COMBAT RATION NETWORK FOR TECHNOLOGY IMPLEMETATION (CORANET)

Failure Analysis and Prevention of Defects in MRE Pouches
Short Term Project #1008

Final Report

Report No. TA020398
CDRL Sequence A004
November 1, 1998

CORANET CONTRACT NO. SPO 103-96-D-0023
CLIN 0004

Contractor:
Texas A&M University
Texas Agriculture Experiment Station
College Station, TX 77843-3123

Dr. Hung Jue Sue
Principal Investigator
979
TEL: (409) 845-5024
FAX: (409) 862-3989

DS 000454

REPORT DOCUMENTATION PAGE

1. AGENCY USE ONLY *(Leave blank)* 2. REPORT DATE 3. REPORT TYPE AND DATES COVERED

12 March 1999 Final Report, STP #1008

4. TITLE AND SUBTITLE: FAILURE ANALYSIS AND PREVENTION OF DEFECTS IN MRE POUCHES

5. FUNDING NUMBERS

6, AUTHOR(S) Dr. Hung Jue Sue

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

8. PERFORMING ORGANIZATION

Texas A&M University, Texas Agricultural Experiment Station,

College Station, TX, 77843-3123

TEL: (~~403~~ 979)845-5024

9, SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) HQS, DLA Ft. Belvoir, VA 22060-6221 ATTN: DLSC-PRT/ Russell Eggers TEL:(703)767-1417

10 SPONSOR/ MONITORING AGENCY REPORT NUMBER: STP # 1008

II. SUPPLEMENTARY NOTES: To be filed with DTIC, Ft. Belvoir, VA

12a. DISTRIBUTION/ AVAILABILITY STATEMENT:

12b DISTRIBUTION CODE: Unrestricted

13. ABSTRACT *(Maximum 200 words)* The objectives are to determine and document why and how MRE pouches fail, in order to improve the performance of MRE packaging materials. The objective has been achieved. The groundwork has been laid to achieve the other objectives in subsequent projects. In general, plastics exhibit many desirable properties such as superb corrosion resistance, light weight, great processability, recyclability, and, most importantly, low cost. Although plastics have been in use in MRE packaging since 1979, defects still occur in MRE pouches, and performance needs remain important. According to the US Department of Agriculture (USDA) that inspects MRE pouches offered to the Government, the production of MRE 16 (during 1996) had 3.9% of lots offered for the first time failed for holes and abrasions. In order to improve MRE pouch performance for combat ration applications, it would be helpful to first establish a meaningful database that describes the nature of MRE pouch failure, the material (laminate plastics) system utilized, the manufacturer, food item packaged, the location of failure, etc. To develop effective strategy for reducing pouch failure, it is also necessary that the root-causes(s) of MRE pouch failure be unambiguously determined. This effort will help guarantee that the MRE pouch material, i.e., the laminated plastic films, will perform as intended during the specified lifetime and service conditions.

14. SUBJECT TERMS

15 Number of PAGES

16. PRICE CODE

17 SECURITY CLASS OF THIS REPORT

18 SECURITY CLASS OF THIS PAGE

18 SECURITY CLASSIFICATION OF ABSTRACT

Contract Number: SP0103-96-D-0023

Contractor: Texas Agriculture Experiment Station
Texas A&M University

Delivery Order Number: STP#1008

Delivery Order (STP) Title: Failure Analysis and Prevention of Defects in MRE Pouches

CDRL Number: A004

CDRL Title: CORANET

Report Date: November 1, 1998

Name of PI: Dr. Hung-Jue Sue

E-mail Address: hjsu@acs.tamu.edu

Phone Number: (409) 845-5024

Fax Number: (409) 862-3989

Mail Address: Texas A&M University
Dept. Mechanical Engineering
College Station, TX 77843-3123

Acknowledgments

The principal investigator, on behalf of his research group, would like to thank Russ Eggers of DLA, Chuck Grabowski of DSCP, James and Marygene of R&DA, and all other CORANET team members for their guidance and support of this project. Special thanks are given to Bob Helgerson of SOPAKCO, John Wiginton and Jim Carroll of the Wornick Company, Dan Bittner of Ameriqual, Barbara Chauvey of VETCOM, Pat Dunn and Peter Sherman of Natick, and Bud Strassheim of Land O'Frost for providing valuable information, in-line process data, and arrangement of plant visits. Administrative assistance from Sue Bonanno and Michal Safar are also greatly appreciated.

