# APPENDIX C

# COMPATIBILITY TEST RESULTS

JLT LABORATORIES, INC.
GEOTECHNICAL, GEOSYNTHETIC AND MATERIALS TESTING AND RESEARCH

June 29, 2009
09LR1826.01

JUL 06 2009
SYRACUSE

Parsons
290 Elwood Davis Road
Suite 312
Liverpool, NY 13088

Attn: David Steele

**RE: COMPATIBILITY TEST RESULTS**
**GEOMEMBRANE SAMPLES WITH SOLVAY WASTE**
**HONEYWELL PROJECT**
**PO NO. 444853.00001.00**

Dear Mr. Steele:

Submitted herein is our report of 120 day compatibility testing performed on four (4) types of geomembrane identified as follows:

| | |
|---|---|
| 40 mil Smooth HDPE | Supplier: GSE |
| 40 mil Smooth LLDPE | Supplier: GSE |
| 40 mil Polypropylene | Supplier: Not Provided |
| 40 mil EPDM | Supplier: Not Provided |

Coupons of the materials were cut and tested for baseline properties as described herein. The remaining coupons were submerged in separate tanks containing Solvay waste. One set of sealed tanks were encased in a Styrofoam housing and maintained at 23 ± 1°C. The other set of tanks were placed on steel shelving, encased in Styrofoam walls and maintained at 50 ± 1°C.

After 30, 60, 90 and 120 days of continuous submergence in the Solvay waste, coupons were removed and tested for the following properties:

938 South Central Avenue • Canonsburg, Pennsylvania 15317 Tel: (724) 746-4441 Fax: (724) 745-4261

Dimensional Properties

The Width, Length, Thickness and Weight of the coupons were tested before exposure for baseline testing. They were then submerged in the tanks at 23°C and 50°C. At 30, 60, 90 and 120 days the coupons were removed, cleaned and retested for the same properties.

Puncture (ASTM D-4833)

Virgin material of each geomembrane type were tested for Puncture to develop baseline properties. At 30, 60, 90 and 120 days, coupons were removed from each tank and tested for Puncture.

Density (ASTM D-1505)

Virgin material of each geomembrane type were tested for Density to develop baseline properties. At 30, 60, 90 and 120 days, coupons were removed from each tank and tested for Density.

Hardness (ASTM D-2240)

Virgin material of each geomembrane type were tested for Hardness to develop baseline properties. At 30, 60, 90 and 120 days, coupons were removed from each tank and tested for Hardness.

2% Secant Modulus (ASTM D-5323)

Virgin material of each geomembrane type were tested for Modulus to develop baseline properties. At 30, 60, 90 and 120 days, coupons were removed from each tank and tested for Modulus.

Tear Resistance (ASTM D-1004)

Virgin material of each geomembrane type were tested for Tear Resistance to develop baseline properties. At 30, 60, 90 and 120 days, coupons were removed from each tank and tested for Tear Resistance.

Volatiles (EPA-SW870)

Virgin material of each geomembrane type were tested for Volatiles to develop baseline properties. At 30, 60, 90 and 120 days, coupons were removed from each tank and tested for Volatiles.

Extractables (EPA-SW870)

Virgin material of each geomembrane type were tested for Extractables to develop baseline properties. At 30, 60, 90 and 120 days, coupons were removed from each tank and tested for Extractables.

Tensile Properties (ASTM D-669)

Virgin material of each geomembrane type were tested for Tensile Properties to develop baseline properties. At 30, 60, 90 and 120 days, coupons were removed from each tank and tested for Tensile Properties.

Test Results

The average value for each baseline test was computed and used as a reference for the subsequent immersion tests. As each test was performed after the 30, 60, 90 and 120 day immersion periods, the average result was computed. This value was compared to the average baseline value and the percent change computed as shown on the attached data sheets. The data was plotted as percent change vs immersion period at 23$^{O}$C and 50$^{O}$C as shown on the tables.

Testing Comments

It is noted the specified tests for this work were based on ASTM D-5747 criteria for HDPE geomembranes. Thus, many of the tests do not apply to LLDPE, Polypropylene and EPDM. However, for comparison purposes, it was decided to run the same tests regardless of the material types as a common baseline.

Summary of HDPE Results

**HDPE Dimensional Properties**
The values varied only slightly with less then 1% difference over the 120 day period. Thus, Solvay waste had little effect on these properties.

**HDPE Puncture**
The results varied with less then 10% decrease in strength over the 120 day period. This is well within the statistical variability of the material itself.

**HDPE Density**
The variation in Density was less then 1% over 120 days indicating the Solvay waste has little effect on the density.

**HDPE Hardness**
The Hardness decreased by 2.78% at 23$^{O}$C and 8.33% at 50$^{O}$C. With immersion, the material tends to soften slightly with greater softening at higher temperatures. However, this softening was quite minimal.

**HDPE 2% Secant Modulus**
At 23°C the Modulus decreased by 22.41% and 11.38% at 50°C. This is as expected. A softening of the material always decreases the Modulus value.

**HDPE Tear Resistance**
Tear strength decreased by 10.5% at 23°C and 8.0% at 50°C. These values are well within the statistical variation of the material itself.

**HDPE Volatiles**
For these tests, Volatiles varied the most. However, Volatiles evaporate very quickly. Once a sample is removed from the tank, volatiles begin to evaporate. The variation can easily be accounted to the time between the sample was extracted, washed and weighed for the test. These tests are not valid for evaluation unless other tests correlate with these results.

**HDPE Extractables**
At 23°C, the Extractables gradually increased over time with a maximum of 19.1% increase. Similarly, at 50°C the Extractables increased through 60 days but decreased at 90 and 120 days. It is difficult to explain this decrease but it does not appear to have an effect on the engineering properties of strength.

**HDPE Tensile Properties**
Although the properties varied vs exposure time, the statistical variations were well within the statistical variations of the material's virgin properties. The plots show no significant and consistent decrease with exposure time vs temperature to indicate degradation of the material.

Summary of LLDPE Results

**LLDPE Dimensional Properties**
The Length, Width, Thickness and Weight all varied by less then 1% indicating that swelling and absorption was very minimal.

**LLDPE Puncture**
Puncture strength did decrease by 15.7% at 23°C and 12.81% at 50°C indicating a slight and expected softening of the geomembrane.

**LLDPE Density**
The Density change was minimal (<1%) indicating a very slight swelling of the geomembrane.

**LLDPE Hardness**
Hardness increased somewhat. However, this test method is not applicable to LLDPE.

**LLDPE 2% Secant Modulus**
This value decreased by 23.00% at 23°C and 27.18% at 50°C. Although this test is not applicable to a LLDPE membrane, the results suggests a softening of the material.

**LLDPE Tear Resistance**
Tear strength varied by +2.94% at 23°C and 12.5% at 50°C. This variation is well within the statistical variation of the material itself.

