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ANALYSIS OF THE RELATIONSHIP BETWEEN PEEL AND BURST TEST RESULTS FOR PEELABLE FLEXIBLE PACKAGES

By

Rosamari Feliú-Báez

AN ABSTRACT OF A DISSERTATION

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Professor Hugh E. Lockhart

ABSTRACT

ANALYSIS OF THE RELATIONSHIP BETWEEN PEEL AND BURST TEST RESULTS FOR PEELABLE FLEXIBLE PACKAGES

By

Rosamari Feliú-Báez

Theoretical formulas that relate peel and burst test results were developed using force diagram analysis. The formula, P=2S/D (P = Burst Pressure, S = Seal Strength, and D = Plate separation) has been studied before (Feliu-Baez, 1998), and it was found to overestimate the actual burst values even when the bursting and peeling times were controlled to be the same. A new theoretical formula, which accounts for package size, was developed but it did not improve the accuracy of the results. The fact that the new formula did not improve accuracy, even when accounting for package size, indicates that random behavior of the package deformation during the burst test makes the actual values differ from the predicted ones. Wrinkles in the seal area, the amount of stretch around the package's perimeter, and its shape when pressurized are difficult to model and therefore cannot be included in the theoretical formulas. For that reason, empirical models were developed by using a linear multiple regression technique to fit experimental data to a power law relationship.

The empirical models developed include the formulas for theoretical development as independent variables. Three models were validated in three different types of Tyvek/plastic pouches. The results were good. The correlation coefficients (R) were all higher than 0.96 and the average percent errors between actual and predicted values ranged from 1% to 7% for predictions of burst test value from seal strength and vice versa.

This Dissertation is dedicated to my husband and family
in appreciation for all their love and support

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CHAPTER 1

INTRODUCTION

The tendency to use more flexible packages for medical device applications has raised concerns about safety, sterility, seal strength and total package quality. This has increased the need for package integrity tests. Package integrity testing assesses a package's ability to protect the product from microbial contamination and remain intact after being stressed by the pressure changes that may occur during sterilization and shipment. These tests are intended to detect the presence of leaks in the seal area and measure seal strength. This project will concentrate on two commonly used tests for measuring the seal strength of medical pouches: the peel test and the burst test. Although both tests provide an indication of the seal strength and structural integrity of the package, they are performed in different ways. Refer to Appendix I for definitions of all terms.

The peel test measures the force required to peel apart a 1-inch wide sample strip cut from the seal. Although the peel test has been used for years in industry, it has some inconveniences. It is a time consuming test because many strips have to be cut from a package in order to get a true measure of the seal strength. It is also possible that the one or more sample strips cut from the seal do not contain a weak spot that may be present in the pouch. If only a small number of strips from a given package are tested, some substandard seal surface may be overlooked (Wachala, 1991).

There is some controversy over whether to use peak or average force as a value for seal strength in the peel test. The peak force is the maximum force required to separate the sealed webs, the maximum force created during peeling. It has been the

commonly accepted value used for quantifying the strength of a seal. According to Barcan (1995), the peak force could be misleading if used alone because it imparts a false sense of security. He believes that the average force provides a more relevant specification number than the peak force data alone. The average force is calculated by dividing the energy, which is the area under the force-deformation curve, by the total length of peel. Barcan thinks that the average force is a better measure-, providing a more comprehensive picture of seal strength because it considers the entire sample strip of seal and not just an instant during peel. There is also some debate regarding how to conduct the test; testing can be performed using a supported tail or an unsupported tail. According to Earl Hackett (1998), in order to obtain good test repeatability the peel angle of the two substrates must be maintained throughout the measurement. He suggests the use of backing plates to maintain a 180° peel angle (supported at 180°). Others prefer not to use the backing plates and perform the "free-tail", or unsupported peel test, because they think it emulates real world conditions more closely.

The other common way of measuring seal strength is by performing a burst test, which consists of pressurizing a package until it breaks. Normally, in pouches with peelable seals (seals that are easy to open and provide a sterile delivery of the product), the break occurs as a separation of the seal, not as a rupture in the material. The pressure required to break the package is recorded and interpreted as an indication of the strength of the seal. This test can be performed with or without the use of restraining plates. When using restraining plates, the deformation of the pressurized package is minimized. The burst can be performed on an open or closed pouch. When performing a burst test with an open package fixture, the pouch supplier's seals are tested. When performing a

closed package burst test, both the pouch supplier and user's seals are tested. The burst test has gained acceptance in the medical device and medical packaging industries because it is easier to perform and it does not require as much time as the peel test. In addition, it provides an evaluation of the entire package system, not only the seal. By supplying air inside the package and pressurizing it, burst testing subjects the entire sterile package system to some of the stresses that the package encounters in the manufacturing, distribution, and use environments (Bohn, 1994), whereas the peel test does not.

The peel and burst tests are used by both pouch users and suppliers to perform incoming and outgoing inspections, to validate the sealing parameters of a package and as a process control tool. Both groups have shown an interest in clarifying the relationship between peel and burst tests. Pouch users tend to have specifications on tensile peel seal strength that are used when testing package seals. With a correlation model between peel and burst test, the faster burst test could be used to update their specifications without an extensive revalidation program. This could reduce sampling and testing costs by reducing labor and material usage costs. Pouch suppliers work with customers that use both the peel and the burst test. Customers usually want to use only one method and suppliers need to show that their method will correlate with the customer's method. Additionally, if the burst and peel tests can be mathematically related, the faster burst test technique can be used to provide peel test values directly to production and quality control personnel. In this way, corrective action can be taken almost immediately to prevent the production of pouches that are out of specification (Barcan and Franks,

1999). This will increase productivity and, at the same time, reduce labor and material costs.

The objective of this work is to analyze and describe the relationship between peel and burst test results for peelable flexible packages for medical applications. Peelable seals are widely used in the medical device industry because they are easy to open and at the same time provide protection and a sterile delivery of the product.

The analysis of the relationship between peel and burst tests was performed by conducting 2^2 factorial experiments and by validating theoretical and empirical models that relate the results of one test in terms of the other. The factorial experiments had the purpose of determining the effect of flow index and plate separation in the burst test, and the effect of crosshead speed and grip separation in the peel test. Theoretical models were developed by using force diagram analysis and the empirical ones by using multiple regression analysis to fit actual data to a power law model. The adequacy of these models was determined by comparing actual values with the predicted ones and by calculating percent error.

The theoretical model, P=2S/D (P= Burst Pressure, S = Seal Strength, and D = Plate separation) has been studied before (Feliu-Baez, 1998, 2001). It was found that this model overestimates the actual burst values. After the completion of those experiments, it was hypothesized that the relationship between peel and burst tests depends on the package size and material characteristics, and that the inclusion of the package's dimensions in the model would improve its accuracy. For that reason a new theoretical model was developed (see Chapter 3) and additional testing was done. The testing results showed that the new model, which accounts for the package size, did not improve

accuracy. For that reason, it was then hypothesized that an empirical model would describe the relationship between peel and burst tests better than the theoretical ones.

The contribution that this project will make to industry consists of a procedure on how to describe the relationship between peel and burst tests for pouches of a specific material combination and sealant characteristics. The relationship developed can be used to predict burst test results from peel test values and vice versa.

CHAPTER 2

LITERATURE REVIEW

The interest in describing the relationship between peel and burst tests is certainly not new. Distinguished minds from both academia and industry have devoted efforts to finding a correlation between these two. In 1991, Thomas Wachala, from Carleton Technologies published his approach to correlating peel and burst tests for medical pouches. In 1993, Dr. Kit Yam from the Department of Food Science at Rutgers University published his approach to finding a relationship between seal strength and burst pressure for Meal-Ready to Eat (MRE) pouches. In 1997, Neil Lorimer, from Rexam Medical Packaging, presented the results of a multivariate regression model developed with the purpose of predicting burst values for any given peel strength value for medical pouches. In 1998, Feliu-Baez, from the Michigan State University School of Packaging published a Master's Thesis in which theoretical equations were developed with the purpose of explaining the pouch behavior during unrestrained and restrained burst test methods. Equations from the Michigan State research are based on force diagrams and consider the effect of the forces needed to peel the seals apart (seal strength) in the burst test of a pouch. Although these equations were not developed with the original intent of correlating peel and burst tests, they were used as a base to build upon, and as a starting point to find such a correlation. In 1999, Stephen Franks and Donald Barcan, from TM Electronics and Dunbar Industries, Inc, respectively, performed a screening experiment to determine whether peel and burst tests were sensitive enough to detect process changes in the seal manufacture of a medical peel pouch.

The following paragraphs contain a detailed explanation, in chronological order, of the different approaches to describing the relationship between peel and burst tests. Refer to Appendix II for a summary of the different approaches.

Thomas Wachala – Carleton Technologies, 1991:

Wachala's formulas were developed in the 1970s with the intent of helping burst tester customers verify if they were operating the tester regulator correctly. In the 70s, the burst tester regulators were operated manually, not automatically. Wachala's approach to correlating peel and burst tests consisted of relating a force acting on a line with a force acting on a surface area (the units of measure are force per unit length and force per unit area for peel and burst tests, respectively).

According to Wachala, an ideal package will not deform under pressure and will have a minimum peel force of 1 lb/in. At the point of seal failure, an ideal package is in equilibrium, and the force attempting to pull the seal apart is balanced by the seal strength. See Figure 1, below.

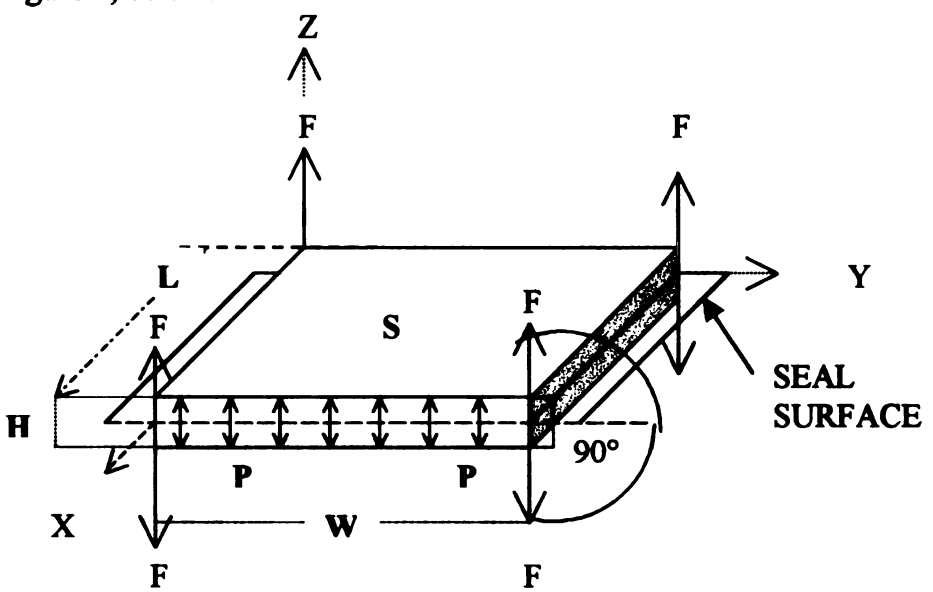


Figure 1. Ideal Package Force Balance (Wachala, 1991)

A correlation may be found by solving the following force balance equation:

$\mathbf{F_{seal}}$ = $\mathbf{F_{surface}}$

S x Perimeter = **P x Area**

Where;

F_{seal} = Force exerted by the seal strength (lbs)

$F_{surface}$ = Force attempting to pull the package's seal apart (lbs)

S = 1 (lb/in) = de facto minimum peel force standard in the medical device industry

Perimeter = 2 x (L+W) (in)

P = Burst Pressure (psi)

Area = (L x W) (in^2)

L = length of the package (in)

W= width of the package (in)

So;

S x {2 x (L+W)} = P x {(L x W)}; units (lbs/in)*(in) = (lb/in^2)*(in^2)

P = S x [{2 x (L+W)}] / {(L x W)}; units (lbs/in^2) = {(lb/in)*(in)}/(in^2)

P = 1 (lb/in) x [Perimeter/Area] units (lbs/in^2) = (lb/in)* [(in/in^2)] **[1]**

This equation represents an ideal case. According to this equation, the internal pressure (P) is equal to the seal strength (S -1 lb/in) times the perimeter of the package (in) divided by its area (in^2).

In his article, Wachala (1991) also used force diagram analysis to describe an actual package under deformation. He estimated the force experienced by the seal by treating the entire package under deformation as a cylinder. According to Wachala, the correlation between peel and burst tests for an actual package deteriorates for at least four

reasons: First, an inflated package usually takes an elliptical form and the angle between the seal surface and the surface of the membrane is rarely 90 °. Second, the end effects caused by the clamping device of a burst tester and the seal opposite the clamp makes the actual shape of the deformed pouch deviate from the ideal shape. Third, when the package is inflated the effective length of the package reduces to a shorter length L′. The angle formed at the end seal is always less than 90°. Lastly, the seal perimeter does not take the same load at all points because of the folds and creases caused by uneven tensions in the surface membranes when the package is pressurized.

Equation [1] is based on the ideal package case and works fine only if a rough estimation of the relationship between peel and burst tests is needed. According to Wachala, since this ideal equation considers no package deformation, the magnitude of error may exceed 30%. For this reason, he included a correction factor in the formula and developed a general equation to describe the correlation between the burst and the peel test:

Test Pressure = [1 (lb/in) x {27.67 (perimeter)/(area)} x K factor] **[2]**

Where: Test Pressure = (psi) or (lbs/in^2)

27.67 is conversion from inches of H_2O to psi (27.67 in H_2O = 1 psi)

Perimeter = 2 (L + W) (in)

Area = (L x W) (in^2)

K factor = Correction factor = [L^2 / (AL^2 + BLW + CW^2)]

A = 0.854, B = 0.093, and C = -0.195

A, B and C were determined empirically for a specific application (30.5" x 25.0" paper plastic pouches)

L = Length of the package (in)

W = Width of the package (in)

The test pressure obtained from equation [2] should correlate to a peel strength of approximately 1 lb/in. It is important to point out that these formulas were developed with the assumption that the pouches had an average peel strength of 1 lb/in. If the pouches under study have an average peel strength different from 1 lb/in, adjustments to the formula need to be made.

Wachala performed peel and burst tests using 30.5" x 25.0" paper/plastic pouches that had, on the average, peak peel strength of 1 lb/in. An unrestrained burst test using an open package fixture was performed. In addition, he performed a "free-tail" or unsupported peel test and used peak peeling force values for the correlation. The percent error between the theoretical burst pressure, estimated with equation [2], and the experimental burst pressure was approximately 3.1%.

According to Wachala (1991), the best correlation is found when each particular package is tested individually, since different results can be obtained when different materials, sizes, and types of seals are used. According to him, a group of packages should be burst tested first, with the average burst pressure and the location of failure recorded. Then a peel test should be performed on the seal areas in which most of the packages failed in the burst test (weakest point). The peel strength values from the weakest point should correlate with the average burst pressure obtained from the burst test.

Wachala believes that developing a correlation model for burst and peel tests is possible. The negative aspect of conducting this type of study is that manufacturers with

an extensive product line must qualify each item individually, which could be a costly and a labor-intensive task.

Dr. Kit Yam - Dept. of Food Science - Rutgers University, 1993:

Dr. Kit Yam correlated the results of a restrained burst test method with the seal strength of retortable pouches. His work was performed during the 1980s and published during the early 1990s. His results showed, based on force analysis, that the seal strength obtained from a peel test (S) is equivalent to the product of the burst pressure (P) obtained from the restrained burst test and half of the plate separation (R), S=PR. He emphasized in his article that the validity of this equation is based on the assumption the "peeling times" for the peel test and the burst test are the same.

The figure below shows a pouch restrained by two parallel plates separated with a distance 2R.

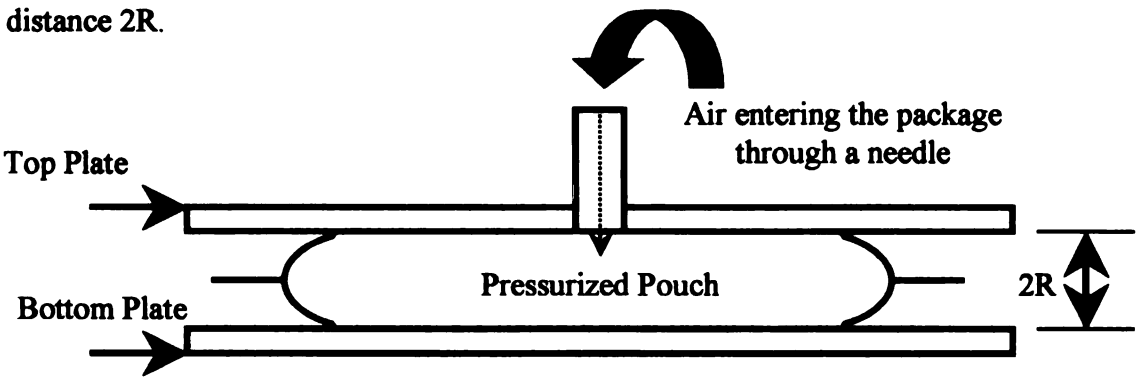


Figure 2. A Schematic of the Internal Burst Test for a Flexible Pouch (Yam, 1993)

According to Dr. Yam, when a pouch is inflated with air, the reaction force exerted by the restraining plates balances the force acting on the top and bottom part of the pouch that is touching the restraining fixture. The reaction force exerted at the pouch's seal area balances the force acting on the unrestrained portion of the pouch.

Since the pouch is flexible, the air exerts a tensile force on the seal and causes the unrestrained portion of the pouch to take on an approximately circular shape.

The y-component of the force around the seal is represented by the following equations. See Figure 3, below:

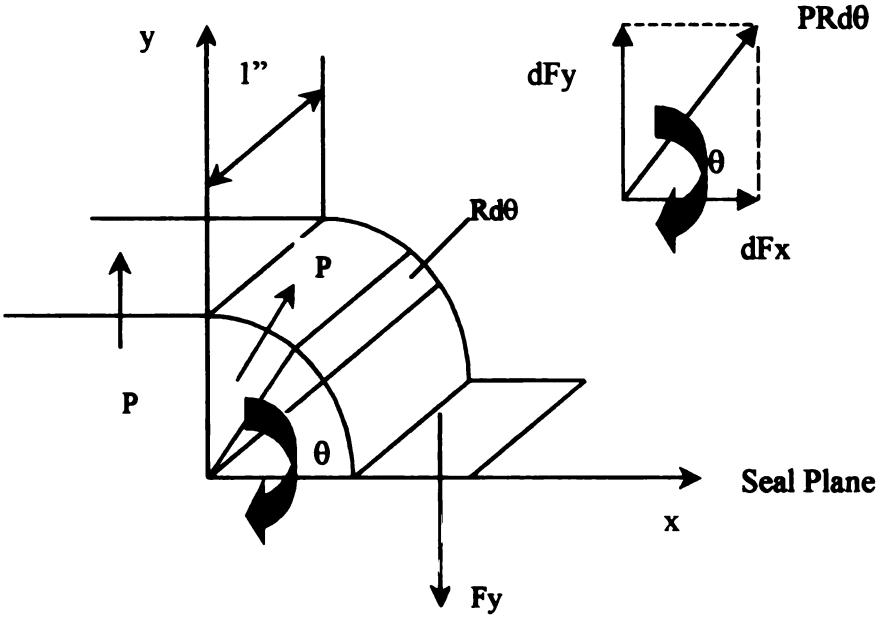


Figure 3. Analysis of Force Near the Seal Area (Yam, 1993)

$dFy = P\,R \sin\theta\, d\theta$

Fy = force peeling a 1 in-wide strip taken from the seal

P = internal pressure

R = half plate separation

θ = angle shown in Figure 3

$Fy = \int_0^{\pi/2} PR \sin\theta\, d\theta$

$Fy = P\,R$; Fy can be substituted by S (lb./in) – seal strength at rupture

P can be substituted by P_b – burst test at rupture

$$S = P_b\,R \qquad [3]$$

Dr. Yam presented in his article data to support his theory. He performed an experiment with 6" x 4" MRE pouches. The pouch material was PET/aluminum/PP. A "free-tail" or unsupported peel test was performed and peak peeling force values were used for the correlation. The burst test was performed with the use of restraining plates and using a closed package fixture. Peel test and burst tests were performed in a way that the peeling times for both tests were similar. According to Yam (1993), the reason to control the "peeling times" of the peel and burst tests is that they have a significant effect on the results. S (seal strength) and P_b (burst pressure) are inversely proportional to the tensile and burst peeling times (t_p and t_b), respectively.

Dr. Yam's results showed that good agreement between observed and predicted values could be obtained, but only when the peeling times of the two tests are the same. The difference between observed and predicted values at plate separation 0.50" ranged from 1% to 4%.

Neil Lorimer – Rexam Medical Packaging, 1997:

During the 1990s Neil Lorimer, from Rexam Medical Packaging, developed a multivariate regression model that correlates peel and restrained burst tests. According to Lorimer (1997), when developing a correlation it is important to recognize that test values for burst strength are correlated only to the weakest areas of the pouch seal, and not to the entire distribution of seal strength values. Lorimer mentioned that no positive correlation has been determined with unrestrained burst testing because pouches tend to burst in the middle of the pouch in spite of where the weakest point in the pouch is located. According to Lorimer, good results have been obtained between restrained burst tests and peel tests. Studies performed on Tyvek/plastic and paper/plastic pouches of

different sizes using a 1" gap on the restraining plates have shown correlation coefficients of 0.92 or greater. The correlation was developed for open package restrained burst test results and the peel test values of the "weakest areas" in the package (areas in which the package failed during a restrained burst test). A "free-tail" or unsupported peel test was performed and peak peeling force values were used for the correlation.

Rexam Medical Packaging has not published the formula they have developed but Lorimer has mentioned that force balance equations, provided by ARO Corporation, are used as factors in their multivariate regression model and that the coefficients are estimated from experimental models. According to Lorimer, the correlation coefficient of the predicted values has been 0.94 or greater, the R square for the predictive model approximately 87.7%, so the correlation between peel and burst test results provides accurate predictions.

Lorimer pointed out factors to consider when developing correlations and predictive models between burst and peel test.

1. Burst pressure is inversely proportional to package size. As package size decreases, the burst pressure for any given seal strength will increase.
2. Burst pressure is inversely proportional to restraining plate gap dimensions. As the restraining plate gap dimension decreases, the burst pressure will increase. Values obtained at different gaps cannot be directly compared to each other.
3. The relationship between burst and peel test values can change depending on the seal peel characteristics of the materials used. Different predictive models may be required for different material combinations that peel differently.

Rosamari Feliu-Baez, Michigan State University – School of Packaging, 1998:

Theoretical equations, based on force diagrams, were developed in order to explain a pouch's behavior during an unrestrained and a restrained burst test. Although these equations were not developed with the original intent of correlating peel and burst test, they will be used as a starting point to find such correlation

Pouch Burst Testing:

When the pouch is pressurized, its center section tries to become circular, and "shrinks". The internal dimensions after pressurization are smaller than before pressurization.

Unrestrained Case:

The force diagram, in the figure below, represents a half center section strip of width (h) in an unrestrained burst test at failure. The work needed to peel the seals apart can be described by the vector component of the force in the Y direction, perpendicular to the plane of the seal.

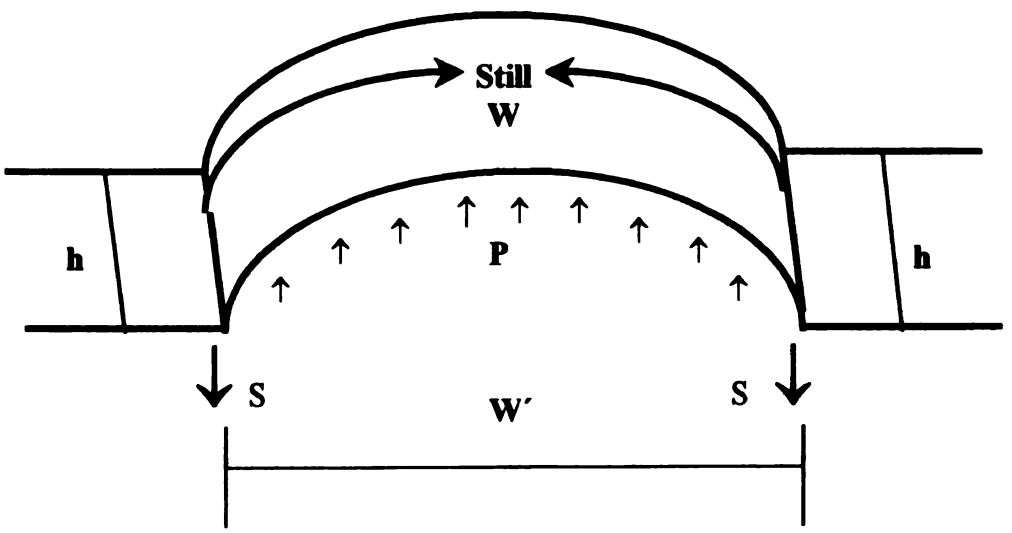


Figure 4. Force Diagram of a Center Section of an Unrestrained Pouch

the vertical component = $\Sigma Fy = P\, W'\, h = 2\, S\, h$;

$$P = [(2\, S) / W'] \qquad \text{(a)}$$

where P = pressure (lbs/in^2)

h = width of the strip (inches)

S = seal strength (lb./inch)

(force required to peel seal apart / the width of the strip)

W′ = diameter of the pouch (inches)

W = original width (inches)

If the center section is approximated as a circle, assuming that the strip does not stretch much along its perimeter, then;

$\pi\, W' = 2\, W$ (π * diameter = circumference)

$W' = [(2\, W) / \pi]$; $W = .636\, W$ (it shrinks about 1/3) (b)

Substitute equation (b) in (a);

$\mathbf{P_{critical} = [(\pi\, S) / W)]}$; $P_{critical}$ = Burst Pressure **[4]**

Therefore, for the **unrestrained case** the burst pressure is a function of seal strength and pouch size. With equation [4], some predictions can be made:

1. The burst pressure increases as the seal strength increases
2. The burst pressure decreases as the width of the package increases. Therefore, bigger pouches are weaker in burst, even when seal strength is the same.
3. Dimension L has no effect on $P_{critical}$. The burst pressure depends only on the smaller dimension W; so lengthening of the pouch while keeping the width the same should not affect the burst strength.

Restrained Case:

The restraining plates apply pressure to the pouch over contact area WL. See Figures 5 and 6 below. **D** represents the plate separation.

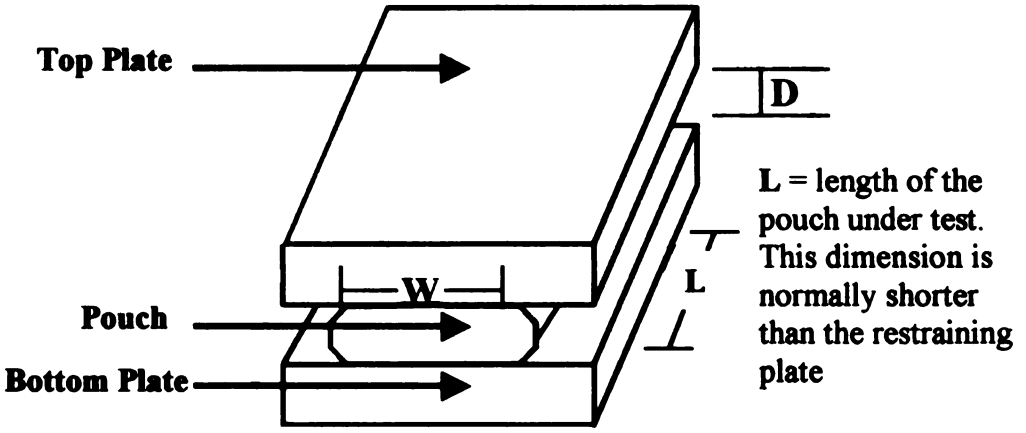


Figure 5. Pressurized Pouch in a Restrained Burst Test

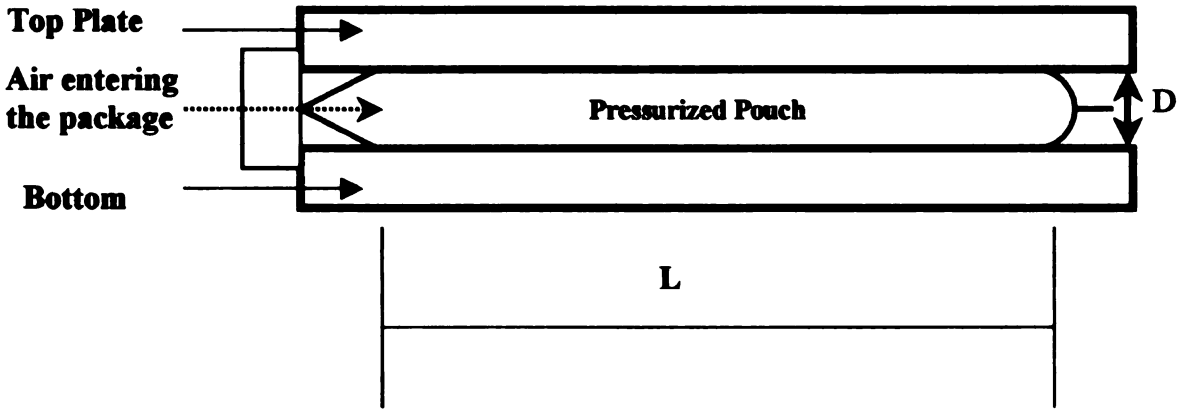


Figure 6. Cross Sectional Edge View of Pressurized Pouch in a Restrained Burst Test

A force diagram of a center section of a pressurized pouch is shown in Figure 7. The force applied by the plates is equal and opposite to the air pressure **P** inside the pouch acting over the contact area, so these forces cancel and do not enter in the force balance equation. The vertical component of the pressure along the curved parts is balanced by the seal strength, SL.

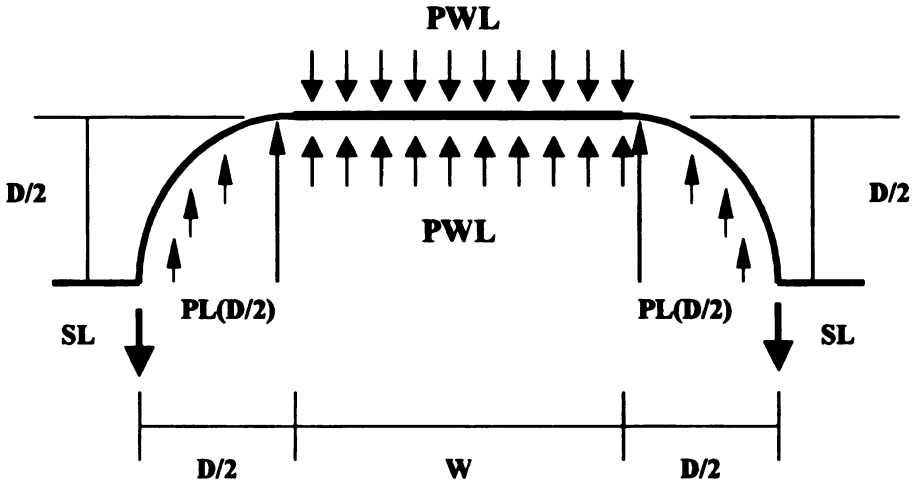


Figure 7. Force Diagram of a Center Section of a Restrained Pouch

If the curved sides of the pouch are assumed to deform into a quarter circle and if the material does not stretch much, then a force balance in the vertical direction in Figure 7 gives:

$2SL = 2PL(D/2)$

$$\mathbf{P_{critical} = [(2\ S) / D]} \qquad \textbf{[5]}$$

W = Width (inches)

L = Length (inches)

S = Seal strength (lb./inch) - unsupported

$P_{critical}$ = Burst Pressure (lbs/in^2)

D = Plate separation (inches)

According to Equation [5], the **restrained** burst pressure is a function of seal strength and plate separation. With this equation, some predictions can be made:

1. The burst pressure increases as the seal strength increases.
2. The burst pressure increases as the distance between the plates decreases, as shown in Figure 8.
3. The burst pressure is independent of pouch dimensions L and W.

The results for both cases, unrestrained and restrained, can be depicted in a single graph. See Figure 8.

Theoretically, restrained test results can be represented as a hyperbolic function. Beyond a certain D (plate separation) value, no contact occurs between the package and the plates; the test is similar to an unrestrained one. In this case $P_{critical}$ is independent of D and the data cannot be represented with a hyperbolic function anymore.

The unrestrained test results agree with the results provided by Wachala (1991) when approximating the depth of the package to a cylinder in shape. Additionally, the restrained test results agree with the results provided by Dr. Kit Yam (1993).

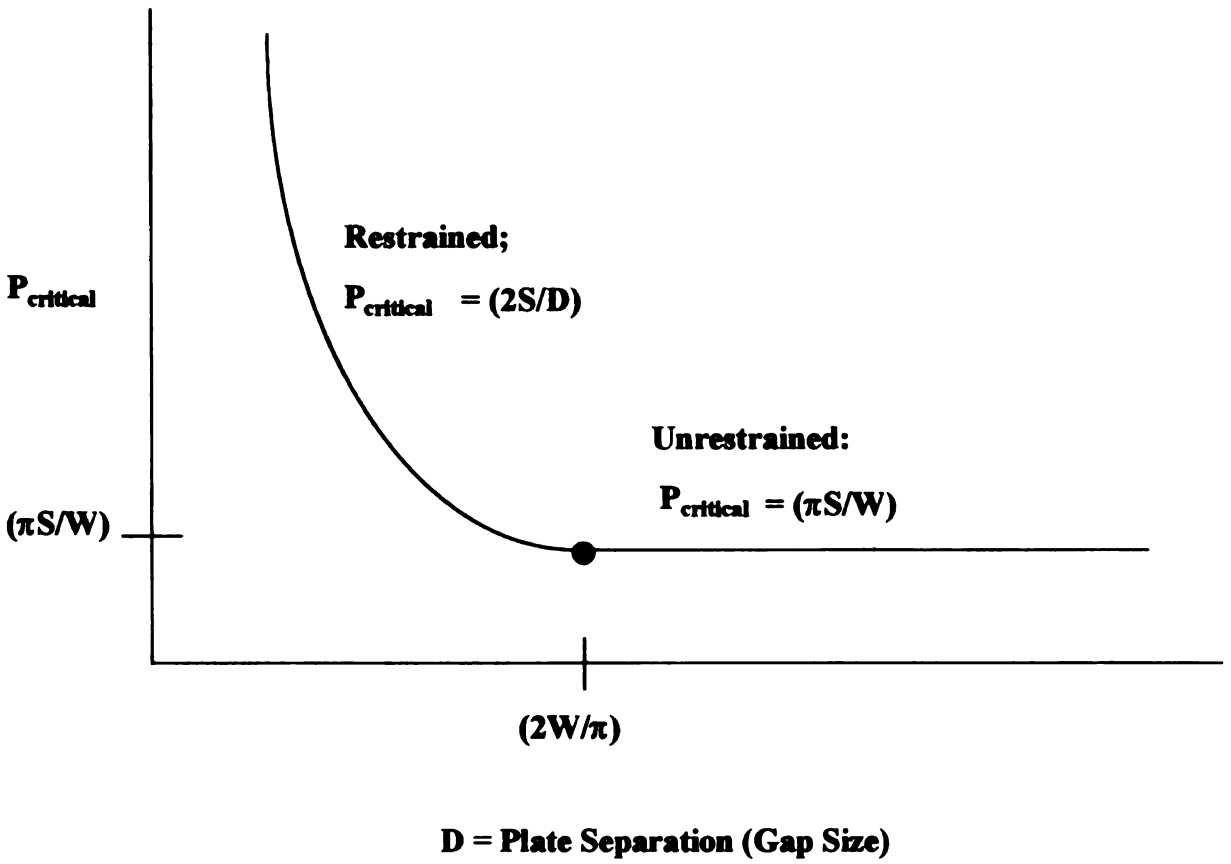


Figure 8. Relationship between Critical Burst Pressure and Plate Separation

Feliu-Baez (1998, 2001) performed restrained burst tests and unsupported peel tests on 6" x 10" Tyvek/plastic chevron seal medical pouches. The restrained burst test was performed using an open package fixture. The average of the peak peeling force was used for the correlation. The tensile peeling times were controlled within a range of 1-8% of the burst times. The results showed that the formula P=2S/D overestimated the actual burst pressure; the overestimation increased at smaller gaps. The overestimation of burst pressure was 22-49% at 0.50" plate separation (Feliu-Baez, 2001)

Stephen Franks – TM Electronics and Donald Barcan – Dunbar Industries, 1999

In 1999, Stephen Franks and Donald Barcan published the results of a screening experiment in which the sealing parameters of temperature, pressure and dwell time were varied for a specific pouch. This experiment was designed to determine whether the burst and the peel tests were sensitive enough to detect process changes in the seal manufacture. The fourth seal was manufactured on the pouch under study at various temperatures and dwell times. The pressure was held constant. A linear regression plot of the burst and tensile seal strength showed a high degree of correlation (R.0.94).

Franks and Barcan (1999) emphasized that this relationship is only valid for the materials and test configuration used. This does not represent a universal algorithm. However, a significant correlation between tensile and burst seal strength values was observed, for the materials and methods used, when varying the sealing parameters. Therefore, pouch manufacturers could develop a relationship between the tests and apply it to process control.

CHAPTER 3

NEW THEORETICAL DEVELOPMENT

The theoretical model, P=2S/D, has been studied before. Two experiments were conducted by Feliu-Baez at the Michigan State University School of Packaging in which a restrained burst test and a peel test were performed on Tyvek/plastic medical pouches. In the first experiment, the peeling times for the peel and burst tests were controlled to be the same (Feliu-Baez, 1998, 2001). In the second experiment, one of the preliminary experiments for this dissertation project, the peeling times for the peel and burst tests were not controlled to be the same (Feliu-Baez, 2000). The reason for not controlling the times was to try to be able to describe the relationship between peel and burst tests when performed at ASTM (American Society for Standards and Materials) recommended settings, which is the way they are performed in industry. In both cases, the results showed that the theoretical development did not exactly explain burst test results in terms of peel test values. The theoretical formula (P= 2S/D) tends to overestimate the actual burst pressure. These results are an indication that the formula is not universal and they suggest that it is an oversimplification.

The theoretical formula (P=2S/D) does not account for package size. It is known from previous experiments that package size has a significant effect on the restrained burst pressure (Feliu-Baez, 1998). For that reason, it was hypothesized that the model accuracy could be improved by adding the package's dimensions. A force diagram analysis was performed on the entire pouch in order to develop a new model that accounts for package size. Figure 9 (a) below shows the original length and width dimensions (L_O and W_O) of a flat pouch. Figure 9 (b) shows the pouch after it is

pressurized in a restrained burst test. The dashed rectangular patch in Figure 9 (b), represents the flat area that is in contact with the restraining plates. The dotted intersecting lines represent the original length, L_O and original width, W_O in a pressurized pouch. Figure 9 (c) shows, individually, the original length, L_O and width, W_O in a pressurized pouch.

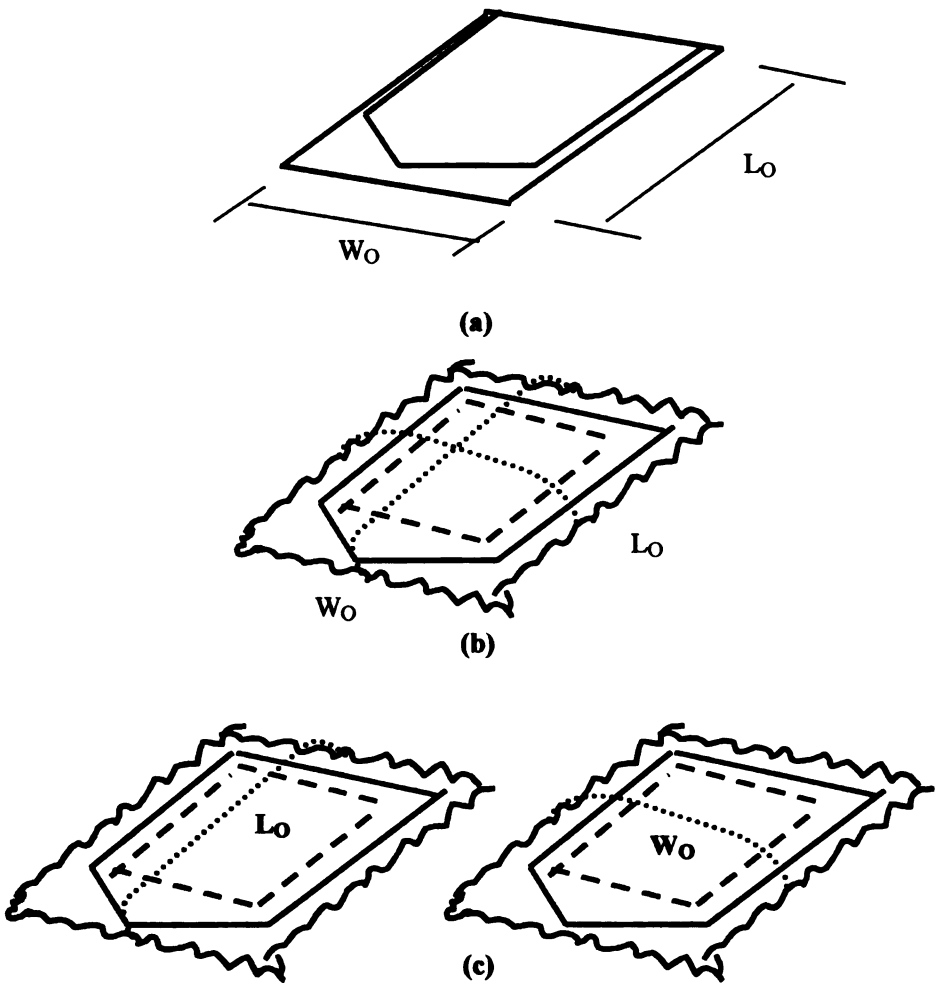


Figure 9. Chevron Seal Pouch (a) Flat (b) Pressurized (c) Original Length, L_O and Width, W_O in a pressurized pouch

A force diagram of a pressurized pouch is shown in Figure 10, below. It shows the original width of the pouch, W_O; the width of the rectangular patch in contact with the restraining plate, W_C; and the width of the pressurized pouch, W_P. It is assumed that the unsupported outer border of the pouch deforms into a circle and that the material does not stretch much.

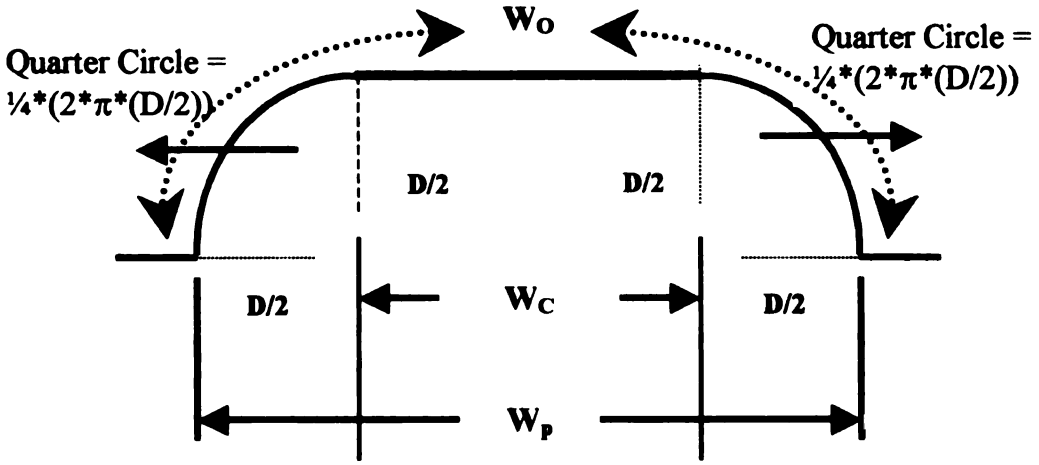


Figure 10. Force Diagram of a Center Section of a Restrained Pouch with Original, Contact and Pressurized Widths (W_O, W_C, and W_P, respectively)

The original dimensions of the flat pouch are L_O and W_O. The length and the width of the rectangular patch in contact with the restraining plates are the following:

$$L_C = L_O - 2/4(2\pi D/2) = L_O - (\pi D/2) = L_O - 1.571\ D$$

$$W_C = W_O - 2/4(2\pi D/2) = W_O - (\pi D/2) = W_O - 1.571\ D$$

The length and the width of the pouch under pressure, with gap D, are the following:

$$L_P = \{L_O - (\pi D/2)\} + 2(D/2) = L_O - (\pi/2 - 1)\,D = L_O - 0.571\ D$$

$$W_P = \{W_O - (\pi D/2)\} + 2(D/2) = W_O - (\pi/2 - 1)\,D = W_O - 0.571\ D$$

Figure 11 (a), below, shows a pressurized chevron seal pouch and (b) the edge view of the deformed perimeter.

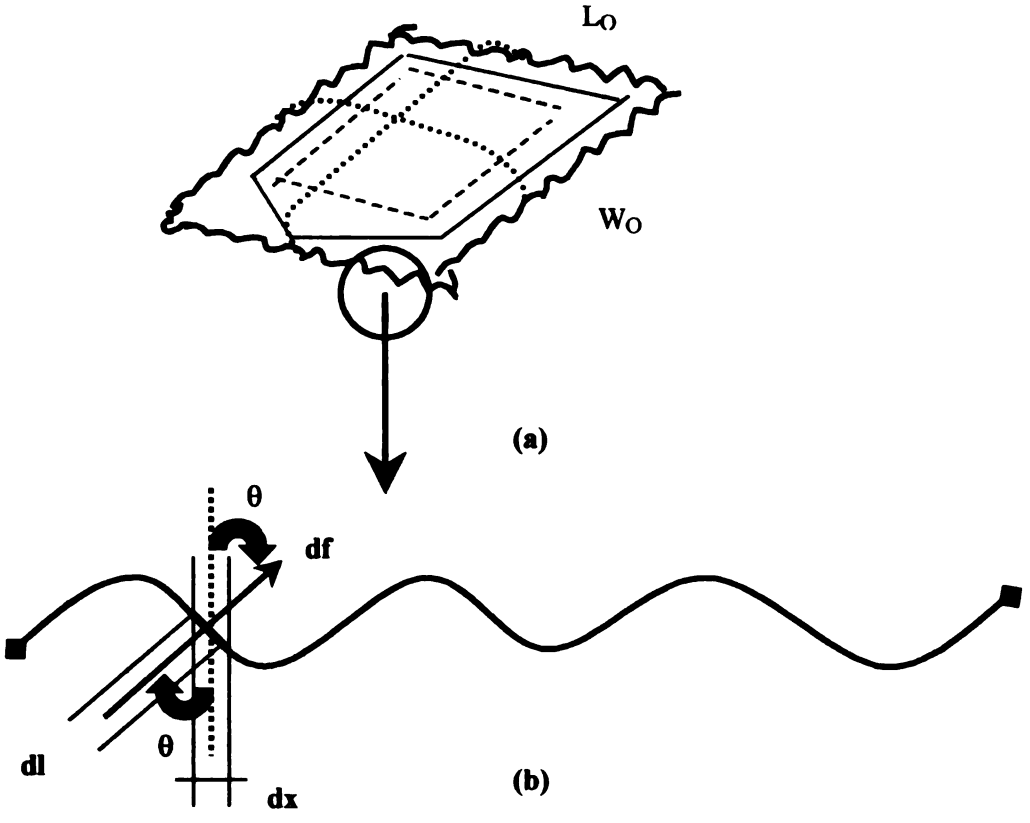


Figure 11. (a) Pressurized Chevron Seal Pouch, (b) Edge View of Deformed/Rippled Perimeter

df = infinitesimal seal force exerted by seal length **dl**

dl = arc (seal) length

dx = projection of arc length **dl** on horizontal plane

θ = projected angle of arc length **dl**

If **S** is the seal strength (lb/in),

then $\mathbf{df = S * dl}$

The component of **df** in the vertical direction is

$\mathbf{df * \cos\theta = S * dl * \cos\theta}$ where; $\mathbf{dl * \cos\theta = dx}$

$\mathbf{df * \cos\theta = S * dx}$

The total seal force in the vertical direction is,

$\int_{\text{around perimeter}} \mathbf{S * dx = S * deformed\ perimeter = S\ [2*(L_P + W_P)]}$

The plate balances the pressure acting on the rectangular patch and the seal balances the pressure acting on the unsupported border:

S[perimeter] = P["working area"]

where; "working area" = total pressurized area – contact area.

$S[2(L_P + W_P)] = P[\{L_P * W_P\} - \{L_C * W_C\}]$

$S[2(L_P + W_P)] = P[\{L_O - (\pi/2 - 1)D\} * \{W_O - (\pi/2 - 1)D\} - \{L_O - (\pi D/2)\} * \{W_O - (\pi D/2)\}]$

$2S(L_P + W_P) = P[\{L_O - 0.571D\} * \{W_O - 0.571D\} - \{L_O - 1.571D\} * \{W_O - 1.571D\}]$

$2S(L_P + W_P) = P[\{L_O W_O - .571D(L_O + W_O) + .571^2 D^2\} - \{L_O W_O - 1.571D(L_O + W_O) + 1.571^2 D^2\}]$

$2S(L_P + W_P) = PD[(L_O + W_O) - 2.142D]$

$P = 2S(L_P + W_P) / D[(L_O + W_O) - 2.142D]$

$\mathbf{P = 2S/D * [\{(L_P + W_P)\} / \{(L_O + W_O) - 2.142D\}]}$

$\mathbf{P = 2S/D * [\{(L_O + W_O - 1.142D)\} / \{(L_O + W_O - 2.142D\}]}$ **[6]**

The term within the brackets in equation [6], $\{(L_O + W_O - 1.142D)\} / \{(L_O + W_O - 2.142D\}$, will be referred to as the correction factor (CF).

The correlation obtained with equation [6] will not be better than P=2S/D. Since the correction factor is a quantity bigger than 1, it will predict a higher burst pressure, so it will overestimate even more than P=2S/D. The fact that the correlation is not better even when taking into consideration the size of the package suggests that there are other factors that affect it that are not included in the model. For example, the model does not account for the wrinkles formed in the seal area and the amount of stretch of the pouch materials during a restrained burst test ("ripple effect"). In addition, if the actual geometry of the "working area" when deformed during a restrained burst test is not a circle, as assumed in the model, then there will be deviations between the actual and predicted burst pressures. All these factors are very difficult to measure and derive with the force diagram analysis.

One way to estimate the "ripple effect" is by using the strain formula. This effect occurs due to the shortening of the length and width dimensions when the pouch is pressurized. Therefore, it depends on the strain in the length and width directions. See the equations below.

ε_L = (length under pressure – original length) / original length

$\varepsilon_L = (\{L_0 - (\pi/2 - 1)D\} - L_0) / L_0 =$ **$-0.571\ D/ L_0$**

ε_W = (width under pressure – original width) / original width

$\varepsilon_W = (\{W_0 - (\pi/2 - 1)D\} - W_0) / W_0 =$ **$-0.571\ D/ W_0$**

According to physical principles,

$P = 2S/D^*[\{(L_O + W_O - 1.142D)\}/\{(L_O + W_O - 2.142D\}]^*\ f\ \{(-0.571\ D/ L_O),(-0.571\ D/ W_O)\}$

The burst pressure is equal to equation [6] times some function of the strain in the length and width directions ("ripple" effect).

Since this new model, equation [6], did not improve the accuracy of the prediction, it was decided to use an empirical approach. Multiple regression analysis was used to fit actual data to a power law model. Chapters 4 and 5 give a detailed explanation of the methodology used and the results obtained.

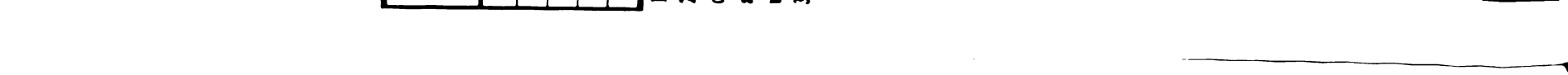
CHAPTER 4

MATERIALS AND METHODS

MATERIALS

Tyvek/plastic chevron seal peelable pouches were studied in this project. This material combination and pouch style was chosen because of their widespread use in the medical device industry. The chevron peelable seal makes the opening of the pouch easier and helps the end user achieve a sterile delivery of the product. Tyvek is used in many medical applications. This spunbonded polyolefin is HDPE, nontoxic, chemically inert, naturally white and contains no binders or fillers. In addition, Tyvek provides a clean peel with low lint and has good tear strength. It is puncture, water and bacterial penetration resistant, and it is compatible with many sterilization methods. Tyvek's porosity permits the use of gas sterilization methods, which are widely used in medical applications. The plastic side of the pouch is usually a lamination. This side provides clarity so the end user can identify the product before actually using it.

This study focused on 1073B and 1059B Tyvek, two of the most commonly used Tyveks in the medical industry. Three different combinations were tested: two variations of 1073B/plastic, from two manufacturers: Rexam Medical Packaging and Tolas Health Care Packaging, and one 1059B/plastic from Rexam Medical Packaging. Pouches of different sizes were tested within each material combination. A description of the pouches tested follows below:



A. Material combination #1:

Uncoated 1073B Tyvek/ Polyester/Poly Laminate –Rexam:

1. Pouch Dimensions, see Table 1

Table 1. Dimensions for Rexam (1073B Tyvek/ Polyester/Poly Laminate) Pouches

PKG	Rexam Pouch Description	Inner[1] Width (in)	Inner[1] Length (in)	Estimated[2] Area (in^2)	Estimated[2] Perimeter (in)	Estimated[2] Aspect Ratio (in/in)
1	R03001B	3.25"	7.25"[3]	23.56	21.00	2.23
2	L03005B	5.25"	9.125"	47.91	28.75	1.74
3	D32001B	7.25"	11.125"	80.66	36.75	1.53
4	T01534A	9.25"	14.125"	130.66	46.75	1.53
5	T02680A	11.25"	15.25"	171.56	53.00	1.36

1. According to equation [6], Chapter 3, inner dimensions should be used
2. The area, perimeter and aspect ratio were estimated using the pouch inner dimensions and without considering the chevron seal's geometry. These quantities are provided only for comparison between package sizes because they will not be used in the models.
3. Pouch R03001B- original length was 9.25", it was cut to 7.25"

2. Thickness:
   a. Uncoated 1073B Tyvek - 0.0060" to 0.0086"
   b. Polyester Poly Laminate – 0.0026-0.0030"

3. Uncoated 1073B Tyvek Porosity: 8-36 sec/100 cc/in^2

4. Uncoated 1073B Tyvek Unit Weight: 2.1-2.3 oz/yd^2

B. Material combination #2:

Uncoated 1073B Tyvek/ PET/LDPE Laminate –Tolas:

1. Pouch Dimensions, see Table 2:

Table 2. Dimensions for Tolas (1073B Tyvek/ PET/PE Laminate) Pouches

PKG	Tolas Pouch Description	Inner[1] Width (in)	Inner[1] Length (in)	Estimated[2] Area (in^2)	Estimated[2] Perimeter (in)	Estimated[2] Aspect Ratio (in/in)
1	1073B Tyvek/ TPF-0501A	3"	11.375"	34.13	28.75	3.79
2	1073B Tyvek/ TPF-0501A	10.625"	15"	159.38	51.25	1.41

1. According to equation [6], Chapter 3, inner dimensions should be used
2. The area, perimeter and aspect ratio were estimated using the pouch inner dimensions and without considering the chevron seal's geometry. These quantities are provided only for comparison between package sizes because they will not be used in the models.

2. Thickness:

   a. Uncoated 1073B Tyvek - 0.005" to 0.011"

   b. TPF-0501A (polyester film/alcohol resistant primer/LDPE) – 0.0024" to 0.0026"

3. Uncoated 1073B Tyvek Porosity: 6-50 sec in 1" orifice

4. Uncoated 1073B Tyvek Basis Weight: 2.09-2.31 oz/yd^2

C. **Material combination #3:**

Uncoated 1059B Tyvek/ Polyester/Poly Laminate –Rexam:

1. Pouch Dimensions, see Table 3:

Table 3. Dimensions for Rexam (1059B Tyvek/ Polyester/Poly Laminate) Pouches

PKG	Rexam Pouch Description	Inner[1] Width (in)	Inner[1] Length (in)	Estimated[2] Area (in^2)	Estimated[2] Perimeter (in)	Estimated[2] Aspect Ratio (in/in)
1	T02748A	5.75"	9.125"[3]	52.47	29.75	1.59
2	A14003B	9.25"	14.125"	130.66	46.75	1.53

1. According to equation [6], Chapter 3, inner dimensions should be used
2. The area, perimeter and aspect ratio were estimated using the pouch inner dimensions and without considering the chevron seal's geometry. These quantities are provided only for comparison between package sizes because they will not be used in the models.
3. Pouch T02748A- original length was 14.125", it was cut to 9.125"

2. Thickness:

   a. Uncoated 1059B Tyvek - 0.0053" to 0.0077"

   b. Polyester Poly Laminate – 0.0026"-0.0030"

3. Uncoated 1059B Tyvek Porosity: 8-36 sec/100 cc/in^2

4. Uncoated 1059B Tyvek Unit Weight: 1.82-1.98 oz/yd^2

EQUIPMENT

A. Burst Test

1. Test-A-Pack Model 2600 Burst Tester (Carleton Technologies)
2. Pneumatic Open Package Fixture - F100-1600-2
3. Aluminum Restraining Fixture (15" x 20" x ¾")
4. Robic Stopwatch (sensitivity +/- 0.001 seconds)

See Figure 12 below

Figure 12. Burst Tester with Open Package Fixture at rear and Aluminum Restraining Plates (15" x 20" x ¾") with gap = 1.0" on the right

B. Peel Test:

1. Instron Model 4201 Universal Testing Instrument – Load Cell Used 1kN (200 lb)
2. Instron X-Y Recorder
3. Epson LX-300 Printer
4. Robic Stopwatch (sensitivity +/- 0.001 seconds)

See Figure 13 below

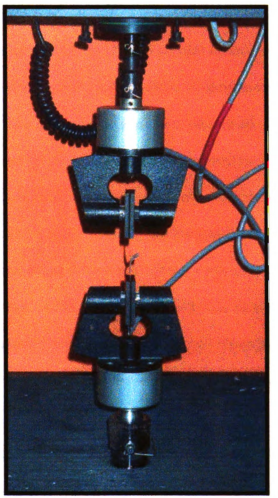


Figure 13. Unsupported Peel Test Specimen Mounted in Pneumatic Grips of Instron Model 4201 Universal Testing Instrument

METHODS

The methodology used in this project is as follows:

1. The pouches were conditioned at ASTM standard test conditions (73 +/- 4° F or 23 +/- 2 ° C and 50 +/- 5% relative humidity) for 48 hours prior to testing.
2. A restrained burst test using an open package fixture was performed according to ASTM F1140-96 *Standard Test Methods for Failure Resistance of Unrestrained and Nonrigid Packages for Medical Applications* and the draft proposal of ASTM F 2054-00 *Standard Test Methods for Burst Test Seal Strength Testing of Flexible Packages using Internal Air Pressurization with Restraining Plates.* The draft proposal was used instead of ASTM F 2054-00 because the standard was not yet published at the time these experiments were performed. The reason for doing a restrained burst test is that according to data reported by Feliu-Baez (1998), the percent error between theoretical and observed burst values is at least 12% lower when using restraining plates with a 1" plate separation (gap) than when performing the unrestrained burst test. There is less package deformation during a retrained burst test. Additionally, the restrained burst test showed a lower coefficient of variation than the unrestrained test. Open packages as opposed to closed packages were tested in order to avoid the added variation of a fourth seal made with a different heat sealer.

   Sixty pouches of each material combination were burst tested at three different flow index values and two different plate separations. The flow index values used were 1, 5 and 9 in order to cover the entire range of possible flow values in the burst tester used. Flow index values of 1 and 9 are the lowest and

highest speeds at which the air enters the package, respectively. The plate separations tested were 0.5" and 1.0", which are the recommended values and the ones usually used in industry for the pouch dimensions tested. The sample size used for each flow/plate separation combination was ten. So, 3 flow values x 2 plate separations x 10 samples = 60 pouches of each material combination. The burst pressure, bursting time and the location of failure were recorded. Appendix III shows the power calculations that were used to determine the sensitivity of the experiments when using a sample size of ten.

3. An unsupported peel test was performed according to ASTM F88-99 *Standard Test Method for Seal Strength of Flexible Barrier Materials*. The unsupported peel test better represents what happens to the seal during a restrained burst test than the supported test. Four locations were tested on each pouch. Locations A and E are the left and right side seals of the pouch, respectively. Locations B and D are the left and right sides of the chevron seal, respectively. See Figure 14 below.

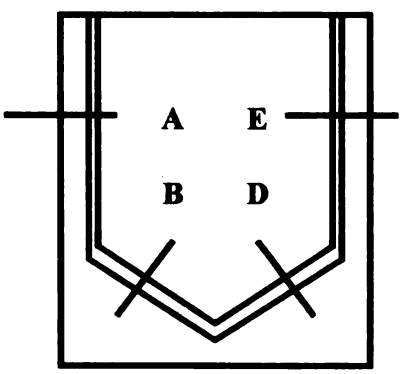


Figure 14. Top view of sample locations in tested pouches. The pouch has the transparent plastic side facing up

Within each location, a one-inch wide sample strip was cut in the region where the pouch failed during the burst test. Out of the four readings taken from each pouch, only the lowest peel value was used for the correlation calculations. This was done because the lowest peel value of the four locations represents the weakest of all the regions tested, presumably where the package would break during a burst test.

Forty pouches of each material combination were tested at two different crosshead speeds and two different grip separations. The crosshead speed values tested were 10 and 12 inches/minute, which are the lowest and highest values of the recommended range in ASTM F88-99. The grip separations used in this test were 1.0", as recommended by ASTM F88-99 and 2.0", which used to be recommended in the ASTM F88-94 version. The sample size used for each crosshead speed/grip separation combination was ten. So, 2 crosshead speeds x 2 grip separations x 10 sample = 40 pouches of each material combination. The peak force, total extension, energy, and peeling time for each location tested were recorded. The average force was calculated by dividing the energy, which is the area under the force-deformation curve, by the total extension. See Appendix III for power calculations.

Readers should note that this research was conducted differently than the work of other researchers, like Yam (1993), in that the bursting and peeling times were not controlled to be the same. The times to burst and peel were recorded in order to be able to see how different they were when changing from flow 1 to 9 in the burst test and from crosshead speed 10 to 12 inches/minute in the peel test.

ASTM recommended settings were used because ASTM standards are usually used in industry as guidelines to perform these tests. This experiment was designed to represent industry practice, and its goal is to describe the relationship between the peel and burst tests by using ASTM recommended settings and a reasonable sample size.

Appendix IV has summary tables with information about testing conditions, parameters and sample size used for the three material combinations studied.

4. Data Analysis:

The data collected was analyzed in two different ways. First, factorial analyses were performed with the purpose of determining the effect of flow index and plate separation, at ASTM settings, on the burst test. Similarly, a factorial experiment was performed to determine the effect of crosshead speed and grip separation, at ASTM settings, on the peel test. Second, the same data was used to validate theoretical and empirical models that predict burst pressure from known seal strength and models that predict seal strength from known burst pressure. These models were developed using data from preliminary experiments (Feliu-Baez, 1998, 1999, 2000)

A. Factorial Analysis:

In a 2^2 factorial analysis all possible combinations of the factors under study are considered. The following hypothesis is tested:

H_0: There is no significant;

a. Factor A effect

b. Factor B effect and

c. Interaction effect.

H_1: There is significant;

a. Factor A effect

b. Factor B effect and

c. Interaction effect.

The first step in this analysis is to conduct a residual analysis with the purpose of checking for normality, equality of variance and independence, which are the assumptions made in order to be able to use analysis of variance (ANOVA) (Montgomery, 1997). Once these assumptions are checked, the analysis of variance is used to test for significance of the effect on test results of the factors under study.

Four 2^2 factorial analyses were performed using the data collected. A 2^2 factorial experiment studies the effect of two factors, each at two levels, on a certain response. See Table 4 below.

Table 4. 2^2 Factorial Experiments for Burst and Peel Tests

#	Response	Factor - Levels (low, high)	Combinations tested
1	Burst Pressure	Flow Index – (1, 9) Plate Separation – (0.5", 1.0")	(1, 0.5"), (9, 0.5") (1, 1.0"), (9, 1.0")
2	Burst Pressure	Flow Index – (1, 5) Plate Separation – (0.5", 1.0")	(1, 0.5"), (5, 0.5") (1, 1.0"), (5, 1.0")
3	Burst Pressure	Flow Index – (5, 9) Plate Separation – (0.5", 1.0")	(5, 0.5"), (9, 0.5") (5, 1.0"), (9, 1.0")
4	Peel Strength	Crosshead Speed – (10 ipm, 12 ipm) Grip Separation – (1.0", 2.0")	(10, 1.0"), (12, 1.0") (10, 2.0"), (12, 2.0")

B. Model Validation:

1) Theoretical approach – the data collected in this experiment was used to validate theoretical models that were derived using force diagram analysis. The following theoretical models were studied:

(a) $P = 2S/D$

(b) $P = 2S/D * [\{(L_0 + W_0 - 1.142D)\} / \{(L_0 + W_0 - 2.142D\}]$

See Chapter 2, equation [5] and Chapter 3 equation [6]), respectively. The analysis of these theoretical models consisted of calculating the predicted burst pressure (P) with the two formulas above and comparing them with the actual burst values obtained experimentally. A calculation of the percent error was performed in order to get a numerical comparison. Additionally, the values obtained with the theoretical formula were plotted with the experimental ones for a graphical comparison.

2) Empirical approach –A multiple regression analysis was used to fit experimental data to different power law models. This was done using a program in BASIC programming language that calculates all the regression parameters, the average percent error, and the correlation coefficient (R). MINITAB statistical software was also used for the same analysis. These power law models need to be transformed from nonlinear to "intrinsically" linear functions (Devore, 1995), by taking the logarithm of the dependent and independent variables, in order to be able to use linear regression in MINITAB. MINITAB outputs provide the regression coefficients and the coefficient of determination (R^2).

C. Comparison of Burst Location of Failure and Minimum Seal Strength Location:

The minimum seal strength values were used in the prediction models to describe quantitatively the relationship between peel and burst test results. This value is the lowest peel value obtained out of the four locations tested in a pouch. In other words, it is the weakest of the tested sample strips cut from the seal. The location which that weakest sample strip was taken from was compared with the location of failure of the pouches that were burst tested. The purpose of doing this is to see how much agreement there was between the two tests in terms of the weakest point in the pouches tested.

The results for the factorial analysis, model validations and comparison of burst location of failure with minimum seal strength location can be found in Chapter 5.

CHAPTER 5

RESULTS AND DISCUSSION

Chapter 5 is divided in four parts. Part A has summary tables of the burst and peel test results for all package sizes and material combinations tested. Section A.1 presents burst test results for the Rexam 1073B/plastic, Tolas 1073B/plastic and Rexam 1059B/plastic pouches, respectively. Section A.2 presents peel test results for the same materials. Raw data can be found in Appendix V.

Part B includes a factorial analysis for burst and peel tests. This analysis has the purpose of determining the effects of flow rate and plate separation, at ASTM settings, on the burst test results and the effect of crosshead speed and grip separation, at ASTM settings, on the peel test results. Sections B.1 and B.2 show a summary of the results for the analysis of residual and the analysis of variance, respectively that were performed as part of the factorial experiments. Appendix VI presents the analysis of variance results obtained with MINITAB statistical software.

Part C uses the collected data for theoretical and empirical model validation. Section C.1 has a summary of the results for models that predict burst pressure when seal strength, plate separation, and package dimensions are known. Section C.2 shows the results for models that predict seal strength from a known burst pressure, plate separation, and package dimensions. Model validation results are found in Appendix VII.

Finally, Part D has a comparison of the location of failure recorded from the pouches that were burst tested with the minimum peel strength values obtained in the pouches that were peel tested. Appendix VIII contains tables with information about location of failure and location of minimum seal strength for burst and peel test, respectively.

Part A. SUMMARY OF TEST RESULTS

The burst test results showed that the burst pressure tends to increase with flow rate and decrease with plate separation. Tables 5 to 7 summarize the burst test results.

The peel test results show no specific pattern in how changes in crosshead speed and grip separation levels affect the peel test results. Tables 8 to 13 summarize the peel test results.

When examining the data from both tests together, it appears that the pouch's seal strength and size have a confounded effect on the burst pressure. In other words, the burst pressure in the packages tested changes because of changes in seal strength and size occurring at the same time (see Tables 5 to 13).

A.1. BURST TEST RESULTS

A summary of burst test results is shown below. Raw data is found Appendix V.

Table 5. Burst Test Results – Burst Pressure Values for Rexam (1073B Tyvek/Polyester/Poly Laminate) Pouches

Package Size (3.25" x 7.25"), n=10

Flow	Gap (in)	Average (inH_20)	Minimum (inH_20)	Maximum (inH_20)	Range (inH_20)	Std Dev (inH_20)	Coefficient of Variation
1	0.5	121.55	107.60	145.80	38.20	11.0569	9.10
5	0.5	127.17	106.50	150.40	43.90	12.3967	9.75
9	0.5	131.41	117.30	154.00	36.70	11.6055	8.83
1	1.0	74.09	64.90	85.70	20.80	8.5548	11.55
5	1.0	79.16	72.20	94.20	22.00	8.2040	10.36
9	1.0	79.76	62.60	105.20	42.60	11.8063	14.80

Package Size (5.25" x 9.125"), n=10

1	0.5	124.47	120.10	136.40	16.30	5.3841	4.33
5	0.5	128.66	111.40	147.30	35.90	10.9909	8.54
9	0.5	129.07	111.90	143.70	31.80	9.9336	7.70
1	1.0	73.46	65.70	78.60	12.90	3.7515	5.11
5	1.0	77.14	69.40	82.80	13.40	4.1021	5.32
9	1.0	77.41	74.60	80.40	5.80	1.8363	2.37

Table 5. Burst Test Results – Burst Pressure Values for Rexam (1073B Tyvek/Polyester/Poly Laminate) Pouches (Continuation)

Package Size (7.25" x 11.125"), n-=10

Flow	Gap (in)	Average (inH_20)	Minimum (inH_20)	Maximum (inH_20)	Range (inH_20)	Std Dev (inH_20)	Coefficient of Variation
1	0.5	99.05	91.80	112.10	20.30	6.9900	7.06
5	0.5	120.23	104.80	132.40	27.60	9.4468	7.86
9	0.5	113.80	97.00	134.10	37.10	12.2291	10.75
1	1.0	61.37	55.10	73.00	17.90	5.7562	9.38
5	1.0	63.69	55.30	69.90	14.60	4.1538	6.52
9	1.0	63.16	55.30	67.20	11.90	4.0034	6.34

Package Size (9.25" x 14.125"), n=10

1	0.5	93.36	81.10	101.00	19.90	6.4662	6.93
5	0.5	108.70	89.30	122.30	33.00	10.1725	9.36
9	0.5	118.63	106.70	128.00	21.30	7.9161	6.67
1	1.0	62.35	53.70	76.50	22.80	7.1444	11.46
5	1.0	65.01	59.40	73.90	14.50	5.4554	8.39
9	1.0	70.15	61.50	78.20	16.70	5.9543	8.49

Package Size (11.25" x 15.25"), n=10

1	0.5	114.43	104.00	125.20	21.20	6.8983	6.03
5	0.5	119.44	112.80	136.50	23.70	7.4610	6.25
9	0.5	119.62	99.00	130.30	31.30	8.6007	7.19
1	1.0	66.71	60.60	76.00	15.40	5.2195	7.82
5	1.0	71.55	59.20	86.40	27.20	8.7746	12.26
9	1.0	77.46	65.40	89.60	24.20	7.5244	9.71

Table 6. Burst Test Results - Burst Pressure Values for Tolas (1073B Tyvek/PET/LDPE Laminate) Pouches

Package Size (3" x 11.375"), n=10

Flow	Gap (in)	Average (inH_2O)	Minimum (inH_2O)	Maximum (inH_2O)	Range (inH_2O)	Std Dev (inH_2O)	Coefficient of Variation
1	0.5	119.93	107.70	136.50	28.80	8.7053	7.26
5	0.5	134.37	112.60	154.90	42.30	12.5471	9.34
9	0.5	134.43	112.80	154.40	41.60	15.8228	11.77
1	1.0	76.69	70.70	93.40	22.70	7.2930	9.51
5	1.0	83.68	76.00	95.50	19.50	5.3483	6.39
9	1.0	84.15	76.30	91.20	14.90	5.6036	6.66

Package Size (10.625" x 15"), n=10

1	0.5	105.51	100.20	110.80	10.60	3.3435	3.17
5	0.5	106.12	94.10	117.60	23.50	6.4594	6.09
9	0.5	107.48	93.00	120.90	27.90	8.4335	7.85
1	1.0	62.97	45.50	72.10	26.60	7.2498	11.51
5	1.0	66.34	52.40	73.50	21.10	7.0454	10.62
9	1.0	69.46	54.40	76.20	21.80	6.2292	8.97

Table 7. Burst Test Results – Burst Pressure Values for Rexam (1059B Tyvek/Polyester/Poly Laminate) Pouches

Package Size (5.75" x 9.125"), n=10

Flow	Gap (in)	Average (inH_2O)	Minimum (inH_2O)	Maximum (inH_2O)	Range (inH_2O)	Std Dev (inH_2O)	Coefficient of Variation
1	0.5	114.28	100.10	133.90	33.80	12.5685	11.00
5	0.5	121.68	106.70	146.60	39.90	12.8236	10.54
9	0.5	123.47	111.10	139.50	28.40	9.1658	7.42
1	1.0	66.37	57.30	79.70	22.40	6.2454	9.41
5	1.0	69.40	59.30	82.70	23.40	6.7676	9.75
9	1.0	71.21	49.20	83.40	34.20	11.1145	15.61

Package Size (9.25" x 14.125"), n-=10

1	0.5	115.47	95.10	133.50	38.40	10.3554	8.97
5	0.5	125.00	118.70	131.70	13.00	4.3594	3.49
9	0.5	132.43	116.80	146.20	29.40	8.7737	6.63
1	1.0	70.30	62.40	75.00	12.60	4.6743	6.65
5	1.0	75.44	69.90	81.60	11.70	3.6846	4.88
9	1.0	76.79	70.10	85.50	15.40	5.6518	7.36

A.2. PEEL TEST RESULTS

A summary of peel test results is shown below. Raw data is found Appendix V.