Table of Contents

List of Illustrations

Objectives

The objectives of this project are to determine and document why and how MRE pouches fail, in order to improve the performance of MRE packaging materials, and to develop simple and reliable laboratory tests for material acceptance testing (to facilitate introduction of new materials). The results of the project are to be demonstrated at suitable vendor facilities or Government laboratories. The first objective: to determine and document why and how MRE pouches fail during production has been achieved, as described and reported here. The ground work has been laid to achieve the other objectives in subsequent projects.

Background

Recent technological advancement of plastics has made plastics material very attractive for all fields of applications. In general, plastics exhibit many desirable properties such as superb corrosion resistance, light weight, great processability, recyclability, and, most importantly, low cost. Although plastics have been in use in MRE packaging since 1979, the lack of materials science knowledge has slowed the adoption of better plastics for performance-driven applications such as this, where durability and performance are critical. Defects still occur in MRE pouches, and performance needs, such as formability and cold weather resistance, are continually increasing.

While current pouches meet field performance requirements (only rarely are pouches returned form the field), many failure occur during production. According to the US Department of Agriculture (USDA) that inspects MRE pouches offered to the Government, the production of MRE 16 (during 1996) had 3.9% of lots failed for holed and abrasions.

There have been several organized efforts to identify and eliminate the causes of MRE pouch failure, but not one that specifically documents and quantifies the types and causes as a basis for engineering improvements. The majority of data produced in the past merely recorded the survival rate and rejection rate of each individual MRE pouch item being manufactured and serviced. The MRE pouch manufacturers tend to address the issue of pouch failure as an isolated event. Thereby, trial-and-error is deemed appropriated among the pouch manufacturers to solve pouch failure problems. Consequently, there is not enough accumulated knowledge to adequately tackle the MRE pouch failure that we are facing today. Comprehensive material science knowledge for solving MRE pouch failure is virtually non-existent. In order to improve MRE pouch performance for combat ration applications, it would be helpful to first establish a meaningful database that describes the nature of MRE pouch failure, the material (laminate plastics) system utilized, the manufacturer, food item packaged, the location of failure, etc. This database will allow us to identify the characteristic failure pattern(s) of the MRE pouch. Without a comprehensive data base, probably only the most obvious causes of failure, such as rough handling, abrasions and punctures can be addressed. To develop effective strategy for reducing pouch failure, it is also necessary that the root-causes(s) of MRE pouch failure be unambiguously determined. This effort will help guarantee that the MRE pouch material, i.e., the laminated plastic films, will perform as intended during the specified lifetime and service conditions.

The MRE pouches addressed in this study are the current "preformed" pouch used on vertical filling machines. Different materials are used on horizontal form, fill and seal machines. Pouch specifications of interest to this project are materials and configurations, performance requirements after thermal processing, and rough handling. The inside layer of the pouch should be 0.0015-inch thick (±10 percent) polypropylene (PP). The outside of the pouch should be 0.0005-inch thick (± 20 percent) poly(ethylene terephthalate) (PET). A single layer of aluminum foil is placed in between the PP and PET. This aluminum foil layer is required to be 0.00035-inch thick (±10 percent) [1]. After thermal processing the pouch should show no evidence of delamination when examined. The lowest temperature that the pouch should be able to withstand is 32 ^{0}F after thermal processing [2]. The highest temperature for pouch handling is 160 ^{0}F after thermal processing [3]. Furthermore, to anticipate unexpected extreme weather MRE pouch delivery, there is a need to make sure that MRE pouches can survive rough handling at -20 °F. According to Peter Sherman of US Army Natick Research, Development, and Engineering Center, Food Engineering Lab, rough handling means that the pouch needs to maintain its structural integrity upon dropping the pouch from a given height at -20 ^{0}F.