**LLDPE Volatiles**
Volatiles increased significantly indicating the LLDPE absorbed the Volatile components in the Solvay waste. However a relationship between Volatiles and engineering properties is not evident.

**LLDPE Extractables**
This value also varied increasing at 23°C and decreasing at 50°C. Again these changes do not correlate well with any engineering properties.

**LLDPE Tensile Properties**
Yield stress and yield strain are not applicable to LLDPE. With respect to the Peak Stress and Peak Strain, the change was less then 8% over 120 days and well within the statistical variation of the material itself.

Summary of Polypropylene Results

**Polypropylene Dimensional Properties**
Length, Width, Thickness and Weight changes exhibition less then 2% change over the 120 days immersion period. This data does not suggest any significant degradation of the material.

**Polypropylene Puncture**
Over 120 days, Puncture strength decreased by 13.97% at 23°C and 21.89% at 50°C.

**Polypropylene Density**
The Density change was on the order of 0.5% which was insignificant at both 23°C and 50°C.

**Polypropylene Hardness**
Since Hardness does not apply to Polypropylene, no meaningful conclusions can be made.

**Polypropylene 2% Secant Modulus**
This test does not apply to Polypropylene. However, using the graphical procedure of the Standard indicated a 61% decrease after 120 days at 23°C and 50°C.

**Polypropylene Tear Resistance**
At 23$^{O}$C the Tear strength decreased by 13% after 120 days and 21.95% after 120 days at 50$^{O}$C. This suggests a softening of the material.

**Polypropylene Volatiles**
At both 23$^{O}$C and 50$^{O}$C after 120 days, the Polypropylene significantly absorbs Volatiles from the Solvay waste.

**Polypropylene Extractables**
Conversely after 120 days, the Polypropylene exhibited a significant decrease in Extractables.

**Polypropylene Tensile Properties**
Similar to LLDPE, yield stress and yield strain are not applicable to Polypropylene. Peak values did not change significantly and were well within the statistical variations of the material itself.

Summary of EPDM Results

**EPDM Dimensional Properties**
Length, Width, Thickness and Weight changes were all less then 2% after 120 days. These values are insignificant.

**EPDM Puncture**
After 120 days of exposure, the average values decreased by 18.66% at 23$^{O}$C and 14.71 at 50$^{O}$C. These values are not that significant in that the values can vary by +20% on virgin materials.

**EPDM Density**
At both 23$^{O}$C and 50$^{O}$C, the Density decreased by less then 1% which is insignificant but does suggest some slight absorption of liquid.

**EPDM Hardness**
The Hardness values decreased due to softening and corresponds with the decrease in Density.

**EPDM 2% Secant Modulus**
Although this test does not apply to EPDM, we used graphical procedure of the Standard. The data indicates a 40 ± % loss over 120 days. This suggests a softening of the material similar to Puncture.

**EPDM Tear Resistance**
Tear strength varied by +12.5% at 23$^{O}$C and +4.17% at 50$^{O}$C after 120 days of exposure. These values are within the statistical variation of the material itself.

**EPDM Volatiles**
After 120 days of exposure, Volatiles increased by 130% at 23$^{O}$C and 216% at 50$^{O}$C. This suggests the EPDM did absorb Volatiles from the Solvay waste.

**EPDM Extractables**
Similar to Volatiles, the Extractables also increased by about 60 ± % at 23$^{O}$C and 50$^{O}$C. This indicates the EPDM does absorb liquids from the Solvay waste.

**EPDM Tensile Properties**
Since yield stress and yield strain does not apply to EPDM, these results were not evaluated. Peak Stress after 120 days of exposure increase by about 15+% with a slight decrease in Peak Strain. This suggests a stiffening of the material which increases Strength but decreases Strain. However, these values are still within the statistical variation of the material itself.

Summary

All four (4) geomembrane types performed well. The HDPE and LLDPE geomembrane performed the best considering all of the properties were relatively consistent. With respect to the Polypropylene and EPDM, they both absorbed the most extractables and volatiles with more strength variations then the HDPE and LLDPE due to the absorption and softening of the materials.

We appreciate the opportunity to provide our services and look forward to working with you again. Should you have any questions, comments or require additional information, please do not hesitate to call. Thank you.

Sincerely,

**JLT LABORATORIES, INC.**

John Boschuk, Jr., P.E.
President

cc: Martin A. Switzer

Enclosures
JB/mlb
\wp10\letter\09121
Inv# 3827

# Summary of Test Results

*PROPERTY CHANGE (ASTM D-5747)*

| | | | |
|---|---|---|---|
| Client: | Parsons | Job No.: | 09LR1826.01 |
| Project: | Honeywell | Date: | 05/15/2009 |
| Material: | GSE 40 mil Smooth | Tested By: | RL/AM/MLB |
| Sample ID: | 101130132 - HDPE | Checked By: | JB |

23° Celcius

| TEST | Baseline | 30-Day Immersion | | 60-Day Immersion | | 90-Day Immersion | | 120-Day Immersion | |
|---|---|---|---|---|---|---|---|---|---|
| READING | Average | Average | % Change | Average | % Change | Average | % Change | Average | % Change |
| Weight, gr | 9.5917 | 9.5931 | 0.01 | 9.61 | 0.20 | 9.62 | 0.25 | 9.60 | 0.09 |
| Length, in | 5.5443 | 5.6135 | 1.25 | 5.56 | 0.22 | 5.54 | -0.14 | 5.54 | -0.02 |
| Width, in | 2.6255 | 2.6153 | -0.39 | 2.62 | -0.34 | 2.61 | -0.61 | 2.61 | -0.49 |
| Thickness, mils | 41 | 41 | 0.00 | 41.33 | 0.00 | 41.33 | 0.00 | 41.33 | 0.00 |

50° Celcius

| TEST | Baseline | 30-Day Immersion | | 60-Day Immersion | | 90-Day Immersion | | 120-Day Immersion | |
|---|---|---|---|---|---|---|---|---|---|
| READING | Average | Average | % Change | Average | % Change | Average | % Change | Average | % Change |
| Weight, gr | 9.1289 | 9.1593 | 0.33 | 9.18 | 0.52 | 9.17 | 0.49 | 9.15 | 0.24 |
| Length, in | 5.2642 | 5.2664 | 0.04 | 5.26 | -0.05 | 5.26 | -0.01 | 5.28 | 0.22 |
| Width, in | 2.7485 | 2.7465 | -0.07 | 2.75 | 0.00 | 2.76 | 0.24 | 2.75 | 0.13 |
| Thickness, mils | 41 | 41 | 0.00 | 41.00 | 0.00 | 41.00 | 0.00 | 41.00 | 0.00 |

