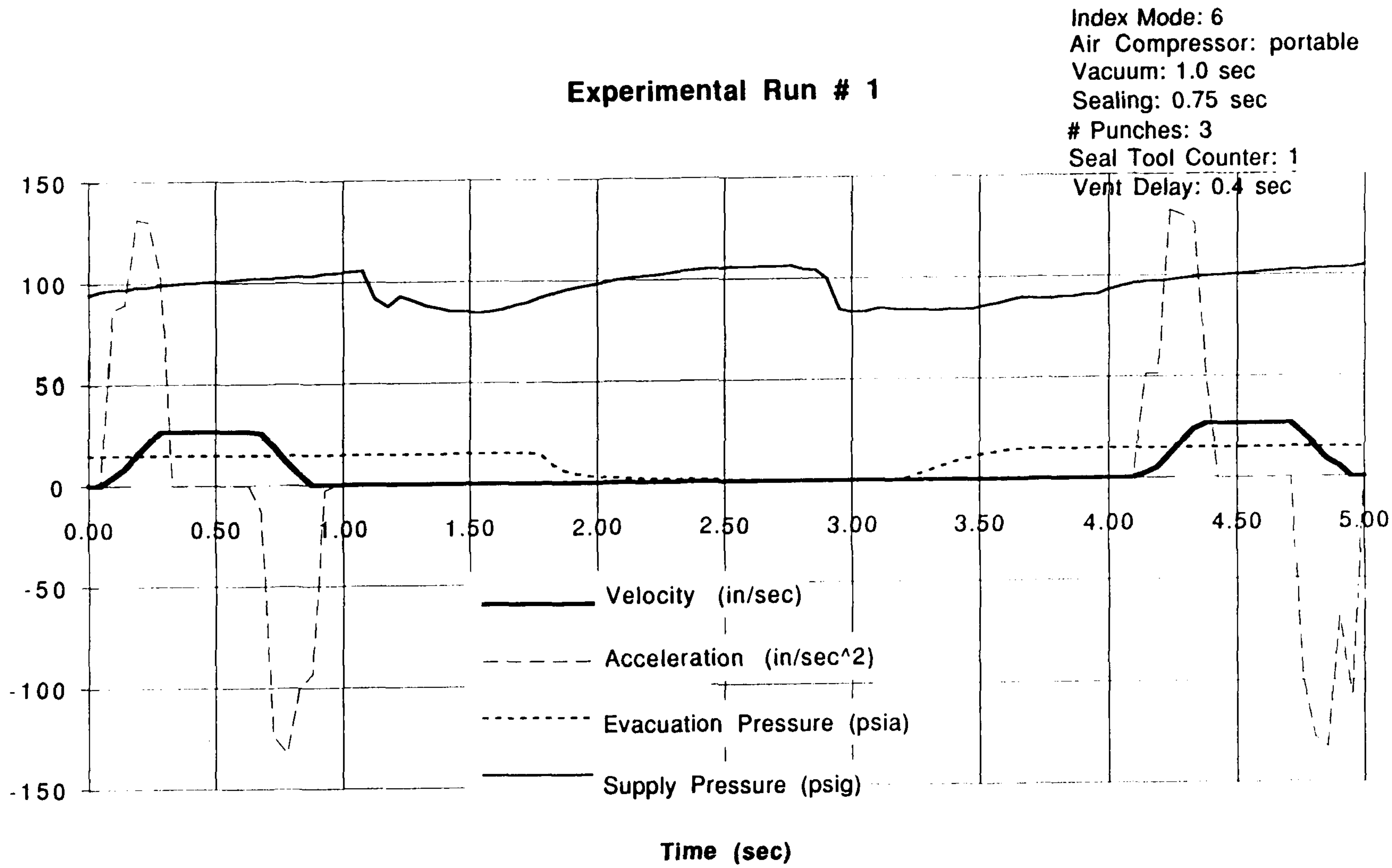
## TIROMAT OPERATING PARAMETERS AND SUMMERY FOR EXPERIMENTAL RUNS

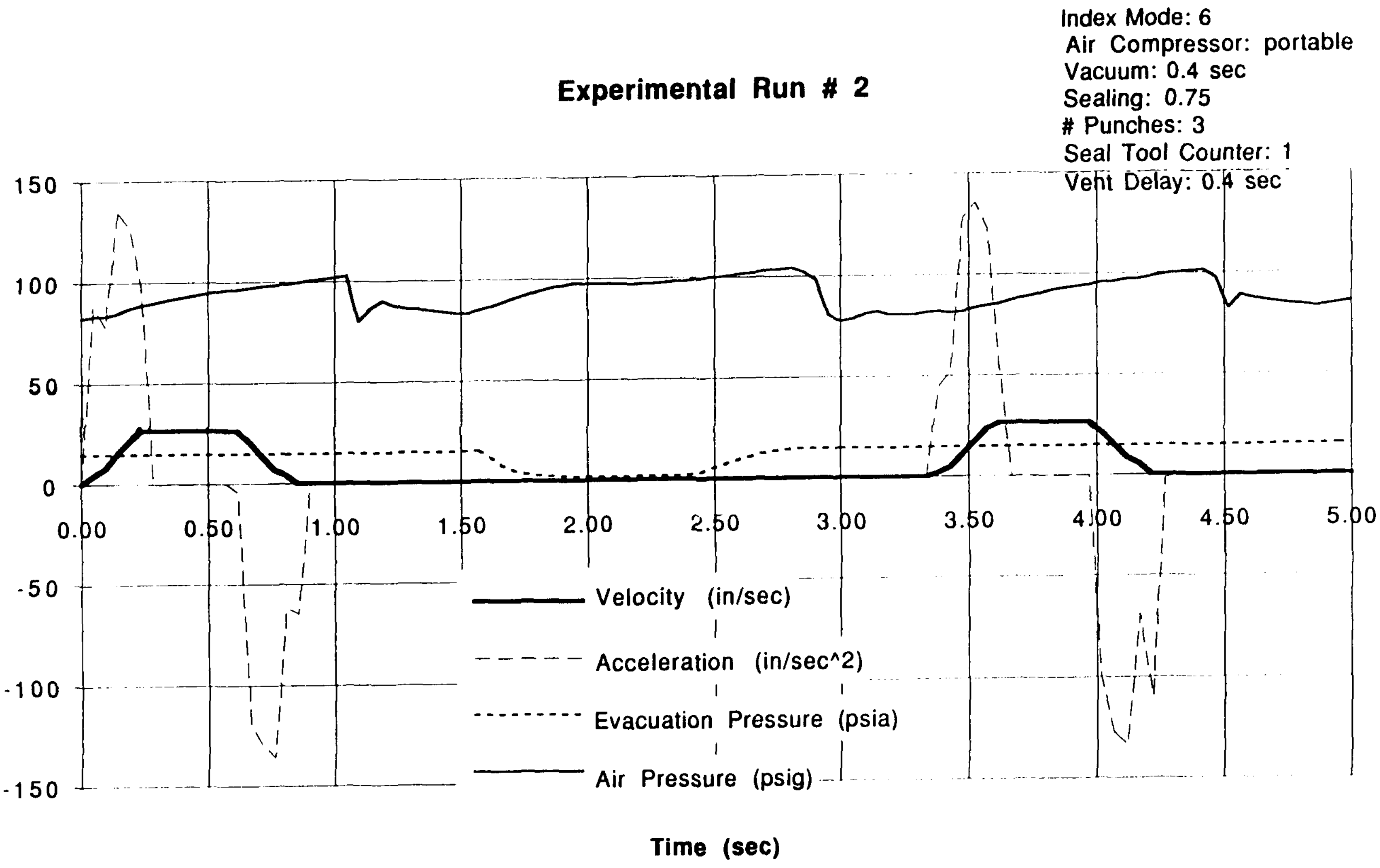
| | Hi Vacuum | Base-Line | Tool Counter | No Punch | House Air | 1 Punch | 2 Punch | 3 Punch | Mod Slosh | Low Slosh | No Slosh | Std Kutter |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Experimental Run # | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| Index Motion Mode # | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 5 | 4 | 3 | Kutter |
| Air Compressor * | P | P | P | P | H | H | H | H | P | P | P | P |
| Vacuum Time (sec) | 1 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |
| Sealing Time (sec) | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 |
| # Punches | 3 | 3 | 3 | 0 | 0 | 1 | 2 | 3 | 3 | 3 | 3 | 3 |
| Seal Tool Counter | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Vent Delay Time (sec) | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |
| Max. Air Pressure (psi) | 107 | 104 | 106 | 110 | 104 | 102 | 95 | 93 | 105 | 108 | 108 | 106 |
| Min. Air Pressure (psi) | 84 | 78 | 81 | 101 | 94 | 87 | 76 | 72 | 78 | 80 | 81 | 78 |
| Min. Pressure @ event # | 10 | 10 | 9 | 9 | 9 | 10 | 9 | 9 | 10 | 10 | 10 | 10 |
| Total Cycle Time (sec) | 4.1 | 3.35 | 3.85 | 3.36 | 3.32 | 3.4 | 3.37 | 3.47 | 3.58 | 4 | 4.52 | 3.85 |
| Production Rate (C/min) | 14.63 | 17.91 | 15.58 | 17.86 | 18.07 | 17.65 | 17.8 | 17.29 | 16.76 | 15 | 13.27 | 15.58 |
| Index Time (sec) | 0.87 | 0.88 | 0.87 | 0.9 | 0.88 | 0.88 | 0.9 | 0.87 | 1.1 | 1.44 | 1.85 | 1.35 |
| Peak Acceleration (in/sec^2) | -133 | -135 | -136 | -135 | -133 | 133 | -134 | 134 | 68 | 34 | -18 | 133 |

* NOTES:

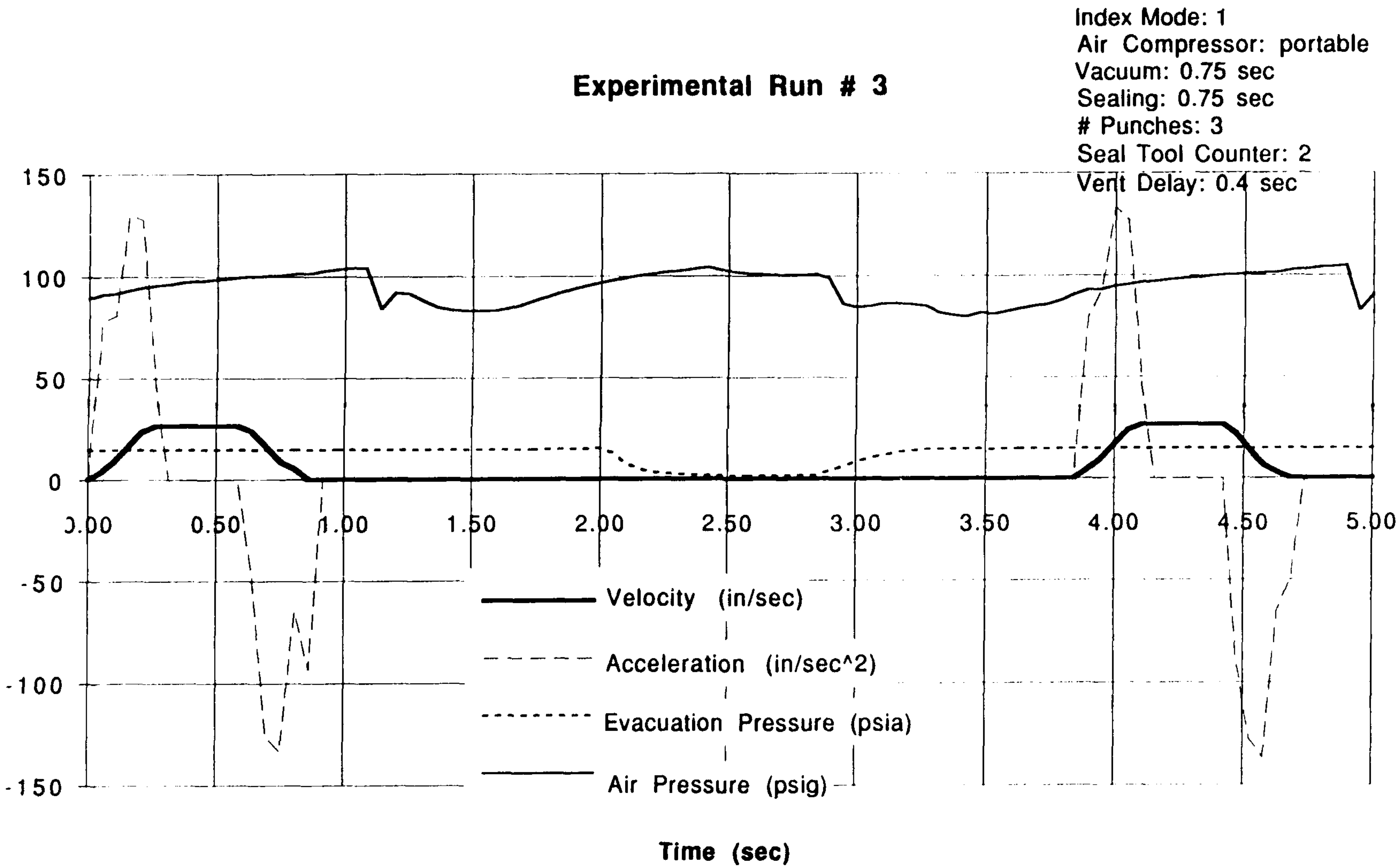
Air Compressor: P = Portable high output (110 psi, 185 cfm), H = House (105 psi, 130 cfm)
Index Motion Chart 8; Tiromat shut down due to low pressure
Index Mode # refers to the slope of the variable speed motor drive velocity (higher slopes produce shorter cycle time/higher acceleration)