Although some difficulties were encountered in collecting necessary field data and failed MRE pouches from the pouch producers due to proprietary reasons, the plant visits as well as individual, off-the-record discussions with the experienced operation supervisors and managers have greatly aided our understanding of MRE pouch operation. Key sources(s) and cause(s) that contribute to pouch defect generation were identified.

Conclusions

The tests that were performed on the various samples of filled, sealed, and some retorted food pouches from each company showed a number of different failure patterns, and occurred at various locations. The different types of failure patterns include delaminations, cuts, folds, abrasions without foil damage, abrasions with foil damage, and pin-holes. However, it appeared that certain type and location of failure are strongly related to the food packaged and the company that performed the task.

Note: In order to maintain company privacy, capital letters (A, B, C) are used to denote the company that produced the product, and lower case letters (a, b, c, d, e, f, g) are used to denote the food type.

The analysis of the field data sent by the companies showed that placeable foods (d-g) in preformed pouches had a larger percent of defects than pumpable foods (a-c). On average this can be shown to be true even though the food type with the largest percent of defects (food type c) was a pumpable food item. The placeable food had a larger number of defects by abrasions, holes and cuts than the pumpable food types. It should be noted that food type a, b, and c are pumpable foods, and food type d, e, f, and g are placeable foods.

It appears that certain companies tend to consistently generate certain types of pouch defect for certain food type. Some companies were shown to throw away too many non-failure pouches during their inspection. Some companies were able to avoid generating certain types of pouch defects (for the same type of food). It is therefore conceivable that improvements can be achieved in reducing pouch defects if the MRE pouch producers would be willing to reveal their in-line process and learn from each other, which has not been the case.

The causes for these defects can be attributed to many different sources. One set of samples that were received for testing had defects caused most notably by retort racks. Another set of samples had the same failure in approximately the same location on the front and back of the pouch which is probably caused by machinery (food type b for Company B). Some cuts and pin-holes can, most probably, be attributed to mishandling.

The data produced at Texas A&M showed that placeable food pouches had more critical failures than pumpable food pouches. It is shown in the Tables in Appendix B that the pumpable pouches had more "non-failures" that were pulled out as defective than the placeable pouches had.

The laboratory pouch defect investigation, using optical microscopy, revealed the nature of the defects found on the failed MRE pouches. It is noted that the defect type and defect category found on the failed pouches, based on microscopy investigation, gives different results from those found based on visual inspections. Therefore, misleading information may be obtained if only visual inspection is performed on MRE pouches. In addition, microscopy investigation allows the detection of the weak links in laminate integrity. Aluminum foil and adhesive strength between laminate layers are found to be prone to failure. Strategies for strengthening pouch package integrity and for preventing pouch failure are proposed.

The microscopy failure analysis clearly showed that the aluminum foil layer is extremely fragile. Any misstep in pouch handling can easily cause foil to fail. Furthermore, the poor interfacial adhesion between the foil layer and the PET and PP layers also contribute to the weakening of the foil strength. There is a need to improve the interfacial adhesion between the laminate layers, and to strengthen the laminate (probably by increasing the thickness of the foil and/or the PET layer).

Abrasion is the most difficult defects to determine whether or not it is a critical, major, or minor defect. The present study indicates that abrasion found in certain foods (a, e) of pouches produced by certain companies (B) is predominantly a minor defect, i.e., no signs of delamination or foil damage is found. On the other hand, abrasion found on other types of food pouches (d, f) tends to be either major or critical defects. As a result, it may be necessary that different set of rules be applied to different food type and to the companies that perform the task.