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# Property Change

ASTM D-5747, paragraphs 11.1 & 11.2

| | | | |
|---|---|---|---|
| Client: | Parsons | Job No.: | 09LR1826.01 |
| Project: | Honeywell | Date: | 05/15/2009 |
| Material: | GSE 40 mil Smooth | Tested By: | RL/AM/MLB |
| Sample ID: | 101130132 - HDPE<br>120 Day Testing | Checked By: | JB |

| | PROPERTY ID | UNIT | REPLICATE 1 | REPLICATE 2 | REPLICATE 3 | AVERAGE | STANDARD DEVIATION |
|---|---|---|---|---|---|---|---|
| 23° C | Weight | grams | 9.0441 | 9.8676 | 9.8882 | 9.6000 | 0.3931 |
| | Length | in | 5.5875 | 5.5690 | 5.4725 | 5.5430 | 0.0504 |
| | Width | in | 2.4030 | 2.6915 | 2.7435 | 2.6127 | 0.1498 |
| | Thickness | mils | 42 | 40 | 42 | 41.3 | 0.9428 |

| | PROPERTY ID | UNIT | REPLICATE 1 | REPLICATE 2 | REPLICATE 3 | AVERAGE | STANDARD DEVIATION |
|---|---|---|---|---|---|---|---|
| 50° C | Weight | grams | 8.7853 | 9.4372 | 9.2310 | 9.1512 | 0.2721 |
| | Length | in | 5.1890 | 5.3900 | 5.2475 | 5.2755 | 0.0844 |
| | Width | in | 2.6835 | 2.7645 | 2.8080 | 2.7520 | 0.0516 |
| | Thickness | mils | 41 | 41 | 41 | 41.0 | 0.0000 |

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# Summary of Test Results
## *HDPE - 23° Celcius*

| | | | |
|---|---|---|---|
| Client: | Parsons | Job No.: | 09LR1826.01 |
| Project: | Honeywell | Date: | 05/15/2009 |
| Material: | GSE 40 mil Smooth | Tested By: | RL/AM/MLB |
| Sample ID: | 101130132 - HDPE | Checked By: | JB |

| TEST | Baseline | 30-Day Immersion | | 60-Day Immersion | | 90-Day Immersion | | 120-Day Immersion | |
|---|---|---|---|---|---|---|---|---|---|
| READING | Average | Average | % Change | Average | % Change | Average | % Change | Average | % Change |
| Puncture | 108.4 | 102.5 | -5.44 | 103.8 | -4.28 | 103.1 | -4.89 | 98.5 | -9.17 |
| Density | 0.931 | 0.932 | 0.07 | 0.944 | 1.36 | 0.943 | 1.22 | 0.940 | 0.89 |
| Hardness | 12 | 12 | 0.00 | 11 | -5.56 | 11 | -8.33 | 12 | -2.78 |
| 2% Modulus | 49750 | 50600 | 1.71 | 36800 | -26.03 | 39768 | -20.06 | 38602 | -22.41 |
| Tear | 40.0 | 38.2 | -4.50 | 35.6 | -11.00 | 36.6 | -8.50 | 35.8 | -10.50 |
| Volatiles | 0.6637 | 0.6943 | 4.61 | 0.6221 | -6.27 | 0.7194 | 8.38 | 0.4710 | -29.04 |
| Extractables | 0.3410 | 0.3746 | 9.85 | 0.3803 | 11.52 | 0.3963 | 16.21 | 0.4061 | 19.10 |

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# Geomembrane Conformance Test Results

*HDPE - 23° Celcius*

JLT

| | | | |
|---|---|---|---|
| Client: | Parsons | Job No.: | 09LR1826.01 |
| Project: | Honeywell | Date: | 05/15/2009 |
| Material: | GSE 40 mil Smooth | Tested By: | RL/AM/MLB |
| Sample ID: | 101130132 - HDPE<br>120 Day Testing | Checked By: | JB |

| PARAMETER | UNITS | REPLICATE No. | | | | | AVERAGE | STANDARD DEVIATION |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | | |
| Puncture Resistance | lbs | 102.8 | 97.0 | 97.6 | 97.6 | 97.3 | 98.5 | 2.1814 |
| Density | gr/cucm | 0.94 | 0.94 | 0.94 | | | 0.94 | 0.0005 |
| Hardness | | 11 | 12 | 12 | | | 12 | 0.4714 |
| 2% Secant Modulus | psi | 38500 | 37850 | 38640 | 39140 | 38880 | 38602 | 434.5 |
| Tear ( MD Only) | lbs | 37 | 35 | 32 | 38 | 37 | 35.8 | 2.1354 |
| Volatiles | % | 0.4372 | 0.5048 | | | | 0.4710 | 0.0338 |
| Extractables | % | 0.3997 | 0.4125 | | | | 0.4061 | 0.0064 |

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# Summary of Test Results
## *HDPE - 50° Celcius*

| | | | |
|---|---|---|---|
| Client: | Parsons | Job No.: | 09LR1826.01 |
| Project: | Honeywell | Date: | 05/15/2009 |
| Material: | GSE 40 mil Smooth | Tested By: | RL/AM/MLB |
| Sample ID: | 101130132 - HDPE | Checked By: | JB |

| TEST | Baseline | 30-Day Immersion | | 60-Day Immersion | | 90-Day Immersion | | 120-Day Immersion | |
|---|---|---|---|---|---|---|---|---|---|
| READING | Average | Average | % Change | Average | % Change | Average | % Change | Average | % Change |
| Puncture | 108.4 | 106.5 | -1.73 | 111.4 | 2.73 | 108.1 | -0.24 | 104.1 | -4.00 |
| Density | 0.931 | 0.944 | 1.32 | 0.945 | 1.43 | 0.942 | 1.11 | 0.939 | 0.86 |
| Hardness | 12 | 12 | 0.00 | 11 | -5.56 | 11 | -5.56 | 11 | -8.33 |
| 2% Modulus | 49750 | 51500 | 3.52 | 45700 | -8.14 | 44582 | -10.39 | 44088 | -11.38 |
| Tear | 40.0 | 36.6 | -8.50 | 38.0 | -5.00 | 37.0 | -7.50 | 36.8 | -8.00 |
| Volatiles | 0.6637 | 0.8376 | 26.20 | 0.8614 | 29.78 | 0.9374 | 41.23 | 0.9218 | 38.88 |
| Extractables | 0.3410 | 0.5713 | 67.55 | 0.7804 | 128.88 | 0.3568 | 4.64 | 0.3466 | 1.65 |

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# Geomembrane Conformance Test Results