## Experimental Run # 1



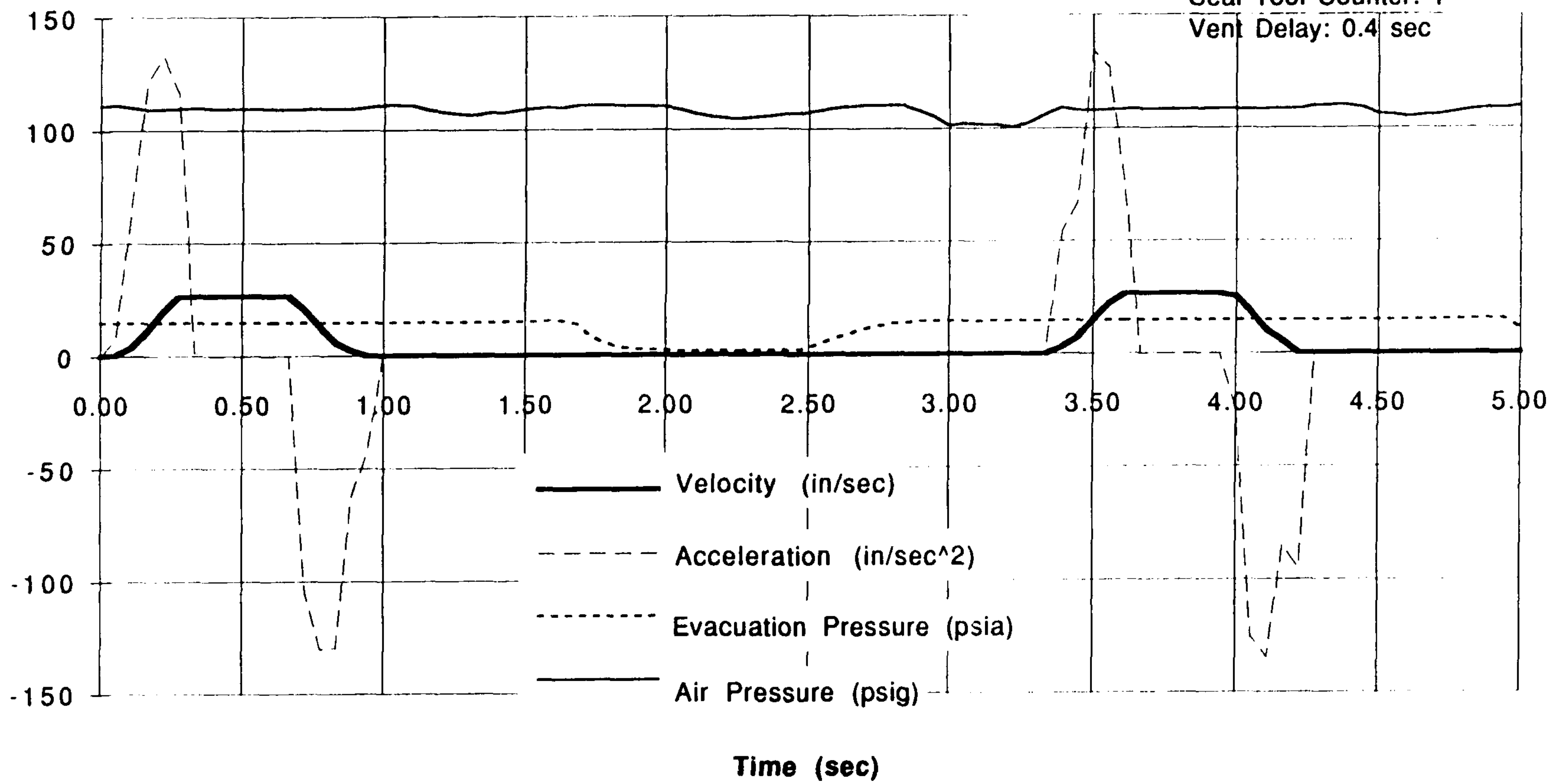

Experimental Run # 2
Index Mode: 6
Air Compressor: portable
Vacuum: 0.4 sec
Sealing: 0.75
# Punches: 3
Seal Tool Counter: 1
Vent Delay: 0.4 sec
150
100
50
0
-50
-100
-150
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00
4.50
5.00
Velocity (in/sec)
Acceleration (in/sec^2)
Evacuation Pressure (psia)
Air Pressure (psig)
Time (sec)

## Experimental Run # 3

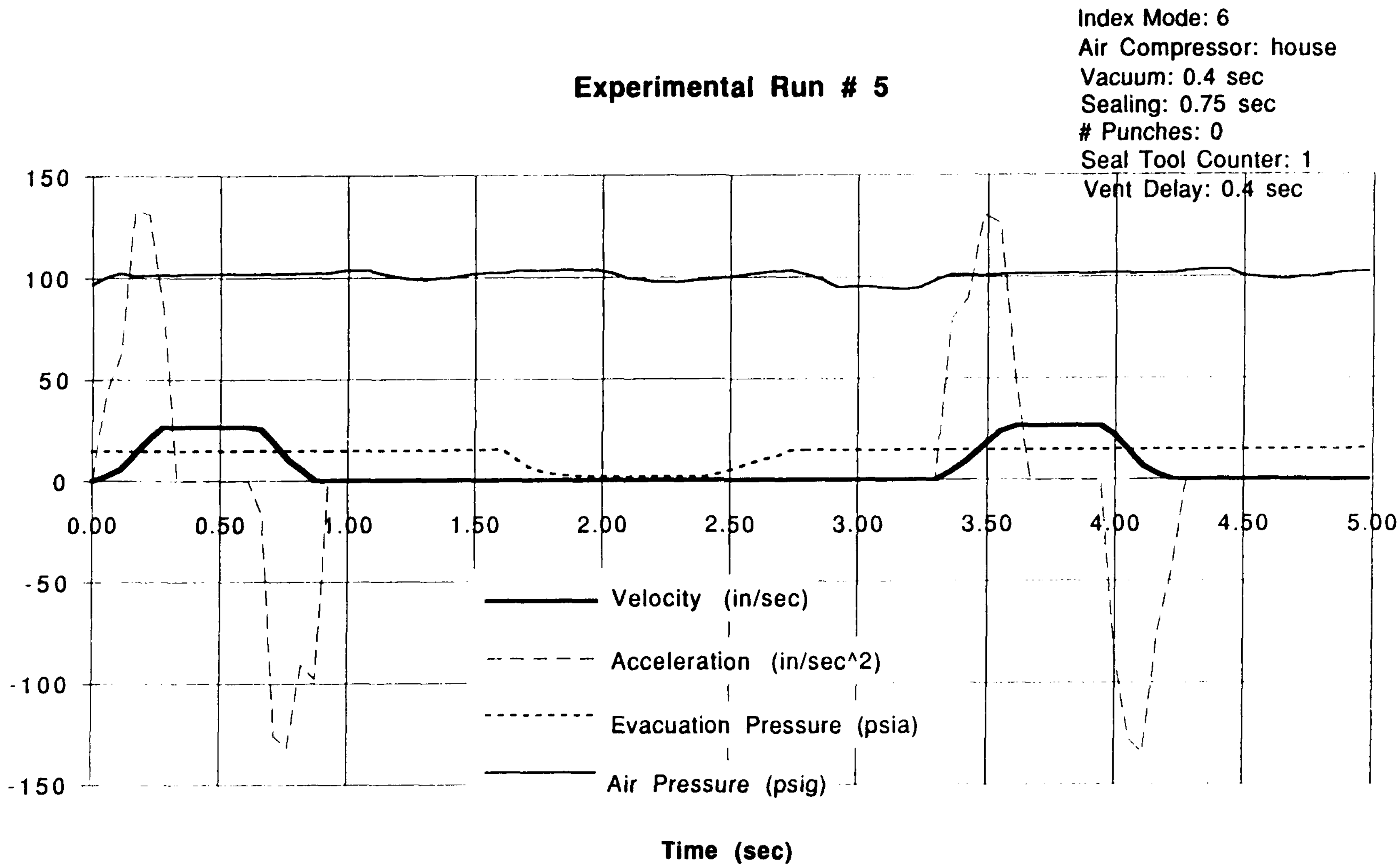


## Experimental Run # 4

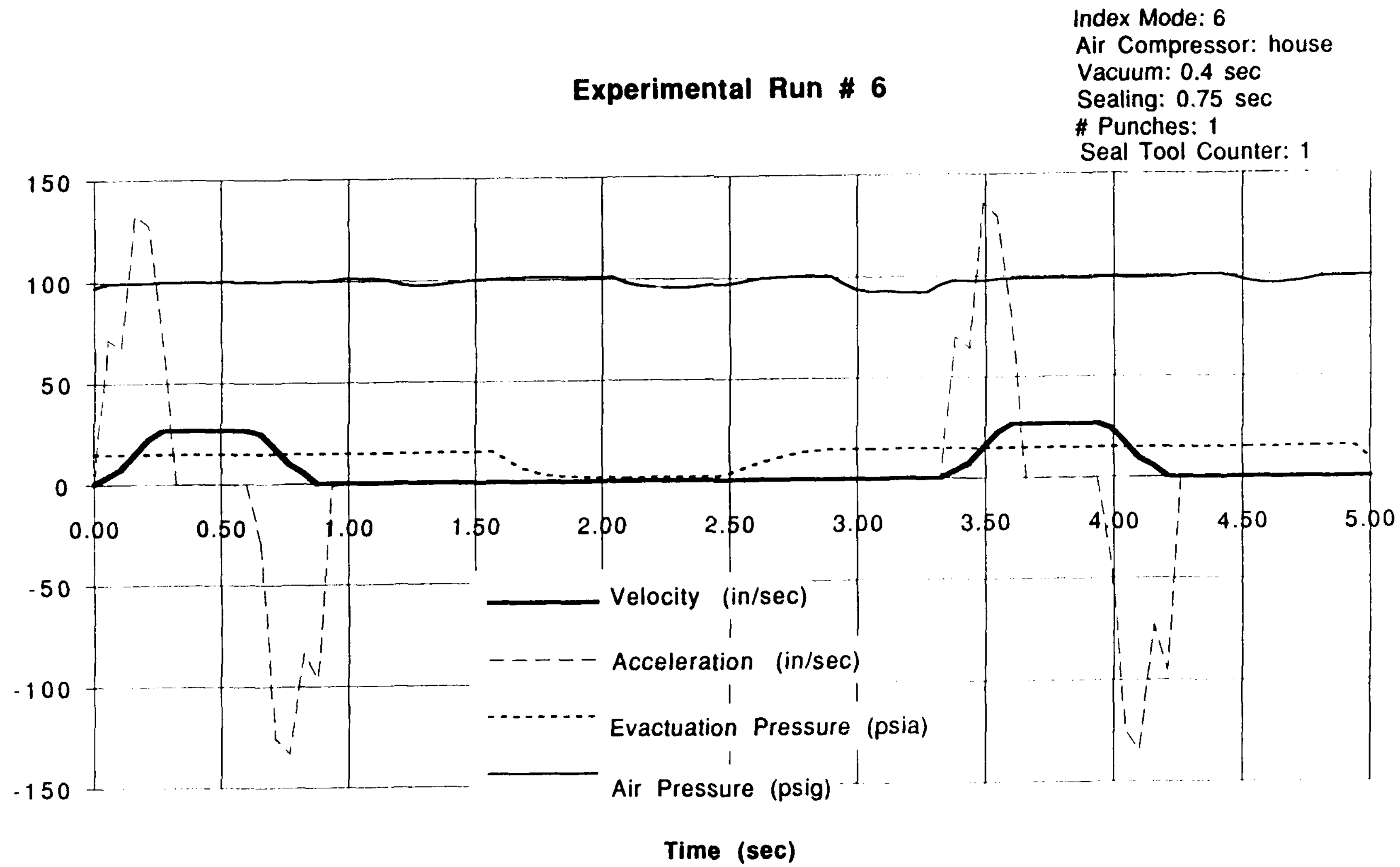
Index Mode: 6
Air Compressor: portable
Vacuum: 0.4 sec
Sealing: 0.75 sec
# Punches: 0
Seal Tool Counter: 1
Vent Delay: 0.4 sec