Table 8. Peel Test Results – Seal Strength Values (PEAK FORCE) for Rexam (1073B Tyvek/Polyester/Poly Laminate) Pouches

Package Size (3.25" x 7.25"), n=10

CS (ipm)	GS (in)	Average (lb/in)	Minimum (lb/in)	Maximum (lb/in)	Range (lb/in)	Standard Deviation (lb/in)	Coefficient of Variation
10	1	1.5983	1.2350	2.0350	0.8000	0.2173	13.60
12	1	1.4840	1.0090	1.8040	0.7950	0.2506	16.89
10	2	1.5054	0.8966	1.9650	1.0684	0.2742	18.21
12	2	1.5775	1.2830	1.8420	0.5590	0.1783	11.30

Package Size (5.25" x 9.125"), n=10

10	1	1.5069	1.1920	1.8520	0.6600	0.2257	14.98
12	1	1.5818	1.1010	1.8740	0.7730	0.2633	16.65
10	2	1.5446	1.3580	1.8090	0.4510	0.1625	10.52
12	2	1.5980	0.9820	2.1740	1.1920	0.3260	20.40

Package Size (7.25" x 11.125"), n-=10

10	1	1.3325	1.0680	1.6380	0.5700	0.1891	14.19
12	1	1.4916	1.0090	1.7400	0.7310	0.2650	17.77
10	2	1.5713	1.1700	1.9170	0.7470	0.2532	16.11
12	2	1.3486	0.8161	1.9810	1.1649	0.3023	22.42

Package Size (9.25" x 14.125"), n=10

10	1	1.5528	1.1330	1.9270	0.7940	0.2557	16.47
12	1	1.6133	1.3850	1.8630	0.4780	0.1740	10.79
10	2	1.5735	1.0090	2.0400	1.0310	0.2876	18.28
12	2	1.6118	1.3960	1.9170	0.5210	0.1665	10.33

Package Size (11.25" x 15.25"), n=10

10	1	1.7273	1.4710	2.1370	0.6660	0.2200	12.74
12	1	1.5892	1.2130	1.7720	0.5590	0.1871	11.77
10	2	1.6317	1.0200	1.9870	0.9670	0.2875	17.62
12	2	1.4629	0.9342	1.7930	0.8588	0.2599	17.77

NOTES:

1. **Column #3 has the average of the "minimum peak peel force" from 10 pouches, Refer to Appendix I for Glossary**
2. **CS = Crosshead Speed (inches per minute), GS = Grip Separation (inches)**

Table 9. Peel Test Results – Seal Strength Values (PEAK FORCE) for Tolas (1073B Tyvek/PET/LDPE Laminate) Pouches

Package Size (3" x 11.375"), n=10

CS (ipm)	GS (in)	Average (lb/in)	Minimum (lb/in)	Maximum (lb/in)	Range (lb/in)	Standard Deviation (lb/in)	Coefficient of Variation
10	1	1.6881	1.2890	1.9700	0.6810	0.2080	12.32
12	1	1.8422	1.4660	2.1640	0.6980	0.1876	10.18
10	2	1.8492	1.5250	2.1050	0.5800	0.1631	8.82
12	2	1.8019	1.5460	2.1370	0.5910	0.1538	8.54

Package Size (10.625" x 15"), n=10

10	1	1.7762	1.4550	2.1370	0.6820	0.2126	11.97
12	1	1.7625	1.4600	2.1260	0.6660	0.2076	11.78
10	2	1.7985	1.1100	2.0780	0.9680	0.2821	15.69
12	2	1.9672	1.2780	2.2600	0.9820	0.3013	15.32

NOTES:

1. **Column #3 has the average of the "minimum peak peel force" from 10 pouches, Refer to Appendix I for Glossary**
2. **CS = Crosshead Speed (inches per minute), GS = Grip Separation (inches)**

Table 10. Peel Test Results – Seal Strength Values (PEAK FORCE) for Rexam (1059B Tyvek/Polyester/Poly Laminate) Pouches

Package Size (5.75" x 9.125"), n=10

CS (ipm)	GS (in)	Average (lb/in)	Minimum (lb/in)	Maximum (lb/in)	Range (lb/in)	Standard Deviation (lb/in)	Coefficient of Variation
10	1	1.1565	0.9127	1.4980	0.5853	0.1942	16.79
12	1	1.2640	0.8698	1.5890	0.7192	0.2422	19.16
10	2	1.3288	0.9342	1.5570	0.6228	0.1810	13.62
12	2	1.1922	0.9074	1.5410	0.6336	0.2179	18.28

Package Size (9.25" x 14.125"), n-=10

10	1	1.3934	1.0680	1.8420	0.7740	0.2761	19.81
12	1	1.4340	1.1380	1.8790	0.7410	0.2305	16.07
10	2	1.4439	1.0360	1.5950	0.5590	0.1639	11.35
12	2	1.4352	1.1220	1.7400	0.6180	0.2642	18.41

NOTES:

1. **Column #3 has the average of the "minimum peak peel force" from 10 pouches, Refer to Appendix I for Glossary**
2. **CS = Crosshead Speed (inches per minute), GS = Grip Separation (inches)**

Table 11. Peel Test Results – Seal Strength Values (AVERAGE FORCE) for Rexam (1073B Tyvek/Polyester/Poly Laminate) Pouches

Package Size (3.25" x 7.25"), n=10

CS (ipm)	GS (in)	Average (lb/in)	Minimum (lb/in)	Maximum (lb/in)	Range (lb/in)	Standard Deviation (lb/in)	Coefficient of Variation
10	1	1.0834	0.8111	1.3078	0.4967	0.1498	13.83
12	1	1.0095	0.5947	1.2788	0.6841	0.2020	20.01
10	2	1.0521	0.6245	1.3323	0.7078	0.1796	17.07
12	2	1.0822	0.8792	1.2583	0.3791	0.1181	10.91

Package Size (5.25" x 9.125"), n=10

10	1	1.0164	0.7133	1.3095	0.5962	0.1922	18.91
12	1	1.0243	0.7026	1.2429	0.5403	0.1762	17.20
10	2	1.1123	0.9855	1.3071	0.3216	0.1147	10.31
12	2	1.1135	0.7087	1.4881	0.7794	0.2113	18.98

Package Size (7.25" x 11.125"), n-=10

10	1	0.8592	0.7265	1.0830	0.3565	0.1186	13.80
12	1	0.9806	0.7007	1.1810	0.4803	0.1665	16.98
10	2	1.0776	0.7985	1.4077	0.6092	0.1969	18.27
12	2	0.9132	0.5967	1.3960	0.7993	0.2169	23.75

Package Size (9.25" x 14.125"), n=10

10	1	1.0181	0.7036	1.3162	0.6126	0.1945	19.10
12	1	1.0093	0.8103	1.1971	0.3868	0.1364	13.51
10	2	1.1235	0.7003	1.5076	0.8073	0.2119	18.86
12	2	1.1169	0.8903	1.2407	0.3504	0.1110	9.94

Package Size (11.25" x 15.25"), n=10

10	1	1.1702	0.8709	1.3772	0.5063	0.1644	14.05
12	1	1.0405	0.8067	1.2292	0.4225	0.1503	14.44
10	2	1.0954	0.6841	1.3599	0.6758	0.2348	21.44
12	2	1.0290	0.6050	1.3361	0.7311	0.2070	20.12

NOTES:

1. **Column #3 has the average of the "minimum average peel force" from 10 pouches, Refer to Appendix I for Glossary**
2. **CS = Crosshead Speed (inches per minute), GS = Grip Separation (inches)**

Table 12. Peel Test Results – Seal Strength Values (AVERAGE FORCE) for Tolas (1073B Tyvek/PET/LDPE Laminate) Pouches

Package Size (3" x 11.375"), n=10

CS (ipm)	GS (in)	Average (lb/in)	Minimum (lb/in)	Maximum (lb/in)	Range (lb/in)	Standard Deviation (lb/in)	Coefficient of Variation
10	1	1.1824	0.9645	1.3968	0.4323	0.1412	11.94
12	1	1.2403	1.0020	1.5177	0.5157	0.1483	11.96
10	2	1.2892	1.0768	1.5230	0.4462	0.1386	10.75
12	2	1.2835	1.0219	1.4974	0.4755	0.1345	10.48

Package Size (10.625" x 15"), n=10

10	1	1.2438	1.0243	1.6099	0.5856	0.1969	15.83
12	1	1.2131	0.9366	1.4898	0.5532	0.1794	14.79
10	2	1.3080	0.7888	1.5349	0.7461	0.2150	16.44
12	2	1.3894	0.9952	1.6920	0.6968	0.2106	15.16

NOTES:

1. **Column #3 has the average of the "minimum average peel force" from 10 pouches, Refer to Appendix I for Glossary**
2. **CS = Crosshead Speed (inches per minute), GS = Grip Separation (inches)**

Table 13. Peel Test Results – Seal Strength Values (AVERAGE FORCE) for Rexam (1059B Tyvek/Polyester/Poly Laminate) Pouches

Package Size (5.75" x 9.125"), n=10

CS (ipm)	GS (in)	Average (lb/in)	Minimum (lb/in)	Maximum (lb/in)	Range (lb/in)	Standard Deviation (lb/in)	Coefficient of Variation
10	1	0.7684	0.5807	1.0201	0.4394	0.1574	20.48
12	1	0.8324	0.6813	1.0540	0.3727	0.1290	15.50
10	2	0.9270	0.6157	1.0634	0.4477	0.1400	15.10
12	2	0.8533	0.6605	1.1195	0.4590	0.1567	18.36

Package Size (9.25" x 14.125"), n-=10

10	1	0.8792	0.7032	1.1925	0.4893	0.1693	19.26
12	1	0.9303	0.7214	1.3133	0.5919	0.1754	18.85
10	2	0.9679	0.7574	1.1495	0.3921	0.1222	12.63
12	2	0.9856	0.7788	1.1823	0.4035	0.1776	18.02

NOTES:

1. **Column #3 has the average of the "minimum average peel force" from 10 pouches, Refer to Appendix I for Glossary**
2. **CS = Crosshead Speed (inches per minute), GS = Grip Separation (inches)**

Part B. FACTORIAL EXPERIMENTS

Four 2^2 factorial experiments were run (see Table 4, Chapter 4) with the purpose of testing the significance of the test parameters, at ASTM settings, on the results. The test parameters under study are the flow rate and plate separation in the burst test, and the crosshead speed and grip separation on the peel test. The analysis was performed for each pouch under study. The peel test results were analyzed using the average of the "minimum peak peel force" and the average of the "minimum average peel force" values. Refer to Appendix I for Glossary.

The factorial experiment analysis was divided in two parts: analysis of residuals and analysis of variance.

B.1. ANALYSIS OF RESIDUALS

The assumptions for an analysis of variance are that model errors and the observations are normally and independently distributed with the same variance in each factor level (Montgomery, 1997). An analysis of the residuals can be used to check these assumptions. The residual is the difference between the actual observation and the predicted value from a least-squares fit of the underlying analysis of variance model to the sample data.

The normality assumption can be checked with a normal probability plot of the residuals and a visual examination of the data. If the data are adequately described by a normal distribution, the plotted data should fall approximately along a straight line. Plotting the residuals against the run order in which the experiment was performed can check the independence assumption. Any pattern in this plot may indicate that the observations are not independent. In order to check the equal variance assumption, the

residuals should be plotted against each factor level. The spread of the data should be similar at each factor level (Montgomery, 1997).

An analysis of residuals was performed with the data from each package tested. All plots showed that the assumptions of normality, independence and equal variance were reasonable. Since the analysis of residuals was satisfactory, an analysis of variance was conducted. The results are summarized in the following section.

B.2. ANALYSIS OF VARIANCE

An analysis of variance was conducted for each of the factorial experiments designed (see Table 4, Chapter 4) and for each of the package sizes and material combinations under study. The analysis of variance results obtained from MINITAB are tabulated in Appendix VI.

The analyses of variance performed with the burst test results showed that plate separation had a significant effect on the burst pressure for all the package sizes at each of the material combinations tested. Additionally, it showed that flow index had a significant effect on the burst pressure when the extreme values, 1 and 9, were used. This was true for all package sizes and each of the material combinations tested. When comparing flow indexes 1 and 5, a significant difference in burst pressure was observed mostly in bigger packages. When the comparison was made between flow indexes 5 and 9, the burst pressure tended to show no significant difference. Burst pressure values obtained at flow index 1 were lower than the ones obtained at flow indexes 5 and 9. Tables 14 to 16, in section B.2a, provide a summary of the analysis of variance for the burst test results.

The analyses of variance performed with the peel test results showed that the crosshead speed and grip separation did not have a significant effect on either the peak or average peel test results. Tables 17 to 19, in section B.2b, provide a summary of the analysis of variance for the peel test results when using peak and average force values.

Differences in the time it takes to burst test a package and the time it takes to peel a sample strip at the selected settings can explain the findings for flow index and crosshead speed effects on the burst and peel test results, respectively. In other words, the time dependency of the viscoelastic materials used in these pouches can be used to explain these results. A summary of the test completion times is provided below:

Burst Test:

1. at Flow index 1 – 100 to 145 seconds
2. at Flow index 5 – 11 to 13 seconds
3. at Flow index 9 – 5.5 to 7 seconds

Peel Test:

1. at Crosshead Speed 10 ipm – 4.6 to 6.6 seconds
2. at Crosshead Speed 12 ipm – 3.9 to 5.6 seconds

Refer to Appendix V for information on test completion times.

If a package seal is stressed slowly, it will elongate and then break at a lower value than if it is stressed quickly. This fact can explain the difference found in burst pressure when using flow index of 1 and 9. At flow index 1, the observed burst test completion times ranged between 100 and 145 seconds at both of the plate separations tested. This is significantly slower than when testing at flow index 9, in which the burst test completion time ranged between 5.5 and 7 seconds. At flow index 9 the burst values

were found to be higher and significantly different than the burst values at flow index 1. Similarly, the difference in burst pressure when testing at flow indexes 1 and 5 can be explained by the difference in the time it takes to complete the test. At flow index 5, it takes approximately 11 to 13 seconds to complete the burst test, which is significantly less time than what it takes at flow index 1 (100 to 145 seconds). The resulting burst pressure for flow index 5 was higher and significantly different than the burst pressure obtained when flow index 1 was used. This was true for bigger packages at each of the materials combinations tested.

According to Burgess, 1994, the force required to stretch a viscoelastic specimen to a given length quickly is always greater than the force required to stretch it to the same length slowly. However, the speed effect on the materials under study is not apparent within the range of crosshead speeds used in the peel tests, because this range is too narrow. It can be seen that the difference in peel test completion times at 10 and 12 ipm is not as large as it was the difference in burst test completion times when using different flow rates. At 10 ipm it takes between 4.6 to 6.6 seconds to complete the test. At 12 ipm it takes between 3.9 to 5.6 seconds.

B.2.a. Factorial Experiment - BURST TEST RESULTS:

Tables 14 to 16 summarize the factorial experiment results for the burst test results of each of the material combinations under study. The analysis of variance results obtained from MINITAB statistical software can be found in Appendix VI.

I. Uncoated 1073B/Polyester/Poly Laminate - Rexam

Table 14. Results for Burst Test 2^2 Factorial Experiments
Rexam (1073B/Polyester/Poly Laminate) Pouches
Experiment #1 – Flow rate and Plate Separation Effect on the Burst Pressure

Factor	Low Level	High Level	Conclusion
A Flow Rate	1	9	**Significant effect on the burst pressure** of the 5 package sizes under study
B Plate Separation	0.5"	1.0"	**Significant effect on the burst pressure** of the 5 package sizes under study

Experiment #2 - Flow rate and Plate Separation Effect on the Burst Pressure

Factor	Low Level	High Level	Conclusion
A Flow Rate	1	5	**Significant effect on the burst pressure** of the following packages sizes: (7.25" x 11.125") (9.25" x 14.125") (11.25" x 15.125")
B Plate Separation	0.5"	1.0"	**Significant effect on the burst pressure** of the 5 package sizes under study

Experiment #3 - Flow rate and Plate Separation Effect on the Burst Pressure

Factor	Low Level	High Level	Conclusion
A Flow Rate	5	9	**Significant effect on the burst pressure** of package size (9.25" x 14.125")
B Plate Separation	0.5"	1.0"	**Significant effect on the burst pressure** of the 5 package sizes under study

II. Uncoated 1073B/PET/PE Laminate - Tolas

Table 15. Results for Burst Test 2^2 Factorial Experiments
Tolas (1073B/PET/PE Laminate) Pouches

Experiment #1 - Flow rate and Plate Separation Effect on the Burst Pressure

Factor	Low Level	High Level	Conclusion
A **Flow Rate**	**1**	**9**	**Significant effect on the burst pressure** of the 2 package sizes under study
B **Plate Separation**	**0.5"**	**1.0"**	**Significant effect on the burst pressure** of the 2 package sizes under study

Experiment #2- Flow rate and Plate Separation Effect on the Burst Pressure

Factor	Low Level	High Level	Conclusion
A **Flow Rate**	**1**	**5**	**Significant effect on the burst pressure** of package size (3" x 11.375")
B **Plate Separation**	**0.5"**	**1.0"**	**Significant effect on the burst pressure** of the 2 package sizes under study

Experiment #3- Flow rate and Plate Separation Effect on the Burst Pressure

Factor	Low Level	High Level	Conclusion
A **Flow Rate**	**5**	**9**	**NO significant effect** on the burst pressure of the 2 package sizes under study
B **Plate Separation**	**0.5"**	**1.0"**	**Significant effect on the burst pressure** of the 2 package sizes under study

III. Uncoated 1059B/Polyester/Poly Laminate - Rexam

Table 16. Results for Burst Test 2^2 Factorial Experiments
Rexam (1059B/Polyester/Poly Laminate) Pouches

Experiment #1 - Flow rate and Plate Separation Effect on the Burst Pressure

Factor	Low Level	High Level	Conclusion
A Flow Rate	1	9	**Significant effect on the burst pressure** of the 2 package sizes under study
B Plate Separation	0.5"	1.0"	**Significant effect on the burst pressure** of the 2 package sizes under study

Experiment #2- Flow rate and Plate Separation Effect on the Burst Pressure

Factor	Low Level	High Level	Conclusion
A Flow Rate	1	5	**Significant effect on the burst pressure** of package size (9.25" x 14.125")
B Plate Separation	0.5"	1.0"	**Significant effect on the burst pressure** of the 2 package sizes under study

Experiment #3- Flow rate and Plate Separation Effect on the Burst Pressure

Factor	Low Level	High Level	Conclusion
A Flow Rate	5	9	**Significant effect on the burst pressure** of package size (9.25" x 14.125")
B Plate Separation	0.5"	1.0"	**Significant effect on the burst pressure** of the 2 package sizes under study

B.2.b. Factorial Experiment – PEEL TEST RESULTS:

Tables 17 to 19 summarize the factorial experiment results for the peel test results of each of the material combinations under study. The analysis of variance results obtained from MINITAB statistical software can be found in Appendix VI.

I. Uncoated 1073B/Polyester/Poly Laminate - Rexam

Table 17. Results for Peel Test 2^2 Factorial Experiment
Rexam (1073B/Polyester/Poly Laminate) Pouches

Using Peak Force Values

Factor	Low Level	High Level	Conclusion
A Crosshead Speed	10 ipm	12 ipm	**NO significant effect** on the peel strength of the 5 package sizes under study
B Grip Separation	1.0"	2.0"	**NO significant effect** on the peel strength of the 5 package sizes under study

Using Average Force Values

Factor	Low Level	High Level	Conclusion
A Crosshead Speed	10 ipm	12 ipm	**NO significant effect** on the peel strength of the 5 package sizes under study
B Grip Separation	1.0"	2.0"	**NO significant effect** on the peel strength of the 5 package sizes under study

II. Uncoated 1073B/PET/PE Laminate - Tolas

Table 18. Results for Peel Test 2^2 Factorial Experiment
Tolas (1073B/PET/PE Laminate) Pouches

Using Peak Force Values

Factor	Low Level	High Level	Conclusion
A Crosshead Speed	10 ipm	12 ipm	**NO significant effect** on the peel strength of the 2 package sizes under study
B Grip Separation	1.0"	2.0"	**NO significant effect** on the peel strength of the 2package sizes under study

Using Average Force Values

Factor	Low Level	High Level	Conclusion
A Crosshead Speed	10 ipm	12 ipm	**NO significant effect** on the peel strength of the 2 package sizes under study
B Grip Separation	1.0"	2.0"	**NO significant effect** on the peel strength of the 2 package sizes under study

III. Uncoated 1059B/Polyester/Poly Laminate - Tolas

Table 19. Results for Peel Test 2^2 Factorial Experiment
Rexam (1059B/Polyester/Poly Laminate) Pouches

Using Peak Force Values

Factor	Low Level	High Level	Conclusion
A Crosshead Speed	10 ipm	12 ipm	**NO significant effect** on the peel strength of the 2 package sizes under study
B Grip Separation	1.0"	2.0"	**NO significant effect** on the peel strength of the 2package sizes under study

Using Average Force Values

Factor	Low Level	High Level	Conclusion
A Crosshead Speed	10 ipm	12 ipm	**NO significant effect** on the peel strength of the 2 package sizes under study
B Grip Separation	1.0"	2.0"	**NO significant effect** on the peel strength of the 2 package sizes under study

Part C. MODEL VALIDATION

Since both the peel and the burst tests are destructive tests, it was not possible to pair individual samples for the data analysis. For that reason, the average of a group of ten samples burst tested under the same testing conditions was compared with the average of a group of ten samples peel tested under the same conditions.

The model validation was performed in a way that, if this method is reproduced in the future for other material and package sizes, it will require the least amount of samples and time. For that reason, the data for this analysis was selected from the data gathered for the factorial experiment. Since the flow index and plate separation were found to be significant in the burst test results, all the data collected in the burst test was used for model validation. In other words, the data coming from 3 different flow rates at each of the 2 plate separations was used. Since the factorial analysis showed no significant effect of crosshead speed and grip separation in the peel test results, only the data obtained at crosshead speed = 12 ipm and a grip separation of 1" was chosen. The reason for choosing 12 ipm is that the peel test is a little faster than when using 10 ipm, so it requires less time. A grip separation = 1.0" is what the ASTM F88-99 recommends. Refer to Appendix VII for the data used in model validation.

C.1 Predicting Burst Pressure

Two theoretical models and three empirical models were used to predict the burst pressure from the seal strength values. The theoretical models were developed with force diagram analysis as described by equations [5] and [6], found in Chapters 2 and 3, respectively. Empirical models were developed by using multiple regression analysis to fit experimental data to a power law relationship. The five models used to predict burst pressure from peel strength are shown below:

Theoretical Model #1:

$P = 2S/D$

Theoretical Model #2:

$P = 2S/D * [CF]$

where: $CF = [\{(L_O+W_O-1.142D)/(L_O+W_O-2.142D)\}]$

Empirical Model #1:

$P = K [X_1]^{P1}[X_2]^{P2}[X_3]^{P3}$

where: $X_1 = \{S/D\}*CF$; $CF = [\{(L_O+W_O-1.142D)/(L_O+W_O-2.142D)\}]$

$X_2 = D/L_c$; $L_c = L_O-1.571D$

$X_3 = D/W_c$; $W_c = W_O-1.571D$

Empirical Model #2:

$P = K [X_1]^{P1}[X_2]^{P2}$

where: $X_1 = \{S/D\}$

$X_2 = CF$; $CF = [\{(L_O+W_O-1.142D)/(L_O+W_O-2.142D)\}]$

Empirical Model #3:

$P = K [X_1]^{P1}[X_2]^{P2}$

where: $X_1 = \{S/D\}$

$X_2 = L/W$

The three empirical models have a power law relationship. A power relationship was used instead of a linear or exponential relationship because of the behavior of the experimental data. Scatter plots of burst pressure (P) vs. (2S/D) and (P) vs. (2S/D*CF) were made with data from the three material combinations tested. A linear, an exponential and a power fit were tried. Out of the three, the best fit was obtained with a power law relationship. This was true for all material combinations tested.

The power law relationships in the empirical models above were converted from a nonlinear function to an "intrinsically linear" one by using logarithms. The transformed data was used to produce a scatter plot to check for linearity and for a residual analysis. Since the scatter plots and the residual analysis were both satisfactory, a linear multiple regression analysis was performed. See Appendix VII.A for an example of transformation of data.

It can be seen that the empirical models are based on the theoretical formulas. The independent variables are equal to terms that were derived theoretically with the use of force diagram analysis, as described in Chapters 2 and 3. In empirical model #1, X_1 is equal to the right side of theoretical model #2, (S/D)*CF (derived in Chapter 3). The other two independent variables (X_2 and X_3) are the ratio of the plate separation to the length (L_c) and width (W_c) of the pouch that is touching the plates (as defined in Chapter 3), respectively. Empirical model #2 moves towards a simpler model because it only has

two independent variables. The first variable is (S/D), as in theoretical model #1 (derived in Chapter 2), and the second one is the correction factor (CF as derived in Chapter 3). In empirical model #3, which is the simplest one, X_1 is equal to (S/D) and X_2 is (L/W), the aspect ratio of the package.

None of the empirical models includes flow index as an independent variable. The effect of flow index on burst test results was so small that it was considered negligible for practical purposes. Including the flow index in the model is equivalent to multiplying the predicted burst pressure by 1.10 at most when the maximum value of flow index (9) is used. That is because the power to which the variable flow would be raised to is 0.04 ($9^{0.04} = 1.10$). These results can be found in Appendix VII. Appendix VII.B includes the formulas used for calculating the average percent error, the regression parameters (K, and p1, p2, ..., pn), correlation coefficients (R), and the burst pressure (P) prediction intervals for the three empirical models. The regression results for empirical models #1, #2, and #3, when flow index is included as one of the independent variables, are tabulated in Appendix VII.C

The positive aspect of not including flow index as independent variable in the empirical models is that the model results will be applicable to burst testers different than the one used. If the flow index was included as an independent variable, the fact that the burst tester used has no measurable units for the flow index would have made the model unique for that particular burst tester.

The regression analysis was performed for the three empirical models without including the flow index as an independent variable. The results were analyzed and

tabulated for an easier comparison against the theoretical model results (Tables 20-22). The following was found:

1. The empirical models had a lower average percent error than the theoretical ones.
2. For 1073B Tyvek/plastic pouches lower average percent errors were obtained when using average force in theoretical models.
3. Slightly better results, in terms of correlation coefficient and average percent errors, were obtained when using average force values in the empirical models. This was true for all material combinations.
4. All empirical models provided good results. In general, empirical models #1 and #3 provided better results than empirical model #2. Model #1 resulted in slightly higher correlation coefficients and tended to have smaller average percent errors, which made it the most accurate. Model #3 provided more simplicity. When all material combinations were compared within the same empirical model (Tables 88 to 90 in Appendix VII.D) model #3 resulted in similar regression parameters for the three material combinations under study. This makes model #3 a very attractive one. Besides being simple and having similar regression parameters for all material combinations, the regression parameters are reasonable in magnitude, and the model results in good correlation coefficient and average percent error results

A summary of the validation results for the two theoretical and three empirical models that predict burst pressure (P) is shown below. Summary Tables 20 to 22 and Figures 15 to 20 display these results. The tables show the average percent errors for all

models and the regression parameters (K, and p1, p2, ..., pn), correlation coefficients (R), and burst pressure (P) prediction intervals for the empirical models.

Appendix VII.D, includes the data arranged in the way it was used for this analysis, the regression results for the three empirical models and has tables with the actual and predicted results for individual observations along with the average percent errors for all models.

I. Uncoated 1073B/Polyester/Poly Laminate – Rexam:

Table 20. Validation Results for Burst Pressure Prediction Models
Rexam (1073B/Polyester Poly Laminate) Pouches
Using Peak Force Values

Model	Average (%) Error	Regression Coefficients	R R_{adj}	PI – Single Response[1] (lbs/in^2)	PI – Mean Response[2] (lbs/in^2)
Theoretical #1	34.66	---	---	---	---
Theoretical #2	41.14	---	---	---	---
Empirical #1	5.48	K = 2.44 p1 = 1.01 p2 = 0.23 p3 = - 0.03	0.9654 0.9612	P +/- 0.5143	P +/- 0.0924
Empirical #2	5.53	K = 1.36 p1 = 0.91 p2 = 3.41	0.9624 0.9597	P +/- 0.5554	P +/- 0.0998
Empirical #3	5.95	K = 1.53 p1 = 0.74 p2 = 0.37	0.9601 0.9571	P +/- 0.5616	P +/- 0.1009

Using Average Force Values

Model	Average (%) Error	Regression Coefficients	R R_{adj}	PI – Single Response[1] (lbs/in^2)	PI – Mean Response[2] (lbs/in^2)
Theoretical #1	14.40	---	---	---	---
Theoretical #2	10.82	---	---	---	---
Empirical #1	5.14	K = 3.87 p1 = 1.00 p2 = 0.29 p3 = - 0.09	0.9704 0.9670	P +/- 0.4713	P +/- 0.0846
Empirical #2	5.27	K = 2.10 p1 = 0.88 p2 = 2.67	0.9677 0.9654	P +/- 0.5080	P +/- 0.0912
Empirical #3	5.78	K = 2.17 p1 = 0.74 p2 = 0.30	0.9656 0.9628	P +/- 0.5220	P +/- 0.0938

NOTES:
P = Burst Pressure, and R = Correlation Coefficient
1.,2. Prediction Interval (PI) for Single Response, and Mean Response, respectively
Refer to Appendix VII.D for a description of the models and data used

II. Uncoated 1073B/PET/PE Laminate – Tolas:

Table 21. Validation Results for Burst Pressure Prediction Models
Tolas (1073B/PET/PE Laminate) Pouches
Using Peak Force Values

Model	Average (%) Error	Regression Coefficients	R R_{adj}	PI – Single Response[1] (lbs/in^2)	PI – Mean Response[2] (lbs/in^2)
Theoretical #1	53.49	---	---	---	---
Theoretical #2	60.04	---	---	---	---
Empirical #1	3.33	K = 7.29 p1 = 1.57 p2 = 0.89 p3 = - 0.11	0.9880 0.9834	P +/- 0.3426	P +/- 0.0950
Empirical #2	4.18	K = 1.12 p1 = 0.92 p2 = 5.37	0.9830 0.9793	P +/- 0.4584	P +/- 0.1271
Empirical #3	3.32	K = 1.54 p1 = 0.68 p2 = 0.17	0.9880 0.9854	P +/- 0.3732	P +/- 0.1035

Using Average Force Values

Model	Average (%) Error	Regression Coefficients	R R_{adj}	PI – Single Response[1] (lbs/in^2)	PI – Mean Response[2] (lbs/in^2)
Theoretical #1	12.96	---	---	---	---
Theoretical #2	13.40	---	---	---	---
Empirical #1	3.33	K = 20.40 p1 = 1.78 p2 = 1.10 p3 = - 0.13	0.9880 0.9834	P +/- 0.3426	P +/- 0.0950
Empirical #2	4.33	K = 1.52 p1 = 0.95 p2 = 5.99	0.9815 0.9772	P +/- 0.4806	P +/- 0.1333
Empirical #3	3.25	K = 1.97 p1 = 0.68 p2 = 0.19	0.9879 0.9854	P +/- 0.3732	P +/- 0.1035

NOTES:
P = Burst Pressure, and R = Correlation Coefficient
1.,2. Prediction Interval (PI) for Single Response, and Mean Response, respectively
Refer to Appendix VII.D for a description of the models and data used

III. Uncoated 1059B/Polyester/Poly Laminate – Rexam:

Table 22. Validation Results for Burst Pressure Prediction Models Rexam (1059B/Polyester Poly Laminate) Pouches Using Peak Force Values

Model	Average (%) Error	Regression Coefficients	R R_{adj}	PI – Single Response[1] (lbs/in^2)	PI – Mean Response[2] (lbs/in^2)
Theoretical #1	13.70	---	---	---	---
Theoretical #2	18.43	---	---	---	---
Empirical #1	3.44	K = 15.45 p1 = 1.21 p2 = 2.50 p3 = - 2.01	0.9887 0.9844	P +/- 0.3675	P +/- 0.1019
Empirical #2	3.82	K = 1.82 p1 = 0.84 p2 = 1.68	0.9866 0.9834	P +/- 0.4425	P +/- 0.1227
Empirical #3	3.59	K = 1.25 p1 = 0.77 p2 = 1.12	0.9882 0.9854	P +/- 0.4078	P +/- 0.1131

Using Average Force Values

Model	Average (%) Error	Regression Coefficients	R R_{adj}	PI – Single Response[1] (lbs/in^2)	PI – Mean Response[2] (lbs/in^2)
Theoretical #1	25.90	---	---	---	---
Theoretical #2	22.60	---	---	---	---
Empirical #1	4.08	K = 20.89 p1 = 1.14 p2 = 2.37 p3 = - 1.94	0.9887 0.9844	P +/- 0.3675	P +/- 0.1019
Empirical #2	3.76	K = 2.69 p1 = 0.82 p2 = 1.10	0.9872 0.9844	P +/- 0.4303	P +/- 0.1193
Empirical #3	3.59	K = 1.98 p1 = 0.77 p2 = 0.82	0.9882 0.9854	P +/- 0.4078	P +/- 0.1131

NOTES:

P = Burst Pressure, and R = Correlation Coefficient

1.,2. Prediction Interval (PI) for Single Response, and Mean Response, respectively

Refer to Appendix VII.D for a description of the models and data used

The data was used to construct bar charts so a visual comparison between the actual burst values at three different flow rates (1, 5 and 9), and the predicted values from the two theoretical and three empirical models could be made (Figures 15 to 20).

It can be seen that, in most cases, the bars representing the empirical models (bars with horizontal stripes) are more similar in height to the bars representing the actual values (bars with inclined stripes) than the bars representing the theoretical models (solid bars). Since there is more agreement between actual and empirical model results than between actual and theoretical model results, it is logical to observe lower percent errors for the empirical models. Second, when comparing Figures 15 with 16 and Figures 17 with 18, for 1073B Tyvek/plastic pouches, it can be seen that the values for the theoretical models (solid bars) are significantly lower when using average force than when using peak force values. That agrees with the finding of lower average percent errors obtained when using average force than when using peak force in theoretical models for 1073B Tyvek/Plastic pouches. Third, it was observed that there is a tendency of the theoretical models to overestimate the actual burst pressure when peak force values are used. The overestimation increases at smaller gaps. Figures 15, 17 and 19 show results using peak values. In addition, a tendency of the theoretical models to underestimate the actual values when average force values are used was observed. The underestimation increases at bigger gaps. Figures 16, 18 and 20 show results using average values.

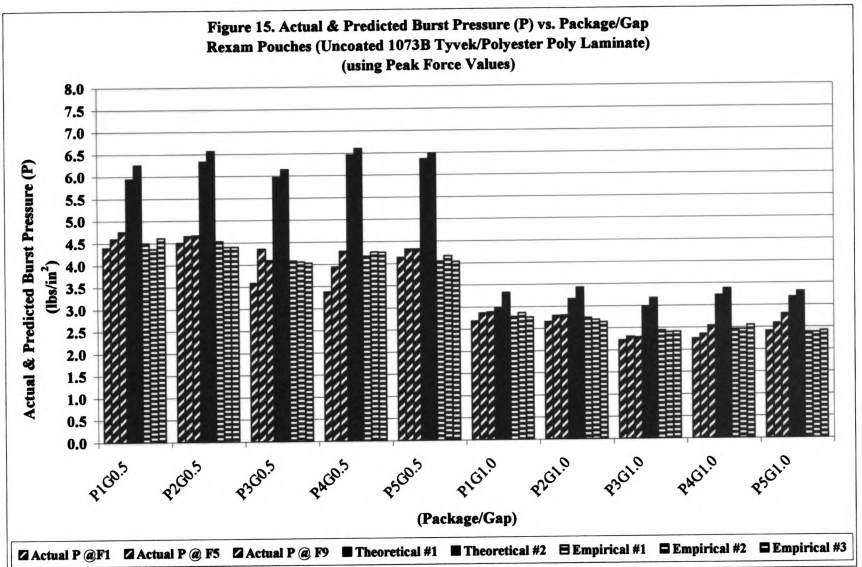


Figure 15. Actual & Predicted Burst Pressure (P) vs. Package/Gap
Rexam Pouches (Uncoated 1073B Tyvek/Polyester Poly Laminate)
(using Peak Force Values)
Actual & Predicted Burst Pressure (P) (lbs/in²)
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
P1G0.5
P2G0.5
P3G0.5
P4G0.5
P5G0.5
P1G1.0
P2G1.0
P3G1.0
P4G1.0
P5G1.0
(Package/Gap)
Actual P @F1
Actual P @ F5
Actual P @ F9
Theoretical #1
Theoretical #2
Empirical #1
Empirical #2
Empirical #3

Figure 16. Actual & Predicted Burst Pressure (P) vs. Package/Gap
Rexam Pouches (Uncoated 1073B Tyvek/Polyester Poly Laminate)
(using Average Force Values)
Actual & Predicted Burst Pressure (P)
(lbs/in²)
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
P1G0.5
P2G0.5
P3G0.5
P4G0.5
P5G0.5
P1G1.0
P2G1.0
P3G1.0
P4G1.0
P5G1.0
(Package/Gap)
Actual P @ F1
Actual P @ F5
Actual P @ F9
Theoretical #1
Theoretical #2
Empirical #1
Empirical #2
Empirical #3

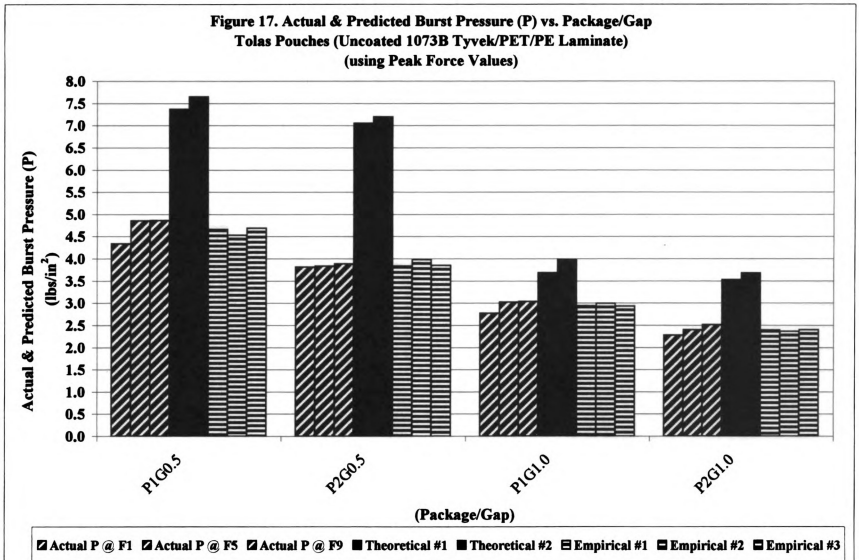


Figure 17. Actual & Predicted Burst Pressure (P) vs. Package/Gap
Tolas Pouches (Uncoated 1073B Tyvek/PET/PE Laminate)
(using Peak Force Values)
Actual & Predicted Burst Pressure (P) (lbs/in²)
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
P1G0.5
P2G0.5
P1G1.0
P2G1.0
(Package/Gap)
Actual P @ F1
Actual P @ F5
Actual P @ F9
Theoretical #1
Theoretical #2
Empirical #1
Empirical #2
Empirical #3

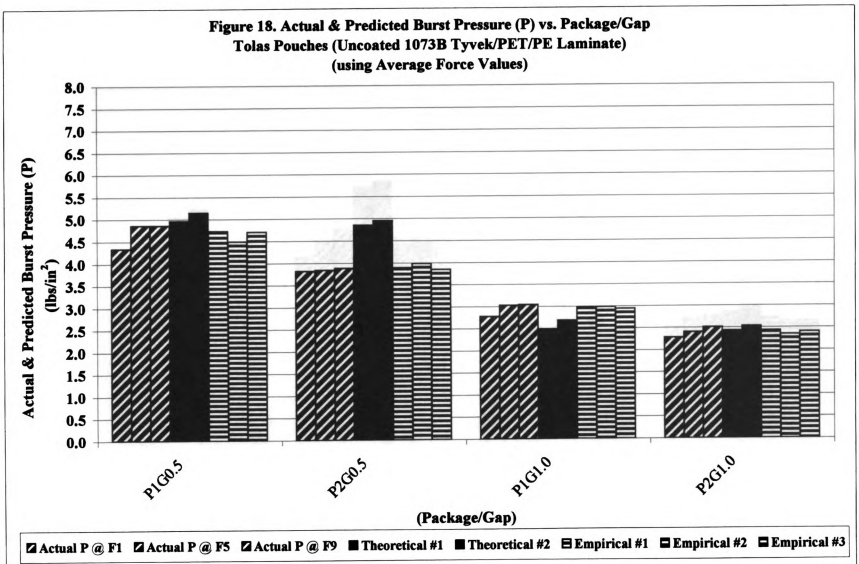
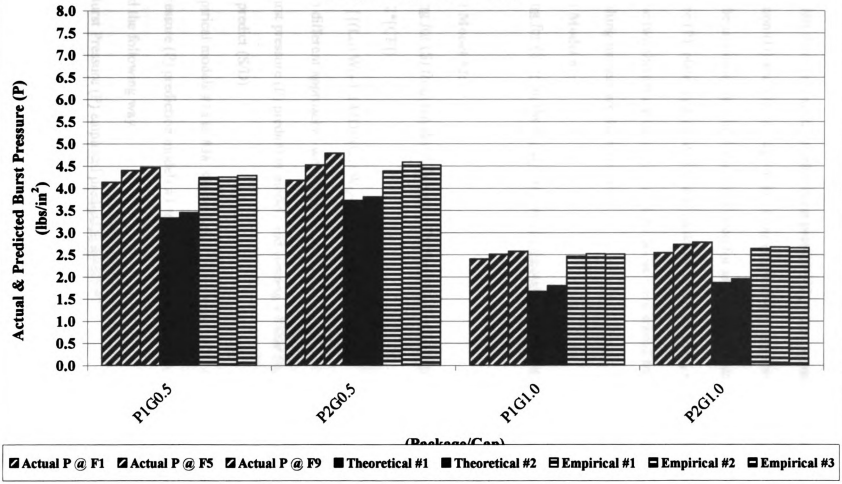


Figure 18. Actual & Predicted Burst Pressure (P) vs. Package/Gap
Tolas Pouches (Uncoated 1073B Tyvek/PET/PE Laminate)
(using Average Force Values)
Actual & Predicted Burst Pressure (P) (lbs/in²)
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
P1G0.5
P2G0.5
P1G1.0
P2G1.0
(Package/Gap)
Actual P @ F1
Actual P @ F5
Actual P @ F9
Theoretical #1
Theoretical #2
Empirical #1
Empirical #2
Empirical #3

Figure 19. Actual & Predicted Burst Pressure (P) vs. Package/Gap
Rexam Pouches (Uncoated 1059B Tyvek/Polyester Poly Laminate)
(using Peak Force Values)
Actual & Predicted Burst Pressure (P)
(lbs/in²)
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
P1G0.5
P2G0.5
P1G1.0
P2G1.0
(Package/Gap)
Actual P @ F1
Actual P @ F5
Actual P @ F9
Theoretical #1
Theoretical #2
Empirical #1
Empirical #2
Empirical #3

Figure 20. Actual & Predicted Burst Pressure (P) vs. Package/Gap Rexam Pouches (Uncoated 1059B Tyvek/Polyester Poly Laminate) (using Average Force Values)



C.2 Predicting Seal Strength

The models discussed so far predict burst pressure (P) when the seal strength (S), the plate separation (D) and the package dimensions (L_O and W_O) are known. However, there might be situations in which there is a need for predicting seal strength (S) from burst pressure (P), plate separation (D), and package dimensions (L_O and W_O). In order to do that, the two theoretical models discussed above were solved for seal strength (S).

The resulting models are the following:

Theoretical Model #1:

When solving for (S) from the Burst Pressure (P) theoretical prediction model #1:

$S = PD/2$

Theoretical Model #2:

When solving for (S) from the Burst Pressure (P) theoretical prediction model #2:

$S = (PD) / (2*[CF])$

where $CF = [\{(L_O+W_O-1.142D)/(L_O+W_O-2.142D)\}]$

Two different approaches were used for the empirical models: solving for (S) from the burst pressure (P) prediction models and running a linear multiple regression analysis to predict (S/D).

Empirical models #1a to #3a, shown below, were derived by solving for (S) from the burst pressure (P) prediction models #1 to #3, respectively. For example, model #3a was derived the following way:

From Burst Pressure (P) empirical prediction model #3:

$$P = K\,[S/D]^{P1}[L/W]^{P2}$$

$$P^{(1/P1)} = K^{(1/P1)}\,[S/D]^{(P1/P1)}\,[L/W]^{(P2/P1)}$$

$$[P/K]^{(1/P1)} = [S/D]\,[L/W]^{(P2/P1)}$$

$$S = [1/K]^{(1/P1)}\,[D]\,[P]^{(1/P1)}\,[W/L]^{(P2/P1)}$$

The following notations were used for the empirical models derived by solving for (S) from the burst pressure (P) prediction models,:

K_S = Regression coefficient (K) for model that predicts (S)

p_{nS} = Power (for independent variables) for model that predicts (S)

K_P = Regression coefficient (K) for model that predicts (P)

p_{nP} = Power (for independent variables) for model that predicts (P)

where; $K_S = (1/K_P)^{1/P1p}$

$P_{1s} = 1/P_{1P}$

$P_{2s} = P_{2P}/P_{1P}$

$P_{3s} = P_{3P}/P_{1P}$

See models #1a, #2a, #3a, below.

A regression analysis was run so empirical models that predict (S/D), and not (S), were developed. The reason for predicting (S/D) and not (S) is due to the nature of the gathered data. Refer to Appendix VII.E, Table 99. It can be seen from the tabulated data that the seal strength (S) does not change significantly with changes in (P), (D) or (PD). The seal strength for the pouches under study does not change drastically within the same package size and material combination. The sealing parameters for these pouches were controlled during manufacturing to stay within a specific range. This was done because it is industrial practice to maintain the seal strength within a certain range. According to Lorimer, 1997, over time acceptable seal strength has been determined to be in the range of target = 1.0 to 1.5 lbs/in and lower limit 0.50 to 0.8 lbs/inch, depending on the

application. If (S), which would be the dependent variable (Y), does not vary significantly with changes in (P), (D) or (PD), which would be the independent variables, then a multiple linear regression model will not work satisfactorily. When looking at Table 99 in Appendix VII.E, one could see that there are significant changes of (S/D) with changes in (P). That is the reason why the regression model works both ways, predicting (P) from (S/D), and vice versa, predicting (S/D) from (P). Because of the nature of the data collected and the way this experiment was designed, a model that predicts seal strength (S) from burst pressure (P) was performed by using regression to predict (S/D) from (P). Seal strength (S) was then obtained by multiplying by (D). A good way to understand the relationship between these variables is by looking at the sample correlation coefficients. According to Devore, 1995, the sample correlation can be used to see if two variables are related. The sample correlation coefficient was calculated for burst pressure (P) and seal strength (S). The results show low correlation between (S) and (P) and between (S) and (PD) but not between (S/D) and (P). See Appendix VII.E.

The three empirical models for seal strength (S) are shown below:

Empirical Model #1:

a. When solving for (S) from the Burst Pressure (P) empirical prediction model #1:

$$S = K_S\, D/CF\, [P]^{P1s}[(L_O-1.571D)/D]^{P2s}[(W_O-1.571D)/D]^{P3s}$$

b. When using regression analysis to predict (S/D):

$$(S/D) = K[X_1]^{P1}[X_2]^{P2}[X_3]^{P3}$$

where; $X_1 = P/CF$; $CF = [\{(L_O+W_O-1.142D)/(L_O+W_O-2.142D)\}]$

$X_2 = L_c/D$; $L_c = L_O-1.571D$

$X_3 = W_c/D$; $W_c = W_O-1.571D$

Empirical Model #2:

a. When solving for (S) from the Burst Pressure (P) empirical prediction model #2:

$$S = K_S\, D\, [P]^{P1s}[1/CF]^{P2s}$$

b. When using regression analysis to predict (S/D):

$$(S/D) = K[X_1]^{P1}[X_2]^{P2}$$

where; $X_1 = P$

$X_2 = 1/CF$; $CF = [\{(L_O+W_O-1.142D)/(L_O+W_O-2.142D)\}]$

Empirical Model #3:

a. When solving for (S) from the Burst Pressure (P) empirical prediction model #2:

$$S = K_S\, D\, [P]^{P1s}[W/L]^{P2s}$$

b. When using regression analysis to predict (S/D):

$$(S/D) = K[X_1]^{P1}[X_2]^{P2}$$

where; $X_1 = P$

$X_2 = W/L$

The same analysis performed for burst pressure (P) prediction models was performed for seal strength (S) prediction models. The results for the empirical models were analyzed and tabulated for an easier comparison against the theoretical model results (Tables 23 to 25).

It can be seen that the findings are similar to the ones for burst pressure (P) prediction models. First, the empirical models have a lower average percent error than the theoretical ones. Second, lower average percent errors are obtained when using average force in theoretical models for 1073B Tyvek/plastic pouches. Third, the results are slightly better, in terms of correlation coefficient and average percent errors, when using average force values than when using peak force values in the empirical models. This is true for all material combinations. Third, if all material combinations are compared within the same empirical model, (Appendix VII.F), it can be seen that model #3b resulted in similar regression parameters for the three material combinations under study. This model has the advantages of being simple, it has regression parameters that are reasonable in magnitude, and has good correlation coefficient and average percent error results. That makes this model a very attractive one.

A summary of the validation results for the theoretical and empirical models that predicts seal strength (S) is shown below. Summary Tables 23 to 25 and Figures 21 to 26 display these results. The tables show the average percent errors for all models, the parameters derived for models #1a, #2a and #3a, and the regression parameters (K, and p1, p2, ..., pn), correlation coefficients (R), and seal strength (S) prediction intervals models #1b, #2b and #3b.

Appendix VII.F includes the data arranged in the way it was used for this analysis, the regression results for empirical models #1b, #2b, and #3b, and tables with the actual and predicted results for individual observations along with the average percent error for the theoretical and all the empirical models. It should be noticed that models #1b, #2b and #3b provided more accurate results. However, since the improvement in accuracy by running the regression all over again is small, models #1a, #2a and #3a can be used for simplicity without serious loss of accuracy.

I. Uncoated 1073B/Polyester/Poly Laminate – Rexam:

Table 23. Validation Results for Seal Strength Prediction Models
Rexam (1073B/Polyester Poly Laminate) Pouches
Predicting Peak Force Values

Model	Average[3] (%) Error	Coefficients	R R_{adj}	PI – Single Response[1] (lbs/in^2)	PI – Mean Response[2] (lbs/in^2)
Theoretical #1	24.32	---	---	---	---
Theoretical #2	28.18	---	---	---	---
Empirical #1a	5.45	K = 0.41 p1 = 0.99 p2 = 0.23 p3 = - 0.03	---	---	---
Empirical #2a	5.89	K = 0.714 p1 = 1.10 p2 = 3.74	---	---	---
Empirical #3a	7.90	K = 0.56 p1 = 1.36 p2 = 0.51	---	---	---
Empirical #1b	4.83	K = 0.27 p1 = 0.660 p2 = 0.77 p3 = - 0.32	0.9864 0.9849	(S/D)+/-0.2916	(S/D)+/-0.0523
Empirical #2b	5.18	K = 0.83 p1 = 0.99 p2 = 4.25	0.9754 0.9737	(S/D)+/-0.4022	(S/D)+/-0.0722
Empirical #3b	7.16	K = 0.63 p1 = 1.25 p2 = 0.47	0.9589 0.9560	(S/D)+/-0.5152	(S/D)+/-0.0925

NOTES:
Refer to Appendix VII.F for a description of the models and data used
S = Seal Strength, D = Plate Separation or Gap, and R = Correlation Coefficient
1.,2. Prediction Interval (PI) for Single Response, and Mean Response, respectively
3. The percent error for models #1b, #2b, and #3b were calculated by multiplying the result by D and then comparing with the actual seal strength (S)

Table 23. Validation Results for Seal Strength Prediction Models
Rexam (1073B/Polyester Poly Laminate) Pouches - Continuation
Predicting Average Force Values

Model	Average[3] (%) Error	Coefficients	R R_{adj}	PI – Single Response[1] (lbs/in^2)	PI – Mean Response[2] (lbs/in^2)
Theoretical #1	17.63	---	---	---	---
Theoretical #2	12.33	---	---	---	---
Empirical #1a	5.04	K = 0.26 p1 = 1.00 p2 = 0.29 p3 = - 0.09	---	---	---
Empirical #2a	5.88	K = 0.43 p1 = 1.14 p2 = 3.04	---	---	---
Empirical #3a	7.58	K = 0.35 p1 = 1.35 p2 = 0.40	---	---	---
Empirical #1b	4.37	K = 0.18 p1 = 0.71 p2 = 0.749 p3 = - 0.34	0.9872 0.9859	(S/D)+/-0.1791	(S/D)+/-0.0322
Empirical #2b	5.28	K = 0.49 p1 = 1.04 p2 = 3.50	0.9767 0.9752	(S/D)+/-0.2483	(S/D)+/-0.0446
Empirical #3b	6.85	K = 0.39 p1 = 1.25 p2 = 0.38	0.9644 0.9618	(S/D)+/-0.3075	(S/D)+/-0.0552

NOTES:
Refer to Appendix VII.F for a description of the models and data used
S = Seal Strength, D = Plate Separation or Gap, and R = Correlation Coefficient
1.,2. Prediction Interval (PI) for Single Response, and Mean Response, respectively
3. The percent error for models #1b, #2b, and #3b were calculated by multiplying the result by D and then comparing with the actual seal strength (S)

II. Uncoated 1073B/PET/PE Laminate – Tolas:

Table 24. Validation Results for Seal Strength Prediction Models
Tolas (1073B/PET/PE Laminate) Pouches
Predicting Peak Force Values

Model	Average[3] (%) Error	Coefficients	R R_{adj}	PI – Single Response[1] (lbs/in^2)	PI – Mean Response[2] (lbs/in^2)
Theoretical #1	33.51	---	---	---	---
Theoretical #2	36.56	---	---	---	---
Empirical #1a	2.14	K = 0.28 p1 = 0.64 p2 = 0.57 p3 = - 0.07	---	---	---
Empirical #2a	4.55	K = 0.88 p1 = 1.08 p2 = 5.82	---	---	---
Empirical #3a	4.76	K = 0.53 p1 = 1.48 p2 = 0.26	---	---	---
Empirical #1b	1.36	K = 0.15 p1 = 0.17 p2 = 1.05 p3 = - 0.20	0.9992 0.9990	(S/D)+/-0.1048	(S/D)+/-0.0291
Empirical #2b	4.45	K = 0.95 p1 = 1.04 p2 = 6.05	0.9894 0.9869	(S/D)+/-0.3671	(S/D)+/-0.1018
Empirical #3b	4.75	K = 0.55 p1 = 1.44 p2 = 0.25	0.9858 0.9829	(S/D)+/-0.4059	(S/D)+/-0.1126

NOTES:
Refer to Appendix VII.F for a description of the models and data used
S = Seal Strength, D = Plate Separation or Gap, and R = Correlation Coefficient
1.,2. Prediction Interval (PI) for Single Response, and Mean Response, respectively
3. The percent error for models #1b, #2b, and #3b were calculated by multiplying the result by D and then comparing with the actual seal strength (S)

Table 24. Validation Results for Seal Strength Prediction Models
Tolas (1073B/PET/PE Laminate) Pouches - Continuation
Predicting Average Force Values

Model	Average[3] (%) Error	Coefficients	R R_{adj}	PI – Single Response[1] (lbs/in^2)	PI – Mean Response[2] (lbs/in^2)
Theoretical #1	12.19	---	---	---	---
Theoretical #2	11.63	---	---	---	---
Empirical #1a	1.89	K = 0.18 p1 = 0.56 p2 = 0.62 p3 = - 0.07	---	---	---
Empirical #2a	4.62	K = 0.64 p1 = 1.05 p2 = 6.31	---	---	---
Empirical #3a	4.81	K = 0.37 p1 = 1.48 p2 = 0.28	---	---	---
Empirical #1b	1.10	K = 0.11 p1 = 0.16 p2 = 1.04 p3 = - 0.19	0.9993 0.9990	(S/D)+/-0.0649	(S/D)+/-0.0180
Empirical #2b	4.49	K = 0.69 p1 = 1.01 p2 = 6.55	0.9892 0.9869	(S/D)+/-0.2533	(S/D)+/-0.0703
Empirical #3b	4.73	K = 0.38 p1 = 1.44 p2 = 0.27	0.9858 0.9823	(S/D)+/-0.2740	(S/D)+/-0.0760

NOTES:
Refer to Appendix VII.F for a description of the models and data used
S = Seal Strength, D = Plate Separation or Gap, and R = Correlation Coefficient
1.,2. Prediction Interval (PI) for Single Response, and Mean Response, respectively
3. The percent error for models #1b, #2b, and #3b were calculated by multiplying the result by D and then comparing with the actual seal strength (S)

III. Uncoated 1059B/Polyester/Poly Laminate – Rexam:

Table 25. Validation Results for Seal Strength Prediction Models
Rexam (1059B/Polyester Poly Laminate) Pouches
Predicting Peak Force Values

Model	Average[3] (%) Error	Coefficients	R R_{adj}	PI – Single Response[1] (lbs/in^2)	PI – Mean Response[2] (lbs/in^2)
Theoretical #1	11.29	---	---	---	---
Theoretical #2	15.01	---	---	---	---
Empirical #1a	3.66	K = 0.10 p1 = 0.83 p2 = 2.10 p3 = - 1.69	---	---	---
Empirical #2a	4.49	K = 0.49 p1 = 1.19 p2 = 2.0	---	---	---
Empirical #3a	4.64	K = 0.75 p1 = 1.30 p2 = 1.45	---	---	---
Empirical #1b	2.26	K = 0.03 p1 = 0.52 p2 = 3.90 p3 = - 3.17	0.9971 0.9960	(S/D)+/-0.1647	(S/D)+/-0.0457
Empirical #2b	4.30	K = 0.61 p1 = 1.07 p2 = 3.43	0.9899 0.9879	(S/D)+/-0.2866	(S/D)+/-0.0795
Empirical #3b	4.63	K = 0.79 p1 = 1.27 p2 = 1.50	0.9885 0.9859	(S/D)+/-0.3151	(S/D)+/-0.0874

NOTES:
Refer to Appendix VII.F for a description of the models and data used
S = Seal Strength, D = Plate Separation or Gap, and R = Correlation Coefficient
1.,2. Prediction Interval (PI) for Single Response, and Mean Response, respectively
3. The percent error for models #1b, #2b, and #3b were calculated by multiplying the result by D and then comparing with the actual seal strength (S)

Table 25. Validation Results for Seal Strength Prediction Models
Rexam (1059B/Polyester Poly Laminate) Pouches - Continuation
Predicting Average Force Values

Model	Average[3] (%) Error	Coefficients	R R_{adj}	PI – Single Response[1] (lbs/in^2)	PI – Mean Response[2] (lbs/in^2)
Theoretical #1	36.15	---	---	---	---
Theoretical #2	30.01	---	---	---	---
Empirical #1a	3.67	K = 0.07 p1 = 0.88 p2 = 2.08 p3 = - 1.70	---	---	---
Empirical #2a	4.53	K = 0.30 p1 = 1.22 p2 = 1.35	---	---	---
Empirical #3a	4.63	K = 0.41 p1 = 1.30 p2 = 1.07	---	---	---
Empirical #1b	2.36	K = 0.02 p1 = 0.55 p2 = 4.01 p3 = - 3.29	0.9967 0.9955	(S/D)+/-0.1135	(S/D)+/-0.0315
Empirical #2b	4.27	K = 0.37 p1 = 1.10 p2 = 2.75	0.9897 0.9874	(S/D)+/-0.1883	(S/D)+/-0.0522
Empirical #3b	4.66	K = 0.44 p1 = 1.27 p2 = 1.11	0.9884 0.9859	(S/D)+/-0.2051	(S/D)+/-0.0569

NOTES:
Refer to Appendix VII.F for a description of the models and data used
S = Seal Strength, D = Plate Separation or Gap, and R = Correlation Coefficient
1.,2. Prediction Interval (PI) for Single Response, and Mean Response, respectively
3. The percent error for models #1b, #2b, and #3b were calculated by multiplying the result by D and then comparing with the actual seal strength (S)

The data were used to construct bar charts in order to perform a visual comparison between the actual seal strength and the ones predicted with the theoretical and empirical models. The bar charts, Figures 21 to 26, were made for models predicting peak force and average force.

In the majority of the cases, there is more similarity between actual values and the ones predicted by the empirical models than between actual values and the ones predicted by the theoretical models. For that reason, that the empirical models had a lower percent error than the theoretical ones. The theoretical models tend to underestimate actual peak force values and overestimate actual average force values, for all material combinations.

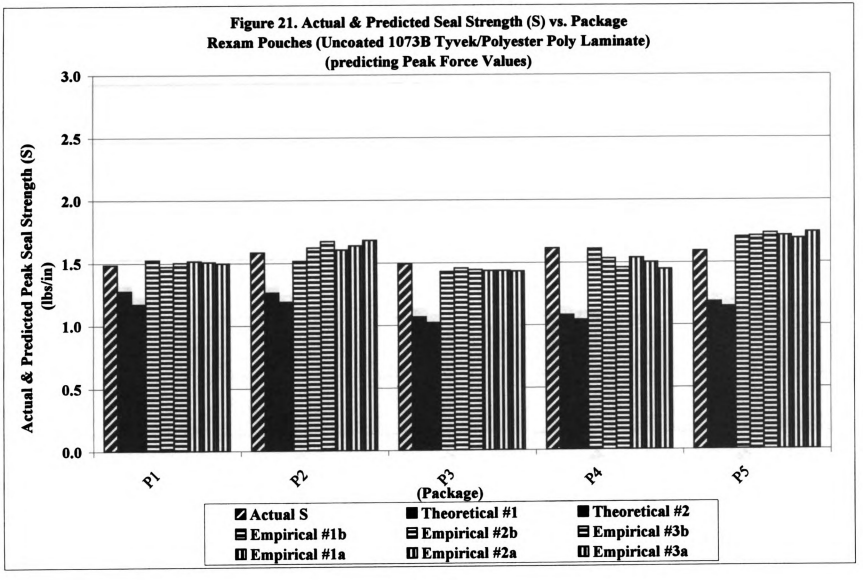


Figure 21. Actual & Predicted Seal Strength (S) vs. Package
Rexam Pouches (Uncoated 1073B Tyvek/Polyester Poly Laminate)
(predicting Peak Force Values)
Actual & Predicted Peak Seal Strength (S) (lbs/in)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
P1
P2
P3
P4
P5
(Package)
Actual S
Theoretical #1
Theoretical #2
Empirical #1b
Empirical #2b
Empirical #3b
Empirical #1a
Empirical #2a
Empirical #3a

Figure 21. Actual & Predicted Seal Strength (S) vs. Package
Rexam Pouches (Uncoated 1073B Tyvek/Polyester Poly Laminate)
(predicting Peak Force Values)
Actual & Predicted Peak Seal Strength (S)
(lbs/in)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
P1
P2
P3
P4
P5
(Package)
Actual S
Empirical #1b
Empirical #1a
Theoretical #1
Empirical #2b
Empirical #2a
Theoretical #2
Empirical #3b
Empirical #3a

Figure 22. Actual & Predicted Seal Strength (S) vs. Package
Rexam Pouches (Uncoated 1073B Tyvek/Polyester Poly Laminate)
(predicting Average Force Values)

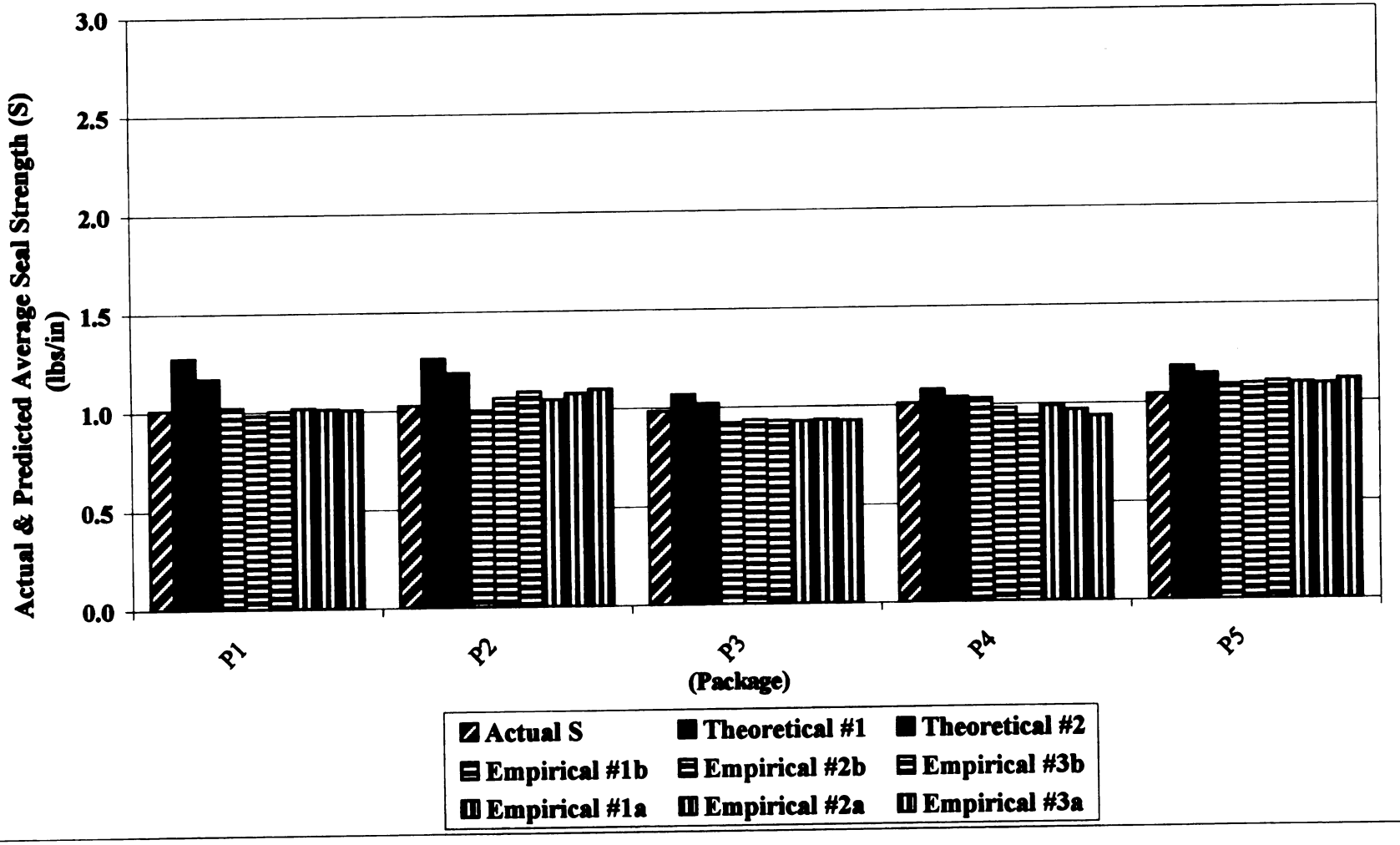


Figure 23. Actual & Predicted Seal Strength (S) vs. Package Tolas Pouches (Uncoated 1073B Tyvek/PET/PE Laminate) (predicting Peak Force Values)

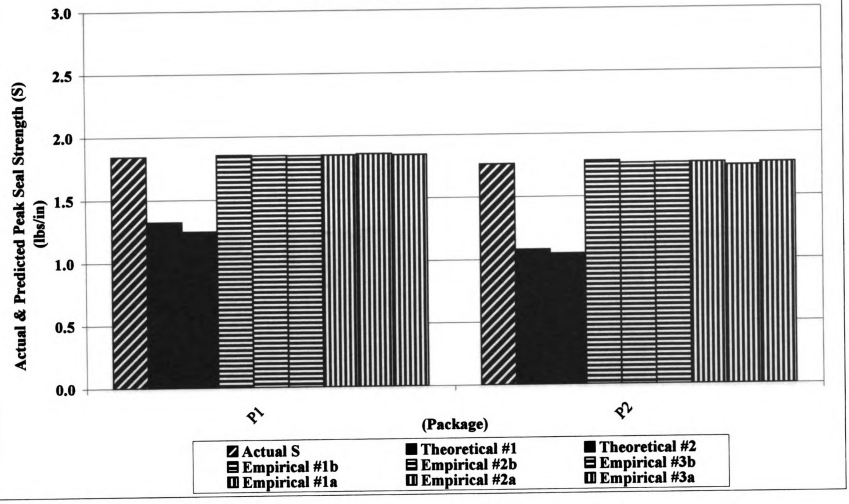


Figure 24. Actual & Predicted Seal Strength (S) vs. Package
Tolas Pouches (Uncoated 1073B Tyvek/PET/PE Laminate)
(predicting Average Force Values)
Actual & Predicted Avg Seal Strength (S)
(lbs/in)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
(Package)
Actual S
Empirical #1b
Empirical #1a
Theoretical #1
Empirical #2b
Empirical #2a
Theoretical #2
Empirical #3b
Empirical #3a

Figure 25. Actual & Predicted Seal Strength (S) vs. Package
Rexam Pouches (Uncoated 1059B Tyvek/Polyester /Poly Laminate)
(predicting Peak Force Values)
Actual & Predicted Peak Seal Strength (S)
(lbs/in)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
(Package)
Actual S
Empirical #1b
Empirical #1a
Theoretical #1
Empirical #2b
Empirical #2a
Theoretical #2
Empirical #3b
Empirical #3a

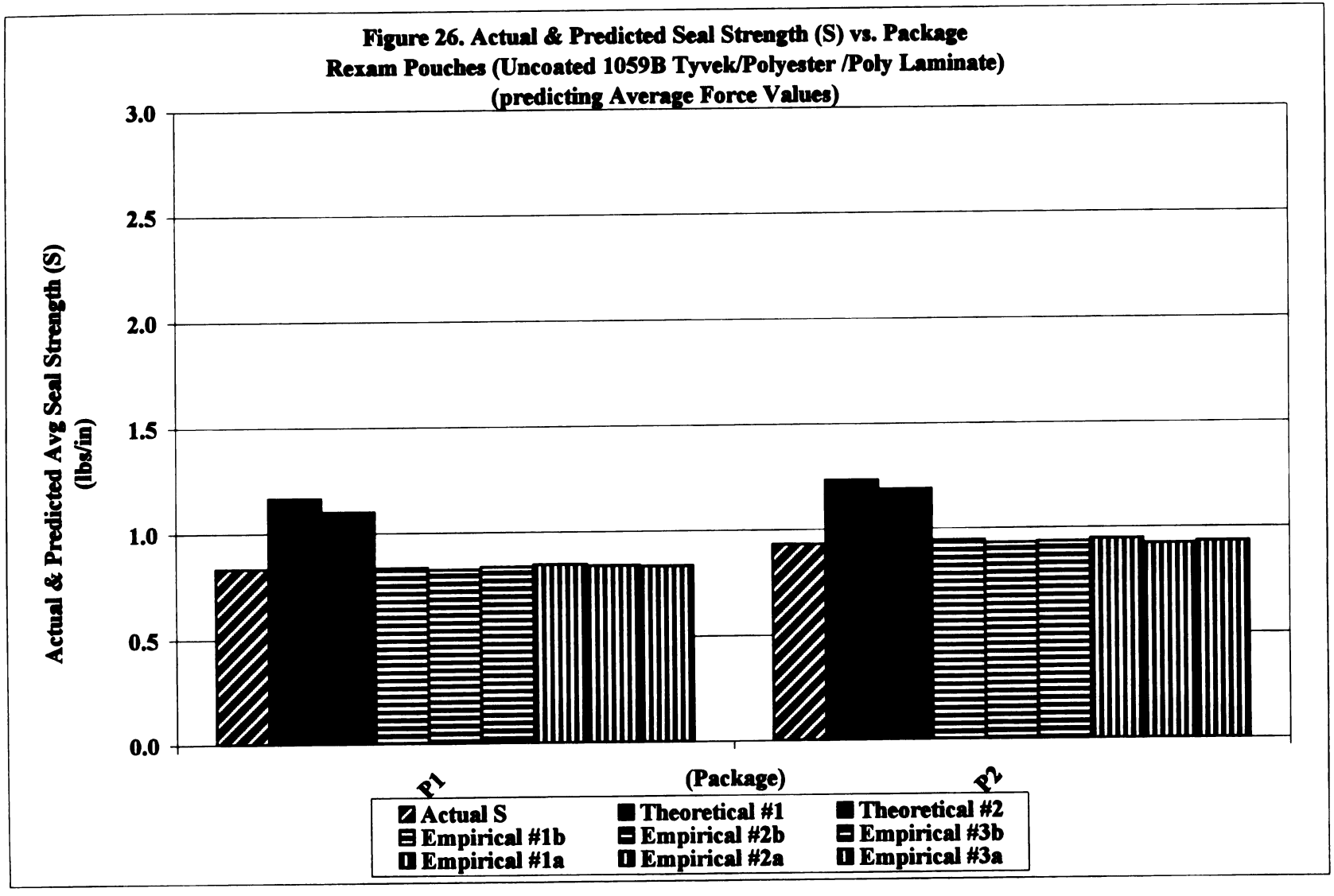


Figure 26. Actual & Predicted Seal Strength (S) vs. Package
Rexam Pouches (Uncoated 1059B Tyvek/Polyester /Poly Laminate)
(predicting Average Force Values)
Actual & Predicted Avg Seal Strength (S)
(lbs/in)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
P1
(Package)
P2
Actual S
Theoretical #1
Theoretical #2
Empirical #1b
Empirical #2b
Empirical #3b
Empirical #1a
Empirical #2a
Empirical #3a

Regression analyses for all the burst pressure (P) and seal strength (S) prediction models shown in section C.1 and C.2 were run using burst test data obtained at flow 5 for Rexam 1073 Tyvek/plastic pouches. There was not enough data to do this for the other two materials under study. The results showed correlation coefficients (R) of 0.97 and higher. The average percent errors ranged from 2.5 to 4% and the regression coefficients obtained were similar to the ones obtained when using burst test data from all flows. These results are tabulated in Appendix VII.G.