## *HDPE - 50° Celcius*

| | | | |
|---|---|---|---|
| Client: | Parsons | Job No.: | 09LR1826.01 |
| Project: | Honeywell | Date: | 05/15/2009 |
| Material: | GSE 40 mil Smooth | Tested By: | RL/AM/MLB |
| Sample ID: | 101130132 - HDPE | Checked By: | JB |
| | 120 Day Testing | | |

| PARAMETER | UNITS | REPLICATE No. | | | | | AVERAGE | STANDARD DEVIATION |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | | |
| Puncture Resistance | lbs | 103.7 | 104.5 | 105.3 | 106.6 | 100.2 | 104.1 | 2.1546 |
| Density | gr/cucm | 0.94 | 0.94 | 0.94 | | | 0.94 | 0.0005 |
| Hardness | | 11 | 12 | 10 | | | 11 | 0.8165 |
| 2% Secant Modulus | psi | 43670 | 43260 | 44120 | 45100 | 44290 | 44088 | 620.7 |
| Tear ( MD Only) | lbs | 39 | 39 | 35 | 35 | 36 | 36.8 | 1.8330 |
| Volatiles | % | 0.9321 | 0.9114 | | | | 0.9218 | 0.0103 |
| Extractables | % | 0.2355 | 0.4577 | | | | 0.3466 | 0.1111 |

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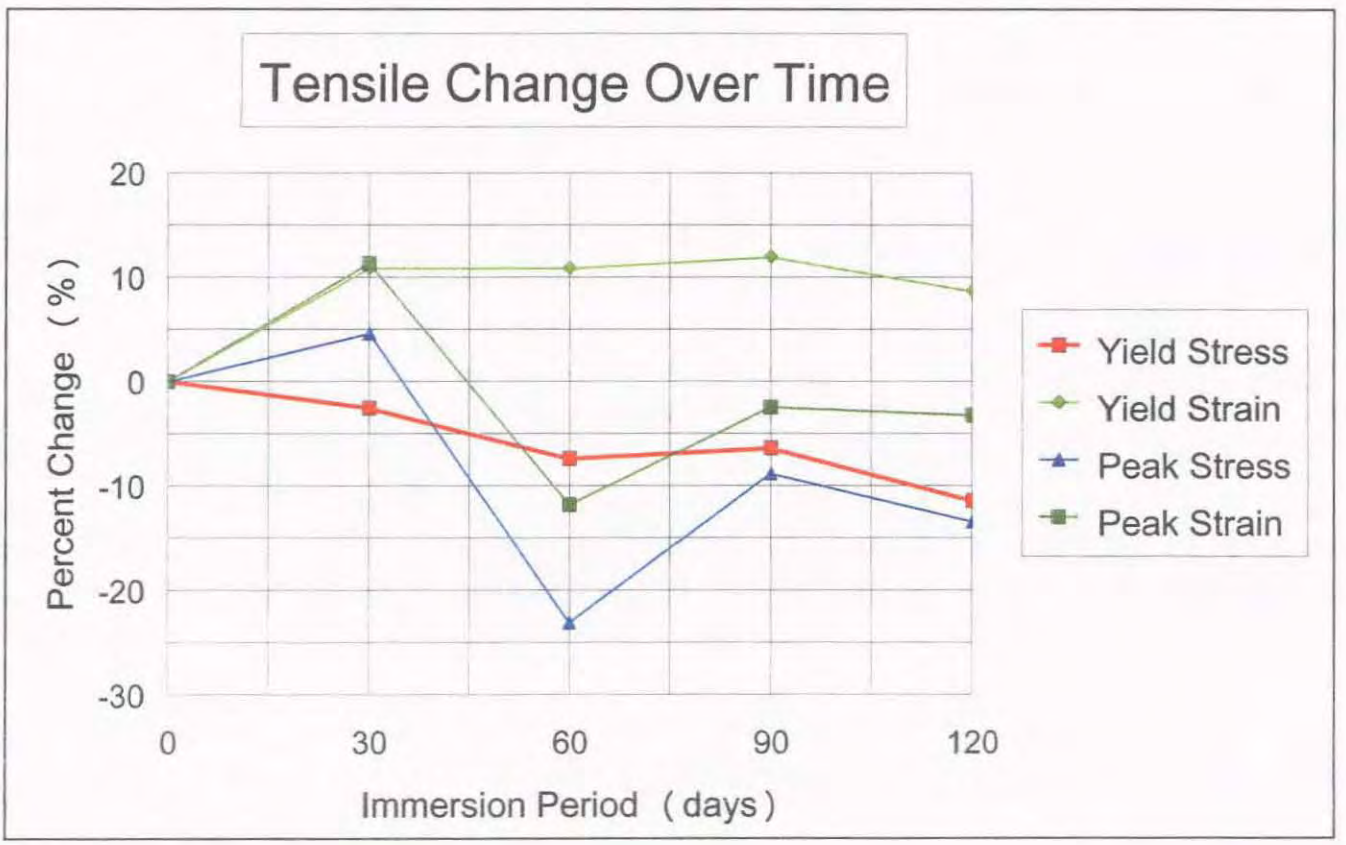
# Summary of Test Results
## *HDPE - 23° Celcius*

| | | | |
|---|---|---|---|
| **Client:** | Parsons | **Job No.:** | 09LR1826.01 |
| **Project:** | Honeywell | **Date:** | 05/15/2009 |
| **Material:** | GSE 40 mil Smooth | **Tested By:** | RL/AM/MLB |
| **Sample ID:** | 101130132 - HDPE | **Checked By:** | JB |

| TEST | Baseline | 30-Day Immersion | | 60-Day Immersion | | 90-Day Immersion | | 120-Day Immersion | |
|---|---|---|---|---|---|---|---|---|---|
| READING | Average | Average | % Change | Average | % Change | Average | % Change | Average | % Change |
| Yield Stress | 103.2 | 100.6 | -2.52 | 95.6 | -7.36 | 96.6 | -6.40 | 91.4 | -11.43 |
| Yield Strain | 18.4 | 20.4 | 10.87 | 20.4 | 10.87 | 20.6 | 11.96 | 20.0 | 8.70 |
| Peak Stress | 190.4 | 199.2 | 4.62 | 146.4 | -23.11 | 173.6 | -8.82 | 164.8 | -13.45 |
| Peak Strain | 532.2 | 592.6 | 11.35 | 469.2 | -11.84 | 519.0 | -2.48 | 515.0 | -3.23 |

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# Tensile Test Results

## *HDPE - 23° Celcius*

JLT

| | | | |
|---|---|---|---|
| **Client:** | Parsons | **Job No.:** | 09LR1826.01 |
| **Project:** | Honeywell | **Date:** | 02/15/2009 |
| **Material:** | GSE 40 mil Smooth | **Tested By:** | RL/AM/MLB |
| **Sample ID:** | 101130132 - HDPE<br>**Baseline Testing** | **Checked By:** | JB |

| PARAMETER | UNITS | REPLICATE No. | | | | | AVERAGE | STANDARD DEVIATION |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | | |
| Yield Stress | lb/in | 102 | 102 | 105 | 103 | 104 | 103.2 | 1.17 |
| Yield Strain | % | 18 | 18 | 19 | 19 | 18 | 18.4 | 0.49 |
| Peak Stress | lb/in | 168 | 220 | 176 | 192 | 196 | 190.4 | 22.86 |
| Peak Strain | % | 184 | 683 | 557 | 613 | 624 | 532.2 | 178.64 |