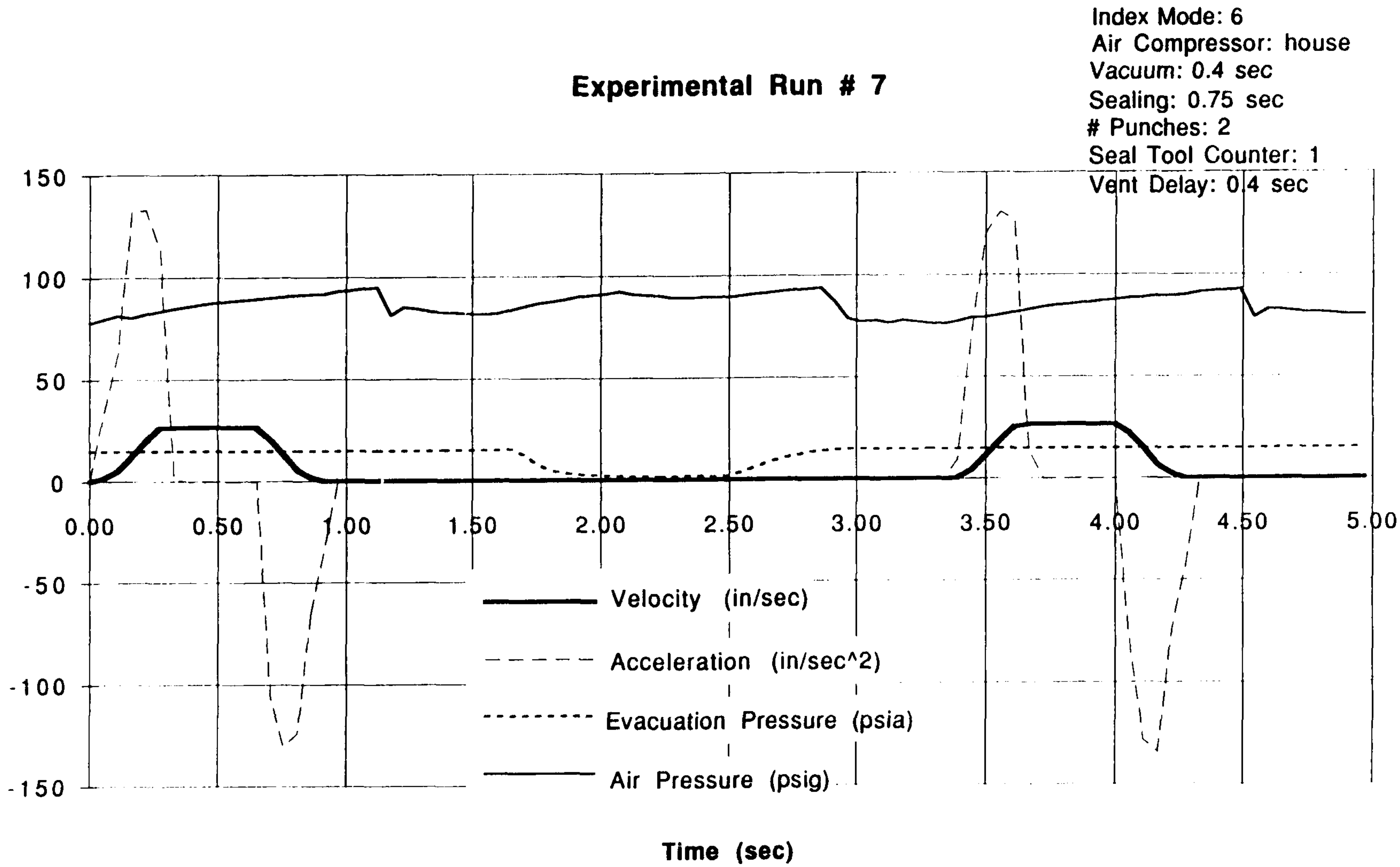
## Experimental Run # 5

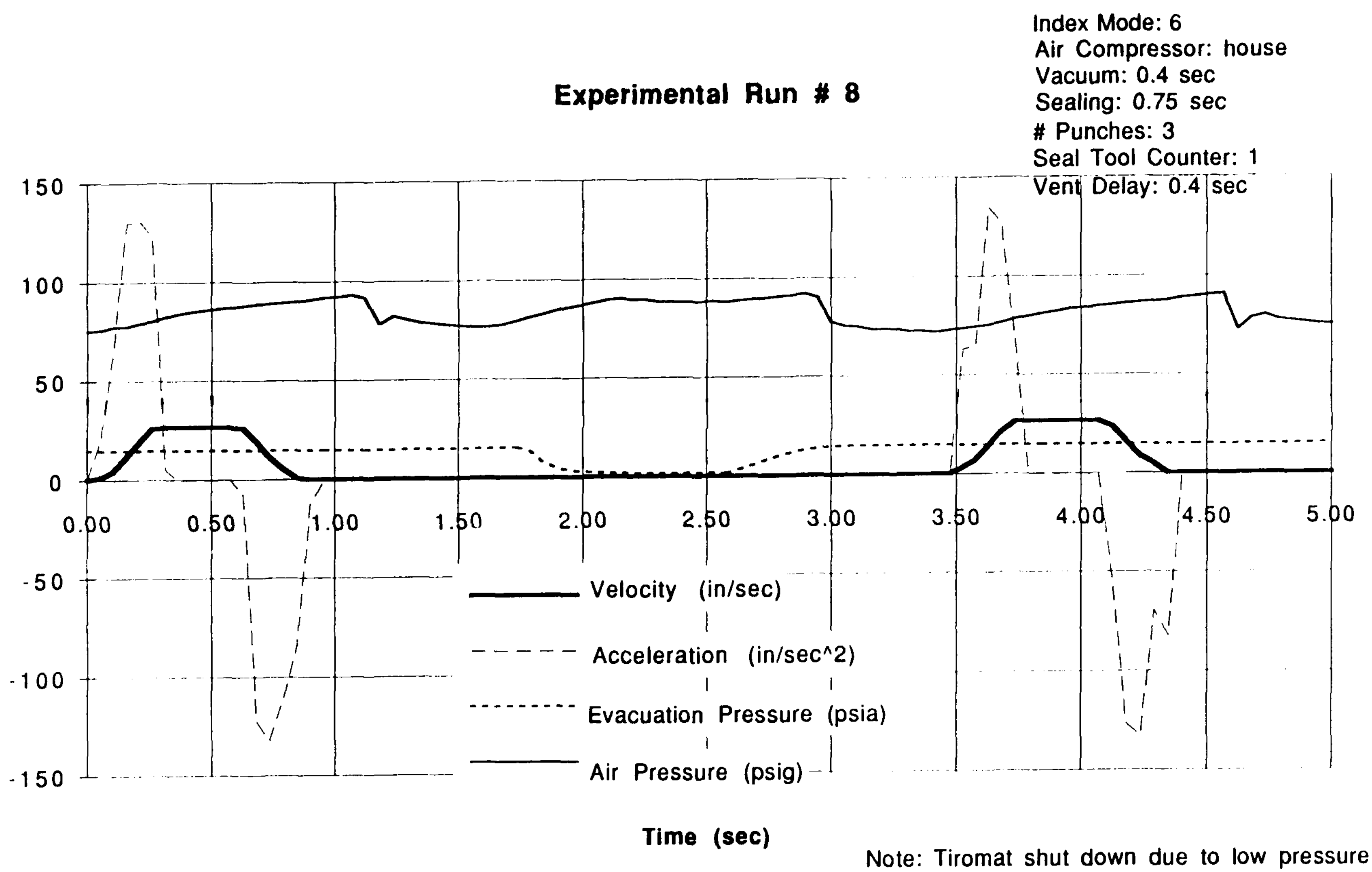


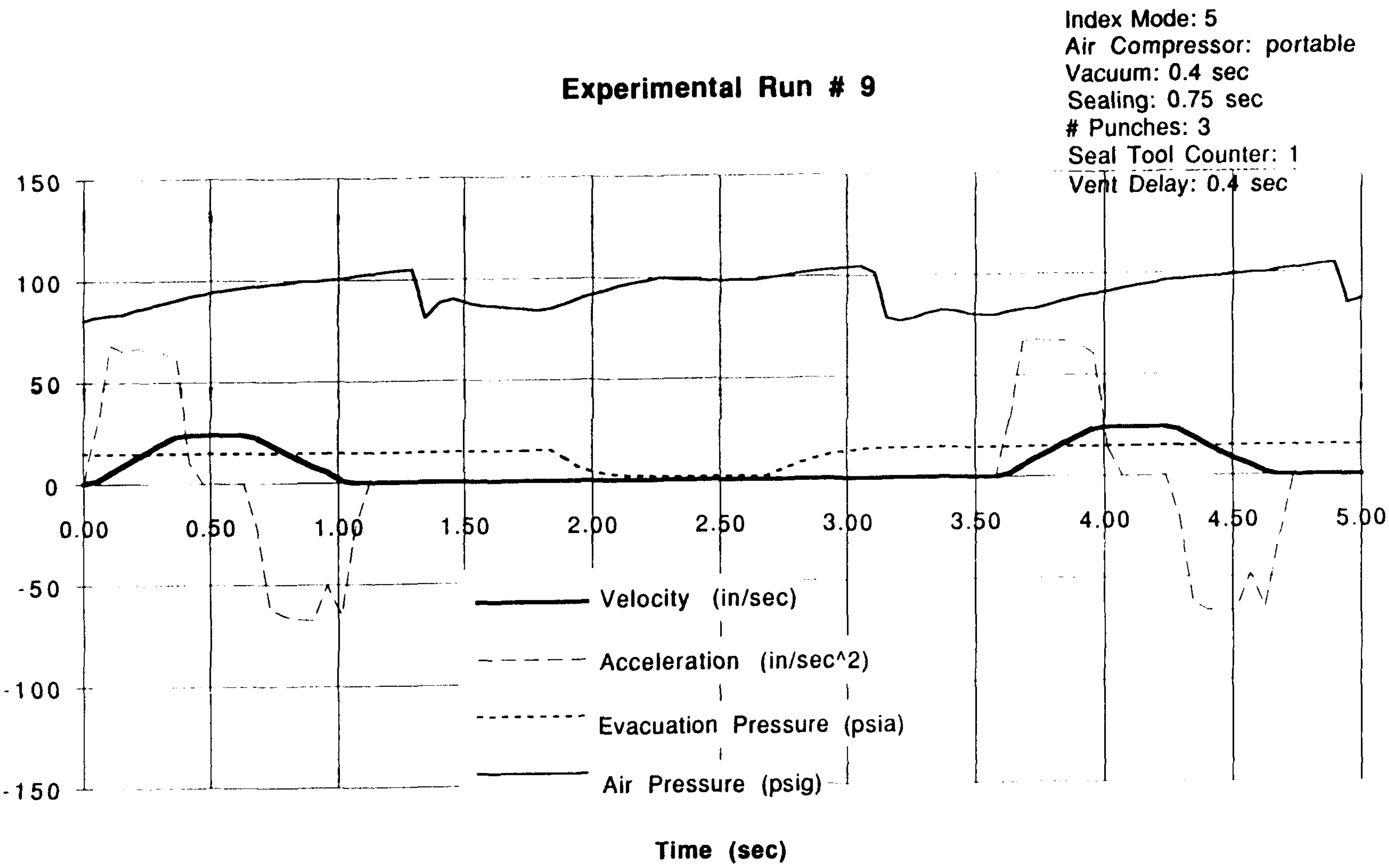
# Experimental Run # 6

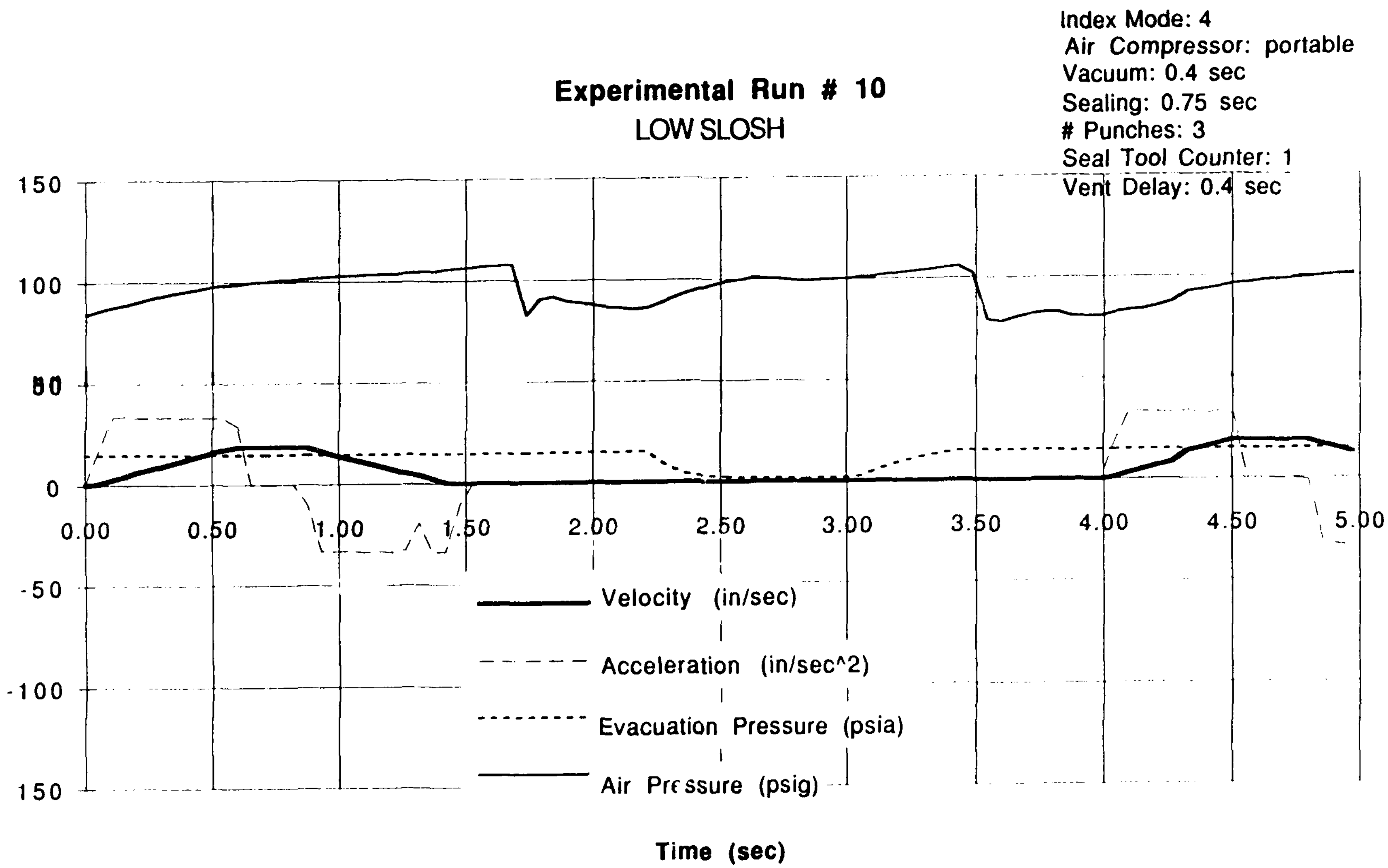


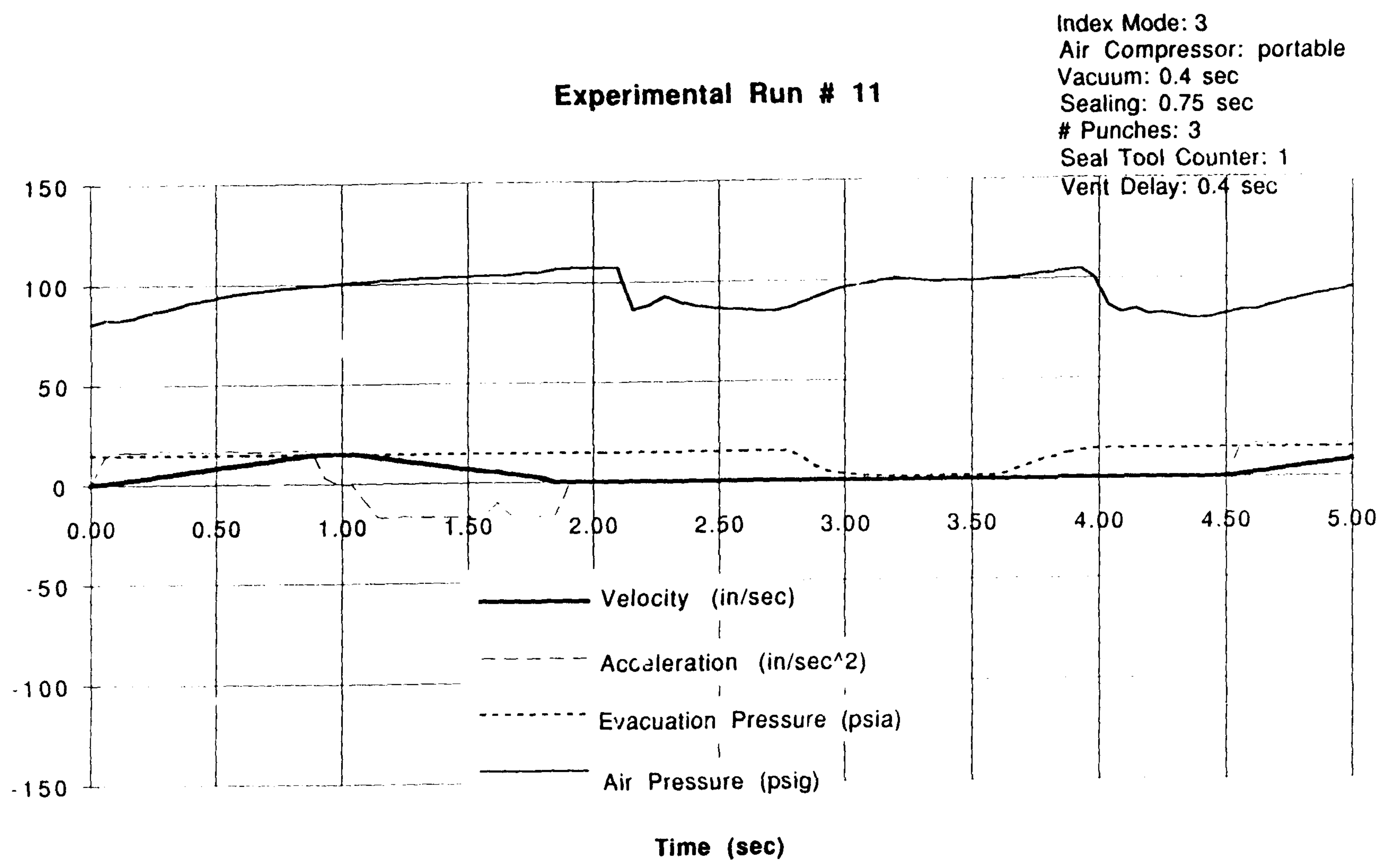
## Experimental Run # 7



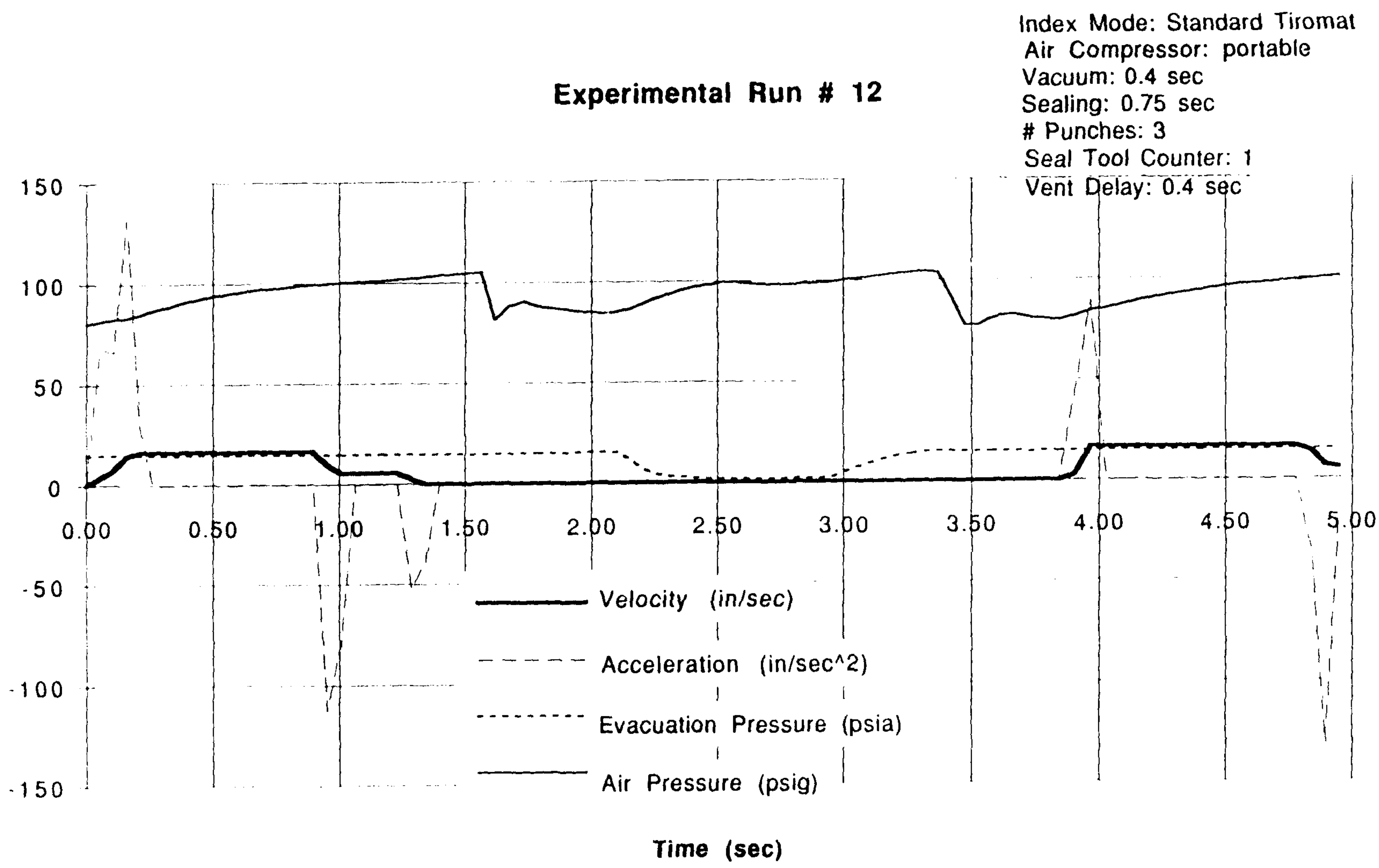

Experimental Run # 8
Index Mode: 6
Air Compressor: house
Vacuum: 0.4 sec
Sealing: 0.75 sec
# Punches: 3
Seal Tool Counter: 1
Vent Delay: 0.4 sec
150
100
50
0
-50
-100
-150
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00
4.50
5.00
Velocity (in/sec)
Acceleration (in/sec^2)
Evacuation Pressure (psia)
Air Pressure (psig)
Time (sec)
Note: Tiromat shut down due to low pressure


Experimental Run # 9
Index Mode: 5
Air Compressor: portable
Vacuum: 0.4 sec
Sealing: 0.75 sec
# Punches: 3
Seal Tool Counter: 1
Vent Delay: 0.4 sec
150
100
50
0
-50
-100
-150
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00
4.50
5.00
Velocity (in/sec)
Acceleration (in/sec^2)
Evacuation Pressure (psia)
Air Pressure (psig)
Time (sec)

