Replacement of Silicone Polymer A With Silicone Polymer B and the Subsequent Characterization of the New Cellular Silicone Materials

Kansas City Division

J. W. Schneider

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Published April 1994

Topical Report
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Abstract

Process characterization of new cellular silicone materials as a result of replacing silicone polymer A with silicone polymer B has been completed. Load deflection requirements for the new cellular silicone materials based on silicone polymer B have been met. The silicone polymer B based cellular silicone materials must be compounded at densities of approximately 0.03 g/cm³ less than the silicone polymer A based cellular silicone materials in order to achieve the same load deflection properties. The ability to achieve the individual part load deflection requirements has also been demonstrated. The change in silicone polymers from A to B involved a decrease in volatile content as well as a decrease in part shrinkage.

Summary

Process characterization of new cellular silicone materials as a result of replacing silicone polymer A with silicone polymer B has been completed. The intent of this substitution work was to utilize the already characterized process for the synthesis of silicone polymer B and the resulting cellular silicone material. The new silicone polymer B based cellular silicone materials will use the same catalyst and ratio as the already characterized B-50 cellular silicone. The catalyzed base-to-urea (CBU) ratio will be adjusted to obtain load deflection properties as defined for the current cellular silicone material standards based on silicone polymer A. A decrease in the density for silicone polymer B cellular silicone materials of approximately 0.03 g/cm³ is required over the cellular silicone materials compounded with silicone polymer A to achieve the required load deflection.

The new cellular silicone material was molded to actual WR part configuration and evaluated for load deflection requirements. Seven different lots of acceptable cellular silicone material were molded into parts. These parts were tested to the current WR part load deflection requirements and all parts were found to be acceptable. These

same parts were also used to evaluate the part shrinkage. The change in silicone polymers from a higher volatile content silicone polymer A to a lower volatile content silicone polymer B was a concern. The decreased volatile content of the silicone polymer B results in less part shrinkage of the molded cellular silicone parts.

The silicone polymer B system uses a different catalyst for the cellular silicone material than silicone polymer A. This different catalyst yields an improved cellular silicone material in respect to compression set properties and long-term stress relaxation at elevated temperatures.

The replacement of silicone polymer A with silicone polymer B has been successfully completed. The resulting cellular silicone materials based on the characterized silicone polymer B system meet the load deflection requirements of the silicone polymer A cellular silicone materials. The new cellular silicone materials based on the silicone polymer B, and the different catalyst, exhibit superior compression set and stress relaxation aging properties.

Discussion

Scope and Purpose

Sandia National Laboratories/New Mexico currently defines three cellular silicone materials as B-3223, 0.64 g/cm³, B-3260, 0.52 g/cm³, and B-3233, 0.29 g/cm³. These cellular silicone materials are based on silicone polymer A produced by Vendor A.

The acquisition of 4000 lbs of silicone polymer A in August 1988 from Vendor A was accomplished with some difficulty. The acquisition of 2000 lbs in July 1991 was nearly impossible. Vendor A indicated that this 2000 lbs would be the last batch sold and that it considered silicone polymer A to be "old technology." Vendor A wanted to sell silicone polymer C as a suitable replacement to silicone polymer A because this is their current high-volume product. Silicone polymer C is a random terpolymer, phenyl, methyl, and vinyl, similar to silicone polymer A, but silicone polymer C is heat-stripped. Selecting silicone polymer C as the replacement did not seem to be a prudent choice, based on past experiences with "current high-volume" silicone material of this type. A sample of silicone polymer C was obtained, and the test results are shown in Appendix A.

The purpose of this project is to replace silicone polymer A with silicone polymer B produced by Vendor B. Silicone polymer B and the resulting B-50 cellular silicone have been used to produce cushions for the W87 program. Approximately 5.5 years of stress relaxation aging study data as well as actual part surveillance data have

been collected, characterizing the stockpile life performance of the B-50 cellular silicone cushion material.