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# Tensile Test Results

*HDPE - 23° Celcius*

JLT

| | | | |
|---|---|---|---|
| **Client:** | Parsons | **Job No.:** | 09LR1826.01 |
| **Project:** | Honeywell | **Date:** | 02/15/2009 |
| **Material:** | GSE 40 mil Smooth | **Tested By:** | RL/AM/MLB |
| **Sample ID:** | 101130132 - HDPE<br>**30 Day Testing** | **Checked By:** | JB |

| PARAMETER | UNITS | REPLICATE No. | | | | | AVERAGE | STANDARD DEVIATION |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | | |
| Yield Stress | lb/in | 99 | 102 | 100 | 98 | 104 | 100.6 | 2.15 |
| Yield Strain | % | 21 | 19 | 21 | 19 | 22 | 20.4 | 1.20 |
| Peak Stress | lb/in | 164 | 220 | 216 | 204 | 192 | 199.2 | 25.51 |
| Peak Strain | % | 506 | 641 | 642 | 615 | 559 | 592.6 | 52.75 |

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# Tensile Test Results

*HDPE - 23° Celcius*

JLT

| | | | |
|---|---|---|---|
| **Client:** | Parsons | **Job No.:** | 09LR1826.01 |
| **Project:** | Honeywell | **Date:** | 03/15/2009 |
| **Material:** | GSE 40 mil Smooth | **Tested By:** | RL/AM/MLB |
| **Sample ID:** | 101130132 - HDPE<br>**60 Day Testing** | **Checked By:** | JB |

| PARAMETER | UNITS | REPLICATE No. | | | | | AVERAGE | STANDARD DEVIATION |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | | |
| Yield Stress | lb/in | 99 | 94 | 96 | 98 | 91 | 95.6 | 2.87 |
| Yield Strain | % | 22 | 22 | 19 | 19 | 20 | 20.4 | 1.36 |
| Peak Stress | lb/in | 220 | 140 | 96 | 136 | 140 | 146.4 | 51.33 |
| Peak Strain | % | 598 | 445 | 450 | 403 | 450 | 469.2 | 66.78 |

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# Tensile Test Results

## *HDPE - 23° Celcius*

| | | | |
|---|---|---|---|
| **Client:** | Parsons | **Job No.:** | 09LR1826.01 |
| **Project:** | Honeywell | **Date:** | 04/15/2009 |
| **Material:** | GSE 40 mil Smooth | **Tested By:** | RL/AM/MLB |
| **Sample ID:** | 101130132 - HDPE<br>**90 Day Testing** | **Checked By:** | JB |

| PARAMETER | UNITS | REPLICATE No. | | | | | AVERAGE | STANDARD DEVIATION |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | | |
| Yield Stress | lb/in | 100 | 95 | 98 | 93 | 97 | 96.6 | 2.42 |
| Yield Strain | % | 20 | 21 | 21 | 21 | 20 | 20.6 | 0.49 |
| Peak Stress | lb/in | 192 | 144 | 164 | 184 | 184 | 173.6 | 19.69 |
| Peak Strain | % | 568 | 441 | 491 | 535 | 560 | 519.0 | 47.34 |

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# Tensile Test Results

## *HDPE - 23° Celcius*

| | | | |
|---|---|---|---|
| **Client:** | Parsons | **Job No.:** | 09LR1826.01 |
| **Project:** | Honeywell | **Date:** | 05/15/2009 |
| **Material:** | GSE 40 mil Smooth | **Tested By:** | RL/AM/MLB |
| **Sample ID:** | 101130132 - HDPE<br>**120 Day Testing** | **Checked By:** | JB |

| PARAMETER | UNITS | REPLICATE No. | | | | | AVERAGE | STANDARD DEVIATION |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | | |
| Yield Stress | lb/in | 93 | 97 | 88 | 93 | 86 | 91.4 | 3.93 |
| Yield Strain | % | 18 | 19 | 18 | 23 | 22 | 20.0 | 2.10 |
| Peak Stress | lb/in | 148 | 136 | 188 | 200 | 152 | 164.8 | 24.71 |
| Peak Strain | % | 462 | 410 | 596 | 611 | 496 | 515.0 | 77.42 |

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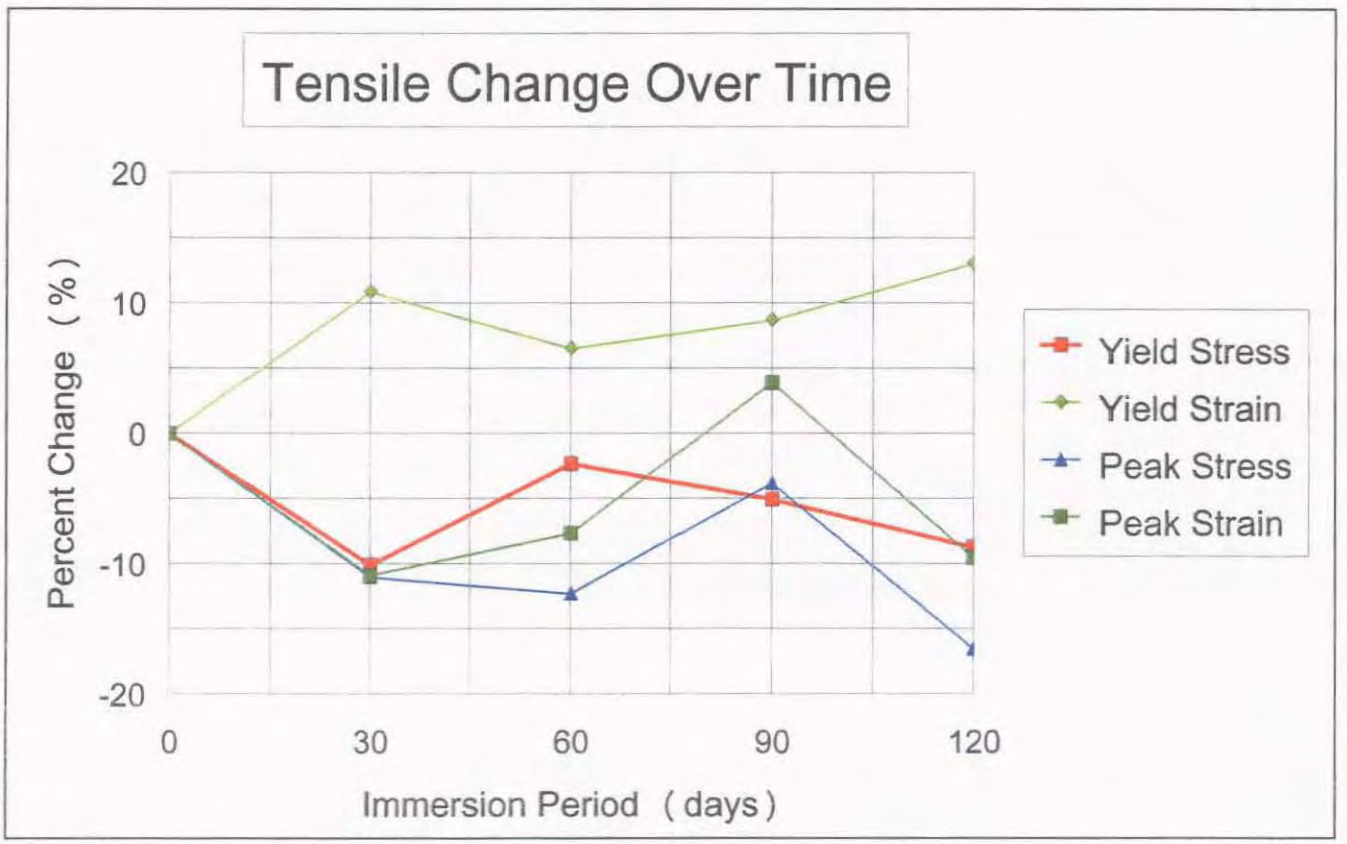
# Summary of Test Results
## *HDPE - 50° Celcius*