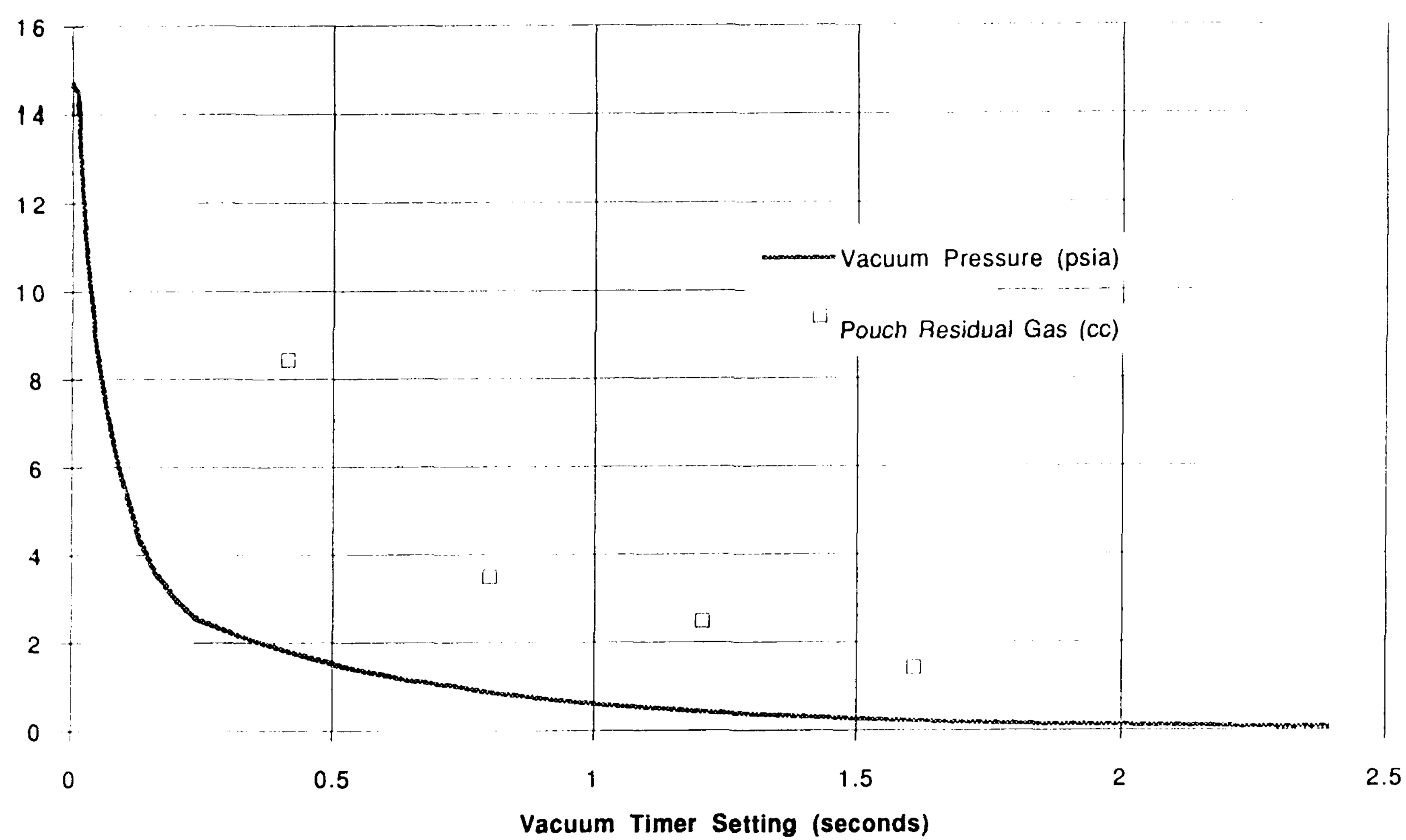

Experimental Run # 10
LOW SLOSH
Index Mode: 4
Air Compressor: portable
Vacuum: 0.4 sec
Sealing: 0.75 sec
# Punches: 3
Seal Tool Counter: 1
Vent Delay: 0.4 sec
150
100
50
0
-50
-100
150
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00
4.50
5.00
Velocity (in/sec)
Acceleration (in/sec^2)
Evacuation Pressure (psia)
Air Pressure (psig)
Time (sec)


Experimental Run # 11
Index Mode: 3
Air Compressor: portable
Vacuum: 0.4 sec
Sealing: 0.75 sec
# Punches: 3
Seal Tool Counter: 1
Vent Delay: 0.4 sec
150
100
50
0
-50
-100
-150
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00
4.50
5.00
Velocity (in/sec)
Acceleration (in/sec^2)
Evacuation Pressure (psia)
Air Pressure (psig)
Time (sec)

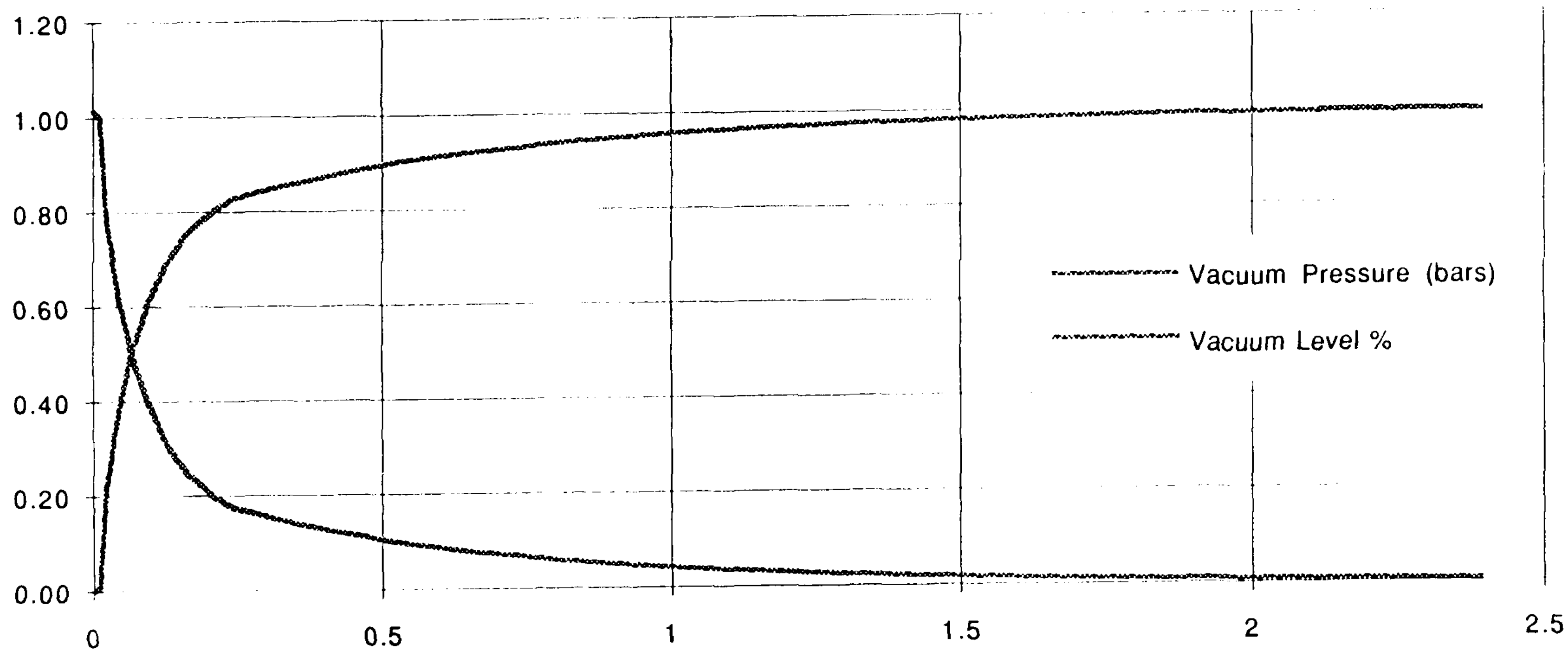
## Experimental Run # 12



## Residual Gas Level



## Tiromat Vacuum Level Chart



## TIROMAT TOOLING CHANGEOVER

| **Estimated Time for Changeover** | Minutes |
|---|---|
| Seal Plate, install and heat up | 10 |
| Seal Support Frame Brilla install and shim | 4 |
| Forming Mold, install and shim, adjust air assist pressure | 10 |
| Upper Circular Knife, remove/add blade and align | 10 |
| Lower Circular Knife, remove/add blade and align | 10 |
| Exit Conveyor adjust height | 4 |
| Punch Die, clean punch pieces and install tooling | 10 |
| Center Support Rails remove/add | 6 |
| Vibrator adjust height | 3 |
| Lower Web Film Change | 10 |
| Upper Web Film Change | 5 |
| Videojet<br>Operating Program load | 3 |
| Index machine, check all functions, make adjustments | 15 |
| TOTAL | 100 minutes |

**CRAMTD**

September 26, 1991

TO: T. Descovich, Files

FROM: Neal Litman

RE: STP# 8 - Tiromat Documentation/Demonstration Runs

PRESENT: R. Eggers, DLA
Col. P. DeBok, DLA
J. Lecollier, DPSC
P. Sherman, Natick
R. Feltner, DPSC

These runs were made as outlined in the attached memo to R. Eggers, dated September 12, 1991. Due to mechanical problems, the the tests were run twice; on September 19 and September 26, 1991.

Run Nos. 1 and 2 successfully demonstrated the Tiromat producing sealed and evacuated pouches at 17.7 indexes per minute (106 pouches per minute). Pouches filled with beef stew were retorted and examined for compliance with MIL-P-44073.

Run No. 3 successfully demonstrated the Tiromat's ability to handle liquid/flowable product. Production rate was 13.8 indexes per minute (83 pouches per minute).

Attachments: Memo to R. Eggers, dated 9/12/91
SMART System Operations Monitor printout
SMART System Operating Program Listing
Instrumentation Chart

CENTER FOR ADVANCED FOOD TECHNOLOGY

Combat Rations Advanced Manufacturing Technology Demonstration
(CRAMTD)/FoodTEX Programs
908/932-8307

September 12, 1991

TO: Russ Eggers

FROM: Ted Descovich TD

SUBJECT: Revised Documentation/Demonstration Run - STP #8

This is a revision of my memo to you on August 29, 1991 as a result of your input. The documentation/demonstration runs will be made at 10:00 A.M. on September 19, 1991. There will be three runs made as follows.

RUN #1 -
No product at 17 cycles per minute for 5 minutes with no vacuum, sealing only.

RUN #~~2~~ 3 -
8 oz. of corn starch with the viscosity for gravy as stated in the Military Specifications for two minutes with vacuum. Also filling several pouches with water and cycling at a rate of 10 per minute or greater to demonstrate the ability of the machine acceleration rate to be controlled so that no product sloshes on the seal area.

RUN #~~3~~ 2 -
Two minutes with product (beef stew) at 17 cycles per minute.

We will be using the Raque Filler to fill gravy into one pouch per cycle as we do not have a six up filler available. until early next year. The vegetables and meat will be pre-weighed and manually placed into the same pouch position. This will demonstrate that the machine can accept product, draw a vacuum, seal and punch out the pouch at a rate 17 cycles per minute.

As mentioned in my original memo we will also demonstrate the features of the SMART system that controls all the machine functions.

Nabisco Advanced
Food Technology Institute
Cook College
P O Box 231
New Brunswick NJ 08903-0231
908/932-8306

THE STATE UNIVERSITY OF NEW JERSEY
RUTGERS

SMART System Operations Monitor

Date: 26-Sep-91    Time: 10:41:13
Program Name: Beef Stew    Latest Rate: 17.7
Cycle Count: 331    Overall Cycle Rate: 16.1
Package Count: 1986  Status: System Available

| | Set Point | Low Limit | Actual | High Li |
|---|---|---|---|---|
| SS1 - Temperature | 220 C | 210 | 221 | 236 |
| SS1 - Pressure | 55 PSIG | 40 | 59 | 65 |
| BF1 - Forming Air Assist Pressure | 25 PSIG | 20 | 0 | 30 |
| BF1 - Forming Vacuum Pressure | 11.0 PSIA | 7.5 | 0.0 | 14.0 |

Prev Screen = Previous Page   Select = Update PLC Parameters   PF4 = Exi
Next Screen = Next Page   Do = Checkpoint Record

SMART System Operations Monitor

Date: 26-Sep-91    Time: 10:41:24

| | Set Point | Low Limit | Actual | High Lim |
|---|---|---|---|---|
| 240 VAC - Phase 1 | 240 VAC | 180 | 214 | 256 |
| 240 VAC - Phase 2 | 240 VAC | 180 | 211 | 256 |
| 240 VAC - Phase 3 | 240 VAC | 180 | 212 | 256 |
| Console Voltage | 120 VAC | 90 | 120 | 128 |
| Incoming Oiled Air Pressure | 80 PSIG | 60 | 111 | 120 |

SS1 - Heater Current: 3 Amp

Prev Screen = Previous Page   Select = Update PLC Parameters   PF4 = Exi
Next Screen = Next Page   Do = Checkpoint Record

# SMART System
# Operating Program Listing
# Date: 26-Sep-91
# Time: 11:09:58



Operating Program Name: Beef Stew
Program Creation Date: 23-Sep-91
Last Modification Date: 26-Sep-91
Operator For Modification: Generic Operator

## Operating Program Information

Program Description: Beef Stew at 17 cycles/min.
Reason For Update: Production run

## Operating Program Configuration

| Y/N | Component | Y/N | Component |
|---|---|---|---|
| Y | BF1 - Installed | Y | BF1 - Positive Forming System |
| N | BF1 - Positive Forming - Air Assist | Y | BF1 - Negative Forming System |
| Y | BF1 - Negative Forming - Air Assist | N | BF1 - Uniform Plug Installed |
| N | BF1 - Uniform Plug Locking Cylinder | Y | BF1 - Foil Forming System |
| N | BF1 - Lower Preheater #1 | N | BF1 - Upper Preheater #1 |
| N | BF1 - Independent Preheaters #1 | N | BF1 - Lower Preheater #2 |
| N | BF1 - Upper Preheater #2 | Y | BF1 - Vacuum Pressure Sensor |
| N | BF1 - Air Assist Below Valve | Y | BF1 - Air Assist Above Valve |
| Y | BF1 - Vacuum/Air Vent | Y | BF1 - Standard Forming Vacuum Val |
| Y | SS1 - Installed | Y | SS1 - Evacution By Timer |
| N | SS1 - Evacution By Vacuum Level | N | SS1 - Gasflushing By Timer |
| N | SS1 - Nozzle | N | SS1 - Evacuate Via Nozzle |
| Y | Punch & Die #1 | Y | Punch & Die #2 |
| Y | Punch & Die #3 | Y | Onboard Vacuum Pump #1 |
| Y | Trim Removal Vacuum Device | Y | Air-Driven Exit Conveyor |
| Y | Conveyor Active During Index Only | Y | Package Marking System |
| Y | Upper Dancer Arm | Y | Lower Dancer Arm |
| Y | SS - Upper Web Brake #1 | Y | BF - Lower Web Brake |
| Y | Stop Lamp | Y | Start Lamp |
| Y | Product Dispensing Unit | N | Product Spill Protection Device |
| N | Product Vibrator | N | Product Temperature Sensor |
| Y | Miscellaneous Device | Y | Video Jet Printer #1 |
| Y | Video Jet Printer #2 | | |