Prior Work

Previous replacement activities for silicone polymer A involved the direct substitution of Vendor C's silicone polymer D into the silicone polymer A formulation. Characterization work for the substitution of silicone polymer D for silicone polymer A resulted in slight modifications to the silica reinforced base formulation. Catalyst A, 2,4-dichlorobenzoyl peroxide, that was used for silicone polymer A was also used for the silicone polymer D system. The stress relaxation data and individual part data (load deflection, compression set, density, and linear shrinkage) illustrated that the silicone polymer D based 3223 type material was equivalent to the silicone polymer A based B-3223.

Activity

Chemical Comparison of Silicone Polymers A and B

The acceptance requirement for silicone polymer A has been a parallel plate plasticity test. The last five lots of silicone polymer A have been tested for tetramethyltetravinylcyclotetrasiloxane (methylvinylsiloxane), octaphenylcyclotetrasiloxane (diphenylsiloxane), weight average molecular weight, and atmospheric volatile content. The

averages of these results are shown in Table 1.

Vendor B synthesizes silicone polymer B as two materials: B-1, a low methylvinylsiloxane (vinyl) silicone polymer, and B-2, a high vinyl silicone polymer. The B-1 is specified as 0.20 ± 0.03 , and the B-2 as $0.68 \pm 0.07-0.08$ wt % vinyl, respectively. These two polymers are blended together during the silica reinforced base compounding process at AlliedSignal Inc., Kansas City Division (KCD), to yield approximately 0.31 wt % vinyl content. The specification also requires a diphenylsiloxane content of 9 ± 2 wt % and an atmospheric volatile content of less than 3%. The weight average molecular weight of the last four lots of silicone polymer B (low or high vinyl content) has been approximately 600,000. A comparison of the average silicone polymer A results and the specification requirements for silicone polymer B silicone polymers are shown in Table 1.

One difference between these two polymers is the diphenylsiloxane content. The lower range of 9.0 wt % diphenylsiloxane has been shown in previous work to be equivalent to the silicone polymer A value for low

temperature tests. Both low temperature compression set and a dynamic torsional test have shown that 9.0 wt % diphenylsiloxane is sufficient for low temperature cellular silicone cushion applications. Based on this, there will be no difference in performance between low and high temperatures for the silicone polymer A and silicone polymer B based cellular silicone materials.

The second difference between these two polymers is the volatile content. Silicone polymer A has a slight heat-stripping following the synthesis operation. Silicone polymer B is heat-stripped until there are less than 3.0 wt % volatiles remaining.

The lot-to-lot variation in molecular weight of the silicone polymer A is an indication that Vendor A's process is not controlled as tightly as Vendor B's process as specified in the process standard.

Compounding of 3223, 3260, and 3233 Type Cellular Silicone Materials Based on Silicone Polymer B

The intent of this substitution work was to utilize the already characterized process

Table 1. Chemical Comparison of Silicone Polymers A and B

Material	Methylvinyl-siloxane (Wt %)	Diphenyl-siloxane (Wt %)	Molecular Weight (Weight Average)	Volatiles (Wt %)
Silicone Polymer A	0.209 ± 0.005	16.47 ± 1.02	$860,247 \pm 145,490$	9.7 ± 0.9
Silicone Polymer B	0.31*	$9 \pm 2^{**}$	$583,576 \pm 51,203$	$< 3.0^{**}$

*The low and high vinyl content polymers are blended to yield this weight percent.

**Specified in both the B-1 and B-2 material standards.

for silicone polymer B and the resulting cellular silicone material. The silicone polymer B silicone polymers (B-1 and B-2) will continue to be synthesized (in accordance with the process standard). The B-1 and B-2 polymers are compounded to yield a 0.31 wt % vinyl silica reinforced base material. The new cellular silicone materials would still use the same catalyst and ratio as the B-50 cellular silicone. The catalyzed base-to-urea (CBU) ratio will be adjusted to obtain load deflection properties as defined in material standards for cellular silicone materials B-3223, B-3260, and B-3233, respectively.