| | | | |
|---|---|---|---|
| **Client:** | Parsons | **Job No.:** | 09LR1826.01 |
| **Project:** | Honeywell | **Date:** | 05/15/2009 |
| **Material:** | GSE 40 mil Smooth | **Tested By:** | RL/AM/MLB |
| **Sample ID:** | 101130132 - HDPE | **Checked By:** | JB |

| TEST | Baseline | 30-Day Immersion | | 60-Day Immersion | | 90-Day Immersion | | 120-Day Immersion | |
|---|---|---|---|---|---|---|---|---|---|
| READING | Average | Average | % Change | Average | % Change | Average | % Change | Average | % Change |
| Yield Stress | 103.2 | 92.8 | -10.08 | 100.8 | -2.33 | 98.0 | -5.04 | 94.2 | -8.72 |
| Yield Strain | 18.4 | 20.4 | 10.87 | 19.6 | 6.52 | 20.0 | 8.70 | 20.8 | 13.04 |
| Peak Stress | 188.8 | 168.0 | -11.02 | 165.6 | -12.29 | 181.6 | -3.81 | 157.6 | -16.53 |
| Peak Strain | 532.2 | 474.2 | -10.90 | 491.4 | -7.67 | 552.8 | 3.87 | 481.4 | -9.55 |

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# Tensile Test Results

## *HDPE - 50° Celcius*

| | | | |
|---|---|---|---|
| **Client:** | Parsons | **Job No.:** | 09LR1826.01 |
| **Project:** | Honeywell | **Date:** | 02/15/2009 |
| **Material:** | GSE 40 mil Smooth | **Tested By:** | RL/AM/MLB |
| **Sample ID:** | 101130132 - HDPE<br>**Baseline Testing** | **Checked By:** | JB |

| PARAMETER | UNITS | REPLICATE No. | | | | | AVERAGE | STANDARD DEVIATION |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | | |
| Yield Stress | lb/in | 102 | 102 | 105 | 103 | 104 | 103.2 | 1.17 |
| Yield Strain | % | 18 | 18 | 19 | 19 | 18 | 18.4 | 0.49 |
| Peak Stress | lb/in | 160 | 220 | 176 | 192 | 196 | 188.8 | 25.37 |
| Peak Strain | % | 184 | 683 | 557 | 613 | 624 | 532.2 | 178.64 |

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# Tensile Test Results

## *HDPE - 50° Celcius*

| | | | |
|---|---|---|---|
| **Client:** | Parsons | **Job No.:** | 09LR1826.01 |
| **Project:** | Honeywell | **Date:** | 02/15/2009 |
| **Material:** | GSE 40 mil Smooth | **Tested By:** | RL/AM/MLB |
| **Sample ID:** | 101130132 - HDPE<br>**30 Day Testing** | **Checked By:** | JB |

| PARAMETER | UNITS | REPLICATE No. | | | | | AVERAGE | STANDARD DEVIATION |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | | |
| Yield Stress | lb/in | 97 | 94 | 93 | 91 | 89 | 92.8 | 2.71 |
| Yield Strain | % | 21 | 19 | 21 | 19 | 22 | 20.4 | 1.20 |
| Peak Stress | lb/in | 164 | 192 | 168 | 168 | 148 | 168.0 | 12.36 |
| Peak Strain | % | 331 | 576 | 513 | 505 | 446 | 474.2 | 82.61 |

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# Tensile Test Results

## *HDPE - 50° Celcius*

| | | | |
|---|---|---|---|
| **Client:** | Parsons | **Job No.:** | 09LR1826.01 |
| **Project:** | Honeywell | **Date:** | 03/15/2009 |
| **Material:** | GSE 40 mil Smooth | **Tested By:** | RL/AM/MLB |
| **Sample ID:** | 101130132 - HDPE<br>**60 Day Testing** | **Checked By:** | JB |

| PARAMETER | UNITS | REPLICATE No. | | | | | AVERAGE | STANDARD DEVIATION |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | | |
| Yield Stress | lb/in | 98 | 101 | 101 | 101 | 103 | 100.8 | 1.60 |
| Yield Strain | % | 21 | 20 | 18 | 19 | 20 | 19.6 | 1.02 |
| Peak Stress | lb/in | 140 | 120 | 176 | 196 | 196 | 165.6 | 23.17 |
| Peak Strain | % | 443 | 351 | 528 | 574 | 561 | 491.4 | 83.74 |

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# Tensile Test Results

*HDPE - 50° Celcius*

| | | | |
|---|---|---|---|
| **Client:** | Parsons | **Job No.:** | 09LR1826.01 |
| **Project:** | Honeywell | **Date:** | 04/15/2009 |
| **Material:** | GSE 40 mil Smooth | **Tested By:** | RL/AM/MLB |
| **Sample ID:** | 101130132 - HDPE<br>**90 Day Testing** | **Checked By:** | JB |

| PARAMETER | UNITS | REPLICATE No. | | | | | AVERAGE | STANDARD DEVIATION |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | | |
| Yield Stress | lb/in | 97 | 100 | 97 | 98 | 98 | 98.0 | 1.10 |
| Yield Strain | % | 20 | 18 | 21 | 21 | 20 | 20.0 | 1.10 |
| Peak Stress | lb/in | 216 | 172 | 168 | 164 | 188 | 181.6 | 21.75 |
| Peak Strain | % | 663 | 522 | 516 | 502 | 561 | 552.8 | 58.47 |

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# Tensile Test Results
## *HDPE - 50° Celcius*