Since it is rather difficult to identify the exact root-cause(s) of defect formation in MRE pouches, it is recommended that higher performance, tougher pouch laminates be utilized. To do so, it is necessary that simple, and yet, effective testing methods be developed to evaluate new pouch laminates. These tests may include tensile strength, fracture toughness, tear resistance, dynamic mechanical spectroscopy, puncture resistance, oxygen and moisture permeability, etc. These efforts are to be included in subsequent project proposals.

Recommendations for Improvements

I) Identification and prevention of Critical Abrasion Defects

Dual or Multiple Standards:

If a proper machine vision inspection setup is not viable, it may be possible for DSCP or VETCOM to accept pouches that contain abrasion defects for companies that have an established record of producing only minor abrasion defects on the food type(s) specified. The highest percentage of defects found in all MRE pouches is abrasion. If abrasion damage can be eliminated, significant savings on MRE pouch production can be realized. The current research findings indicate that abrasion defects in MRE pouches produced by certain companies (i.e, company B) on certain food type (i.e., a and e) are minor. On the other hand, the pouches produced by a different company (i.e., Company A or C) on the same food type, abrasion defects may be critical defects. It is evident that not all abrasion defects are critical defects, but unfortunately, it is nearly impossible to visually distinguish between critical abrasion defects and non-critical abrasion defects. The above approach may encourage the MRE pouch producers to actively improve their in-line process on certain food type pouches to gain waivers from DSCP/VETCOM on abrasion defects for MRE pouches.

An alternative, longer term solution to this problem is to use a more durable preformed MRE pouch laminate. The experimental quad-layer (PET/Nylon/Al/PP) MRE pouches currently being evaluated by AMERIQUAL, WORNICK, SOPAKCO, SMURFIT, and NATICK have clearly shown that a great reduction in defect rate can be achieved, when compared with the tri-layer MRE pouches. However, some companies are less enthusiastic in implementing the quad-layer pouches in their productions. They cited that both cost and the extent of defect rate reduction do not justify the use of quad-layer pouches. To address this issue, one would need to collect information concerning the typical levels of forces (vacuum, dropping on the floor, etc.) and strains (crease, contour of the placeable foods, etc.) that are imposed on MRE pouches, from which a simplified mechanical and material science analysis can be applied to determine whether the existing tri-layer or quad-layer pouches can meet the demands and to what degree one is better than the other. Factors to be considered include the optimal thicknesses for PET, foil and PP, the interfacial strength among the layers, and, most importantly, the choices of a durable, inexpensive exterior polymer layer. There are many kinds of exterior films, such as polyketone, modified PET, and modified-PP that may be suitable for MRE pouch applications. It is conceivable that a new and uniquely low cost, high performance MRE pouch laminate could be developed to withstand abrasion defects during MRE pouch production. It is also possible that an existing polymeric configuration might be available and is more than adequate, lower cost, and better than present configurations.

II) Prevention of Cut, Pin-Hole, etc.

<u>Process Examination and Inspection</u>:

It is possible for the companies that produce cut defects to prevent defects by careful inspection and proper maintenance of their equipment and setup. The microscopy investigation conducted in this study clearly indicates that for the same food type, certain companies (d-A) tend to produce MRE pouches with an overwhelming number of cut defects and certain companies (d-C) tend to produce abrasion defects. This implies that the companies that produce cut defects may have operated their plant with unsuitable belt conveyers or improper tooling, or both.

Improved Retort Racks:

Also, it appears that the retort process itself may cause severe damage to MRE pouches. That is, only a few minor defects are found prior to the retort process and a larger number of critical defects are found after the retort process (b-B and f-B). As a result, there is a need to redesign or change the material utilized for the current retort rack to reduce possible defect generation in MRE pouches. This is subject of a separate project which is just starting.