Part D. Location of Burst Failure Vs. Minimum Seal Strength

As mentioned previously, the minimum seal strength values were used in the prediction models to describe quantitatively the relationship between peel and burst test results. This value is the lowest peel value obtained out of the four locations tested in a pouch. In other words, it is the weakest of the tested sample strips cut from the seal. The location which that weakest sample strip was taken from was compared with the location of failure of the pouches that were burst tested. The purpose of doing this is to see how much agreement there was between the two tests in terms of the weakest point in the pouches tested.

For this comparison, the percentage of pouches with failure in the chevron seal found in the burst test was compared with the percentage of pouches with minimum seal strength found in the chevron seal in the peel test. The percentage of pouches with minimum seal strength found in the chevron seal during a peel tended to be less than the percentage of pouches with burst test failures in the chevron seal. Refer to Table 26, shown below. It is necessary to consider that both tests are destructive and that different pouches are being compared. Inconsistencies in the sealing die heat distribution could cause differences in seal strength within a pouch and between pouches of the same lot. Additionally, it is important to remember that sample strips cut from the pouch seal, and not the entire package, are tested in the peel test. The weakest point in the pouch might not be within the samples tested. These reasons explain the differences in results. Appendix VIII shows location of failure and minimum seal strength location for all packages tested.

Table 26. Percentage of Location of Failure and Minimum Seal Strength Location in the Chevron Seal

Rexam (1073B Tyvek/Polyester/Poly Laminate) Pouches

	Percentage of Location of Failure found in the Chevron Seal during a BURST TEST						Percentage of Minimum Seal Strength found in the Chevron Seal during a PEEL TEST	
Package Size	Gap 0.5" Flow 1	Gap 0.5" Flow 5	Gap 0.5" Flow 9	Gap 1.0" Flow 1	Gap 1.0" Flow 5	Gap 1.0" Flow 9	Grip Separation 1.0" Crosshead Speed 12 Using PEAK FORCE	Grip Separation 1.0" Crosshead Speed 12 Using AVG Force
(3.25" x 7.25")	80	70	70	40	60	40	80	80
(5.25" x 9.125")	60	50	70	80	60	70	30	20
(7.25" x 11.125")	50	60	40	70	60	80	20	20
(9.25" x 14.125")	100	100	100	100	100	100	60	40
(11.25" x 15.25")	70	80	80	60	100	60	40	20

Tolas (1073B Tyvek/PET/PE Laminate) Pouches

(3" x 11.375")	100	100	100	100	100	100	70	80
(10.625" x 15")	100	100	100	100	100	100	50	60

Rexam (1059B Tyvek/Polyester Poly Laminate) Pouches

(5.75" x 9.125")	30	40	20	40	20	10	40	30
(9.25" x 14.125")	70	70	80	30	10	10	50	30

NOTE: Refer to Appendix VIII for location of failure and minimum seal strength for all packages tested

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

Empirical models explained the relationship between peel and burst tests results better than the theoretical ones. The theoretical models are based on physical principles using force diagram analysis. When using experimental data for validation of the theoretical models, it was found that there was a tendency for these models to overestimate the actual burst pressure when peak force values were used and to underestimate it when average force values were used. For that reason, empirical models were developed by using multiple regression techniques to fit experimental data to a power relationship.

The reasons for the disagreement between the actual values and the ones predicted by the theoretical models are believed to be the following:

1. The peel test is a uni-axial test in which deformation is evenly applied to a 1-inch wide strip of seal. The burst test is a multi-axial test in which force is applied by internal air pressure. When the package is pressurized, the seal perimeter does not take the same load at all points because it deforms differently around that perimeter. Areas that have wrinkles are loose and slack, so they do not take any force. Only the stressed part of the perimeter takes the force [Feliu-Baez et al., 2001].
2. The theoretical models involve the assumption that the material does not stretch much around its perimeter and that the seal area assumes a circular shape. The amount of stretch that the package experiences when pressurized and the actual

shape its seal area assumes are both variable and unpredictable. For that reason it is not accounted for in the model.

3. Sharp edges, corners and angles on the package seal can act as stress concentrators during the burst test and affect the results [Feliu-Baez et al., 2001].
4. Since both tests are destructive, the correlation is made between the average burst pressure of a group of pouches with the average peel strength of a different group of pouches. For that reason, any variation in the seal strength around the seal perimeter of a pouch or significant seal strength variations between pouches makes the correlation weaker. In addition, the strip cuts for the peel test may not represent the point at which the pouch would break in a burst test. Such a strip does not necessarily represent either a stress concentrating deformation or the weakest point in the seal.

The characteristics of the peel and burst tests, listed above, as well as the characteristics of the package design and behavior under deformation are not included in the theoretical models presented in this work because of the great difficulty in controlling and measuring them.

Three empirical models were presented in this project. Empirical model #1 is the closest to physical theory. It provides more accurate results than the two other models. However, it is a complex model. Empirical model #3 is a simple model. The first term [S/D] comes from the theoretical development and the second term [L/W], aspect ratio, accounts for the package size. Besides its simplicity, model #3 provides good accuracy, close to that of Model #1. Additionally, the resulting regression coefficients were similar for the three material combinations studied, which indicates that the model works well for

the different types of Tyvek /plastic pouches. Model#2 provides good results. It is the intermediate point between the accuracy provided by Model #1and the simplicity provided by Model #3.

The validation results for the empirical models are good. The correlation coefficients (R) were all higher than 0.96 and the average percent errors between actual and predicted values ranged from 1% to 7% for predictions of burst test value from seal strength and vice versa. The model to use, out of the three presented, will be the user's choice. Readers should note that these results are applicable for the material combinations tested within the range of package sizes tested. However, because the independent variables for the empirical models are based on theoretical principles, and the models were run for three different Tyvek/plastic types of pouches, the model should work for other types of Tyvek/plastic combinations. A change in the regression parameters when the materials under study are changed should be expected.

The results obtained when using average values tended to be slightly better than the ones obtained when using peak values. This was expected because the average peel force results were less variable than the peak peel force results. Refer to Tables 47, 49, 51, 53, 55, 57, 59, 61 and 63 in Appendix V.

The contribution that this project will make to industry is a procedure on how to perform an experiment so the regression coefficients for any particular material combination can be obtained.

The recommended procedure is as follows:

1. Choose at least three pouch sizes of the material combination of interest. The pouches should have the same material combination, type of sealant and seal configuration (chevron vs. no chevron). Sizes should be chosen so a wide range of packages sizes for that particular material combination is covered. The validity of the model is limited to the range of values covered in the experiment.
2. Condition samples at ASTM standard test conditions (73 +/- 4° F or 23 +/- 2 ° C and 50 +/- 5% relative humidity).
3. Burst test 10 packages at each flow index/plate separation combination according to ASTM F1140 and ASTM F2054. Choose at least 2 plate separations. The use of three flow index values that cover the entire range (lowest, highest and a mid-value) is recommended for more accuracy. Note that three flow index values at two plate separation will require 60 pouches for the burst test. If it is found that the flow index does not have a significant effect on the burst test results of the packages under study, a mid-range flow index is recommended. In the case in which only the mid-range flow index is tested at two plate separations, only 20 pouches will be required.
4. Peel test 10 packages according to ASTM F88.
    a.) If pouches similar to the ones tested in this project are used, a crosshead speed of 12 ipm and a grip separation of 1.0" are recommended. A crosshead speed of 12 ipm requires a little less time to complete a test. than a crosshead speed of 10 ipm. The crosshead speed and grip separation in ASTM F88 were shown not to have a significant effect on peel test results.

b.) The sample strips should be cut from regions where the package tended to break in the burst test.

c.) The use of average values is recommended due to the fact that they provided more accurate results than using peak values. If the user does not have a way to measure average values, peak values can be used because the results obtained using peak values are also good.

5. Run a linear multiple regression analysis to obtain regression parameters. Empirical models #1, #2, #3 all work well for the three different kinds of Tyvek/Plastic pouches. Any of these models is recommended for this type of material combination. If the user needs more accuracy, model #1 is recommended. However, if some accuracy can be sacrificed for simplicity then model #3 is the one of choice. The user can also choose whether the regression technique will be used to predict burst pressure or to predict seal strength as it can be done both ways.

Once the model is developed for a particular group of pouches made out of the same materials, it should be revised every time there is a change in the sealing process, or in the materials and sealants used.

Since the length, L and width, W dimensions of the package are part of the model, it is important to define the way L is used for the data analysis. L refers to the distance from the tip of the chevron to the open side of the pouch (see Figure 27).

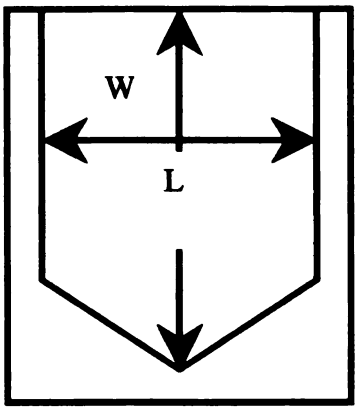


Figure 27. Length and Width Dimensions of a Chevron Seal Pouch

The total number of pouches that need to be tested if only the mid-range flow index value is used is 90, or 30 per package size (20 for the burst test and 10 for the peel test). If three flow index values are used a total of 210, or 70 per package size, need to be tested (60 for the burst test and 10 for the peel test). It will be the user's choice what to do. The more pouches tested, the more accuracy is obtained in the results.

This proposed methodology can bring a number of benefits to pouch users and manufacturers. An empirical model that describes the relationship between peel and burst test results with good accuracy can be developed by testing at least ninety pouches (60 burst tests and 30 peel tests) of a particular material combination. The time and number of samples required for the development of the model is reasonable. The developed model could be used to predict the results of one test in terms of the other. The use of the models can bring cost benefits in terms of reduced labor testing time and material usage.

RECOMMENDATIONS:

Even though some of the goals in terms of defining the relationship between peel and burst tests were accomplished in this project, there is still some more research that needs to be done. Some of the recommendations for future research are:

1. Test the validity of the empirical models developed in this project for use with other types of materials
    a. Coated Tyvek/Plastic Pouches
    b. 2FS Tyvek/plastic Pouches
    c. Paper/Plastic Pouches
    d. Paper/Paper Pouches
    e. Plastic/Plastic Pouches
2. Perform the proposed methodology with a burst tester different than the one used.
3. Investigate whether finite element analysis can be used to estimate the deformation of the package under pressure.

APPENDIX I

GLOSSARY

GLOSSARY

ASTM - American Society for Testing and Materials (ASTM) is the largest technical standard writing organization in the United States. ASTM is made up of technical committees, which in turn are divided in subcommittees. These committees are a group of people with different backgrounds: educators, engineers, consumers, as well as people from government and industry. The committees develop, publish and regularly update standards in all fields. Voting interests are always balanced between users and suppliers so that neither group can dictate policy in standards approval. Committee D-10 on packaging is the major committee responsible for packaging standards. Committee F-2 is responsible for the medical packaging standards

Average Peel Force - is calculated by dividing the area under the force deformation curve (energy) by the total extension of the seal. Some researchers consider it a better indicator of seal strength than peak peel force.

Burst Test - A method of testing the package's seal strength and structural integrity by filling it with air until it breaks. The pressure required to burst the package gives an indication of the seal strength.

Closed Package Fixture - A fixture that is used with the burst tester to test sealed pouches or lidded trays. See ASTM F 1140

Crosshead Speed - The rate at which the sample specimen is pulled apart

Energy - Area under the force-deformation curve obtained in a peel test

Flow Index - The speed at which the air flows from the burst tester into the package. Factors affecting the flow rate are: 1) air source pressure, 2) supply tubing diameter, orifice diameter, c) package size and porosity

Gap –the distance between the top and bottom plates in the restraining fixture used in a restrained burst test. It is also called "Plate Separation".

Grip Separation - Original distance between the lower and upper jaw, in the tensile tester, that contains the sample.

Minimum of Average Peel Force - The lowest average peel force value obtained out of the four locations tested in a pouch. This is the value used for the correlation analysis. Refer to Figure 14 for pouch locations.

Minimum of Peak Peel Force - The lowest peak peel force value obtained out of the four locations tested in a pouch. This is the value used for the correlation analysis. Refer to Figure 14 for pouch locations.

Open Package Fixture - A fixture that is used with the burst tester to test open-ended pouches. See ASTM F 1140.

Peak Peel Force - The maximum force during peeling. It has been used through the years as the way of quantifying seal strength.

Peel Test - A 1-inch wide sample strip cut from the seal is gripped between jaws (one movable and one fixed) and pulled apart at a controlled rate. The force required to separate two sealed surfaces gives an indication of the seal strength

Peelable Seal - A seal that is easy to open and that at the same time provides sterile delivery of the product. The peelable characteristic can be achieved by design of adhesives or sealants.

Plate Separation –the distance between the top and bottom plates in the restraining fixture used in a restrained burst test. It is also called "Gap".

Restrained Burst Test - A burst test in which the package is placed within a restraining fixture while being pressurized. It is described in ASTM F 2054.

Supported Peel Test - A peel test in which the "tail" angle of the sample strip is controlled by the use of backing plates. It is described in ASTM F 88.

Unrestrained Burst Test - A burst test in which the package moves freely while pressurized. The deformation of the pressurized package is not controlled. It is described in ASTM F 1140.

Unsupported Peel Test ("Free tail" test) - A peel test in which the "tail" of the sample is allowed to move freely. It is described in ASTM F-88.

APPENDIX II

LITERATURE REVIEW SUMMARY TABLE

Table 27. Different approaches to describing the relationship between peel and burst tests

Researcher Year	Package and Materials	Peel Test	Burst Test	Formula (Correlation)	Comments
Thomas Wachala **Carleton Technologies** **1991**	Paper/Plastic Pouch For packages with average peel strength of **(1 lb./in)**	Use of peak peeling force "Free-tail" (unsupported) peel test	Unrestrained burst test Open package fixture	**$P = \frac{27.67 \text{ (perimeter)}}{\text{Area}} \times K \text{ factor}$** Where; P = Test Pressure - psi Perimeter = 2 (L + W) - in Area = L x W – in^2 L = Length - in W = Width - in K factor = Correction Factor (see Chapter 1-Literature Review)	• Formula based on force diagram analysis • Burst strength is correlated only to the weakest areas of the pouch seal, not the entire distribution of seal strength values • The formula takes into consideration the package size.
Kit Yam **Rutgers University** **1993**	PET/Al/PP Al = Aluminum MRE pouches	Use of the maximum peak seal strength "Free-tail" (unsupported) peel test Tensile peeling time controlled (gauge length and crosshead speed)	Restrained Burst Test Closed Package Fixture Burst peeling time controlled (plate separation and flow rate)	**S = PR** S = Seal Strength – lb/in P = Burst Pressure - psi R = Half of Plate Separation - in	• Formula based on force diagram analysis. • The validity of the formula is based on the assumption that the peeling times for the peel test and the burst test are the same.

Table 27. Different approaches to describing the relationship between peel and burst tests (Continuation)

Researcher Year	Package and Materials	Peel Test	Burst Test	Formula (Correlation)	Comments
Neil Lorimer **Rexam Medical Packaging** **1997**	Tyvek/Plastic & Paper/Plastic Pouches Peelable pouches of various sizes and different peeling characteristics	Use of peak peeling force "Free-tail" (unsupported) peel test	Restrained Burst Test Open Package Fixture	Multivariate Regression Model Formula not provided	• Burst strength is correlated only to the weakest areas of the pouch seal, not the entire distribution of seal strength values • The formula takes into consideration the package size. • Different predictive models are needed for different peeling characteristics
Rosamari Feliu-Baez **Michigan State University School of Packaging** **1998**	Tyvek/plastic chevron seal pouches	Use of peak peeling force "Free-tail" (unsupported) peel test Tensile peeling time controlled (gauge length and crosshead speed)	Restrained Burst Test Open Package Fixture Burst peeling time controlled (plate separation and flow rate)	$P_{critical} = [(2\ S) / D]$ $P_{critical}$ = Restrained burst pressure – psi **S** = Seal strength – lb/in **D** – Plate separation – in This formula overestimated the actual burst pressure. The overestimation was higher at smaller plate separations	• Formula based on force diagram analysis • Burst strength was correlated with the minimum seal strength of the four locations tested around the seal of a pouch • This formula does not take into consideration package size

Table 27. Different approaches to describing the relationship between peel and burst tests (Continuation)

Researcher Year	Package and Materials	Peel Test	Burst Test	Formula (Correlation)	Comments
Steve Franks Donald Barcan **TM Electronics Dunbar Industries** **1999**	Plastic/plastic peelable pouches (nonporous) with different length-to-width ratios	It is not specified	Restrained Burst Test Closed Package Fixture	Used linear regression to calculate the correlation coefficient (R)	• Experiment designed with the purpose of determining if the burst and peel tests were sensitive enough to detect changes in the sealing process

Table 28. Michigan State University School of Packaging – CURRENT WORK

Researcher Year	Package and Materials	Peel Test	Burst Test	Formula (Correlation)	Comments
Rosamari Feliu-Baez **Michigan State University School of Packaging** **2001**	1073 B Tyvek/plastic chevron seal pouches (from two different manufacturers) and 1059 B Tyvek/plastic chevron seal pouches	Use of peak and average peeling forces "Free-tail" (unsupported) peel test ASTM recommended settings	Restrained Burst Test Open Package Fixture ASTM recommended settings	**Theoretical approach:** $P = [(2S) / D]*CF$ **Empirical Approach:** Uses multiple regression analysis to fit experimental data to a power law relationship. $P = K [(S/D)*CF]^{p1}[D/Lc]^{p2} [D/Wc]^{p3}$ $P = K [(S/D)]^{p1}[CF]^{p2}$ $P = K [(S/D)]^{p1}[L/W]^{p2}$ **P** = Restrained burst pressure – psi **S** = Seal strength – lb/in **D** – Plate separation – in **CF** – correction factor considering the package's size (working area and pressurized perimeter - see Equation [6], Chapter 3) (in/in) **L and Lc** = original and contact length (in), respectively as defined in Chapter 3. **W and Wc** = original and contact width (in), respectively as defined in Chapter 3. **K, p1 and p2** – parameters obtained with multiple regression analysis. **Models that predict seal strength (S) were also developed** – see Chapter 5	• Burst strength was correlated with the minimum seal strength of the four locations tested around the seal of a pouch • This formula takes into consideration package size • Theoretical and empirical approaches were used. The theoretical approach uses formulas based on force diagram analysis.

NOTE: Underlined means things that were done differently than the Feliu-Baez study published in 1998

APPENDIX III

POWER CALCULATIONS

A sample size of ten was chosen for the following reasons:

1. It was the highest sample size that could be tested with the number of samples available.
2. It is a reasonable number of samples, which makes feasible (in terms of samples and time spent) the application of this experiment in industry.
3. According to the power calculations performed, see below, a sample size of ten provided acceptable test sensitivity and good test power.

Power calculations were performed in order to determine the sensitivity and power of the factorial experiments when using a sample size of ten. In the 2^2 factorial experiments for peel and burst tests the following hypothesis are tested:

H_0: There is no significant;

a. Factor A effect

b. Factor B effect and

c. Interaction effect.

H_1: There is significant;

a. Factor A effect

b. Factor B effect and

c. Interaction effect.

Operating characteristic (OC) curves are used in power calculations with the quantity ϕ^2.

$$\phi^2 = naD^2 / 2b\sigma^2$$

where;

n = sample size

a = number of Factor A levels

D = specified difference in the response variable between any two factors

b = number of Factor B levels

σ = standard deviation of burst pressure

D and σ were chosen based on data from preliminary experiments.

A table like the one shown below is filled out. The first five columns gather important information for the use and interpretation of the OC curve.

n	ϕ^2	ϕ	$\nu_1 = (a - 1)$	$\nu_2 = ab(n - 1)$	β	$1-\beta$

NOTE: ν_1 = degrees of freedom in the numerator
ν_2 = degrees of freedom in the denominator

With that information and the OC curve, β and $(1- \beta)$ can be determined. According to Montgomery, 1997,

β = P{type II error} = P{fail to reject H_0/ H_0 is false}

$1- \beta$ = Power = P{reject H_0/ H_0 is false}= probability of correctly rejecting H_0.

Burst Test:

Three factorial analyses were performed with the data collected. See Table 29 below.

Table 29. 2^2 Factorial Experiments for Burst Test

Response	Factor - Levels (low, high)	Combinations tested
Burst Pressure	Factor A = Flow Index – (1, 9) Factor B = Plate Separation – (0.5", 1.0")	(1, 0.5"), (9, 0.5") (1, 1.0"), (9, 1.0")
Burst Pressure	Factor A = Flow Index – (1, 5 Factor B = Plate Separation – (0.5", 1.0")	(1, 0.5"), (5, 0.5") (1, 1.0"), (5, 1.0")
Burst Pressure	Factor A = Flow Index – (5, 9) Factor B =Plate Separation – (0.5", 1.0")	(5, 0.5"), (9, 0.5") (5, 1.0"), (9, 1.0")

Power calculations:

$\phi^2 = naD^2 / 2b\sigma^2$

Where; n = 10 D = 9 in H_2O σ = 8 in H_2O

a = 2 b = 2

$\phi^2 = naD^2 / 2b\sigma^2 = [(10*2*(9)^2 / 2*2*(8)^2] = 6.3281$

Table 30. Power calculation results for the Burst Test

n	ϕ^2	ϕ	$\nu_1 = (a - 1)$	$\nu_2 = ab(n - 1)$	β	1-β
10	6.3281	2.5156	1	36	0.065	0.9350

These results were obtained from a $\nu_1 = 1$ OC curve, at $\alpha = 0.05$ and $\nu_2 = 36$ (Montgomery, 1991).

With a sample size of ten this experiment will be able to detect a difference in burst pressure of 9 in H_2O due to changes in the factors under study. The probability of correctly rejecting H_0 (no significant factor and interaction effects) is 0.9350.

Peel Test:

One factorial analysis was performed with the data collected. See the table below.

Table 31. 2^2 Factorial Experiments for Peel Test

Response	Factor - Levels (low, high)	Combinations tested
Peel Strength	Factor A -Crosshead Speed – (10 ipm, 12 ipm) Factor B - Grip Separation – (1.0", 2.0")	(10, 1.0"), (12, 1.0") (10, 1.0"), (12, 2.0")

NOTE: ipm = inches/minute

Power calculations:

$\phi^2 = naD^2 / 2b\sigma^2$

Where; n = 10 D = 0.24 lb/in σ = .21 lb/in

a = 2 b = 2

$\phi^2 = naD^2 / 2b\sigma^2 = [(10*2*(0.24)^2 / 2*2*(0.21)^2] = 6.5306$

Table 32. Power calculation results for the Peel Test

n	ϕ^2	ϕ	$\nu_1 = (a - 1)$	$\nu_2 = ab(n - 1)$	β	1-β
10	6.5306	2.5555	1	36	0.06	0.94

These results were obtained from a $\nu_1 = 1$ OC curve, at $\alpha = 0.05$ and $\nu_2 = 36$ (Montgomery, 1991).

With a sample size of ten this experiment will be able to detect a difference in peel strength of 0.24 lb/in due to changes in the factors under study. The probability of correctly rejecting H_0 (no significant factor and interaction effects) is 0.94.

It has been found in previous experiments that the influence of crosshead speed and grip separation in the peel test results, if any, is very small. This influence can't be detected with a sample size of ten. It would require very large sizes. For example, if a difference of 0.05 lb/in would like to be detected with the same power, then a sample size of 231 samples would be needed. See calculations below.

$$n = \phi^2\, 2\, b\, \sigma^2 / a\, D^2 = [\{(6.5306*2*2*(0.21)^2\}/\{2*(0.05)^2\}] = 230.40$$

Although a sample size of ten sacrifices some sensitivity in the peel test, it is a reasonable number of samples to be tested. A sample size of ten pouches represents 40 peel tests because each pouch is tested in four different locations (see Chapter 4). A sample size bigger than that would make this experiment not practical and not feasible for industry application.

APPENDIX IV

TESTING INFORMATION

APPENDIX IV CONTENTS:

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Table 33. Testing Information for Material combination #1: Uncoated 1073B Tyvek/ Polyester/Poly Laminate –Rexam

Burst Test

Package Size (W" x L")	Date Start Time	Temperature (° C) Relative Humidity (%)	Other Test Parameters	(Flow Index, Plate separation (in)) Number of Samples Tested					
(3.25" x 7.25")	4/12/01 4:00 p.m.	23.0 ° C 37 %	Sensitivity = 1 Prefill = N	(1,0.5) 10	(5,0.5) 10	(9,0.5) 10	(1,1.0) 10	(5,1.0) 10	(9,1.0) 10
(5.25" x 9.125")	4/5/01 2:30 p.m.	23.5 ° C 36 %	Sensitivity = 1 Prefill = N	(1,0.5) 10	(5,0.5) 10	(9,0.5) 10	(1,1.0) 10	(5,1.0) 10	(9,1.0) 10
(7.25" x 11.125")	4/3/01 2:30 p.m.	22.0 ° C 38 %	Sensitivity = 1 Prefill = N	(1,0.5) 10	(5,0.5) 10	(9,0.5) 10	(1,1.0) 10	(5,1.0) 10	(9,1.0) 10
(9.25" x 14.125")	4/2/01 2:00 p.m.	22.0 ° C 38 %	Sensitivity = 1 Prefill = N	(1,0.5) 10	(5,0.5) 10	(9,0.5) 10	(1,1.0) 10	(5,1.0) 10	(9,1.0) 10
(11.25" x 15.25")	4/4/01 2:00 p.m.	22.0 ° C 38 %	Sensitivity = 1 Prefill = N	(1,0.5) 10	(5,0.5) 10	(9,0.5) 10	(1,1.0) 10	(5,1.0) 10	(9,1.0) 10

Peel Test

Package Size (W" x L")	Date Start Time	Temperature (° C) Relative Humidity (%)	Other Test Parameters	(Crosshead Speed (ipm), Grip separation (in)) Number of Samples Tested			
(3.25" x 7.25")	4/13/01 8:00 a.m.	27.5 ° C 55 %	X axis = 7.5 in Y axis = 5%	(10,1.0) 10	(12,1.0) 10	(10,2.0) 10	(12,2.0) 10
(5.25" x 9.125")	4/6/01 9:00 a.m.	23.0 ° C 49 %	X axis = 7.5 in Y axis = 5%	(10,1.0) 10	(12,1.0) 10	(10,2.0) 10	(12,2.0) 10
(7.25" x 11.125")	4/4/01 8:15 a.m.	23.0 ° C 49 %	X axis = 7.5 in Y axis = 5%	(10,1.0) 10	(12,1.0) 10	(10,2.0) 10	(12,2.0) 10
(9.25" x 14.125")	4/3/01 9:30 a.m.	23.0 ° C 49 %	X axis = 7.5 in Y axis = 5%	(10,1.0) 10	(12,1.0) 10	(10,2.0) 10	(12,2.0) 10
(11.25" x 15.25")	4/3/01 9:15 a.m.	22.0 ° C 52 %	X axis = 7.5 in Y axis = 5%	(10,1.0) 10	(12,1.0) 10	(10,2.0) 10	(12,2.0) 10

Table 34. Testing Information for Material combination #2: Uncoated 1073B Tyvek/ PET/LDPE Laminate –Tolas

Burst Test

Package Size (W" x L")	Date Start Time	Temperature (° C) Relative Humidity (%)	Other Test Parameters	(Flow Index, Plate separation (in)) Number of Samples Tested					
(3" x 11.375")	4/9/01 3:30 p.m.	22.0 ° C 41 %	Sensitivity = 1 Prefill = N	(1,0.5) 10	(5,0.5) 10	(9,0.5) 10	(1,1.0) 10	(5,1.0) 10	(9,1.0) 10
(10.625" x 15")	4/10/01 2:00 p.m.	21.5 ° C 38 %	Sensitivity = 1 Prefill = N	(1,0.5) 10	(5,0.5) 10	(9,0.5) 10	(1,1.0) 10	(5,1.0) 10	(9,1.0) 10

Peel Test

Package Size (W" x L")	Date Start Time	Temperature (° C) Relative Humidity (%)	Other Test Parameters	(Crosshead Speed (ipm), Grip separation (in)) Number of Samples Tested			
(3" x 11.375")	4/10/01 8:00 a.m.	23.0 ° C 52 %	X axis = 7.5 in Y axis = 5%	(10,1.0) 10	(12,1.0) 10	(10,2.0) 10	(12,2.0) 10
(10.625" x 15")	4/12/01 8:00 a.m.	23.5 ° C 55 %	X axis = 7.5 in Y axis = 5%	(10,1.0) 10	(12,1.0) 10	(10,2.0) 10	(12,2.0) 10

Table 35. Testing Information for Material combination #3: Uncoated 1059B Tyvek/ Polyester/Poly Laminate –Rexam

Burst Test

Package Size (W" x L")	Date Start Time	Temperature (° C) Relative Humidity (%)	Other Test Parameters	(Flow Index, Plate separation (in)) Number of Samples Tested					
(5.75" x 9.125")	4/6/01 2:00 p.m.	22.0 ° C 38 %	Sensitivity = 1 Prefill = N	(1,0.5) 10	(5,0.5) 10	(9,0.5) 10	(1,1.0) 10	(5,1.0) 10	(9,1.0) 10
(9.25" x 14.125")	4/7/01 2:00 p.m.	22.0 ° C 38 %	Sensitivity = 1 Prefill = N	(1,0.5) 10	(5,0.5) 10	(9,0.5) 10	(1,1.0) 10	(5,1.0) 10	(9,1.0) 10

Peel Test

Package Size (W" x L")	Date Start Time	Temperature (° C) Relative Humidity (%)	Other Test Parameters	(Crosshead Speed (ipm), Grip separation (in)) Number of Samples Tested			
(5.75" x 9.125")	4/9/01 8:30 a.m.	22.5 ° C 55 %	X axis = 7.5 in Y axis = 5%	(10,1.0) 10	(12,1.0) 10	(10,2.0) 10	(12,2.0) 10
(9.25" x 14.125")	4/8/01 8:15 a.m.	24.0 ° C 52 %	X axis = 7.5 in Y axis = 5%	(10,1.0) 10	(12,1.0) 10	(10,2.0) 10	(12,2.0) 10

APPENDIX V

RAW DATA

APPENDIX V CONTENTS:

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II.	**Tolas (1073B Tyvek/PET/PE Laminate) Pouches**	
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	1) Results	166
	2) Minimum Peel Strength Values	170
III.	**Rexam (1059B Tyvek/Polyester/Poly Laminate) Pouches**	
	a. Package Size (5.75" x 9.125")	
	1) Results	171
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A. BURST TEST RESULTS

I. Rexam (1073B Tyvek/Polyester/Poly Laminate) Pouches

Table 36. Burst Test Results for Package Size (3.25" x 7.25") – 1073B Rexam at Plate Separation 0.50"

	Flow = 1			Flow = 5			Flow = 9		
Sample	Burst Pressure (in H_2O)	LF	Time (sec)	Burst Pressure (in H_2O)	LF	Time (sec)	Burst Pressure (in H_2O)	LF	Time (sec)
1	113.5	D	102.451	116.4	D	11.952	124.0	B	5.432
2	119.8	B	113.400	129.3	B	12.823	119.2	D	5.345
3	110.4	B	109.153	133.0	E	12.711	120.8	B	5.400
4	118.9	D	114.541	120.9	B	12.305	117.3	A	5.201
5	121.1	B	121.628	128.8	B	13.067	154.0	B	5.730
6	131.5	E	118.670	150.4	B	13.364	134.5	D	5.580
7	125.9	B	114.494	117.4	D	12.336	143.0	E	5.548
8	107.6	B	107.993	137.4	B	12.871	137.6	D	5.445
9	121.0	D	112.310	106.5	E	11.804	130.5	A	5.295
10	145.8	A	124.323	131.6	E	12.444	133.2	B	5.554
Average	**121.55**	**NA**	**113.90**	**127.17**	**NA**	**12.57**	**131.41**	**NA**	**5.45**
Std Dev	**11.0569**	**NA**	**6.5248**	**12.3967**	**NA**	**0.4901**	**11.6055**	**NA**	**0.1548**

at Plate Separation 1.0"

	Flow = 1			Flow = 5			Flow = 9		
Sample	Burst Pressure (in H_2O)	LF	Time (sec)	Burst Pressure (in H_2O)	LF	Time (sec)	Burst Pressure (in H_2O)	LF	Time (sec)
1	65.8	E	95.653	73.7	B	11.102	68.1	A	4.650
2	65.6	B	96.798	75.5	D	10.782	79.4	E	4.820
3	64.9	E	96.970	94.2	B	11.676	82.6	D	4.852
4	81.5	E	102.868	72.8	B	10.593	85.7	E	4.817
5	85.7	E	103.585	72.2	E	10.952	85.9	B	4.932
6	71.5	D	93.310	84.1	B	11.400	105.2	D	5.170
7	68.1	B	93.842	73.3	A	10.583	62.6	A	4.676
8	83.5	A	105.849	82.0	E	11.487	72.0	E	4.762
9	70.3	B	98.676	91.0	D	12.000	74.2	A	4.743
10	84.0	A	101.166	72.8	E	10.766	81.9	B	4.852
Average	**74.09**	**NA**	**98.87**	**79.16**	**NA**	**11.13**	**79.76**	**NA**	**4.83**
Std Dev	**8.5548**	**NA**	**4.3035**	**8.2040**	**NA**	**0.4864**	**11.8063**	**NA**	**0.1474**

NOTE: LF = Location of Failure, Refer to Figure 14

Table 37. Burst Test Results for Package Size (5.25" x 9.125") - 1073B Rexam at Plate Separation 0.50"

	Flow = 1			Flow = 5			Flow = 9		
Sample	Burst Pressure (in H_2O)	LF	Time (sec)	Burst Pressure (in H_2O)	LF	Time (sec)	Burst Pressure (in H_2O)	LF	Time (sec)
1	121.5	E	120.271	111.4	B	13.038	122.7	A	5.731
2	120.9	E	125.803	147.3	B	13.611	138.2	B	5.875
3	126.3	B	127.505	128.0	E	13.613	130.2	E	5.609
4	123.1	D	126.868	141.8	B	13.916	111.9	A	5.490
5	136.4	B	124.826	121.0	E	13.105	143.7	B	6.188
6	121.3	A	128.038	125.3	E	13.179	120.4	B	5.673
7	131.1	D	128.964	136.2	B	13.628	140.9	D	5.800
8	120.1	E	127.826	123.1	E	13.250	124.2	B	5.484
9	120.2	D	120.150	133.3	A	13.255	132.0	B	5.666
10	123.8	B	124.198	119.2	B	13.140	126.5	D	5.599
Average	**124.47**	**NA**	**125.44**	**128.66**	**NA**	**13.37**	**129.07**	**NA**	**5.71**
Std Dev	**5.3841**	**NA**	**3.1255**	**10.9909**	**NA**	**0.2942**	**9.9336**	**NA**	**0.2080**

at Plate Separation 1.0"

	Flow = 1			Flow = 5			Flow = 9		
Sample	Burst Pressure (in H_2O)	LF	Time (sec)	Burst Pressure (in H_2O)	LF	Time (sec)	Burst Pressure (in H_2O)	LF	Time (sec)
1	71.9	A	109.060	75.5	D	12.063	80.4	D	5.269
2	65.7	D	101.964	82.8	D	12.345	75.3	D	5.320
3	72.3	D	105.163	77.0	D	11.932	78.3	A	5.672
4	77.5	B	111.708	78.2	E	12.139	75.9	B	5.407
5	74.9	D	111.125	69.4	E	11.691	74.6	A	5.301
6	74.0	B	112.923	74.3	B	11.948	77.1	B	5.275
7	73.2	D	107.881	76.4	E	12.397	77.1	B	5.298
8	76.2	B	111.702	80.5	B	12.192	78.6	B	5.422
9	70.3	E	102.788	74.7	B	12.211	77.3	B	5.233
10	78.6	D	108.303	82.6	E	12.631	79.5	A	5.513
Average	**73.46**	**NA**	**108.26**	**77.14**	**NA**	**12.15**	**77.41**	**NA**	**5.37**
Std Dev	**3.7515**	**NA**	**3.8535**	**4.1021**	**NA**	**0.2672**	**1.8363**	**NA**	**0.1359**

NOTE: LF = Location of Failure, Refer to Figure 14

Table 38. Burst Test Results for Package Size (7.25" x 11.125") - 1073B Rexam at Plate Separation 0.50"

	Flow = 1			Flow = 5			Flow = 9		
Sample	Burst Pressure (in H_2O)	LF	Time (sec)	Burst Pressure (in H_2O)	LF	Time (sec)	Burst Pressure (in H_2O)	LF	Time (sec)
1	97.9	E	119.970	111.7	E	13.393	105.8	A	5.563
2	91.8	A	122.323	117.2	B	13.217	113.5	E	5.685
3	99.4	B	122.429	129.4	B	14.034	132.7	A	6.070
4	110.3	B	122.121	111.4	B	13.349	107.1	A	5.836
5	99.9	B	116.733	104.8	B	12.637	134.1	B	5.628
6	93.6	A	113.520	132.4	B	13.634	97.0	A	5.448
7	96.6	B	119.208	116.2	B	13.374	103.2	B	5.499
8	92.2	B	119.930	128.6	E	13.932	116.2	B	5.690
9	96.7	A	118.375	121.1	A	12.932	115.7	E	5.595
10	112.1	A	122.115	129.5	A	14.073	105.5	B	5.522
Average	**99.05**	**NA**	**119.67**	**120.23**	**NA**	**13.46**	**113.08**	**NA**	**5.65**
Std Dev	**6.9900**	**NA**	**2.8893**	**9.4468**	**NA**	**0.4711**	**12.2291**	**NA**	**0.1840**

at Plate Separation 1.0"

	Flow = 1			Flow = 5			Flow = 9		
Sample	Burst Pressure (in H_2O)	LF	Time (sec)	Burst Pressure (in H_2O)	LF	Time (sec)	Burst Pressure (in H_2O)	LF	Time (sec)
1	65.2	D	116.942	55.3	E	12.024	65.3	B	5.240
2	57.5	A	118.262	62.1	E	12.490	62.8	D	5.403
3	73.0	E	116.852	63.2	B	12.544	64.1	B	5.435
4	55.9	A	116.804	61.4	D	12.128	55.3	B	5.140
5	58.6	D	111.929	69.4	D	12.490	57.8	E	5.137
6	55.1	D	112.089	63.6	E	12.345	67.2	E	5.467
7	61.2	B	113.294	65.9	E	12.714	61.3	B	5.525
8	62.7	B	117.191	69.9	B	12.311	64.1	D	5.355
9	67.4	D	118.942	63.0	B	12.092	66.5	B	5.512
10	57.1	D	111.349	63.1	D	11.952	67.2	D	5.371
Average	**61.37**	**NA**	**115.37**	**63.69**	**NA**	**12.31**	**63.16**	**NA**	**5.36**
Std Dev	**5.7562**	**NA**	**2.8722**	**4.1538**	**NA**	**0.2527**	**4.0034**	**NA**	**0.1422**

NOTE: LF = Location of Failure, Refer to Figure 14

Table 39. Burst Test Results for Package Size (9.25" x 14.125") – 1073B Rexam at Plate Separation 0.50"

	Flow = 1			Flow = 5			Flow = 9		
Sample	Burst Pressure (in H_2O)	LF	Time (sec)	Burst Pressure (in H_2O)	LF	Time (sec)	Burst Pressure (in H_2O)	LF	Time (sec)
1	81.1	B	127.333	101.1	B	13.403	124.3	D	6.223
2	92.3	D	130.163	115.8	B	15.255	121.5	D	6.384
3	98.2	B	137.339	89.3	D	13.564	114.1	B	6.317
4	87.5	B	131.586	111.5	D	13.868	128.0	B	6.448
5	101.0	B	140.281	102.6	B	14.124	126.8	B	6.362
6	91.0	D	131.493	103.7	D	14.294	118.5	B	6.452
7	100.9	D	135.464	105.5	D	14.673	106.7	B	5.791
8	96.0	B	135.861	114.2	D	14.727	109.8	B	5.964
9	88.4	B	129.358	121.0	B	14.532	126.3	B	6.355
10	97.2	B	133.727	122.3	D	14.255	110.3	B	6.048
Average	**93.36**	**NA**	**133.26**	**108.70**	**NA**	**14.27**	**118.63**	**NA**	**6.23**
Std Dev	**6.4662**	**NA**	**3.9951**	**10.1725**	**NA**	**0.5621**	**7.9161**	**NA**	**0.2255**

at Plate Separation 1.0"

	Flow = 1			Flow = 5			Flow = 9		
Sample	Burst Pressure (in H_2O)	LF	Time (sec)	Burst Pressure (in H_2O)	LF	Time (sec)	Burst Pressure (in H_2O)	LF	Time (sec)
1	65.4	D	122.672	59.6	B	12.795	73.3	D	6.294
2	67.0	D	121.073	60.4	D	13.124	74.7	B	6.494
3	57.1	B	121.285	68.7	D	14.169	71.4	D	6.121
4	55.5	D	121.734	68.6	D	14.054	73.5	D	5.958
5	67.2	D	126.612	61.3	B	12.827	65.1	D	5.740
6	62.6	B	122.714	67.1	B	13.305	75.9	B	6.111
7	55.0	B	127.060	71.1	B	14.050	61.5	D	5.781
8	53.7	B	121.005	59.4	B	13.605	63.4	B	5.906
9	63.5	B	120.608	73.9	D	14.699	78.2	D	6.221
10	76.5	D	125.451	60.0	D	13.811	64.5	B	6.002
Average	**62.35**	**NA**	**123.02**	**65.01**	**NA**	**13.64**	**70.15**	**NA**	**6.06**
Std Dev	**7.1444**	**NA**	**2.4423**	**5.4554**	**NA**	**0.6258**	**5.9543**	**NA**	**0.2340**

NOTE: LF = Location of Failure, Refer to Figure 14

Table 40. Burst Test Results for Package Size (11.25" x 15.25") – 1073B Rexam at Plate Separation 0.50"

	Flow = 1			Flow = 5			Flow = 9		
Sample	Burst Pressure (in H_2O)	LF	Time (sec)	Burst Pressure (in H_2O)	LF	Time (sec)	Burst Pressure (in H_2O)	LF	Time (sec)
1	125.2	B	151.067	113.1	A	15.352	126.3	B	6.891
2	113.8	E	151.067	123.1	A	16.134	119.3	B	6.653
3	121.8	A	148.682	118.6	B	14.829	122.2	D	6.448
4	106.4	B	144.932	114.7	D	15.830	126.7	B	7.060
5	116.0	B	148.400	136.5	D	16.032	117.9	B	7.099
6	104.0	D	132.361	117.6	D	15.621	130.3	D	6.763
7	112.2	D	142.332	112.8	D	15.852	117.3	B	6.984
8	113.6	E	137.865	126.6	D	15.420	121.3	A	6.480
9	109.6	D	146.327	117.5	D	15.451	99.0	A	6.022
10	121.7	D	142.400	113.9	B	15.581	115.9	B	6.480
Average	**114.43**	**NA**	**144.54**	**119.44**	**NA**	**15.61**	**119.62**	**NA**	**6.69**
Std Dev	**6.8983**	**NA**	**5.9902**	**7.4610**	**NA**	**0.3798**	**8.6007**	**NA**	**0.3384**

at Plate Separation 1.0"

	Flow = 1			Flow = 5			Flow = 9		
Sample	Burst Pressure (in H_2O)	LF	Time (sec)	Burst Pressure (in H_2O)	LF	Time (sec)	Burst Pressure (in H_2O)	LF	Time (sec)
1	71.1	A	139.910	61.2	D	14.374	77.1	B	6.753
2	76.0	A	139.015	59.2	D	14.507	83.5	B	7.115
3	64.8	A	137.865	66.5	B	13.996	73.5	B	6.628
4	62.4	D	126.435	78.9	D	16.443	74.9	D	6.710
5	65.0	B	131.766	80.4	D	15.689	65.4	E	6.169
6	72.2	B	145.347	70.1	D	14.935	83.7	E	7.179
7	63.1	D	129.445	76.7	B	15.067	89.6	B	7.262
8	70.0	A	134.515	67.1	D	14.160	82.6	E	7.053
9	60.6	B	136.714	86.4	B	15.742	76.4	B	6.663
10	61.9	B	131.274	69.0	B	14.563	67.9	E	6.080
Average	**66.71**	**NA**	**135.23**	**71.55**	**NA**	**14.95**	**77.46**	**NA**	**6.76**
Std Dev	**5.2195**	**NA**	**5.6441**	**8.7746**	**NA**	**0.7908**	**7.5244**	**NA**	**0.4056**

NOTE: LF = Location of Failure, Refer to Figure 14

II. Tolas (1073B Tyvek/PET/PE Laminate) Pouches

Table 41. Burst Test Results for Package Size (3" x 11.375") – 1073B Tolas at Plate Separation 0.50"

	Flow = 1			Flow = 5			Flow = 9		
Sample	Burst Pressure (in H_2O)	LF	Time (sec)	Burst Pressure (in H_2O)	LF	Time (sec)	Burst Pressure (in H_2O)	LF	Time (sec)
1	127.0	B	118.685	139.3	D	13.595	139.3	B	5.791
2	111.8	B	122.499	140.3	D	13.750	154.4	D	6.175
3	136.5	B	132.021	137.7	B	13.710	119.1	B	5.643
4	123.1	D	123.685	129.3	B	13.522	115.3	B	5.531
5	110.7	B	123.112	148.8	D	13.823	112.8	B	5.717
6	115.8	D	123.753	127.1	D	13.381	126.3	B	5.675
7	125.2	B	123.384	112.6	B	13.103	149.5	B	6.032
8	120.3	D	124.499	131.9	B	14.041	154.4	D	5.897
9	121.2	D	124.795	154.9	B	14.093	131.1	B	4.922
10	107.7	B	115.868	121.8	B	13.597	142.1	D	5.771
Average	**119.93**	**NA**	**123.23**	**134.37**	**NA**	**13.66**	**134.43**	**NA**	**5.72**
Std Dev	**8.7053**	**NA**	**4.1800**	**12.5471**	**NA**	**0.2954**	**15.8228**	**NA**	**0.3372**

at Plate Separation 1.0"

	Flow = 1			Flow = 5			Flow = 9		
Sample	Burst Pressure (in H_2O)	LF	Time (sec)	Burst Pressure (in H_2O)	LF	Time (sec)	Burst Pressure (in H_2O)	LF	Time (sec)
1	93.4	B	114.290	76.0	D	11.121	76.3	B	5.140
2	74.0	B	100.987	80.4	D	11.778	89.2	B	5.237
3	83.5	D	114.461	83.0	B	11.836	77.5	B	4.836
4	73.0	D	103.907	83.1	D	11.874	79.1	D	5.352
5	70.7	B	111.798	86.9	B	12.182	85.0	D	5.259
6	70.7	D	101.553	84.2	D	11.784	87.9	B	5.227
7	71.3	D	97.939	79.3	B	11.550	85.5	B	5.253
8	80.9	D	103.695	81.3	B	11.561	79.5	B	5.125
9	76.4	B	101.493	87.1	B	12.265	91.2	B	5.205
10	73.0	D	110.480	95.5	B	12.862	90.3	D	5.247
Average	**76.69**	**NA**	**106.06**	**83.68**	**NA**	**11.88**	**84.15**	**NA**	**5.19**
Std Dev	**7.2930**	**NA**	**6.0906**	**5.3483**	**NA**	**0.4728**	**5.6036**	**NA**	**0.1391**

NOTE: LF = Location of Failure, Refer to Figure 14

Table 42. Burst Test Results for Package Size (10.625" x 15") – 1073B Tolas at Plate Separation 0.50"

	Flow = 1			Flow = 5			Flow = 9		
Sample	Burst Pressure (in H_2O)	LF	Time (sec)	Burst Pressure (in H_2O)	LF	Time (sec)	Burst Pressure (in H_2O)	LF	Time (sec)
1	104.6	B	123.560	110.9	B	14.121	110.2	B	5.913
2	102.6	B	130.425	98.9	B	14.085	105.6	B	5.524
3	109.3	B	132.490	105.5	B	13.643	119.0	B	6.115
4	105.7	D	132.250	107.9	D	13.432	104.2	B	5.993
5	110.8	B	131.762	103.0	B	13.826	106.6	B	5.958
6	108.7	B	131.861	117.6	B	14.051	98.3	B	5.964
7	106.5	B	126.878	108.3	B	13.531	120.9	B	6.422
8	100.2	B	122.641	94.1	D	13.614	106.4	D	6.114
9	103.0	B	122.217	108.6	B	14.284	110.6	D	6.016
10	103.7	B	120.599	106.4	B	13.862	93.0	B	5.865
Average	**105.51**	**NA**	**127.47**	**106.12**	**NA**	**13.84**	**107.48**	**NA**	**5.99**
Std Dev	**3.3435**	**NA**	**4.8102**	**6.4594**	**NA**	**0.2854**	**8.4335**	**NA**	**0.2258**

at Plate Separation 1.0"

	Flow = 1			Flow = 5			Flow = 9		
Sample	Burst Pressure (in H_2O)	LF	Time (sec)	Burst Pressure (in H_2O)	LF	Time (sec)	Burst Pressure (in H_2O)	LF	Time (sec)
1	61.0	B	121.874	64.2	B	13.801	74.3	B	6.147
2	72.1	B	136.759	60.5	B	13.202	73.8	B	6.374
3	64.5	B	119.932	59.7	D	13.307	69.7	B	6.005
4	60.1	B	125.763	72.3	B	14.150	66.7	D	5.794
5	68.4	B	140.920	73.3	B	14.541	54.4	B	5.534
6	62.2	B	125.022	73.5	B	14.452	76.2	B	6.327
7	67.9	B	129.323	71.8	B	13.855	66.5	B	5.685
8	45.5	B	110.624	67.7	B	13.435	73.7	B	5.945
9	61.4	B	125.108	68.0	D	13.692	69.3	D	6.025
10	66.6	B	124.742	52.4	D	12.663	70.0	B	5.813
Average	**62.97**	**NA**	**126.01**	**66.34**	**NA**	**13.71**	**69.46**	**NA**	**5.96**
Std Dev	**7.2498**	**NA**	**8.4529**	**7.0454**	**NA**	**0.5828**	**6.2292**	**NA**	**0.2695**

NOTE: LF = Location of Failure, Refer to Figure 14

III. Rexam (1059B Tyvek/Polyester/Poly Laminate) Pouches

Table 43. Burst Test Results for Package Size (5.75" x 9.125") - 1059B Rexam at Plate Separation 0.50"

	Flow = 1			Flow = 5			Flow = 9		
Sample	Burst Pressure (in H_2O)	LF	Time (sec)	Burst Pressure (in H_2O)	LF	Time (sec)	Burst Pressure (in H_2O)	LF	Time (sec)
1	130.8	A	121.454	146.6	B	13.162	123.9	E	5.435
2	106.3	A	108.022	109.8	A	11.512	126.4	E	5.470
3	122.1	B	114.750	124.1	B	12.724	132.0	B	5.621
4	100.1	B	106.791	106.7	A	11.769	127.2	E	5.621
5	110.1	A	111.846	133.5	E	13.323	111.8	B	5.480
6	133.9	B	114.015	121.4	E	12.525	139.5	E	5.723
7	123.5	A	117.625	113.9	A	12.272	116.6	E	5.294
8	101.1	E	106.224	116.7	B	12.281	111.1	E	5.330
9	113.3	E	110.852	110.6	A	11.820	128.9	E	5.352
10	101.6	A	103.673	133.5	B	13.073	117.3	A	5.211
Average	**114.28**	**NA**	**111.53**	**121.68**	**NA**	**12.45**	**123.47**	**NA**	**5.45**
Std Dev	**12.5685**	**NA**	**5.5517**	**12.8236**	**NA**	**0.6270**	**9.1658**	**NA**	**0.1633**

at Plate Separation 1.0"

	Flow = 1			Flow = 5			Flow = 9		
Sample	Burst Pressure (in H_2O)	LF	Time (sec)	Burst Pressure (in H_2O)	LF	Time (sec)	Burst Pressure (in H_2O)	LF	Time (sec)
1	70.0	E	109.262	73.8	A	11.932	83.4	E	5.185
2	69.2	B	110.230	74.6	A	12.022	80.1	E	5.291
3	60.3	E	107.505	59.3	E	11.743	65.4	B	5.121
4	65.0	E	105.080	82.7	E	11.954	80.9	E	5.441
5	62.2	B	100.766	72.6	B	11.650	80.0	E	5.234
6	57.3	A	98.890	70.1	A	12.423	60.6	A	5.052
7	79.7	E	111.685	67.4	E	12.045	66.7	E	5.105
8	69.3	D	108.804	64.4	A	11.291	49.2	A	4.708
9	66.6	E	104.756	64.8	A	11.951	78.2	A	5.265
10	64.1	B	104.673	64.3	B	11.596	67.6	A	4.980
Average	**66.37**	**NA**	**106.17**	**69.40**	**NA**	**11.86**	**71.21**	**NA**	**5.14**
Std Dev	**6.2454**	**NA**	**4.1205**	**6.7676**	**NA**	**0.3075**	**11.1145**	**NA**	**0.2004**

NOTE: LF = Location of Failure, Refer to Figure 14

Table 44. Burst Test Results for Package Size (9.25" x 14.125") - 1059B Rexam

at Plate Separation 0.50"

	Flow = 1			Flow = 5			Flow = 9		
Sample	Burst Pressure (in H_2O)	LF	Time (sec)	Burst Pressure (in H_2O)	LF	Time (sec)	Burst Pressure (in H_2O)	LF	Time (sec)
1	122.0	D	144.634	131.7	E	13.903	138.8	B	6.303
2	133.5	B	141.563	127.4	B	13.791	134.0	D	6.632
3	120.9	B	125.105	118.7	B	14.403	116.8	A	5.810
4	117.6	A	127.269	123.0	B	14.224	124.1	B	6.041
5	95.1	B	120.614	119.5	B	13.641	131.6	B	6.253
6	112.9	A	122.220	124.6	A	13.956	139.3	B	6.307
7	119.1	A	122.102	121.0	D	13.653	123.9	B	6.053
8	111.9	B	124.271	128.8	B	14.603	132.1	B	6.470
9	104.8	B	122.672	128.6	A	14.320	146.2	E	6.560
10	116.9	B	121.176	126.7	B	14.134	137.5	D	6.481
Average	**115.47**	**NA**	**127.16**	**125.00**	**NA**	**14.06**	**132.43**	**NA**	**6.29**
Std Dev	**10.3554**	**NA**	**8.6548**	**4.3594**	**NA**	**0.3268**	**8.7737**	**NA**	**0.2602**

at Plate Separation 1.0"

	Flow = 1			Flow = 5			Flow = 9		
Sample	Burst Pressure (in H_2O)	LF	Time (sec)	Burst Pressure (in H_2O)	LF	Time (sec)	Burst Pressure (in H_2O)	LF	Time (sec)
1	63.8	B	111.577	70.9	D	13.211	80.7	A	6.175
2	74.6	E	135.858	69.9	E	13.138	70.1	A	6.131
3	70.0	A	129.670	76.0	E	13.585	70.6	E	5.778
4	75.0	B	135.035	79.5	A	13.624	83.2	A	6.019
5	74.2	A	130.628	77.4	A	13.891	85.5	A	6.109
6	72.8	A	132.558	76.9	A	13.695	70.1	A	5.938
7	69.9	B	128.364	72.6	E	13.464	74.2	B	6..041
8	74.0	A	129.958	75.6	A	13.612	78.0	E	6.192
9	62.4	E	128.714	74.0	A	13.798	80.7	E	5.865
10	66.3	A	124.022	81.6	E	13.660	74.8	E	5.849
Average	**70.30**	**NA**	**128.64**	**75.44**	**NA**	**13.57**	**76.79**	**NA**	**6.01**
Std Dev	**4.6743**	**NA**	**6.8932**	**3.6846**	**NA**	**0.2381**	**5.6518**	**NA**	**1.9049**

NOTE: LF = Location of Failure, Refer to Figure 14

IV. Summary of Burst Test Results in psi

Table 45. Summary of Burst Test Results in (lbs/in^2)
Rexam (1073B Tyvek/Polyester Poly Laminate) Pouches

PKG	Length (in)	Width (in)	Gap (in)	Flow Index	Burst Pressure (in H_2O)	Burst Pressure (lbs/in^2)
1	7.25	3.25	0.5	1	121.55	4.3928
1	7.25	3.25	0.5	5	127.17	4.5960
1	7.25	3.25	0.5	9	131.41	4.7492
1	7.25	3.25	1.0	1	74.09	2.6776
1	7.25	3.25	1.0	5	79.16	2.8609
1	7.25	3.25	1.0	9	79.76	2.8825
2	9.125	5.25	0.5	1	124.47	4.4984
2	9.125	5.25	0.5	5	128.66	4.6498
2	9.125	5.25	0.5	9	129.07	4.6646
2	9.125	5.25	1.0	1	73.46	2.6549
2	9.125	5.25	1.0	5	77.14	2.7879
2	9.125	5.25	1.0	9	77.41	2.7976
3	11.125	7.25	0.5	1	99.05	3.5797
3	11.125	7.25	0.5	5	120.23	4.3451
3	11.125	7.25	0.5	9	113.08	4.0867
3	11.125	7.25	1.0	1	61.37	2.2179
3	11.125	7.25	1.0	5	63.69	2.3018
3	11.125	7.25	1.0	9	63.16	2.2826
4	14.125	9.25	0.5	1	93.36	3.3741
4	14.125	9.25	0.5	5	108.70	3.9284
4	14.125	9.25	0.5	9	118.63	4.2873
4	14.125	9.25	1.0	1	62.35	2.2533
4	14.125	9.25	1.0	5	65.01	2.3495
4	14.125	9.25	1.0	9	70.15	2.5352
5	15.25	11.25	0.5	1	114.43	4.1355
5	15.25	11.25	0.5	5	119.44	4.3166
5	15.25	11.25	0.5	9	119.62	4.3231
5	15.25	11.25	1.0	1	66.71	2.4109
5	15.25	11.25	1.0	5	71.55	2.5858
5	15.25	11.25	1.0	9	77.46	2.7994

NOTES:
1 lb/in^2 = 1 psi = 27.67 in H_2O
Refer to Tables 36 to 40

Table 45. Summary of Burst Test Results in (lbs/in^2) - Continuation

Tolas (1073B Tyvek/PET/PE Laminate) Pouches

PKG	Length (in)	Width (in)	Gap (in)	Flow Index	Burst Pressure (in H_2O)	Burst Pressure (lbs/in^2)
1	11.375	3	0.5	1	119.93	4.3343
1	11.375	3	0.5	5	134.37	4.8562
1	11.375	3	0.5	9	134.43	4.8583
1	11.375	3	1.0	1	76.69	2.7716
1	11.375	3	1.0	5	83.69	3.0246
1	11.375	3	1.0	9	84.15	3.0412
2	15	10.625	0.5	1	105.51	3.8132
2	15	10.625	0.5	5	106.12	3.8352
2	15	10.625	0.5	9	107.48	3.8844
2	15	10.625	1.0	1	62.97	2.2757
2	15	10.625	1.0	5	66.34	2.3975
2	15	10.625	1.0	9	69.46	2.5103

Rexam (1059B Tyvek/Polyester Poly Laminate) Pouches

PKG	Length (in)	Width (in)	Gap (in)	Flow Index	Burst Pressure (in H_2O)	Burst Pressure (lbs/in^2)
1	9.125	5.75	0.5	1	114.28	4.1301
1	9.125	5.75	0.5	5	121.68	4.3975
1	9.125	5.75	0.5	9	123.47	4.4622
1	9.125	5.75	1.0	1	66.37	2.3986
1	9.125	5.75	1.0	5	69.40	2.5081
1	9.125	5.75	1.0	9	71.21	2.5735
2	14.125	9.25	0.5	1	115.47	4.1731
2	14.125	9.25	0.5	5	125.00	4.5175
2	14.125	9.25	0.5	9	132.43	4.7860
2	14.125	9.25	1.0	1	70.30	2.5407
2	14.125	9.25	1.0	5	75.44	2.7264
2	14.125	9.25	1.0	9	76.79	2.7752

NOTES:

1 lb/in^2 = 1 psi = 27.67 in H_2O

Refer to Tables 41 and 42 for Tolas 1073B Tyvek/plastic pouches and to Tables 43 and 44 for Rexam 1059B Tyvek/plastic pouches.

B. PEEL TEST RESULTS

I. Rexam (1073B Tyvek/Polyester/Poly Laminate) Pouches

Table 46. Peel Test Results for Package Size (3.25" x 7.25") – 1073B Rexam at Crosshead Speed = 10 ipm and Grip Separation = 1.0"

	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)
n	Location A					Location B				
1	2.0720	1.4180	0.928	1.5280	5.542	1.3260	0.7170	0.884	0.8111	5.298
2	2.5930	1.5690	0.885	1.7729	5.285	2.1850	1.3870	0.931	1.4898	5.605
3	2.3620	1.4650	0.865	1.6936	5.131	1.8790	1.1360	0.867	1.3103	5.224
4	1.6640	1.1610	0.931	1.2470	5.624	1.8150	1.0860	0.834	1.3022	4.922
5	2.0720	1.4630	0.927	1.5782	5.605	1.9010	1.1770	0.951	1.2376	5.708
6	2.2010	1.4300	0.897	1.5942	5.365	1.6210	0.9689	0.901	1.0754	5.381
7	1.9270	1.2950	0.957	1.3532	5.714	1.9760	1.2040	0.859	1.4016	5.125
8	1.8420	1.1180	0.907	1.2326	5.420	1.9760	1.1590	0.904	1.2821	5.390
9	2.0670	1.3620	0.884	1.5407	5.313	1.2350	0.7159	0.831	0.8615	5.003
10	2.3680	1.5870	0.897	1.7692	5.406	2.1100	1.3470	0.862	1.5626	5.173
A	**2.1168**	**1.3868**	**0.9078**	**1.5310**	**5.4405**	**1.8024**	**1.0898**	**0.8824**	**1.2334**	**5.2829**
SD	**0.2749**	**0.1565**	**0.0277**	**0.1970**	**0.1793**	**0.3160**	**0.2298**	**0.0395**	**0.2488**	**0.2483**
n	Location D					Location E				
1	**1.9870**	1.1070	0.853	**1.2978**	5.128	**2.0510**	1.1620	0.801	**1.4507**	4.775
2	**2.0890**	1.3130	1.004	**1.3078**	6.143	**2.0350**	1.2000	0.800	**1.5000**	4.835
3	**1.7290**	1.0610	0.909	**1.1672**	5.432	**1.5570**	0.9021	0.788	**1.1448**	4.737
4	**1.7400**	1.1020	0.933	**1.1811**	5.580	**2.0670**	1.1470	0.757	**1.5152**	4.532
5	**1.6590**	1.0230	0.986	**1.0375**	5.874	**2.2440**	1.1610	0.744	**1.5605**	4.426
6	**1.7610**	1.1270	0.884	**1.2749**	5.271	**2.1580**	1.1760	0.752	**1.5638**	4.422
7	**2.0080**	1.1650	0.850	**1.3706**	5.160	**1.7290**	0.8983	0.764	**1.1758**	4.553
8	**2.2070**	1.4120	0.861	**1.6400**	5.147	**1.5840**	0.8220	0.717	**1.1464**	4.313
9	**2.0990**	1.3430	0.973	**1.3803**	5.846	**1.8360**	1.0250	0.752	**1.3630**	4.544
10	**1.5730**	0.9181	0.840	**1.0930**	5.000	**1.6640**	0.8891	0.797	**1.1156**	4.727
A	**1.8852**	**1.1571**	**0.9093**	**1.2750**	**5.4581**	**1.8925**	**1.0383**	**0.7672**	**1.3536**	**4.5864**
SD	**0.2175**	**0.1544**	**0.0614**	**0.1716**	**0.3869**	**0.2494**	**0.1471**	**0.0282**	**0.1882**	**0.1742**

NOTE: The minimum peak and average peel strength values, out of the four locations, from each sample, were used for the analysis. Refer to Table 47 for information about the location and value of minimum peel strength for this package size.

Table 46. Peel Test Results for Package Size (3.25" x 7.25") – 1073B Rexam at Crosshead Speed = 12 ipm and Grip Separation = 1.0" – Continuation

	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)
n	Location A					Location B				
1	2.0190	1.2820	0.985	1.3015	4.871	1.7930	1.1990	0.965	1.2425	4.843
2	2.0460	1.4600	0.938	1.5565	4.685	2.0990	1.3190	0.897	1.4705	4.502
3	1.8900	1.2920	0.896	1.4420	4.480	1.6590	1.0670	0.904	1.1803	4.596
4	2.1100	1.5140	0.921	1.6439	4.602	2.1150	1.3290	0.833	1.5954	4.150
5	2.1530	1.3630	0.893	1.5263	4.423	2.1260	1.1420	0.885	1.2904	4.381
6	2.1320	1.4910	0.932	1.5998	4.624	1.3420	0.8610	0.869	0.9908	4.313
7	2.1850	1.4350	0.919	1.5615	4.554	1.0090	0.5281	0.888	0.5947	4.480
8	2.1480	1.4130	0.882	1.6020	4.413	1.2670	0.8110	0.856	0.9474	4.300
9	2.0720	1.3740	0.860	1.5977	4.294	1.7770	1.1420	0.835	1.3677	4.157
10	1.9170	1.3470	0.909	1.4818	4.515	1.6270	0.9414	0.871	1.0808	4.313
A	2.0672	1.3971	0.9135	1.5313	4.5461	1.6814	1.0340	0.8803	1.1761	4.4035
SD	0.1003	0.0793	0.0345	0.1009	0.1619	0.3836	0.2503	0.0383	0.2888	0.2104
n	Location D					Location E				
1	1.7720	1.1240	0.895	1.2559	4.544	1.9270	1.1140	0.779	1.4300	3.941
2	1.9540	1.2210	0.868	1.4067	4.349	1.3100	0.7187	0.837	0.8587	4.160
3	2.0720	1.1620	0.933	1.2454	4.640	2.1150	1.1680	0.741	1.5762	3.769
4	1.8040	1.0780	0.843	1.2788	4.214	2.1910	1.2100	0.805	1.5031	4.060
5	1.4930	0.9348	0.940	0.9945	4.702	1.6640	0.9506	0.774	1.2282	3.807
6	1.7720	1.0460	0.868	1.2051	4.323	2.0620	1.1380	0.828	1.3744	4.085
7	1.1440	0.6541	0.872	0.7501	4.330	2.2760	1.2600	0.777	1.6216	3.903
8	1.4340	0.8372	0.837	1.0002	4.140	2.2500	1.2270	0.784	1.5651	3.932
9	1.8470	1.1230	0.907	1.2381	4.599	1.5570	0.7413	0.800	0.9266	4.002
10	1.9330	1.0890	0.937	1.1622	4.669	1.8790	1.0720	0.804	1.3333	4.041
A	1.7225	1.0269	0.8900	1.1537	4.4510	1.9231	1.0600	0.7929	1.3417	3.9700
SD	0.2824	0.1716	0.0383	0.1886	0.2031	0.3229	0.1947	0.0280	0.2660	0.1235

NOTE: The minimum peak and average peel strength values, out of the four locations, from each sample, were used for the analysis. Refer to Table 47 for information about the location and value of minimum peel strength for this package size.