## Index Parameters

| Parameter Name | Value |
|---|---|
| Index Length (mm): | 364.0 mm |
| Index Correction Factor (mm): | .0 mm |
| Index Speed [L,H]: | H |
| Ramp-up Distance From Start (mm): | 0 mm |
| Slow-Down Distance From End (mm): | 122 mm |
| Low-Speed Camera Enable Distance From End (mm): | 0 mm |
| High-Speed Camera Enable Distance From End (mm): | 0 mm |
| Ink Jet Distance (mm): | 0 mm |
| Packages Per Cycle: | [illegible] |
| Forming Cycle Counter: | [illegible] |
| Sealing Cycle Counter: | [illegible] |

# SMART System
# Operating Program Listing
Date: 26-Sep-91
Time: 11:09:58



## Timer Set Points

| Timer Description | Value |
| --- | --- |
| BF1 - Forming Time | 1.00 Secs. |
| BF1 - Air Assist Forming Time | 1.00 Secs. |
| BF1 - Forming Time | 1.00 Secs. |
| SS1 - Package Sealing Time | .75 Secs. |
| SS1 - Upper Chamber Evac Time | 1.00 Secs. |
| SS1 - Lower Chamber Evac Time | 1.00 Secs. |
| SS1 - Evac Chamber Vent Delay | .40 Secs. |
| AS - Tool Separation Delay #1 | .00 Secs. |
| AS - Tool Separation Delay #2 | .00 Secs. |
| AS - Miscellaneous Timer | .00 Secs. |
| Video Jet Printer #1 Delay | .00 Secs. |
| Video Jet Printer #2 Delay | .00 Secs. |
| AS - Ink Jet Timer | .00 Secs. |
| AS - Start Warning Time | 3.00 Secs. |

## Temperature Set Points

| Temperature Description | Lower Limit | Set Point | Upper Limit |
| --- | --- | --- | --- |
| SS1 - Temperature | 210 (C) | 220 (C) | 235 (C) |

## Pressure Set Points

| Pressure Description | Lower Limit | Set Point | Upper Limit |
| --- | --- | --- | --- |
| AS - Incoming Oiled Air Pressure | 50 PSI | 80 PSI | 120 PSI |
| BF1 - Air Assist Forming Pressure | 20 PSI | 25 PSI | 30 PSI |
| SS - Seal #1 Pressure | 40 PSI | 55 PSI | 65 PSI |

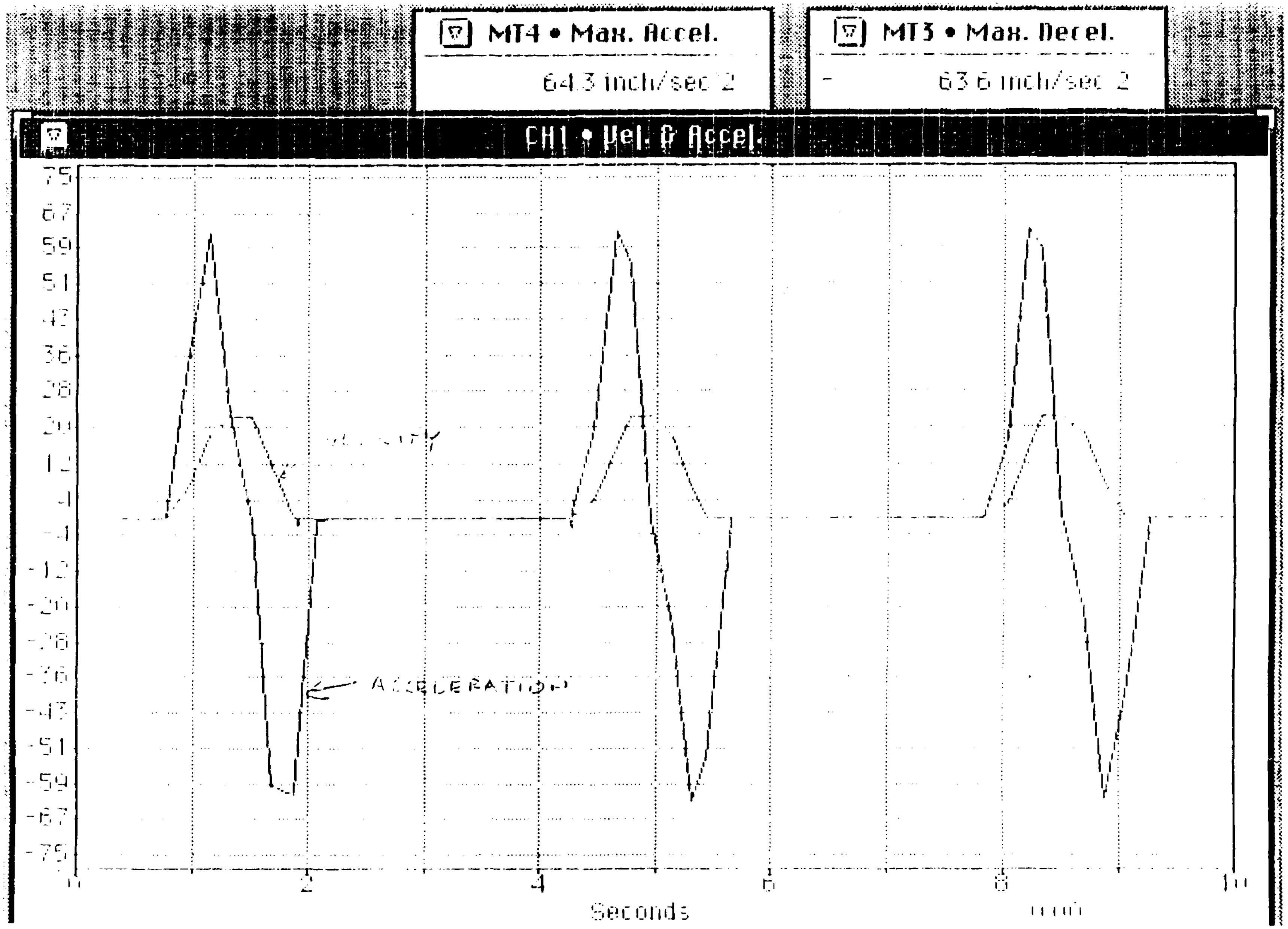
## Forming Vacuum Pressure Set Points

| Pressure Description | Lower Limit | Set Point | Upper Limit |
| --- | --- | --- | --- |
| BF1 - Forming Vacuum Pressure | 7.5 PSI | 11.0 PSI | 14.0 PSI |

## Heater PID Parameters

| Heater Name | Gain Factor | Integral Factor | Derivation Factor |
| --- | --- | --- | --- |
| SS1 - Heater | 50.00 | 1.00 | .25 |

BEEF STEW


MT4 • Max. Accel.
64.3 inch/sec 2
MT3 • Max. Decel.
- 63.6 inch/sec 2
CH1 • Vel. & Accel.
75
67
59
51
43
36
28
20
12
4
-4
-12
-20
-28
-36
-43
-51
-59
-67
-75
0
2
4
6
8
10
Seconds
ACCELERATION

SMART System Operations Monitor

Date: 26-Sep-91 Time: 11:25:47

Program Name: Eight Oz Water Latest Rate: 13.8

Cycle Count: 82 Overall Cycle Rate: 13.3

Package Count: 492 Status: System Available

| | Set Point | Low Limit | Actual | High Lim |
|---|---|---|---|---|
| SS1 - Temperature | 220 oC | 210 | 220 | 236 |
| SS1 - Pressure | 55 PSIG | 40 | 59 | 65 |
| BF1 - Forming Air Assist Pressure | 25 PSIG | 20 | 0 | 30 |
| BF1 - Forming Vacuum Pressure | 11.0 PSIA | 7.5 | 0.0 | 14.0 |

<Prev Screen> = Previous Page <Select> = Update PLC Parameters <PF4> = Exit

<Next Screen> = Next Page <Do> = Checkpoint Record

SMART System Operations Monitor

Date: 26-Sep-91 Time: 11:26:03

| | Set Point | Low Limit | Actual | High Lim |
|---|---|---|---|---|
| 240 VAC - Phase 1 | 240 VAC | 180 | 213 | 256 |
| 240 VAC - Phase 2 | 240 VAC | 180 | 210 | 256 |
| 240 VAC - Phase 3 | 240 VAC | 180 | 211 | 256 |
| Console Voltage | 120 VAC | 90 | 120 | 128 |
| Incoming Oiled Air Pressure | 80 PSIG | 60 | 111 | 120 |

SS1 - Heater Current: 4 Amp

<Prev Screen> = Previous Page <Select> = Update PLC Parameters <PF4> = Exit

<Next Screen> = Next Page <Do> = Checkpoint Record

# SMART System
# Operating Program Listing
# Date: 26-Sep-91
# Time: 11:22:30



Operating Program Name: Eight Oz Water
Program Creation Date: 23-Sep-91
Last Modification Date: 26-Sep-91
Operator For Modification: Generic Operator

## Operating Program Information

Program Description: Water 8 oz. fill
Reason For Update: Slosh evaluation

## Operating Program Configuration

| Y/N | Component | Y/N | Component |
|---|---|---|---|
| Y | BF1 - Installed | N | BF1 - Positive Forming System |
| N | BF1 - Positive Forming - Air Assist | Y | BF1 - Negative Forming System |
| Y | BF1 - Negative Forming - Air Assist | N | BF1 - Uniform Plug Installed |
| N | BF1 - Uniform Plug Locking Cylinder | Y | BF1 - Foil Forming System |
| N | BF1 - Lower Preheater #1 | N | BF1 - Upper Preheater #1 |
| N | BF1 - Independant Preheaters #1 | N | BF1 - Lower Preheater #2 |
| N | BF1 - Upper Preheater #2 | Y | BF1 - Vacuum Pressure Sensor |
| Y | BF1 - Air Assist Below Valve | Y | BF1 - Air Assist Above Valve |
| Y | BF1 - Vacuum/Air Vent | Y | BF1 - Standard Forming Vacuum Va |
| Y | SS1 - Installed | Y | SS1 - Evacution By Timer |
| N | SS1 - Evacution By Vacuum Level | N | SS1 - Gasflushing By Timer |
| N | SS1 - Nozzle | N | SS1 - Evacuate Via Nozzle |
| Y | Punch & Die #1 | Y | Punch & Die #2 |
| Y | Punch & Die #3 | Y | Onboard Vacuum Pump #1 |
| Y | Trim Removal Vacuum Device | Y | Air-Driven Exit Conveyor |
| Y | Conveyor Active During Index Only | Y | Package Marking System |
| N | Upper Dancer Arm | N | Lower Dancer Arm |
| Y | SS - Upper Web Brake #1 | Y | BF - Lower Web Brake |
| Y | Stop Lamp | Y | Start Lamp |
| Y | Product Dispensing Unit | N | Product Spill Protection Device |
| N | Product Vibrator | N | Product Temperature Sensor |
| Y | Miscellaneous Device | Y | Video Jet Printer #1 |
| Y | Video Jet Printer #2 | | |

## Index Parameters

| Parameter Name | Value |
|---|---|
| Index Length (mm): | 364.0 mm |
| Index Correction Factor (mm): | .0 mm |
| Index Speed [L/H]: | H |
| Ramp-Up Distance From Start (mm): | 0 mm |
| Slow-Down Distance From End (mm): | 160 mm |
| Low-Speed Camera Enable Distance From End (mm): | 0 mm |
| High-Speed Camera Enable Distance From End (mm): | 0 mm |
| Ink Jet Distance (mm) | 0 mm |
| Packages Per Cycle: | 6 |
| Forming Tools Counter: | 2 |
| Sealing Tools Counter: | 1 |

# SMART System
# Operating Program Listing
# Date: 26-Sep-91
# Time: 11:22:30



## Timer Set Points

| Timer Description | Value |
|---|---|
| BF1 - Forming Time | 1.00 Secs. |
| BF1 - Air Assist Forming Time | 1.00 Secs. |
| BF1 - Forming Time | 1.00 Secs. |
| SS1 - Package Sealing Time | .75 Secs. |
| SS1 - Upper Chamber Evac Time | .00 Secs. |
| SS1 - Lower Chamber Evac Time | .00 Secs. |
| SS1 - Evac Chamber Vent Delay | .00 Secs. |
| AS - Tool Separation Delay #1 | .00 Secs. |
| AS - Tool Separation Delay #2 | .00 Secs. |
| AS - Miscellaneous Timer | .00 Secs. |
| Video Jet Printer #1 Delay | .00 Secs. |
| Video Jet Printer #2 Delay | .00 Secs. |
| AS - Ink Jet Timer | .00 Secs. |
| AS - Start Warning Time | 3.00 Secs. |