The physical properties defined in the material standards pertain to the acceptance requirements for the bulk cellular silicone material itself. After compounding to cellular silicone, the material is molded into a standard test slab, 12 X 12 X 0.160-inch thick. The test slab is leached and post-cured, and test samples are cut from the test slab to be used in determining load at 30% deflection, density, and compression set. The test slab has bench marks that are molded into the slab to aid in determining the linear shrinkage. The bulk material must pass the acceptance requirements before it can be used for the production of parts. The parts often have load deflection requirements of their own that they must pass as part of their acceptance.

The change from catalyst A (2,4-dichlorobenzoyl peroxide) to catalyst B or catalyst C (t-butyl peroxide 2-methylbenzoate in mineral spirit solution) is significant. The catalyst B and catalyst C materials are equivalent and are both listed in material specification. Catalyst B or catalyst C is a vinyl specific catalyst that yields cushion materials that have significantly improved compression

set and stress relaxation percent load retention (PLR) properties. The disadvantage, from the production point of view, in going from catalyst A to catalyst B or catalyst C is an increase in molding time from 20 to 120 minutes.

A concern in changing from silicone polymer A to silicone polymer B is the difference in linear shrinkage. The silicone polymer B based material has a lower volatile content than silicone polymer A. The lower volatile content of the material will result in less shrinkage of the part following the leaching and post-cure operations. There is a concern as to what effect the silicone polymer B based material shrinkage will be for certified tooling used to produce molded-to-shape parts.

Test Results of the 3223 Cellular Silicone Based on Silicone Polymer B

The main emphasis of this work will be for the 3223 type material since it accounts for approximately 95% of all cellular silicone materials compounded based on silicone polymer A. The 3260 and 3233 materials account for the remaining 3.5 and 1.5%, respectively. The current formulations for the WR production of cellular silicone materials based on silicone polymer B and silicone polymer A are shown in Table 2.

Again, the goal of this project is to produce a cellular silicone material based on silicone polymer B that will meet the load deflection properties of the bulk material requirements for the B-3223. The B-3223 density requirement of 0.64 g/cm³ will have to be reduced to obtain the load deflection requirement for silicone polymer B based cellular silicone material. Using this strategy would utilize the characterized WR production process for the B-50 cellular

Table 2. Comparison of Cellular Silicone Materials

Silicone Polymer	Material Type	Catalyzed Base (lbs)	Urea (lbs)	Load Deflection (psi)	Density (g/cm ³)
Silicone Polymer B	B-50	46.0 Catalyst B	58.7	21.0 +/-3.0	0.57 +/-0.01
Silicone Polymer A	B-3223	52.0 Catalyst A	51.6	27.0 +/-3.0	0.64 +/-0.01
Silicone Polymer A	B-3260	37.7	64.3	15.0 +/-3.0	0.52 +/-0.01
Silicone Polymer A	B-3233	18.5	85.5	3.5 +/-0.5	0.29 +/-0.02

silicone material up to the urea addition compounding step. As stated, the compression set and long-term stress relaxation properties will improve due to the vinyl specific catalyst used with silicone polymer B, catalyst B, or catalyst C, over the catalyst A previously used with silicone polymer A.

The first lot compounded was targeted for a 3223 type material having a density of 0.64 g/cm³ and a CBU ratio of 1.036. The standard test slab samples had load values at 30% deflection of 31.1 psi, which were over the high limit (OHL); the acceptable range is 27.0 +/-3.0 psi.

The designation for a cellular silicone material of this density, based on the nomenclature developed for the B83, W84, and W87 programs, would be B-44, if required. The B-44 designation is based on silicone polymer B, referring to the silicone polymer used, and the 44 referring to the percent porosity of the material. The porosity is the amount of compression the cushion could experience before collapsing all of the cellular structure and

becoming solid rubber. The calculation for porosity is

$$P = [1.0 - (A/B)] * 100 \quad (1)$$

where

P = porosity, percent,

A = density of the cellular silicone, g/cm³,

and

B = density of the catalyzed base material, approximately 1.16 g/cm³.

A plot of load versus CBU ratio for B-44 and of the WR B-50 cellular silicone material is shown in Figure 1.