Table 46. Peel Test Results for Package Size (3.25" x 7.25") – 1073B Rexam at Crosshead Speed = 10 ipm and Grip Separation = 2.0" – Continuation

	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)
n	Location A					Location B				
1	2.1580	1.3500	0.933	1.4469	5.521	1.6540	1.0280	0.841	1.2224	5.048
2	2.1640	1.4880	0.903	1.6478	5.477	1.7660	1.0650	0.887	1.2007	5.262
3	1.8630	1.2630	1.050	1.2029	6.224	0.8966	0.5727	0.917	0.6245	5.442
4	2.0890	1.3810	0.944	1.4629	5.619	1.6110	0.9808	0.877	1.1184	5.265
5	1.5090	0.9802	0.949	1.0329	5.640	1.7230	1.1120	0.824	1.3495	4.920
6	1.7930	1.1580	0.900	1.2867	5.346	1.6430	0.9327	0.864	1.0795	5.189
7	2.0990	1.2870	0.917	1.4035	5.493	1.6590	0.9982	0.844	1.1827	5.025
8	1.9110	1.2570	0.887	1.4171	5.320	1.5460	0.9724	0.817	1.1902	4.878
9	1.7130	1.0630	1.007	1.0556	6.060	1.8360	1.1410	0.852	1.3392	5.031
10	2.1320	1.3980	0.927	1.5081	5.524	2.0300	1.2790	0.960	1.3323	5.727
A	1.9431	1.2625	0.9417	1.3464	5.6224	1.6365	1.0082	0.8683	1.1639	5.1787
SD	0.2230	0.1570	0.0508	0.1989	0.2943	0.2936	0.1834	0.0440	0.2107	0.2591
n	Location D					Location E				
1	1.5360	0.8729	0.842	1.0367	4.980	1.5250	0.8021	0.744	1.0781	4.438
2	1.6380	1.0310	0.888	1.1610	5.266	2.3360	1.3660	0.890	1.5348	5.307
3	0.9664	0.5713	0.813	0.7027	4.868	2.2340	1.2730	0.884	1.4400	5.323
4	1.7130	1.0840	0.848	1.2783	5.105	2.3780	1.2890	0.763	1.6894	4.586
5	1.9700	1.2160	0.854	1.4239	5.130	1.9970	1.0960	0.830	1.3205	5.012
6	1.5190	0.8741	0.835	1.0468	5.013	1.7990	1.0100	0.737	1.3704	4.455
7	1.7340	1.0530	0.919	1.1458	5.522	2.1420	1.2160	0.755	1.6106	4.515
8	1.6540	0.9474	0.847	1.1185	5.022	1.3530	0.7691	0.755	1.0187	4.524
9	1.3690	0.8236	0.820	1.0044	4.881	2.3300	1.3570	0.782	1.7353	4.730
10	2.2440	1.4170	0.903	1.5692	5.390	1.9650	1.1350	0.818	1.3875	4.868
A	1.6343	0.9890	0.8569	1.1487	5.1177	2.0059	1.1313	0.7958	1.4185	4.7758
SD	0.3400	0.2309	0.0352	0.2388	0.2153	0.3536	0.2144	0.0568	0.2388	0.3387

NOTE: The minimum peak and average peel strength values, out of the four locations, from each sample, were used for the analysis. Refer to Table 47 for information about the location and value of minimum peel strength for this package size.

Table 46. Peel Test Results for Package Size (3.25" x 7.25") – 1073B Rexam at Crosshead Speed = 12 ipm and Grip Separation = 2.0" - Continuation

	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)
n	Location A					Location B				
1	1.8470	1.2940	0.972	1.3313	4.907	1.5460	0.9041	0.934	0.9680	4.611
2	1.7400	1.1900	0.955	1.2461	4.762	1.8250	1.0540	0.920	1.1457	4.553
3	1.7400	1.1990	0.981	1.2222	4.919	1.9760	1.3180	0.928	1.4203	4.570
4	1.5680	1.0570	0.903	1.1705	4.573	1.7770	1.0460	0.881	1.1873	4.364
5	2.0830	1.2930	0.920	1.4054	4.592	1.7560	1.0450	0.844	1.2382	4.194
6	2.1800	1.4210	0.884	1.6075	4.391	1.7720	1.0180	0.809	1.2583	4.035
7	1.8420	1.1010	0.965	1.1409	4.813	2.1480	1.4030	0.843	1.6643	4.195
8	2.0510	1.4620	0.893	1.6372	4.455	1.8150	1.1420	0.828	1.3792	4.082
9	2.1100	1.3530	0.911	1.4852	4.521	1.7450	1.1110	0.926	1.1998	4.570
10	2.1800	1.5020	0.915	1.6415	4.625	1.2830	0.7315	0.832	0.8792	4.140
A	1.9341	1.2872	0.9299	1.3888	4.6558	1.7643	1.0773	0.8745	1.2340	4.3314
SD	0.2143	0.1505	0.0351	0.1953	0.1852	0.2305	0.1900	0.0487	0.2234	0.2276
n	Location D					Location E				
1	1.8910	1.2450	0.864	1.4410	4.263	2.0720	1.1340	0.764	1.4843	3.807
2	1.4070	0.8145	0.853	0.9549	4.211	1.6700	0.8691	0.791	1.0987	3.977
3	1.7720	1.0330	0.896	1.1529	4.464	1.9170	1.0910	0.819	1.3321	4.057
4	2.0400	1.2230	0.944	1.2956	4.685	1.6110	0.9032	0.767	1.1776	3.804
5	1.5730	1.0300	0.930	1.1075	4.650	1.5360	0.8631	0.792	1.0898	3.923
6	1.9110	1.2090	0.852	1.4190	4.221	2.2930	1.2630	0.795	1.5887	3.961
7	1.9170	1.1970	0.861	1.3902	4.253	2.0030	1.1230	0.767	1.4641	3.765
8	1.9440	1.2320	0.880	1.4000	4.340	1.6640	0.8888	0.765	1.1618	3.784
9	1.4170	0.8470	0.810	1.0457	4.012	2.0030	1.1310	0.733	1.5430	3.650
10	1.8420	1.2200	0.936	1.3034	4.670	2.3780	1.3780	0.816	1.6887	3.999
A	1.7714	1.1051	0.8826	1.2510	4.3769	1.9147	1.0644	0.7809	1.3629	3.8727
SD	0.2260	0.1646	0.0434	0.1734	0.2304	0.2899	0.1785	0.0265	0.2198	0.1288

NOTE: The minimum peak and average peel strength values, out of the four locations, from each sample, were used for the analysis. Refer to Table 47 for information about the location and value of minimum peel strength for this package size.

Rexam (1073B Tyvek/Polyester/Poly Laminate) Pouches – Continuation

Table 47. Minimum Peel Strength Values for Package Size (3.25" x 7.25") – 1073B Rexam

	Crosshead Speed = 10 ipm Grip Separation = 1.0"				Crosshead Speed = 12 ipm Grip Separation = 1.0"				Crosshead Speed = 10 ipm Grip Separation = 2.0"				Crosshead Speed = 12 ipm Grip Separation = 2.0"			
Sample	**Peak Force (lbs)**	**L**	**Average Force (lbs)**	**L**	**Peak Force (lbs)**	**L**	**Average Force (lbs)**	**L**	**Peak Force (lbs)**	**L**	**Average Force (lbs)**	**L**	**Peak Force (lbs)**	**L**	**Average Force (lbs)**	**L**
1	1.3260	B	0.8111	B	1.7720	D	1.2425	B	1.5250	E	1.0367	D	1.5460	B	0.9680	B
2	2.0350	E	1.3078	D	1.3100	E	0.8587	E	1.6380	D	1.1610	D	1.4070	D	0.9549	D
3	1.5570	E	1.1448	E	1.6590	B	1.1803	B	0.8966	B	0.6245	B	1.7400	A	1.1529	D
4	1.6640	A	1.1811	D	1.8040	D	1.2788	D	1.6110	B	1.1184	B	1.5680	A	1.1705	A
5	1.6590	D	1.0375	D	1.4930	D	0.9945	D	1.5090	A	1.0329	A	1.5360	E	1.0898	E
6	1.6210	B	1.0754	B	1.3420	B	0.9908	B	1.5190	D	1.0468	D	1.7720	B	1.2583	B
7	1.7290	E	1.1758	E	1.0090	B	0.5947	B	1.6590	B	1.1458	D	1.8420	A	1.1409	A
8	1.5840	E	1.1464	E	1.2670	B	0.9474	B	1.3530	E	1.0187	E	1.6640	E	1.1618	E
9	1.2350	B	0.8615	B	1.5570	E	0.9266	E	1.3690	D	1.0044	D	1.4170	D	1.0457	D
10	1.5730	D	1.0930	D	1.6270	B	1.0808	B	1.9650	E	1.3323	B	1.2830	B	0.8792	B
Average	**1.5983**	**NA**	**1.0834**	**NA**	**1.4840**	**NA**	**1.0095**	**NA**	**1.5045**	**NA**	**1.0522**	**NA**	**1.5775**	**NA**	**1.0822**	**NA**
Std Dev	**0.2173**	**NA**	**0.1498**	**NA**	**0.2506**	**NA**	**0.2020**	**NA**	**0.2742**	**NA**	**0.1796**	**NA**	**0.1783**	**NA**	**0.1181**	**NA**

NOTE: L = Location of the minimum peel strength value in a sample (pouch), Refer to Figure 14
The minimum values were taken from Table 46, pages 136-139

Table 48. Peel Test Results for Package Size (5.25" x 9.125") – 1073B Rexam at Crosshead Speed = 10 ipm and Grip Separation = 1.0"

	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)
n	Location A					Location B				
1	1.2400	0.7468	1.047	0.7133	6.233	2.2230	1.6650	1.025	1.6244	6.034
2	1.5840	1.0500	0.954	1.1006	5.737	1.8900	1.3500	1.002	1.3473	5.980
3	1.7660	1.1550	0.940	1.2287	5.621	2.2340	1.7170	1.051	1.6337	6.230
4	2.1150	1.4320	1.048	1.3664	6.282	2.0720	1.4400	1.059	1.3598	6.281
5	2.1580	1.4520	1.016	1.4291	6.070	1.9760	1.5060	1.014	1.4852	6.077
6	2.4000	1.4360	0.997	1.4403	5.935	2.2760	1.7020	1.064	1.5996	6.335
7	2.2550	1.3030	0.995	1.3095	5.890	2.4000	1.7130	1.010	1.6960	5.922
8	1.1920	0.7644	0.950	0.8046	5.695	2.1420	1.6470	1.011	1.6291	6.025
9	1.7610	1.0590	1.127	0.9397	6.750	1.5140	1.1040	0.984	1.1220	5.910
10	1.5190	0.9410	0.967	0.9731	5.755	1.8850	1.4400	1.084	1.3284	6.445
A	1.7990	1.1339	1.0041	1.1305	5.9968	2.0612	1.5284	1.0304	1.4825	6.1239
SD	0.4224	0.2680	0.0578	0.2635	0.3469	0.2562	0.2002	0.0321	0.1859	0.1859
n	Location D					Location E				
1	2.3140	1.6940	1.000	1.6940	5.949	1.9270	1.4910	1.118	1.3336	6.670
2	1.6910	1.2570	1.050	1.1971	6.310	1.8740	1.4520	1.127	1.2884	6.765
3	1.5730	1.1720	0.998	1.1743	5.977	1.6640	1.1880	1.067	1.1134	6.394
4	2.1100	1.5200	1.068	1.4232	6.404	1.8520	1.3540	1.049	1.2908	6.243
5	1.9490	1.4000	1.156	1.2111	6.919	1.4760	1.1060	1.101	1.0045	6.576
6	2.2230	1.6560	1.014	1.6331	6.031	1.3150	0.9789	1.070	0.9149	6.387
7	1.9600	1.4770	1.073	1.3765	6.461	1.8520	1.4670	1.089	1.3471	6.522
8	1.9490	1.4950	1.033	1.4472	6.179	1.7020	1.2920	1.103	1.1714	6.628
9	1.4660	0.9777	1.037	0.9428	6.208	1.9920	1.4560	1.164	1.2509	6.845
10	2.0830	1.5330	1.047	1.4642	5.269	1.9330	1.3630	1.094	1.2459	6.487
A	1.9318	1.4182	1.0476	1.3564	6.1707	1.7587	1.3148	1.0982	1.1961	6.5517
SD	0.2770	0.2227	0.0459	0.2275	0.4267	0.2193	0.1732	0.0331	0.1445	0.1839

NOTE: The minimum peak and average peel strength values, out of the four locations, from each sample, were used for the analysis. Refer to Table 49 for information about the location and value of minimum peel strength for this package size.

Table 48. Peel Test Results for Package Size (5.25" x 9.125") – 1073B Rexam at Crosshead Speed = 12 ipm and Grip Separation = 1.0" - Continuation

	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)
n	Location A					Location B				
1	1.7830	1.1620	1.130	1.0283	5.637	1.7180	1.2190	1.025	1.1893	5.051
2	1.9170	1.2230	0.984	1.2429	4.907	2.1370	1.6480	1.044	1.5785	5.210
3	1.5410	1.0190	0.957	1.0648	4.794	2.2930	1.7540	1.021	1.7179	5.131
4	1.7180	1.1080	1.002	1.1058	4.840	2.2010	1.6830	1.090	1.5440	5.439
5	1.8630	1.1790	0.953	1.2371	4.727	2.1740	1.6480	1.083	1.5217	5.391
6	1.5410	0.9160	1.051	0.8716	5.282	1.8740	1.3430	1.009	1.3310	5.021
7	2.0940	1.3190	1.065	1.2385	5.342	1.9440	1.4430	1.192	1.2106	5.893
8	1.4500	1.0210	1.056	0.9669	5.191	1.6540	1.1400	1.024	1.1133	5.063
9	1.7450	1.0920	1.111	0.9829	5.599	1.2240	0.8823	1.029	0.8574	5.112
10	1.1010	0.7785	1.108	0.7026	5.524	2.2170	1.6340	1.089	1.5005	5.435
A	1.6753	1.0818	1.0417	1.0441	5.1843	1.9436	1.4394	1.0606	1.3564	5.2746
SD	0.2797	0.1563	0.0648	0.1748	0.3470	0.3352	0.2870	0.0553	0.2627	0.2706
n	Location D					Location E				
1	2.1960	1.7410	1.096	1.5885	5.475	1.8740	1.4990	1.077	1.3918	5.323
2	2.1100	1.5230	1.029	1.4801	5.153	1.8740	1.4270	1.060	1.3462	5.242
3	1.9700	1.5010	1.031	1.4559	5.073	1.8090	1.4350	1.153	1.2446	5.711
4	2.1850	1.4910	1.045	1.4268	5.134	1.8150	1.3210	1.009	1.3092	5.051
5	1.9330	1.3580	1.064	1.2763	5.284	1.9010	1.3860	1.091	1.2704	5.419
6	1.9970	1.5140	1.053	1.4378	5.263	2.2340	1.6210	1.113	1.4564	5.506
7	1.7880	1.3020	1.117	1.1656	5.586	1.8090	1.2660	1.065	1.1887	5.324
8	1.6380	1.2170	0.990	1.2293	4.987	1.8630	1.4040	1.313	1.0693	6.499
9	2.2010	1.6190	1.096	1.4772	5.407	2.0080	1.4760	1.107	1.3333	5.577
10	2.0030	1.4660	1.087	1.3487	5.400	1.8250	1.3400	1.056	1.2689	5.324
A	2.0021	1.4732	1.0608	1.3886	5.2762	1.9012	1.4175	1.1044	1.2879	5.4976
SD	0.1845	0.1515	0.0388	0.1308	0.1910	0.1314	0.1007	0.0829	0.1082	0.3967

NOTE: The minimum peak and average peel strength values, out of the four locations, from each sample, were used for the analysis. Refer to Table 49 for information about the location and value of minimum peel strength for this package size.

Table 48. Peel Test Results for Package Size (5.25" x 9.125") – 1073B Rexam at Crosshead Speed = 10 ipm and Grip Separation = 2.0" - Continuation

	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)
n	Location A					Location B				
1	1.8420	1.2310	0.845	1.4568	5.045	1.9600	1.4580	0.978	1.4908	5.823
2	1.4280	0.9718	0.943	1.0305	5.654	2.2070	1.6240	0.961	1.6899	5.750
3	2.1210	1.2700	0.869	1.4614	5.204	1.9490	1.4970	1.008	1.4851	5.980
4	1.9760	1.2680	0.897	1.4136	5.323	1.8040	1.3020	0.956	1.3619	5.730
5	2.1480	1.4040	0.950	1.4779	5.672	1.8950	1.3470	1.000	1.3470	5.913
6	1.3580	0.8569	0.847	1.0117	5.064	1.6860	1.1340	0.993	1.1420	5.910
7	1.8200	1.1960	0.873	1.3700	5.166	2.2440	1.5380	0.973	1.5807	5.823
8	1.8310	1.1860	0.883	1.3431	5.310	1.8950	1.3280	0.988	1.3441	5.862
9	1.8200	1.1740	0.907	1.2944	5.425	2.0830	1.5060	1.016	1.4823	6.073
10	1.4390	0.8712	0.884	0.9855	5.262	1.8520	1.3660	1.040	1.3135	6.170
A	1.7783	1.1429	0.8898	1.2845	5.3125	1.9575	1.4100	0.9913	1.4237	5.9034
SD	0.2825	0.1820	0.0356	0.1984	0.2180	0.1752	0.1421	0.0259	0.1545	0.1391
n	Location D					Location E				
1	2.0890	1.4550	0.964	1.5093	5.795	1.3740	1.0620	1.044	1.0172	6.266
2	2.1690	1.6060	0.978	1.6421	5.871	1.8790	1.4480	0.993	1.4582	5.903
3	1.7830	1.3010	1.010	1.2881	6.015	2.1420	1.5830	1.035	1.5295	6.105
4	1.8200	1.3360	0.963	1.3873	5.792	1.6110	1.1870	1.038	1.1435	6.243
5	1.5460	1.1120	0.992	1.1210	5.893	1.9920	1.3870	1.064	1.3036	6.335
6	2.0130	1.5510	1.033	1.5015	6.163	1.9220	1.4350	1.051	1.3654	6.220
7	1.8090	1.2600	0.964	1.3071	5.843	2.2340	1.6150	0.984	1.6413	5.887
8	1.4550	1.0730	1.020	1.0520	6.082	2.1530	1.5090	1.014	1.4882	6.050
9	1.6430	1.1160	0.957	1.1661	5.691	1.9760	1.5360	1.036	1.4826	6.224
10	2.0300	1.5270	1.020	1.4971	6.109	1.7720	1.3650	1.019	1.3395	6.055
A	1.8357	1.3337	0.9901	1.3472	5.9254	1.9055	1.4127	1.0278	1.3769	6.1288
SD	0.2390	0.1956	0.0286	0.1936	0.1575	0.2636	0.1742	0.0252	0.1868	0.1540

NOTE: The minimum peak and average peel strength values, out of the four locations, from each sample, were used for the analysis. Refer to Table 49 for information about the location and value of minimum peel strength for this package size.

Table 48. Peel Test Results for Package Size (5.25" x 9.125") – 1073B Rexam at Crosshead Speed = 12 ipm and Grip Separation = 2.0" - Continuation

	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)
n	Location A					Location B				
1	1.8040	1.2280	0.840	1.4619	4.188	2.3140	1.6400	0.969	1.6925	4.835
2	1.2300	0.8403	0.894	0.9399	4.400	2.1210	1.6040	0.958	1.6743	4.750
3	0.9825	0.6385	0.901	0.7087	4.532	2.3250	1.6940	0.992	1.7077	4.903
4	1.8250	1.2110	0.894	1.3546	4.374	1.8150	1.2120	0.982	1.2342	4.878
5	1.7450	1.0970	0.873	1.2566	4.332	2.5500	1.9310	1.009	1.9138	4.977
6	1.7230	1.1140	0.896	1.2433	4.451	1.9060	1.4150	0.968	1.4618	4.778
7	1.7290	1.1000	0.937	1.1740	4.682	2.2660	1.7150	1.017	1.6863	4.929
8	2.2870	1.5510	0.901	1.7214	4.483	2.1850	1.6860	0.992	1.6996	4.980
9	1.4600	0.8877	0.930	0.9545	4.608	1.6160	1.1110	0.979	1.1348	4.897
10	1.5410	1.0130	0.917	1.1047	4.602	2.4590	1.8470	1.033	1.7880	5.111
A	1.6327	1.0681	0.8983	1.1920	4.4652	2.1557	1.5855	0.9899	1.5993	4.9038
SD	0.3571	0.2484	0.0278	0.2883	0.1484	0.2954	0.2632	0.0238	0.2463	0.1052
n	Location D					Location E				
1	1.6430	1.1600	0.972	1.1934	4.823	1.9600	1.3900	0.988	1.4069	4.971
2	1.7560	1.3240	0.998	1.3267	4.977	2.1800	1.5570	1.030	1.5117	5.031
3	2.8460	1.5220	1.019	1.4936	5.073	1.7070	1.3360	1.059	1.2616	5.250
4	2.2070	1.6030	0.982	1.6324	4.874	2.1050	1.7040	1.136	1.5000	5.770
5	2.1100	1.4550	1.007	1.4449	4.951	2.1050	1.6230	1.041	1.5591	5.114
6	2.2820	1.7840	1.080	1.6519	5.378	1.7180	1.1950	1.049	1.1392	5.182
7	1.6700	1.1380	1.020	1.1157	5.201	1.9440	1.4800	1.022	1.4481	5.096
8	2.1740	1.5640	1.051	1.4881	5.256	2.4270	1.7620	1.026	1.7173	5.150
9	2.0300	1.5520	1.058	1.4669	5.266	2.2870	1.7900	1.025	1.7463	5.051
10	1.8630	1.3210	0.989	1.3357	4.893	1.7660	1.3490	1.001	1.3477	4.961
A	2.0581	1.4423	1.0176	1.4149	5.0692	2.0199	1.5186	1.0377	1.4638	5.1576
SD	0.3594	0.2047	0.0355	0.1736	0.1940	0.2450	0.2012	0.0404	0.1886	0.2335

NOTE: The minimum peak and average peel strength values, out of the four locations, from each sample, were used for the analysis. Refer to Table 49 for information about the location and value of minimum peel strength for this package size.

Rexam (1073B Tyvek/Polyester/Poly Laminate) Pouches - Continuation

Table 49. Minimum Peel Strength Values for Package Size (5.25" x 9.125") – 1073B Rexam

	Crosshead Speed = 10 ipm Grip Separation = 1.0"				Crosshead Speed = 12 ipm Grip Separation = 1.0"				Crosshead Speed = 10 ipm Grip Separation = 2.0"				Crosshead Speed = 12 ipm Grip Separation = 2.0"			
Sample	**Peak Force (lbs)**	**L**	**Average Force (lbs)**	**L**	**Peak Force (lbs)**	**L**	**Average Force (lbs)**	**L**	**Peak Force (lbs)**	**L**	**Average Force (lbs)**	**L**	**Peak Force (lbs)**	**L**	**Average Force (lbs)**	**L**
1	1.2400	A	0.7133	A	1.7180	B	1.0283	A	1.3740	E	1.0172	E	1.6430	D	1.1934	D
2	1.5840	A	1.1006	A	1.8740	E	1.2429	A	1.4280	A	1.0305	A	1.2300	A	0.9399	A
3	1.5730	D	1.1134	E	1.5410	A	1.0648	A	1.7830	D	1.2881	D	0.9825	A	0.7087	A
4	1.8520	E	1.2908	E	1.7180	A	1.1058	A	1.6110	E	1.1435	E	1.8150	B	1.2342	B
5	1.4760	E	1.0045	E	1.8630	A	1.2371	A	1.5460	D	1.1210	D	1.7450	A	1.2566	A
6	1.3150	E	0.9149	E	1.5410	A	0.8716	A	1.3580	A	1.0117	A	1.7180	E	1.1392	E
7	1.8520	E	1.3095	A	1.7880	D	1.1656	D	1.8090	D	1.3071	D	1.6700	D	1.1157	D
8	1.1920	A	0.8046	A	1.4500	A	0.9669	A	1.4550	D	1.0520	D	2.1740	D	1.4881	D
9	1.4660	D	0.9397	A	1.2240	B	0.8574	B	1.6430	D	1.1661	D	1.4600	A	0.9545	A
10	1.5190	A	0.9731	A	1.1010	A	0.7026	A	1.4390	A	0.9855	A	1.5410	A	1.1047	A
Average	**1.5069**	**NA**	**1.0164**	**NA**	**1.5818**	**NA**	**1.0243**	**NA**	**1.5446**	**NA**	**1.1123**	**NA**	**1.5979**	**NA**	**1.1135**	**NA**
Std Dev	**0.2257**	**NA**	**0.1923**	**NA**	**0.2633**	**NA**	**0.1762**	**NA**	**0.1625**	**NA**	**0.1147**	**NA**	**0.3264**	**NA**	**0.2113**	**NA**

NOTE: L = Location of the minimum peel strength value in a sample (pouch), Refer to Figure 14
The minimum values were taken from Table 48, pages 141-144

Table 50. Peel Test Results for Package Size (7.25" x 11.125") – 1073B Rexam at Crosshead Speed = 10 ipm and Grip Separation = 1.0"

	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)
n	Location A					Location B				
1	1.4550	0.8794	1.029	0.8546	6.169	1.6380	1.3260	1.108	1.1968	6.560
2	1.0680	0.6466	0.890	0.7265	5.291	1.6430	1.3220	1.063	1.2437	6.361
3	1.2560	0.7420	0.915	0.8109	5.445	1.7020	1.4270	1.099	1.2985	6.592
4	1.5300	0.9169	0.904	1.0143	5.391	2.0830	1.6580	1.120	1.4804	6.714
5	2.0460	1.2780	0.868	1.4724	5.170	1.4280	1.0440	1.103	0.9465	6.600
6	1.6380	0.9701	0.898	1.0803	5.355	1.9110	1.6270	1.126	1.4449	6.695
7	1.4390	0.7978	0.871	0.9160	5.195	1.9810	1.6080	1.087	1.4793	6.505
8	1.4870	0.9234	0.855	1.0800	4.984	1.1220	0.8680	1.124	0.7722	6.650
9	1.6320	1.0410	0.895	1.1631	5.352	1.6590	1.3970	1.064	1.3130	6.339
10	1.1970	0.7674	0.899	0.8536	5.374	1.7070	1.4070	1.151	1.2224	6.830
A	1.4748	0.8963	0.9024	0.9972	5.3726	1.6874	1.3684	1.1045	1.2398	6.5846
SD	0.2735	0.1783	0.0481	0.2168	0.3111	0.2760	0.2524	0.0278	0.2292	0.1531
n	Location D					Location E				
1	2.0670	1.6020	1.068	1.5000	6.384	1.5460	1.0160	1.046	0.9713	6.220
2	2.1370	1.7640	1.263	1.3967	7.528	1.3100	0.7794	0.941	0.8283	5.618
3	1.6050	1.2130	1.183	1.0254	7.034	1.4230	0.8481	1.043	0.8131	6.179
4	1.8360	1.3490	1.104	1.2219	6.592	1.4820	0.8811	1.110	0.7938	6.587
5	1.7070	1.3300	1.138	1.1687	6.730	1.7770	1.2280	1.011	1.2146	6.012
6	1.8740	1.4370	1.070	1.3430	6.400	1.9490	1.3120	0.990	1.3253	5.920
7	1.7020	1.3630	1.106	1.2324	6.609	1.1920	0.7799	1.054	0.7399	6.253
8	1.6110	1.0510	1.054	0.9972	6.294	1.6430	1.0690	0.983	1.0875	5.801
9	1.9330	1.4160	1.110	1.2757	6.641	1.4870	0.9368	0.924	1.0139	5.542
10	1.9110	1.5680	1.051	1.4919	6.253	1.3050	0.8636	0.893	0.9671	5.252
A	1.8383	1.4093	1.1147	1.2653	6.6465	1.5114	0.9714	0.9995	0.9755	5.9384
SD	0.1823	0.2022	0.0661	0.1737	0.3869	0.2297	0.1835	0.0668	0.1915	0.3961

NOTE: The minimum peak and average peel strength values, out of the four locations, from each sample, were used for the analysis. Refer to Table 51 for information about the location and value of minimum peel strength for this package size.

Table 50. Peel Test Results for Package Size (7.25" x 11.125") – 1073B Rexam at Crosshead Speed = 12 ipm and Grip Separation = 1.0" - Continuation

	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)
n	Location A					Location B				
1	1.6700	1.0660	1.043	1.0221	5.170	1.6700	1.3440	1.117	1.2032	5.535
2	1.7400	0.9344	0.900	1.0382	5.734	1.8040	1.4410	1.072	1.3442	5.339
3	1.5840	0.9050	0.810	1.1173	4.003	1.4120	1.1200	1.084	1.0332	5.432
4	1.8040	1.0190	0.836	1.2189	4.173	2.3680	1.9440	1.168	1.6644	5.733
5	1.8680	1.0820	0.912	1.1864	4.519	1.9220	1.5550	1.080	1.4398	5.320
6	1.0090	0.6138	0.876	0.7007	4.384	2.0350	1.7460	1.102	1.5844	5.435
7	1.0470	0.6106	0.825	0.7401	4.092	2.1150	1.7950	1.096	1.6378	5.456
8	1.7180	1.0450	0.893	1.1702	4.455	2.1640	1.6780	1.128	1.4876	5.602
9	1.4820	0.8338	0.852	0.9786	4.317	1.8090	1.5490	1.133	1.3672	5.554
10	1.6270	0.9450	0.878	1.0763	4.342	2.3030	1.9900	1.100	1.8091	5.420
A	1.5549	0.9055	0.8825	1.0249	4.5189	1.9602	1.6162	1.1080	1.4571	5.4826
SD	0.2984	0.1728	0.0656	0.1778	0.5336	0.2960	0.2706	0.0291	0.2314	0.1253
n	Location D					Location E				
1	1.7560	1.3590	1.121	1.2123	5.516	1.6970	1.2030	1.422	0.8460	6.105
2	2.1100	1.7620	1.077	1.6360	5.361	1.7610	1.2010	1.018	1.1798	4.990
3	1.9810	1.5900	1.253	1.2690	6.172	1.9110	1.3090	1.025	1.2771	5.060
4	2.0830	1.4380	1.089	1.3205	5.448	1.5520	1.1430	1.097	1.0419	5.439
5	1.6590	1.3570	1.149	1.1810	5.650	1.8150	1.3410	1.002	1.3383	4.920
6	2.2390	1.7950	1.083	1.6574	5.384	1.4170	1.0660	1.057	1.0085	5.529
7	2.4540	2.1490	1.160	1.8526	5.717	1.6270	1.1460	1.029	1.1137	5.022
8	1.8470	1.5630	1.153	1.3556	5.714	1.9170	1.2740	1.026	1.2417	4.961
9	2.2390	1.6640	1.072	1.5522	5.332	1.5790	1.1230	0.957	1.1735	4.817
10	1.7770	1.4760	1.112	1.3273	5.410	1.7930	1.2550	1.016	1.2352	5.034
A	2.0145	1.6153	1.1269	1.4364	5.5704	1.7069	1.2061	1.0649	1.1456	5.1877
SD	0.2553	0.2421	0.0551	0.2238	0.2559	0.1629	0.0882	0.1305	0.1468	0.3927

NOTE: The minimum peak and average peel strength values, out of the four locations, from each sample, were used for the analysis. Refer to Table 51 for information about the location and value of minimum peel strength for this package size.

Table 50. Peel Test Results for Package Size (7.25" x 11.125") – 1073B Rexam at Crosshead Speed = 10 ipm and Grip Separation = 2.0" - Continuation

	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)
n	Location A					Location B				
1	1.8520	1.0700	0.807	1.3259	4.846	1.6640	1.4080	1.142	1.2329	6.769
2	1.8520	1.0930	0.877	1.2463	5.250	1.9330	1.6410	1.117	1.4691	6.663
3	2.0240	1.1820	0.832	1.4207	4.952	1.6590	1.1580	1.069	1.0833	6.311
4	1.8740	1.0950	0.828	1.3225	4.893	1.9060	1.5680	1.097	1.4294	6.535
5	2.4380	1.4080	0.804	1.7512	4.762	1.9380	1.5110	1.073	1.4082	6.452
6	1.5030	0.8038	0.870	0.9239	5.175	1.6910	1.2520	1.073	1.1668	6.467
7	1.5620	0.8040	0.779	1.0321	4.650	1.8040	1.2830	1.082	1.1858	6.484
8	1.1700	0.6588	0.825	0.7985	4.906	1.3370	0.9713	1.041	0.9330	6.217
9	2.1740	1.1360	0.807	1.4077	4.759	2.0620	1.5640	1.079	1.4495	6.451
10	1.4600	0.8397	0.843	0.9961	4.977	1.7020	1.3670	1.080	1.2657	6.440
A	1.7909	1.0090	0.8272	1.2225	4.9170	1.7696	1.3723	1.0853	1.2624	6.4789
SD	0.3748	0.2258	0.0303	0.2850	0.1851	0.2059	0.2100	0.0278	0.1774	0.1568
n	Location D					Location E				
1	2.4380	2.0480	1.073	1.9087	6.426	1.7720	1.2110	1.038	1.1667	6.170
2	2.3030	1.9100	1.164	1.6409	7.019	1.6910	1.2270	0.960	1.2781	5.723
3	2.0400	1.5290	1.141	1.3401	6.826	1.8740	1.3260	0.920	1.4413	5.452
4	1.1920	0.9080	1.074	0.8454	6.429	1.7230	1.1800	0.967	1.2203	5.788
5	2.2820	1.8060	1.116	1.6183	6.670	1.9170	1.2020	0.942	1.2760	5.499
6	1.6970	1.2990	1.035	1.2551	6.137	2.2010	1.4700	0.949	1.5490	5.631
7	2.2440	1.6930	1.088	1.5561	6.452	1.6380	1.0400	0.936	1.1111	5.582
8	2.1260	1.5890	1.073	1.4809	6.324	1.6110	1.0470	0.954	1.0975	5.653
9	2.0510	1.7180	1.094	1.5704	6.509	1.8950	1.3330	0.937	1.4226	5.554
10	1.8090	1.3510	1.068	1.2650	6.330	1.8850	1.3140	0.926	1.4190	5.512
A	2.0182	1.5851	1.0926	1.4481	6.5122	1.8207	1.2350	0.9529	1.2982	5.6564
SD	0.3683	0.3327	0.0381	0.2890	0.2598	0.1740	0.1323	0.0333	0.1538	0.2081

NOTE: The minimum peak and average peel strength values, out of the four locations, from each sample, were used for the analysis. Refer to Table 51 for information about the location and value of minimum peel strength for this package size.

Table 50. Peel Test Results for Package Size (7.25" x 11.125") – 1073B Rexam at Crosshead Speed = 12 ipm and Grip Separation = 2.0" - Continuation

	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)
n	Location A					Location B				
1	1.9700	1.0680	0.857	1.2462	4.291	1.6480	1.3320	1.096	1.2153	5.460
2	2.2500	1.1680	0.789	1.4804	3.903	1.9810	1.6640	1.107	1.5032	5.525
3	1.8250	1.0670	0.819	1.3028	4.073	1.0470	0.8600	1.268	0.6782	6.310
4	1.4600	0.8564	0.809	1.0586	4.012	1.8580	1.5530	1.109	1.4004	5.473
5	0.8161	0.4714	0.790	0.5967	3.929	1.6270	1.3850	1.097	1.2625	5.487
6	1.4070	0.7821	0.820	0.9538	4.073	1.7720	1.4430	1.230	1.1732	6.085
7	1.3640	0.7250	0.802	0.9040	3.925	1.9650	1.5430	1.088	1.4182	5.403
8	1.4120	0.8179	0.908	0.9008	4.528	2.1320	1.7170	1.077	1.5942	5.320
9	1.3320	0.7165	0.807	0.8879	3.983	1.9060	1.5280	1.110	1.3766	5.464
10	2.1050	1.2190	0.824	1.4794	4.070	1.4870	1.1120	1.079	1.0306	5.624
A	1.5941	0.8891	0.8225	1.0810	4.0787	1.7423	1.4137	1.1261	1.2652	5.6151
SD	0.4345	0.2355	0.0358	0.2881	0.1937	0.3110	0.2603	0.0664	0.2645	0.3210
n	Location D					Location E				
1	1.4600	1.0280	1.069	0.9616	5.336	2.0350	1.4490	0.988	1.4666	4.901
2	2.1100	1.4700	1.053	1.3960	5.234	2.0830	1.3630	0.944	1.4439	4.672
3	1.9490	1.6040	1.105	1.4516	5.496	1.7560	1.3020	1.036	1.2568	5.128
4	1.9540	1.5050	1.096	1.3732	5.461	1.9760	1.3620	0.989	1.3771	4.871
5	1.3370	0.9370	1.054	0.8890	5.272	1.6750	1.1690	0.949	1.2318	4.643
6	2.3300	1.7460	1.257	1.3890	6.220	1.2720	0.9063	0.977	0.9276	4.871
7	1.8580	1.3630	1.053	1.2944	5.225	1.2720	0.8178	1.008	0.8113	4.984
8	2.1690	1.7360	1.064	1.6316	5.252	1.5090	0.9957	0.932	1.0683	4.637
9	1.6050	1.2100	1.069	1.1319	5.291	1.9490	1.3600	0.929	1.4639	4.553
10	2.4860	2.0740	1.088	1.9063	5.416	1.4340	0.8853	0.969	0.9136	4.631
A	1.9258	1.4673	1.0908	1.3425	5.4203	1.6961	1.1610	0.9721	1.1961	4.7891
SD	0.3716	0.3479	0.0612	0.3012	0.2970	0.3117	0.2380	0.0345	0.2495	0.1879

NOTE: The minimum peak and average peel strength values, out of the four locations, from each sample, were used for the analysis. Refer to Table 51 for information about the location and value of minimum peel strength for this package size.

Rexam (1073B Tyvek/Polyester/Poly Laminate) Pouches - Continuation

Table 51. Minimum Peel Strength Values for Package Size (7.25" x 11.125") – 1073B Rexam

	Crosshead Speed = 10 ipm Grip Separation = 1.0"				Crosshead Speed = 12 ipm Grip Separation = 1.0"				Crosshead Speed = 10 ipm Grip Separation = 2.0"				Crosshead Speed = 12 ipm Grip Separation = 2.0"			
Sample	Peak Force (lbs)	L	Average Force (lbs)	L	Peak Force (lbs)	L	Average Force (lbs)	L	Peak Force (lbs)	L	Average Force (lbs)	L	Peak Force (lbs)	L	Average Force (lbs)	L
1	1.4550	A	0.8546	A	1.6700	A	0.8460	E	1.6640	B	1.1667	E	1.4600	D	0.9616	D
2	1.0680	A	0.7265	A	1.7400	A	1.0382	A	1.6910	E	1.2463	A	1.9810	B	1.3960	D
3	1.2560	A	0.8109	A	1.4120	B	1.0332	B	1.6590	B	1.0833	B	1.0470	B	0.6782	B
4	1.4820	E	0.7938	E	1.5520	E	1.0419	E	1.1920	D	0.8454	D	1.4600	A	1.0586	A
5	1.4280	B	0.9465	B	1.6590	D	1.1810	D	1.9170	E	1.2760	E	0.8161	A	0.5967	A
6	1.6380	A	1.0803	A	1.0090	A	0.7007	A	1.5030	A	0.9239	A	1.2720	E	0.9276	E
7	1.1920	E	0.7399	E	1.0470	A	0.7401	A	1.5620	A	1.0321	A	1.2720	E	0.8113	E
8	1.1220	B	0.7722	B	1.7180	A	1.1702	A	1.1700	A	0.7985	A	1.4120	A	0.9008	A
9	1.4870	E	1.0139	E	1.4820	A	0.9786	A	1.8950	E	1.4077	A	1.3320	A	0.8879	A
10	1.1970	A	0.8536	A	1.6270	A	1.0763	A	1.4600	A	0.9961	A	1.4340	E	0.9136	E
Average	**1.3325**	**NA**	**0.8592**	**NA**	**1.4916**	**NA**	**0.9806**	**NA**	**1.5713**	**NA**	**1.0776**	**NA**	**1.3486**	**NA**	**0.9132**	**NA**
Std Dev	**0.1891**	**NA**	**0.1185**	**NA**	**0.2650**	**NA**	**0.1665**	**NA**	**0.2532**	**NA**	**0.1969**	**NA**	**0.3023**	**NA**	**0.2169**	**NA**

NOTE: L = Location of the minimum peel strength value in a sample (pouch), Refer to Figure 14
The minimum values were taken from Table 50, pages 146-149

Table 52. Peel Test Results for Package Size (9.25" x 14.125") - 1073B Rexam at Crosshead Speed = 10 ipm and Grip Separation = 1.0"

	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)
n	Location A					Location B				
1	1.8850	1.2650	1.064	1.1889	6.310	2.1150	1.6040	1.067	1.5033	6.342
2	1.3050	0.9221	1.273	0.7244	6.396	1.8200	1.3260	1.107	1.1978	6.644
3	2.2930	1.6190	1.041	1.5552	6.240	2.0990	1.4500	1.127	1.2866	6.679
4	1.8200	1.2780	1.018	1.2554	6.015	1.9220	1.4950	1.137	1.3149	6.820
5	2.5450	1.7470	1.120	1.5598	6.698	1.8150	1.3150	1.031	1.2755	6.185
6	1.6540	1.1300	0.980	1.1531	5.859	1.6970	1.1940	1.261	0.9469	7.536
7	2.4000	1.6190	0.990	1.6354	5.929	1.9270	1.5000	1.022	1.4677	6.141
8	1.6860	1.1460	0.951	1.2050	5.788	1.7500	1.1920	1.007	1.1837	6.053
9	2.0130	1.3590	1.001	1.3576	5.974	1.7880	1.3750	1.011	1.3600	6.035
10	1.9330	1.3450	0.979	1.3739	5.907	1.8250	1.3200	1.027	1.2853	6.144
A	1.9534	1.3430	1.0417	1.3009	6.1116	1.8758	1.3771	1.0797	1.2822	6.4579
SD	0.3761	0.2555	0.0949	0.2646	0.2892	0.1401	0.1347	0.0801	0.1563	0.4722
n	Location D					Location E				
1	1.4930	1.0780	1.057	1.0199	6.349	1.9330	1.2070	0.969	1.2456	5.836
2	1.7450	1.1950	1.034	1.1557	6.244	1.9920	1.2360	0.993	1.2447	5.935
3	1.1330	0.7599	1.080	0.7036	6.484	1.9490	1.3190	1.073	1.2293	6.432
4	1.8900	1.4120	1.134	1.2451	6.817	2.2120	1.3770	1.166	1.1810	6.954
5	1.9270	1.3390	1.041	1.2863	6.237	1.8040	1.2280	1.074	1.1434	6.425
6	1.3530	0.9743	1.025	0.9505	6.121	1.9600	1.2510	0.990	1.2636	5.952
7	1.9870	1.4600	1.016	1.4370	6.108	2.1050	1.3610	1.034	1.3162	6.202
8	2.0620	1.5620	1.063	1.4694	6.356	1.6810	1.0170	0.910	1.1176	5.461
9	1.4280	1.0650	0.984	1.0823	5.852	1.8950	1.1510	0.974	1.1817	5.791
10	1.8630	1.2920	0.976	1.3238	5.823	1.5840	0.9062	0.958	0.9459	5.746
A	1.6881	1.2137	1.0410	1.1674	6.2391	1.9115	1.2053	1.0141	1.1869	6.0734
SD	0.3139	0.2466	0.0463	0.2357	0.2932	0.1858	0.1483	0.0739	0.1033	0.4342

NOTE: The minimum peak and average peel strength values, out of the four locations, from each sample, were used for the analysis. Refer to Table 53 for information about the location and value of minimum peel strength for this package size.

Table 52. Peel Test Results for Package Size (9.25" x 14.125") - 1073B Rexam at Crosshead Speed = 12 ipm and Grip Separation = 1.0" - Continuation

	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)
n	Location A					Location B				
1	1.8090	1.1810	1.066	1.1079	5.260	1.5090	1.1810	1.044	1.1312	5.252
2	1.7830	1.1920	1.153	1.0338	5.723	1.8040	1.3060	1.112	1.1745	5.563
3	2.1640	1.5440	1.097	1.4075	5.499	1.9170	1.4810	1.138	1.3014	5.656
4	2.0720	1.3640	1.084	1.2583	5.413	1.8680	1.3500	1.051	1.2845	5.153
5	1.8850	1.3440	1.174	1.1448	5.839	1.4070	0.9542	1.046	0.9122	5.140
6	2.1910	1.6190	1.124	1.4404	5.592	2.1480	1.5310	1.112	1.3768	5.563
7	2.3520	1.5740	1.100	1.4309	5.499	1.8090	1.3170	1.006	1.3091	5.000
8	1.9440	1.3710	1.043	1.3145	5.099	2.2230	1.5490	1.029	1.5053	5.112
9	1.7340	1.2140	1.072	1.1325	5.320	1.6480	1.2150	1.320	0.9205	6.582
10	1.4550	0.9910	1.223	0.8103	6.096	1.7930	1.2990	1.036	1.2539	5.166
A	1.9389	1.3394	1.1136	1.2081	5.5340	1.8126	1.3183	1.0894	1.2169	5.4187
SD	0.2631	0.2002	0.0554	0.2015	0.2935	0.2537	0.1791	0.0916	0.1886	0.4667
n	Location D					Location E				
1	1.9060	1.4310	1.046	1.3681	5.191	1.9330	1.2060	1.031	1.1697	5.170
2	1.7180	1.2990	1.083	1.1994	5.412	2.1210	1.3960	0.960	1.4542	4.820
3	1.8630	1.3360	1.116	1.1971	5.557	2.2760	1.3940	1.106	1.2604	5.513
4	1.8250	1.2830	1.022	1.2554	5.076	1.5620	1.0080	1.132	0.8905	5.618
5	1.8040	1.3630	1.141	1.1946	5.749	1.8040	1.0130	1.012	1.0010	5.041
6	1.3850	1.0340	1.123	0.9207	5.612	1.9220	1.1910	0.989	1.2042	4.926
7	1.8470	1.3640	1.125	1.2124	5.586	1.7930	1.1440	1.033	1.1075	5.140
8	1.9810	1.4420	1.090	1.3229	5.445	1.7930	1.1350	0.952	1.1922	4.730
9	1.9270	1.4720	1.191	1.2359	5.955	1.7720	1.1430	0.912	1.2533	4.551
10	1.8630	1.4460	1.050	1.3771	5.204	1.5730	1.0070	0.922	1.0922	4.573
A	1.8119	1.3470	1.0987	1.2284	5.4787	1.8549	1.1637	1.0049	1.1625	5.0082
SD	0.1661	0.1276	0.0508	0.1288	0.2711	0.2214	0.1425	0.0734	0.1541	0.3635

NOTE: The minimum peak and average peel strength values, out of the four locations, from each sample, were used for the analysis. Refer to Table 53 for information about the location and value of minimum peel strength for this package size.

Table 52. Peel Test Results for Package Size (9.25" x 14.125") - 1073B Rexam at Crosshead Speed = 10 ipm and Grip Separation = 2.0" - Continuation

	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)
n	Location A					Location B				
1	1.9060	1.3240	1.102	1.2015	6.624	2.0720	1.5540	0.989	1.5713	5.903
2	1.4710	1.0640	0.984	1.0813	5.935	1.7130	1.2310	0.956	1.2877	5.727
3	2.1320	1.5490	1.116	1.3880	6.722	1.7990	1.2330	0.971	1.2698	5.800
4	2.1260	1.4860	1.040	1.4288	6.214	1.9600	1.4360	1.009	1.4232	6.009
5	2.0190	1.4050	1.000	1.4050	6.035	1.6700	1.1980	1.014	1.1815	6.082
6	2.1100	1.4650	0.960	1.5260	5.733	1.8200	1.3150	1.000	1.3150	5.999
7	1.9760	1.4250	0.974	1.4630	5.840	1.0090	0.6947	0.992	0.7003	5.993
8	2.2820	1.5850	0.944	1.6790	5.621	2.2170	1.5790	0.994	1.5885	6.003
9	2.2390	1.5220	1.134	1.3422	6.884	1.5570	1.1400	1.028	1.1089	6.115
10	1.4820	0.9537	0.953	1.0007	5.721	1.6810	1.2080	0.959	1.2596	5.730
A	1.9743	1.3779	1.0207	1.3516	6.1329	1.7498	1.2589	0.9912	1.2706	5.9361
SD	0.2855	0.2099	0.0723	0.2052	0.4577	0.3286	0.2504	0.0235	0.2531	0.1399
n	Location D					Location E				
1	1.7340	1.2770	0.967	1.3206	5.814	2.0940	1.3260	0.890	1.4899	5.275
2	1.9220	1.4600	1.024	1.4258	6.082	1.5190	0.9657	0.884	1.0924	5.330
3	1.5620	1.1790	1.002	1.1766	5.971	2.0400	1.2640	0.912	1.3860	5.471
4	1.9870	1.5360	1.017	1.5103	6.111	1.8740	1.1120	0.865	1.2855	5.153
5	1.8950	1.3790	1.001	1.3776	5.981	1.6480	1.0460	0.871	1.2009	5.211
6	1.6000	1.0380	0.922	1.1258	5.570	1.7720	1.1120	0.822	1.3528	5.230
7	1.8580	1.4310	1.012	1.4140	5.993	1.9220	1.1790	0.861	1.3693	5.230
8	2.0400	1.5080	0.980	1.5388	5.826	2.0510	1.2920	0.857	1.5076	5.131
9	1.7450	1.1250	0.969	1.1610	5.772	1.3150	0.8351	0.857	0.9744	5.121
10	1.6210	1.1260	0.984	1.1443	5.887	1.9970	1.2750	0.941	1.3549	5.576
A	1.7964	1.3059	0.9878	1.3195	5.9007	1.8232	1.1407	0.8760	1.3014	5.2728
SD	0.1686	0.1802	0.0304	0.1570	0.1620	0.2580	0.1587	0.0330	0.1687	0.1489

NOTE: The minimum peak and average peel strength values, out of the four locations, from each sample, were used for the analysis. Refer to Table 53 for information about the location and value of minimum peel strength for this package size.

Table 52. Peel Test Results for Package Size (9.25" x 14.125") - 1073B Rexam at Crosshead Speed = 12 ipm and Grip Separation = 2.0" - Continuation

	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)
n	Location A					Location B				
1	2.1260	1.3790	1.015	1.3586	5.082	1.9760	1.3880	1.000	1.3880	4.974
2	2.2440	1.5950	0.939	1.6986	4.714	1.6050	1.2010	0.968	1.2407	4.839
3	2.1320	1.4550	0.962	1.5125	4.798	1.8150	1.3160	0.973	1.3525	4.849
4	2.1100	1.3660	1.121	1.2186	5.589	1.9110	1.4300	0.946	1.5116	4.704
5	1.9110	1.2880	0.904	1.4248	4.612	1.9490	1.4070	0.963	1.4611	4.810
6	2.1420	1.4690	0.954	1.5398	4.788	2.1210	1.5560	0.955	1.6293	4.804
7	2.1320	1.5290	0.941	1.6249	4.683	1.7660	1.3120	0.952	1.3782	4.752
8	1.5570	1.1100	1.028	1.0798	5.153	1.4550	0.9799	1.005	0.9750	4.922
9	1.4600	0.9890	0.933	1.0600	4.621	1.6480	1.1260	1.040	1.0827	5.185
10	2.0030	1.3390	1.009	1.3271	5.061	1.7450	1.2150	1.023	1.1877	5.060
A	1.9817	1.3519	0.9806	1.3845	4.9101	1.7991	1.2931	0.9825	1.3207	4.8899
SD	0.2656	0.1857	0.0636	0.2181	0.3095	0.1981	0.1671	0.0324	0.2001	0.1475
n	Location D					Location E				
1	2.1420	1.5840	0.996	1.5904	4.893	1.6860	1.0850	0.934	1.1617	4.595
2	1.9810	1.3320	0.982	1.3564	4.907	2.0030	1.2900	0.909	1.4191	4.454
3	2.0670	1.5390	1.010	1.5238	5.073	1.7290	1.0680	0.881	1.2123	4.394
4	1.4070	0.9550	0.976	0.9785	4.862	1.8850	1.1310	0.849	1.3322	4.230
5	1.8310	1.2340	0.939	1.3142	4.676	1.6430	1.0370	0.883	1.1744	4.445
6	1.9490	1.4330	0.969	1.4788	4.855	1.9170	1.2450	1.051	1.1846	4.140
7	2.0460	1.5170	0.989	1.5339	4.932	1.5300	0.9756	0.888	1.0986	4.374
8	1.3960	0.8440	0.948	0.8903	4.641	1.7340	1.1570	0.939	1.2322	4.672
9	1.9700	1.4150	0.995	1.4221	4.929	1.6270	1.0890	0.974	1.1181	4.823
10	1.7610	1.2440	0.965	1.2891	4.771	1.7500	1.0800	0.925	1.1676	4.570
A	1.8550	1.3097	0.9769	1.3377	4.8539	1.7504	1.1158	0.9233	1.2101	4.4697
SD	0.2630	0.2473	0.0222	0.2349	0.1282	0.1453	0.0943	0.0574	0.0978	0.2037

NOTE: The minimum peak and average peel strength values, out of the four locations, from each sample, were used for the analysis. Refer to Table 53 for information about the location and value of minimum peel strength for this package size.

Rexam (1073B Tyvek/Polyester/Poly Laminate) Pouches - Continuation

Table 53. Minimum Peel Strength Values for Package Size (9.25" x 14.125") - 1073B Rexam

	Crosshead Speed = 10 ipm Grip Separation = 1.0"				Crosshead Speed = 12 ipm Grip Separation = 1.0"				Crosshead Speed = 10 ipm Grip Separation = 2.0"				Crosshead Speed = 12 ipm Grip Separation = 2.0"			
Sample	Peak Force (lbs)	L	Average Force (lbs)	L	Peak Force (lbs)	L	Average Force (lbs)	L	Peak Force (lbs)	L	Average Force (lbs)	L	Peak Force (lbs)	L	Average Force (lbs)	L
1	1.4930	D	1.0199	D	1.5090	B	1.1079	A	1.7340	D	1.2015	A	1.6860	E	1.1617	E
2	1.3050	A	0.7244	A	1.7180	D	1.0338	A	1.4710	A	1.0813	A	1.6050	B	1.2407	B
3	1.1330	D	0.7036	D	1.8630	D	1.1971	D	1.5620	D	1.1766	D	1.7290	E	1.2123	E
4	1.8200	A	1.1810	E	1.5620	E	0.8905	E	1.8740	E	1.2855	E	1.4070	D	0.9785	D
5	1.8040	E	1.1434	E	1.4070	B	0.9122	B	1.6480	E	1.1815	B	1.6430	E	1.1744	E
6	1.3530	D	0.9469	B	1.3850	D	0.9207	D	1.6000	D	1.1258	D	1.9170	E	1.1846	E
7	1.9270	B	1.3162	E	1.7930	E	1.1075	E	1.0090	B	0.7003	B	1.5300	E	1.0986	E
8	1.6810	E	1.1176	E	1.7930	E	1.1922	E	2.0400	D	1.5076	E	1.3960	D	0.8903	D
9	1.4280	D	1.0823	D	1.6480	B	0.9205	B	1.3150	E	0.9744	E	1.4600	A	1.0600	A
10	1.5840	E	0.9459	E	1.4550	A	0.8103	A	1.4820	A	1.0007	A	1.7450	B	1.1676	E
Average	**1.5528**	**NA**	**1.0181**	**NA**	**1.6133**	**NA**	**1.0093**	**NA**	**1.5735**	**NA**	**1.1235**	**NA**	**1.6118**	**NA**	**1.1169**	**NA**
Std Dev	**0.2557**	**NA**	**0.1945**	**NA**	**0.1740**	**NA**	**0.1365**	**NA**	**0.2876**	**NA**	**0.2119**	**NA**	**0.1665**	**NA**	**0.1110**	**NA**

NOTE: L = Location of the minimum peel strength value in a sample (pouch), Refer to Figure 14
The minimum values were taken from Table 52, pages 151-154

Table 54. Peel Test Results for Package Size (11.25" x 15.25") – 1073B Rexam at Crosshead Speed = 10 ipm and Grip Separation = 1.0"

	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)
n	Location A					Location B				
1	2.0990	1.5650	1.099	1.4240	6.570	1.5790	1.2050	1.021	1.1802	6.105
2	2.1370	1.4420	1.040	1.3865	6.233	2.0780	1.6400	1.047	1.5664	6.242
3	1.7500	1.1970	1.121	1.0678	6.714	1.6430	1.2000	1.041	1.1527	6.153
4	1.8250	1.3260	1.067	1.2427	6.345	1.9540	1.5200	0.978	1.5542	5.855
5	1.8630	1.1980	1.139	1.0518	6.820	1.9490	1.4770	1.061	1.3921	6.272
6	2.1800	1.5720	0.937	1.6777	5.541	1.7450	1.3120	1.007	1.3029	6.009
7	2.0030	1.4220	1.033	1.3766	6.153	2.1050	1.6270	1.011	1.6093	6.092
8	1.9010	1.3000	0.977	1.3306	5.810	2.0350	1.5680	0.999	1.5696	6.015
9	2.2070	1.5350	1.127	1.3620	6.624	1.6320	1.2580	1.059	1.1879	6.282
10	2.1420	1.5230	1.021	1.4917	6.082	2.3520	1.8290	1.000	1.8290	5.973
A	2.0107	1.4080	1.0561	1.3411	6.2892	1.9072	1.4636	1.0224	1.4344	6.0998
SD	0.1648	0.1450	0.0671	0.1870	0.4097	0.2508	0.2127	0.0282	0.2261	0.1404
n	Location D					Location E				
1	1.5840	1.1200	1.029	1.0884	6.281	1.9810	1.2970	1.026	1.2641	6.220
2	2.2120	1.5920	1.056	1.5076	6.317	2.2070	1.3690	1.009	1.3568	5.958
3	2.0620	1.4520	1.051	1.3815	6.270	2.5340	1.5640	0.924	1.6926	5.545
4	2.0670	1.4930	0.977	1.5281	5.852	1.6590	1.0470	0.924	1.1331	5.599
5	1.9220	1.5010	1.042	1.4405	6.214	1.4710	0.8343	0.958	0.8709	5.685
6	2.0080	1.4480	1.047	1.3830	6.208	2.0940	1.3460	1.130	1.1912	5.685
7	1.7830	1.3780	0.971	1.4192	5.823	1.9170	1.2330	0.890	1.3854	5.313
8	2.0720	1.5610	1.017	1.5349	6.013	1.5460	0.9856	0.937	1.0519	5.535
9	2.0670	1.5040	1.038	1.4489	6.214	2.0080	1.2540	0.939	1.3355	5.593
10	2.1370	1.5700	1.140	1.3772	6.849	2.2010	1.3610	0.891	1.5275	5.300
A	1.9914	1.4619	1.0368	1.4109	6.2041	1.9618	1.2291	0.9628	1.2809	5.6433
SD	0.1848	0.1362	0.0468	0.1281	0.2877	0.3287	0.2151	0.0736	0.2359	0.2765

NOTE: The minimum peak and average peel strength values, out of the four locations, from each sample, were used for the analysis. Refer to Table 55 for information about the location and value of minimum peel strength for this package size.

Table 54. Peel Test Results for Package Size (11.25" x 15.25") – 1073B Rexam at Crosshead Speed = 12 ipm and Grip Separation = 1.0" - Continuation

	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)
n	Location A					Location B				
1	1.8520	1.2980	1.056	1.2292	5.275	2.3030	1.6880	1.095	1.5416	5.384
2	1.9440	1.3870	1.088	1.2748	5.346	2.1150	1.4970	0.998	1.5000	4.960
3	1.7230	1.1330	0.945	1.1989	4.714	1.9920	1.4740	1.007	1.4638	4.987
4	1.6320	1.0060	1.027	0.9796	5.083	2.3520	1.7300	1.041	1.6619	5.190
5	1.9060	1.3410	1.052	1.2747	5.262	1.9010	1.4920	1.018	1.4656	5.012
6	2.2070	1.6240	1.045	1.5541	5.240	2.4640	1.8140	1.032	1.7578	5.227
7	2.2390	1.5220	0.990	1.5374	4.935	1.7020	1.2640	1.073	1.1780	5.374
8	1.2130	0.8537	1.010	0.8452	4.929	1.7990	1.2610	1.146	1.1003	5.714
9	1.3800	0.9309	1.154	0.8067	5.766	1.9600	1.5010	1.066	1.4081	5.230
10	1.7990	1.2310	1.200	1.0258	5.855	2.0350	1.5340	1.092	1.4048	5.406
A	1.7895	1.2327	1.0567	1.1726	5.2405	2.0623	1.5255	1.0568	1.4482	5.2484
SD	0.3244	0.2523	0.0754	0.2589	0.3588	0.2466	0.1811	0.0463	0.1975	0.2327
n	Location D					Location E				
1	1.7290	1.3210	1.069	1.2357	5.317	1.8250	1.1570	0.940	1.2309	4.644
2	1.7720	1.1370	0.978	1.1626	4.862	1.8630	1.1670	0.920	1.2685	4.531
3	1.7990	1.3820	1.069	1.2928	5.300	2.3460	1.5790	0.898	1.7584	4.484
4	1.8900	1.2490	0.985	1.2680	4.926	1.4230	0.8653	0.912	0.9488	4.548
5	1.6320	1.1130	1.011	1.1009	5.045	2.5130	1.3980	0.960	1.4563	4.775
6	2.0830	1.5590	1.006	1.5497	4.984	1.7180	1.0330	1.036	0.9971	5.163
7	2.1640	1.6400	1.029	1.5938	5.182	1.9760	1.2000	1.036	1.1583	5.169
8	2.0890	1.3590	0.980	1.3867	4.771	1.5680	0.9671	0.959	1.0084	4.755
9	1.4500	1.0570	1.026	1.0302	5.109	1.9540	1.1800	1.039	1.1357	5.172
10	1.6380	1.2540	1.096	1.1442	5.490	1.6000	1.0270	1.073	0.9571	4.940
A	1.8246	1.3071	1.0249	1.2765	5.0986	1.8786	1.1573	0.9773	1.1919	4.8181
SD	0.2312	0.1880	0.0413	0.1860	0.2255	0.3410	0.2087	0.0630	0.2557	0.2760

NOTE: The minimum peak and average peel strength values, out of the four locations, from each sample, were used for the analysis. Refer to Table 55 for information about the location and value of minimum peel strength for this package size.

Table 54. Peel Test Results for Package Size (11.25" x 15.25") – 1073B Rexam at Crosshead Speed = 10 ipm and Grip Separation = 2.0" - Continuation

	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)
n	Location A					Location B				
1	2.0780	1.4770	1.125	1.3129	6.692	2.3840	1.7380	0.988	1.7591	5.283
2	2.0400	1.4370	0.961	1.4953	5.798	2.0720	1.6550	1.080	1.5324	6.439
3	1.9870	1.3940	1.047	1.3314	6.227	2.0300	1.5880	1.010	1.5723	6.044
4	1.8040	1.2000	0.944	1.2712	5.595	1.7290	1.3510	1.051	1.2854	6.031
5	1.7770	1.2960	1.130	1.1469	6.778	2.1910	1.7100	1.207	1.4167	6.078
6	1.7180	1.1600	0.956	1.2134	5.685	1.6430	1.0430	1.043	1.0000	6.204
7	1.7340	1.1450	1.000	1.1450	5.932	2.1210	1.5660	1.111	1.4095	6.634
8	2.2010	1.6070	0.985	1.6315	5.865	1.8850	1.4620	1.101	1.3279	6.548
9	1.9870	1.3830	1.006	1.3748	6.015	1.3580	0.9902	1.049	0.9439	6.243
10	1.5730	1.0010	1.126	0.8890	6.756	1.9970	1.4740	1.050	1.4038	6.252
A	1.8899	1.3100	1.0280	1.2811	6.1343	1.9410	1.4577	1.0690	1.3651	6.1756
SD	0.1966	0.1832	0.0743	0.2044	0.4539	0.2974	0.2608	0.0612	0.2474	0.3762
n	Location D					Location E				
1	1.6700	1.1510	1.024	1.1240	6.140	1.6910	1.1170	0.986	1.1329	5.903
2	1.8740	1.3540	0.986	1.3732	5.897	1.9490	1.1600	0.853	1.3599	5.070
3	2.5070	1.8550	0.970	1.9124	5.820	1.9870	1.2360	0.905	1.3657	5.330
4	2.0350	1.3630	1.031	1.3220	6.147	1.9220	1.2230	0.952	1.2847	5.670
5	1.0200	0.6766	0.989	0.6841	5.884	1.9810	1.2570	0.994	1.2646	5.999
6	1.7660	1.3180	1.018	1.2947	6.051	1.4870	0.9002	1.026	0.8774	6.076
7	2.0400	1.5500	1.051	1.4748	6.252	1.8580	1.2260	0.865	1.4173	5.147
8	2.1960	1.6930	1.009	1.6779	6.061	1.9010	1.2460	0.897	1.3891	5.263
9	2.0080	1.4410	1.046	1.3776	6.273	2.3090	1.4470	0.889	1.6277	5.314
10	1.7880	1.3860	1.034	1.3404	6.214	2.2660	1.4900	0.909	1.6392	5.400
A	1.8904	1.3788	1.0158	1.3581	6.0739	1.9351	1.2302	0.9276	1.3358	5.5172
SD	0.3892	0.3177	0.0269	0.3229	0.1610	0.2408	0.1640	0.0586	0.2229	0.3664

NOTE: The minimum peak and average peel strength values, out of the four locations, from each sample, were used for the analysis. Refer to Table 55 for information about the location and value of minimum peel strength for this package size.

Table 54. Peel Test Results for Package Size (11.25" x 15.25") – 1073B Rexam at Crosshead Speed = 12 ipm and Grip Separation = 2.0" - Continuation

	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)
n	Location A					Location B				
1	2.0300	1.4490	1.043	1.3893	5.175	1.4760	1.1390	1.204	0.9460	5.923
2	2.1480	1.4540	1.012	1.4368	5.048	2.1740	1.6950	1.052	1.6112	5.330
3	1.7930	1.2880	0.964	1.3361	4.733	2.1050	1.6220	1.020	1.5902	5.053
4	1.9220	1.3220	0.985	1.3421	4.862	2.1850	1.5680	0.988	1.5870	4.910
5	1.7610	1.2480	0.977	1.2774	4.903	1.9650	1.5480	1.332	1.1622	5.743
6	1.5730	1.1330	0.942	1.2028	4.669	2.3250	1.8300	1.057	1.7313	5.282
7	1.9330	1.3540	0.952	1.4223	4.794	1.5620	1.1880	1.001	1.1868	4.961
8	1.6380	1.1560	0.963	1.2004	4.742	1.2830	0.9530	0.975	0.9774	4.852
9	1.9920	1.4450	0.972	1.4866	4.852	2.1480	1.5997	1.132	1.4132	5.621
10	1.9600	1.3130	0.916	1.4334	4.596	2.2550	1.6470	1.032	1.5959	5.140
A	1.8750	1.3162	0.9726	1.3527	4.8374	1.9478	1.4790	1.0793	1.3801	5.2815
SD	0.1802	0.1152	0.0356	0.0997	0.1738	0.3686	0.2834	0.1128	0.2881	0.3711
n	Location D					Location E				
1	2.0300	1.5670	1.010	1.5515	5.073	1.6210	0.9946	0.921	1.0799	4.541
2	1.3320	1.0030	1.071	0.9365	5.298	1.2400	0.8104	0.916	0.8847	4.512
3	2.3250	1.7500	0.993	1.7623	4.894	1.8520	1.2130	0.870	1.3943	4.317
4	2.1640	1.6590	1.027	1.6154	5.053	1.6480	1.0420	0.869	1.1991	4.303
5	1.9270	1.4990	1.060	1.4142	5.349	2.0350	1.0760	0.884	1.2172	4.330
6	2.1320	1.6330	1.044	1.5642	5.231	1.8040	1.0890	0.861	1.2648	4.326
7	1.9700	1.3330	0.971	1.3728	4.775	0.9342	0.5572	0.921	0.6050	4.570
8	1.4550	0.9879	0.959	1.0301	4.769	2.1690	1.3540	0.877	1.5439	4.355
9	1.4280	0.9555	0.987	0.9681	4.903	1.7720	1.1540	0.896	1.2879	4.505
10	2.0460	1.4750	0.997	1.4794	4.920	1.4930	0.9607	0.953	1.0081	4.710
A	1.8809	1.3862	1.0119	1.3695	5.0265	1.6568	1.0251	0.8968	1.1485	4.4469
SD	0.3477	0.3009	0.0376	0.2913	0.2098	0.3655	0.2204	0.0299	0.2680	0.1395

NOTE: The minimum peak and average peel strength values, out of the four locations, from each sample, were used for the analysis. Refer to Table 55 for information about the location and value of minimum peel strength for this package size.

Rexam (1073B Tyvek/Polyester/Poly Laminate) Pouches - Continuation

Table 55. Minimum Peel Strength Values for Package Size (11.25" x 15.25") – 1073B Rexam

	Crosshead Speed = 10 ipm Grip Separation = 1.0"				Crosshead Speed = 12 ipm Grip Separation = 1.0"				Crosshead Speed = 10 ipm Grip Separation = 2.0"				Crosshead Speed = 12 ipm Grip Separation = 2.0"			
Sample	Peak Force (lbs)	L	Average Force (lbs)	L	Peak Force (lbs)	L	Average Force (lbs)	L	Peak Force (lbs)	L	Average Force (lbs)	L	Peak Force (lbs)	L	Average Force (lbs)	L
1	1.5790	B	1.0884	D	1.7290	D	1.2292	A	1.6700	D	1.1240	D	1.4760	B	0.9460	B
2	2.0780	B	1.3568	A	1.7720	D	1.1626	D	1.8740	D	1.3599	E	1.2400	E	0.8847	E
3	1.6430	B	1.0678	A	1.7230	A	1.1989	A	1.9870	E	1.3314	A	1.7930	A	1.3361	A
4	1.6590	E	1.1331	E	1.4230	E	0.9488	E	1.7290	B	1.2712	A	1.6480	E	1.1991	E
5	1.4710	E	0.8709	E	1.6320	D	1.1009	D	1.0200	D	0.6841	D	1.7610	A	1.1622	B
6	1.7450	B	1.1912	E	1.7180	E	0.9971	E	1.4870	E	0.8774	E	1.5730	A	1.2028	A
7	1.7830	D	1.3766	A	1.7020	B	1.1583	E	1.7340	A	1.1450	A	0.9342	E	0.6050	E
8	1.5460	E	1.0519	E	1.2130	A	0.8452	A	1.8850	B	1.3279	B	1.2830	B	0.9774	B
9	1.6320	B	1.1879	B	1.3800	A	0.8067	A	1.3580	B	0.9439	B	1.4280	D	0.9681	D
10	2.1370	D	1.3772	D	1.6000	E	0.9571	E	1.5730	A	0.8890	A	1.4930	E	1.0081	E
Average	**1.7273**	**NA**	**1.1702**	**NA**	**1.5892**	**NA**	**1.0405**	**NA**	**1.6317**	**NA**	**1.0954**	**NA**	**1.4629**	**NA**	**1.0289**	**NA**
Std Dev	**0.2200**	**NA**	**0.1644**	**NA**	**0.1871**	**NA**	**0.1502**	**NA**	**0.2875**	**NA**	**0.2348**	**NA**	**0.2599**	**NA**	**0.2069**	**NA**

NOTE: L = Location of the minimum peel strength value in a sample (pouch), Refer to Figure 14
The minimum values were taken from Table 54, pages 156-159

I. Tolas (1073B Tyvek/PET/PE Laminate) Pouches

Table 56. Peel Test Results for Package Size (3" x 11.375") – 1073B Tolas at Crosshead Speed = 10 ipm and Grip Separation = 1.0"

	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)
n	Location A					Location B				
1	2.3620	1.3700	0.852	1.6080	5.028	1.7500	1.1040	0.927	1.1909	5.567
2	2.7870	1.8770	0.890	2.1090	5.362	2.0940	1.3470	0.919	1.4657	5.525
3	1.9380	1.1440	0.814	1.4054	4.861	1.9440	1.2860	0.884	1.4548	5.265
4	2.7700	1.6650	0.829	2.0084	4.945	2.1320	1.4600	0.940	1.5532	5.614
5	2.1480	1.3410	0.847	1.5832	5.041	2.0670	1.3680	0.890	1.5371	5.304
6	1.6640	1.0070	0.870	1.1575	5.191	1.9540	1.2650	0.862	1.4675	5.224
7	2.3410	1.5490	0.892	1.7365	5.303	2.1530	1.3660	1.010	1.3525	6.025
8	2.1050	1.3600	0.965	1.4093	5.720	1.7340	1.0710	0.898	1.1927	5.361
9	2.6950	1.7780	0.949	1.8736	5.670	1.5030	0.8985	0.910	0.9874	5.500
10	2.2710	1.5560	0.911	1.7080	5.487	1.7720	1.1000	0.938	1.1727	5.721
A	2.3081	1.4647	0.8819	1.6599	5.2608	1.9103	1.2266	0.9178	1.3374	5.5106
SD	0.3676	0.2731	0.0495	0.2917	0.2997	0.2137	0.1752	0.0408	0.1903	0.2428
n	Location D					Location E				
1	2.2930	1.2480	0.891	1.4007	5.391	2.0300	1.4580	1.044	1.3966	6.250
2	1.6160	0.9648	0.870	1.1090	5.233	2.4430	1.6180	0.845	1.9148	5.035
3	1.9650	1.1430	0.850	1.3447	5.060	1.8630	1.3230	1.021	1.2958	6.006
4	1.9700	1.2390	0.887	1.3968	5.298	2.1850	1.4260	0.984	1.4492	5.884
5	1.6700	0.9690	0.834	1.1619	4.977	1.8360	1.3690	1.027	1.3330	6.140
6	2.3780	1.5750	0.870	1.8103	5.250	1.2890	0.8709	0.903	0.9645	5.410
7	1.8790	1.1540	0.842	1.3705	5.057	2.5230	1.6540	0.888	1.8626	5.330
8	2.3950	1.4680	0.877	1.6739	5.227	1.6380	1.1090	0.914	1.2133	5.471
9	1.4340	0.8248	0.826	0.9985	4.894	1.5680	0.9986	0.920	1.0854	5.423
10	2.0890	1.2750	0.909	1.4026	5.471	2.0080	1.2960	0.864	1.5000	5.143
A	1.9689	1.1861	0.8656	1.3669	5.1858	1.9383	1.3123	0.9410	1.4015	5.6092
SD	0.3294	0.2297	0.0269	0.2447	0.1842	0.3852	0.2544	0.0721	0.3037	0.4274

NOTE: The minimum peak and average peel strength values, out of the four locations, from each sample, were used for the analysis. Refer to Table 57 for information about the location and value of minimum peel strength for this package size.