## Temperature Set Points

| Temperature Description | Lower Limit | Set Point | Upper Limit |
|---|---|---|---|
| SS1 - Temperature | 220 (C) | 220 (C) | 236 (C) |

## Pressure Set Points

| Pressure Description | Lower Limit | Set Point | Upper Limit |
|---|---|---|---|
| AS - Incoming Oiled Air Pressure | 60 PSI | 80 PSI | 120 PSI |
| BF1 - Air Assist Forming Pressure | 20 PSI | 25 PSI | 30 PSI |
| SS - Seal #1 Pressure | 40 PSI | 55 PSI | 65 PSI |

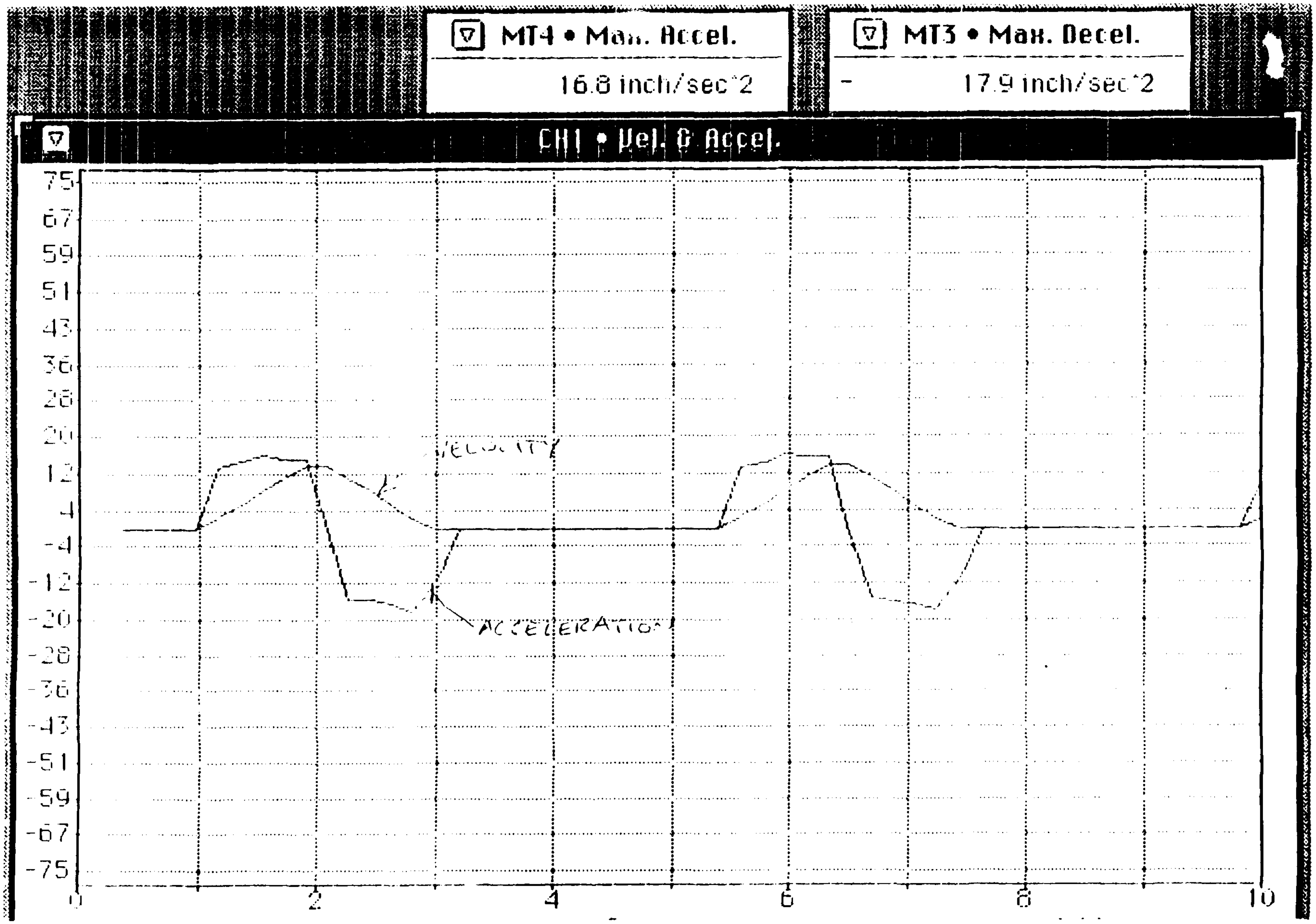
## Forming Vacuum Pressure Set Points

| Pressure Description | Lower Limit | Set Point | Upper Limit |
|---|---|---|---|
| BF1 - Forming Vacuum Pressure | 7.5 PSI | 11.0 PSI | 14.0 PSI |

## Heater PID Parameters

| Heater Name | Gain Factor | Integral Factor | Derivation Factor |
|---|---|---|---|
| SS1 - Heater | 60.00 | 1.00 | .25 |

WATER


MT4 • Max. Accel.
16.8 inch/sec^2
MT3 • Max. Decel.
- 17.9 inch/sec^2
CH1 • Vel. & Accel.
75
67
59
51
43
36
28
20
12
4
-4
-12
-20
-28
-36
-43
-51
-59
-67
-75
0
2
4
6
8
10
VELOCITY
ACCELERATION

SMART System Operations Monitor

Date: 26-Sep-91 Time: 10:41:18

Program Name: Beef Stew Latest Rate: 17.7

Cycle Count: 331 Overall Cycle Rate: 16.1

Package Count: 1986 Status: System Available

| | Set Point | Low Limit | Actual | High Li i |
|---|---|---|---|---|
| SS1 - Temperature | 220 oC | 210 | 221 | 236 |
| SS1 - Pressure | 55 PSIG | 40 | 59 | 65 |
| BF1 - Forming Air Assist Pressure | 25 PSIG | 20 | 0 | 30 |
| BF1 - Forming Vacuum Pressure | 11.0 PSIA | 7.5 | 0.0 | 14.0 |

<Prev Screen> = Previous Page <Select> = Update PLC Parameters <PF4> = Exi
<Next Screen> = Next Page <Do> = Checkpoint Record

SMART System Operations Monitor

Date: 26-Sep-91 Time: 10:41:24

| | Set Point | | Low Limit | Actual | High Limi |
|---|---|---|---|---|---|
| 240 VAC - Phase 1 | 240 | VAC | 180 | 214 | 256 |
| 240 VAC - Phase 2 | 240 | VAC | 180 | 211 | 256 |
| 240 VAC - Phase 3 | 240 | VAC | 180 | 212 | 256 |
| Console Voltage | 120 | VAC | 90 | 120 | 128 |
| Incoming Oiled Air Pressure | 80 | PSIG | 60 | 111 | 120 |

SS1 - Heater Current: 3 Amp

<Prev Screen> = Previous Page <Select> = Update PLC Parameters <PF4> = Exit
<Next Screen> = Next Page <Do> = Checkpoint Record

## PROCESS PARAMETERS: BEEF STEW (MRE)

| PRODUCT | BEEW STEW (MRE) | |
|---|---|---|
| FILL DATE/TIME | 9/26/91 | |
| BEEF LOT # | [illegible] | < 24 hr out of freezer |
| POTATO LOT # | dehydrated 1/2" | |
| PEA LOT # | IQF grade A | |
| CARROT LOT # | IQF 3/8" grade A | |
| SAUCE BATCH # | starch 4.5% | |
| BEEF FILL WEIGHT | 87 | |
| POTATO FILL WEIGHT | 20 | |
| PEA FILL WEIGHT | 9.7 | |
| CARROT FILL WEIGHT | 20 | |
| SAUCE FILL WEIGHT | 90 | |
| BEEF FILL TEMPERATURE | | 32°F @ 9:30 |
| VEGETABLE FILL TEMPERATURE | | 32°F @ 9:30 |
| SAUCE FILL TEMPERATURE | | 42°F @ 9:30 |
| SAUCE VISCOSITY | | |
| | | |
| | | |
| TIROMAT CYCLE RATE [c/min] | 17 cycles/min | |
| BOTTEM WEB LOT # | RND NEW EXP | |
| TOP WEB LOT # | RND 11 GS | |
| POUCH PREFORM SIZE [oz] | 125 oz nom | |
| VACUUM TIME [sec] | 0.0 | |
| SEALING TEMPERATURE [C] | 220 C | |
| SEALING PRESSURE [psig] | 55 PSI | |
| SEALING TIME [sec] | 0.15 SEC | |
| NUMBER POUCHES PRODUCED | ~~2297 g~~ 50 | |
| NET WEIGHT [g] | 2297 g | |
| RESIDUAL GAS BEFORE RETORT [cc] | | no vacuum applied. |
| | | |
| RETORT RUN # | | |
| I.T. OF PRODUCT | | |
| COME UP TIME | | |
| HOLD TIME | | |
| COOL DOWN TIME | | |
| AVERAGE MIG READING | | |
| ROTATION SPEED | | |
| MIN LETHALITY (GEN METHOD) | | |
| BALL HEATING FACTORS | | |
| Fh | | |
| Jh | | |
| F2 | | |
| Xhb | | |
| Fc | 1.41 | |
| Jc | | |
| RECOMMENDED COOK TIME | | |
| (RT=250 F, IT=70 F, F0=6) | | |
| | | |
| FINISHED PRODUCT ANALYSIS | | |
| NET WEIGHT (>226.8 g) | | |
| DRAIN WEIGHT BEEF (>68.0 g) | | |
| DRAIN WEIGHT VEGETABLES (>45.4 g) | | |
| RESIDUAL GAS (<10 cc) | | |
| SALT | | |
| FAT | | |
| POUCH DEFECTS | | |
| BURST STRENGTH | | |

# SMART System
# Operating Program Listing
# Date: 26-Sep-91
# Time: 11:09:58



Operating Program Name: Beef Stew
Program Creation Date: 23-Sep-91
Last Modification Date: 26-Sep-91
Operator For Modification: Generic Operator

## Operating Program Information

Program Description: Beef Stew at 17 cycles/min.
Reason For Update: Production run

## Operating Program Configuration

| Y/N | Component | Y/N | Component |
|---|---|---|---|
| Y | BF1 - Installed | N | BF1 - Positive Forming System |
| N | BF1 - Positive Forming - Air Assist | Y | BF1 - Negative Forming System |
| Y | BF1 - Negative Forming - Air Assist | N | BF1 - Uniform Plug Installed |
| N | BF1 - Uniform Plug Locking Cylinder | Y | BF1 - Foil Forming System |
| N | BF1 - Lower Preheater #1 | N | BF1 - Upper Preheater #1 |
| N | BF1 - Independent Preheaters #1 | N | BF1 - Lower Preheater #2 |
| N | BF1 - Upper Preheater #2 | Y | BF1 - Vacuum Pressure Sensor |
| N | BF1 - Air Assist Below Valve | Y | BF1 - Air Assist Above Valve |
| Y | BF1 - Vacuum/Air Vent | Y | BF1 - Standard Forming Vacuum Valve |
| Y | SS1 - Installed | Y | SS1 - Evacution By Timer |
| N | SS1 - Evacution By Vacuum Level | N | SS1 - Gasflushing By Timer |
| N | SS1 - Nozzle | N | SS1 - Evacuate Via Nozzle |
| Y | Punch & Die #1 | Y | Punch & Die #2 |
| Y | Punch & Die #3 | Y | Onboard Vacuum Pump #1 |
| Y | Trim Removal Vacuum Device | Y | Air-Driven Exit Conveyor |
| Y | Conveyor Active During Index Only | Y | Package Marking System |
| Y | Upper Dancer Arm | Y | Lower Dancer Arm |
| Y | SS - Upper Web Brake #1 | Y | BF - Lower Web Brake |
| Y | Stop Lamp | Y | Start Lamp |
| Y | Product Dispensing Unit | N | Product Spill Protection Device |
| N | Product Vibrator | N | Product Temperature Sensor |
| Y | Miscellaneous Device | Y | Video Jet Printer #1 |
| Y | Video Jet Printer #2 | | |

## Index Parameters

| Parameter Name | Value |
|---|---|
| Index Length (mm): | 364.0 mm |
| Index Correction Factor (mm): | .0 mm |
| Index Speed [L/H]: | H |
| Ramp-Up Distance From Start (mm): | 0 mm |
| Slow-Down Distance From End (mm): | 122 mm |
| Low-Speed Camera Enable Distance From End (mm): | 0 mm |
| High-Speed Camera Enable Distance From End (mm): | 0 mm |
| Ink Jet Distance (mm) | 0 mm |
| Packages Per Cycle: | 6 |
| Forming Tools Counter: | 2 |
| Sealing Tools Counter: | 1 |