III) Identification of Source(s) and Cause(s) of MRE Pouch Failure

Contractually Required Data:

It is evident that, based on this project effort, the pouch producers are not enthusiastic in sharing their in-process operation conditions and pouch defect statistical data with their competitors. As a result, it is extremely difficult to clearly identify the source(s) and cause(s) of pouch failure, and no specific solution can be recommended to reduce pouch defects for all producers. To circumvent this problem, it is possible that DSCP would require their contractors submit their defective pouches with all necessary background information in a statistically meaningful way to a credible organization for detailed microscopy investigation. The information could then be given back to the company for process improvement to reduce pouch defects. The data submitted and analyzed will only be kept confidential for a year or two. Subsequently, the competitors can learn from each other to improve their pouch productivity, which will ultimately help reduce MRE pouch production cost.

IV) Evaluation and Design of High Performance MRE Pouch Laminate

Long Term R&D Relationships:

The interactions with Smurfit, Plastics Corporation of America, Cadillac, Wornick, SOPAKCO, Ameriqual, Natick and many governmental agencies reveal that there are common concerns on the lack of research and development effort in the MRE pouch industry. The managers of the pouch producers, the Armed Services, and the governmental contracting officers are in agreement that there are strong needs to improve the durability of pouch laminate material, the performance of the retort rack material and their design, and the in-line process to reduce production of defective MRE pouches. To do so, it may be best to establish a long term research and development relationship between CORANET with universities to help provide state of the art technology and knowledge related to the needs of the MRE pouch industry.

Sample Test Procedure:

There is an immediate need to establish a testing protocol for the evaluation of laminate films for MRE pouch applications. In the last ten years or so, many new, high-performance, low cost polymeric materials have been introduced to replace the existing polymers for applications ranging from the aerospace structural components to grocery bags. Potentially, significant savings can be made if Natick-FEL had a simple process for evaluating present and new configurations for adequacy of performance, and if the MRE pouch producers have a way to quickly test incoming materials to avoid defects. This test capability will help accelerate the introduction of new ideas and use of new technology in this industry.

Procedure

Key field data related to in-plant failure of MRE pouches and typical failed sample pouches were collected. The major field data that were gathered include MRE pouch failure pattern, location and frequency of failure, storage and service environment, and data on how the problems were handled. Figure 24 in Appendix B shows the grid to locate the failure on the pouches [4]. The data obtained from the governmental agencies and manufacturers was gathered, categorized, and analyzed. Charts and tables were prepared to indicate the frequency of each type of failure with respect to such things as MRE pouch failure events vs. pouch manufacturers and MRE pouch failure events vs. food items.

The pouches are being categorized according to food and failure type. There are two main categories of food types: pumpables and placeables. Originally two different food types for each of these were requested. However, not all companies (i.e., A, B, and C) produce the food type requested. As a result, data and failed pouches for seven different food types (i.e., a-g) were gathered and analyzed. The food types in focus, sent by each company, are two placeables: beef steak and chicken breast or equivalent, and two pumpables: beef stew and applesauce or equivalent.

Visual observations as well as optical microscopy was used to identify key failure patterns, such as abrasion, delamination, pin-holes, and cuts. Each food pouch was examined individually to determine the visual failure type and category of failure. The failure types that can easily be determined visually are cuts, pin-holes, and abrasions.

Often the visual observations turn out to be "non-failures" once optical microscopy is performed. Delaminations can usually be found near folds, cuts, and abrasions on the pouch. Category of failure is used to determine how critical, if at all, each failure is. The classification of category of failure is based on the guidelines provided by DSCP [5,6].