JLT

| | | | |
|---|---|---|---|
| **Client:** | Parsons | **Job No.:** | 09LR1826.01 |
| **Project:** | Honeywell | **Date:** | 05/15/2009 |
| **Material:** | GSE 40 mil Smooth | **Tested By:** | RL/AM/MLB |
| **Sample ID:** | 101130132 - HDPE<br>**120 Day Testing** | **Checked By:** | JB |

| PARAMETER | UNITS | REPLICATE No. | | | | | AVERAGE | STANDARD DEVIATION |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | | |
| Yield Stress | lb/in | 95 | 96 | 97 | 89 | 94 | 94.2 | 2.79 |
| Yield Strain | % | 22 | 20 | 21 | 21 | 20 | 20.8 | 0.75 |
| Peak Stress | lb/in | 188 | 168 | 148 | 144 | 140 | 157.6 | 16.33 |
| Peak Strain | % | 572 | 501 | 448 | 464 | 422 | 481.4 | 52.04 |

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# Summary of Test Results

*PROPERTY CHANGE (ASTM D-5747)*

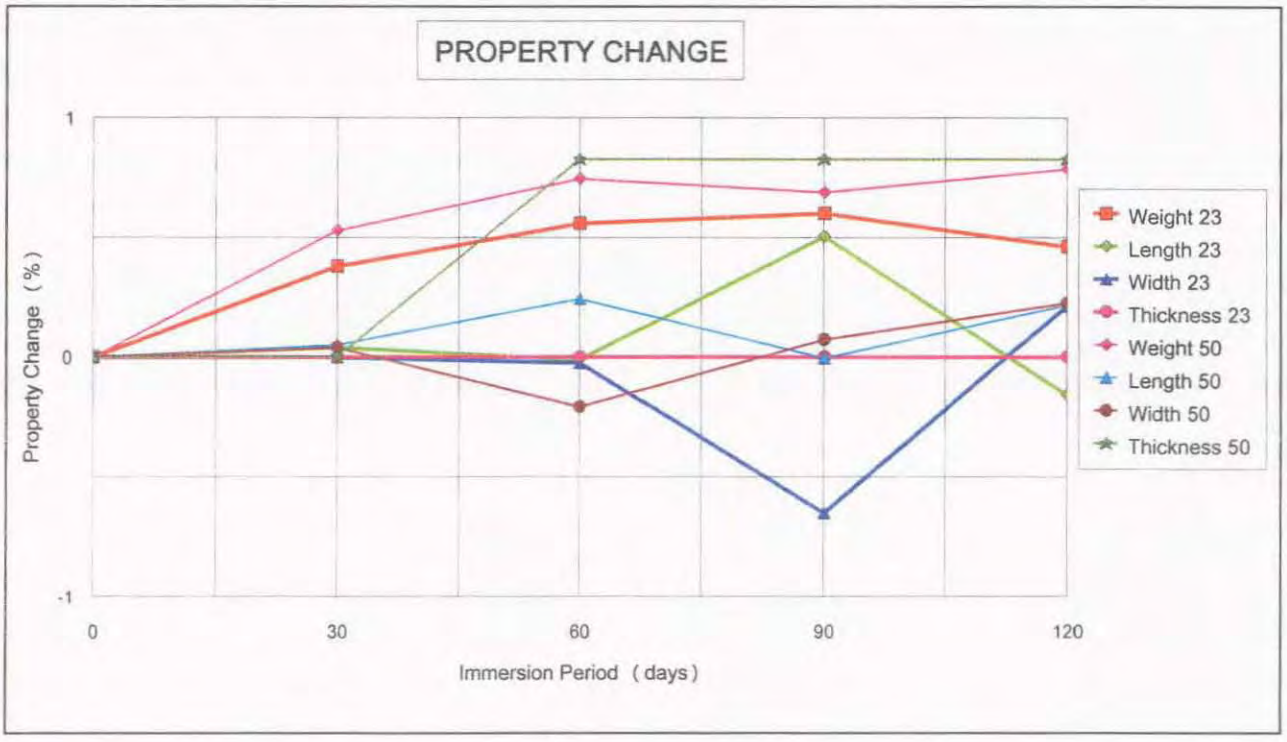
| | | | |
|---|---|---|---|
| Client: | Parsons | Job No.: | 09LR1826.01 |
| Project: | Honeywell | Date: | 05/15/2009 |
| Material: | GSE 40 mil Smooth | Tested By: | RL/AM/MLB |
| Sample ID: | 104143221 - LLDPE | Checked By: | JB |

23° Celcius

| TEST | Baseline | 30-Day Immersion | | 60-Day Immersion | | 90-Day Immersion | | 120-Day Immersion | |
|---|---|---|---|---|---|---|---|---|---|
| READING | Average | Average | % Change | Average | % Change | Average | % Change | Average | % Change |
| Weight, gr | 8.5775 | 8.6102 | 0.38 | 8.63 | 0.56 | 8.63 | 0.60 | 8.62 | 0.46 |
| Length, in | 4.8562 | 4.8577 | 0.03 | 4.86 | -0.01 | 4.88 | 0.50 | 4.85 | -0.16 |
| Width, in | 2.8250 | 2.8262 | 0.04 | 2.82 | -0.02 | 2.81 | -0.65 | 2.83 | 0.21 |
| Thickness, mils | 41 | 41 | 0.00 | 40.67 | 0.00 | 40.67 | 0.00 | 40.67 | 0.00 |

50° Celcius

| TEST | Baseline | 30-Day Immersion | | 60-Day Immersion | | 90-Day Immersion | | 120-Day Immersion | |
|---|---|---|---|---|---|---|---|---|---|
| READING | Average | Average | % Change | Average | % Change | Average | % Change | Average | % Change |
| Weight, gr | 7.6216 | 7.6620 | 0.53 | 7.68 | 0.75 | 7.67 | 0.69 | 7.68 | 0.79 |
| Length, in | 4.8562 | 4.8587 | 0.05 | 4.87 | 0.24 | 4.86 | -0.00 | 4.87 | 0.22 |
| Width, in | 2.5017 | 2.5027 | 0.04 | 2.50 | -0.21 | 2.50 | 0.07 | 2.51 | 0.23 |
| Thickness, mils | 40 | 40 | 0.00 | 40.67 | 0.83 | 40.67 | 0.83 | 40.67 | 0.83 |

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# Property Change

ASTM D-5747, paragraphs 11.1 & 11.2

| | | | |
|---|---|---|---|
| Client: | Parsons | Job No.: | 09LR1826.01 |
| Project: | Honeywell | Date: | 05/15/2009 |
| Material: | GSE 40 mil Smooth | Tested By: | RL/AM/MLB |
| Sample ID: | 104143221 - LLDPE<br>120 Day Testing | Checked By: | JB |

| | PROPERTY ID | UNIT | REPLICATE 1 | REPLICATE 2 | REPLICATE 3 | AVERAGE | STANDARD DEVIATION |
|---|---|---|---|---|---|---|---|
| 23° C | Weight | grams | 7.7665 | 9.0903 | 8.9948 | 8.6172 | 0.6028 |
| | Length | in | 4.6190 | 4.9805 | 4.9460 | 4.8485 | 0.1629 |
| | Width | in | 2.6690 | 2.9130 | 2.9110 | 2.8310 | 0.1146 |
| | Thickness | mils | 40 | 41 | 41 | 40.7 | 0.4714 |

| | PROPERTY ID | UNIT | REPLICATE 1 | REPLICATE 2 | REPLICATE 3 | AVERAGE | STANDARD DEVIATION |
|---|---|---|---|---|---|---|---|
| 50° C | Weight | grams | 8.4800 | 7.5752 | 6.9893 | 7.6815 | 0.6132 |
| | Length | in | 5.2615 | 4.8345 | 4.5040 | 4.8667 | 0.3101 |
| | Width | in | 2.5355 | 2.4930 | 2.4935 | 2.5073 | 0.0199 |
| | Thickness | mils | 41 | 41 | 40 | 40.7 | 0.4714 |