SMART System
Operating Program Listing
Date: 26-Sep-91
Time: 11:09:58



# Timer Set Points

| Timer Description | Value |
|---|---|
| BF1 - Forming Time | 1.00 Secs. |
| BF1 - Air Assist Forming Time | 1.00 Secs. |
| BF1 - Forming Time | 1.00 Secs. |
| SS1 - Package Sealing Time | .75 Secs. |
| SS1 - Upper Chamber Evac Time | 1.00 Secs. |
| SS1 - Lower Chamber Evac Time | 1.00 Secs. |
| SS1 - Evac Chamber Vent Delay | .40 Secs. |
| AS - Tool Separation Delay #1 | .00 Secs. |
| AS - Tool Separation Delay #2 | .00 Secs. |
| AS - Miscellaneous Timer | .00 Secs. |
| Video Jet Printer #1 Delay | .00 Secs. |
| Video Jet Printer #2 Delay | .00 Secs. |
| AS - Ink Jet Timer | .00 Secs. |
| AS - Start Warning Time | 3.00 Secs. |

# Temperature Set Points

| Temperature Description | Lower Limit | Set Point | Upper Limit |
|---|---|---|---|
| SS1 - Temperature | 210 (C) | 220 (C) | 235 (C) |

# Pressure Set Points

| Pressure Description | Lower Limit | Set Point | Upper Limit |
|---|---|---|---|
| AS - Incoming Oiled Air Pressure | 60 PSI | 80 PSI | 120 PSI |
| BF1 - Air Assist Forming Pressure | 20 PSI | 25 PSI | 30 PSI |
| SS - Seal #1 Pressure | 40 PSI | 55 PSI | 65 PSI |

# Forming Vacuum Pressure Set Points

| Pressure Description | Lower Limit | Set Point | Upper Limit |
|---|---|---|---|
| BF1 - Forming Vacuum Pressure | 7.5 PSI | 11.0 PSI | 14.0 PSI |

# Heater PID Parameters

| Heater Name | Gain Factor | Integral Factor | Derivation Factor |
|---|---|---|---|
| SS1 - Heater | 50.00 | 1.00 | .25 |

# SMART System
# Operating Program Listing
# Date: 26-Sep-91
# Time: 11:22:30



Operating Program Name: Eight Oz Water
Program Creation Date: 23-Sep-91
Last Modification Date: 26-Sep-91
Operator For Modification: Generic Operator

## Operating Program Information

Program Description: Water 8 oz. fill
Reason For Update: Slosh evaluation

## Operating Program Configuration

| Y/N | Component | Y/N | Component |
|---|---|---|---|
| Y | BF1 - Installed | N | BF1 - Positive Forming System |
| N | BF1 - Positive Forming - Air Assist | Y | BF1 - Negative Forming System |
| Y | BF1 - Negative Forming - Air Assist | N | BF1 - Uniform Plug Installed |
| N | BF1 - Uniform Plug Locking Cylinder | Y | BF1 - Foil Forming System |
| N | BF1 - Lower Preheater #1 | N | BF1 - Upper Preheater #1 |
| N | BF1 - Independent Preheaters #1 | N | BF1 - Lower Preheater #2 |
| N | BF1 - Upper Preheater #2 | Y | BF1 - Vacuum Pressure Sensor |
| Y | BF1 - Air Assist Below Valve | Y | BF1 - Air Assist Above Valve |
| Y | BF1 - Vacuum/Air Vent | Y | BF1 - Standard Forming Vacuum V[illegible] |
| Y | SS1 - Installed | Y | SS1 - Evacution By Timer |
| N | SS1 - Evacution By Vacuum Level | N | SS1 - Gasflushing By Timer |
| N | SS1 - Nozzle | N | SS1 - Evacuate Via Nozzle |
| Y | Punch & Die #1 | Y | Punch & Die #2 |
| Y | Punch & Die #3 | Y | Onboard Vacuum Pump #1 |
| Y | Trim Removal Vacuum Device | Y | Air-Driven Exit Conveyor |
| Y | Conveyor Active During Index Only | Y | Package Marking System |
| N | Upper Dancer Arm | N | Lower Dancer Arm |
| Y | SS - Upper Web Brake #1 | Y | BF - Lower Web Brake |
| Y | Stop Lamp | Y | Start Lamp |
| Y | Product Dispensing Unit | N | Product Spill Protection Device |
| N | Product Vibrator | N | Product Temperature Sensor |
| Y | Miscellaneous Device | Y | Video Jet Printer #1 |
| Y | Video Jet Printer #2 | | |

## Index Parameters

| Parameter Name | Value |
|---|---|
| Index Length (mm): | 364.0 mm |
| Index Correction Factor (mm): | .0 mm |
| Index Speed [L/H]: | H |
| Ramp-Up Distance From Start (mm): | 0 mm |
| Slow-Down Distance From End (mm): | 160 mm |
| Low-Speed Camera Enable Distance From End (mm): | 0 mm |
| High-Speed Camera Enable Distance From End (mm): | 0 mm |
| Ink Jet Distance (mm) | 0 mm |
| Packages Per Cycle: | 6 |
| Forming Tools Counter: | 2 |
| Sealing Tools Counter: | 1 |

BEEF STEW

MT4 • Max. Accel.

64.3 inch/sec^2

MT3 • Max. Decel.

- 63.6 inch/sec^2

SMART System Operations Monitor

Date: 26-Sep-91 Time: 11:25:47
Program Name: Eight Oz Water Latest Rate: 13.8
Cycle Count: 82 Overall Cycle Rate: 13.3
Package Count: 492 Status: System Available

| | Set Point | Low Limit | Actual | High Lim |
|---|---|---|---|---|
| SS1 - Temperature | 220 oC | 210 | 220 | 236 |
| SS1 - Pressure | 55 PSIG | 40 | 59 | 65 |
| BF1 - Forming Air Assist Pressure | 25 PSIG | 20 | 0 | 30 |
| BF1 - Forming Vacuum Pressure | 11.0 PSIA | 7.5 | 0.0 | 14.0 |

<Prev Screen> = Previous Page <Select> = Update PLC Parameters <PF4> = Exit
<Next Screen> = Next Page <Do> = Checkpoint Record

SMART System Operations Monitor

Date: 26-Sep-91 Time: 11:26:03

| | Set Point | Low Limit | Actual | High Lim: |
|---|---|---|---|---|
| 240 VAC - Phase 1 | 240 VAC | 180 | 213 | 256 |
| 240 VAC - Phase 2 | 240 VAC | 180 | 210 | 256 |
| 240 VAC - Phase 3 | 240 VAC | 180 | 211 | 256 |
| Console Voltage | 120 VAC | 90 | 120 | 128 |
| Incoming Oiled Air Pressure | 80 PSIG | 60 | 111 | 120 |

SS1 - Heater Current: 4 Amp

<Prev Screen> = Previous Page <Select> = Update PLC Parameters <PF4> = Exit
<Next Screen> = Next Page <Do> = Checkpoint Record

SMART System
Operating Program Listing
Date: 26-Sep-91
Time: 11:22:30



## Timer Set Points

| Timer Description | Value |
|---|---|
| BF1 - Forming Time | 1.00 Secs. |
| BF1 - Air Assist Forming Time | 1.00 Secs. |
| BF1 - Forming Time | 1.00 Secs. |
| SS1 - Package Sealing Time | .75 Secs. |
| SS1 - Upper Chamber Evac Time | .00 Secs. |
| SS1 - Lower Chamber Evac Time | .00 Secs. |
| SS1 - Evac Chamber Vent Delay | .00 Secs. |
| AS - Tool Separation Delay #1 | .00 Secs. |
| AS - Tool Separation Delay #2 | .00 Secs. |
| AS - Miscellaneous Timer | .00 Secs. |
| Video Jet Printer #1 Delay | .00 Secs. |
| Video Jet Printer #2 Delay | .00 Secs. |
| AS - Ink Jet Timer | .00 Secs. |
| AS - Start Warning Time | 3.00 Secs. |

## Temperature Set Points

| Temperature Description | Lower Limit | Set Point | Upper Limit |
|---|---|---|---|
| SS1 - Temperature | 220 (C) | 220 (C) | 236 (C) |

## Pressure Set Points

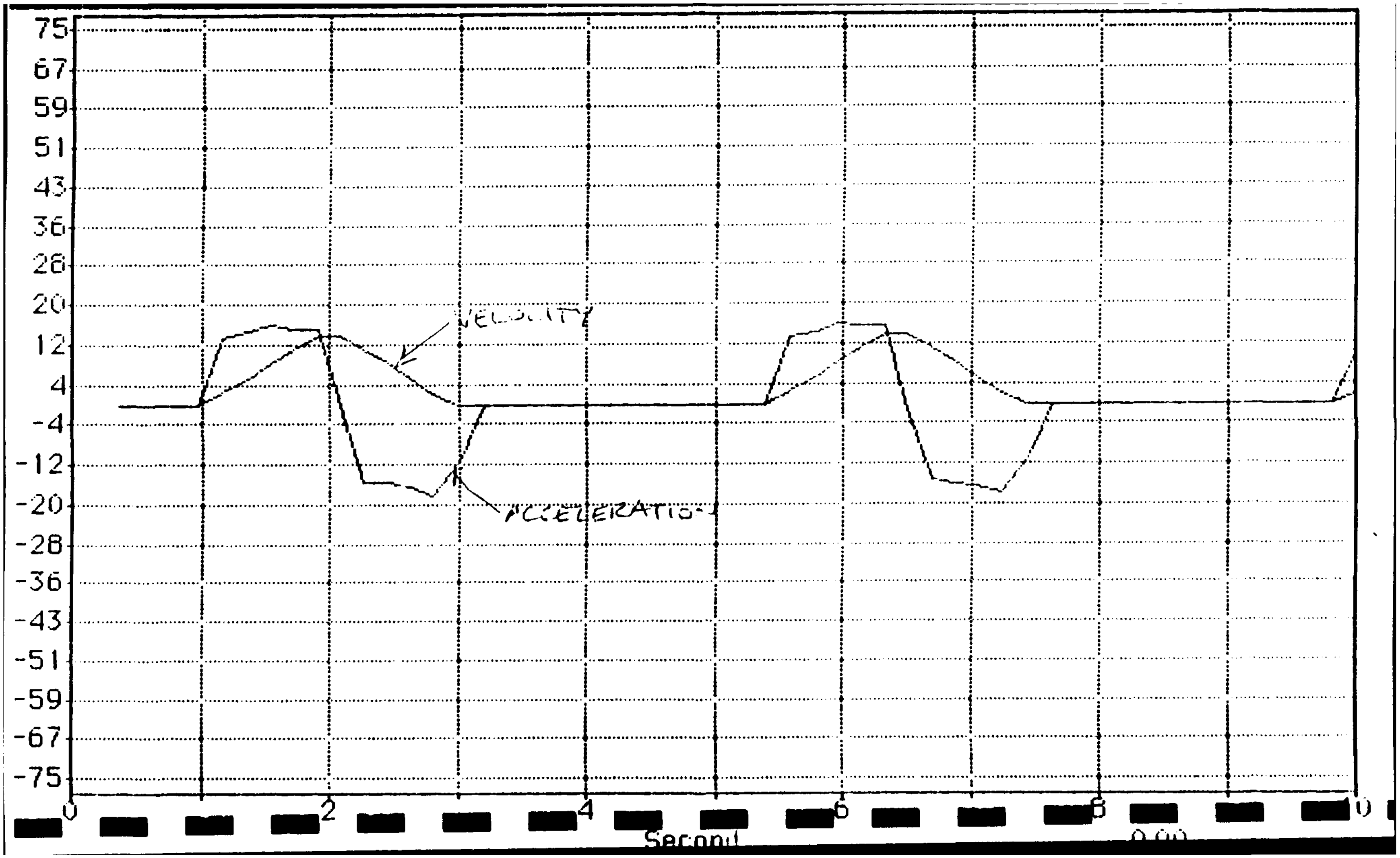
| Pressure Description | Lower Limit | Set Point | Upper Limit |
|---|---|---|---|
| AS - Incoming Oiled Air Pressure | 60 PSI | 80 PSI | 120 PSI |
| BF1 - Air Assist Forming Pressure | 20 PSI | 25 PSI | 30 PSI |
| SS - Seal #1 Pressure | 40 PSI | 55 PSI | 65 PSI |

## Forming Vacuum Pressure Set Points

| Pressure Description | Lower Limit | Set Point | Upper Limit |
|---|---|---|---|
| BF1 - Forming Vacuum Pressure | 7.5 PSI | 11.0 PSI | 14.0 PSI |

## Heater PID Parameters

| Heater Name | Gain Factor | Integral Factor | Derivation Factor |
|---|---|---|---|
| SS1 - Heater | 60.00 | 1.00 | .25 |


75
67
59
51
43
36
28
20
12
4
-4
-12
-20
-28
-36
-43
-51
-59
-67
-75
0
2
4
6
8
VELOCITY
ACCELERATION
Second