Table 56. Peel Test Results for Package Size (3" x 11.375") – 1073B Tolas at Crosshead Speed = 12 ipm and Grip Separation = 1.0" - Continuation

	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)
n	Location A					Location B				
1	2.2340	1.5830	0.918	1.7244	4.550	1.9810	1.2870	0.868	1.4827	4.346
2	2.1910	1.3460	0.972	1.3848	4.855	1.8950	1.2020	1.004	1.1972	4.983
3	2.9420	1.7600	0.988	1.7814	4.874	1.9170	1.1370	0.906	1.2550	4.474
4	2.5880	1.5980	0.905	1.7657	4.467	2.0190	1.2860	0.950	1.3537	4.858
5	2.0400	1.2640	0.850	1.4871	4.243	1.6970	1.1380	0.913	1.2464	4.500
6	2.1640	1.2460	0.821	1.5177	4.137	2.3730	1.4510	0.843	1.7212	4.163
7	2.1530	1.2750	0.843	1.5125	4.169	2.0130	1.2240	0.875	1.3989	4..358
8	1.8580	1.0440	0.829	1.2593	4.080	1.8250	1.0830	0.865	1.2520	4.339
9	2.3090	1.3520	0.943	1.4337	4.650	1.9650	1.2220	0.851	1.4360	4.224
10	2.1100	1.1360	0.808	1.4059	4.021	1.4660	0.8832	0.883	1.0002	4.313
A	2.2589	1.3604	0.8877	1.5272	4.4046	1.9151	1.1913	0.8958	1.3343	4.4667
SD	0.3044	0.2226	0.0659	0.1757	0.3187	0.2344	0.1491	0.0496	0.1937	1.4369
n	Location D					Location E				
1	2.3140	1.3110	0.876	1.4966	4.432	1.8630	1.2190	0.921	1.3236	4.557
2	2.4860	1.5530	0.841	1.8466	4.167	2.2600	1.3650	0.988	1.3816	4.942
3	1.9970	1.2410	0.893	1.3897	4.432	2.5560	1.7690	0.982	1.8014	4.842
4	1.8950	1.1910	0.982	1.2128	4.932	1.8740	1.3930	0.944	1.4756	4.695
5	2.1740	1.4860	0.950	1.5642	4.769	2.1910	1.5560	0.928	1.6767	4.555
6	2.3250	1.4160	0.880	1.6091	4.384	2.6740	1.7770	0.896	1.9833	4.444
7	2.0620	1.2950	0.873	1.4834	4.385	2.7110	1.8850	0.940	2.0053	4.672
8	1.7770	1.1000	1.005	1.0945	5.070	2.2660	1.6240	0.949	1.7113	4.727
9	1.7560	1.0130	0.876	1.1564	4.403	2.3680	1.5410	0.918	1.6786	4.531
10	2.2340	1.4220	0.869	1.6364	4.303	2.6090	1.7310	0.908	1.9064	4.544
A	2.1020	1.3028	0.9045	1.4490	4.5277	2.3372	1.5860	0.9374	1.6944	4.6509
SD	0.2462	0.1715	0.0546	0.2371	0.2927	0.3069	0.2123	0.0299	0.2405	0.1549

NOTE: The minimum peak and average peel strength values, out of the four locations, from each sample, were used for the analysis. Refer to Table 57 for information about the location and value of minimum peel strength for this package size.

Table 56. Peel Test Results for Package Size (3" x 11.375") – 1073B Tolas at Crosshead Speed = 10 ipm and Grip Separation = 2.0" - Continuation

	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)
n	Location A					Location B				
1	2.2010	1.3030	0.814	1.6007	4.813	2.2120	1.3600	0.893	1.5230	5.324
2	1.9170	1.1540	0.817	1.4125	4.903	1.8150	1.0270	0.811	1.2663	4.894
3	2.5720	1.5050	0.820	1.8354	4.900	1.8420	1.0970	0.806	1.3610	4.823
4	1.8420	1.1500	0.861	1.3357	5.175	1.9490	1.1950	0.874	1.3673	5.198
5	2.1150	1.3670	0.826	1.6550	4.945	2.0560	1.2560	0.984	1.2764	5.960
6	2.0240	1.1980	0.954	1.2558	5.743	1.9870	1.1680	0.810	1.4420	4.855
7	2.5400	1.4920	0.830	1.7976	5.041	1.9920	1.2430	0.843	1.4745	5.057
8	2.3090	1.3200	0.826	1.5981	4.971	1.9760	1.3100	0.914	1.4333	5.461
9	1.7930	1.0570	0.826	1.2797	4.952	1.9270	1.2120	0.859	1.4109	5.147
10	1.9760	1.1110	0.796	1.3957	4.714	1.9010	1.2410	0.826	1.5024	4.916
A	2.1289	1.2657	0.8370	1.5166	5.0157	1.9657	1.2109	0.8620	1.4057	5.1635
SD	0.2744	0.1567	0.0442	0.2097	0.2837	0.1126	0.0971	0.0566	0.0879	0.3506
n	Location D					Location E				
1	2.1050	1.3480	0.846	1.5934	5.073	2.2820	1.5510	0.979	1.5843	5.855
2	1.8310	0.9914	0.897	1.1052	5.410	2.0940	1.3730	0.884	1.5532	5.259
3	1.5250	0.9411	0.874	1.0768	5.214	2.6250	1.6890	0.844	2.0012	4.981
4	1.9600	1.1740	0.847	1.3861	5.093	2.5180	1.3420	0.947	1.4171	5.765
5	2.0190	1.1820	0.847	1.3955	5.051	2.5560	1.4180	0.827	1.7146	4.926
6	1.7660	1.2060	0.888	1.3581	5.214	1.7660	1.0740	0.835	1.2862	4.983
7	2.0720	1.3060	0.827	1.5792	4.944	2.4480	1.5070	0.861	1.7503	5.112
8	2.1690	1.3310	0.850	1.5659	5.064	1.8740	1.1920	0.912	1.3070	5.390
9	2.3570	1.5490	0.843	1.8375	5.012	2.1690	1.3930	0.868	1.6048	5.182
10	2.2070	1.3960	0.869	1.6064	5.170	1.7610	1.1960	0.951	1.2576	5.663
A	2.0011	1.2425	0.8588	1.4504	5.1245	2.2093	1.3735	0.8908	1.5476	5.3116
SD	0.2417	0.1838	0.0222	0.2355	0.1323	0.3292	0.1845	0.0536	0.2373	0.3425

NOTE: The minimum peak and average peel strength values, out of the four locations, from each sample, were used for the analysis. Refer to Table 57 for information about the location and value of minimum peel strength for this package size.

Table 56. Peel Test Results for Package Size (3" x 11.375") – 1073B Tolas at Crosshead Speed = 12 ipm and Grip Separation = 2.0" - Continuation

	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)
n	Location A					Location B				
1	2.7220	1.8960	0.955	1.9853	4.742	1.8580	1.1930	0.864	1.3808	4.303
2	1.9540	1.3280	0.881	1.5074	4.393	2.4000	1.5040	0.855	1.7591	4.274
3	2.9050	1.9690	0.909	2.1661	4.525	2.0720	1.3270	0.865	1.5341	4.323
4	2.0510	1.4430	0.900	1.6033	4.468	2.2710	1.4780	1.007	1.4677	4.990
5	2.2820	1.5820	0.886	1.7856	4.426	2.1640	1.3410	0.867	1.5467	4.326
6	2.3890	1.6630	0.900	1.8478	4.503	2.1370	1.3520	0.841	1.6076	4.153
7	2.2930	1.5790	0.922	1.7126	4.599	2.0890	1.4020	0.860	1.6302	4.249
8	2.8460	1.9310	0.911	2.1196	4.553	2.0670	1.2140	0.868	1.3986	4.243
9	2.0890	1.4610	0.946	1.5444	4.743	1.9330	1.2510	0.876	1.4281	4.391
10	2.6520	1.8970	0.949	1.9989	4.679	1.6750	0.9886	0.853	1.1590	4.278
A	2.4183	1.6749	0.9159	1.8271	4.5631	2.0666	1.3051	0.8756	1.4912	4.3530
SD	0.3433	0.2329	0.0264	0.2363	0.1252	0.2062	0.1516	0.0472	0.1651	0.2324
n	Location D					Location E				
1	2.2170	1.3850	0.941	1.4718	4.682	2.1370	1.3390	0.870	1.5391	4.327
2	1.7830	1.1360	0.884	1.2851	4.352	1.9810	1.0730	0.797	1.3463	3.971
3	1.8360	1.0850	0.850	1.2765	4.298	2.0030	1.2800	0.900	1.4222	4.461
4	2.1420	1.4010	0.854	1.6405	4.211	1.8040	1.1520	0.868	1.3272	4.355
5	1.5460	0.9350	0.915	1.0219	4.605	1.8040	1.1550	0.875	1.3200	4.339
6	2.2820	1.4920	0.881	1.6935	4.335	2.2340	1.4420	0.963	1.4974	4.832
7	1.8900	1.2460	0.881	1.4143	4.355	2.4540	1.5840	0.895	1.7698	4.432
8	1.7450	1.0800	0.878	1.2301	4.393	2.4640	1.6280	0.849	1.9176	4.288
9	2.1050	1.2970	0.869	1.4925	4.349	1.7450	1.1670	0.939	1.2428	4.682
10	1.7720	1.1760	0.838	1.4033	4.150	2.3190	1.4210	0.871	1.6315	4.307
A	1.9318	1.2233	0.8791	1.3930	4.3730	2.0945	1.3241	0.8827	1.5014	4.3994
SD	0.2405	0.1727	0.0306	0.1994	0.1613	0.2687	0.1919	0.0461	0.2171	0.2327

NOTE: The minimum peak and average peel strength values, out of the four locations, from each sample, were used for the analysis. Refer to Table 57 for information about the location and value of minimum peel strength for this package size.

Tolas (1073B Tyvek/PET/PE Laminate) Pouches – Continuation

Table 57. Minimum Peel Strength Values for Package Size (3" x 11.375") – 1073B Tolas

	Crosshead Speed = 10 ipm Grip Separation = 1.0"				Crosshead Speed = 12 ipm Grip Separation = 1.0"				Crosshead Speed = 10 ipm Grip Separation = 2.0"				Crosshead Speed = 12 ipm Grip Separation = 2.0"			
Sample	Peak Force (lbs)	L	Average Force (lbs)	L	Peak Force (lbs)	L	Average Force (lbs)	L	Peak Force (lbs)	L	Average Force (lbs)	L	Peak Force (lbs)	L	Average Force (lbs)	L
1	1.7500	B	1.1909	B	1.8630	E	1.3236	E	2.1050	D	1.5230	B	1.8580	B	1.3808	B
2	1.6160	D	1.1090	D	1.8950	B	1.1972	B	1.8150	B	1.1052	D	1.7830	D	1.2851	D
3	1.8630	E	1.2958	E	1.9170	B	1.2550	B	1.5250	D	1.0768	D	1.8360	D	1.2765	D
4	1.9700	D	1.3968	D	1.8740	E	1.2128	D	1.8420	A	1.3357	A	1.8040	E	1.3272	E
5	1.6700	D	1.1619	D	1.6970	B	1.2464	B	2.0190	D	1.2764	B	1.5460	D	1.0219	D
6	1.2890	E	0.9645	E	2.1640	A	1.5177	A	1.7660	E	1.2558	A	2.1370	B	1.4974	E
7	1.8790	D	1.3525	B	2.0130	B	1.3989	B	1.9920	B	1.4745	B	1.8900	D	1.4143	D
8	1.6380	E	1.1927	B	1.7770	D	1.0945	D	1.8740	E	1.3070	E	1.7450	D	1.2301	D
9	1.4340	D	0.9874	B	1.7560	D	1.1564	D	1.7930	A	1.2797	A	1.7450	E	1.2428	E
10	1.7720	B	1.1727	B	1.4660	B	1.0002	B	1.7610	E	1.2576	E	1.6750	B	1.1590	B
Average	**1.6881**	**NA**	**1.1824**	**NA**	**1.8422**	**NA**	**1.2403**	**NA**	**1.8492**	**NA**	**1.2892**	**NA**	**1.8019**	**NA**	**1.2835**	**NA**
Std Dev	**0.2080**	**NA**	**0.1412**	**NA**	**0.1876**	**NA**	**0.1482**	**NA**	**0.1631**	**NA**	**0.1386**	**NA**	**0.1538**	**NA**	**0.1345**	**NA**

NOTE: L = Location of the minimum peel strength value in a sample (pouch), Refer to Figure 14
The minimum values were taken from Table 56, pages 161-164

Table 58. Peel Test Results for Package Size (10.625" x 15") – 1073B Tolas at Crosshead Speed = 10 ipm and Grip Separation = 1.0"

	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)
n	Location A					Location B				
1	2.1260	1.2730	0.934	1.3630	5.596	2.0830	1.5080	0.953	1.5824	5.724
2	1.9220	1.3390	1.037	1.2912	6.214	1.9490	1.4320	0.951	1.5058	5.734
3	2.1580	1.5500	0.993	1.5609	5.932	1.5840	1.1030	0.937	1.1772	5.666
4	2.0300	1.4330	0.949	1.5100	5.615	1.5030	1.0250	0.987	1.0385	5.897
5	2.2870	1.6290	0.938	1.7367	5.609	2.1640	1.4290	1.001	1.4276	5.977
6	2.1370	1.4360	0.892	1.6099	5.435	2.2660	1.5830	0.937	1.6894	5.573
7	2.1850	1.4830	1.028	1.4426	6.160	1.6810	0.9977	0.974	1.0243	5.884
8	2.1050	1.3670	0.914	1.4956	5.484	1.8420	1.3540	1.044	1.2969	6.256
9	2.6580	1.8540	0.895	2.0715	5.371	2.0400	1.4720	0.963	1.5286	5.734
10	1.6750	1.0810	0.920	1.1750	5.519	1.6700	1.2160	0.933	1.3033	5.573
A	2.1283	1.4445	0.9500	1.5256	5.6935	1.8782	1.3120	0.9680	1.3574	5.8018
SD	0.2513	0.2090	0.0522	0.2502	0.3006	0.2616	0.2112	0.0349	0.2282	0.2085
n	Location D					Location E				
1	1.9870	1.3990	0.990	1.4131	5.941	2.6360	1.5880	0.976	1.6270	5.800
2	2.1690	1.4680	0.964	1.5228	5.755	2.1210	1.1870	0.893	1.3292	5.291
3	1.4550	1.0390	0.991	1.0484	5.884	2.1100	1.2680	0.863	1.4693	5.156
4	2.3730	1.6130	0.977	1.6510	5.774	2.7540	1.7950	0.886	2.0260	5.314
5	2.2500	1.5110	0.974	1.5513	5.836	1.8470	1.1730	0.859	1.3655	5.054
6	2.3680	1.6740	0.969	1.7276	5.775	2.7220	1.5930	0.847	1.8808	5.025
7	1.9760	1.4080	1.001	1.4066	5.993	2.1320	1.3230	0.844	1.5675	5.005
8	2.6090	1.7020	0.984	1.7297	5.845	1.7180	1.0490	0.951	1.1030	5.720
9	2.3300	1.6860	0.957	1.7618	5.698	1.8420	1.1720	0.826	1.4189	4.900
10	2.1580	1.5070	0.956	1.5764	5.654	2.4160	1.3400	0.875	1.5314	5.194
A	2.1675	1.5007	0.9763	1.5389	5.8155	2.2298	1.3488	0.8820	1.5319	5.2459
SD	0.3140	0.1974	0.0152	0.2134	0.1055	0.3817	0.2360	0.0477	0.2678	0.3005

NOTE: The minimum peak and average peel strength values, out of the four locations, from each sample, were used for the analysis. Refer to Table 59 for information about the location and value of minimum peel strength for this package size.

Table 58. Peel Test Results for Package Size (10.625" x 15") – 1073B Tolas at Crosshead Speed = 12 ipm and Grip Separation = 1.0" - Continuation

	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)
n	Location A					Location B				
1	2.0620	1.5140	1.111	1.3627	5.551	2.2390	1.5000	0.980	1.5306	4.832
2	2.3520	1.6590	0.952	1.7426	4.803	2.0130	1.4000	1.006	1.3917	5.000
3	2.8460	1.7420	0.896	1.9442	4.445	1.4600	0.9994	1.067	0.9366	5.314
4	2.3890	1.6320	0.936	1.7436	4.651	1.9440	1.3420	0.931	1.4415	4.714
5	1.6540	1.0800	0.940	1.1489	4.682	2.4160	1.6340	0.955	1.7110	4.743
6	2.7650	1.9020	0.909	2.0924	4.545	2.2870	1.7680	0.988	1.7895	4.942
7	2.1800	1.5110	0.902	1.6752	4.506	2.0670	1.4420	0.971	1.4851	4.807
8	2.5130	1.6290	0.883	1.8448	4.445	2.2710	1.5790	0.955	1.6534	4.727
9	2.7060	1.7310	0.899	1.9255	4.481	1.6860	1.2100	0.992	1.2198	4.946
10	2.1260	1.3900	0.933	1.4898	4.599	2.3030	1.6560	0.970	1.7072	4.801
A	2.3593	1.5790	0.9361	1.6970	4.6708	2.0686	1.4530	0.9815	1.4866	4.8826
SD	0.3680	0.2259	0.0655	0.2889	0.3298	0.3034	0.2288	0.0369	0.2593	0.1809
n	Location D					Location E				
1	2.1100	1.4140	0.999	1.4154	5.002	1.6320	0.9097	0.868	1.0480	4.320
2	2.0300	1.5660	1.144	1.3689	5.692	2.4480	1.3790	0.838	1.6456	4.160
3	1.8950	1.4390	0.976	1.4744	4.884	2.2500	1.4590	0.872	1.6732	4.380
4	2.3730	1.7410	0.985	1.7675	4.874	1.7230	1.1030	0.881	1.2520	4.391
5	2.3300	1.6720	0.966	1.7308	4.852	2.4110	1.5720	0.860	1.8279	4.285
6	1.5730	0.9648	0.972	0.9926	4.903	2.6850	1.6820	0.893	1.8835	4.461
7	1.8470	1.2780	0.953	1.3410	4.798	2.1740	1.3280	0.911	1.4577	4.580
8	2.1100	1.3440	1.008	1.3333	5.009	1.9110	1.2320	0.900	1.3689	4.435
9	2.1210	1.5940	1.017	1.5674	5.051	1.9920	1.2430	0.936	1.3280	4.653
10	2.6090	1.9560	1.023	1.9120	5.085	2.5500	1.5910	0.878	1.8121	4.365
A	2.0998	1.4969	1.0043	1.4903	5.0150	2.1776	1.3499	0.8837	1.5297	4.4030
SD	0.2936	0.2748	0.0541	0.2654	0.2556	0.3557	0.2383	0.0277	0.2806	0.1415

NOTE: The minimum peak and average peel strength values, out of the four locations, from each sample, were used for the analysis. Refer to Table 59 for information about the location and value of minimum peel strength for this package size.

Table 58. Peel Test Results for Package Size (10.625" x 15") – 1073B Tolas at Crosshead Speed = 10 ipm and Grip Separation = 2.0" - Continuation

	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)
n	Location A					Location B				
1	2.0830	1.3320	0.886	1.5034	5.281	2.1690	1.4010	0.964	1.4533	5.781
2	2.4480	1.6390	0.928	1.7662	5.550	2.3360	1.5670	0.994	1.5765	5.932
3	2.2660	1.4540	0.885	1.6429	5.233	1.1110	0.7494	0.950	0.7888	5.657
4	2.2760	1.4970	0.904	1.6560	5.416	1.8740	1.3460	0.983	1.3693	5.903
5	2.7490	1.8100	0.919	1.9695	5.496	1.9650	1.3300	0.967	1.3754	5.766
6	2.3570	1.6160	0.871	1.8553	5.179	2.1260	1.5720	0.925	1.6995	5.502
7	2.8400	1.9170	0.892	2.1491	5.349	1.9060	1.3990	0.912	1.5340	5.419
8	2.3360	1.5170	0.887	1.7103	5.295	2.2600	1.5860	0.910	1.7429	5.422
9	2.2660	1.5900	0.927	1.7152	5.553	1.7610	1.3330	0.990	1.3465	5.987
10	2.4970	1.6630	0.935	1.7786	5.625	1.7660	1.2110	0.990	1.2232	5.942
A	2.4118	1.6035	0.9034	1.7747	5.3977	1.9274	1.3494	0.9585	1.4109	5.7311
SD	0.2318	0.1703	0.0223	0.1818	0.1529	0.3497	0.2445	0.0328	0.2723	0.2197
n	Location D					Location E				
1	2.0780	1.5100	0.947	1.5945	5.702	2.3460	1.5620	0.888	1.7590	5.266
2	1.9270	1.3340	1.017	1.3117	6.022	2.2930	1.5600	0.894	1.7450	5.291
3	1.8850	1.1430	1.017	1.1239	6.170	1.9170	1.1900	0.900	1.3222	5.464
4	2.2440	1.5830	0.947	1.6716	5.711	2.7540	1.8130	0.920	1.9707	5.477
5	2.4320	1.7760	0.967	1.8366	5.785	2.0620	1.2590	0.834	1.5096	5.012
6	2.2980	1.6790	0.966	1.7381	5.734	1.9810	1.2740	0.830	1.5349	4.984
7	1.8250	1.3440	0.940	1.4298	5.611	2.4640	1.5000	0.860	1.7442	5.105
8	1.9170	1.3820	0.957	1.4441	5.714	2.6680	1.6800	0.854	1.9672	5.105
9	1.5410	1.1070	0.963	1.1495	5.772	2.4320	1.5320	0.862	1.7773	5.125
10	2.0080	1.4680	0.968	1.5165	5.782	2.3360	1.4810	0.886	1.6716	5.308
A	2.0155	1.4326	0.9689	1.4816	5.8003	2.3253	1.4851	0.8728	1.7002	5.2137
SD	0.2594	0.2156	0.0271	0.2388	0.1675	0.2765	0.1950	0.0294	0.2014	0.1747

NOTE: The minimum peak and average peel strength values, out of the four locations, from each sample, were used for the analysis. Refer to Table 59 for information about the location and value of minimum peel strength for this package size.

Table 58. Peel Test Results for Package Size (10.625" x 15") – 1073B Tolas at Crosshead Speed = 12 ipm and Grip Separation = 2.0" - Continuation

	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)
n	Location A					Location B				
1	2.2440	1.5240	0.968	1.5744	4.798	2.2230	1.5370	0.940	1.6351	4.689
2	1.9600	1.3870	0.944	1.4693	4.666	2.3140	1.6400	0.948	1.7300	4.682
3	2.4160	1.6080	0.944	1.7034	4.705	1.2780	0.9345	0.939	0.9952	4.695
4	1.9010	1.3190	0.964	1.3683	4.771	1.9440	1.3090	0.952	1.3750	4.749
5	2.3030	1.4890	0.880	1.6920	4.368	2.5830	1.8410	0.967	1.9038	4.811
6	2.5990	1.7680	0.936	1.8889	4.660	1.9380	1.2680	0.940	1.3489	4.682
7	2.2600	1.4730	0.919	1.6028	4.605	2.0830	1.4820	0.933	1.5884	4.605
8	2.4540	1.6250	0.916	1.7740	4.560	2.2390	1.5170	0.953	1.5918	4.714
9	2.5450	1.8090	0.922	1.9620	4.570	2.2280	1.6150	0.948	1.7036	4.737
10	2.4210	1.6940	0.961	1.7627	4.723	1.8520	1.2600	0.977	1.2897	4.835
A	2.3103	1.5696	0.9354	1.6798	4.6426	2.0682	1.4404	0.9497	1.5162	4.7199
SD	0.2309	0.1601	0.0270	0.1820	0.1251	0.3509	0.2546	0.0135	0.2639	0.0670
n	Location D					Location E				
1	2.3620	1.6090	0.999	1.6106	4.948	2.5990	1.5430	0.846	1.8239	4.249
2	2.6310	2.0030	1.054	1.9004	5.211	1.9970	1.1940	0.921	1.2964	4.585
3	2.0400	1.3520	1.001	1.3506	4.922	2.0940	1.1420	0.837	1.3644	4.205
4	2.0940	1.5180	0.962	1.5780	4.774	2.0510	1.2830	0.848	1.5130	4.204
5	2.2600	1.6660	0.959	1.7372	4.794	2.6470	1.7090	0.881	1.9398	4.371
6	2.7270	2.0260	1.005	2.0159	4.974	2.0460	1.3030	0.846	1.5402	4.182
7	1.7930	1.1280	0.935	1.2064	4.641	2.4000	1.4470	0.854	1.6944	4.195
8	2.4210	1.8040	0.991	1.8204	4.871	2.3190	1.3300	0.880	1.5114	4.154
9	2.3460	1.5820	0.982	1.6110	4.855	2.6790	1.6330	0.833	1.9604	4.150
10	1.9270	1.3160	0.960	1.3708	4.794	2.1260	1.2540	0.800	1.5675	3.903
A	2.2601	1.6004	0.9848	1.6201	4.8784	2.2958	1.3838	0.8546	1.6211	4.2198
SD	0.2990	0.2910	0.0333	0.2575	0.1522	0.2697	0.1909	0.0328	0.2280	0.1729

NOTE: The minimum peak and average peel strength values, out of the four locations, from each sample, were used for the analysis. Refer to Table 59 for information about the location and value of minimum peel strength for this package size.

Tolas 1073B Tyvek/PET/PE Laminate) Pouches – Continuation

Table 59. Minimum Peel Strength Values for Package Size (10.625" x 15") – 1073B Tolas

	Crosshead Speed = 10 ipm Grip Separation = 1.0"				Crosshead Speed = 12 ipm Grip Separation = 1.0"				Crosshead Speed = 10 ipm Grip Separation = 2.0"				Crosshead Speed = 12 ipm Grip Separation = 2.0"			
Sample	Peak Force (lbs)	L	Average Force (lbs)	L	Peak Force (lbs)	L	Average Force (lbs)	L	Peak Force (lbs)	L	Average Force (lbs)	L	Peak Force (lbs)	L	Average Force (lbs)	L
1	1.9870	D	1.3630	A	1.6320	E	1.0480	E	2.0780	D	1.4533	B	2.2230	B	1.5744	A
2	1.9220	A	1.2912	A	2.0130	B	1.3689	D	1.9270	D	1.3117	D	1.9600	A	1.2964	E
3	1.4550	D	1.0484	D	1.4600	B	0.9366	B	1.1110	B	0.7888	B	1.2780	B	0.9952	B
4	1.5030	B	1.0385	B	1.7230	E	1.2520	E	1.8740	B	1.3693	B	1.9010	A	1.3683	A
5	1.8470	E	1.3655	E	1.6540	A	1.1489	A	1.9650	B	1.3754	B	2.2600	D	1.6920	A
6	2.1370	A	1.6099	A	1.5730	D	0.9926	D	1.9810	E	1.5349	E	1.9380	B	1.3489	B
7	1.6810	B	1.0243	B	1.8470	D	1.3410	D	1.8250	D	1.4298	D	1.7930	D	1.2064	D
8	1.7180	E	1.1030	E	1.9110	E	1.3333	D	1.9170	D	1.4441	D	2.2390	B	1.5114	E
9	1.8420	E	1.4189	E	1.6860	B	1.2198	B	1.5410	D	1.1495	D	2.2280	B	1.6110	D
10	1.6700	B	1.1750	A	2.1260	A	1.4898	A	1.7660	B	1.2232	B	1.8520	B	1.2897	B
Average	**1.7762**	**NA**	**1.2438**	**NA**	**1.7625**	**NA**	**1.2131**	**NA**	**1.7985**	**NA**	**1.3080**	**NA**	**1.9672**	**NA**	**1.3894**	**NA**
Std Dev	**0.2126**	**NA**	**0.1969**	**NA**	**0.2076**	**NA**	**0.1794**	**NA**	**0.2821**	**NA**	**0.2150**	**NA**	**0.3013**	**NA**	**0.2106**	**NA**

NOTE: L = Location of the minimum peel strength value in a sample (pouch), Refer to Figure 14
The minimum values were taken from Table 58, pages 166-169

III. Rexam (1059B Tyvek/Polyester Poly Laminate) Pouches

Table 60. Peel Test Results for Package Size (5.75" x 9.125") – 1059B Rexam at Crosshead Speed = 10 ipm and Grip Separation = 1.0"

	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)
n	Location A					Location B				
1	1.1700	0.7704	1.122	0.6866	5.913	1.2300	0.7253	0.917	0.7909	5.496
2	0.9825	0.6566	1.079	0.6085	6.452	1.5790	0.9670	0.897	1.0780	5.374
3	1.6210	1.1130	0.968	1.1498	5.701	0.9127	0.5065	0.861	0.5883	5.131
4	1.5190	0.9821	0.926	1.0606	5.502	1.3370	0.8532	0.918	0.9294	5.477
5	1.0420	0.7194	0.934	0.7702	5.422	1.3850	0.8654	0.826	1.0477	4.974
6	1.8850	1.3300	0.979	1.3585	5.814	1.9110	1.2700	1.022	1.2427	6.147
7	1.8740	1.2840	1.063	1.2079	6.298	1.6750	1.0570	0.890	1.1876	5.369
8	1.9270	1.2540	1.021	1.2282	6.124	1.7070	1.0630	0.817	1.3011	4.900
9	1.1380	0.7481	1.011	0.7400	5.971	1.6540	0.9939	0.844	1.1776	5.128
10	1.7130	1.2090	0.986	1.2262	5.894	1.6540	1.0600	0.877	1.2087	5.234
A	1.4872	1.0067	1.0089	1.0037	5.9091	1.5045	0.9361	0.8869	1.0552	5.3230
SD	0.3722	0.2631	0.0636	0.2734	0.3252	0.2893	0.2115	0.0591	0.2251	0.3529
n	Location D					Location E				
1	1.2830	0.7257	0.933	0.7778	5.551	1.9270	1.2830	1.004	1.2779	6.003
2	1.4660	0.8841	0.907	0.9748	5.416	1.7660	0.9845	0.952	1.0341	5.644
3	1.1110	0.6088	0.903	0.6742	5.432	1.7770	1.0130	0.887	1.1421	5.304
4	1.3960	0.8821	0.972	0.9075	5.817	1.5840	0.9705	0.862	1.1259	5.169
5	1.4340	0.8275	0.854	0.9690	5.012	1.2620	0.7193	0.974	0.7385	5.814
6	1.9170	1.0930	0.834	1.3106	4.935	0.9396	0.5499	0.947	0.5807	5.675
7	1.6110	0.9122	0.857	1.0644	5.111	1.3530	0.8097	0.884	0.9160	5.311
8	1.1920	0.7337	0.817	0.8980	4.865	1.7830	1.0920	0.839	1.3015	5.003
9	1.9060	1.1110	0.971	1.1442	5.772	1.2990	0.8379	0.977	0.8576	5.811
10	1.4980	0.8732	0.856	1.0201	5.131	1.9270	1.0200	0.899	1.1346	5.355
A	1.4814	0.8651	0.8904	0.9741	5.3042	1.5618	0.9280	0.9225	1.0109	5.5089
SD	0.2702	0.1560	0.0554	0.1799	0.3421	0.3323	0.2061	0.0554	0.2342	0.3250

NOTE: The minimum peak and average peel strength values, out of the four locations, from each sample, were used for the analysis. Refer to Table 61 for information about the location and value of minimum peel strength for this package size.

Table 60. Peel Test Results for Package Size (5.75" x 9.125") – 1059B Rexam at Crosshead Speed = 12 ipm and Grip Separation = 1.0" - Continuation

	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)
n	Location A					Location B				
1	1.6910	0.9410	0.969	0.9711	4.846	1.5790	0.9937	0.964	1.0308	4.823
2	1.6860	1.0180	0.996	1.0221	4.970	1.7180	1.0330	0.921	1.1216	4.573
3	1.5890	0.9939	0.943	1.0540	4.711	1.9650	1.2680	1.058	1.1985	5.271
4	1.6160	0.9771	0.956	1.0221	4.727	1.1600	0.7226	0.819	0.8823	4.080
5	1.7450	1.1000	0.942	1.1677	4.746	1.9440	1.1650	0.911	1.2788	4.535
6	1.3530	0.8569	0.976	0.8780	4.845	1.4760	0.8823	0.868	1.0165	4.282
7	1.4390	0.9501	1.104	0.8606	5.484	1.9540	1.1950	0.901	1.3263	4.487
8	1.0310	0.6535	0.956	0.6836	4.740	1.3740	0.7739	0.864	0.8957	4.342
9	1.5840	0.9822	0.966	1.0168	4.874	1.2080	0.6418	0.864	0.7428	4.323
10	1.5790	0.9476	0.985	0.9620	4.958	1.8090	1.0570	0.875	1.2080	4.311
A	1.5313	0.9420	0.9793	0.9638	4.8901	1.6187	0.9732	0.9045	1.0701	4.5027
SD	0.2112	0.1187	0.0471	0.1316	0.2285	0.3064	0.2120	0.0669	0.1899	0.3369
n	Location D					Location E				
1	2.0130	1.2510	0.921	1.3583	4.634	1.7930	1.0700	1.011	1.0584	5.064
2	1.3960	0.8222	0.893	0.9207	4.451	1.6700	1.0210	0.869	1.1749	4.275
3	2.2710	1.4040	0.979	1.4341	4.874	1.8680	1.1430	0.920	1.2424	4.592
4	1.8850	1.1840	0.952	1.2437	4.740	1.6540	1.0760	0.956	1.1255	4.740
5	1.1220	0.7045	0.884	0.7969	4.384	1.3210	0.8523	0.937	0.9096	4.670
6	2.0890	1.2220	0.883	1.3839	4.352	0.8698	0.5757	0.845	0.6813	4.188
7	1.5680	0.9918	0.917	1.0816	4.605	1.9870	1.2770	0.940	1.3585	4.705
8	2.0030	1.2290	0.923	1.3315	4.682	1.6700	1.0350	0.868	1.1924	4.330
9	2.0890	1.2680	0.848	1.4953	4.195	1.1010	0.6504	0.953	0.6825	4.685
10	1.6910	1.0460	0.832	1.2572	4.085	1.3530	0.8053	1.018	0.7911	5.054
A	1.8127	1.1123	0.9032	1.2303	4.5002	1.5287	0.9506	0.9317	1.0217	4.6303
SD	0.3605	0.2183	0.0448	0.2282	0.2500	0.3562	0.2229	0.0582	0.2412	0.2988

NOTE: The minimum peak and average peel strength values, out of the four locations, from each sample, were used for the analysis. Refer to Table 61 for information about the location and value of minimum peel strength for this package size.

Table 60. Peel Test Results for Package Size (5.75" x 9.125") – 1059B Rexam at Crosshead Speed = 10 ipm and Grip Separation = 2.0" - Continuation

	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)
n	Location A					Location B				
1	1.2190	0.8820	0.955	0.9236	5.695	1.7130	1.0520	0.961	1.0947	5.753
2	1.9490	1.3460	1.026	1.3119	6.131	1.5250	0.9133	0.938	0.9737	5.643
3	1.8040	1.1730	0.978	1.1994	5.804	1.4500	0.9078	0.878	1.0339	5.227
4	1.7230	1.2220	0.941	1.2986	5.592	1.5250	0.9891	0.901	1.0978	5.429
5	1.2890	0.8834	0.966	0.9145	5.820	1.2720	0.7928	0.877	0.9040	5.242
6	0.9342	0.6354	1.032	0.6157	6.185	1.5950	0.9446	0.923	1.0234	5.473
7	1.8420	1.3580	0.982	1.3829	5.916	1.3740	0.8337	0.845	0.9866	5.134
8	1.9330	1.3450	0.915	1.4699	5.451	1.5090	0.9053	0.876	1.0334	5.201
9	1.6590	1.1540	0.934	1.2355	5.624	1.8580	1.2020	0.877	1.3706	5.201
10	1.9920	1.3030	0.915	1.4240	5.480	1.9060	1.1470	0.902	1.2716	5.355
A	1.6344	1.1302	0.9644	1.1776	5.7698	1.5727	0.9688	0.8978	1.0790	5.3658
SD	0.3619	0.2478	0.0412	0.2737	0.2521	0.2017	0.1309	0.0346	0.1415	0.2068
n	Location D					Location E				
1	2.2550	1.3690	0.887	1.5434	5.317	1.9380	1.2060	0.908	1.3282	5.454
2	1.6380	0.9964	0.894	1.1145	5.326	1.9270	1.1780	0.874	1.3478	5.282
3	2.3190	1.4990	0.919	1.6311	5.477	1.2350	0.7223	0.934	0.7733	5.653
4	1.4280	0.9054	0.855	1.0589	5.082	2.0890	1.3480	0.914	1.4748	5.496
5	1.6810	1.0650	0.918	1.1601	5.432	1.7230	1.0600	0.904	1.1726	5.467
6	1.9540	1.2970	0.943	1.3754	5.648	1.4340	0.7843	0.921	0.8516	5.488
7	1.4170	0.8774	0.854	1.0274	5.022	1.5890	0.9455	0.922	1.0255	5.493
8	2.3520	1.4590	0.850	1.7165	5.102	1.3050	0.7664	0.827	0.9267	4.935
9	1.4390	0.8621	0.826	1.0437	4.945	1.7660	1.0590	0.917	1.1549	5.493
10	1.5570	0.9709	0.913	1.0634	5.425	1.9920	1.3020	0.884	1.4729	5.307
A	1.8040	1.1301	0.8859	1.2735	5.2776	1.6998	1.0372	0.9005	1.1528	5.4068
SD	0.3829	0.2501	0.0381	0.2685	0.2289	0.2991	0.2263	0.0315	0.2533	0.1955

NOTE: The minimum peak and average peel strength values, out of the four locations, from each sample, were used for the analysis. Refer to Table 61 for information about the location and value of minimum peel strength for this package size.

Table 60. Peel Test Results for Package Size (5.75" x 9.125") – 1059B Rexam at Crosshead Speed = 12 ipm and Grip Separation = 2.0" - Continuation

	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)
n	Location A					Location B				
1	1.0200	0.6757	1.023	0.6605	5.115	0.9557	0.5940	0.839	0.7080	4.233
2	1.6000	1.0990	0.936	1.1741	4.618	2.0190	1.3140	0.845	1.5550	4.192
3	1.6640	0.9504	0.915	1.0387	4.596	1.1540	0.7034	0.833	0.8444	4.130
4	1.9540	1.3020	0.913	1.4261	4.528	1.1060	0.6485	0.825	0.7861	4.092
5	1.1540	0.8282	0.932	0.8886	4.602	1.1220	0.6493	0.835	0.7776	4.111
6	2.2340	1.5460	0.905	1.7083	4.496	1.9380	1.2540	0.840	1.4929	4.185
7	1.9970	1.3360	0.916	1.4585	4.605	0.9074	0.5598	0.841	0.6656	4.143
8	1.6210	1.0580	0.996	1.0622	5.016	1.5140	0.9857	0.833	1.1833	4.070
9	1.6590	1.1310	0.999	1.1321	4.912	1.5840	0.9326	0.846	1.1024	4.198
10	1.5300	1.0590	0.952	1.1124	4.763	1.6160	1.0690	0.871	1.2273	4.335
A	1.6433	1.0985	0.9487	1.1662	4.7251	1.3916	0.8710	0.8408	1.0343	4.1689
SD	0.3673	0.2530	0.0423	0.3001	0.2166	0.3986	0.2788	0.0123	0.3251	0.0779
n	Location D					Location E				
1	1.4870	0.9010	0.853	1.0563	4.233	1.4500	0.8913	0.897	0.9936	4.471
2	1.5890	0.9714	0.844	1.1509	4.182	1.5300	0.9090	0.812	1.1195	4.176
3	1.8040	1.1010	0.881	1.2497	4.378	1.7930	1.0810	0.800	1.3513	4.006
4	1.2300	0.7763	0.871	0.8913	4.330	1.1810	0.7394	0.855	0.8648	4.269
5	1.9220	1.1330	0.863	1.3129	4.323	1.1330	0.6943	0.793	0.8755	3.929
6	1.5410	0.9162	0.826	1.1092	4.060	1.7660	1.1160	0.823	1.3560	4.102
7	1.6750	1.0010	0.891	1.1235	4.441	1.9920	1.2260	0.819	1.4969	4.083
8	1.3510	0.7466	0.868	0.8601	4.285	1.7610	1.0320	0.797	1.2949	3.964
9	1.4170	0.8006	0.865	0.9255	4.368	1.0680	0.6919	0.839	0.8247	4.153
10	1.1870	0.7404	0.836	0.8856	4.115	1.7930	1.1250	0.809	1.3906	4.050
A	1.5203	0.9088	0.8598	1.0565	4.2715	1.5467	0.9506	0.8244	1.1568	4.1203
SD	0.2373	0.1429	0.0202	0.1604	0.1222	0.3261	0.1943	0.0319	0.2516	0.1599

NOTE: The minimum peak and average peel strength values, out of the four locations, from each sample, were used for the analysis. Refer to Table 61 for information about the location and value of minimum peel strength for this package size.

Rexam (1059B Tyvek/Polyester Poly Laminate) Pouches - Continuation

Table 61. Minimum Peel Strength Values for Package Size (5.75" x 9.125") – 1059B Rexam

	Crosshead Speed = 10 ipm Grip Separation = 1.0"				Crosshead Speed = 12 ipm Grip Separation = 1.0"				Crosshead Speed = 10 ipm Grip Separation = 2.0"				Crosshead Speed = 12 ipm Grip Separation = 2.0"			
Sample	Peak Force (lbs)	L	Average Force (lbs)	L	Peak Force (lbs)	L	Average Force (lbs)	L	Peak Force (lbs)	L	Average Force (lbs)	L	Peak Force (lbs)	L	Average Force (lbs)	L
1	1.1700	A	0.6866	A	1.5790	B	0.9711	A	1.2190	A	0.9236	A	0.9557	B	0.6605	A
2	0.9825	A	0.6085	A	1.3960	D	0.9207	D	1.5250	B	0.9737	B	1.5300	E	1.1195	E
3	0.9127	B	0.5883	B	1.5890	A	1.0540	A	1.2350	E	0.7733	E	1.1540	B	0.8444	B
4	1.3370	B	0.9075	D	1.1600	B	0.8823	B	1.4280	D	1.0589	D	1.1060	B	0.7861	B
5	1.0420	A	0.7385	E	1.1220	D	0.7969	D	1.2720	B	0.9040	B	1.1220	B	0.7776	B
6	0.9396	E	0.5807	E	0.8698	E	0.6813	E	0.9342	A	0.6157	A	1.5410	D	1.1092	D
7	1.3530	E	0.9160	E	1.4390	A	0.8606	A	1.3740	B	0.9866	B	0.9074	B	0.6656	B
8	1.1920	D	0.8980	D	1.0310	A	0.6836	A	1.3050	E	0.9267	E	1.3510	D	0.8601	D
9	1.1380	A	0.7400	A	1.1010	E	0.6825	E	1.4390	D	1.0437	D	1.0680	E	0.8247	E
10	1.4980	D	1.0201	D	1.3530	E	0.7911	E	1.5570	D	1.0634	D	1.1870	D	0.8856	D
Average	**1.1565**	**NA**	**0.7684**	**NA**	**1.2640**	**NA**	**0.8324**	**NA**	**1.3288**	**NA**	**0.9270**	**NA**	**1.1922**	**NA**	**0.8533**	**NA**
Std Dev	**0.1942**	**NA**	**0.1574**	**NA**	**0.2422**	**NA**	**0.1290**	**NA**	**0.1810**	**NA**	**0.1400**	**NA**	**0.2179**	**NA**	**0.1567**	**NA**

NOTE: L = Location of the minimum peel strength value in a sample (pouch), Refer to Figure 14

The minimum values were taken from Table 60, pages 171-174

Table 62. Peel Test Results for Package Size (9.25" x 14.125") – 1059B Rexam at Crosshead Speed = 10 ipm and Grip Separation = 1.0"

	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)
n	Location A					Location B				
1	1.5460	0.9359	1.004	0.9322	5.990	1.2030	0.7405	1.053	0.7032	6.255
2	1.9330	1.3480	0.932	1.4464	5.603	1.7560	1.2170	0.976	1.2469	5.814
3	2.1370	1.4030	0.908	1.5452	5.398	1.7340	1.1250	0.964	1.1670	5.730
4	1.1330	0.7081	0.958	0.7391	5.711	1.9110	1.3660	1.000	1.3660	5.973
5	1.8630	1.1350	0.921	1.2324	5.487	1.0680	0.7471	0.950	0.7864	5.691
6	1.2240	0.8296	0.964	0.8606	5.753	1.6380	1.1260	0.994	1.1328	5.929
7	1.9650	1.3390	1.007	1.3297	6.016	1.6480	1.1390	0.947	1.2027	5.647
8	1.5790	1.1240	1.019	1.1030	6.064	1.6970	1.1360	0.970	1.1711	5.820
9	1.5620	1.1200	1.133	0.9885	6.733	2.3680	1.6760	0.943	1.7773	5.634
10	1.8850	1.1730	1.157	1.0138	6.923	1.9060	1.3510	0.987	1.3688	5.916
A	1.6827	1.1116	1.0003	1.1191	5.9678	1.6929	1.1624	0.9784	1.1922	5.8409
SD	0.3298	0.2286	0.0851	0.2625	0.5067	0.3636	0.2785	0.0328	0.3010	0.1882
n	Location D					Location E				
1	1.8090	1.2530	0.971	1.2904	5.705	1.7880	1.1470	0.924	1.2413	5.524
2	1.8740	1.4030	0.970	1.4464	5.810	1.6380	1.0220	0.857	1.1925	5.083
3	1.4760	0.9114	0.941	0.9685	5.621	1.1600	0.7248	0.997	0.7270	5.903
4	1.2190	0.8529	0.941	0.9064	5.606	1.7720	1.0500	0.937	1.1206	5.638
5	1.2240	0.8345	1.001	0.8337	6.032	1.6430	1.0700	0.951	1.1251	5.634
6	1.8250	1.1930	0.957	1.2466	5.720	1.1540	0.6527	0.913	0.7149	5.471
7	1.5950	1.0300	0.999	1.0310	5.932	1.7830	1.0380	1.018	1.0196	6.034
8	1.7720	1.1580	1.075	1.0772	6.432	1.6430	0.8089	0.892	0.9068	5.335
9	1.9490	1.4190	1.006	1.4105	6.073	1.7720	1.0990	0.914	1.2024	5.493
10	1.8420	1.3450	0.985	1.3655	5.891	2.0190	1.2980	0.921	1.4093	5.502
A	1.6585	1.1400	0.9846	1.1576	5.8822	1.6372	0.9910	0.9324	1.0660	5.5617
SD	0.2681	0.2224	0.0395	0.2217	0.2519	0.2764	0.2004	0.0473	0.2249	0.2686

NOTE: The minimum peak and average peel strength values, out of the four locations, from each sample, were used for the analysis. Refer to Table 63 for information about the location and value of minimum peel strength for this package size.

Table 62. Peel Test Results for Package Size (9.25" x 14.125") – 1059B Rexam at Crosshead Speed = 12 ipm and Grip Separation = 1.0" - Continuation

	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)
n	Location A					Location B				
1	2.4910	1.6120	1.092	1.4762	5.419	1.1380	0.7798	1.081	0.7214	5.263
2	1.4340	0.9215	1.024	0.8999	5.053	1.2990	0.8533	1.004	0.8499	5.015
3	1.6380	1.1430	1.076	1.0623	5.320	1.3420	0.8734	0.992	0.8804	5.003
4	1.5360	0.9064	0.944	0.9602	4.730	2.3460	1.5000	0.980	1.5306	4.862
5	1.2990	0.7855	0.933	0.8419	4.666	1.9110	1.3830	0.995	1.3899	4.974
6	1.5410	0.9637	1.053	0.9152	5.274	1.8420	1.2500	0.971	1.2873	4.785
7	1.8790	1.2870	0.980	1.3133	4.849	2.2500	1.6490	0.993	1.6606	4.932
8	1.3690	0.8943	1.091	0.8197	5.374	1.4760	1.0790	0.983	1.0977	4.801
9	1.7560	1.2110	1.029	1.1769	5.150	2.1850	1.5920	0.968	1.6446	4.874
10	2.2170	1.4940	1.123	1.3304	5.609	1.8790	1.2510	0.969	1.2910	4.833
A	1.7160	1.1218	1.0345	1.0796	5.1444	1.7668	1.2211	0.9936	1.2354	4.9342
SD	0.3834	0.2771	0.0650	0.2315	0.3141	0.4297	0.3158	0.0330	0.3371	0.1414
n	Location D					Location E				
1	2.2280	1.7200	0.981	1.7533	4.839	1.7180	1.1460	1.217	0.9417	6.031
2	1.7610	1.3010	0.979	1.3289	4.833	1.4660	0.8927	0.968	0.9222	4.771
3	1.9920	1.3870	0.981	1.4139	4.884	1.8680	1.1640	0.997	1.1675	4.955
4	1.7880	1.2580	0.963	1.3063	4.820	2.2280	1.4370	0.928	1.5485	4.688
5	1.9760	1.3560	1.128	1.2021	5.634	1.7400	1.0790	0.936	1.1528	4.622
6	1.6910	1.2030	0.936	1.2853	4.615	1.8950	1.2060	0.988	1.2206	4.958
7	2.3570	1.7260	0.956	1.8054	4.695	2.0510	1.3530	0.976	1.3863	4.820
8	1.9170	1.2990	1.016	1.2785	5.163	1.1490	0.6853	0.942	0.7275	4.631
9	1.6160	1.2110	0.991	1.2220	4.967	1.6210	0.9090	0.880	1.0330	4.371
10	1.5410	1.0680	0.960	1.1125	4.791	1.5680	1.0010	0.944	1.0604	4.663
A	1.8867	1.3529	0.9891	1.3708	4.9241	1.7304	1.0873	0.9776	1.1160	4.8510
SD	0.2613	0.2144	0.0534	0.2300	0.2899	0.3060	0.2249	0.0907	0.2366	0.4491

NOTE: The minimum peak and average peel strength values, out of the four locations, from each sample, were used for the analysis. Refer to Table 63 for information about the location and value of minimum peel strength for this package size.

Table 62. Peel Test Results for Package Size (9.25" x 14.125") – 1059B Rexam at Crosshead Speed = 10 ipm and Grip Separation = 2.0" - Continuation

	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)
n	Location A					Location B				
1	1.9490	1.3300	1.093	1.2168	6.483	1.7500	1.2940	1.110	1.1658	6.534
2	2.0720	1.2660	1.189	1.0648	7.031	2.2710	1.6430	1.002	1.6397	5.941
3	1.9650	1.3310	0.939	1.4175	5.573	1.5360	1.0190	0.970	1.0505	5.785
4	1.4230	0.9466	1.074	0.8814	6.503	1.8740	1.4110	0.976	1.4457	5.846
5	1.8740	1.3380	0.968	1.3822	5.647	1.4660	0.8536	0.993	0.8596	5.948
6	1.5460	1.0750	0.927	1.1597	5.528	1.4660	0.9299	0.980	0.9489	5.855
7	1.9810	1.2930	0.901	1.4351	5.320	1.0360	0.7476	0.987	0.7574	5.893
8	1.5790	0.9173	0.918	0.9992	5.467	2.1480	1.5830	0.967	1.6370	5.791
9	1.6380	1.0880	0.979	1.1113	5.832	2.1740	1.5480	0.997	1.5527	5.973
10	1.8150	1.3100	0.950	1.3789	5.672	1.9490	1.3890	0.999	1.3904	5.900
A	1.7842	1.1895	0.9938	1.2047	5.9056	1.7670	1.2418	0.9981	1.2448	5.9466
SD	0.2214	0.1665	0.0937	0.1936	0.5649	0.3914	0.3276	0.0412	0.3306	0.2159
n	Location D					Location E				
1	2.3570	1.4140	1.012	1.3972	6.060	1.5460	0.9920	0.863	1.1495	5.134
2	2.6360	1.9590	1.023	1.9150	5.887	1.5950	0.9940	0.904	1.0996	5.599
3	1.3210	0.8787	0.957	0.9182	5.723	1.5300	0.9278	0.852	1.0890	5.086
4	1.7290	1.1450	0.994	1.1519	5.881	1.6750	0.9656	0.886	1.0898	5.262
5	1.9060	1.3400	1.076	1.2454	6.114	1.9270	1.1920	0.919	1.2971	5.477
6	1.8470	1.3480	0.994	1.3561	5.912	1.5190	0.9370	0.910	1.0297	5.430
7	2.1960	1.6730	0.959	1.7445	5.727	1.6970	0.9363	0.887	1.0556	5.295
8	1.7230	1.1780	1.051	1.1208	6.263	1.7130	0.9972	0.853	1.1691	5.112
9	1.4930	1.0300	1.056	0.9754	6.342	1.9380	1.2340	0.950	1.2989	5.714
10	2.0620	1.2820	1.011	1.2681	6.045	1.5140	0.9480	0.843	1.1246	5.044
A	1.9270	1.3248	1.0133	1.3093	5.9954	1.6654	1.0124	0.8867	1.1403	5.3153
SD	0.3974	0.3116	0.0396	0.3157	0.2083	0.1592	0.1092	0.0345	0.0926	0.2315

NOTE: The minimum peak and average peel strength values, out of the four locations, from each sample, were used for the analysis. Refer to Table 63 for information about the location and value of minimum peel strength for this package size.

Table 62. Peel Test Results for Package Size (9.25" x 14.125") – 1059B Rexam at Crosshead Speed = 12 ipm and Grip Separation = 2.0" - Continuation

	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)	Peak Force (lbs)	Energy (in*lbs)	Total Ext (in)	Avg Force (lbs)	Time (sec)
n	Location A					Location B				
1	1.8150	1.1700	1.006	1.1630	4.990	1.7400	1.2030	1.006	1.1958	5.034
2	2.1640	1.4400	0.976	1.4754	4.794	1.5410	1.0720	0.975	1.0995	4.923
3	1.5570	1.0450	0.938	1.1141	4.631	1.3580	0.8944	0.952	0.9395	4.749
4	1.4660	0.9317	0.982	0.9488	4.823	2.0300	1.4090	0.957	1.4723	4.733
5	2.2550	1.4520	1.008	1.4405	5.012	1.8680	1.2380	0.973	1.2724	4.778
6	1.7660	1.0770	0.900	1.1967	4.470	1.1220	0.8429	1.029	0.8191	5.105
7	1.9170	1.2560	1.022	1.2290	5.099	2.3570	1.6250	0.998	1.6283	4.922
8	1.8950	1.2320	0.949	1.2982	4.685	2.1320	1.6590	0.974	1.7033	4.836
9	1.9270	1.2000	1.014	1.1834	5.063	2.2500	1.6340	0.973	1.6793	4.820
10	1.8250	1.1960	0.993	1.2044	4.990	1.7290	1.1640	1.024	1.1367	5.118
A	1.8587	1.2000	0.9788	1.2253	4.8557	1.8127	1.2741	0.9861	1.2946	4.9018
SD	0.2396	0.1624	0.0390	0.1527	0.2097	0.3958	0.2997	0.0267	0.3133	0.1432
n	Location D					Location E				
1	2.0780	1.6210	1.074	1.5093	5.426	1.9760	1.2100	0.956	1.2657	4.740
2	2.1640	1.5100	1.019	1.4818	5.000	1.7930	1.1020	0.859	1.2829	4.223
3	1.6860	1.4300	1.002	1.4271	4.948	2.1740	1.3600	0.852	1.5962	4.230
4	1.1650	0.7761	0.975	0.7960	4.803	1.4010	0.9018	0.901	1.0009	4.643
5	2.3190	1.7970	1.000	1.7970	4.974	1.1650	0.6815	0.868	0.7851	4.320
6	2.4640	1.7990	1.004	1.7918	4.996	1.8090	1.1840	0.847	1.3979	4.202
7	2.1050	1.4250	1.019	1.3984	5.092	1.6430	1.0310	0.872	1.1823	4.330
8	1.9270	1.4300	1.035	1.3816	5.140	1.7130	1.0880	0.941	1.1562	4.785
9	1.2080	0.7829	1.005	0.7790	5.019	1.1760	0.7173	0.921	0.7788	4.624
10	2.1210	1.5820	1.121	1.4112	5.592	1.8150	1.1610	0.900	1.2900	4.477
A	1.9237	1.4153	1.0254	1.3773	5.0990	1.6665	1.0437	0.8917	1.1736	4.4574
SD	0.4404	0.3622	0.0425	0.3458	0.2368	0.3295	0.2172	0.0383	0.2582	0.2253

NOTE: The minimum peak and average peel strength values, out of the four locations, from each sample, were used for the analysis. Refer to Table 63 for information about the location and value of minimum peel strength for this package size.

Rexam (1059B Tyvek/Polyester Poly Laminate) Pouches - Continuation

Table 63. Minimum Peel Strength Values for Package Size (9.25" x 14.125") – 1059B Rexam

	Crosshead Speed = 10 ipm Grip Separation = 1.0"				Crosshead Speed = 12 ipm Grip Separation = 1.0"				Crosshead Speed = 10 ipm Grip Separation = 2.0"				Crosshead Speed = 12 ipm Grip Separation = 2.0"			
Sample	Peak Force (lbs)	L	Average Force (lbs)	L	Peak Force (lbs)	L	Average Force (lbs)	L	Peak Force (lbs)	L	Average Force (lbs)	L	Peak Force (lbs)	L	Average Force (lbs)	L
1	1.2030	B	0.7032	B	1.1380	B	0.7214	B	1.5460	E	1.1495	E	1.7400	B	1.1630	A
2	1.6380	E	1.1925	E	1.2990	B	0.8499	B	1.5950	E	1.0648	A	1.5410	B	1.0995	B
3	1.1600	E	0.7270	E	1.3420	B	0.8804	B	1.3210	D	0.9182	D	1.3580	B	0.9395	B
4	1.1330	A	0.7391	A	1.5360	A	0.9602	A	1.4230	A	0.8814	A	1.1650	D	0.7960	D
5	1.0680	B	0.7864	B	1.2990	A	0.8419	A	1.4660	B	0.8596	B	1.1650	E	0.7851	E
6	1.1540	E	0.7149	E	1.5410	A	0.9152	A	1.4660	B	0.9489	B	1.1220	B	0.8191	B
7	1.5950	D	1.0196	E	1.8790	A	1.3133	A	1.0360	B	0.7574	B	1.6430	E	1.1823	E
8	1.5790	A	0.9068	E	1.1490	E	0.7275	E	1.5790	A	0.9992	A	1.7130	E	1.1562	E
9	1.5620	A	0.9885	A	1.6160	D	1.0330	E	1.4930	D	0.9754	D	1.1760	E	0.7788	E
10	1.8420	D	1.0138	A	1.5410	D	1.0604	E	1.5140	E	1.1246	E	1.7290	B	1.1367	B
Average	**1.3934**	**NA**	**0.8792**	**NA**	**1.4340**	**NA**	**0.9303**	**NA**	**1.4439**	**NA**	**0.9679**	**NA**	**1.4352**	**NA**	**0.9856**	**NA**
Std Dev	**0.2761**	**NA**	**0.1693**	**NA**	**0.2305**	**NA**	**0.1754**	**NA**	**0.1639**	**NA**	**0.1221**	**NA**	**0.2642**	**NA**	**0.1776**	**NA**

NOTE: L = Location of the minimum peel strength value in a sample (pouch), Refer to Figure 14
The minimum values were taken from Table 62, pages 176-179

APPENDIX VI

ANALYSIS OF VARIANCE FOR FACTORIAL EXPERIMENTS

MINITAB RESULTS

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A. ANALYSIS OF VARIANCE for Burst Test Factorial Experiments

Three 2^2 factorial experiments were performed for the burst test. The levels for the factors studied in each of the experiments are shown below.

2^2 Factorial Experiment #1 for Burst Test

Factor	Low Level	High Level
A **Flow Rate**	1	9
B **Plate Separation**	0.5"	1.0"

2^2 Factorial Experiment #2 for Burst Test

Factor	Low Level	High Level
A **Flow Rate**	1	5
B **Plate Separation**	0.5"	1.0"

2^2 Factorial Experiment #3 for Burst Test

Factor	Low Level	High Level
A **Flow Rate**	5	9
B **Plate Separation**	0.5"	1.0"

The results for the three experiments are shown below for each package size and material combination studied.

I. Rexam (1073B Tyvek/Polyester/Poly Laminate) Pouches

Table 64. Analysis of Variance for Burst Pressure – Factorial Experiment #1
Rexam (1073B Tyvek/Polyester/Poly Laminate) Pouches
Package Size (3.25" x 7.25")

Source	Degrees of Freedom	Sum of Squares	Mean Square	F calculated	F 2,36,0.05 1,36,0.05	P value	Conclusion
Main Effects:	2	25160	12580	107.17	3.26	0.000	Significant
A = Flow	1	603	603	5.15	4.11	0.030	Significant
B = Gap	1	24557	24557	209.89	4.11	0.000	Significant
Interaction	1	44	44	0.37	4.11	0.545	Not Significant
Error	36	4226	117	---	---	---	---
Total	39	29430	---	---	---	---	---

Package Size (5.25" x 9.125")

Source	Degrees of Freedom	Sum of Squares	Mean Square	F calculated	F 2,36,0.05 1,36,0.05	P value	Conclusion
Main Effects:	2	26536	13268	365.7	3.26	0.000	Significant
A = Flow	1	183	183	5.04	4.11	0.031	Significant
B = Gap	1	26353	26353	724	4.11	0.000	Significant
Interaction	1	1	1	0.03	4.11	0.865	Not Significant
Error	36	1306	36	---	---	---	---
Total	39	27843	---	---	---	---	---

Package Size (7.25" x 11.125")

Source	Degrees of Freedom	Sum of Squares	Mean Square	F calculated	F 2,36,0.05 1,36,0.05	P value	Conclusion
Main Effects:	2	19810	9905	160.04	3.26	0.000	Significant
A = Flow	1	626	626	10.11	4.11	0.003	Significant
B = Gap	1	19184	19184	309.92	4.11	0.000	Significant
Interaction	1	375	375	6.05	4.11	0.019	Significant
Error	36	2228	61.9	---	---	---	---
Total	39	22413	---	---	---	---	---

Table 64. Analysis of Variance for Burst Pressure – Factorial Experiment #1 Rexam (1073B Tyvek/Polyester/Poly Laminate) Pouches– Continuation

Package Size (9.25" x 14.125")

Source	Degrees of Freedom	Sum of Squares	Mean Square	F calculated	F 2,36,0.05 1,36,0.05	P value	Conclusion
Main Effects:	2	18531	9265	194.07	3.26	0.000	Significant
A = Flow	1	2734	2734	57.32	4.11	0.000	Significant
B = Gap	1	15797	15797	331.17	4.11	0.000	Significant
Interaction	1	763	763	15.98	4.11	0.000	Significant
Error	36	1719	47.7	---	---	---	---
Total	39	21013	---	---	---	---	---

Package Size (11.25" x 15.25")

Source	Degrees of Freedom	Sum of Squares	Mean Square	F calculated	F 2,36,0.05 1,36,0.05	P value	Conclusion
Main Effects:	2	20831	10416	202.82	3.26	0.000	Significant
A = Flow	1	635	635	12.35	4.11	0.001	Significant
B = Gap	1	20196	20196	392.92	4.11	0.000	Significant
Interaction	1	77	77	1.50	4.11	0.228	Not Significant
Error	36	1849	51.4	---	---	---	---
Total	39	22757	---	---	---	---	---

Table 65. Analysis of Variance for Burst Pressure – Factorial Experiment #2
Rexam (1073B Tyvek/Polyester/Poly Laminate) Pouches

Package Size (3.25" x 7.25")

Source	Degrees of Freedom	Sum of Squares	Mean Square	F calculated	F 2,36,0.05 1,36,0.05	P value	Conclusion
Main Effects:	2	23072	11536	110.9	3.26	0.000	**Significant**
A = Flow	1	286	286	2.75	4.11	0.106	Not Significant
B = Gap	1	22786	22786	219.10	4.11	0.000	**Significant**
Interaction	1	1	1	0.01	4.11	0.933	Not Significant
Error	36	3748	104	---	---	---	---
Total	39	26821	---	---	---	---	---

Package Size (5.25" x 9.125")

Source	Degrees of Freedom	Sum of Squares	Mean Square	F calculated	F 2,36,0.05 1,36,0.05	P value	Conclusion
Main Effects:	2	26436	13218	292.6	3.26	0.000	**Significant**
A = Flow	1	155	155	3.43	4.11	0.072	Not Significant
B = Gap	1	26281	26281	581.44	4.11	0.000	**Significant**
Interaction	1	0.7	0.7	0.01	4.11	0.905	Not Significant
Error	36	1626	45.2	---	---	---	---
Total	39	28062.7	---	---	---	---	---

Package Size (7.25" x 11.125")

Source	Degrees of Freedom	Sum of Squares	Mean Square	F calculated	F 2,36,0.05 1,36,0.05	P value	Conclusion
Main Effects:	2	23574	11787	250.14	3.26	0.000	**Significant**
A = Flow	1	1381	1381	29.32	4.11	0.000	**Significant**
B = Gap	1	22193	22193	471.19	4.11	0.000	**Significant**
Interaction	1	889	889	18.87	4.11	0.000	**Significant**
Error	36	1696	47.1	---	---	---	---
Total	39	26159	---	---	---	---	---

Table 65. Analysis of Variance for Burst Pressure – Factorial Experiment #2 Rexam (1073B Tyvek/Polyester/Poly Laminate) Pouches- Continuation

Package Size (9.25" x 14.125")

Source	Degrees of Freedom	Sum of Squares	Mean Square	F calculated	F 2,36,0.05 1,36,0.05	P value	Conclusion
Main Effects:	2	14760	7380	130.57	3.26	0.000	**Significant**
A = Flow	1	810	810	14.33	4.11	0.001	**Significant**
B = Gap	1	13950	13950	246.90	4.11	0.000	**Significant**
Interaction	1	402	402	7.11	4.11	0.011	**Significant**
Error	36	2035	56.5	---	---	---	---
Total	39	17197	---	---	---	---	---

Package Size (11.25" x 15.25")

Source	Degrees of Freedom	Sum of Squares	Mean Square	F calculated	F 2,36,0.05 1,36,0.05	P value	Conclusion
Main Effects:	2	23096	11548	222.62	3.26	0.000	**Significant**
A = Flow	1	243	243	4.66	4.11	0.037	**Significant**
B = Gap	1	22853	22853	440.33	4.11	0.000	**Significant**
Interaction	1	0.1	0.1	0.000	4.11	0.970	Not Significant
Error	36	1867	51.9	---	---	---	---
Total	39	24963	---	---	---	---	---

Table 66. Analysis of Variance for Burst Pressure – Factorial Experiment #3 Rexam (1073B Tyvek/Polyester/Poly Laminate) Pouches

Package Size (3.25" x 7.25")

Source	Degrees of Freedom	Sum of Squares	Mean Square	F calculated	F 2,36,0.05 1,36,0.05	P value	Conclusion
Main Effects:	2	24889	12444	100.52	3.26	0.000	**Significant**
A = Flow	1	59	59	0.48	4.11	0.496	Not Significant
B = Gap	1	24830	24830	200.2	4.11	0.000	**Significant**
Interaction	1	33	33	0.27	4.11	0.608	Not Significant
Error	36	4456	124	---	---	---	---
Total	39	29378	---	---	---	---	---

Package Size (5.25" x 9.125")

Source	Degrees of Freedom	Sum of Squares	Mean Square	F calculated	F 2,36,0.05 1,36,0.05	P value	Conclusion
Main Effects:	2	26617	13308	222.10	3.26	0.000	**Significant**
A = Flow	1	1	1	0.02	4.11	0.890	Not Significant
B = Gap	1	26616	26616	444.37	4.11	0.000	**Significant**
Interaction	1	0.0	0.0	0.00	4.11	0.977	Not Significant
Error	36	2157	59.9	---	---	---	---
Total	39	28774	---	---	---	---	---

Package Size (7.25" x 11.125")

Source	Degrees of Freedom	Sum of Squares	Mean Square	F calculated	F 2,36,0.05 1,36,0.05	P value	Conclusion
Main Effects:	2	28482	14241	209.37	3.26	0.000	**Significant**
A = Flow	1	148	148	2.17	4.11	0.150	Not Significant
B = Gap	1	28334	28334	416.60	4.11	0.000	**Significant**
Interaction	1	110	110	1.61	4.11	0.213	Not Significant
Error	36	2449	68.0	---	---	---	---
Total	39	31041	---	---	---	---	---

Table 66. Analysis of Variance for Burst Pressure – Factorial Experiment #3 Rexam (1073B Tyvek/Polyester/Poly Laminate) Pouches- Continuation

Package Size (9.25" x 14.125")

Source	Degrees of Freedom	Sum of Squares	Mean Square	F calculated	F 2,36,0.05 1,36,0.05	P value	Conclusion
Main Effects:	2	21806	10903	188.5	3.26	0.000	**Significant**
A = Flow	1	568	568	9.82	4.11	0.003	**Significant**
B = Gap	1	21238	21238	367.40	4.11	0.000	**Significant**
Interaction	1	57	57	0.99	4.11	0.326	Not Significant
Error	36	2082	57.8	---	---	---	---
Total	39	23945	---	---	---	---	---

Package Size (11.25" x 15.25")

Source	Degrees of Freedom	Sum of Squares	Mean Square	F calculated	F 2,36,0.05 1,36,0.05	P value	Conclusion
Main Effects:	2	20365	10183	154.72	3.26	0.000	**Significant**
A = Flow	1	93	93	1.41	4.11	0.243	Not Significant
B = Gap	1	20272	20272	308.09	4.11	0.000	**Significant**
Interaction	1	82	82	1.25	4.11	0.271	Not Significant
Error	36	2369	65.8	---	---	---	---
Total	39	22816	---	---	---	---	---

II. Tolas (1073B Tyvek/PET/PE Laminate) Pouches

Table 67. Analysis of Variance for Burst Pressure – Factorial Experiment #1
Tolas (1073B Tyvek/PET/PE Laminate) Pouches
Package Size (3" x 11.375")

Source	Degrees of Freedom	Sum of Squares	Mean Square	F calculated	F 2,36,0.05 1,36,0.05	P value	Conclusion
Main Effects:	2	23071	11535	112.34	3.26	0.000	**Significant**
A = Flow	1	1206	1206	11.70	4.11	0.002	**Significant**
B = Gap	1	21865	21865	212.20	4.11	0.000	**Significant**
Interaction	1	124	124	1.21	4.11	0.279	Not Significant
Error	36	3696	103	---	---	---	---
Total	39	26891	---	---	---	---	---

Package Size (10.625" x 15")

Source	Degrees of Freedom	Sum of Squares	Mean Square	F calculated	F 2,36,0.05 1,36,0.05	P value	Conclusion
Main Effects:	2	16404	8202	188.91	3.26	0.000	**Significant**
A = Flow	1	179	179	4.12	4.11	0.050	**Significant**
B = Gap	1	16225	16225	373.84	4.11	0.000	**Significant**
Interaction	1	51	51	1.18	4.11	0.285	Not Significant
Error	36	1563	43.4	---	---	---	---
Total	39	18018	---	---	---	---	---

Table 68. Analysis of Variance for Burst Pressure – Factorial Experiment #2
Tolas (1073B Tyvek/PET/PE Laminate) Pouches
Package Size (3" x 11.375")

Source	Degrees of Freedom	Sum of Squares	Mean Square	F calculated	F 2,36,0.05 1,36,0.05	P value	Conclusion
Main Effects:	2	23205	11602	147.33	3.26	0.000	**Significant**
A = Flow	1	1148	1148	14.56	4.11	0.001	**Significant**
B = Gap	1	22057	22057	279.91	4.11	0.000	**Significant**
Interaction	1	139	139	1.76	4.11	0.193	Not Significant
Error	36	2835	78.8	---	---	---	---
Total	39	26179	---	---	---	---	---

Table 68. Analysis of Variance for Burst Pressure – Factorial Experiment #2 Tolas (1073B Tyvek/PET/PE Laminate) Pouches - Continuation

Package Size (10.625" x 15")

Source	Degrees of Freedom	Sum of Squares	Mean Square	F calculated	F 2,36,0.05 1,36,0.05	P value	Conclusion
Main Effects:	2	16981	8490	218.97	3.26	0.000	**Significant**
A = Flow	1	40	40	1.03	4.11	0.319	Not Significant
B = Gap	1	16941	16941	436.62	4.11	0.000	**Significant**
Interaction	1	19	19	0.49	4.11	0.488	Not Significant
Error	36	1396	38.8	---	---	---	---
Total	39	18396	---	---	---	---	---

Table 69. Analysis of Variance for Burst Pressure – Factorial Experiment #3 Tolas (1073B Tyvek/PET/PE Laminate) Pouches

Package Size (3" x 11.375")

Source	Degrees of Freedom	Sum of Squares	Mean Square	F calculated	F 2,36,0.05 1,36,0.05	P value	Conclusion
Main Effects:	2	25488	12744	108.97	3.26	0.000	**Significant**
A = Flow	1	1	1	0.008	4.11	0.939	Not Significant
B = Gap	1	25487	25487	217.83	4.11	0.000	**Significant**
Interaction	1	0	0	0.00	4.11	0.953	Not Significant
Error	36	4210	117	---	---	---	---
Total	39	29698	---	---	---	---	---

Package Size (10.625" x 15")

Source	Degrees of Freedom	Sum of Squares	Mean Square	F calculated	F 2,36,0.05 1,36,0.05	P value	Conclusion
Main Effects:	2	15182	7591	150.85	3.26	0.000	**Significant**
A = Flow	1	50	50	0.99	4.11	0.325	Not Significant
B = Gap	1	15132	15132	300.83	4.11	0.000	**Significant**
Interaction	1	8	8	0.15	4.11	0.697	Not Significant
Error	36	1812	50.3	---	---	---	---
Total	39	17002	---	---	---	---	---

III. Rexam (1059B Tyvek/Polyester/Poly Laminate) Pouches

Table 70. Analysis of Variance for Burst Pressure – Factorial Experiment #1
Rexam (1059 Tyvek/Polyester/Poly Laminate) Pouches
Package Size (5.75" x 9.125")

Source	Degrees of Freedom	Sum of Squares	Mean Square	F calculated	F 2,36,0.05 1,36,0.05	P value	Conclusion
Main Effects:	2	25577	12788	126.45	3.26	0.000	Significant
A = Flow	1	492	492	4.87	4.11	0.034	Significant
B = Gap	1	25085	25085	248.36	4.11	0.000	Significant
Interaction	1	47	47	0.47	4.11	0.498	Not Significant
Error	36	3641	101	---	---	---	---
Total	39	29265	---	---	---	---	---

Package Size (9.25" x 14.125")

Source	Degrees of Freedom	Sum of Squares	Mean Square	F calculated	F 2,36,0.05 1,36,0.05	P value	Conclusion
Main Effects:	2	26781	13391	225.05	3.26	0.000	Significant
A = Flow	1	1375	1375	23.11	4.11	0.000	Significant
B = Gap	1	25406	25406	426.99	4.11	0.000	Significant
Interaction	1	274	274	4.61	4.11	0.039	Significant
Error	36	2142	59.5	---	---	---	---
Total	39	29197	---	---	---	---	---

Table 71. Analysis of Variance for Burst Pressure – Factorial Experiment #2
Rexam (1059 Tyvek/Polyester/Poly Laminate) Pouches
Package Size (5.75" x 9.125")

Source	Degrees of Freedom	Sum of Squares	Mean Square	F calculated	F 2,36,0.05 1,36,0.05	P value	Conclusion
Main Effects:	2	25367	12684	124.59	3.26	0.000	Significant
A = Flow	1	272	272	2.67	4.11	0.111	Not Significant
B = Gap	1	25095	25095	246.03	4.11	0.000	Significant
Interaction	1	48	48	0.47	4.11	0.498	Not Significant
Error	36	3665	102	---	---	---	---
Total	39	29080	---	---	---	---	---

Table 71. Analysis of Variance for Burst Pressure – Factorial Experiment #2
Rexam (1059 Tyvek/Polyester/Poly Laminate) Pouches - Continuation
Package Size (9.25" x 14.125")

Source	Degrees of Freedom	Sum of Squares	Mean Square	F calculated	F 2,36,0.05 1,36,0.05	P value	Conclusion
Main Effects:	2	22972	11486	284.20	3.26	0.000	**Significant**
A = Flow	1	538	538	13.31	4.11	0.001	**Significant**
B = Gap	1	22434	22434	555.20	4.11	0.000	**Significant**
Interaction	1	48	48	1.19	4.11	0.282	Not Significant
Error	36	1455	40.4	---	---	---	---
Total	39	24475	---	---	---	---	---

Table 72. Analysis of Variance for Burst Pressure – Factorial Experiment #3
Rexam (1059 Tyvek/Polyester/Poly Laminate) Pouches
Package Size (5.75" x 9.125")

Source	Degrees of Freedom	Sum of Squares	Mean Square	F calculated	F 2,36,0.05 1,36,0.05	P value	Conclusion
Main Effects:	2	27354	13677	130.94	3.26	0.000	**Significant**
A = Flow	1	32	32	0.31	4.11	0.581	Not Significant
B = Gap	1	27322	27322	262.71	4.11	0.000	**Significant**
Interaction	1	0	0	0	4.11	0.998	Not Significant
Error	36	3760	104	---	---	---	---
Total	39	31114	---	---	---	---	---

Package Size (9.25" x 14.125")

Source	Degrees of Freedom	Sum of Squares	Mean Square	F calculated	F 2,36,0.05 1,36,0.05	P value	Conclusion
Main Effects:	2	27860	13930	393.78	3.26	0.000	**Significant**
A = Flow	1	193	193	5.45	4.11	0.025	**Significant**
B = Gap	1	27667	27667	781.55	4.11	0.000	**Significant**
Interaction	1	92	92	2.61	4.11	0.115	Not Significant
Error	36	1274	35.4	---	---	---	---
Total	39	29226	---	---	---	---	---

B. ANALYSIS OF VARIANCE for Peel Test Factorial Experiments

One 2^2 factorial experiments was performed for the peel test. The levels for the factors studied are shown below.