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# Summary of Test Results
## *LLDPE - 23° Celcius*

| | | | |
|---|---|---|---|
| Client: | Parsons | Job No.: | 09LR1826.01 |
| Project: | Honeywell | Date: | 05/15/2009 |
| Material: | GSE 40 mil Smooth | Tested By: | RL/AM/MLB |
| Sample ID: | 104143221 - LLDPE | Checked By: | JB |

| TEST | Baseline | 30-Day Immersion | | 60-Day Immersion | | 90-Day Immersion | | 120-Day Immersion | |
|---|---|---|---|---|---|---|---|---|---|
| READING | Average | Average | % Change | Average | % Change | Average | % Change | Average | % Change |
| Puncture | 94.5 | 86.5 | -8.43 | 88.6 | -6.22 | 85.6 | -9.40 | 79.6 | -15.71 |
| Density | 0.931 | 0.932 | 0.07 | 0.931 | -0.04 | 0.931 | 0.00 | 0.928 | -0.32 |
| Hardness | 9 | 9 | 0.00 | 11 | 22.22 | 10 | 11.11 | 10 | 11.11 |
| 2% Modulus | 22000 | 28600 | 30.00 | 16300 | -25.91 | 17138 | -22.10 | 16896 | -23.20 |
| Tear | 27.2 | 30.2 | 11.03 | 28.6 | 5.15 | 28.0 | 2.94 | 28.0 | 2.94 |
| Volatiles | 0.1340 | 0.4315 | 221.89 | 0.7014 | 423.31 | 0.6719 | 401.23 | 0.6885 | 413.66 |
| Extractables | 0.3461 | 0.4045 | 16.87 | 0.7062 | 104.05 | 0.4468 | 29.09 | 0.5117 | 47.85 |

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# Geomembrane Conformance Test Results

*LLDPE - 23° Celcius*

| | | | |
|---|---|---|---|
| Client: | Parsons | Job No.: | 09LR1826.01 |
| Project: | Honeywell | Date: | 05/15/2009 |
| Material: | GSE 40 mil Smooth | Tested By: | RL/AM/MLB |
| Sample ID: | 104143221 - LLDPE<br>120 Day Testing | Checked By: | JB |

| PARAMETER | UNITS | REPLICATE No. | | | | | AVERAGE | STANDARD DEVIATION |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | | |
| Puncture Resistance | lbs | 78.6 | 80.3 | 80.1 | 81.2 | 78.0 | 79.6 | 1.1706 |
| Density | gr/cucm | 0.93 | 0.93 | 0.93 | | | 0.93 | 0.0005 |
| Hardness | | 9 | 10 | 11 | | | 10 | 0.8165 |
| 2% Secant Modulus | psi | 16920 | 16850 | 17160 | 16540 | 17010 | 16896 | 206.0 |
| Tear ( MD Only) | lbs | 29 | 28 | 28 | 30 | 25 | 28.0 | 1.6733 |
| Volatiles | % | 0.6311 | 0.7459 | | | | 0.6885 | 0.0574 |
| Extractables | % | 0.5355 | 0.4879 | | | | 0.5117 | 0.0238 |

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# Summary of Test Results
## *LLDPE - 50° Celcius*

| | | | |
|---|---|---|---|
| Client: | Parsons | Job No.: | 09LR1826.01 |
| Project: | Honeywell | Date: | 05/15/2009 |
| Material: | GSE 40 mil Smooth | Tested By: | RL/AM/MLB |
| Sample ID: | 104143221 - LLDPE | Checked By: | JB |

| TEST | Baseline | 30-Day Immersion | | 60-Day Immersion | | 90-Day Immersion | | 120-Day Immersion | |
|---|---|---|---|---|---|---|---|---|---|
| READING | Average | Average | % Change | Average | % Change | Average | % Change | Average | % Change |
| Puncture | 94.5 | 85.3 | -9.72 | 86.2 | -8.81 | 87.1 | -7.77 | 82.4 | -12.81 |
| Density | 0.931 | 0.932 | 0.07 | 0.931 | 0.00 | 0.931 | -0.07 | 0.927 | -0.47 |
| Hardness | 9 | 9 | 0.00 | 11 | 18.52 | 10 | 7.41 | 11 | 18.52 |
| 2% Modulus | 22000 | 28500 | 29.55 | 15800 | -28.18 | 16188 | -26.42 | 16020 | -27.18 |
| Tear | 27.2 | 31.2 | 14.71 | 27.6 | 1.47 | 28.2 | 3.68 | 30.6 | 12.50 |
| Volatiles | 0.1340 | 0.4870 | 263.29 | 1.0762 | 702.87 | 0.6659 | 396.76 | 0.6229 | 364.68 |
| Extractables | 0.3461 | 0.5112 | 47.70 | 0.4840 | 39.85 | 0.3527 | 1.91 | 0.3077 | -11.11 |

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# Geomembrane Conformance Test Results

## *LLDPE - 50° Celcius*

| | | | |
|---|---|---|---|
| Client: | Parsons | Job No.: | 09LR1826.01 |
| Project: | Honeywell | Date: | 05/15/2009 |
| Material: | GSE 40 mil Smooth | Tested By: | RL/AM/MLB |
| Sample ID: | 104143221 - LLDPE<br>120 Day Testing | Checked By: | JB |

| PARAMETER | UNITS | REPLICATE No. | | | | | AVERAGE | STANDARD DEVIATION |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | | |
| Puncture Resistance | lbs | 79.5 | 83.6 | 85.0 | 80.5 | 83.3 | 82.4 | 2.0508 |
| Density | gr/cucm | 0.93 | 0.93 | 0.93 | | | 0.93 | 0.0000 |
| Hardness | | 11 | 10 | 11 | | | 11 | 0.4714 |
| 2% Secant Modulus | psi | 15640 | 16210 | 16360 | 16110 | 15780 | 16020 | 269.0 |
| Tear ( MD Only) | lbs | 31 | 31 | 32 | 32 | 27 | 30.6 | 1.8547 |
| Volatiles | % | 0.6609 | 0.5848 | | | | 0.6229 | 0.0381 |
| Extractables | % | 0.2754 | 0.3399 | | | | 0.3077 | 0.0323 |

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