The next four lots were compounded in the range of 0.909 to 0.923 CBU ratio to obtain acceptable load deflection values. The load for test slab samples at 30% deflection was acceptable, and the densities of the samples were in the range of 0.609 to 0.618 g/cm³. The test slab results for the first five lots of cellular silicone material are shown in Table 3.

Figure 1. Relationship of Load, at 30% Deflection, and CBU Ratio for WR B-50 and B-44 Cellular Silicone Materials

Table 3. Load at 30% Deflection and Density Results for 3223 Type Materials Based on Silicone Polymer B

Lot #	Catalyzed Base (lbs)	Urea (lbs)	Ratio (Catalyzed Base/Urea)	Load Deflection (psi)	Density (g/cm ³)	Number of Samples
0117921	52.0	50.2	1.036	31.1 +/- 0.8	0.644 +/- 0.003	12
0205921	50.0	55.0	0.909	25.3 +/- 0.7	0.609 +/- 0.003	9
0309921	50.4	54.6	0.923	28.9 +/- 0.4	0.617 +/- 0.005	9
0429921	50.2	54.8	0.916	27.4 +/- 1.1	0.614 +/- 0.005	9
1001921	50.3	54.7	0.920	26.7 +/- 0.8	0.618 +/- 0.004	6

The formulation sheets for all five lots are located in Appendix B.

The plot of the load, at 30% deflection, and the CBU ratio for these first five lots of cellular silicone material compounded are shown in Figure 2.

Based on this data, the plan was to compound only four additional lots of 3223 type material based on the silicone polymer B. The strategy for the next four lots of 3223 material was to determine the repeatability of the process and to generate two new data points for the plot. The plan was to duplicate the two extreme CBU ratio points, 0.909 and 0.923, that were acceptable for load at 30% deflection. The plan would also generate

two new CBU ratio points that would be equally spaced "IN" 0.005 from these extreme points, 0.914 and 0.918. The formulation sheets for these four lots are also in Appendix B. The new test results for load at 30% deflection and density along with the previous data are shown in Table 4. The plot of load at 30% deflection and CBU ratio for these same lots are shown in Figure 3.

Only the CBU ratio of 0.909 for lot 0119932 resulted in a repeatable load deflection value. The duplicate of CBU ratio 0.923 resulted in a load deflection value of 26.4 versus 28.9 psi from the first trial. The new points of 0.914 and 0.918 from the duplicate points had approximately the same load deflection values. The

Figure 2. Relationship of Load, at 30% Deflection, and CBU Ratio for the Five Initial Lots of Cellular Silicone Material

Table 4. Load at 30% Deflection and Density Results for All Lots of 3223 Type Material

Lot #	Cat. Base (lbs)	Urea (lbs)	Ratio (Cat. Base/Urea)	Load Deflection (psi)	Density (g/cm ³)	Number of Samples
0117921	52.0	50.2	1.036	31.1 +/-0.8	0.644 +/-0.003	12
0205921	50.0	55.0	0.909	25.3 +/-0.7	0.609 +/-0.003	9
0309921	50.4	54.6	0.923	28.9 +/-0.4	0.617 +/-0.005	9
0429921	50.2	54.8	0.916	27.4 +/-1.1	0.614 +/-0.005	9
1001921	50.3	54.7	0.920	26.7 +/-0.8	0.618 +/-0.004	6
0118931	50.1	54.8	0.914	26.1 +/-0.7	0.614 +/-0.002	9
0118932	50.4	54.6	0.923	26.4 +/-0.6	0.614 +/-0.004	9
0119931	50.2	54.7	0.918	25.7 +/-0.6	0.610 +/-0.003	9
0119932	50.0	55.0	0.909	25.4 +/-0.4	0.609 +/-0.004	9

Figure 3. Relationship of Load, at 30% Deflection, and CBU Ratio for All Lots of Cellular Silicone Materials Compounded

complete data set, in spread sheet format for load at 30% deflection, density, compression set, and linear shrinkage, for all nine lots of 3223 type material compounded based on silicone polymer B is listed in Appendix C.