2^2 Factorial Experiment for Peel Test

Factor	Low Level	High Level
A **Crosshead Speed**	10 ipm	12 ipm
B **Grip Separation**	1.0"	2.0"

The results of this experiment are shown below when using peak and average peel forces for each package size and material combination studied.

I. Rexam (1073B Tyvek/Polyester/Poly Laminate) Pouches

Table 73. Analysis of Variance for Peel Strength when using Peak Force Values Rexam (1073 Tyvek/Polyester/Poly Laminate) Pouches

Package Size (3.25" x 7.25")

Source	Degrees of Freedom	Sum of Squares	Mean Square	F calculated	F 2,36,0.05 1,36,0.05	P value	Conclusion
Main Effects:	2	0.0043	0.0021	0.04	3.26	0.962	Not Significant
A = Speed	1	0.0043	0.0043	0.08	4.11	0.781	Not Significant
B = Grip	1	0.0000	0.0000	0.00	4.11	0.998	Not Significant
Interaction	1	0.0877	0.0877	1.62	4.11	0.212	Not Significant
Error	36	1.9526	0.0542	---	---	---	---
Total	39	2.0446	---	---	---	---	---

Package Size (5.25" x 9.125")

Source	Degrees of Freedom	Sum of Squares	Mean Square	F calculated	F 2,36,0.05 1,36,0.05	P value	Conclusion
Main Effects:	2	0.0483	0.0241	0.38	3.26	0.686	Not Significant
A = Speed	1	0.0411	0.0411	0.65	4.11	0.426	Not Significant
B = Grip	1	0.0072	0.0072	0.11	4.11	0.737	Not Significant
Interaction	1	0.0012	0.0012	0.02	4.11	0.893	Not Significant
Error	36	2.2786	0.0633	---	---	---	---
Total	39	2.3281	---	---	---	---	---

Package Size (7.25" x 11.125")

Source	Degrees of Freedom	Sum of Squares	Mean Square	F calculated	F 2,36,0.05 1,36,0.05	P value	Conclusion
Main Effects:	2	0.0331	0.0165	0.25	3.26	0.778	Not Significant
A = Speed	1	0.0101	0.0101	0.15	4.11	0.696	Not Significant
B = Grip	1	0.0229	0.0229	0.35	4.11	0.557	Not Significant
Interaction	1	0.3644	0.3644	5.57	4.11	0.024	Significant
Error	36	2.3532	0.0654	---	---	---	---
Total	39	2.7507	---	---	---	---	---

Table 73. Analysis of Variance for Peel Strength when using Peak Force Values Rexam (1073 Tyvek/Polyester/Poly Laminate) Pouches - Continuation

Package Size (9.25" x 14.125")

Source	Degrees of Freedom	Sum of Squares	Mean Square	F calculated	F 2,36,0.05 1,36,0.05	P value	Conclusion
Main Effects:	2	0.0253	0.0127	0.25	3.26	0.783	Not Significant
A = Speed	1	0.0244	0.0244	0.47	4.11	0.496	Not Significant
B = Grip	1	0.0009	0.0009	0.02	4.11	0.894	Not Significant
Interaction	1	0.0012	0.0012	0.02	4.11	0.878	Not Significant
Error	36	1.8548	0.0515	---	---	---	---
Total	39	1.8814	---	---	---	---	---

Package Size (11.25" x 15.25")

Source	Degrees of Freedom	Sum of Squares	Mean Square	F calculated	F 2,36,0.05 1,36,0.05	P value	Conclusion
Main Effects:	2	0.3585	0.1793	3.07	3.26	0.059	Not Significant
A = Speed	1	0.2354	0.2354	4.03	4.11	0.052	Not Significant
B = Grip	1	0.1231	0.1231	2.11	4.11	0.155	Not Significant
Interaction	1	0.0024	0.0024	0.04	4.11	0.842	Not Significant
Error	36	2.1028	0.0584	---	---	---	---
Total	39	2.4636	---	---	---	---	---

Table 74. Analysis of Variance for Peel Strength when using Average Force Values Rexam (1073 Tyvek/Polyester/Poly Laminate) Pouches

Package Size (3.25" x 7.25")

Source	Degrees of Freedom	Sum of Squares	Mean Square	F calculated	F 2,36,0.05 1,36,0.05	P value	Conclusion
Main Effects:	2	0.0091	0.0045	0.17	3.26	0.847	Not Significant
A = Speed	1	0.0048	0.0048	0.18	4.11	0.677	Not Significant
B = Grip	1	0.0043	0.0043	0.16	4.11	0.695	Not Significant
Interaction	1	0.0270	0.0270	0.99	4.11	0.327	Not Significant
Error	36	0.9848	0.0274	---	---	---	---
Total	39	1.0210	---	---	---	---	---

Package Size (5.25" x 9.125")

Source	Degrees of Freedom	Sum of Squares	Mean Square	F calculated	F 2,36,0.05 1,36,0.05	P value	Conclusion
Main Effects:	2	0.0858	0.0429	1.36	3.26	0.268	Not Significant
A = Speed	1	0.0002	0.0002	0.0064	4.11	0.936	Not Significant
B = Grip	1	0.0856	0.0856	2.73	4.11	0.108	Not Significant
Interaction	1	0.0001	0.0001	0.003	4.11	0.953	Not Significant
Error	36	1.1321	0.0314	---	---	---	---
Total	39	1.2180	---	---	---	---	---

Package Size (7.25" x 11.125")

Source	Degrees of Freedom	Sum of Squares	Mean Square	F calculated	F 2,36,0.05 1,36,0.05	P value	Conclusion
Main Effects:	2	0.0616	0.0308	0.97	3.26	0.390	Not Significant
A = Speed	1	0.0046	0.0046	0.14	4.11	0.706	Not Significant
B = Grip	1	0.0570	0.0570	1.79	4.11	0.190	Not Significant
Interaction	1	0.2042	0.2042	6.40	4.11	0.016	**Significant**
Error	36	1.1482	0.0319	---	---	---	---
Total	39	1.4140	---	---	---	---	---

Table 74. Analysis of Variance for Peel Strength when using Average Force Values Rexam (1073 Tyvek/Polyester/Poly Laminate) Pouches - Continuation

Package Size (9.25" x 14.125")

Source	Degrees of Freedom	Sum of Squares	Mean Square	F calculated	F 2,36,0.05 1,36,0.05	P value	Conclusion
Main Effects:	2	0.1140	0.0570	2.01	3.26	0.149	Not Significant
A = Speed	1	0.0006	0.0006	0.02	4.11	0.885	Not Significant
B = Grip	1	0.1134	0.1134	3.99	4.11	0.053	Not Significant
Interaction	1	0.0000	0.000	0.00	4.11	0.984	Not Significant
Error	36	1.0234	0.0284	---	---	---	---
Total	39	1.1374	---	---	---	---	---

Package Size (11.25" x 15.25")

Source	Degrees of Freedom	Sum of Squares	Mean Square	F calculated	F 2,36,0.05 1,36,0.05	P value	Conclusion
Main Effects:	2	0.1148	0.0574	1.56	3.26	0.225	Not Significant
A = Speed	1	0.0962	0.0962	2.60	4.11	0.115	Not Significant
B = Grip	1	0.0186	0.0186	0.50	4.11	0.482	Not Significant
Interaction	1	0.0100	0.0100	0.27	4.11	0.606	Not Significant
Error	36	1.3280	0.0369	---	---	---	---
Total	39	1.4528	---	---	---	---	---

II. Tolas (1073B Tyvek/PET/PE Laminate) Pouches

Table 75. Analysis of Variance for Peel Strength when using Peak Force Values Tolas (1073 Tyvek/PET/PE Laminate) Pouches

Package Size (3" x 11.375")

Source	Degrees of Freedom	Sum of Squares	Mean Square	F calculated	F 2,36,0.05 1,36,0.05	P value	Conclusion
Main Effects:	2	0.0650	0.0325	1.01	3.26	0.374	Not Significant
A = Speed	1	0.0285	0.0285	0.88	4.11	0.353	Not Significant
B = Grip	1	0.0365	0.0365	1.13	4.11	0.294	Not Significant
Interaction	1	0.1014	0.1014	3.15	4.11	0.084	Not Significant
Error	36	1.1583	0.0322	---	---	---	---
Total	39	1.3247	---	---	---	---	---

Package Size (10.625" x 15")

Source	Degrees of Freedom	Sum of Squares	Mean Square	F calculated	F 2,36,0.05 1,36,0.05	P value	Conclusion
Main Effects:	2	0.1889	0.0944	1.46	3.26	0.245	Not Significant
A = Speed	1	0.0601	0.0601	0.92	4.11	0.342	Not Significant
B = Grip	1	0.1288	0.1288	1.99	4.11	0.167	Not Significant
Interaction	1	0.0832	0.0832	1.29	4.11	0.264	Not Significant
Error	36	2.3275	0.0647	---	---	---	---
Total	39	2.5996	---	---	---	---	---

Table 76. Analysis of Variance for Peel Strength when using Average Force Values Tolas (1073 Tyvek/PET/PE Laminate) Pouches

Package Size (3" x 11.375")

Source	Degrees of Freedom	Sum of Squares	Mean Square	F calculated	F 2,36,0.05 1,36,0.05	P value	Conclusion
Main Effects:	2	0.0630	0.0315	1.59	3.26	0.217	Not Significant
A = Speed	1	0.0068	0.0068	0.34	4.11	0.561	Not Significant
B = Grip	1	0.0562	0.0562	2.83	4.11	0.101	Not Significant
Interaction	1	0.0101	0.0101	0.51	4.11	0.480	Not Significant
Error	36	0.7128	0.0198	---	---	---	---
Total	39	0.7859	---	---	---	---	---

Package Size (10.625" x 15")

Source	Degrees of Freedom	Sum of Squares	Mean Square	F calculated	F 2,36,0.05 1,36,0.05	P value	Conclusion
Main Effects:	2	0.1510	0.0755	1.87	3.26	0.169	Not Significant
A = Speed	1	0.0064	0.0064	0.16	4.11	0.692	Not Significant
B = Grip	1	0.1446	0.1446	3.57	4.11	0.067	Not Significant
Interaction	1	0.0314	0.0314	0.78	4.11	0.384	Not Significant
Error	36	1.4542	0.0404	---	---	---	---
Total	39	1.6366	---	---	---	---	---

III. Rexam (1059B Tyvek/Polyester/Poly Laminate) Pouches

Table 77. Analysis of Variance for Peel Strength when using Peak Force Values Rexam (1059 Tyvek/Polyester/Poly Laminate) Pouches

Package Size (5.75" x 9.125")

Source	Degrees of Freedom	Sum of Squares	Mean Square	F calculated	F 2,36,0.05 1,36,0.05	P value	Conclusion
Main Effects:	2	0.0274	0.0137	0.31	3.26	0.735	Not Significant
A = Speed	1	0.0021	0.0021	0.05	4.11	0.828	Not Significant
B = Grip	1	0.0253	0.0253	0.57	4.11	0.454	Not Significant
Interaction	1	0.1490	0.1490	3.37	4.11	0.075	Not Significant
Error	36	1.5898	0.0442	---	---	---	---
Total	39	1.7662	---	---	---	---	---

Package Size (9.25" x 14.125")

Source	Degrees of Freedom	Sum of Squares	Mean Square	F calculated	F 2,36,0.05 1,36,0.05	P value	Conclusion
Main Effects:	2	0.0092	0.0046	0.08	3.26	0.922	Not Significant
A = Speed	1	0.0025	0.0025	0.04	4.11	0.833	Not Significant
B = Grip	1	0.0067	0.0067	0.12	4.11	0.733	Not Significant
Interaction	1	0.0061	0.0061	0.11	4.11	0.745	Not Significant
Error	36	2.0343	0.0565	---	---	---	---
Total	39	2.0496	---	---	---	---	---

Table 78. Analysis of Variance for Peel Strength when using Average Force Values Rexam (1059 Tyvek/Polyester/Poly Laminate) Pouches

Package Size (5.75" x 9.125")

Source	Degrees of Freedom	Sum of Squares	Mean Square	F calculated	F 2,36,0.05 1,36,0.05	P value	Conclusion
Main Effects:	2	0.0807	0.0404	1.89	3.26	0.166	Not Significant
A = Speed	1	0.0002	0.0002	0.01	4.11	0.918	Not Significant
B = Grip	1	0.0805	0.0805	3.76	4.11	0.060	Not Significant
Interaction	1	0.0473	0.0473	2.21	4.11	0.146	Not Significant
Error	36	0.7702	0.0214	---	---	---	---
Total	39	0.8983	---	---	---	---	---

Package Size (9.25" x 14.125")

Source	Degrees of Freedom	Sum of Squares	Mean Square	F calculated	F 2,36,0.05 1,36,0.05	P value	Conclusion
Main Effects:	2	0.0637	0.0319	1.20	3.26	.312	Not Significant
A = Speed	1	0.0119	0.0119	0.45	4.11	0.508	Not Significant
B = Grip	1	0.0519	0.0519	1.95	4.11	0.170	Not Significant
Interaction	1	0.0028	0.0028	0.11	4.11	0.747	Not Significant
Error	36	0.9530	0.0265	---	---	---	---
Total	39	1.0195	---	---	---	---	---

APPENDIX VII

MODEL VALIDATION INFORMATION

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A. Data Transformation - from Nonlinear to Intrinsically Linear Functions

The transformation of data is necessary in order to be able to use linear multiple regression analysis. An example of the data transformation for a model with three independent variables is shown below:

Nonlinear (power): $Y = K (X_1)^{p1} (X_2)^{p2} (X_3)^{p3}$

"Intrinsically linear": $\log_{10} Y = \log_{10} K + p1 * \log_{10} X_1 + p2 * \log_{10} X_2 + p3 * \log_{10} X_3$

The logarithm of the independent (X's) and dependent (Y) variables is used to perform a scatter plot to check for linearity of the transformed data, residual analysis and, if satisfactory, a linear multiple regression analysis. The regression parameters K, p1, p2 and p3 are obtained from the regression analysis results. The p's are obtained directly from the linear regression but the K needs to be derived in the following way:

$\ln K = \log_{10} K * \ln 10$

$K = e^{\ln K}$

where; $\log_{10} K$ is obtained from the linear multiple regression analysis

$\ln 10 = 2.3026$

B. Formulas used in Calculations

1. **Conversion from in H_2O to (psi, which is lbs/in^2):**

   1 psi = 27.67 in H_2O

   The burst pressure was recorded in in $H_2O$and converted to psi for the calculations.

2. **Percent Error:**

$$\frac{\{\text{average of predicted values} - \text{average of actual values}\}}{\text{average of actual values}} \times 100$$

Average Percent Error:

$\sum |\text{Percent error}| / n$ where n = number if observations

It was found that in some cases the models overestimated the actual values and in others they underestimated them. For that reason, it is important to mention that the reported average percent error is the average of the magnitude (absolute value) of the percent error from all observations.

3. **Coefficient of Multiple Determination (R^2)**

   $R^2 = 1 - SSE/SST = (SST - SSE)/SST = SSR/SST$

   where;

   SSE = error sum of squares; variation explained by the error

   SSR = regression sum of squares – variation explained by the regression model

   SST = total sum of squares; - total variation (SSE + SSR = SST)

According to Devore, 1995, R^2 = ratio of explained variation to total variation. The higher the R^2, the more successful is the regression model in explaining the variation. The **multiple correlation coefficient (R)**, is the positive square root of the coefficient of multiple determination ($R = \sqrt{R^2}$). The R^2, R, SSE, SSR, SST and the regression coefficients (K, p1, ..., pn) were obtained from MINITAB and the BASIC program.

According to Neter et al., 1990, R^2_p indicates that there are p parameters, or (p – 1) predictor variables in the regression function on which R^2_p is based.

$$R^2_p = 1 - SSE_p/SST_p = (SST - SSE_p)/SST = SSR_p/SST$$

Since the denominator is constant for all possible regressions, R^2_p varies inversely with the error of sum squares, SSE_p. But it is known that SSE_p can never increase as additional X variables are included in the model. Thus, R^2_p will be a maximum when all $P - 1$ potential X variables are included in the model.

Since R^2_p does not take account of the number of parameters in the regression model and since max (R^2_p) can never decrease as p increases, the use of the adjusted coefficient of multiple determination (R^2_{adj}) is suggested as a criterion, which takes the number of parameters in the model into account through the degrees of freedom.

$$R^2_{adj} = 1 - [\{(n-1)/(n-p)\} * \{SSE/SST\}] = 1 - MSE/\{SST/(n-1)\}$$

R^2_{adj} increases if and only if MSE decreases since {SST/(n-1)} is fixed for a given Y observations (Neter, J., et al., 1990).

4. Prediction Intervals for single observation and for the mean response:

The most important objective in regression analysis is to use the fitted regression model to estimate the expected response (Bhattacharyya, Johnson, 1977). In order to do that, the t distribution is used to construct confidence intervals.

The prediction interval of the expected response (burst pressure or seal strength) for a single pouch was estimated with the following formula:

Expected Single Response = Value predicted with the model +/- $t_{\alpha/2,n-2}$ $s\sqrt{\{1 + (1/n)\}}$

The prediction intervals of the expected response (burst pressure or seal strength) for a group of pouches was estimated by using the following formula:

Expected Mean Response = Value predicted with the model +/- $t_{\alpha/2,n-2}$ $s\sqrt{(1/n)}$

where; **$t_{0.05}$ = t statistic at α= 0.05, $\alpha/2$ = 0.025**

$t_{0.25,28}$ = 2.048 for Rexam's 1073B Tyvek/plastic pouches

$t_{0.025,10}$ = 2.228 for Tolas 0073B and Rexam's 1059B Tyvek/plastic pouches

$s = \sqrt{(SSE/(n-2)} = \sqrt{(\sum(actual-predicted)^2/(n-2)}$

n = sample size

The prediction intervals for a single response and the mean response were obtained with the BASIC program.

C. Burst Pressure (P) Empirical Model Results when Using Flow Index as an Independent Variable

A linear multiple regression analysis was performed with flow index as an independent variable. The three models are shown below.

Empirical Model #1 with flow index as an independent variable:

$$P = K\,[\{S/D\}*CF]^{P1}[D/(L_O-1.571D)]^{P2}[D/(W_O-1.571D)]^{P3}[F]^{P4}$$

where $CF = [\{(L_O+W_O-1.142D)/(L_O+W_O-2.142D)\}]$

Empirical Model #2 with flow index as an independent variable:

$$P = K\,[\{S/D\}]^{P1}[CF]^{P2}[F]^{P3}$$

where $CF = [\{(L_O+W_O-1.142D)/(L_O+W_O-2.142D)\}]$

Empirical Model #3 with flow index as an independent variable:

$$P = K\,[\{S/D\}]^{P1}[L/W]^{P2}[F]^{P3}$$

Tables 79 to 81, have a summary of the results.

The data used in this analysis is in Appendix V. The formulas used in the calculation of the quantities reported in the tables below appear in section B of this appendix.

Table 79. Empirical Model #1 Results with Flow Index as an Independent Variable

Rexam (1073B Tyvek/Polyester Poly Laminate) Pouches, n=30

Data using	Average (%) Error	Regression Coefficients	R R_{adj}	PI – Single Response[1] (lbs/in^2)	PI – Mean Response[2] (lbs/in^2)	Equal to multiplying P by
S Peak Force	4.51	K = 2.31 p1 = 1.01 p2 = 0.23 p3 = - 0.03 **p4 = 0.0438**	0.9770 0.9731	P +/-0.4104	P +/- 0.0737	1.00 if F=1 1.07 if F=5 1.10 if F=9
S Avg Force	3.93	K = 3.66 p1 = 1.00 p2 = 0.29 p3 = - 0.90 **p4 = 0.0438**	0.9820 0.9788	P +/- 0.3563	P +/- 0.0640	1.00 if F=1 1.07 if F=5 1.10 if F=9

Tolas (1073B Tyvek/PET/PE Laminate) Pouches, n=12

Data using	Average (%) Error	Regression Coefficients	R R_{adj}	PI – Single Response[1] (lbs/in^2)	PI – Mean Response[2] (lbs/in^2)	Equal to multiplying P by
S Peak Force	1.59	K = 6.90 p1 = 1.57 p2 = 0.89 p3 = - 0.11 **p4 = 0.0375**	0.9972 0.9955	P +/- 0.1934	P +/- 0.0536	1.00 if F=1 1.06 if F=5 1.09 if F=9
S Avg Force	1.59	K = 19.45 p1 = 1.78 p2 = 1.10 p3 = - 0.13 **p4 = 0.0375**	0.9972 0.9955	P +/- 0.1934	P +/- 0.0536	1.00 if F=1 1.06 if F=5 1.09 if F=9

Rexam (1059B Tyvek/Polyester/Poly Laminate) Pouches, n = 12

Data using	Average (%) Error	Regression Coefficients	R R_{adj}	PI – Single Response[1] (lbs/in^2)	PI – Mean Response[2] (lbs/in^2)	Equal to multiplying P by
S Peak Force	0.88	K = 14.70 p1 = 1.21 p2 = 2.50 p3 = - 2.01 **p4 = 0.0419**	0.9991 0.9985	P +/- 0.1199	P +/- 0.0333	1.00 if F=1 1.07 if F=5 1.10 if F=9
S Avg Force	0.88	K = 19.90 p1 = 1.14 p2 = 2.37 p3 = - 1.94 **p4 = 0.0419**	0.9991 0.9985	P +/- 0.1200	P +/- 0.0333	1.00 if F=1 1.07 if F=5 1.10 if F=9

NOTES: P = Burst Pressure, S = Seal Strength and R = Correlation Coefficient

1.,2. Prediction Interval (PI) for Single Response, and Mean Response, respectively

Table 80. Empirical Model #2 Results with Flow Index as an Independent Variable

Rexam (1073B Tyvek/Polyester Poly Laminate) Pouches, n = 30

Data using	Average (%) Error	Regression Coefficients	R R_{adj}	PI – Single Response[1] (lbs/in^2)	PI – Mean Response[2] (lbs/in^2)	Equal to multiplying P by
S Peak Force	4.91	K = 1.28 p1 = 0.91 p2 = 3.41 p3 = 0.0438	0.9740 0.9711	P +/- 0.4596	P +/- 0.0825	1.00 if F=1 1.07 if F=5 1.10 if F=9
S Avg Force	4.41	K = 1.99 p1 = 0.88 p2 = 2.67 p3 = 0.0438	0.9793 0.9767	P +/- 0.4020	P +/- 0.0722	1.00 if F=1 1.07 if F=5 1.10 if F=9

Tolas (1073B Tyvek/PET/PE Laminate) Pouches, n = 12

Data using	Average (%) Error	Regression Coefficients	R R_{adj}	PI – Single Response[1] (lbs/in^2)	PI – Mean Response[2] (lbs/in^2)	Equal to multiplying P by
S Peak Force	2.53	K = 1.06 p1 = 0.92 p2 = 5.37 p3 = 0.0375	0.9922 0.9894	P +/- 0.3335	P +/- 0.0925	1.00 if F=1 1.06 if F=5 1.09 if F=9
S Avg Force	2.78	K = 1.45 p1 = 0.95 p2 = 5.99 p3 = 0.0375	0.9908 0.9874	P +/- 0.3639	P +/- 0.1009	1.00 if F=1 1.06 if F=5 1.09 if F=9

Rexam (1059B Tyvek/Polyester Poly Laminate) Pouches, n = 12

Data using	Average (%) Error	Regression Coefficients	R R_{adj}	PI – Single Response[1] (lbs/in^2)	PI – Mean Response[2] (lbs/in^2)	Equal to multiplying P by
S Peak Force	1.74	K = 1.73 p1 = 0.84 p2 = 1.68 p3= 0.0419	0.9969 0.9960	P +/- 0.2219	P +/- 0.0616	1.00 if F=1 1.07 if F=5 1.10 if F=9
S Avg Force	1.59	K = 2.55 p1 = 0.82 p2 = 1.10 p3 = 0.0419	0.9976 0.9965	P +/- 0.1968	P +/- 0.0546	1.00 if F=1 1.07 if F=5 1.10 if F=9

NOTES: P = Burst Pressure, S = Seal Strength and R = Correlation Coefficient

1.,2. Prediction Interval (PI) for Single Response, and Mean Response, respectively

Table 81. Empirical Model #3 Results with Flow Index as an Independent Variable
Rexam (1073B Polyester/Polyester Poly Laminate) Pouches, n = 30

Data using	Average (%) Error	Regression Coefficients	R R_{adj}	PI – Single Response[1] (lbs/in^2)	PI – Mean Response[2] (lbs/in^2)	Equal to multiplying P by
S Peak Force	5.31	K = 1.45 p1 = 0.74 p2 = 0.37 **p3 = 0.0438**	0.9717 0.9685	P +/- 0.4669	P +/- 0.0839	1.00 if F=1 1.07 if F=5 1.10 if F=9
S Avg Force	4.76	K = 2.05 p1 = 0.74 p2 = 0.30 **p3 = 0.0438**	0.9771 0.9747	P +/- 0.4194	P +/-0.0753	1.00 if F=1 1.07 if F=5 1.10 if F=9

Tolas (1073B Tyvek/PET/PE Laminate) Pouches, n = 12

Data using	Average (%) Error	Regression Coefficients	R R_{adj}	PI – Single Response[1] (lbs/in^2)	PI – Mean Response[2] (lbs/in^2)	Equal to multiplying P by
S Peak Force	1.55	K = 1.47 p1 = 0.68 p2 = 0.17 **p3 = 0.0375**	0.9971 0.9960	P +/- 0.1938	P +/- 0.0537	1.00 if F=1 1.06 if F=5 1.09 if F=9
S Avg Force	1.55	K = 1.88 p1 = 0.68 p2 = 0.19 **p3 = 0.0375**	0.9971 0.9960	P +/- 0.1938	P +/- 0.0537	1.00 if F=1 1.06 if F=5 1.09 if F=9

Rexam (1059B Tyvek/Polyester Poly Laminate) Pouches, n = 12

Data using	Average (%) Error	Regression Coefficients	R R_{adj}	PI – Single Response[1] (lbs/in^2)	PI – Mean Response[2] (lbs/in^2)	Equal to multiplying P by
S Peak Force	1.29	K = 1.19 p1 = 0.77 p2 = 1.12 **p3 = 0.0419**	0.9986 0.9980	P +/- 0.1429	P +/- 0.0396	1.00 if F=1 1.07 if F=5 1.10 if F=9
S Avg Force	1.29	K = 1.88 p1 = 0.77 p2 = 0.82 **p3 = 0.0419**	0.9986 0.9980	P +/- 0.1429	P +/- 0.0396	1.00 if F=1 1.07 if F=5 1.10 if F=9

NOTES: P = Burst Pressure, S = Seal Strength and R = Correlation Coefficient
1.,2. Prediction Interval (PI) for Single Response, and Mean Response, respectively

D. Burst Pressure (P) Empirical Models Results WITHOUT using Flow Index as an Independent Variable:

D.1 Models

The models analyzed are the following:

Burst Pressure, Model #1:

$$P = K\,[\{S/D\}*CF]^{P1}[D/(L_O-1.571D)]^{P2}[D/(W_O-1.571D)]^{P3}$$

$$\text{where } CF = [\{(L_O+W_O-1.142D)/(L_O+W_O-2.142D)\}]$$

Burst Pressure, Model #2:

$$P = K\,[\{S/D\}]^{P1}[CF]^{P2}$$

$$\text{where } CF = [\{(L_O+W_O-1.142D)/(L_O+W_O-2.142D)\}]$$

Burst Pressure, Model #3:

$$P = K\,[\{S/D\}]^{P1}[L/W]^{P2}$$

D.2 Data used in the analysis

The data collected for each material combination was used to run a regression analysis in order to calculate the regression coefficients for the three empirical models shown above. Rexam 1073B Tyvek/plastic pouches will have 30 data points to run the regression analysis if the burst data obtained from 3 different flow index values are used. The number of data points for Tolas 1073B and Rexam 1059B Tyvek/plastic pouches is 12. Refer to Tables 82 to 87, below

Table 82. Data used for the Burst Pressure (P) Prediction Models – Rexam (1073B Tyvek/Polyester Poly Laminate) Pouches (when using Peak Force Values)

Sample	L Length (in)	W Width (in)	D Gap (in)	F Flow Index	P Burst Pressure (lbs/in^2)	S Peak Force (lbs/in)	S/D (lbs/in^2)	L/W (in/in)	CF (in/in)	(S/D)*CF (lbs/in^2)	D/L_c (in/in)	D/W_c (in/in)
1	7.25	3.25	0.5	1	4.3928	1.4840	2.968	2.2308	1.0530	3.1254	0.0773	0.2029
2	7.25	3.25	0.5	5	4.5960	1.4840	2.968	2.2308	1.0530	3.1254	0.0773	0.2029
3	7.25	3.25	0.5	9	4.7492	1.4840	2.968	2.2308	1.0530	3.1254	0.0773	0.2029
4	7.25	3.25	1.0	1	2.6776	1.4840	1.484	2.2308	1.1196	1.6616	0.1761	0.5956
5	7.25	3.25	1.0	5	2.8609	1.4840	1.484	2.2308	1.1196	1.6616	0.1761	0.5956
6	7.25	3.25	1.0	9	2.8825	1.4840	1.484	2.2308	1.1196	1.6616	0.1761	0.5956
7	9.125	5.25	0.5	1	4.4984	1.5818	3.1636	1.7381	1.0376	3.2825	0.0600	0.1120
8	9.125	5.25	0.5	5	4.6498	1.5818	3.1636	1.7381	1.0376	3.2825	0.0600	0.1120
9	9.125	5.25	0.5	9	4.6646	1.5818	3.1636	1.7381	1.0376	3.2825	0.0600	0.1120
10	9.125	5.25	1.0	1	2.6549	1.5818	1.5818	1.7381	1.0817	1.7111	0.1324	0.2718
11	9.125	5.25	1.0	5	2.7879	1.5818	1.5818	1.7381	1.0817	1.7111	0.1324	0.2718
12	9.125	5.25	1.0	9	2.7976	1.5818	1.5818	1.7381	1.0817	1.7111	0.1324	0.2718
13	11.125	7.25	0.5	1	3.5797	1.4916	2.9832	1.5345	1.0289	3.0694	0.0484	0.0773
14	11.125	7.25	0.5	5	4.3451	1.4916	2.9832	1.5345	1.0289	3.0694	0.0484	0.0773
15	11.125	7.25	0.5	9	4.0867	1.4916	2.9832	1.5345	1.0289	3.0694	0.0484	0.0773

NOTE:

The data shown can be found in Appendix V

L_c and W_c = Contact Length and Width, respectively as described in Chapter 3

Theoretical Model #1: $P = (2S/D)$

Theoretical Model #2: $P = (2S/D)*CF$; **$CF = (L+W-(1.142D))/(L+W-(2.142D))$**

Empirical Model #1: $Y = K [X_1]^{p1} [X_2]^{p2} [X_3]^{p3}$; **$Y = \log P$, $X_1 = \log \{(S/D)*CF\}$, $X_2 = \log (D/L_c)$, $X_3 = \log (D/W_c)$**

Empirical Model #2: $Y = K [X_1]^{p1} [X_2]^{p2}$; **$Y = \log P$, $X_1 = \log (S/D)$, $X_2 = \log (CF)$**

Empirical Model #3: $Y = K [X_1]^{p1} [X_2]^{p2}$; **$Y = \log P$, $X_1 = \log (S/D)$, $X_2 = \log (L/W)$**

Table 82. Data used for the Burst Pressure (P) Prediction Models – Rexam (1073B Tyvek/Polyester Poly Laminate) Pouches (when using Peak Force Values) - Continuation

Sample	L Length (in)	W Width (in)	D Gap (in)	F Flow Index	P Burst Pressure (lbs/in^2)	S Peak Force (lbs/in)	S/D (lbs/in^2)	L/W (in/in)	CF (in/in)	(S/D)*CF (lbs/in^2)	D/L_c (in/in)	D/W_c (in/in)
16	11.125	7.25	1.0	1	2.2179	1.4916	1.4916	1.5345	1.0616	1.5835	0.1047	0.1761
17	11.125	7.25	1.0	5	2.3018	1.4916	1.4916	1.5345	1.0616	1.5835	0.1047	0.1761
18	11.125	7.25	1.0	9	2.2826	1.4916	1.4916	1.5345	1.0616	1.5835	0.1047	0.1761
19	14.125	9.25	0.5	1	3.3741	1.6133	3.2266	1.5270	1.0224	3.2989	0.0375	0.0591
20	14.125	9.25	0.5	5	3.9284	1.6133	3.2266	1.5270	1.0224	3.2989	0.0375	0.0591
21	14.125	9.25	0.5	9	4.2873	1.6133	3.2266	1.5270	1.0224	3.2989	0.0375	0.0591
22	14.125	9.25	1.0	1	2.2533	1.6133	1.6133	1.5270	1.0471	1.6893	0.0797	0.1302
23	14.125	9.25	1.0	5	2.3495	1.6133	1.6133	1.5270	1.0471	1.6893	0.0797	0.1302
24	14.125	9.25	1.0	9	2.5352	1.6133	1.6133	1.5270	1.0471	1.6893	0.0797	0.1302
25	15.25	11.25	0.5	1	4.1355	1.5892	3.1784	1.3556	1.0197	3.2409	0.0346	0.0478
26	15.25	11.25	0.5	5	4.3166	1.5892	3.1784	1.3556	1.0197	3.2409	0.0346	0.0478
27	15.25	11.25	0.5	9	4.3231	1.5892	3.1784	1.3556	1.0197	3.2409	0.0346	0.0478
28	15.25	11.25	1.0	1	2.4109	1.5892	1.5892	1.3556	1.0411	1.6544	0.0731	0.1033
29	15.25	11.25	1.0	5	2.5858	1.5892	1.5892	1.3556	1.0411	1.6544	0.0731	0.1033
30	15.25	11.25	1.0	9	2.7994	1.5892	1.5892	1.3556	1.0411	1.6544	0.0731	0.1033

NOTE:

The data shown can be found in Appendix V

L_c and W_c = Contact Length and Width, respectively as described in Chapter 3

Theoretical Model #1: $P = (2S/D)$

Theoretical Model #2: $P = (2S/D)*CF$; **$CF = (L+W-(1.142D))/(L+W-(2.142D))$**

Empirical Model #1: $Y = K [X_1]^{p1} [X_2]^{p2} [X_3]^{p3}$; **$Y = \log P$, $X_1 = \log \{(S/D)*CF\}$, $X_2 = \log (D/L_c)$, $X_3 = \log (D/W_c)$**

Empirical Model #2: $Y = K [X_1]^{p1} [X_2]^{p2}$; **$Y = \log P$, $X_1 = \log (S/D)$, $X_2 = \log (CF)$**

Empirical Model #3: $Y = K [X_1]^{p1} [X_2]^{p2}$; **$Y = \log P$, $X_1 = \log (S/D)$, $X_2 = \log (L/W)$**

Table 83. Data used for the Burst Pressure (P) Prediction Models – Rexam (1073B Tyvek/Polyester Poly Laminate) Pouches (when using Average Force Values)

Sample	L Length (in)	W Width (in)	D Gap (in)	F Flow Index	P Burst Pressure (lbs/in^2)	S Avg Force (lbs/in)	S/D (lbs/in^2)	L/W (in/in)	CF (in/in)	(S/D)*CF (lbs/in^2)	D/L_c (in/in)	D/W_c (in/in)
1	7.25	3.25	0.5	1	4.3928	1.0095	2.0190	2.2308	1.0530	2.1261	0.0773	0.2029
2	7.25	3.25	0.5	5	4.5960	1.0095	2.0190	2.2308	1.0530	2.1261	0.0773	0.2029
3	7.25	3.25	0.5	9	4.7492	1.0095	2.0190	2.2308	1.0530	2.1261	0.0773	0.2029
4	7.25	3.25	1.0	1	2.6776	1.0095	1.0095	2.2308	1.1196	1.1303	0.1761	0.5956
5	7.25	3.25	1.0	5	2.8609	1.0095	1.0095	2.2308	1.1196	1.1303	0.1761	0.5956
6	7.25	3.25	1.0	9	2.8825	1.0095	1.0095	2.2308	1.1196	1.1303	0.1761	0.5956
7	9.125	5.25	0.5	1	4.4984	1.0243	2.0486	1.7381	1.0376	2.1256	0.0600	0.1120
8	9.125	5.25	0.5	5	4.6498	1.0243	2.0486	1.7381	1.0376	2.1256	0.0600	0.1120
9	9.125	5.25	0.5	9	4.6646	1.0243	2.0486	1.7381	1.0376	2.1256	0.0600	0.1120
10	9.125	5.25	1.0	1	2.6549	1.0243	1.0243	1.7381	1.0817	1.1080	0.1324	0.2718
11	9.125	5.25	1.0	5	2.7879	1.0243	1.0243	1.7381	1.0817	1.1080	0.1324	0.2718
12	9.125	5.25	1.0	9	2.7976	1.0243	1.0243	1.7381	1.0817	1.1080	0.1324	0.2718
13	11.125	7.25	0.5	1	3.5797	0.9806	1.9612	1.5345	1.0289	2.0179	0.0484	0.0773
14	11.125	7.25	0.5	5	4.3451	0.9806	1.9612	1.5345	1.0289	2.0179	0.0484	0.0773
15	11.125	7.25	0.5	9	4.0867	0.9806	1.9612	1.5345	1.0289	2.0179	0.0484	0.0773

NOTE:

The data shown can be found in Appendix V

L_c and W_c = Contact Length and Width, respectively as described in Chapter 3

Theoretical Model #1: P = (2S/D)

Theoretical Model #2: P = (2S/D)*CF; **CF = (L+W-(1.142D))/(L+W-(2.142D))**

Empirical Model #1: $Y = K [X_1]^{p1} [X_2]^{p2} [X_3]^{p3}$; **$Y = \log P$, $X_1 = \log \{(S/D)*CF\}$, $X_2 = \log (D/L_c)$, $X_3 = \log (D/W_c)$**

Empirical Model #2: $Y = K [X_1]^{p1} [X_2]^{p2}$; **$Y = \log P$, $X_1 = \log (S/D)$, $X_2 = \log (CF)$**

Empirical Model #3: $Y = K [X_1]^{p1} [X_2]^{p2}$; **$Y = \log P$, $X_1 = \log (S/D)$, $X_2 = \log (L/W)$**

Table 83. Data used for the Burst Pressure (P) Prediction Models – Rexam (1073B Tyvek/Polyester Poly Laminate) Pouches (when using Average Force Values) - Continuation

Sample	L Length (in)	W Width (in)	D Gap (in)	F Flow Index	P Burst Pressure (lbs/in^2)	S Avg Force (lbs/in)	S/D (lbs/in^2)	L/W (in/in)	CF (in/in)	(S/D)*CF (lbs/in^2)	D/L_c (in/in)	D/W_c (in/in)
16	11.125	7.25	1.0	1	2.2179	0.9806	0.9806	1.5345	1.0616	1.0410	0.1047	0.1761
17	11.125	7.25	1.0	5	2.3018	0.9806	0.9806	1.5345	1.0616	1.0410	0.1047	0.1761
18	11.125	7.25	1.0	9	2.2826	0.9806	0.9806	1.5345	1.0616	1.0410	0.1047	0.1761
19	14.125	9.25	0.5	1	3.3741	1.0093	2.0186	1.5270	1.0224	2.0639	0.0375	0.0591
20	14.125	9.25	0.5	5	3.9284	1.0093	2.0186	1.5270	1.0224	2.0639	0.0375	0.0591
21	14.125	9.25	0.5	9	4.2873	1.0093	2.0186	1.5270	1.0224	2.0639	0.0375	0.0591
22	14.125	9.25	1.0	1	2.2533	1.0093	1.0093	1.5270	1.0471	1.0568	0.0797	0.1302
23	14.125	9.25	1.0	5	2.3495	1.0093	1.0093	1.5270	1.0471	1.0568	0.0797	0.1302
24	14.125	9.25	1.0	9	2.5352	1.0093	1.0093	1.5270	1.0471	1.0568	0.0797	0.1302
25	15.25	11.25	0.5	1	4.1355	1.0405	2.0810	1.3556	1.0197	2.1219	0.0346	0.0478
26	15.25	11.25	0.5	5	4.3166	1.0405	2.0810	1.3556	1.0197	2.1219	0.0346	0.0478
27	15.25	11.25	0.5	9	4.3231	1.0405	2.0810	1.3556	1.0197	2.1219	0.0346	0.0478
28	15.25	11.25	1.0	1	2.4109	1.0405	1.0405	1.3556	1.0411	1.0832	0.0731	0.1033
29	15.25	11.25	1.0	5	2.5858	1.0405	1.0405	1.3556	1.0411	1.0832	0.0731	0.1033
30	15.25	11.25	1.0	9	2.7994	1.0405	1.0405	1.3556	1.0411	1.0832	0.0731	0.1033

NOTE:

The data shown can be found in Appendix V

L_c and W_c = Contact Length and Width, respectively as described in Chapter 3

Theoretical Model #1: $P = (2S/D)$

Theoretical Model #2: $P = (2S/D)*CF$; **$CF = (L+W-(1.142D))/(L+W-(2.142D))$**

Empirical Model #1: $Y = K [X_1]^{p1} [X_2]^{p2} [X_3]^{p3}$; **$Y = \log P$, $X_1 = \log \{(S/D)*CF\}$, $X_2 = \log (D/L_c)$, $X_3 = \log (D/W_c)$**

Empirical Model #2: $Y = K [X_1]^{p1} [X_2]^{p2}$; **$Y = \log P$, $X_1 = \log (S/D)$, $X_2 = \log (CF)$**

Empirical Model #3: $Y = K [X_1]^{p1} [X_2]^{p2}$; **$Y = \log P$, $X_1 = \log (S/D)$, $X_2 = \log (L/W)$**

Table 84. Data used for the Burst Pressure (P) Prediction Models – Tolas (1073B Tyvek/PET/PE Laminate) Pouches (when using Peak Force Values)

Sample	L Length (in)	W Width (in)	D Gap (in)	F Flow Index	P Burst Pressure (lbs/in^2)	S Peak Force (lbs/in)	S/D (lbs/in^2)	L/W (in/in)	CF (in/in)	(S/D)*CF (lbs/in^2)	D/L_c (in/in)	D/W_c (in/in)
1	11.375	3	0.5	1	4.3343	1.8422	3.6844	3.7917	1.0376	3.8229	0.0472	0.2258
2	11.375	3	0.5	5	4.8562	1.8422	3.6844	3.7917	1.0376	3.8229	0.0472	0.2258
3	11.375	3	0.5	9	4.8583	1.8422	3.6844	3.7917	1.0376	3.8229	0.0472	0.2258
4	11.375	3	1.0	1	2.7716	1.8422	1.8422	3.7917	1.0817	1.9928	0.1020	0.6998
5	11.375	3	1.0	5	3.0246	1.8422	1.8422	3.7917	1.0817	1.9928	0.1020	0.6998
6	11.375	3	1.0	9	3.0412	1.8422	1.8422	3.7917	1.0817	1.9928	0.1020	0.6998
7	15	10.625	0.5	1	3.8132	1.7625	3.5250	1.4118	1.0204	3.5968	0.0352	0.0508
8	15	10.625	0.5	5	3.8352	1.7625	3.5250	1.4118	1.0204	3.5968	0.0352	0.0508
9	15	10.625	0.5	9	3.8844	1.7625	3.5250	1.4118	1.0204	3.5968	0.0352	0.0508
10	15	10.625	1.0	1	2.2757	1.7625	1.7625	1.4118	1.0426	1.8376	0.0745	0.1104
11	15	10.625	1.0	5	2.3975	1.7625	1.7625	1.4118	1.0426	1.8376	0.0745	0.1104
12	15	10.625	1.0	9	2.5103	1.7625	1.7625	1.4118	1.0426	1.8376	0.0745	0.1104

NOTE:

The data shown can be found in Appendix V

L_c and W_c = Contact Length and Width, respectively as described in Chapter 3

Theoretical Model #1: P = (2S/D)

Theoretical Model #2: P = (2S/D)*CF; **CF = (L+W-(1.142D))/(L+W-(2.142D))**

Empirical Model #1: $Y = K [X_1]^{p1} [X_2]^{p2} [X_3]^{p3}$; **$Y = \log P$, $X_1 = \log \{(S/D)*CF\}$, $X_2 = \log (D/L_c)$, $X_3 = \log (D/W_c)$**

Empirical Model #2: $Y = K [X_1]^{p1} [X_2]^{p2}$; **$Y = \log P$, $X_1 = \log (S/D)$, $X_2 = \log (CF)$**

Empirical Model #3: $Y = K [X_1]^{p1} [X_2]^{p2}$; **$Y = \log P$, $X_1 = \log (S/D)$, $X_2 = \log (L/W)$**

Table 85. Data used for the Burst Pressure (P) Prediction Models – Tolas (1073B Tyvek/PET/PE Laminate) Pouches (when using Average Force Values)

Sample	L Length (in)	W Width (in)	D Gap (in)	F Flow Index	P Burst Pressure (lbs/in^2)	S Avg Force (lbs/in)	S/D (lbs/in^2)	L/W (in/in)	CF (in/in)	(S/D)*CF (lbs/in^2)	D/L_c (in/in)	D/W_c (in/in)
1	11.375	3	0.5	1	4.3343	1.2403	2.4806	3.7917	1.0376	2.5738	0.0472	0.2258
2	11.375	3	0.5	5	4.8562	1.2403	2.4806	3.7917	1.0376	2.5738	0.0472	0.2258
3	11.375	3	0.5	9	4.8583	1.2403	2.4806	3.7917	1.0376	2.5738	0.0472	0.2258
4	11.375	3	1.0	1	2.7716	1.2403	1.2403	3.7917	1.0817	1.3417	0.1020	0.6998
5	11.375	3	1.0	5	3.0246	1.2403	1.2403	3.7917	1.0817	1.3417	0.1020	0.6998
6	11.375	3	1.0	9	3.0412	1.2403	1.2403	3.7917	1.0817	1.3417	0.1020	0.6998
7	15	10.625	0.5	1	3.8132	1.2131	2.4262	1.4118	1.0204	2.4756	0.0352	0.0508
8	15	10.625	0.5	5	3.8352	1.2131	2.4262	1.4118	1.0204	2.4756	0.0352	0.0508
9	15	10.625	0.5	9	3.8844	1.2131	2.4262	1.4118	1.0204	2.4756	0.0352	0.0508
10	15	10.625	1.0	1	2.2757	1.2131	1.2131	1.4118	1.0426	1.2648	0.0745	0.1104
11	15	10.625	1.0	5	2.3975	1.2131	1.2131	1.4118	1.0426	1.2648	0.0745	0.1104
12	15	10.625	1.0	9	2.5103	1.2131	1.2131	1.4118	1.0426	1.2648	0.0745	0.1104

NOTE:

The data shown can be found in Appendix V

L_c and W_c = Contact Length and Width, respectively as described in Chapter 3

Theoretical Model #1: $P = (2S/D)$

Theoretical Model #2: $P = (2S/D)*CF$; **$CF = (L+W-(1.142D))/(L+W-(2.142D))$**

Empirical Model #1: $Y = K [X_1]^{p1} [X_2]^{p2} [X_3]^{p3}$; **$Y = \log P$, $X_1 = \log \{(S/D)*CF\}$, $X_2 = \log (D/L_c)$, $X_3 = \log (D/W_c)$**

Empirical Model #2: $Y = K [X_1]^{p1} [X_2]^{p2}$; **$Y = \log P$, $X_1 = \log (S/D)$, $X_2 = \log (CF)$**

Empirical Model #3: $Y = K [X_1]^{p1} [X_2]^{p2}$; **$Y = \log P$, $X_1 = \log (S/D)$, $X_2 = \log (L/W)$**

Table 86. Data used for the Burst Pressure (P) Prediction Models – Rexam (1059B Tyvek/Polyester Poly Laminate) Pouches (when using Peak Force Values)

Sample	L Length (in)	W Width (in)	D Gap (in)	F Flow Index	P Burst Pressure (lbs/in^2)	S Peak Force (lbs/in)	S/D (lbs/in^2)	L/W (in/in)	CF (in/in)	(S/D)*CF (lbs/in^2)	D/L_c (in/in)	D/W_c (in/in)
1	9.125	5.75	0.5	1	4.1301	1.2640	2.5280	1.5870	1.0362	2.6196	0.0600	0.1007
2	9.125	5.75	0.5	5	4.3975	1.2640	2.5280	1.5870	1.0362	2.6196	0.0600	0.1007
3	9.125	5.75	0.5	9	4.4622	1.2640	2.5280	1.5870	1.0362	2.6196	0.0600	0.1007
4	9.125	5.75	1.0	1	2.3986	1.2640	1.2640	1.5870	1.0785	1.3633	0.1324	0.2393
5	9.125	5.75	1.0	5	2.5081	1.2640	1.2640	1.5870	1.0785	1.3633	0.1324	0.2393
6	9.125	5.75	1.0	9	2.5735	1.2640	1.2640	1.5870	1.0785	1.3633	0.1324	0.2393
7	14.125	9.25	0.5	1	4.1731	1.4340	2.8680	1.5270	1.0224	2.9323	0.0375	0.0591
8	14.125	9.25	0.5	5	4.5175	1.4340	2.8680	1.5270	1.0224	2.9323	0.0375	0.0591
9	14.125	9.25	0.5	9	4.7860	1.4340	2.8680	1.5270	1.0224	2.9323	0.0375	0.0591
10	14.125	9.25	1.0	1	2.5407	1.4340	1.4340	1.5270	1.0471	1.5015	0.0797	0.1302
11	14.125	9.25	1.0	5	2.7264	1.4340	1.4340	1.5270	1.0471	1.5015	0.0797	0.1302
12	14.125	9.25	1.0	9	2.7752	1.4340	1.4340	1.5270	1.0471	1.5015	0.0797	0.1302

NOTE:

The data shown can be found in Appendix V

L_c and W_c = Contact Length and Width, respectively as described in Chapter 3

Theoretical Model #1: P = (2S/D)

Theoretical Model #2: P = (2S/D)*CF; **CF = (L+W-(1.142D))/(L+W-(2.142D))**

Empirical Model #1: $Y = K [X_1]^{p1} [X_2]^{p2} [X_3]^{p3}$; **$Y = \log P$, $X_1 = \log \{(S/D)*CF\}$, $X_2 = \log (D/L_c)$, $X_3 = \log (D/W_c)$**

Empirical Model #2: $Y = K [X_1]^{p1} [X_2]^{p2}$; **$Y = \log P$, $X_1 = \log (S/D)$, $X_2 = \log (CF)$**

Empirical Model #3: $Y = K [X_1]^{p1} [X_2]^{p2}$; **$Y = \log P$, $X_1 = \log (S/D)$, $X_2 = \log (L/W)$**

Table 87. Data used for the Burst Pressure (P) Prediction Models – Rexam (1059B Tyvek/Polyester Poly Laminate) Pouches (when using Average Force Values)

Sample	L Length (in)	W Width (in)	D Gap (in)	F Flow Index	P Burst Pressure (lbs/in^2)	S Avg Force (lbs/in)	S/D (lbs/in^2)	L/W (in/in)	CF (in/in)	(S/D)*CF (lbs/in^2)	D/L_c (in/in)	D/W_c (in/in)
1	9.125	5.75	0.5	1	4.1301	0.8324	1.6648	1.5870	1.0362	1.7251	0.0600	0.1007
2	9.125	5.75	0.5	5	4.3975	0.8324	1.6648	1.5870	1.0362	1.7251	0.0600	0.1007
3	9.125	5.75	0.5	9	4.4622	0.8324	1.6648	1.5870	1.0362	1.7251	0.0600	0.1007
4	9.125	5.75	1.0	1	2.3986	0.8324	0.8324	1.5870	1.0785	0.8978	0.1324	0.2393
5	9.125	5.75	1.0	5	2.5081	0.8324	0.8324	1.5870	1.0785	0.8978	0.1324	0.2393
6	9.125	5.75	1.0	9	2.5735	0.8324	0.8324	1.5870	1.0785	0.8978	0.1324	0.2393
7	14.125	9.25	0.5	1	4.1731	0.9303	1.8606	1.5270	1.0224	1.9023	0.0375	0.0591
8	14.125	9.25	0.5	5	4.5175	0.9303	1.8606	1.5270	1.0224	1.9023	0.0375	0.0591
9	14.125	9.25	0.5	9	4.7860	0.9303	1.8606	1.5270	1.0224	1.9023	0.0375	0.0591
10	14.125	9.25	1.0	1	2.5407	0.9303	0.9303	1.5270	1.0471	0.9741	0.0797	0.1302
11	14.125	9.25	1.0	5	2.7264	0.9303	0.9303	1.5270	1.0471	0.9741	0.0797	0.1302
12	14.125	9.25	1.0	9	2.7752	0.9303	0.9303	1.5270	1.0471	0.9741	0.0797	0.1302

NOTE:

The data shown can be found in Appendix V

L_c and W_c = Contact Length and Width, respectively as described in Chapter 3

Theoretical Model #1: P = (2S/D)

Theoretical Model #2: P = (2S/D)*CF; **CF = (L+W-(1.142D))/(L+W-(2.142D))**

Empirical Model #1: $Y = K [X_1]^{p1} [X_2]^{p2} [X_3]^{p3}$; **$Y = \log P$, $X_1 = \log \{(S/D)*CF\}$, $X_2 = \log (D/L_c)$, $X_3 = \log (D/W_c)$**

Empirical Model #2: $Y = K [X_1]^{p1} [X_2]^{p2}$; **$Y = \log P$, $X_1 = \log (S/D)$, $X_2 = \log (CF)$**

Empirical Model #3: $Y = K [X_1]^{p1} [X_2]^{p2}$; **$Y = \log P$, $X_1 = \log (S/D)$, $X_2 = \log (L/W)$**

D. 3 Tabulated Results

Empirical model results, for the three material combinations, are shown below.

Table 88. Burst Pressure Model #1 Results – using data from 3 flow index values
Rexam (1073B Tyvek/Polyester Poly Laminate) Pouches

Data using	Average (%) Error	Regression Coefficients	R R_{adj}	PI – Single Response[1] (lbs/in^2)	PI – Mean Response[2] (lbs/in^2)
S Peak Force	5.48	K = 2.44 p1 = 1.01 p2 = 0.23 p3 = - 0.03	0.9654 0.9612	P +/- 0.5143	P +/- 0.0924
S Average Force	5.14	K = 3.87 p1 = 1.00 p2 = 0.29 p3 = - 0.09	0.9704 0.9670	P +/- 0.4713	P +/- 0.0846

Tolas (1073B Tyvek/PET/PE Laminate) Pouches

Data using	Average (%) Error	Regression Coefficients	R R_{adj}	PI – Single Response[1] (lbs/in^2)	PI – Mean Response[2] (lbs/in^2)
S Peak Force	3.33	K = 7.29 p1 = 1.57 p2 = 0.89 p3 = - 0.11	0.9880 0.9834	P +/- 0.3426	P +/- 0.0950
S Average Force	3.33	K = 20.40 p1 = 1.78 p2 = 1.10 p3 = - 0.13	0.9880 0.9834	P +/- 0.3426	P +/- 0.0950

Rexam (1059B Tyvek/Polyester/Poly Laminate) Pouches

Data using	Average (%) Error	Regression Coefficients	R R_{adj}	PI – Single Response[1] (lbs/in^2)	PI – Mean Response[2] (lbs/in^2)
S Peak Force	3.44	K = 15.45 p1 = 1.21 p2 = 2.50 p3 = - 2.01	0.9887 0.9844	P +/- 0.3675	P +/- 0.1019
S Average Force	4.08	K = 20.89 p1 = 1.14 p2 = 2.37 p3 = - 1.94	0.9887 0.9844	P +/- 0.3675	P +/- 0.1019

NOTES:
P = Burst Pressure, S = Seal Strength, D = gap, and R = Correlation Coefficient
1.,2. Prediction Interval (PI) for Single Response, and Mean Response, respectively

Table 89. Burst Pressure Model #2 Results – using data from 3 flow index values

Rexam (1073B Polyester/Polyester Poly Laminate) Pouches

Data using	Average (%) Error	Regression Coefficients	R R_{adj}	PI – Single Response[1] (lbs/in^2)	PI – Mean Response[2] (lbs/in^2)
S Peak Force	5.53	K = 1.36 p1 = 0.91 p2 = 3.41	0.9624 0.9597	P +/- 0.5554	P +/- 0.0998
S Average Force	5.27	K = 2.10 p1 = 0.88 p2 = 2.67	0.9677 0.9654	P +/- 0.5080	P +/- 0.0912

Tolas (1073B Tyvek/PET/PE Laminate) Pouches

Data using	Average (%) Error	Regression Coefficients	R R_{adj}	PI – Single Response[1] (lbs/in^2)	PI – Mean Response[2] (lbs/in^2)
S Peak Force	4.18	K = 1.12 p1 = 0.92 p2 = 5.37	0.9830 0.9793	P +/- 0.4584	P +/- 0.1271
S Average Force	4.33	K = 1.52 p1 = 0.95 p2 = 5.99	0.9815 0.9772	P +/- 0.4806	P +/- 0.1333

Rexam (1059B Tyvek/Polyester Poly Laminate) Pouches

Data using	Average (%) Error	Regression Coefficients	R R_{adj}	PI – Single Response[1] (lbs/in^2)	PI – Mean Response[2] (lbs/in^2)
S Peak Force	3.82	K = 1.82 p1 = 0.84 p2 = 1.68	0.9866 0.9834	P +/- 0.4425	P +/- 0.1227
S Average Force	3.76	K = 2.69 p1 = 0.82 p2 = 1.10	0.9872 0.9844	P +/- 0.4303	P +/- 0.1193

NOTES:

P = Burst Pressure, S = Seal Strength, D = gap, and R = Correlation Coefficient

1.,2. Prediction Interval (PI) for Single Response, and Mean Response, respectively

Table 90. Burst Pressure Model #3 Results – using data from 3 flow index values

Rexam (1073B Polyester/Polyester Poly Laminate) Pouches

Data using	Average (%) Error	Regression Coefficients	R R_{adj}	PI – Single Response[1] (lbs/in^2)	PI – Mean Response[2] (lbs/in^2)
S Peak Force	5.95	K = 1.53 p1 = 0.74 p2 = 0.37	0.9601 0.9571	P +/- 0.5616	P +/- 0.1009
S Average Force	5.78	K = 2.17 p1 = 0.74 p2 = 0.30	0.9656 0.9628	P +/- 0.5220	P +/-0.0938

Tolas (1073B Tyvek/PET/PE Laminate) Pouches

Data using	Average (%) Error	Regression Coefficients	R R_{adj}	PI – Single Response[1] (lbs/in^2)	PI – Mean Response[2] (lbs/in^2)
S Peak Force	3.32	K = 1.54 p1 = 0.68 p2 = 0.17	0.9880 0.9854	P +/- 0.3732	P +/- 0.1035
S Average Force	3.25	K = 1.97 p1 = 0.68 p2 = 0.19	0.9879 0.9854	P +/- 0.3732	P +/- 0.1035

Rexam (1059B Tyvek/Polyester Poly Laminate) Pouches

Data using	Average (%) Error	Regression Coefficients	R R_{adj}	PI – Single Response[1] (lbs/in^2)	PI – Mean Response[2] (lbs/in^2)
S Peak Force	3.59	K = 1.25 p1 = 0.77 p2 = 1.12	0.9882 0.9854	P +/- 0.4078	P +/- 0.1131
S Average Force	3.59	K = 1.98 p1 = 0.77 p2 = 0.82	0.9882 0.9854	P +/- 0.4078	P +/- 0.1131

NOTES:

P = Burst Pressure, S = Seal Strength, D = gap, and R = Correlation Coefficient

1.,2. Prediction Interval (PI) for Single Response, and Mean Response, respectively

Section D.4, below has Tables 91 to 96 with the individual percent error results for burst pressure (P) predicting models.