Optical microscopy was performed on each failed pouch to determine the actual failure type. Each pouch had to be prepared for optical microscopy by cutting the sample perpendicular to the failure area by visual inspection with a fresh razor blade. The samples were then embedded in a clear epoxy mount using a double-sided Scotch tape to secure the sample with the failed edge facing down. The mounted specimens were then vacuum dried for about thirty minutes and left to cure overnight. The mounted samples were polished using an Abramin polishing machine so that a clear image could be obtained. It is noted that the polishing was done to make sure that the original cutting surface due to the razor blade cut was analyzed. An Olympus optical microscope (Model BX-60) was used for detailed failure analysis. Microscopy allowed the actual failure or non-failure to be determined. Visual abrasions on the MRE pouches frequently turned out to be non-failures after microscopy was performed. Also, optical microscopy allows unambiguous determination on whether or not the failure is critical. Micrographs were taken for each failed pouch and can be found in Appendix B. Each set of experimental data was collected, analyzed, and compared to the field data that was sent by each company. Comparison between the experimental data and the field data allowed the conclusions and recommendations for better pouches.

Results and Discussion

The field data that was received from each company were analyzed in order to compare the failure rates and types of failures on each type of food. The data were categorized by tow main groups: pumpables and placeables. Also, the data were separated into each different food type. This will allow for the comparison between pumpables and placeables, and also, the comparison between the same food type produced by different companies. It is noted that the percent defective pouch data were collected and provided by the pouch producers. The approach and basis for gathering the percent defective pouch data are very different among the pouch producers. Therefore, direct comparisons on percent defective data among the pouch producers should not be made.

Note that for proprietary reasons, code name for each company and food type was given. Food type "a" is the only food type which all three companies produce. Two out of the three companies produce food type "b, d and f." While only one company produces food type "c, e, and g." Comparing Figures 1 and 2 in Appendix A, it can be seen that Company C, for food type "c", had the largest percent of defective pouches at 0.64% defective, followed by food type "b" produced by Company B (0.194% defective). It is important to note that both of these food items are pumpable foods. The samples after retort had more visible failures than the samples that were sent before retort for food types and company of b-B and f-B. Figures 1 and 2 also show that the placeable food types have a pretty consistent defective percentages near 0.1%.

Figures 3 and 4 show the percent of abrasions for pumpable and placeable food types respectively. With exception to food type "c" the total percent of abrasions for pumpables are lower than those for placeable foods. Figures 5 and 6 shows the percent of holes and cuts for pumpable and placeable foods respectively. When considering the pumpable foods data, Company A has a high percentage of holes and cuts compared to the other companies. Once again, the placeable foods have a higher percent of holes and cuts, on average, than pumpable foods. Food type "f" produced by Company B has the largest percent of holes and cuts of any other food type.

Figures 7, 8, and 9 were plotted to show the percentage of each type of defect produced for each company. Obviously, Company C has the highest percent of defects due to food types "c and g." Company A and B consistently have defect percentages under 0.1%, and Company B has the lowest total percent defective [7-9].

According to the test performed at Texas A&M, on the samples provided, the major source of failure in MRE pouches was abrasion with foil damage. Optical microscopy was performed and showed that many visual failures turned out to be non-failures such as a fold in the pouch. For food type "a" (Figures 10 - 12) abrasions with foil damage were the most common type of defect. Figures 14 and 15 show types of failures for food type "d" produced by Companies A and C. The most common failure for Company A was a cut, and for Company C was abrasion with foil damage. Figures 17 and 18 show that delamination, cut, and foil damage were the most common type of failure for food type "f" of the samples tested.

The Tables in Appendix B show the types of failure and the categories of failure for each food type for all three companies. From these data, one can see that pumpable food items had more non-failures than placeable food items. Micrographs for each of these samples are shown in Appendix B.

It is noted that there may be many factors that can cause MRE pouches to fail. The quality of the preformed MRE pouch rollstock, the experience of the workers, the level of the vacuum force, the status of the machinery, the retort rack, the retorting condition, etc., can all have an effect on pouch integrity. To make direct correlation on how each factor affects pouch defect generation, it will require that the pouch producers run controlled MRE pouch production tests to eliminate uncertainty. Although each company was eager to assist the completion of this project, they were not willing to share their setups and results with their competitors. Consequently, only general statements can be made to address the cause and source of MRE pouch failure.