Based on these results, the load deflection property of the 3223 type material based on the silicone polymer B process is obtainable with a CBU ratio of 0.909 to 0.923, or a bulk material density of approximately 0.613 g/cm³. The lower density results in a silicone polymer B cushion that is lighter weight than the silicone polymer A cushion. The load deflection properties of the silicone polymer B cushion will have the same contour as a silicone polymer A cushion but will be shifted slightly to allow for increased compression, due to increased porosity (decreased density), before the cushion goes solid.

Load-Bearing Properties of Parts Molded to WR Configuration

Three different production parts, Compression Pad A, Compression Pad EX, and Compression Pad E, were molded using various combinations of all of the lots of acceptable 3223 cellular silicone material, except lot 0429921. All test parts molded for the different part numbers were acceptable for the individual part load deflection requirement. The individual part load deflection results and the bulk cellular silicone load deflection value are shown in Tables 5, 6, and 7.

Shrinkage of Parts Molded to WR Configuration

As stated earlier, the reduced volatile content of silicone polymer B compared to silicone polymer A was a concern. The

silicone polymer B parts would shrink less with the reduced volatile content and these parts could have a larger diameter than the part requirement. Certified molds that control the part diameters could require rework to allow for the lower part diameter shrinkage with the 3223 type material based on the silicone polymer B.

The three parts used for the load deflection evaluation are parts that have the part diameter controlled by the mold. The Compression Pad EX and Compression Pad E were molded from the last five lots of acceptable 3223 type cellular silicone: 1001921, 0118931, 0118932, 0119931, and 0119932. The diameters of these parts were inspected at three to five locations, by open setup technique, to determine correlation to the part diameter. There was evidence from the test results that centering the parts for measurement was a problem. However, evaluation of the test results (diameters) for both parts indicate that the dimensions meet the drawing requirements.

Evaluation of 3260 and 3233 Type Cellular Silicone Based on Silicone Polymer B

Parts molded from the 3260 and 3233 type cellular silicone materials are occasionally required. To complete the characterization of the replacement of silicone polymer B for silicone polymer A for Sandia National Laboratories/New Mexico, one lot each of these two different materials was compounded. Based on the decrease in density required to produce acceptable load deflection values for the 3223 material, the 3260 and 3233 type cellular silicone materials were compounded with the same decrease, approximately 0.03 g/cm³. The formulation sheets for

Table 5. Load Deflection Results of Compression Pad A, Thickness, 0.365 Inch

	Serial Number	Test Point One 0.321" (10.5 - 100.0 psi)	Test Point Two 0.226" (0.0 - 55.0 psi)
3223 Type	1	12.21	39.14
Lot 0205921	2	12.28	39.03
Acceptance Load	3	12.41	39.24
of 25.25 +/-0.7 psi	4	11.99	38.52
	5	12.36	38.78
3223 Type	1	12.92	41.75
Lot 0309921	2	13.25	42.45
Acceptance Load	3	13.27	42.15
of 28.90 +/-0.4 psi	4	13.49	42.38
	5	13.24	41.71

these two lots of materials are also shown in Appendix D.

Both the 3260 and 3233 materials were acceptable for the bulk material requirements of load at 30% deflection. The complete test results, in spread sheet format, for load at 30% deflection, density, compression set, and linear shrinkage, are shown in Appendix E.

Comparison of the Compression Set Methods for Silicone Polymers A and B

The change from silicone polymer A to silicone polymer B results in a change of catalyst. Silicone polymer B uses catalyst B or catalyst C, t-butyl peroxide 2-methylbenzoate in mineral spirit solution, while silicone polymer A uses catalyst A, 2,4-dichlorobenzoyl peroxide catalyst.

There is a difference in the test method used to determine the compression set based on the material. The compression set test method for silicone

polymer A/catalyst A is 300°F for 22 hours at 40% compression. The compression set test method for silicone polymer B/catalyst B or catalyst C is 158°F (70°C) for 72 hours at 40% compression with the samples sandwiched between SS shims. The SS shims eliminate peeling the sample from the compression set plates and increasing any rebound in the sample. The compression set test is very sensitive to the accuracy of the thickness measurements. The rounding of the thickness values on the initial and/or final measurement is enough to generate compression set values between 0.0 and 4.6%.