Table 91. Average Percent Error for Burst Pressure Prediction Models

Results for Rexam (1073B Tyvek/Polyester Poly Laminate) Pouches - using Peak Force Values

					Theoretical #1		Theoretical #2		Empirical #1		Empirical #2		Empirical #3	
n	PKG	D (in)	F	P_a (lb/in^2)	P_p (lb/in^2)	(%) Error	P_p (lb/in^2)	(%) Error	P_p (lb/in^2)	(%) Error	P_p (lb/in^2)	(%) Error	P_p (lb/in^2)	(%) Error
1	1	0.5	1	4.3928	5.9360	35.13	6.2508	42.29	4.4912	2.24	4.3652	-0.63	4.6051	4.83
2	1	0.5	5	4.5960	5.9360	29.16	6.2508	36.01	4.4912	-2.28	4.3652	-5.02	4.6051	0.20
3	1	0.5	9	4.7492	5.9360	24.99	6.2508	31.62	4.4912	-5.43	4.3652	-8.09	4.6051	-3.03
4	2	0.5	1	4.4984	6.3272	40.66	6.5650	45.94	4.5309	0.72	4.3989	-2.21	4.4020	-2.14
5	2	0.5	5	4.6498	6.3272	36.07	6.5650	41.19	4.5309	-2.56	4.3989	-5.40	4.4020	-5.33
6	2	0.5	9	4.6646	6.3272	35.64	6.5650	40.74	4.5309	-2.87	4.3989	-5.70	4.4020	-5.63
7	3	0.5	1	3.5797	5.9664	66.67	6.1388	71.49	4.0746	13.83	4.0521	13.20	4.0250	12.44
8	3	0.5	5	4.3451	5.9664	37.31	6.1388	41.28	4.0746	-6.23	4.0521	-6.74	4.0250	-7.37
9	3	0.5	9	4.0867	5.9664	45.99	6.1388	50.21	4.0746	-0.30	4.0521	-0.85	4.0250	-1.51
10	4	0.5	1	3.3741	6.4532	91.26	6.5979	95.55	4.1666	23.49	4.2592	26.23	4.2578	26.19
11	4	0.5	5	3.9284	6.4532	64.27	6.5979	67.95	4.1666	6.06	4.2592	8.42	4.2578	8.38
12	4	0.5	9	4.2873	6.4532	50.52	6.5979	53.89	4.1666	-2.81	4.2592	-0.66	4.2578	-0.69
13	5	0.5	1	4.1355	6.3568	53.71	6.4818	56.73	4.0428	-2.24	4.1628	0.66	4.0291	-2.57
14	5	0.5	5	4.3166	6.3568	47.26	6.4818	50.16	4.0428	-6.34	4.1628	-3.56	4.0291	-6.66
15	5	0.5	9	4.3231	6.3568	47.04	6.4818	49.93	4.0428	-6.48	4.1628	-3.71	4.0291	-6.80

NOTES:

PKG = Package, D = Plate Separation or Gap (in), F=Flow Index, P_a and P_p = Actual and Predicted Burst Pressure (lbs/in^2)

PKG 1, 2, 3, 4, & 5 are (3.25" x 7.25"), (5.25" x 9.125"), (7.25" x 11.125"), (9.25" x 14.125"), (11.25" x 15.25"), respectively

Theoretical #1; $P = 2S/D$; **Theoretical #2;** $P = (2S/D)((L+W-(1.142D))/(L+W-(2.142D)))$

Empirical #1; $P = K[(S/D)((L+W-(1.142D))/(L+W-(2.142D)))]^{p1}[D/(L-1.571D)]^{p2}[D/(W-1.571D)]^{p3}$**, see K and p's in Table 20**

Empirical #2; $P = K[(S/D)]^{p1}[((L+W-(1.142D))/(L+W-(2.142D)))]^{p2}$**, see K and p's in Table 20**

Empirical #3; $P = K[(S/D)]^{p1}[(L/W)]^{p2}$**, see K and p's in Table 20**

Table 91. Average Percent Error for Burst Pressure Prediction Models - Continuation
Results for Rexam (1073B Tyvek/Polyester Poly Laminate) Pouches - using Peak Force Values

					Theoretical #1		Theoretical #2		Empirical #1		Empirical #2		Empirical #3	
n	PKG	D (in)	F	P_a (lb/in^2)	P_p (lb/in^2)	(%) Error	P_p (lb/in^2)	(%) Error	P_p (lb/in^2)	(%) Error	P_p (lb/in^2)	(%) Error	P_p (lb/in^2)	(%) Error
16	1	1.0	1	2.6776	2.9680	10.84	3.3231	24.11	2.7757	3.66	2.8636	6.94	2.7573	2.97
17	1	1.0	5	2.8609	2.9680	3.75	3.3231	16.16	2.7757	-2.98	2.8636	0.09	2.7573	-3.62
18	1	1.0	9	2.8825	2.9680	2.96	3.3231	15.28	2.7757	-3.71	2.8636	-0.66	2.7573	-4.35
19	2	1.0	1	2.6549	3.1636	19.16	3.4222	28.90	2.7415	3.26	2.6986	1.65	2.6357	-0.72
20	2	1.0	5	2.7879	3.1636	13.48	3.4222	22.75	2.7415	-1.66	2.6986	-3.20	2.6357	-5.46
21	2	1.0	9	2.7976	3.1636	13.08	3.4222	22.33	2.7415	-2.01	2.6986	-3.54	2.6357	-5.79
22	3	1.0	1	2.2179	2.9832	34.50	3.1670	42.79	2.4332	9.71	2.3993	8.18	2.4099	8.66
23	3	1.0	5	2.3018	2.9832	29.60	3.1670	37.59	2.4332	5.71	2.3993	4.24	2.4099	4.70
24	3	1.0	9	2.2826	2.9832	30.69	3.1670	38.74	2.4332	6.60	2.3993	5.11	2.4099	5.58
25	4	1.0	1	2.2533	3.2266	43.19	3.3786	49.94	2.4615	9.24	2.4587	9.12	2.5493	13.13
26	4	1.0	5	2.3495	3.2266	37.33	3.3786	43.80	2.4615	4.77	2.4587	4.65	2.5493	8.51
27	4	1.0	9	2.5352	3.2266	27.27	3.3786	33.26	2.4615	-2.91	2.4587	-3.02	2.5493	0.56
28	5	1.0	1	2.4109	3.1784	31.83	3.3089	37.25	2.3796	-1.30	2.3779	-1.37	2.4124	0.06
29	5	1.0	5	2.5858	3.1784	22.92	3.3089	27.96	2.3796	-7.97	2.3779	-8.04	2.4124	-6.71
30	5	1.0	9	2.7994	3.1784	13.54	3.3089	18.20	2.3796	-15.00	2.3779	-15.06	2.4124	-13.83
--	---	---	-	Average	---	**34.66**	---	**41.14**	---	**5.48**	---	**5.53**	---	**5.95**

NOTES:

PKG = Package, D = Plate Separation or Gap (in), F=Flow Index, P_a and P_p = Actual and Predicted Burst Pressure (lbs/in^2)
PKG 1, 2, 3, 4, & 5 are (3.25" x 7.25"), (5.25" x 9.125"), (7.25" x 11.125"), (9.25" x 14.125"), (11.25" x 15.25"), respectively
Theoretical #1; $P = 2S/D$; **Theoretical #2; $P = (2S/D)((L+W-(1.142D))/(L+W-(2.142D)))$**
Empirical #1; $P = K[(S/D)((L+W-(1.142D))/(L+W-(2.142D)))]^{P1}[D/(L-1.571D)]^{P2}[D/(W-1.571D)]^{P3}$, see K and p's in Table 20
Empirical #2; $P = K[(S/D)]^{P1}[((L+W-(1.142D))/(L+W-(2.142D)))]^{P2}$, see K and p's in Table 20
Empirical #3; $P = K[(S/D)]^{P1}[(L/W)]^{P2}$, see K and p's in Table 20

Table 92. Average Percent Error for Burst Pressure Prediction Models
Results for Rexam (1073B Tyvek/Polyester Poly Laminate) Pouches - using Average Force Values

					Theoretical #1		Theoretical #2		Empirical #1		Empirical #2		Empirical #3	
n	PKG	D (in)	F	P_a (lb/in^2)	P_p (lb/in^2)	(%) Error	P_p (lb/in^2)	(%) Error	P_p (lb/in^2)	(%) Error	P_p (lb/in^2)	(%) Error	P_p (lb/in^2)	(%) Error
1	1	0.5	1	4.3928	4.0380	-8.08	4.2521	-3.20	4.5563	3.72	4.4736	1.84	4.6430	5.69
2	1	0.5	5	4.5960	4.0380	-12.14	4.2521	-7.48	4.5563	-0.86	4.4736	-2.66	4.6430	1.02
3	1	0.5	9	4.7492	4.0380	-14.97	4.2521	-10.47	4.5563	-4.06	4.4736	-5.80	4.6430	-2.24
4	2	0.5	1	4.4984	4.0972	-8.92	4.2512	-5.50	4.4668	-0.70	4.3559	-3.17	4.3547	-3.19
5	2	0.5	5	4.6498	4.0972	-11.88	4.2512	-8.57	4.4668	-3.93	4.3559	-6.32	4.3547	-6.35
6	2	0.5	9	4.6646	4.0972	-12.16	4.2512	-8.86	4.4668	-4.24	4.3559	-6.62	4.3547	-6.64
7	3	0.5	1	3.5797	3.9224	9.57	4.0357	12.74	4.1218	15.14	4.0989	14.50	4.0618	13.47
8	3	0.5	5	4.3451	3.9224	-9.73	4.0357	-7.12	4.1218	-5.14	4.0989	-5.67	4.0618	-6.52
9	3	0.5	9	4.0867	3.9224	-4.02	4.0357	-1.25	4.1218	0.86	4.0989	0.30	4.0618	-0.61
10	4	0.5	1	3.3741	4.0372	19.65	4.1277	22.34	4.0147	18.99	4.1340	22.52	4.1433	22.80
11	4	0.5	5	3.9284	4.0372	2.77	4.1277	5.07	4.0147	2.20	4.1340	5.23	4.1433	5.47
12	4	0.5	9	4.2873	4.0372	-5.83	4.1277	-3.72	4.0147	-6.36	4.1340	-3.58	4.1433	-3.36
13	5	0.5	1	4.1355	4.1620	0.64	4.2438	2.62	4.1106	-0.60	4.2158	1.94	4.0890	-1.13
14	5	0.5	5	4.3166	4.1620	-3.58	4.2438	-1.69	4.1106	-4.77	4.2158	-2.34	4.0890	-5.27
15	5	0.5	9	4.3231	4.1620	-3.73	4.2438	-1.83	4.1106	-4.92	4.2158	-2.48	4.0890	-5.42

NOTES:

PKG = Package, D = Plate Separation or Gap (in), F=Flow Index, P_a and P_p = Actual and Predicted Burst Pressure (lbs/in^2)
PKG 1, 2, 3, 4, & 5 are (3.25" x 7.25"), (5.25" x 9.125"), (7.25" x 11.125"), (9.25" x 14.125"), (11.25" x 15.25"), respectively
Theoretical #1; $P = 2S/D$; **Theoretical #2;** $P = (2S/D)((L+W-(1.142D))/(L+W-(2.142D)))$
Empirical #1; $P = K[(S/D)((L+W-(1.142D))/(L+W-(2.142D)))]^{p1}[D/(L-1.571D)]^{p2}[D/(W-1.571D)]^{p3}$, **see K and p's in Table 20**
Empirical #2; $P = K[(S/D)]^{p1}[((L+W-(1.142D))/(L+W-(2.142D)))]^{p2}$, **see K and p's in Table 20**
Empirical #3; $P = K[(S/D)]^{p1}[(L/W)]^{p2}$, **see K and p's in Table 20**

Table 92. Average Percent Error for Burst Pressure Prediction Models - Continuation
Results for Rexam (1073B Tyvek/Polyester Poly Laminate) Pouches - using Average Force Values

					Theoretical #1		Theoretical #2		Empirical #1		Empirical #2		Empirical #3	
n	PKG	D (in)	F	P_a (lb/in^2)	P_p (lb/in^2)	(%) Error	P_p (lb/in^2)	(%) Error	P_p (lb/in^2)	(%) Error	P_p (lb/in^2)	(%) Error	P_p (lb/in^2)	(%) Error
16	1	1.0	1	2.6776	2.0190	-24.60	2.2606	-15.58	2.7840	3.97	2.8634	6.94	2.7799	3.82
17	1	1.0	5	2.8609	2.0190	-29.43	2.2606	-20.98	2.7840	-2.68	2.8634	0.09	2.7799	-2.83
18	1	1.0	9	2.8825	2.0190	-29.96	2.2606	-21.58	2.7840	-3.42	2.8634	-0.67	2.7799	-3.56
19	2	1.0	1	2.6549	2.0486	-22.84	2.2161	-16.53	2.6986	1.65	2.6455	-0.35	2.6073	-1.79
20	2	1.0	5	2.7879	2.0486	-26.52	2.2161	-20.51	2.6986	-3.20	2.6455	-5.11	2.6073	-6.48
21	2	1.0	9	2.7976	2.0486	-26.77	2.2161	-20.79	2.6986	-3.54	2.6455	-5.44	2.6073	-6.80
22	3	1.0	1	2.2179	1.9612	-11.58	2.0820	-6.13	2.4645	11.12	2.4213	9.17	2.4319	9.65
23	3	1.0	5	2.3018	1.9612	-14.80	2.0820	-9.55	2.4645	7.07	2.4213	5.19	2.4319	5.66
24	3	1.0	9	2.2826	1.9612	-14.08	2.0820	-8.79	2.4645	7.97	2.4213	6.08	2.4319	6.54
25	4	1.0	1	2.2533	2.0186	-10.42	2.1137	-6.20	2.3771	5.49	2.3940	6.24	2.4808	10.09
26	4	1.0	5	2.3495	2.0186	-14.08	2.1137	-10.04	2.3771	1.18	2.3940	1.89	2.4808	5.59
27	4	1.0	9	2.5352	2.0186	-20.38	2.1137	-16.63	2.3771	-6.24	2.3940	-5.57	2.4808	-2.15
28	5	1.0	1	2.4109	2.0810	-13.68	2.1664	-10.14	2.4272	0.68	2.4213	0.43	2.4482	1.55
29	5	1.0	5	2.5858	2.0810	-19.52	2.1664	-16.22	2.4272	-6.14	2.4213	-6.36	2.4482	-5.32
30	5	1.0	9	2.7994	2.0810	-25.66	2.1664	-22.61	2.4272	-13.30	2.4213	-13.51	2.4482	-12.54
--	---	---	-	Average	---	14.40	---	10.82	---	5.14	---	5.27	---	5.78

NOTES:

PKG = Package, D = Plate Separation or Gap (in), F=Flow Index, P_a and P_p = Actual and Predicted Burst Pressure (lbs/in^2)
PKG 1, 2, 3, 4, & 5 are (3.25" x 7.25"), (5.25" x 9.125"), (7.25" x 11.125"), (9.25" x 14.125"), (11.25" x 15.25"), respectively
Theoretical #1; $P = 2S/D$; **Theoretical #2;** $P = (2S/D)((L+W-(1.142D))/(L+W-(2.142D)))$
Empirical #1; $P = K[(S/D)((L+W-(1.142D))/(L+W-(2.142D)))]^{p1}[D/(L-1.571D)]^{p2}[D/(W-1.571D)]^{p3}$, **see K and p's in Table 20**
Empirical #2; $P = K[(S/D)]^{p1}[((L+W-(1.142D))/(L+W-(2.142D)))]^{p2}$, **see K and p's in Table 20**
Empirical #3; $P = K[(S/D)]^{p1}[(L/W)]^{p2}$, **see K and p's in Table 20**

Table 93. Average Percent Error for Burst Pressure Prediction Models
Results for Tolas (1073B Tyvek/PET/PE Laminate) Pouches - using Peak Force Values

					Theoretical #1		Theoretical #2		Empirical #1		Empirical #2		Empirical #3	
n	PKG	D (in)	F	P_a (lb/in^2)	P_p (lb/in^2)	(%) Error	P_p (lb/in^2)	(%) Error	P_p (lb/in^2)	(%) Error	P_p (lb/in^2)	(%) Error	P_p (lb/in^2)	(%) Error
1	1	0.5	1	4.3343	7.3688	70.01	7.6457	76.40	4.6571	7.45	4.5323	4.57	4.6887	8.18
2	1	0.5	5	4.8562	7.3688	51.74	7.6457	57.44	4.6571	-4.10	4.5323	-6.67	4.6887	-3.45
3	1	0.5	9	4.8583	7.3688	51.67	7.6457	57.37	4.6571	-4.14	4.5323	-6.71	4.6887	-3.49
4	2	0.5	1	3.8132	7.0500	84.89	7.1936	88.65	3.8371	0.63	3.9776	4.31	3.8463	0.87
5	2	0.5	5	3.8352	7.0500	83.82	7.1936	87.57	3.8371	0.05	3.9776	3.71	3.8463	0.29
6	2	0.5	9	3.8844	7.0500	81.50	7.1936	85.19	3.8371	-1.22	3.9776	2.40	3.8463	-0.98
7	1	1.0	1	2.7716	3.6844	32.93	3.9856	43.80	2.9349	5.89	2.9963	8.11	2.9265	5.59
8	1	1.0	5	3.0246	3.6844	21.82	3.9856	31.77	2.9349	-2.97	2.9963	-0.94	2.9265	-3.24
9	1	1.0	9	3.0412	3.6844	21.15	3.9856	31.05	2.9349	-3.50	2.9963	-1.48	2.9265	-3.77
10	2	1.0	1	2.2757	3.5250	54.89	3.6751	61.49	2.3926	5.14	2.3600	3.70	2.4008	5.49
11	2	1.0	5	2.3975	3.5250	47.03	3.6751	53.29	2.3926	-0.20	2.3600	-1.57	2.4008	0.13
12	2	1.0	9	2.5103	3.5250	40.42	3.6751	46.40	2.3926	-4.69	2.3600	-5.99	2.4008	-4.36
--	---	---	-	Average	---	53.49	---	60.04	---	3.33	---	4.18	---	3.32

NOTES:

PKG = Package, D = Plate Separation or Gap (in), F=Flow Index, P_a and P_p = Actual and Predicted Burst Pressure (lbs/in^2)
PKG 1 and 2 are (3" x 11.375") and (10.625" x 15"), respectively
Theoretical #1; $P = 2S/D$
Theoretical #2; $P = (2S/D)((L+W-(1.142D))/(L+W-(2.142D)))$
Empirical #1; $P = K[(S/D)((L+W-(1.142D))/(L+W-(2.142D)))]^{p1}[D/(L-1.571D)]^{p2}[D/(W-1.571D)]^{p3}$, see K and p's in Table 21
Empirical #2; $P = K[(S/D)]^{p1}[((L+W-(1.142D))/(L+W-(2.142D)))]^{p2}$, see K and p's in Table 21
Empirical #3; $P = K[(S/D)]^{p1}[(L/W)]^{p2}$, see K and p's in Table 21

Table 94. Average Percent Error for Burst Pressure Prediction Models

Results for Tolas (1073B Tyvek/PET/PE Laminate) Pouches - using Average Force Values

					Theoretical #1		Theoretical #2		Empirical #1		Empirical #2		Empirical #3	
n	PKG	D (in)	F	P_a (lb/in^2)	P_p (lb/in^2)	(%) Error	P_p (lb/in^2)	(%) Error	P_p (lb/in^2)	(%) Error	P_p (lb/in^2)	(%) Error	P_p (lb/in^2)	(%) Error
1	1	0.5	1	4.3343	4.9612	14.46	5.1477	18.77	4.7330	9.20	4.4942	3.69	4.7070	8.60
2	1	0.5	5	4.8562	4.9612	2.16	5.1477	6.00	4.7330	-2.54	4.4942	-7.45	4.7070	-3.07
3	1	0.5	9	4.8583	4.9612	2.12	5.1477	5.96	4.7330	-2.58	4.4942	-7.50	4.7070	-3.12
4	2	0.5	1	3.8132	4.8524	27.25	4.9512	29.85	3.8910	2.04	3.9808	4.40	3.8430	0.78
5	2	0.5	5	3.8352	4.8524	26.52	4.9512	29.10	3.8910	1.46	3.9808	3.80	3.8430	0.20
6	2	0.5	9	3.8844	4.8524	24.92	4.9512	27.47	3.8910	0.17	3.9808	2.48	3.8430	-1.06
7	1	1.0	1	2.7716	2.4806	-10.50	2.6834	-3.18	2.9861	7.74	2.9861	7.74	2.9379	6.00
8	1	1.0	5	3.0246	2.4806	-17.99	2.6834	-11.28	2.9861	-1.27	2.9861	-1.27	2.9379	-2.86
9	1	1.0	9	3.0412	2.4806	-18.43	2.6834	-11.77	2.9861	-1.81	2.9861	-1.81	2.9379	-3.40
10	2	1.0	1	2.2757	2.4262	6.61	2.5295	11.15	2.4266	6.63	2.3444	3.02	2.3987	5.40
11	2	1.0	5	2.3975	2.4262	1.20	2.5295	5.50	2.4266	1.21	2.3444	-2.22	2.3987	0.05
12	2	1.0	9	2.5103	2.4262	-3.35	2.5295	0.77	2.4266	-3.33	2.3444	-6.61	2.3987	-4.45
--	---	---	-	Average	---	12.96	---	13.40	---	3.33	---	4.33	---	3.25

NOTES:

PKG = Package, D = Plate Separation or Gap (in), F=Flow Index, P_a and P_p = Actual and Predicted Burst Pressure (lbs/in^2)
PKG 1 and 2 are (3" x 11.375") and (10.625" x 15"), respectively

Theoretical #1; $P = 2S/D$

Theoretical #2; $P = (2S/D)((L+W-(1.142D))/(L+W-(2.142D)))$

Empirical #1; $P = K[(S/D)((L+W-(1.142D))/(L+W-(2.142D)))]^{p1}[D/(L-1.571D)]^{p2}[D/(W-1.571D)]^{p3}$**, see K and p's in Table 21**

Empirical #2; $P = K[(S/D)]^{p1}[((L+W-(1.142D))/(L+W-(2.142D)))]^{p2}$**, see K and p's in Table 21**

Empirical #3; $P = K[(S/D)]^{p1}[(L/W)]^{p2}$**, see K and p's in Table 21**

Table 95. Average Percent Error for Burst Pressure Prediction Models
Results for Rexam (1059B Tyvek/Polyester Poly Laminate) Pouches - using Peak Force Values

					Theoretical #1		Theoretical #2		Empirical #1		Empirical #2		Empirical #3	
n	PKG	D (in)	F	P_a (lb/in^2)	P_p (lb/in^2)	(%) Error	P_p (lb/in^2)	(%) Error	P_p (lb/in^2)	(%) Error	P_p (lb/in^2)	(%) Error	P_p (lb/in^2)	(%) Error
1	1	0.5	1	4.1301	5.0560	22.42	5.2391	26.85	4.4103	6.78	4.2108	1.95	4.2823	3.69
2	1	0.5	5	4.3975	5.0560	14.97	5.2391	19.14	4.4103	0.29	4.2108	-4.25	4.2823	-2.62
3	1	0.5	9	4.4622	5.0560	13.31	5.2391	17.41	4.4103	-1.16	4.2108	-5.63	4.2823	-4.03
4	2	0.5	1	4.1731	5.7360	37.45	5.8646	40.53	4.5656	9.41	4.5773	9.69	4.5202	8.32
5	2	0.5	5	4.5175	5.7360	26.97	5.8646	29.82	4.5656	1.06	4.5773	1.32	4.5202	0.06
6	2	0.5	9	4.7860	5.7360	19.85	5.8646	22.54	4.5656	-4.61	4.5773	-4.36	4.5202	-5.56
7	1	1.0	1	2.3986	2.5280	5.39	2.7265	13.67	2.5457	6.13	2.5159	4.89	2.5112	4.69
8	1	1.0	5	2.5081	2.5280	0.79	2.7265	8.71	2.5457	1.50	2.5159	0.31	2.5112	0.12
9	1	1.0	9	2.5735	2.5280	-1.77	2.7265	5.94	2.5457	-1.08	2.5159	-2.24	2.5112	-2.42
10	2	1.0	1	2.5407	2.8680	12.88	3.0031	18.20	2.7300	7.45	2.6616	4.76	2.6507	4.33
11	2	1.0	5	2.7264	2.8680	5.19	3.0031	10.15	2.7300	0.13	2.6616	-2.38	2.6507	-2.78
12	2	1.0	9	2.7752	2.8680	3.34	3.0031	8.21	2.7300	-1.63	2.6616	-4.09	2.6507	-4.49
--	---	---	-	Average	---	**13.70**	---	**18.43**	---	**3.44**	---	**3.82**	---	**3.59**

NOTES:

PKG = Package, D = Plate Separation or Gap (in), F=Flow Index, P_a and P_p = Actual and Predicted Burst Pressure (lbs/in^2)
PKG 1 and 2 are (5.75" x 9.125") and (9.25" x 14.125"), respectively
Theoretical #1; $P = 2S/D$
Theoretical #2; $P = (2S/D)((L+W-(1.142D))/(L+W-(2.142D)))$
Empirical #1; $P = K[(S/D)((L+W-(1.142D))/(L+W-(2.142D)))]^{p1}[D/(L-1.571D)]^{p2}[D/(W-1.571D)]^{p3}$**, see K and p's in Table 22**
Empirical #2; $P = K[(S/D)]^{p1}[((L+W-(1.142D))/(L+W-(2.142D)))]^{p2}$**, see K and p's in Table 22**
Empirical #3; $P = K[(S/D)]^{p1}[(L/W)]^{p2}$**, see K and p's in Table 22**

Table 96. Average Percent Error for Burst Pressure Prediction Models
Results for Rexam (1059B Tyvek/Polyester Poly Laminate) Pouches - using Average Force Values

					Theoretical #1		Theoretical #2		Empirical #1		Empirical #2		Empirical #3	
n	PKG	D (in)	F	P_a (lb/in^2)	P_p (lb/in^2)	(%) Error	P_p (lb/in^2)	(%) Error	P_p (lb/in^2)	(%) Error	P_p (lb/in^2)	(%) Error	P_p (lb/in^2)	(%) Error
1	1	0.5	1	4.1301	3.3296	-19.38	3.4502	-16.46	4.2400	2.66	4.2488	2.87	4.2813	3.66
2	1	0.5	5	4.3975	3.3296	-24.28	3.4502	-21.54	4.2400	-3.58	4.2488	-3.38	4.2813	-2.64
3	1	0.5	9	4.4622	3.3296	-25.38	3.4502	-22.68	4.2400	-4.98	4.2488	-4.78	4.2813	-4.05
4	2	0.5	1	4.1731	3.7212	-10.83	3.8046	-8.83	4.3837	5.05	4.5863	9.90	4.5191	8.29
5	2	0.5	5	4.5175	3.7212	-17.63	3.8046	-15.78	4.3837	-2.96	4.5863	1.52	4.5191	0.03
6	2	0.5	9	4.7860	3.7212	-22.25	3.8046	-20.51	4.3837	-8.41	4.5863	-4.17	4.5191	-5.58
7	1	1.0	1	2.3986	1.6648	-30.59	1.7955	-25.14	2.4556	2.37	2.5150	4.85	2.5106	4.67
8	1	1.0	5	2.5081	1.6648	-33.62	1.7955	-28.41	2.4556	-2.10	2.5150	0.27	2.5106	0.10
9	1	1.0	9	2.5735	1.6648	-35.31	1.7955	-30.23	2.4556	-4.58	2.5150	-2.27	2.5106	-2.44
10	2	1.0	1	2.5407	1.8606	-26.77	1.9482	-23.32	2.6323	3.61	2.6669	4.97	2.6501	4.31
11	2	1.0	5	2.7264	1.8606	-31.76	1.9482	-28.54	2.6323	-3.45	2.6669	-2.18	2.6501	-2.80
12	2	1.0	9	2.7752	1.8606	-32.96	1.9482	-29.80	2.6323	-5.15	2.6669	-3.90	2.6501	-4.51
--	---	---	-	Average		**25.90**		**22.60**		**4.08**		**3.76**		**3.59**

NOTES:

PKG = Package, D = Plate Separation or Gap (in), F=Flow Index, P_a and P_p = Actual and Predicted Burst Pressure (lbs/in^2)
PKG 1 and 2 are (5.75" x 9.125") and (9.25" x 14.125"), respectively

Theoretical #1; $P = 2S/D$

Theoretical #2; $P = (2S/D)((L+W-(1.142D))/(L+W-(2.142D)))$

Empirical #1; $P = K[(S/D)((L+W-(1.142D))/(L+W-(2.142D)))]^{P1}[D/(L-1.571D)]^{P2}[D/(W-1.571D)]^{P3}$**, see K and p's in Table 22**

Empirical #2; $P = K[(S/D)]^{P1}[((L+W-(1.142D))/(L+W-(2.142D)))]^{P2}$**, see K and p's in Table 22**

Empirical #3; $P = K[(S/D)]^{P1}[(L/W)]^{P2}$**, see K and p's in Table 22**

E. Correlation Calculations

Linear multiple regression analysis was used with the intent of developing models that predict seal strength (S) from burst pressure (P). The same steps that used when developing models that predict burst pressure (P) from seal strength (S) were followed. It was found that, differently than the burst pressure (P) predicting models, the residual analysis for the transformed data was not satisfactory. For that reason, sample correlation coefficient calculations were performed with the purpose of finding out if the variables (P) and (S) were related. According to Devore, 1995, the sample correlation coefficient (r) is a measure of how strongly related two variables x and y (P and S, respectively) are in a sample. The formula for (r) is as follows:

$$r = \frac{[\{n \sum x_i y_i - (\sum x_i)(\sum y_i)\}]}{[\{\sqrt{(n \sum x_i^2 - (\sum x_i^2)\}} * \{\sqrt{(n \sum y_i^2 - (\sum y_i^2)\}}]}$$

One of the properties of r ids that its value does not depend on which of the two variables under study is labeled as "x" (independent variable) and which is labeled as "y" (dependent variable).

Tables 97 and 98, below show the sample correlation coefficient that resulted from the data collected for each of the material combinations under study.

Table 97. Sample Correlation Coefficient for Seal Strength (S) Prediction Models

Rexam (1073 B Tyvek/Polyester Poly Laminate) Pouches

Y		X	r_{peak}[1]	$r_{average}$[2]
S_{peak}	$S_{average}$	D	-3.78×10^{-14}	2.55×10^{-14}
S_{peak}	$S_{average}$	P	-0.0486	0.1390
S_{peak}	$S_{average}$	PD	-0.0830	0.3135

Tolas (1073 B Tyvek/PET/PE Laminate) Pouches

Y		X	r_{peak}[1]	$r_{average}$[2]
S_{peak}	$S_{average}$	D	1.98×10^{-14}	0
S_{peak}	$S_{average}$	P	0.3929	0.3929
S_{peak}	$S_{average}$	PD	0.6431	0.6431

Rexam's (1059 B Tyvek/Polyester Poly Laminate) Pouches

Y		X	r_{peak}[1]	$r_{average}$[2]
S_{peak}	$S_{average}$	D	9.29×10^{-15}	-1.61×10^{-15}
S_{peak}	$S_{average}$	P	0.0940	0.0940
S_{peak}	$S_{average}$	PD	0.2981	0.2981

1. r_{peak} is the sample correlation coefficient between S_{peak} and the corresponding "X"
2. $r_{average}$ is the sample correlation coefficient between $S_{average}$ and the corresponding "X"

Table 98. Sample Correlation Coefficient for Burst Pressure (P) Prediction Models

Rexam (1073 B Tyvek/Polyester Poly Laminate) Pouches

Y	X		r_{peak}[1]	$r_{average}$[2]
P	D		r = -0.9380	
P	S_{peak}	$S_{average}$	-0.0486	0.1390
P	$(S_{peak})/D$	$(S_{average})/D$	0.9263	0.9445

Tolas (1073 B Tyvek/PET/PE Laminate) Pouches

Y	X		r_{peak}[1]	$r_{average}$[2]
P	D		r = -0.9010	
P	S_{peak}	$S_{average}$	0.3929	0.3929
P	$(S_{peak})/D$	$(S_{average})/D$	0.9264	0.9143

Rexam (1059 B Tyvek/Polyester Poly Laminate) Pouches

Y	X		r_{peak}[1]	$r_{average}$[2]
P	D		r = -0.9811	
P	S_{peak}	$S_{average}$	0.0940	0.0940
P	$(S_{peak})/D$	$(S_{average})/D$	0.9792	0.9813

NOTES:

P = Burst Pressure, S = Seal Strength, D = Plate Separation

1. r_{peak} = sample correlation coefficient for P and the corresponding "X" with S_{peak}
2. $r_{average}$ = sample correlation coefficient for P and the corresponding "X" with $S_{average}$

The "r" results obtained with the collected data show the following:

1. There is no correlation between seal strength (S) and plate separation (D)
2. There is a weak correlation between:
    a. seal strength (S) and burst pressure (P)
    b. strength (S) and burst pressure x plate separation (PD)
3. There is a strong correlation between:
    a. burst pressure (P) and plate separation (D)
    b. burst pressure (P) and seal strength/plate separation (S/D)

These results make sense when looking at the collected data. Table 99 below has a summary of the results for Rexam 1073B Tyvek/Plastic pouches.

Table 99. Summarized results for Rexam 1073B Tyvek/plastic pouches (when using Peak Values)

Package	D (in)	S (lbs/in)	PD (lbs/in)	P[1] (lbs/in^2)	S/D (lbs/in^2)
1	0.5	1.48	2.20	4.10	2.97
1	1.0	1.48	2.81	2.81	1.48
2	0.5	1.58	2.30	4.60	3.16
2	1.0	1.58	2.75	2.75	1.58
3	0.5	1.47	2.00	4.00	2.94
3	1.0	1.47	2.27	2.27	1.47
4	0.5	1.61	1.93	3.86	3.22
4	1.0	1.61	2.38	2.38	1.61
5	0.5	1.59	2.13	4.26	3.18
5	1.0	1.59	2.60	2.60	1.59

NOTES:
P = Burst Pressure, S = Seal Strength, D = Plate Separation
The data shown is taken from Table 82 in Appendix VII.D
1. The burst pressure values (P) at each gap are an average of the burst pressure obtained from three flow index values

When looking at columns 3 and 4, one can see that S changes very little when PD changes. That explains the weak correlation between S and PD. When looking at columns 5 and 6, it can be seen that P changes significantly with S/D. It is important to

notice that the changes in P are mostly due to changes in D rather than due to changes in S. That explains the strong correlation between P and S/D and between P and D. It is important to mention that the weak correlation between S and P that was found with the experimental data is due to the fact that the seal strength of the different packages was very similar. If the seal strength had been significantly different, then its effect on the burst pressure, and vice versa, would have been more noticeable. Similar findings were observed when looking at the data for the other materials under study.

For all the reasons explained above it was decided that in order to predict seal strength from burst pressure, plate separation and package dimensions, the empirical models were developed by running a regression analysis to predict (S/D) instead of (S). After the prediction model was obtained, S was estimated by multiplying the equation by D on both sides. The results are shown in Chapter 5.

F. Seal Strength (S) Empirical Models Results:

F.1 Models

Seal Strength/Gap, Model #1:

$$(S/D) = K\,[P/CF]^{P1}[(L_O\text{-}1.571D)/D]^{P2}[(W_O\text{-}1.571D)/D]^{P3}$$

where $CF = [\{(L_O+W_O\text{-}1.142D)/(L_O+W_O\text{-}2.142D)\}]$

Seal Strength/Gap, Model #2:

$$(S/D) = K[P]^{P1}[1/CF]^{P2}$$

where $CF = [\{(L_O+W_O\text{-}1.142D)/(L_O+W_O\text{-}2.142D)\}]$

Seal Strength/Gap, Model #3:

$$(S/D) = K\,[P\,]^{P1}[W/L]^{P2}$$

F.2 Data used in the analysis

The data collected for each material combination was used to run a regression analysis in order to calculate the regression coefficients for the three empirical models shown above. Rexam 1073B Tyvek/plastic pouches will have 30 data points to run the regression analysis if the burst data obtained from 3 different flow index values are used. The number of data point for Tolas 1073B and Rexam 1059B Tyvek/plastic pouches is 12. Refer to Tables 100 to 105, below

Table 100. Data used for the Seal Strength (S) Prediction Models – Rexam (1073B Tyvek/Polyester Poly Laminate) Pouches (when predicting Peak Force Values)

Sample	L Length (in)	W Width (in)	D Gap (in)	F Flow Index	P Burst Pressure (lbs/in^2)	S Peak Force (lbs/in)	S/D (lbs/in^2)	W/L (in/in)	1/CF (in/in)	(P)/CF (lbs/in^2)	L_c/D (in/in)	W_c/D (in/in)
1	7.25	3.25	0.5	1	4.3928	1.4840	2.9680	0.4483	0.9496	4.1716	12.9290	4.9290
2	7.25	3.25	0.5	5	4.5960	1.4840	2.9680	0.4483	0.9496	4.3645	12.9290	4.9290
3	7.25	3.25	0.5	9	4.7492	1.4840	2.9680	0.4483	0.9496	4.5100	12.9290	4.9290
4	7.25	3.25	1.0	1	2.6776	1.4840	1.4840	0.4483	0.8931	2.3915	5.6790	1.6790
5	7.25	3.25	1.0	5	2.8609	1.4840	1.4840	0.4483	0.8931	2.5551	5.6790	1.6790
6	7.25	3.25	1.0	9	2.8825	1.4840	1.4840	0.4483	0.8931	2.5745	5.6790	1.6790
7	9.125	5.25	0.5	1	4.4984	1.5818	3.1636	0.5753	0.9638	4.3354	16.6790	8.9290
8	9.125	5.25	0.5	5	4.6498	1.5818	3.1636	0.5753	0.9638	4.4814	16.6790	8.9290
9	9.125	5.25	0.5	9	4.6646	1.5818	3.1636	0.5753	0.9638	4.4957	16.6790	8.9290
10	9.125	5.25	1.0	1	2.6549	1.5818	1.5818	0.5753	0.9244	2.4542	7.5540	3.6790
11	9.125	5.25	1.0	5	2.7879	1.5818	1.5818	0.5753	0.9244	2.5772	7.5540	3.6790
12	9.125	5.25	1.0	9	2.7976	1.5818	1.5818	0.5753	0.9244	2.5862	7.5540	3.6790
13	11.125	7.25	0.5	1	3.5797	1.4916	2.9832	0.6517	0.9719	3.4792	20.6790	12.9290
14	11.125	7.25	0.5	5	4.3451	1.4916	2.9832	0.6517	0.9719	4.2231	20.6790	12.9290
15	11.125	7.25	0.5	9	4.0867	1.4916	2.9832	0.6517	0.9719	3.9720	20.6790	12.9290

NOTE:

The data shown can be found in Appendix V

L_c and W_c = Contact Length and Width, respectively as described in Chapter 3

Theoretical Model #1: S = (PD/2)

Theoretical Model #2: S = (PD/2CF); **CF = (L+W-(1.142D))/(L+W-(2.142D))**

Model #1: $Y = K [X_1]^{p1} [X_2]^{p2} [X_3]^{p3}$; **Y = log (S/D), X_1 = log {(P)/CF}, X_2 = log (L_c/D), X_3 = log (W_c/D)**

Model #2: $Y = K [X_1]^{p1} [X_2]^{p2}$; **Y = log (S/D), X_1 = log (P), X_2 = log (1/CF)**

Model #3: $Y = K [X_1]^{p1} [X_2]^{p2}$; **Y = log (S/D), X_1 = log (P), X_2 = log (W/L)**

Table 100. Data used for the Seal Strength (S) Prediction Models – Rexam (1073B Tyvek/Polyester Poly Laminate) Pouches (when predicting Peak Force Values) - Continuation

Sample	L Length (in)	W Width (in)	D Gap (in)	F Flow Index	P Burst Pressure (lbs/in^2)	S Peak Force (lbs/in)	S/D (lbs/in^2)	W/L (in/in)	1/CF (in/in)	(P)/CF (lbs/in^2)	L_c/D (in/in)	W_c/D (in/in)
16	11.125	7.25	1.0	1	2.2179	1.4916	1.4916	0.6517	0.9420	2.0892	9.5540	5.6790
17	11.125	7.25	1.0	5	2.3018	1.4916	1.4916	0.6517	0.9420	2.1682	9.5540	5.6790
18	11.125	7.25	1.0	9	2.2826	1.4916	1.4916	0.6517	0.9420	2.1502	9.5540	5.6790
19	14.125	9.25	0.5	1	3.3741	1.6133	3.2266	0.6549	0.9781	3.3001	26.6790	16.9290
20	14.125	9.25	0.5	5	3.9284	1.6133	3.2266	0.6549	0.9781	3.8423	26.6790	16.9290
21	14.125	9.25	0.5	9	4.2873	1.6133	3.2266	0.6549	0.9781	4.1933	26.6790	16.9290
22	14.125	9.25	1.0	1	2.2533	1.6133	1.6133	0.6549	0.9550	2.1520	12.5540	7.6790
23	14.125	9.25	1.0	5	2.3495	1.6133	1.6133	0.6549	0.9550	2.2438	12.5540	7.6790
24	14.125	9.25	1.0	9	2.5352	1.6133	1.6133	0.6549	0.9550	2.4212	12.5540	7.6790
25	15.25	11.25	0.5	1	4.1355	1.5892	3.1784	0.7377	0.9807	4.0558	28.9290	20.9290
26	15.25	11.25	0.5	5	4.3166	1.5892	3.1784	0.7377	0.9807	4.2333	28.9290	20.9290
27	15.25	11.25	0.5	9	4.3231	1.5892	3.1784	0.7377	0.9807	4.2397	28.9290	20.9290
28	15.25	11.25	1.0	1	2.4109	1.5892	1.5892	0.7377	0.9606	2.3158	13.6790	9.6790
29	15.25	11.25	1.0	5	2.5858	1.5892	1.5892	0.7377	0.9606	2.4839	13.6790	9.6790
30	15.25	11.25	1.0	9	2.7994	1.5892	1.5892	0.7377	0.9606	2.6890	13.6790	9.6790

NOTE:

The data shown can be found in Appendix V

L_c and W_c = Contact Length and Width, respectively as described in Chapter 3

Theoretical Model #1: S = (PD/2); Theoretical Model #2: S = (PD/2CF) where CF = (L+W-(1.142D))/(L+W-(2.142D))

Empirical Models #1a, #2a and #3a were obtained by solving the burst pressure (P) predicting models by S

Empirical Model #1b: $Y = K [X_1]^{p1} [X_2]^{p2} [X_3]^{p3}$; $Y = \log (S/D)$, $X_1 = \log \{(P)/CF\}$, $X_2 = \log (L_c/D)$, $X_3 = \log (W_c/D)$

Empirical Model #2b: $Y = K [X_1]^{p1} [X_2]^{p2}$; $Y = \log (S/D)$, $X_1 = \log (P)$, $X_2 = \log (1/CF)$

Empirical Model #3b: $Y = K [X_1]^{p1} [X_2]^{p2}$; $Y = \log (S/D)$, $X_1 = \log (P)$, $X_2 = \log (W/L)$

Table 101. Data used for the Seal Strength (S) Prediction Models – Rexam (1073B Tyvek/Polyester Poly Laminate) Pouches (when predicting Average Force Values)

Sample	L Length (in)	W Width (in)	D Gap (in)	F Flow Index	P Burst Pressure (lbs/in^2)	S Avg Force (lbs/in)	S/D (lbs/in^2)	W/L (in/in)	1/CF (in/in)	(P)/CF (lbs/in^2)	L_c/D (in/in)	W_c/D (in/in)
1	7.25	3.25	0.5	1	4.3928	1.0095	2.0190	0.4483	0.9496	4.1716	12.9290	4.9290
2	7.25	3.25	0.5	5	4.5960	1.0095	2.0190	0.4483	0.9496	4.3645	12.9290	4.9290
3	7.25	3.25	0.5	9	4.7492	1.0095	2.0190	0.4483	0.9496	4.5100	12.9290	4.9290
4	7.25	3.25	1.0	1	2.6776	1.0095	1.0095	0.4483	0.8931	2.3915	5.6790	1.6790
5	7.25	3.25	1.0	5	2.8609	1.0095	1.0095	0.4483	0.8931	2.5551	5.6790	1.6790
6	7.25	3.25	1.0	9	2.8825	1.0095	1.0095	0.4483	0.8931	2.5745	5.6790	1.6790
7	9.125	5.25	0.5	1	4.4984	1.0243	2.0486	0.5753	0.9638	4.3354	16.6790	8.9290
8	9.125	5.25	0.5	5	4.6498	1.0243	2.0486	0.5753	0.9638	4.4814	16.6790	8.9290
9	9.125	5.25	0.5	9	4.6646	1.0243	2.0486	0.5753	0.9638	4.4957	16.6790	8.9290
10	9.125	5.25	1.0	1	2.6549	1.0243	1.0243	0.5753	0.9244	2.4542	7.5540	3.6790
11	9.125	5.25	1.0	5	2.7879	1.0243	1.0243	0.5753	0.9244	2.5772	7.5540	3.6790
12	9.125	5.25	1.0	9	2.7976	1.0243	1.0243	0.5753	0.9244	2.5862	7.5540	3.6790
13	11.125	7.25	0.5	1	3.5797	0.9806	1.9612	0.6517	0.9719	3.4792	20.6790	12.9290
14	11.125	7.25	0.5	5	4.3451	0.9806	1.9612	0.6517	0.9719	4.2231	20.6790	12.9290
15	11.125	7.25	0.5	9	4.0867	0.9806	1.9612	0.6517	0.9719	3.9720	20.6790	12.9290

NOTE:

The data shown can be found in Appendix V

L_c and W_c = Contact Length and Width, respectively as described in Chapter 3

Theoretical Model #1: S = (PD/2); Theoretical Model #2: S = (PD/2CF) where CF = (L+W-(1.142D))/(L+W-(2.142D))

Empirical Models #1a, #2a and #3a were obtained by solving the burst pressure (P) predicting models by S

Empirical Model #1b: $Y = K [X_1]^{p1} [X_2]^{p2} [X_3]^{p3}$; $Y = \log (S/D)$, $X_1 = \log \{(P)/CF\}$, $X_2 = \log (L_c/D)$, $X_3 = \log (W_c/D)$

Empirical Model #2b: $Y = K [X_1]^{p1} [X_2]^{p2}$; $Y = \log (S/D)$, $X_1 = \log (P)$, $X_2 = \log (1/CF)$

Empirical Model #3b: $Y = K [X_1]^{p1} [X_2]^{p2}$; $Y = \log (S/D)$, $X_1 = \log (P)$, $X_2 = \log (W/L)$

Table 101. Data used for the Seal Strength (S) Prediction Models – Rexam (1073B Tyvek/Polyester Poly Laminate) Pouches (when predicting Average Force Values) - Continuation

Sample	L Length (in)	W Width (in)	D Gap (in)	F Flow Index	P Burst Pressure (lbs/in^2)	S Avg Force (lbs/in)	S/D (lbs/in^2)	W/L (in/in)	1/CF (in/in)	(P)/CF (lbs/in^2)	L_c/D (in/in)	W_c/D (in/in)
16	11.125	7.25	1.0	1	2.2179	0.9806	0.9806	0.6517	0.9420	2.0892	9.5540	5.6790
17	11.125	7.25	1.0	5	2.3018	0.9806	0.9806	0.6517	0.9420	2.1682	9.5540	5.6790
18	11.125	7.25	1.0	9	2.2826	0.9806	0.9806	0.6517	0.9420	2.1502	9.5540	5.6790
19	14.125	9.25	0.5	1	3.3741	1.0093	2.0186	0.6549	0.9781	3.3001	26.6790	16.9290
20	14.125	9.25	0.5	5	3.9284	1.0093	2.0186	0.6549	0.9781	3.8423	26.6790	16.9290
21	14.125	9.25	0.5	9	4.2873	1.0093	2.0186	0.6549	0.9781	4.1933	26.6790	16.9290
22	14.125	9.25	1.0	1	2.2533	1.0093	1.0093	0.6549	0.9550	2.1520	12.5540	7.6790
23	14.125	9.25	1.0	5	2.3495	1.0093	1.0093	0.6549	0.9550	2.2438	12.5540	7.6790
24	14.125	9.25	1.0	9	2.5352	1.0093	1.0093	0.6549	0.9550	2.4212	12.5540	7.6790
25	15.25	11.25	0.5	1	4.1355	1.0405	2.0810	0.7377	0.9807	4.0558	28.9290	20.9290
26	15.25	11.25	0.5	5	4.3166	1.0405	2.0810	0.7377	0.9807	4.2333	28.9290	20.9290
27	15.25	11.25	0.5	9	4.3231	1.0405	2.0810	0.7377	0.9807	4.2397	28.9290	20.9290
28	15.25	11.25	1.0	1	2.4109	1.0405	1.0405	0.7377	0.9606	2.3158	13.6790	9.6790
29	15.25	11.25	1.0	5	2.5858	1.0405	1.0405	0.7377	0.9606	2.4839	13.6790	9.6790
30	15.25	11.25	1.0	9	2.7994	1.0405	1.0405	0.7377	0.9606	2.6890	13.6790	9.6790

NOTE:

The data shown can be found in Appendix V

L_c and W_c = Contact Length and Width, respectively as described in Chapter 3

Theoretical Model #1: S = (PD/2); Theoretical Model #2: S = (PD/2CF) where CF = (L+W-(1.142D))/(L+W-(2.142D))

Empirical Models #1a, #2a and #3a were obtained by solving the burst pressure (P) predicting models by S

Empirical Model #1b: $Y = K [X_1]^{p1} [X_2]^{p2} [X_3]^{p3}$; $Y = \log (S/D)$, $X_1 = \log \{(P)/CF\}$, $X_2 = \log (L_c/D)$, $X_3 = \log (W_c/D)$

Empirical Model #2b: $Y = K [X_1]^{p1} [X_2]^{p2}$; $Y = \log (S/D)$, $X_1 = \log (P)$, $X_2 = \log (1/CF)$

Empirical Model #3b: $Y = K [X_1]^{p1} [X_2]^{p2}$; $Y = \log (S/D)$, $X_1 = \log (P)$, $X_2 = \log (W/L)$

Table 102. Data used for the Seal Strength (S) Prediction Models – Tolas (1073B Tyvek/PET/PE Laminate) Pouches (when predicting Peak Force Values)

Sample	L Length (in)	W Width (in)	D Gap (in)	F Flow Index	P Burst Pressure (lbs/in^2)	S Peak Force (lbs/in)	S/D (lbs/in^2)	W/L (in/in)	1/CF (in/in)	(P)/CF (lbs/in^2)	L_c/D (in/in)	W_c/D (in/in)
1	11.375	3	0.5	1	4.3343	1.8422	3.6844	0.2637	0.9638	4.1773	21.1790	4.4290
2	11.375	3	0.5	5	4.8562	1.8422	3.6844	0.2637	0.9638	4.6803	21.1790	4.4290
3	11.375	3	0.5	9	4.8583	1.8422	3.6844	0.2637	0.9638	4.6824	21.1790	4.4290
4	11.375	3	1.0	1	2.7716	1.8422	1.8422	0.2637	0.9244	2.5621	9.8040	1.4290
5	11.375	3	1.0	5	3.0246	1.8422	1.8422	0.2637	0.9244	2.7960	9.8040	1.4290
6	11.375	3	1.0	9	3.0412	1.8422	1.8422	0.2637	0.9244	2.8114	9.8040	1.4290
7	15	10.625	0.5	1	3.8132	1.7625	3.5250	0.7083	0.9800	3.7371	28.4290	19.6790
8	15	10.625	0.5	5	3.8352	1.7625	3.5250	0.7083	0.9800	3.7587	28.4290	19.6790
9	15	10.625	0.5	9	3.8844	1.7625	3.5250	0.7083	0.9800	3.8068	28.4290	19.6790
10	15	10.625	1.0	1	2.2757	1.7625	1.7625	0.7083	0.9592	2.1828	13.4290	9.0540
11	15	10.625	1.0	5	2.3975	1.7625	1.7625	0.7083	0.9592	2.2996	13.4290	9.0540
12	15	10.625	1.0	9	2.5103	1.7625	1.7625	0.7083	0.9592	2.4078	13.4290	9.0540

NOTE:

The data shown can be found in Appendix V

L_c and W_c = Contact Length and Width, respectively as described in Chapter 3

Theoretical Model #1: S = (PD/2); Theoretical Model #2: S = (PD/2CF) where CF = (L+W-(1.142D))/(L+W-(2.142D))

Empirical Models #1a, #2a and #3a were obtained by solving the burst pressure (P) predicting models by S

Empirical Model #1b: $Y = K [X_1]^{p1} [X_2]^{p2} [X_3]^{p3}$; $Y = \log (S/D)$, $X_1 = \log \{(P)/CF\}$, $X_2 = \log (L_c/D)$, $X_3 = \log (W_c/D)$

Empirical Model #2b: $Y = K [X_1]^{p1} [X_2]^{p2}$; $Y = \log (S/D)$, $X_1 = \log (P)$, $X_2 = \log (1/CF)$

Empirical Model #3b: $Y = K [X_1]^{p1} [X_2]^{p2}$; $Y = \log (S/D)$, $X_1 = \log (P)$, $X_2 = \log (W/L)$

Table 103. Data used for the Seal Strength (S) Prediction Models – Tolas (1073B Tyvek/PET/PE Laminate) Pouches (when predicting Average Force Values)

Sample	L Length (in)	W Width (in)	D Gap (in)	F Flow Index	P Burst Pressure (lbs/in^2)	S Avg Force (lbs/in)	S/D (lbs/in^2)	W/L (in/in)	1/CF (in/in)	(P)/CF (lbs/in^2)	L_c/D (in/in)	W_c/D (in/in)
1	11.375	3	0.5	1	4.3343	1.2403	2.4806	0.2637	0.9638	4.1773	21.1790	4.4290
2	11.375	3	0.5	5	4.8562	1.2403	2.4806	0.2637	0.9638	4.6803	21.1790	4.4290
3	11.375	3	0.5	9	4.8583	1.2403	2.4806	0.2637	0.9638	4.6824	21.1790	4.4290
4	11.375	3	1.0	1	2.7716	1.2403	1.2403	0.2637	0.9244	2.5621	9.8040	1.4290
5	11.375	3	1.0	5	3.0246	1.2403	1.2403	0.2637	0.9244	2.7960	9.8040	1.4290
6	11.375	3	1.0	9	3.0412	1.2403	1.2403	0.2637	0.9244	2.8114	9.8040	1.4290
7	15	10.625	0.5	1	3.8132	1.2131	2.4262	0.7083	0.9800	3.7371	28.4290	19.6790
8	15	10.625	0.5	5	3.8352	1.2131	2.4262	0.7083	0.9800	3.7587	28.4290	19.6790
9	15	10.625	0.5	9	3.8844	1.2131	2.4262	0.7083	0.9800	3.8068	28.4290	19.6790
10	15	10.625	1.0	1	2.2757	1.2131	1.2131	0.7083	0.9592	2.1828	13.4290	9.0540
11	15	10.625	1.0	5	2.3975	1.2131	1.2131	0.7083	0.9592	2.2996	13.4290	9.0540
12	15	10.625	1.0	9	2.5103	1.2131	1.2131	0.7083	0.9592	2.4078	13.4290	9.0540

NOTE:

The data shown can be found in Appendix V

L_c and W_c = Contact Length and Width, respectively as described in Chapter 3

Theoretical Model #1: S = (PD/2); Theoretical Model #2: S = (PD/2CF) where CF = (L+W-(1.142D))/(L+W-(2.142D))

Empirical Models #1a, #2a and #3a were obtained by solving the burst pressure (P) predicting models by S

Empirical Model #1b: $Y = K [X_1]^{p1} [X_2]^{p2} [X_3]^{p3}$; $Y = \log (S/D)$, $X_1 = \log \{(P)/CF\}$, $X_2 = \log (L_c/D)$, $X_3 = \log (W_c/D)$

Empirical Model #2b: $Y = K [X_1]^{p1} [X_2]^{p2}$; $Y = \log (S/D)$, $X_1 = \log (P)$, $X_2 = \log (1/CF)$

Empirical Model #3b: $Y = K [X_1]^{p1} [X_2]^{p2}$; $Y = \log (S/D)$, $X_1 = \log (P)$, $X_2 = \log (W/L)$

Table 104. Data used for the Seal Strength (S) Prediction Models – Rexam (1059B Tyvek/Polyester Poly Laminate) Pouches (when predicting Peak Force Values)

Sample	L Length (in)	W Width (in)	D Gap (in)	F Flow Index	P Burst Pressure (lbs/in^2)	S Peak Force (lbs/in)	S/D (lbs/in^2)	W/L (in/in)	1/CF (in/in)	(P)/CF (lbs/in^2)	L_c/D (in/in)	W_c/D (in/in)
1	9.125	5.75	0.5	1	4.1301	1.2640	2.5280	0.6301	0.9650	3.9857	16.6790	9.9290
2	9.125	5.75	0.5	5	4.3975	1.2640	2.5280	0.6301	0.9650	4.2438	16.6790	9.9290
3	9.125	5.75	0.5	9	4.4622	1.2640	2.5280	0.6301	0.9650	4.3063	16.6790	9.9290
4	9.125	5.75	1.0	1	2.3986	1.2640	1.2640	0.6301	0.9272	2.2240	7.5540	4.1790
5	9.125	5.75	1.0	5	2.5081	1.2640	1.2640	0.6301	0.9272	2.3255	7.5540	4.1790
6	9.125	5.75	1.0	9	2.5735	1.2640	1.2640	0.6301	0.9272	2.3861	7.5540	4.1790
7	14.125	9.25	0.5	1	4.1731	1.4340	2.8680	0.6549	0.9781	4.0816	26.6790	16.9290
8	14.125	9.25	0.5	5	4.5175	1.4340	2.8680	0.6549	0.9781	4.4185	26.6790	16.9290
9	14.125	9.25	0.5	9	4.7860	1.4340	2.8680	0.6549	0.9781	4.6811	26.6790	16.9290
10	14.125	9.25	1.0	1	2.5407	1.4340	1.4340	0.6549	0.9550	2.4264	12.5540	7.6790
11	14.125	9.25	1.0	5	2.7264	1.4340	1.4340	0.6549	0.9550	2.6038	12.5540	7.6790
12	14.125	9.25	1.0	9	2.7752	1.4340	1.4340	0.6549	0.9550	2.6504	12.5540	7.6790

NOTE:

The data shown can be found in Appendix V

L_c and W_c = Contact Length and Width, respectively as described in Chapter 3

Theoretical Model #1: S = (PD/2); Theoretical Model #2: S = (PD/2CF) where CF = (L+W-(1.142D))/(L+W-(2.142D))

Empirical Models #1a, #2a and #3a were obtained by solving the burst pressure (P) predicting models by S

Empirical Model #1b: $Y = K [X_1]^{p1} [X_2]^{p2} [X_3]^{p3}$; $Y = \log (S/D)$, $X_1 = \log \{(P)/CF\}$, $X_2 = \log (L_c/D)$, $X_3 = \log (W_c/D)$

Empirical Model #2b: $Y = K [X_1]^{p1} [X_2]^{p2}$; $Y = \log (S/D)$, $X_1 = \log (P)$, $X_2 = \log (1/CF)$

Empirical Model #3b: $Y = K [X_1]^{p1} [X_2]^{p2}$; $Y = \log (S/D)$, $X_1 = \log (P)$, $X_2 = \log (W/L)$

Table 105. Data used for the Seal Strength (S) Prediction Models – Rexam (1059B Tyvek/Polyester Poly Laminate) Pouches (when predicting Average Force Values)

Sample	L Length (in)	W Width (in)	D Gap (in)	F Flow Index	P Burst Pressure (lbs/in^2)	S Avg Force (lbs/in)	S/D (lbs/in^2)	W/L (in/in)	1/CF (in/in)	(P)/CF (lbs/in^2)	L_c/D (in/in)	W_c/D (in/in)
1	9.125	5.75	0.5	1	4.1301	0.8324	1.6648	0.6301	0.9650	3.9857	16.6790	9.9290
2	9.125	5.75	0.5	5	4.3975	0.8324	1.6648	0.6301	0.9650	4.2438	16.6790	9.9290
3	9.125	5.75	0.5	9	4.4622	0.8324	1.6648	0.6301	0.9650	4.3063	16.6790	9.9290
4	9.125	5.75	1.0	1	2.3986	0.8324	0.8324	0.6301	0.9272	2.2240	7.5540	4.1790
5	9.125	5.75	1.0	5	2.5081	0.8324	0.8324	0.6301	0.9272	2.3255	7.5540	4.1790
6	9.125	5.75	1.0	9	2.5735	0.8324	0.8324	0.6301	0.9272	2.3861	7.5540	4.1790
7	14.125	9.25	0.5	1	4.1731	0.9303	1.8606	0.6549	0.9781	4.0816	26.6790	16.9290
8	14.125	9.25	0.5	5	4.5175	0.9303	1.8606	0.6549	0.9781	4.4185	26.6790	16.9290
9	14.125	9.25	0.5	9	4.7860	0.9303	1.8606	0.6549	0.9781	4.6811	26.6790	16.9290
10	14.125	9.25	1.0	1	2.5407	0.9303	0.9303	0.6549	0.9550	2.4264	12.5540	7.6790
11	14.125	9.25	1.0	5	2.7264	0.9303	0.9303	0.6549	0.9550	2.6038	12.5540	7.6790
12	14.125	9.25	1.0	9	2.7752	0.9303	0.9303	0.6549	0.9550	2.6504	12.5540	7.6790

NOTE:

The data shown can be found in Appendix V

L_c and W_c = Contact Length and Width, respectively as described in Chapter 3

Theoretical Model #1: S = (PD/2); Theoretical Model #2: S = (PD/2CF) where CF = (L+W-(1.142D))/(L+W-(2.142D))

Empirical Models #1a, #2a and #3a were obtained by solving the burst pressure (P) predicting models by S

Empirical Model #1b: $Y = K [X_1]^{p1} [X_2]^{p2} [X_3]^{p3}$; $Y = \log (S/D)$, $X_1 = \log \{(P)/CF\}$, $X_2 = \log (L_c/D)$, $X_3 = \log (W_c/D)$

Empirical Model #2b: $Y = K [X_1]^{p1} [X_2]^{p2}$; $Y = \log (S/D)$, $X_1 = \log (P)$, $X_2 = \log (1/CF)$

Empirical Model #3b: $Y = K [X_1]^{p1} [X_2]^{p2}$; $Y = \log (S/D)$, $X_1 = \log (P)$, $X_2 = \log (W/L)$

F.3 Tabulated Results

Table 106. Seal Strength Model#1 Results – using data from 3 flow index values

Rexam (1073B Tyvek/Polyester Poly Laminate) Pouches

Predicting	Average[3] (%) Error	Regression Coefficients	R R_{adj}	PI – Single Response[1] (lbs/in^2)	PI – Mean Response[2] (lbs/in^2)
S_{peak}/D	4.83	K = 0.27 p1 = 0.66 p2 = 0.77 p3 = - 0.32	0.9864 0.9849	(S/D)+/-0.2916	(S/D)+/-0.0523
$S_{average}/D$	4.37	K = 0.18 p1 = 0.71 p2 = 0.75 p3 = - 0.34	0.9872 0.9859	(S/D)+/-0.1791	(S/D)+/-0.0322

Tolas (1073B Tyvek/PET/PE Laminate) Pouches

Predicting	Average[3] (%) Error	Regression Coefficients	R R_{adj}	PI – Single Response[1] (lbs/in^2)	PI – Mean Response[2] (lbs/in^2)
S_{peak}/D	1.36	K = 0.15 p1 = 0.17 p2 = 1.05 p3 = - 0.20	0.9992 0.9990	(S/D)+/-0.1048	(S/D)+/-0.0291
$S_{average}/D$	1.10	K = 0.11 p1 = 0.16 p2 = 1.04 p3 = - 0.19	0.9993 0.9990	(S/D)+/-0.0649	(S/D)+/-0.0180

Rexam (1059B Tyvek/Polyester/Poly Laminate) Pouches

Predicting	Average[3] (%) Error	Regression Coefficients	R R_{adj}	PI – Single Response[1] (lbs/in^2)	PI – Mean Response[2] (lbs/in^2)
S_{peak}/D	2.26	K = 0.03 p1 = 0.52 p2 = 3.90 p3 = - 3.17	0.9971 0.9960	(S/D)+/-0.1647	(S/D)+/-0.0457
$S_{average}/D$	2.36	K = 0.02 p1 = 0.55 p2 = 4.01 p3 = - 3.29	0.9967 0.9955	(S/D)+/-0.1135	(S/D)+/-0.0315

NOTES:

S = Seal Strength, D = gap, and R = Correlation Coefficient

1.,2. Prediction Interval (PI) for Single Response, and Mean Response, respectively

3., The percent error were calculated by multiplying the result by D and then comparing with the actual seal strength (S)

Table 107. Seal Strength, Model#2 Results – using data from 3 flow index values

Rexam (1073B Polyester/Polyester Poly Laminate) Pouches

Predicting	Average[3] (%) Error	Regression Coefficients	R R_{adj}	PI – Single Response[1] (lbs/in^2)	PI – Mean Response[2] (lbs/in^2)
S_{peak}/D	5.18	K = 0.83 p1 = 0.99 p2 = 4.25	0.9754 0.9737	(S/D)+/-0.4022	(S/D)+/-0.0722
$S_{average}/D$	5.28	K = 0.49 p1 = 1.04 p2 = 3.50	0.9767 0.9752	(S/D)+/-0.2483	(S/D)+/-0.0446

Tolas (1073B Tyvek/PET/PE Laminate) Pouches

Predicting	Average[3] (%) Error	Regression Coefficients	R R_{adj}	PI – Single Response[1] (lbs/in^2)	PI – Mean Response[2] (lbs/in^2)
S_{peak}/D	4.45	K = 0.95 p1 = 1.04 p2 = 6.05	0.9894 0.9869	(S/D)+/-0.3671	(S/D)+/-0.1018
$S_{average}/D$	4.49	K = 0.69 p1 = 1.01 p2 = 6.55	0.9892 0.9869	(S/D)+/-0.2533	(S/D)+/-0.0703

Rexam (1059B Tyvek/Polyester Poly Laminate) Pouches

Predicting	Average[3] (%) Error	Regression Coefficients	R R_{adj}	PI – Single Response[1] (lbs/in^2)	PI – Mean Response[2] (lbs/in^2)
S_{peak}/D	4.30	K = 0.61 p1 = 1.07 p2 = 3.43	0.9899 0.9879	(S/D)+/-0.2866	(S/D)+/-0.0795
$S_{average}/D$	4.27	K = 0.37 p1 = 1.10 p2 = 2.75	0.9897 0.9874	(S/D)+/-0.1883	(S/D)+/-0.0522

NOTES:

S = Seal Strength, D = gap, and R = Correlation Coefficient

1.,2. Prediction Interval (PI) for Single Response, and Mean Response, respectively

3., The percent error were calculated by multiplying the result by D and then comparing with the actual seal strength (S)

Table 108. Seal Strength Model#3 Results – using data from 3 flow index values

Rexam (1073B Polyester/Polyester Poly Laminate) Pouches

Predicting	Average[3] (%) Error	Regression Coefficients	R R_{adj}	PI – Single Response[1] (lbs/in^2)	PI – Mean Response[2] (lbs/in^2)
S_{peak}/D	7.16	K = 0.63 p1 = 1.25 p2 = 0.47	0.9589 0.9560	(S/D)+/-0.5152	(S/D)+/-0.0925
$S_{average}/D$	6.85	K = 0.39 p1 = 1.25 p2 = 0.38	0.9644 0.9618	(S/D)+/-0.3075	(S/D)+/-0.0552

Tolas (1073B Tyvek/PET/PE Laminate) Pouches

Predicting	Average[3] (%) Error	Regression Coefficients	R R_{adj}	PI – Single Response[1] (lbs/in^2)	PI – Mean Response[2] (lbs/in^2)
S_{peak}/D	4.75	K = 0.55 p1 = 1.44 p2 = 0.25	0.9858 0.9829	(S/D)+/-0.4059	(S/D)+/-0.1126
$S_{average}/D$	4.73	K = 0.38 p1 = 1.44 p2 = 0.27	0.9858 0.9823	(S/D)+/-0.2740	(S/D)+/-0.0760

Rexam (1059B Tyvek/Polyester Poly Laminate) Pouches

Predicting	Average[3] (%) Error	Regression Coefficients	R R_{adj}	PI – Single Response[1] (lbs/in^2)	PI – Mean Response[2] (lbs/in^2)
S_{peak}/D	4.63	K = 0.79 p1 = 1.27 p2 = 1.50	0.9885 0.9859	(S/D)+/-0.3151	(S/D)+/-0.0874
$S_{average}/D$	4.66	K = 0.44 p1 = 1.27 p2 = 1.11	0.9884 0.9859	(S/D)+/-0.2051	(S/D)+/-0.0569

NOTES:

S = Seal Strength, D = gap, and R = Correlation Coefficient

1.,2. Prediction Interval (PI) for Single Response, and Mean Response, respectively

3., The percent error were calculated by multiplying the result by D and then comparing with the actual seal strength (S)

Section F.4, below has Tables 109 to 114 with the individual percent error results for burst pressure (P) predicting models.