On the other hand, the present study has demonstrated that it is possible to distinguish between minor and critical abrasion defects. We have also shown that the weak links in affecting MRE pouch integrity lie in the fragility of the aluminum foil and the poor interfacial adhesion between the layers. Furthermore, several of the optical micrographs (Appendix B) show evidence of curling of the foil upon delamination between the foil and the plastic films. This suggests that the foil exhibits high levels of residual stress due to their extrusion forming process. It is generally possible to reduce the presence of residual stress on a foil by annealing the foil before making the laminated pouches. This should be pursued with the manufacturers of laminated films.

The heat of the retort process alone causes the PET layer to soften significantly, which was apparent immediately after the MRE pouches were pulled out of the pressurized cooker. Any surface contact on the PET layer by rough objects, such as the worn out retort rack surfaces, can easily lead to generation of abrasion, and pin-hole defects in MRE pouches. Delamination is probably caused by heating of laminates while under conditions of deformation and stress. This problem can be overcome by 1) the use of adequate retort rack material with proper design or by 2) fast cooling of the retorted pouches immediately after the retort process. The fast cooling of the MRE pouches will help harden the PET surface and make the PET layer tougher, which, in turn, will reduce the chances for defects formation. It is well known that for semi-crystalline polymers, such as PET and PP, slow cooling usually results in higher crystallinity and leads to brittleness. Fast cooling (quenching) will reduce the level of crystallinity and allow the polymer to become more ductile and tougher. The drawback of fast cooling is that a higher level of residual stress may be present between the layers. Therefore, it is important that the interfacial adhesion between the layers is strong, to avoid delamination. The relationship between slow and fast cool down in the retort and the related crystallinity and delamination could be the topic of a separate project.

Finally, to be able to achieve a long term significant saving for MRE pouch production, it is important that state of the art research and development effort be carried out continuously. It is acknowledged that research on in-line processes of pouch production will not be supported by the retorters, due to proprietary reasons. It is also unlikely that the retorters will share any of their in-house knowledge and statistical database with outsiders. Therefore, apparently only the introduction of a new pouch laminate material, retort rack material and design, and testing methodology development for laminated films are generic enough and can easily gain acceptance, support and cooperation from the retorters. It is thus recommended that CORANET consider research efforts in the above areas, not dependant on proprietary input from the producers.

Summary of Recommendations

I. Identification and Prevention of Critical Defects

  a. Dual or Multiple acceptance standards

  b. Improved, more durable, preformed pouch laminated materials

I. Prevention of Cuts, Pin holes, Etc.

  a. Process Inspection

  b. Improved Retort Racks

I. Identification of Sources and Causes of MRE Pouch Failures

  a. Contractually Required Data

I. Evaluation and Design of High Performance MRE Pouch Laminates

  a. Long Term Relationships with Government, Industry and Academia

  b. Simple Test Procedures

Significant savings should be realized once progress in any of those areas is made.

References

[1] Military Specification: MIL-M-44074E, January 31, 1997 (3.1.2.1)

[2] Performance Specification: MIL-PRF-44073E, May 7, 1997 (3.1.1.5.1)

[3] Performance Specification: MIL-PRF-44059E, May 7, 1997 (3.1.1.5.2)

[4] Based on Memorandum produced by John R. Stacey at SOPAKCO

[5] Performance Specification: MIL-PRF-44059E, April 24, 1997 (Supplemental Information)

[6] Based on private conversation with O.J. Hunt

[7] MRE Pouch Producer: Company A (field data)

[8] MRE Pouch Producer: Company B (field data)

[9] MRE Pouch Producer: Company C (field data)