Table 109a. Average Percent Error for PEAK Seal Strength Prediction Models
Results for Rexam (1073B Tyvek/Polyester Poly Laminate) Pouches

					Theoretical #1		Theoretical #2		Empirical #1a		Empirical #2a		Empirical #3a	
n	PKG	D (in)	F	$(S_{peak})_a$ (lb/in)	$(S_{peak})_p$ (lb/in)	(%) Error	$(S_{peak})_p$ (lb/in)	(%) Error	$(S_{peak})_p$ (lb/in)	(%) Error	$(S_{peak})_p$ (lb/in)	(%) Error	$(S_{peak})_p$ (lb/in)	(%) Error
1	1	0.5	1	1.4840	1.0982	-26.00	1.0429	-29.72	1.4592	-1.67	1.4925	0.58	1.3940	-6.07
2	1	0.5	5	1.4840	1.1490	-22.57	1.0911	-26.47	1.5260	2.83	1.5685	5.69	1.4823	-0.12
3	1	0.5	9	1.4840	1.1873	-19.99	1.1275	-24.02	1.5763	6.22	1.6260	9.57	1.5498	4.44
4	2	0.5	1	1.5818	1.1246	-28.90	1.0839	-31.48	1.5794	-0.15	1.6191	2.36	1.6343	3.32
5	2	0.5	5	1.5818	1.1625	-26.51	1.1203	-29.17	1.6320	3.17	1.6790	6.14	1.7095	8.08
6	2	0.5	9	1.5818	1.1662	-26.28	1.1239	-28.95	1.6371	3.50	1.6849	6.52	1.7169	8.54
7	3	0.5	1	1.4916	0.8949	-40.00	0.8698	-41.69	1.3200	-11.50	1.3003	-12.83	1.2766	-14.42
8	3	0.5	5	1.4916	1.0863	-27.17	1.0558	-29.22	1.5992	7.21	1.6085	7.83	1.6611	11.36
9	3	0.5	9	1.4916	1.0217	-31.50	0.9930	-33.43	1.5050	0.90	1.5038	0.82	1.5283	2.46
10	4	0.5	1	1.6133	0.8435	-47.72	0.8250	-48.86	1.3177	-18.32	1.2477	-22.66	1.1809	-26.80
11	4	0.5	5	1.6133	0.9821	-39.12	0.9606	-40.46	1.5319	-5.05	1.4744	-8.61	1.4520	-10.00
12	4	0.5	9	1.6133	1.0718	-33.56	1.0483	-35.02	1.6704	3.54	1.6229	0.60	1.6351	1.35
13	5	0.5	1	1.5892	1.0339	-34.94	1.0139	-36.20	1.6362	2.96	1.5758	-0.84	1.6541	4.09
14	5	0.5	5	1.5892	1.0791	-32.09	1.0583	-33.40	1.7071	7.42	1.6517	3.93	1.7533	10.33
15	5	0.5	9	1.5892	1.0808	-31.99	1.0599	-33.30	1.7096	7.58	1.6544	4.10	1.7569	10.55

NOTES:

PKG = Package, F=Flow Index, $(S_{peak})_a$ and $(S_{peak})_p$ = Actual and Predicted PEAK Seal Strength (lbs/in), respectively
PKG 1, 2, 3, 4, & 5 are (3.25" x 7.25"), (5.25" x 9.125"), (7.25" x 11.125"), (9.25" x 14.125"), (11.25" x 15.25"), respectively
Theoretical #1; $S = PD/2$; **Theoretical #2;** $S = (PD)/(2*((L+W-(1.142D))/(L+W-(2.142D))))$
Empirical #1a; $S = K_S\, D/CF\, [P]^{P1s}[(L_O-1.571D)/D]^{P2s}[(W_O-1.571D)/D]^{P3s}$**, see K & p's in Table 23**
Empirical #2a; $S = K_S\, D\, [P]^{P1s}[1/CF]^{P2s}$**, see K & p's in Table 23**
Empirical #3a; $S = K_S\, D\, [P]^{P1s}[W/L]^{P2s}$**, see K & p's in Table 23**
Refer to pages 76-78 for more information about empirical models #1a, #2a, and #3a

Table 109a. Average Percent Error for PEAK Seal Strength Prediction Models - Continuation
Results for Rexam (1073B Tyvek/Polyester Poly Laminate) Pouches

					Theoretical #1		Theoretical #2		Empirical #1a		Empirical #2a		Empirical #3a	
n	PKG	D (in)	F	$(S_{peak})_a$ (lb/in)	$(S_{peak})_p$ (lb/in)	(%) Error	$(S_{peak})_p$ (lb/in)	(%) Error	$(S_{peak})_p$ (lb/in)	(%) Error	$(S_{peak})_p$ (lb/in)	(%) Error	$(S_{peak})_p$ (lb/in)	(%) Error
16	1	1.0	1	1.4840	1.3388	-9.78	1.1957	-19.42	1.4370	-3.17	1.3780	-7.15	1.4229	-4.12
17	1	1.0	5	1.4840	1.4304	-3.61	1.2776	-13.91	1.5343	3.39	1.4818	-0.15	1.5568	4.91
18	1	1.0	9	1.4840	1.4413	-2.88	1.2873	-13.26	1.5458	4.17	1.4941	0.68	1.5729	5.99
19	2	1.0	1	1.5818	1.3274	-16.08	1.2271	-22.42	1.5384	-2.74	1.5529	-1.83	1.5967	0.94
20	2	1.0	5	1.5818	1.3939	-11.88	1.2886	-18.54	1.6147	2.08	1.6385	3.59	1.7063	7.87
21	2	1.0	9	1.5818	1.3988	-11.57	1.2931	-18.25	1.6203	2.44	1.6448	3.98	1.7144	8.38
22	3	1.0	1	1.4916	1.1090	-25.65	1.0446	-29.97	1.3670	-8.36	1.3677	-8.31	1.3323	-10.68
23	3	1.0	5	1.4916	1.1509	-22.84	1.0841	-27.32	1.4181	-4.93	1.4245	-4.50	1.4012	-6.06
24	3	1.0	9	1.4916	1.1413	-23.48	1.0751	-27.92	1.4064	-5.71	1.4115	-5.37	1.3854	-7.12
25	4	1.0	1	1.6133	1.1267	-30.16	1.0760	-33.30	1.4856	-7.92	1.4652	-9.18	1.3647	-15.41
26	4	1.0	5	1.6133	1.1747	-27.18	1.1219	-30.46	1.5483	-4.03	1.5340	-4.92	1.4444	-10.47
27	4	1.0	9	1.6133	1.2676	-21.43	1.2106	-24.96	1.6695	3.48	1.6676	3.37	1.6017	-0.72
28	5	1.0	1	1.5892	1.2055	-24.15	1.1579	-27.14	1.6183	1.83	1.6126	1.47	1.5893	0.00
29	5	1.0	5	1.5892	1.2929	-18.64	1.2419	-21.85	1.7345	9.14	1.7415	9.58	1.7479	9.99
30	5	1.0	9	1.5892	1.3997	-11.92	1.3445	-15.40	1.8762	18.06	1.9000	19.56	1.9469	22.51
--	---	---	-	Average	---	24.32	---	28.18	---	5.45	---	5.89	---	7.90

NOTES:

PKG = Package, F=Flow Index, $(S_{peak})_a$ and $(S_{peak})_p$ = Actual and Predicted PEAK Seal Strength (lbs/in), respectively

PKG 1, 2, 3, 4, & 5 are (3.25" x 7.25"), (5.25" x 9.125"), (7.25" x 11.125"), (9.25" x 14.125"), (11.25" x 15.25"), respectively

Theoretical #1; $S = PD/2$; **Theoretical #2;** $S = (PD)/(2*((L+W-(1.142D))/(L+W-(2.142D))))$

Empirical #1a; $S = K_S\, D/CF\, [P]^{P1s}[(L_O-1.571D)/D]^{P2s}[(W_O-1.571D)/D]^{P3s}$, **see K & p's in Table 23**

Empirical #2a; $S = K_S\, D\, [P]^{P1s}[1/CF]^{P2s}$, **see K & p's in Table 23**

Empirical #3a; $S = K_S\, D\, [P]^{P1s}[W/L]^{P2s}$, **see K & p's in Table 23**

Refer to pages 76-78 for more information about empirical models #1a, #2a, and #3a

109b. Average Percent Error for PEAK Seal Strength Prediction Models

Results for Rexam (1073B Tyvek/Polyester Poly Laminate) Pouches

					Theoretical #1		Theoretical #2		Empirical #1b		Empirical #2b		Empirical #3b	
n	PKG	D (in)	F	$(S_{peak})_a$ (lb/in)	$(S_{peak})_p$ (lb/in)	(%) Error	$(S_{peak})_p$ (lb/in)	(%) Error	$(S_{peak})_p$ (lb/in)	(%) Error	$(S_{peak})_p$ (lb/in)	(%) Error	$(S_{peak})_p$ (lb/in)	(%) Error
1	1	0.5	1	1.4840	1.0982	-26.00	1.0429	-29.72	1.4446	-2.66	1.4499	-2.30	1.3663	-7.93
2	1	0.5	5	1.4840	1.1490	-22.57	1.0911	-26.47	1.4883	0.29	1.5164	2.18	1.4457	-2.58
3	1	0.5	9	1.4840	1.1873	-19.99	1.1275	-24.02	1.5209	2.48	1.5665	5.56	1.5062	1.49
4	2	0.5	1	1.5818	1.1246	-28.90	1.0839	-31.48	1.4853	-6.10	1.5806	-0.07	1.5849	0.20
5	2	0.5	5	1.5818	1.1625	-26.51	1.1203	-29.17	1.5181	-4.03	1.6334	3.26	1.6519	4.43
6	2	0.5	9	1.5818	1.1662	-26.28	1.1239	-28.95	1.5213	-3.82	1.6386	3.59	1.6585	4.85
7	3	0.5	1	1.4916	0.8949	-40.00	0.8698	-41.69	1.3429	-9.97	1.3060	-12.45	1.2640	-15.26
8	3	0.5	5	1.4916	1.0863	-27.17	1.0558	-29.22	1.5262	2.32	1.5828	6.11	1.6105	7.97
9	3	0.5	9	1.4916	1.0217	-31.50	0.9930	-33.43	1.4656	-1.74	1.4894	-0.15	1.4917	0.00
10	4	0.5	1	1.6133	0.8435	-47.72	0.8250	-48.86	1.4438	-10.51	1.2650	-21.59	1.1766	-27.07
11	4	0.5	5	1.6133	0.9821	-39.12	0.9606	-40.46	1.5963	-1.05	1.4711	-8.81	1.4231	-11.79
12	4	0.5	9	1.6133	1.0718	-33.56	1.0483	-35.02	1.6911	4.82	1.6044	-0.55	1.5874	-1.61
13	5	0.5	1	1.5892	1.0339	-34.94	1.0139	-36.20	1.6432	3.40	1.5659	-1.47	1.6060	1.06
14	5	0.5	5	1.5892	1.0791	-32.09	1.0583	-33.40	1.6903	6.36	1.6339	2.81	1.6944	6.62
15	5	0.5	9	1.5892	1.0808	-31.99	1.0599	-33.30	1.6920	6.47	1.6363	2.96	1.6975	6.82

NOTES:

PKG = Package, F=Flow Index, $(S_{peak})_a$ and $(S_{peak})_p$ = Actual and Predicted PEAK Seal Strength (lbs/in), respectively

PKG 1, 2, 3, 4, & 5 are (3.25" x 7.25"), (5.25" x 9.125"), (7.25" x 11.125"), (9.25" x 14.125"), (11.25" x 15.25"), respectively

Theoretical #1; $S = PD/2;$ **Theoretical #2;** $S = (PD)/(2*((L+W-(1.142D))/(L+W-(2.142D))))$

Empirical #1b; $(S/D) = K[P/((L+W-(1.142D))/(L+W-(2.142D)))]^{p1}[(L-1.571D/D]^{p2}[(W-1.571D)/D]^{p3}$**, see K & p's in Table 23**

Empirical #2b; $(S/D) = K[P]^{p1}[1/((L+W-(1.142D))/(L+W-(2.142D)))]^{p2}$**, see K & p's in Table 23**

Empirical #3b; $(S/D) = K[P]^{p1}[(W/L)]^{p2}$**, see K & p's in Table 23**

Table 109b. Average Percent Error for PEAK Seal Strength Prediction Models - Continuation
Results for Rexam (1073B Tyvek/Polyester Poly Laminate) Pouches

					Theoretical #1		Theoretical #2		Empirical #1b		Empirical #2b		Empirical #3b	
n	PKG	D (in)	F	$(S_{peak})_a$ (lb/in)	$(S_{peak})_p$ (lb/in)	(%) Error	$(S_{peak})_p$ (lb/in)	(%) Error	$(S_{peak})_p$ (lb/in)	(%) Error	$(S_{peak})_p$ (lb/in)	(%) Error	$(S_{peak})_p$ (lb/in)	(%) Error
16	1	1.0	1	1.4840	1.3388	-9.78	1.1957	-19.42	1.5127	1.93	1.3673	-7.86	1.4717	-0.83
17	1	1.0	5	1.4840	1.4304	-3.61	1.2776	-13.91	1.5802	6.48	1.4601	-1.61	1.5986	7.73
18	1	1.0	9	1.4840	1.4413	-2.88	1.2873	-13.26	1.5881	7.01	1.4711	-0.87	1.6138	8.75
19	2	1.0	1	1.5818	1.3274	-16.08	1.2271	-22.42	1.4848	-6.13	1.5694	-0.78	1.6397	3.66
20	2	1.0	5	1.5818	1.3939	-11.88	1.2886	-18.54	1.5335	-3.06	1.6474	4.15	1.7430	10.19
21	2	1.0	9	1.5818	1.3988	-11.57	1.2931	-18.25	1.5370	-2.83	1.6531	4.51	1.7507	10.68
22	3	1.0	1	1.4916	1.1090	-25.65	1.0446	-29.97	1.3882	-6.93	1.4222	-4.65	1.3897	-6.83
23	3	1.0	5	1.4916	1.1509	-22.84	1.0841	-27.32	1.4226	-4.63	1.4755	-1.08	1.4556	-2.41
24	3	1.0	9	1.4916	1.1413	-23.48	1.0751	-27.92	1.4148	-5.15	1.4634	-1.89	1.4405	-3.42
25	4	1.0	1	1.6133	1.1267	-30.16	1.0760	-33.30	1.5816	-1.97	1.5317	-5.06	1.4208	-11.93
26	4	1.0	5	1.6133	1.1747	-27.18	1.1219	-30.46	1.6258	0.77	1.5966	-1.04	1.4969	-7.21
27	4	1.0	9	1.6133	1.2676	-21.43	1.2106	-24.96	1.7095	5.96	1.7217	6.72	1.6463	2.05
28	5	1.0	1	1.5892	1.2055	-24.15	1.1579	-27.14	1.6447	3.49	1.6787	5.63	1.6362	2.96
29	5	1.0	5	1.5892	1.2929	-18.64	1.2419	-21.85	1.7225	8.39	1.7995	13.24	1.7859	12.38
30	5	1.0	9	1.5892	1.3997	-11.92	1.3445	-15.40	1.8152	14.22	1.9469	22.51	1.9722	24.10
--	---	---	-	Average	---	**24.32**	---	**28.18**	-----	**4.83**	-----	**5.18**	-----	**7.16**

NOTES:

PKG = Package, F=Flow Index, $(S_{peak})_a$ and $(S_{peak})_p$ = Actual and Predicted PEAK Seal Strength (lbs/in), respectively

PKG 1, 2, 3, 4, & 5 are (3.25" x 7.25"), (5.25" x 9.125"), (7.25" x 11.125"), (9.25" x 14.125"), (11.25" x 15.25"), respectively

Theoretical #1; $S = PD/2$; **Theoretical #2;** $S = (PD)/(2*((L+W-(1.142D))/(L+W-(2.142D))))$

Empirical #1b; $(S/D) = K[P/((L+W-(1.142D))/(L+W-(2.142D)))]^{P1}[(L-1.571D)/D]^{P2}[(W-1.571D)/D]^{P3}$, **see K & p's in Table 23**

Empirical #2b; $(S/D) = K[P]^{P1}[1/((L+W-(1.142D))/(L+W-(2.142D)))]^{P2}$, **see K & p's in Table 23**

Empirical #3b; $(S/D) = K[P]^{P1}[(W/L)]^{P2}$, **see K & p's in Table 23**

Table 110a. Average Percent Error for AVERAGE Seal Strength Prediction Models
Results for Rexam (1073B Tyvek/Polyester Poly Laminate) Pouches

					Theoretical #1		Theoretical #2		Empirical #1a		Empirical #2a		Empirical #3a	
n	PKG	D (in)	F	$(S_{avg})_a$ (lb/in)	$(S_{avg})_p$ (lb/in)	(%) Error	$(S_{avg})_p$ (lb/in)	(%) Error	$(S_{avg})_p$ (lb/in)	(%) Error	$(S_{avg})_p$ (lb/in)	(%) Error	$(S_{avg})_p$ (lb/in)	(%) Error
1	1	0.5	1	1.0095	1.0982	8.79	1.0429	3.31	0.9733	-3.59	0.9896	-1.97	0.9349	-7.39
2	1	0.5	5	1.0095	1.1490	13.82	1.0911	8.09	1.0183	0.87	1.0418	3.20	0.9937	-1.57
3	1	0.5	9	1.0095	1.1873	17.61	1.1275	11.69	1.0522	4.23	1.0814	7.12	1.0386	2.89
4	2	0.5	1	1.0243	1.1246	9.79	1.0839	5.81	1.0315	0.71	1.0634	3.81	1.0683	4.30
5	2	0.5	5	1.0243	1.1625	13.49	1.1203	9.38	1.0663	4.10	1.1042	7.80	1.1171	9.06
6	2	0.5	9	1.0243	1.1662	13.85	1.1239	9.73	1.0697	4.43	1.1082	8.19	1.1219	9.53
7	3	0.5	1	0.9806	0.8949	-8.74	0.8698	-11.30	0.8516	-13.15	0.8412	-14.22	0.8256	-15.80
8	3	0.5	5	0.9806	1.0863	10.78	1.0558	7.67	1.0337	5.42	1.0487	6.94	1.0724	9.36
9	3	0.5	9	0.9806	1.0217	4.19	0.9930	1.26	0.9723	-0.85	0.9780	-0.26	0.9872	0.68
10	4	0.5	1	1.0093	0.8435	-16.43	0.8250	-18.26	0.8482	-15.96	0.8017	-20.57	0.7638	-24.33
11	4	0.5	5	1.0093	0.9821	-2.69	0.9606	-4.83	0.9876	-2.15	0.9532	-5.56	0.9378	-7.08
12	4	0.5	9	1.0093	1.0718	6.20	1.0483	3.87	1.0778	6.79	1.0528	4.31	1.0553	4.56
13	5	0.5	1	1.0405	1.0339	-0.64	1.0139	-2.55	1.0468	0.61	1.0188	-2.08	1.0550	1.39
14	5	0.5	5	1.0405	1.0791	3.71	1.0583	1.71	1.0926	5.01	1.0697	2.81	1.1178	7.43
15	5	0.5	9	1.0405	1.0808	3.87	1.0599	1.87	1.0943	5.17	1.0716	2.99	1.1201	7.65

NOTES:

PKG = Package, F=Flow Index, $(S_{avg})_a$ and $(S_{avg})_p$ = Actual and Predicted AVERAGE Seal Strength (lbs/in), respectively
PKG 1, 2, 3, 4, & 5 are (3.25" x 7.25"), (5.25" x 9.125"), (7.25" x 11.125"), (9.25" x 14.125"), (11.25" x 15.25"), respectively
Theoretical #1; $S = PD/2$; **Theoretical #2;** $S = (PD)/(2*((L+W-(1.142D))/(L+W-(2.142D))))$
Empirical #1a; $S = K_S\, D/CF\, [P]^{P1s}[(L_O\text{-}1.571D)/D]^{P2s}[(W_O\text{-}1.571D)/D]^{P3s}$**, see K & p's in Table 23**
Empirical #2a; $S = K_S\, D\, [P]^{P1s}[1/CF]^{P2s}$**, see K & p's in Table 23**
Empirical #3a; $S = K_S\, D\, [P]^{P1s}[W/L]^{P2s}$**, see K & p's in Table 23**
Refer to pages 76-78 for more information about empirical models #1a, #2a, and #3a

Table 110a. Average Percent Error for AVERAGE Seal Strength Prediction Models - Continuation
Results for Rexam (1073B Tyvek/Polyester Poly Laminate) Pouches

					Theoretical #1		Theoretical #2		Empirical #1a		Empirical #2a		Empirical #3a	
n	PKG	D (in)	F	$(S_{avg})_a$ (lb/in)	$(S_{avg})_p$ (lb/in)	(%) Error	$(S_{avg})_p$ (lb/in)	(%) Error	$(S_{avg})_p$ (lb/in)	(%) Error	$(S_{avg})_p$ (lb/in)	(%) Error	$(S_{avg})_p$ (lb/in)	(%) Error
16	1	1.0	1	1.0095	1.3388	32.62	1.1957	18.45	0.9709	-3.82	0.9353	-7.35	0.9586	-5.04
17	1	1.0	5	1.0095	1.4304	41.70	1.2776	26.56	1.0374	2.76	1.0085	-0.10	1.0482	3.83
18	1	1.0	9	1.0095	1.4413	42.77	1.2873	27.51	1.0452	3.54	1.0172	0.76	1.0589	4.89
19	2	1.0	1	1.0243	1.3274	29.59	1.2271	19.80	1.0077	-1.62	1.0284	0.40	1.0487	2.38
20	2	1.0	5	1.0243	1.3939	36.09	1.2886	25.80	1.0582	3.31	1.0873	6.15	1.1202	9.37
21	2	1.0	9	1.0243	1.3988	36.56	1.2931	26.24	1.0619	3.67	1.0916	6.57	1.1255	9.88
22	3	1.0	1	0.9806	1.1090	13.09	1.0446	6.53	0.8825	-10.01	0.8874	-9.50	0.8655	-11.74
23	3	1.0	5	0.9806	1.1509	17.37	1.0841	10.55	0.9158	-6.60	0.9257	-5.60	0.9099	-7.21
24	3	1.0	9	0.9806	1.1413	16.39	1.0751	9.63	0.9082	-7.38	0.9169	-6.49	0.8997	-8.25
25	4	1.0	1	1.0093	1.1267	11.63	1.0760	6.61	0.9568	-5.21	0.9421	-6.66	0.8859	-12.22
26	4	1.0	5	1.0093	1.1747	16.39	1.1219	11.16	0.9976	-1.16	0.9880	-2.11	0.9373	-7.13
27	4	1.0	9	1.0093	1.2676	25.59	1.2106	19.94	1.0765	6.65	1.0773	6.74	1.0387	2.91
28	5	1.0	1	1.0405	1.2055	15.85	1.1579	11.28	1.0335	-0.67	1.0355	-0.48	1.0186	-2.10
29	5	1.0	5	1.0405	1.2929	24.26	1.2419	19.36	1.1085	6.54	1.1214	7.77	1.1196	7.60
30	5	1.0	9	1.0405	1.3997	34.52	1.3445	29.22	1.2001	15.34	1.2273	17.96	1.2462	19.77
--	---	---	-	Average	---	17.63	---	12.33	---	5.04	-----	5.88	---	7.58

NOTES:

PKG = Package, F=Flow Index, $(S_{avg})_a$ and $(S_{avg})_p$ = Actual and Predicted AVERAGE Seal Strength (lbs/in), respectively
PKG 1, 2, 3, 4, & 5 are (3.25" x 7.25"), (5.25" x 9.125"), (7.25" x 11.125"), (9.25" x 14.125"), (11.25" x 15.25"), respectively
Theoretical #1; $S = PD/2$; **Theoretical #2;** $S = (PD)/(2*((L+W-(1.142D))/(L+W-(2.142D))))$
Empirical #1a; $S = K_S\, D/CF\, [P]^{P1s}[(L_O-1.571D)/D]^{P2s}[(W_O-1.571D)/D]^{P3s}$**, see K & p's in Table 23**
Empirical #2a; $S = K_S\, D\, [P]^{P1s}[1/CF]^{P2s}$**, see K & p's in Table 23**
Empirical #3a; $S = K_S\, D\, [P]^{P1s}[W/L]^{P2s}$**, see K & p's in Table 23**
Refer to pages 76-78 for more information about empirical models #1a, #2a, and #3a

Table 110b. Average Percent Error for AVERAGE Seal Strength Prediction Models
Results for Rexam (1073B Tyvek/Polyester Poly Laminate) Pouches

					Theoretical #1		Theoretical #2		Empirical #1b		Empirical #2b		Empirical #3b	
n	PKG	D (in)	F	$(S_{avg})_a$ (lb/in)	$(S_{avg})_p$ (lb/in)	(%) Error	$(S_{avg})_p$ (lb/in)	(%) Error	$(S_{avg})_p$ (lb/in)	(%) Error	$(S_{avg})_p$ (lb/in)	(%) Error	$(S_{avg})_p$ (lb/in)	(%) Error
1	1	0.5	1	1.0095	1.0982	8.79	1.0429	3.31	0.9655	-4.36	0.9547	-5.43	0.9142	-9.44
2	1	0.5	5	1.0095	1.1490	13.82	1.0911	8.09	0.9971	-1.23	1.0007	-0.87	0.9674	-4.17
3	1	0.5	9	1.0095	1.1873	17.61	1.1275	11.69	1.0207	1.11	1.0354	2.57	1.0079	-0.16
4	2	0.5	1	1.0243	1.1246	9.79	1.0839	5.81	0.9783	-4.49	1.0305	0.61	1.0354	1.09
5	2	0.5	5	1.0243	1.1625	13.49	1.1203	9.38	1.0017	-2.21	1.0666	4.13	1.0792	5.36
6	2	0.5	9	1.0243	1.1662	13.85	1.1239	9.73	1.0040	-1.98	1.0702	4.48	1.0835	5.78
7	3	0.5	1	0.9806	0.8949	-8.74	0.8698	-11.30	0.8646	-11.83	0.8369	-14.66	0.8160	-16.79
8	3	0.5	5	0.9806	1.0863	10.78	1.0558	7.67	0.9927	1.23	1.0237	4.40	1.0396	6.02
9	3	0.5	9	0.9806	1.0217	4.19	0.9930	1.26	0.9502	-3.10	0.9605	-2.05	0.9629	-1.80
10	4	0.5	1	1.0093	0.8435	-16.43	0.8250	-18.26	0.9182	-9.03	0.8045	-20.29	0.7592	-24.78
11	4	0.5	5	1.0093	0.9821	-2.69	0.9606	-4.83	1.0234	1.40	0.9424	-6.62	0.9182	-9.02
12	4	0.5	9	1.0093	1.0718	6.20	1.0483	3.87	1.0892	7.92	1.0321	2.26	1.0242	1.48
13	5	0.5	1	1.0405	1.0339	-0.64	1.0139	-2.55	1.0504	0.95	1.0036	-3.55	1.0245	-1.54
14	5	0.5	5	1.0405	1.0791	3.71	1.0583	1.71	1.0829	4.08	1.0493	0.85	1.0808	3.88
15	5	0.5	9	1.0405	1.0808	3.87	1.0599	1.87	1.0841	4.19	1.0510	1.01	1.0829	4.07

NOTES:

PKG = Package, F=Flow Index, $(S_{avg})_a$ and $(S_{avg})_p$ = Actual and Predicted AVERAGE Seal Strength (lbs/in), respectively

PKG 1, 2, 3, 4, & 5 are (3.25" x 7.25"), (5.25" x 9.125"), (7.25" x 11.125"), (9.25" x 14.125"), (11.25" x 15.25"), respectively

Theoretical #1; $S = PD/2$; **Theoretical #2;** $S = (PD)/(2*((L+W-(1.142D))/(L+W-(2.142D))))$

Empirical #1b; $(S/D) = K[P/((L+W-(1.142D))/(L+W-(2.142D)))]^{p1}[(L-1.571D)/D]^{P2}[(W-1.571D)/D]^{P3}$, **see K & p's in Table 23**

Empirical #2b; $(S/D) = K[P]^{p1}[1/((L+W-(1.142D))/(L+W-(2.142D)))]^{p2}$, **see K & p's in Table 23**

Empirical #3b; $(S/D) = K[P]^{p1}[(W/L)]^{P2}$, **see K & p's in Table 23**

Table 110b. Average Percent Error for AVERAGE Seal Strength Prediction Models - Continuation
Results for Rexam (1073B Tyvek/Polyester Poly Laminate) Pouches

					Theoretical #1		Theoretical #2		Empirical #1b		Empirical #2b		Empirical #3b	
n	PKG	D (in)	F	$(S_{avg})_a$ (lb/in)	$(S_{avg})_p$ (lb/in)	(%) Error	$(S_{avg})_p$ (lb/in)	(%) Error	$(S_{avg})_p$ (lb/in)	(%) Error	$(S_{avg})_p$ (lb/in)	(%) Error	$(S_{avg})_p$ (lb/in)	(%) Error
16	1	1.0	1	1.0095	1.3388	32.62	1.1957	18.45	1.0168	0.72	0.9206	-8.81	0.9848	-2.45
17	1	1.0	5	1.0095	1.4304	41.70	1.2776	26.56	1.0659	5.59	0.9862	-2.31	1.0697	5.97
18	1	1.0	9	1.0095	1.4413	42.77	1.2873	27.51	1.0717	6.16	0.9940	-1.54	1.0799	6.97
19	2	1.0	1	1.0243	1.3274	29.59	1.2271	19.80	0.9784	-4.48	1.0293	0.49	1.0712	4.58
20	2	1.0	5	1.0243	1.3939	36.09	1.2886	25.80	1.0131	-1.09	1.0830	5.73	1.1387	11.17
21	2	1.0	9	1.0243	1.3988	36.56	1.2931	26.24	1.0156	-0.85	1.0870	6.12	1.1437	11.66
22	3	1.0	1	0.9806	1.1090	13.09	1.0446	6.53	0.8954	-8.69	0.9118	-7.01	0.8971	-8.52
23	3	1.0	5	0.9806	1.1509	17.37	1.0841	10.55	0.9194	-6.24	0.9477	-3.36	0.9397	-4.17
24	3	1.0	9	0.9806	1.1413	16.39	1.0751	9.63	0.9139	-6.80	0.9395	-4.19	0.9299	-5.17
25	4	1.0	1	1.0093	1.1267	11.63	1.0760	6.61	1.0111	0.18	0.9727	-3.63	0.9167	-9.17
26	4	1.0	5	1.0093	1.1747	16.39	1.1219	11.16	1.0417	3.21	1.0159	0.65	0.9659	-4.30
27	4	1.0	9	1.0093	1.2676	25.59	1.2106	19.94	1.0998	8.96	1.0996	8.94	1.0622	5.25
28	5	1.0	1	1.0405	1.2055	15.85	1.1579	11.28	1.0490	0.81	1.0649	2.34	1.0437	0.31
29	5	1.0	5	1.0405	1.2929	24.26	1.2419	19.36	1.1027	5.98	1.1454	10.08	1.1392	9.49
30	5	1.0	9	1.0405	1.3997	34.52	1.3445	29.22	1.1669	12.15	1.2439	19.55	1.2580	20.91
--	---	---	-	Average	---	17.63	---	12.33	-----	4.37	---	5.28	---	6.85

NOTES:

PKG = Package, F=Flow Index, $(S_{avg})_a$ and $(S_{avg})_p$ = Actual and Predicted AVERAGE Seal Strength (lbs/in), respectively
PKG 1, 2, 3, 4, & 5 are (3.25" x 7.25"), (5.25" x 9.125"), (7.25" x 11.125"), (9.25" x 14.125"), (11.25" x 15.25"), respectively
Theoretical #1; $S = PD/2$; **Theoretical #2;** $S = (PD)/(2*((L+W-(1.142D))/(L+W-(2.142D))))$
Empirical #1b; $(S/D) = K[P/((L+W-(1.142D))/(L+W-(2.142D)))]^{P1}[(L-1.571D)/D]^{P2}[(W-1.571D)/D]^{P3}$, **see K & p's in Table 23**
Empirical #2b; $(S/D) = K[P]^{P1}[1/((L+W-(1.142D))/(L+W-(2.142D)))]^{P2}$, **see K & p's in Table 23**
Empirical #3b; $(S/D) = K[P]^{P1}[(W/L)]^{P2}$, **see K & p's in Table 23**

Table 111a. Average Percent Error for PEAK Seal Strength Prediction Models
Results for Tolas (1073B Tyvek/PET/PE Laminate) Pouches

					Theoretical #1		Theoretical #2		Empirical #1a		Empirical #2a		Empirical #3a	
n	PKG	D (in)	F	$(S_{peak})_a$ (lb/in)	$(S_{peak})_p$ (lb/in)	(%) Error	$(S_{peak})_p$ (lb/in)	(%) Error	$(S_{peak})_p$ (lb/in)	(%) Error	$(S_{peak})_p$ (lb/in)	(%) Error	$(S_{peak})_p$ (lb/in)	(%) Error
1	1	0.5	1	1.8422	1.0836	-41.18	1.0443	-43.31	1.7615	-4.38	1.7501	-5.00	1.6397	-10.99
2	1	0.5	5	1.8422	1.2140	-34.10	1.1701	-36.49	1.8938	2.80	1.9798	7.47	1.9400	5.31
3	1	0.5	9	1.8422	1.2146	-34.07	1.1706	-36.46	1.8943	2.83	1.9808	7.52	1.9413	5.38
4	2	0.5	1	1.7625	0.9533	-45.91	0.9343	-46.99	1.7588	-0.21	1.6790	-4.74	1.7495	-0.74
5	2	0.5	5	1.7625	0.9588	-45.60	0.9397	-46.69	1.7653	0.16	1.6896	-4.14	1.7645	0.11
6	2	0.5	9	1.7625	0.9711	-44.90	0.9517	-46.00	1.7796	0.97	1.7131	-2.81	1.7980	2.02
7	1	1.0	1	1.8422	1.3858	-24.77	1.2811	-30.46	1.7767	-3.56	1.6906	-8.23	1.6925	-8.12
8	1	1.0	5	1.8422	1.5123	-17.91	1.3980	-24.11	1.8783	1.96	1.8586	0.89	1.9260	4.55
9	1	1.0	9	1.8422	1.5206	-17.46	1.4057	-23.70	1.8849	2.32	1.8697	1.49	1.9417	5.40
10	2	1.0	1	1.7625	1.1379	-35.44	1.0914	-38.08	1.7095	-3.00	1.6923	-3.98	1.6306	-7.48
11	2	1.0	5	1.7625	1.1988	-31.98	1.1498	-34.76	1.7673	0.27	1.7907	1.60	1.7613	-0.07
12	2	1.0	9	1.7625	1.2551	-28.79	1.2039	-31.69	1.8198	3.25	1.8822	6.79	1.8852	6.96
--	---	---	-	Average	---	33.51	---	36.56	---	2.14	---	4.55	---	4.76

NOTES:

PKG = Package, F=Flow Index, $(S_{peak})_a$ and $(S_{peak})_p$ = Actual and Predicted PEAK Seal Strength (lbs/in), respectively
PKG 1 and 2 are (3" x 11.375") and (10.625" x 15"), respectively
Theoretical #1; $S = PD/2$
Theoretical #2; $S = (PD)/(2*((L+W-(1.142D))/(L+W-(2.142D))))$
Empirical #1a; $S = K_S\, D/CF\, [P]^{P1s}[(L_O-1.571D)/D]^{P2s}[(W_O-1.571D)/D]^{P3s}$**, see K & p's in Table 24**
Empirical #2a; $S = K_S\, D\, [P]^{P1s}[1/CF]^{P2s}$**, see K & p's in Table 24**
Empirical #3a; $S = K_S\, D\, [P]^{P1s}[W/L]^{P2s}$**, see K & p's in Table 24**
Refer to pages 76-78 for more information about empirical models #1a, #2a, and #3a

Table 111b. Average Percent Error for PEAK Seal Strength Prediction Models
Results for Tolas (1073B Tyvek/PET/PE Laminate) Pouches

					Theoretical #1		Theoretical #2		Empirical #1b		Empirical #2b		Empirical #3b	
n	PKG	D (in)	F	$(S_{peak})_a$ (lb/in)	$(S_{peak})_p$ (lb/in)	(%) Error	$(S_{peak})_p$ (lb/in)	(%) Error	$(S_{peak})_p$ (lb/in)	(%) Error	$(S_{peak})_p$ (lb/in)	(%) Error	$(S_{peak})_p$ (lb/in)	(%) Error
1	1	0.5	1	1.8422	1.0836	-41.18	1.0443	-43.31	1.8100	-1.75	1.7404	-5.53	1.6285	-11.60
2	1	0.5	5	1.8422	1.2140	-34.10	1.1701	-36.49	1.8453	0.17	1.9588	6.33	1.9182	4.12
3	1	0.5	9	1.8422	1.2146	-34.07	1.1706	-36.46	1.8455	0.18	1.9597	6.38	1.9194	4.19
4	2	0.5	1	1.7625	0.9533	-45.91	0.9343	-46.99	1.8008	2.17	1.6856	-4.36	1.7336	-1.64
5	2	0.5	5	1.7625	0.9588	-45.60	0.9397	-46.69	1.8026	2.27	1.6957	-3.79	1.7480	-0.82
6	2	0.5	9	1.7625	0.9711	-44.90	0.9517	-46.00	1.8065	2.49	1.7183	-2.51	1.7804	1.01
7	1	1.0	1	1.8422	1.3858	-24.77	1.2811	-30.46	1.8564	0.77	1.6990	-7.77	1.7107	-7.14
8	1	1.0	5	1.8422	1.5123	-17.91	1.3980	-24.11	1.8842	2.28	1.8606	1.00	1.9400	5.31
9	1	1.0	9	1.8422	1.5206	-17.46	1.4057	-23.70	1.8859	2.37	1.8712	1.57	1.9554	6.15
10	2	1.0	1	1.7625	1.1379	-35.44	1.0914	-38.08	1.7440	-1.05	1.7300	-1.84	1.6489	-6.45
11	2	1.0	5	1.7625	1.1988	-31.98	1.1498	-34.76	1.7595	-0.17	1.8264	3.63	1.7774	0.85
12	2	1.0	9	1.7625	1.2551	-28.79	1.2039	-31.69	1.7733	0.62	1.9158	8.70	1.8990	7.75
--	---	---	-	Average	---	**33.51**	---	**36.56**	---	**1.36**	---	**4.45**	---	**4.75**

NOTES:

PKG = Package, F=Flow Index, $(S_{peak})_a$ and $(S_{peak})_p$ = Actual and Predicted PEAK Seal Strength (lbs/in), respectively

PKG 1 and 2 are (3" x 11.375") and (10.625" x 15"), respectively

Theoretical #1; $S = PD/2$

Theoretical #2; $S = (PD)/(2*((L+W-(1.142D))/(L+W-(2.142D))))$

Empirical #1b; $(S/D) = K[P/((L+W-(1.142D))/(L+W-(2.142D)))]^{P1}[(L-1.571D)/D]^{P2}[(W-1.571D)/D]^{P3}$**, see K & p's in Table 24**

Empirical #2b; $(S/D) = K[P]^{P1}[1/((L+W-(1.142D))/(L+W-(2.142D)))]^{P2}$**, see K & p's in Table 24**

Empirical #3b; $(S/D) = K[P]^{P1}[(W/L)]^{P2}$**, see K & p's in Table 24**

Table 112a. Average Percent Error for AVERAGE Seal Strength Prediction Models
Results for Tolas (1073B Tyvek/PET/PE Laminate) Pouches

					Theoretical #1		Theoretical #2		Empirical #1a		Empirical #2a		Empirical #3a	
n	PKG	D (in)	F	$(S_{avg})_a$ (lb/in)	$(S_{avg})_p$ (lb/in)	(%) Error	$(S_{avg})_p$ (lb/in)	(%) Error	$(S_{avg})_p$ (lb/in)	(%) Error	$(S_{avg})_p$ (lb/in)	(%) Error	$(S_{avg})_p$ (lb/in)	(%) Error
1	1	0.5	1	1.2403	1.0836	-12.64	1.0443	-15.80	1.1915	-3.93	1.1939	-3.74	1.1059	-10.83
2	1	0.5	5	1.2403	1.2140	-2.12	1.1701	-5.66	1.2701	2.40	1.3457	8.50	1.3085	5.50
3	1	0.5	9	1.2403	1.2146	-2.07	1.1706	-5.62	1.2704	2.43	1.3463	8.55	1.3093	5.57
4	2	0.5	1	1.2131	0.9533	-21.42	0.9343	-22.99	1.2099	-0.27	1.1594	-4.43	1.2061	-0.58
5	2	0.5	5	1.2131	0.9588	-20.96	0.9397	-22.54	1.2138	0.06	1.1665	-3.85	1.2164	0.27
6	2	0.5	9	1.2131	0.9711	-19.95	0.9517	-21.55	1.2225	0.78	1.1822	-2.55	1.2396	2.18
7	1	1.0	1	1.2403	1.3858	11.73	1.2811	3.29	1.2021	-3.08	1.1467	-7.55	1.1415	-7.96
8	1	1.0	5	1.2403	1.5123	21.93	1.3980	12.72	1.2625	1.79	1.2571	1.36	1.2990	4.73
9	1	1.0	9	1.2403	1.5206	22.60	1.4057	13.33	1.2664	2.11	1.2644	1.94	1.3096	5.59
10	2	1.0	1	1.2131	1.1379	-6.20	1.0914	-10.03	1.1814	-2.62	1.1757	-3.08	1.1241	-7.33
11	2	1.0	5	1.2131	1.1988	-1.18	1.1498	-5.22	1.2165	0.28	1.2421	2.39	1.2143	0.10
12	2	1.0	9	1.2131	1.2551	3.47	1.2039	-0.76	1.2483	2.90	1.3036	7.46	1.2997	7.14
--	---	---	-	Average	---	12.19	---	11.63	---	1.89	---	4.62	---	4.81

NOTES:

PKG = Package, F=Flow Index, $(S_{avg})_a$ and $(S_{avg})_p$ = Actual and Predicted AVERAGE Seal Strength (lbs/in), respectively
PKG 1 and 2 are (3" x 11.375") and (10.625" x 15"), respectively
Theoretical #1; $S = PD/2$
Theoretical #2; $S = (PD)/(2*((L+W-(1.142D))/(L+W-(2.142D))))$
Empirical #1a; $S = K_S\, D/CF\, [P]^{P1s}[(L_O-1.571D)/D]^{P2s}[(W_O-1.571D)/D]^{P3s}$**, see K & p's in Table 24**
Empirical #2a; $S = K_S\, D\, [P]^{P1s}[1/CF]^{P2s}$**, see K & p's in Table 24**
Empirical #3a; $S = K_S\, D\, [P]^{P1s}[W/L]^{P2s}$**, see K & p's in Table 24**
Refer to pages 76-78 for more information about empirical models #1a, #2a, and #3a

Table 112b. Average Percent Error for AVERAGE Seal Strength Prediction Models
Results for Tolas (1073B Tyvek/PET/PE Laminate) Pouches

					Theoretical #1		Theoretical #2		Empirical #1b		Empirical #2b		Empirical #3b	
n	PKG	D (in)	F	$(S_{avg})_a$ (lb/in)	$(S_{avg})_p$ (lb/in)	(%) Error	$(S_{avg})_p$ (lb/in)	(%) Error	$(S_{avg})_p$ (lb/in)	(%) Error	$(S_{avg})_p$ (lb/in)	(%) Error	$(S_{avg})_p$ (lb/in)	(%) Error
1	1	0.5	1	1.2403	1.0836	-12.64	1.0443	-15.80	1.2082	-2.59	1.1867	-4.32	1.0956	-11.67
2	1	0.5	5	1.2403	1.2140	-2.12	1.1701	-5.66	1.2298	-0.84	1.3311	7.32	1.2904	4.04
3	1	0.5	9	1.2403	1.2146	-2.07	1.1706	-5.62	1.2299	-0.84	1.3317	7.37	1.2913	4.11
4	2	0.5	1	1.2131	0.9533	-21.42	0.9343	-22.99	1.2239	0.89	1.1634	-4.09	1.1895	-1.94
5	2	0.5	5	1.2131	0.9588	-20.96	0.9397	-22.54	1.2250	0.98	1.1702	-3.53	1.1994	-1.13
6	2	0.5	9	1.2131	0.9711	-19.95	0.9517	-21.55	1.2274	1.18	1.1854	-2.29	1.2216	0.70
7	1	1.0	1	1.2403	1.3858	11.73	1.2811	3.29	1.2390	-0.11	1.1499	-7.29	1.1509	-7.21
8	1	1.0	5	1.2403	1.5123	21.93	1.3980	12.72	1.2560	1.26	1.2559	1.26	1.3051	5.23
9	1	1.0	9	1.2403	1.5206	22.60	1.4057	13.33	1.2570	1.35	1.2629	1.82	1.3155	6.06
10	2	1.0	1	1.2131	1.1379	-6.20	1.0914	-10.03	1.1912	-1.81	1.1997	-1.10	1.1314	-6.74
11	2	1.0	5	1.2131	1.1988	-1.18	1.1498	-5.22	1.2009	-1.01	1.2646	4.25	1.2196	0.53
12	2	1.0	9	1.2131	1.2551	3.47	1.2039	-0.76	1.2095	-0.29	1.3247	9.20	1.3030	7.41
--	---	---	-	Average	---	12.19	---	11.63	---	1.10	---	4.49	---	4.73

NOTES:

PKG = Package, F=Flow Index, $(S_{avg})_a$ and $(S_{avg})_p$ = Actual and Predicted AVERAGE Seal Strength (lbs/in), respectively
PKG 1 and 2 are (3" x 11.375") and (10.625" x 15"), respectively
Theoretical #1; $S = PD/2$
Theoretical #2; $S = (PD)/(2*((L+W-(1.142D))/(L+W-(2.142D))))$
Empirical #1b; $(S/D) = K[P/((L+W-(1.142D))/(L+W-(2.142D)))]^{p1}[(L-1.571D)/D]^{p2}[(W-1.571D)/D]^{p3}$**, see K & p's in Table 24**
Empirical #2b; $(S/D) = K[P]^{p1}[1/((L+W-(1.142D))/(L+W-(2.142D)))]^{p2}$**, see K & p's in Table 24**
Empirical #3b; $(S/D) = K[P]^{p1}[(W/L)]^{p2}$**, see K & p's in Table 24**

Table 113a. Average Percent Error for PEAK Seal Strength Prediction Models
Results for Rexam (1059B Tyvek/Polyester Poly Laminate) Pouches

					Theoretical #1		Theoretical #2		Empirical #1a		Empirical #2a		Empirical #3a	
n	PKG	D (in)	F	$(S_{peak})_a$ (lb/in)	$(S_{peak})_p$ (lb/in)	(%) Error	$(S_{peak})_p$ (lb/in)	(%) Error	$(S_{peak})_p$ (lb/in)	(%) Error	$(S_{peak})_p$ (lb/in)	(%) Error	$(S_{peak})_p$ (lb/in)	(%) Error
1	1	0.5	1	1.2640	1.0325	-18.31	0.9964	-21.17	1.2440	-1.59	1.2313	-2.59	1.2060	-4.59
2	1	0.5	5	1.2640	1.0994	-13.02	1.0610	-16.06	1.3102	3.65	1.3264	4.94	1.3084	3.51
3	1	0.5	9	1.2640	1.1156	-11.74	1.0766	-14.83	1.3261	4.91	1.3496	6.77	1.3335	5.50
4	2	0.5	1	1.4340	1.0433	-27.25	1.0204	-28.84	1.3864	-3.32	1.2803	-10.72	1.2927	-9.85
5	2	0.5	5	1.4340	1.1294	-21.24	1.1046	-22.97	1.4803	3.23	1.4066	-1.91	1.4330	-0.07
6	2	0.5	9	1.4340	1.1965	-16.56	1.1703	-18.39	1.5527	8.28	1.5063	5.04	1.5446	7.71
7	1	1.0	1	1.2640	1.1993	-5.12	1.1120	-12.03	1.2444	-1.55	1.1935	-5.58	1.1910	-5.78
8	1	1.0	5	1.2640	1.2541	-0.79	1.1627	-8.01	1.2911	2.15	1.2584	-0.44	1.2620	-0.16
9	1	1.0	9	1.2640	1.2868	1.80	1.1931	-5.61	1.3189	4.34	1.2974	2.65	1.3049	3.24
10	2	1.0	1	1.4340	1.2703	-11.41	1.2132	-15.40	1.3997	-2.39	1.3554	-5.48	1.3572	-5.35
11	2	1.0	5	1.4340	1.3632	-4.94	1.3019	-9.21	1.4838	3.47	1.4737	2.77	1.4875	3.73
12	2	1.0	9	1.4340	1.3876	-3.24	1.3252	-7.59	1.5057	5.00	1.5050	4.95	1.5222	6.15
--	---	---	-	Average	---	11.29	---	15.01	---	3.66	---	4.49	---	4.64

NOTES:

PKG = Package, F=Flow Index, $(S_{peak})_a$ and $(S_{peak})_p$ = Actual and Predicted PEAK Seal Strength (lbs/in), respectively
PKG 1 and 2 are (5.75" x 9.125") and (9.25" x 14.125"), respectively
Theoretical #1; $S = PD/2$
Theoretical #2; $S = (PD)/(2*((L+W-(1.142D))/(L+W-(2.142D))))$
Empirical #1a; $S = K_S\, D/CF\, [P]^{P1s}[(L_O-1.571D)/D]^{P2s}[(W_O-1.571D)/D]^{P3s}$**, see K & p's in Table 25**
Empirical #2a; $S = K_S\, D\, [P]^{P1s}[1/CF]^{P2s}$**, see K & p's in Table 25**
Empirical #3a; $S = K_S\, D\, [P]^{P1s}[W/L]^{P2s}$**, see K & p's in Table 25**
Refer to pages 76-78 for more information about empirical models #1a, #2a, and #3a

Table 113b. Average Percent Error for PEAK Seal Strength Prediction Models
Results for Rexam (1059B Tyvek/Polyester Poly Laminate) Pouches

					Theoretical #1		Theoretical #2		Empirical #1b		Empirical #2b		Empirical #3b	
n	PKG	D (in)	F	$(S_{peak})_a$ (lb/in)	$(S_{peak})_p$ (lb/in)	(%) Error	$(S_{peak})_p$ (lb/in)	(%) Error	$(S_{peak})_p$ (lb/in)	(%) Error	$(S_{peak})_p$ (lb/in)	(%) Error	$(S_{peak})_p$ (lb/in)	(%) Error
1	1	0.5	1	1.2640	1.0325	-18.31	0.9964	-21.17	1.1970	-5.30	1.2275	-2.89	1.1979	-5.23
2	1	0.5	5	1.2640	1.0994	-13.02	1.0610	-16.06	1.2369	-2.15	1.3127	3.86	1.2972	2.63
3	1	0.5	9	1.2640	1.1156	-11.74	1.0766	-14.83	1.2463	-1.40	1.3334	5.49	1.3215	4.55
4	2	0.5	1	1.4340	1.0433	-27.25	1.0204	-28.84	1.3948	-2.73	1.2996	-9.37	1.2859	-10.33
5	2	0.5	5	1.4340	1.1294	-21.24	1.1046	-22.97	1.4538	1.38	1.4147	-1.35	1.4221	-0.83
6	2	0.5	9	1.4340	1.1965	-16.56	1.1703	-18.39	1.4983	4.48	1.5049	4.94	1.5303	6.72
7	1	1.0	1	1.2640	1.1993	-5.12	1.1120	-12.03	1.2493	-1.16	1.1965	-5.34	1.2015	-4.95
8	1	1.0	5	1.2640	1.2541	-0.79	1.1627	-8.01	1.2788	1.17	1.2550	-0.71	1.2716	0.60
9	1	1.0	9	1.2640	1.2868	1.80	1.1931	-5.61	1.2961	2.54	1.2901	2.06	1.3138	3.94
10	2	1.0	1	1.4340	1.2703	-11.41	1.2132	-15.40	1.3778	-3.92	1.4084	-1.79	1.3694	-4.51
11	2	1.0	5	1.4340	1.3632	-4.94	1.3019	-9.21	1.4295	-0.32	1.5188	5.91	1.4978	4.45
12	2	1.0	9	1.4340	1.3876	-3.24	1.3252	-7.59	1.4428	0.61	1.5479	7.94	1.5319	6.83
--	---	---	-	Average	---	**11.29**	---	**15.01**	---	**2.26**	---	**4.30**	---	**4.63**

NOTES:

PKG = Package, F=Flow Index, $(S_{peak})_a$ and $(S_{peak})_p$ = Actual and Predicted PEAK Seal Strength (lbs/in), respectively

PKG 1 and 2 are (5.75" x 9.125") and (9.25" x 14.125"), respectively

Theoretical #1; $S = PD/2$

Theoretical #2; $S = (PD)/(2*((L+W-(1.142D))/(L+W-(2.142D))))$

Empirical #1b; $(S/D) = K[P/((L+W-(1.142D))/(L+W-(2.142D)))]^{p1}[(L-1.571D)/D]^{p2}[(W-1.571D)/D]^{p3}$**, see K & p's in Table 25**

Empirical #2b; $(S/D) = K[P]^{p1}[1/((L+W-(1.142D))/(L+W-(2.142D))))]^{p2}$**, see K & p's in Table 25**

Empirical #3b; $(S/D) = K[P]^{p1}[(W/L)]^{p2}$**, see K & p's in Table 25**

Table 114a. Average Percent Error for AVERAGE Seal Strength Prediction Models
Results for Rexam (1059B Tyvek/Polyester Poly Laminate) Pouches

					Theoretical #1		Theoretical #2		Empirical #1a		Empirical #2a		Empirical #3a	
n	PKG	D (in)	F	$(S_{avg})_a$ (lb/in)	$(S_{avg})_p$ (lb/in)	(%) Error	$(S_{avg})_p$ (lb/in)	(%) Error	$(S_{avg})_p$ (lb/in)	(%) Error	$(S_{avg})_p$ (lb/in)	(%) Error	$(S_{avg})_p$ (lb/in)	(%) Error
1	1	0.5	1	0.8324	1.0325	24.04	0.9964	19.71	0.8135	-2.28	0.8055	-3.23	0.7935	-4.68
2	1	0.5	5	0.8324	1.0994	32.07	1.0610	27.46	0.8595	3.25	0.8698	4.50	0.8608	3.42
3	1	0.5	9	0.8324	1.1156	34.02	1.0766	29.33	0.8706	4.59	0.8855	6.38	0.8773	5.40
4	2	0.5	1	0.9303	1.0433	12.14	1.0204	9.69	0.8910	-4.23	0.8307	-10.71	0.8380	-9.93
5	2	0.5	5	0.9303	1.1294	21.40	1.1046	18.74	0.9552	2.67	0.9153	-1.61	0.9289	-0.16
6	2	0.5	9	0.9303	1.1965	28.62	1.1703	25.80	1.0048	8.01	0.9824	5.60	1.0012	7.62
7	1	1.0	1	0.8324	1.1993	44.08	1.1120	33.59	0.8155	-2.04	0.7850	-5.70	0.7836	-5.87
8	1	1.0	5	0.8324	1.2541	50.66	1.1627	39.69	0.8480	1.88	0.8290	-0.40	0.8303	-0.25
9	1	1.0	9	0.8324	1.2868	54.59	1.1931	43.33	0.8674	4.20	0.8556	2.79	0.8586	3.14
10	2	1.0	1	0.9303	1.2703	36.55	1.2132	30.41	0.9018	-3.06	0.8765	-5.79	0.8798	-5.43
11	2	1.0	5	0.9303	1.3632	46.53	1.3019	39.94	0.9594	3.13	0.9555	2.71	0.9642	3.64
12	2	1.0	9	0.9303	1.3876	49.16	1.3252	42.45	0.9745	4.75	0.9765	4.96	0.9867	6.06
--	---	---	-	Average	---	**36.15**	---	**30.01**	---	**3.67**	---	**4.53**	---	**4.63**

NOTES:

PKG = Package, F=Flow Index, $(S_{avg})_a$ and $(S_{avg})_p$ = Actual and Predicted AVERAGE Seal Strength (lbs/in), respectively
PKG 1 and 2 are (5.75" x 9.125") and (9.25" x 14.125"), respectively
Theoretical #1; $S = PD/2$
Theoretical #2; $S = (PD)/(2*((L+W-(1.142D))/(L+W-(2.142D))))$
Empirical #1a; $S = K_S\, D/CF\, [P]^{P1s}[(L_O-1.571D)/D]^{P2s}[(W_O-1.571D)/D]^{P3s}$**, see K & p's in Table 25**
Empirical #2a; $S = K_S\, D\, [P]^{P1s}[1/CF]^{P2s}$**, see K & p's in Table 25**
Empirical #3a; $S = K_S\, D\, [P]^{P1s}[W/L]^{P2s}$**, see K & p's in Table 25**
Refer to pages 76-78 for more information about empirical models #1a, #2a, and #3a

Table 114b. Average Percent Error for AVERAGE Seal Strength Prediction Models
Results for Rexam (1059B Tyvek/Polyester Poly Laminate) Pouches

					Theoretical #1		Theoretical #2		Empirical #1b		Empirical #2b		Empirical #3b	
n	PKG	D (in)	F	$(S_{avg})_a$ (lb/in)	$(S_{avg})_p$ (lb/in)	(%) Error	$(S_{avg})_p$ (lb/in)	(%) Error	$(S_{avg})_p$ (lb/in)	(%) Error	$(S_{avg})_p$ (lb/in)	(%) Error	$(S_{avg})_p$ (lb/in)	(%) Error
1	1	0.5	1	0.8324	1.0325	24.04	0.9964	19.71	0.7979	-4.14	0.7926	-4.78	0.7900	-5.10
2	1	0.5	5	0.8324	1.0994	32.07	1.0610	27.46	0.8260	-0.77	0.8492	2.02	0.8555	2.77
3	1	0.5	9	0.8324	1.1156	34.02	1.0766	29.33	0.8327	0.04	0.8630	3.67	0.8715	4.70
4	2	0.5	1	0.9303	1.0433	12.14	1.0204	9.69	0.9190	-1.22	0.8318	-10.59	0.8354	-10.21
5	2	0.5	5	0.9303	1.1294	21.40	1.1046	18.74	0.9601	3.20	0.9076	-2.44	0.9239	-0.69
6	2	0.5	9	0.9303	1.1965	28.62	1.1703	25.80	0.9912	6.55	0.9671	3.96	0.9942	6.87
7	1	1.0	1	0.8324	1.1993	44.08	1.1120	33.59	0.8321	-0.03	0.7811	-6.17	0.7923	-4.81
8	1	1.0	5	0.8324	1.2541	50.66	1.1627	39.69	0.8529	2.46	0.8204	-1.44	0.8386	0.74
9	1	1.0	9	0.8324	1.2868	54.59	1.1931	43.33	0.8651	3.93	0.8439	1.39	0.8664	4.09
10	2	1.0	1	0.9303	1.2703	36.55	1.2132	30.41	0.9044	-2.78	0.9026	-2.98	0.8896	-4.37
11	2	1.0	5	0.9303	1.3632	46.53	1.3019	39.94	0.9404	1.08	0.9755	4.85	0.9730	4.59
12	2	1.0	9	0.9303	1.3876	49.16	1.3252	42.45	0.9496	2.08	0.9947	6.92	0.9952	6.97
--	---	---	-	Average	---	**36.15**	---	**30.01**	---	**2.36**	---	**4.27**	---	**4.66**

NOTES:

PKG = Package, F=Flow Index, $(S_{avg})_a$ and $(S_{avg})_p$ = Actual and Predicted AVERAGE Seal Strength (lbs/in), respectively
PKG 1 and 2 are (5.75" x 9.125") and (9.25" x 14.125"), respectively
Theoretical #1; $S = PD/2$
Theoretical #2; $S = (PD)/(2*((L+W-(1.142D))/(L+W-(2.142D))))$
Empirical #1b; $(S/D) = K[P/((L+W-(1.142D))/(L+W-(2.142D)))]^{p1}[(L-1.571D)/D]^{p2}[(W-1.571D)/D]^{p3}$**, see K & p's in Table 25**
Empirical #2b; $(S/D) = K[P]^{p1}[1/((L+W-(1.142D))/(L+W-(2.142D)))]^{p2}$**, see K & p's in Table 25**
Empirical #3b; $(S/D) = K[P]^{p1}[(W/L)]^{p2}$**, see K & p's in Table 25**

G. Burst Pressure (P) and Seal Strength (S) Empirical Model Results –using burst test data obtained flow index =5

In this case, the regression analysis was run with the results obtained using a flow index value of 5. This analysis was performed only for Rexam 1073B Tyvek/Plastic pouches. See Tables 115 to 120 for results. The reason for this is because in the other two materials the number of data points to run the analysis, when using only observations from flow index 5, was too small. For Rexam1073B Tyvek/plastic pouches the number of data points when using the results obtained with a flow index of 5 is10 (observations 2, 5, 8, 11, 14, 17, 20, 23, 26 and 29, in Tables 82 & 83 for burst pressure prediction models and 91 & 92 for seal strength prediction models). For Tolas 1073B and Rexam 1059 B Tyvek/plastic pouches the number of data point is 4 (observations 2, 5, 8, and 11, in Tables 84 to 87 for burst pressure prediction models and 93 to 96 for seal strength prediction models). Four data points is not enough data to run the regression analysis for the three models. When running a regression analysis for model #1 with 4 data points, the mean square error (MSE) and the F statistic cannot be calculated.

MSE = (SSE)/Error DF; MSE = SSE/0

where; SSE = Error sum of squares and DF = degrees of freedom

Regression DF = (number of regression coefficient – 1)

Total DF = (total number of observations – 1)

Error DF = Total DF – Regression DF

Model #1, with n= 4, then; Regression DF = 4-1 = 3

Total DF = 4-1 = 3

Error DF = 3 – 3 = 0

G.1 Tabulated Results

Empirical model results, for the three material combinations, are shown below.

Table 115. Burst Pressure Model #1 Results – using data from flow index = 5 Rexam (1073B Tyvek/Polyester Poly Laminate) Pouches

Data using	Average (%) Error	Regression Coefficients	R R_{adj}	PI – Single Response[1] (lbs/in^2)	PI – Mean Response[2] (lbs/in^2)
S Peak Force	3.92	K = 2.69 p1 = 1.08 p2 = 0.32 p3 = - 0.08	0.9845 0.9767	P +/- 0.4271	P +/- 0.1289
S Average Force	3.04	K = 4.48 p1 = 1.08 p2 = 0.39 p3 = - 0.15	0.9909 0.9864	P +/- 0.2966	P +/- 0.0894

Table 116. Burst Pressure Model #2 Results – using data from flow index = 5 Rexam (1073B Polyester/Polyester Poly Laminate) Pouches

Data using	Average (%) Error	Regression Coefficients	R R_{adj}	PI – Single Response[1] (lbs/in^2)	PI – Mean Response[2] (lbs/in^2)
S Peak Force	4.33	K = 1.33 p1 = 0.95 p2 = 3.59	0.9821 0.9772	P +/- 0.4954	P +/- 0.1494
S Average Force	3.51	K = 2.09 p1 = 0.91 p2 = 2.82	0.9882 0.9849	P +/- 0.3879	P +/- 0.1170

Table 117. Burst Pressure Model #3 Results – using data from flow index = 5 Rexam (1073B Polyester/Polyester Poly Laminate) Pouches

Data using	Average (%) Error	Regression Coefficients	R R_{adj}	PI – Single Response[1] (lbs/in^2)	PI – Mean Response[2] (lbs/in^2)
S Peak Force	5.47	K = 1.53 p1 = 0.76 p2 = 0.37	0.9764 0.9695	P +/- 0.5553	P +/- 0.1674
S Average Force	4.77	K = 2.19 p1 = 0.77 p2 = 0.30	0.9831 0.9783	P +/- 0.4657	P +/-0.1404

NOTES:

P = Burst Pressure, S = Seal Strength, D = gap, and R = Correlation Coefficient

1.,2. Prediction Interval (PI) for Single Response, and Mean Response, respectively

Table 118. Seal Strength Model#1 Results– using data from flow index = 5 Rexam (1073B Tyvek/Polyester Poly Laminate) Pouches

Predicting	Average[3] (%) Error	Regression Coefficients	R R_{adj}	PI – Single Response[1] (lbs/in^2)	PI – Mean Response[2] (lbs/in^2)
S_{peak}/D	3.64	K = 0.32 p1 = 0.55 p2 = 0.77 p3 = - 0.21	0.9931 0.9894	(S/D)+/-0.2488	(S/D)+/-0.0750
$S_{average}/D$	2.56	K = 0.22 p1 = 0.84 p2 = 0.51 p3 = - 0.21	0.9955 0.9935	(S/D)+/-0.1099	(S/D)+/-0.0331

Table 119. Seal Strength Model#2 Results – using data from flow index = 5 Rexam (1073B Polyester/Polyester Poly Laminate) Pouches

Predicting	Average[3] (%) Error	Regression Coefficients	R R_{adj}	PI – Single Response[1] (lbs/in^2)	PI – Mean Response[2] (lbs/in^2)
S_{peak}/D	4.04	K = 0.79 p1 = 1.01 p2 = 4.03	0.9882 0.9849	(S/D)+/-0.3586	(S/D)+/-0.1081
$S_{average}/D$	3.78	K = 0.47 p1 = 1.06 p2 = 3.26	0.9914 0.9889	(S/D)+/-0.1873	(S/D)+/-0.0565

Table 120. Seal Strength Model#3 Results – using data from flow index = 5 Rexam (1073B Polyester/Polyester Poly Laminate) Pouches

Predicting	Average[3] (%) Error	Regression Coefficients	R R_{adj}	PI – Single Response[1] (lbs/in^2)	PI – Mean Response[2] (lbs/in^2)
S_{peak}/D	6.73	K = 0.61 p1 = 1.25 p2 = 0.47	0.9757 0.9685	(S/D)+/-0.4972	(S/D)+/-0.1499
$S_{average}/D$	5.91	K = 0.38 p1 = 1.26 p2 = 0.37	0.9826 0.9778	(S/D)+/-0.2654	(S/D)+/-0.0800

NOTES:

S = Seal Strength, D = gap, and R = Correlation Coefficient

1.,2. Prediction Interval (PI) for Single Response, and Mean Response, respectively

3., The percent error were calculated by multiplying the result by D and then comparing with the actual seal strength (S)

APPENDIX VIII

LOCATION OF FAILURE

VS

LOCATION OF MINIMUM SEAL STRENGTH

APPENDIX VIII CONTENTS:

A. BURST TEST Location of Failure for

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B. PEEL TEST Location of Minimum Seal Strength for

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Tables 121 to 123 have a summary of the location of failure for each of the package sizes and materials combinations that were burst tested. Tables 124 to 126 show the location at which the minimum peak and average peel strength values were found on each of the package sizes and materials combinations that were peel tested. The data for individual observations can be found in Appendix V. Refer to Figure 14, Chapter 4 for pouch locations.

BURST TEST:

Table 121. Location of Failure for Rexam's 1073B Tyvek/Polyester Poly Laminate
Burst Test at Flow = 1 and Plate Separation = 0.50"

Package Size	Number of Failures at Location A (out of 10)	Number of Failures at Location B (out of 10)	Number of Failures at Location D (out of 10)	Number of Failures at Location E (out of 10)
(3.25" X 7.25")	1	5	3	1
(5.25" X 9.125")	1	3	3	3
(7.25" X 11.125")	4	5	0	1
(9.25" X 14.125")	0	7	3	0
(11.25" X 15.25")	1	3	4	2

Burst Test at Flow = 5 and Plate Separation = 0.50"

Package Size	Number of Failures at Location A (out of 10)	Number of Failures at Location B (out of 10)	Number of Failures at Location D (out of 10)	Number of Failures at Location E (out of 10)
(3.25" X 7.25")	0	5	2	3
(5.25" X 9.125")	1	5	0	4
(7.25" X 11.125")	2	6	0	2
(9.25" X 14.125")	0	4	6	0
(11.25" X 15.25")	2	2	6	0

Burst Test at Flow = 9 and Plate Separation = 0.50"

Package Size	Number of Failures at Location A (out of 10)	Number of Failures at Location B (out of 10)	Number of Failures at Location D (out of 10)	Number of Failures at Location E (out of 10)
(3.25" X 7.25")	2	4	3	1
(5.25" X 9.125")	2	5	2	1
(7.25" X 11.125")	4	4	0	2
(9.25" X 14.125")	0	8	2	0
(11.25" X 15.25")	2	6	2	0

Table 121. Location of Failure for Rexam's 1073B Tyvek/Polyester Poly Laminate – Continuation

Burst Test at Flow = 1 and Plate Separation = 1.0"

Package Size	Number of Failures at Location A (out of 10)	Number of Failures at Location B (out of 10)	Number of Failures at Location D (out of 10)	Number of Failures at Location E (out of 10)
(3.25" X 7.25")	2	3	1	4
(5.25" X 9.125")	1	3	5	1
(7.25" X 11.125")	2	2	5	1
(9.25" X 14.125")	0	5	5	0
(11.25" X 15.25")	4	4	2	0

Burst Test at Flow = 5 and Plate Separation = 1.0"

Package Size	Number of Failures at Location A (out of 10)	Number of Failures at Location B (out of 10)	Number of Failures at Location D (out of 10)	Number of Failures at Location E (out of 10)
(3.25" X 7.25")	1	4	2	3
(5.25" X 9.125")	0	3	3	4
(7.25" X 11.125")	0	3	3	4
(9.25" X 14.125")	0	5	5	0
(11.25" X 15.25")	0	4	6	0

Burst Test at Flow = 9 and Plate Separation = 1.0"

Package Size	Number of Failures at Location A (out of 10)	Number of Failures at Location B (out of 10)	Number of Failures at Location D (out of 10)	Number of Failures at Location E (out of 10)
(3.25" X 7.25")	3	2	2	3
(5.25" X 9.125")	3	5	2	0
(7.25" X 11.125")	0	5	3	2
(9.25" X 14.125")	0	4	6	0
(11.25" X 15.25")	0	5	1	4

Table 122. Location of Failure for Tolas 1073B Tyvek/PET/PE Laminate

Burst Test at Flow = 1 and Plate Separation = 0.50"

Package Size	Number of Failures at Location A (out of 10)	Number of Failures at Location B (out of 10)	Number of Failures at Location D (out of 10)	Number of Failures at Location E (out of 10)
(3" x 11.375")	0	6	4	0
(10.625" x 15")	0	9	1	0

Burst Test at Flow = 5 and Plate Separation = 0.50"

Package Size	Number of Failures at Location A (out of 10)	Number of Failures at Location B (out of 10)	Number of Failures at Location D (out of 10)	Number of Failures at Location E (out of 10)
(3" x 11.375")	0	6	4	0
(10.625" x 15")	0	8	2	0

Burst Test at Flow = 9 and Plate Separation = 0.50"

Package Size	Number of Failures at Location A (out of 10)	Number of Failures at Location B (out of 10)	Number of Failures at Location D (out of 10)	Number of Failures at Location E (out of 10)
(3" x 11.375")	0	7	3	0
(10.625" x 15")	0	8	2	0

Burst Test at Flow = 1 and Plate Separation = 1.0"

Package Size	Number of Failures at Location A (out of 10)	Number of Failures at Location B (out of 10)	Number of Failures at Location D (out of 10)	Number of Failures at Location E (out of 10)
(3" x 11.375")	0	4	6	0
(10.625" x 15")	0	10	0	0

Burst Test at Flow = 5 and Plate Separation = 1.0"Se

Package Size	Number of Failures at Location A (out of 10)	Number of Failures at Location B (out of 10)	Number of Failures at Location D (out of 10)	Number of Failures at Location E (out of 10)
(3" x 11.375")	0	6	4	0
(10.625" x 15")	0	7	3	0

Burst Test at Flow = 9 and Plate Separation = 1.0"

Package Size	Number of Failures at Location A (out of 10)	Number of Failures at Location B (out of 10)	Number of Failures at Location D (out of 10)	Number of Failures at Location E (out of 10)
(3" x 11.375")	0	7	3	0
(10.625" x 15")	0	8	2	0

Table 123. Location of Failure for Rexam's 1059B Tyvek/Polyester Poly Laminate

Burst Test at Flow = 1 and Plate Separation = 0.50"

Package Size	Number of Failures at Location A (out of 10)	Number of Failures at Location B (out of 10)	Number of Failures at Location D (out of 10)	Number of Failures at Location E (out of 10)
(5.75" x 9.125")	5	3	0	2
(9.25" x 14.125")	3	6	1	0

Burst Test at Flow = 5 and Plate Separation = 0.50"

Package Size	Number of Failures at Location A (out of 10)	Number of Failures at Location B (out of 10)	Number of Failures at Location D (out of 10)	Number of Failures at Location E (out of 10)
(5.75" x 9.125")	4	4	0	2
(9.25" x 14.125")	2	6	1	1

Burst Test at Flow = 9 and Plate Separation = 0.50"

Package Size	Number of Failures at Location A (out of 10)	Number of Failures at Location B (out of 10)	Number of Failures at Location D (out of 10)	Number of Failures at Location E (out of 10)
(5.75" x 9.125")	1	2	0	7
(9.25" x 14.125")	1	6	2	1

Burst Test at Flow = 1 and Plate Separation = 1.0"

Package Size	Number of Failures at Location A (out of 10)	Number of Failures at Location B (out of 10)	Number of Failures at Location D (out of 10)	Number of Failures at Location E (out of 10)
(5.75" x 9.125")	1	3	1	5
(9.25" x 14.125")	5	3	0	2

Burst Test at Flow = 5 and Plate Separation = 1.0"Se

Package Size	Number of Failures at Location A (out of 10)	Number of Failures at Location B (out of 10)	Number of Failures at Location D (out of 10)	Number of Failures at Location E (out of 10)
(5.75" x 9.125")	5	2	0	3
(9.25" x 14.125")	5	0	1	4

Burst Test at Flow = 9 and Plate Separation = 1.0"

Package Size	Number of Failures at Location A (out of 10)	Number of Failures at Location B (out of 10)	Number of Failures at Location D (out of 10)	Number of Failures at Location E (out of 10)
(5.75" x 9.125")	4	1	0	5
(9.25" x 14.125")	5	1	0	4

PEEL TEST:

Table 124. Location of Minimum Seal Strength for Rexam 1073B Tyvek/Polyester Poly Laminate

Peel Test at Crosshead Speed = 10 ipm and Grip Separation = 1.0"

	Number of Minimum at Location A (out of 10)		Number of Minimum at Location B (out of 10)		Number of Minimum at Location D (out of 10)		Number of Minimum at Location E (out of 10)	
Package Size	Peak	Avg	Peak	Avg	Peak	Avg	Peak	Avg
(3.25" X 7.25")	1	0	3	3	2	4	4	3
(5.25" X 9.125")	4	6	0	0	2	0	4	4
(7.25" X 11.125")	5	5	2	2	0	0	3	3
(9.25" X 14.125")	2	1	1	1	4	3	3	5
(11.25" X 15.25")	0	3	5	1	2	2	3	4

Peel Test at Crosshead Speed = 12 ipm and Grip Separation = 1.0"

	Number of Minimum at Location A (out of 10)		Number of Minimum at Location B (out of 10)		Number of Minimum at Location D (out of 10)		Number of Minimum at Location E (out of 10)	
Package Size	Peak	Avg	Peak	Avg	Peak	Avg	Peak	Avg
(3.25" X 7.25")	0	0	5	6	3	2	2	2
(5.25" X 9.125")	6	8	2	1	1	1	1	0
(7.25" X 11.125")	7	6	1	1	1	1	1	2
(9.25" X 14.125")	1	3	3	2	3	2	3	3
(11.25" X 15.25")	3	4	1	0	3	2	3	4

Table 124. Location of Minimum Seal Strength for Rexam 1073B Tyvek/Polyester Poly Laminate – Continuation

Peel Test at Crosshead Speed = 10 ipm and Grip Separation = 2.0"

	Number of Minimum at Location A (out of 10)		Number of Minimum at Location B (out of 10)		Number of Minimum at Location D (out of 10)		Number of Minimum at Location E (out of 10)	
Package Size	Peak	Avg	Peak	Avg	Peak	Avg	Peak	Avg
(3.25" X 7.25")	1	1	3	3	3	5	3	1
(5.25" X 9.125")	3	3	0	0	5	5	2	2
(7.25" X 11.125")	4	6	2	1	1	1	3	2
(9.25" X 14.125")	2	3	1	2	4	2	3	3
(11.25" X 15.25")	2	4	3	2	3	2	2	2

Peel Test at Crosshead Speed = 12 ipm and Grip Separation = 2.0"

	Number of Minimum at Location A (out of 10)		Number of Minimum at Location B (out of 10)		Number of Minimum at Location D (out of 10)		Number of Minimum at Location E (out of 10)	
Package Size	Peak	Avg	Peak	Avg	Peak	Avg	Peak	Avg
(3.25" X 7.25")	3	2	3	3	2	3	2	2
(5.25" X 9.125")	5	5	1	1	3	3	1	1
(7.25" X 11.125")	4	4	2	1	1	2	3	3
(9.25" X 14.125")	1	1	2	1	2	2	5	6
(11.25" X 15.25")	3	2	2	3	1	1	4	4

Table 125. Location of Minimum Seal Strength for Tolas 1073B Tyvek/PET/PE Laminate

Peel Test at Crosshead Speed = 10 ipm and Grip Separation = 1.0"

	Number of Minimum at Location A (out of 10)		Number of Minimum at Location B (out of 10)		Number of Minimum at Location D (out of 10)		Number of Minimum at Location E (out of 10)	
Package Size	Peak	Avg	Peak	Avg	Peak	Avg	Peak	Avg
(3" x 11.375")	0	0	2	5	5	3	3	2
(10.625" x 15")	2	4	3	2	2	1	3	3

Peel Test at Crosshead Speed = 12 ipm and Grip Separation = 1.0"

	Number of Minimum at Location A (out of 10)		Number of Minimum at Location B (out of 10)		Number of Minimum at Location D (out of 10)		Number of Minimum at Location E (out of 10)	
Package Size	Peak	Avg	Peak	Avg	Peak	Avg	Peak	Avg
(3" x 11.375")	1	1	5	5	2	3	2	1
(10.625" x 15")	2	2	3	2	2	4	3	2

Peel Test at Crosshead Speed = 10 ipm and Grip Separation = 2.0"

	Number of Minimum at Location A (out of 10)		Number of Minimum at Location B (out of 10)		Number of Minimum at Location D (out of 10)		Number of Minimum at Location E (out of 10)	
Package Size	Peak	Avg	Peak	Avg	Peak	Avg	Peak	Avg
(3" x 11.375")	2	3	2	3	3	2	3	2
(10.625" x 15")	0	0	4	5	5	4	1	1

Peel Test at Crosshead Speed = 12 ipm and Grip Separation = 2.0"

	Number of Minimum at Location A (out of 10)		Number of Minimum at Location B (out of 10)		Number of Minimum at Location D (out of 10)		Number of Minimum at Location E (out of 10)	
Package Size	Peak	Avg	Peak	Avg	Peak	Avg	Peak	Avg
(3" x 11.375")	0	0	3	2	5	5	2	3
(10.625" x 15")	2	3	6	3	2	2	0	2

Table 126. Location of Minimum Seal Strength for Rexam 1059B Tyvek/Polyester Poly Laminate

Peel Test at Crosshead Speed = 10 ipm and Grip Separation = 1.0"

	Number of Minimum at Location A (out of 10)		Number of Minimum at Location B (out of 10)		Number of Minimum at Location D (out of 10)		Number of Minimum at Location E (out of 10)	
Package Size	Peak	Avg	Peak	Avg	Peak	Avg	Peak	Avg
(5.75" x 9.125")	4	3	2	1	2	3	2	3
(9.25" x 14.125")	3	3	2	2	2	0	3	5

Peel Test at Crosshead Speed = 12 ipm and Grip Separation = 1.0"

	Number of Minimum at Location A (out of 10)		Number of Minimum at Location B (out of 10)		Number of Minimum at Location D (out of 10)		Number of Minimum at Location E (out of 10)	
Package Size	Peak	Avg	Peak	Avg	Peak	Avg	Peak	Avg
(5.75" x 9.125")	3	4	2	1	2	2	3	3
(9.25" x 14.125")	4	4	3	3	2	0	1	3

Peel Test at Crosshead Speed = 10 ipm and Grip Separation = 2.0"

	Number of Minimum at Location A (out of 10)		Number of Minimum at Location B (out of 10)		Number of Minimum at Location D (out of 10)		Number of Minimum at Location E (out of 10)	
Package Size	Peak	Avg	Peak	Avg	Peak	Avg	Peak	Avg
(5.75" x 9.125")	2	2	3	3	3	3	2	2
(9.25" x 14.125")	2	3	3	3	2	2	3	2

Peel Test at Crosshead Speed = 12 ipm and Grip Separation = 2.0"

	Number of Minimum at Location A (out of 10)		Number of Minimum at Location B (out of 10)		Number of Minimum at Location D (out of 10)		Number of Minimum at Location E (out of 10)	
Package Size	Peak	Avg	Peak	Avg	Peak	Avg	Peak	Avg
(5.75" x 9.125")	0	1	5	4	3	3	2	2
(9.25" x 14.125")	0	1	5	4	1	1	4	3

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