Since the silicone polymer B was being compared to the silicone polymer A, both tests methods were used and the results are shown in Table 8. The results show some improvement, but the real evidence of the superior performance of the vinyl specific catalyst will be seen in stress relaxation aging studies of the material at elevated temperatures, approximately 158°F (70°C).

Table 6. Load Deflection Results of Compression Pad EX, Thickness, 0.310 Inch

	Serial Number	Test Point One 0.275" (9.5 - 100.0 psi)	Test Point Two 0.188" (0.0 - 77.0 psi)
3223 Type	1	11.70	39.37
Lot 0205921	2	11.15	38.28
Acceptance Load	3	12.18	40.10
of 25.25 +/-0.7 psi	4	12.04	40.48
	5	11.86	39.72
3223 Type	1	13.29	46.71
Lot 0309921	2	12.81	45.68
Acceptance Load	3	13.13	45.41
of 28.90 +/-0.4 psi	4	12.95	45.62
	5	13.41	45.49
3223 Type	1	14.17	42.47
Lot 0118931	2	13.85	42.84
Acceptance Load	3	13.62	42.27
of 26.13 +/-0.7 psi	4	13.84	43.10
	5	13.88	41.98
3223 Type	1	13.64	43.02
Lot 0118932	2	14.16	43.18
Acceptance Load	3	14.23	43.08
of 26.44 +/-0.6 psi	4	13.83	42.78
	5	14.15	42.71
3223 Type	1	14.50	44.50
Lot 0119931	2	14.39	44.73
Acceptance Load	3	14.49	44.25
of 25.71 +/-0.6 psi	4	14.22	43.86
	5	14.57	43.90
3223 Type	1	14.13	43.05
Lot 0119932	2	14.08	43.33
Acceptance Load	3	14.10	43.41
of 25.44 +/-0.4 psi	4	14.42	42.74
	5	13.89	42.29

Comparison of Catalyst A and Catalyst B/Catalyst C in Stress Relaxation Tests

The silicone polymer B and vinyl specific catalyst results in cellular silicone

materials that are an improved cushion material over the silicone polymer A and catalyst A materials. The following PLR curves, Figures 4 through 9, for the B-50, silicone polymer B with a 50% minimum porosity, and catalyst B, show PLR values above 50% after 2000 days for worst case.

Table 7. Total Load Deflection Results of Compression Pad E, Thickness, 0.816 Inch

	Serial Number	Test Point One 0.321" (10.5 - 100.0 psi)	Test Point Two 0.226" (0.0 - 55.0 psi)
3223 Type	1	1125	4250
Lot 1001921	2	1188	4250
Acceptance Load	3	1125	4500
of 26.68 +/-0.8	4	1125	4700
	5	1125	4250
3223 Type	1	1225	4125
Lot 0118931	2	1250	4250
Acceptance Load	3	1250	4125
of 26.13 +/-0.7	4	1250	4175
	5	1225	4000
3223 Type	1	1250	4250
Lot 0118932	2	1250	3875
Acceptance Load	3	1250	4250
of 26.44 +/-0.6	4	1225	3750
	5	1250	4250
3223 Type	1	1250	4125
Lot 0119931	2	1200	3800
Acceptance Load	3	1225	4000
of 25.71 +/-0.6	4	1237	4125
	5	1200	4000
3223 Type	1	1225	4000
Lot 0119932	2	1175	3875
Acceptance Load	3	1250	4100
of 25.44 +/-0.4	4	1250	4050
	5	1250	3900

Actual parts returned for surveillance testing show much higher load retention values, indicating that the controlled stress relaxation aging study is a more severe test than actual stockpile conditions.

Also included are the final PLR curves, Figures 10 through 13, for silicone polymer A and the substituted silicone polymer D into the silicone polymer A formulation as part of the past characterization work. Both of these

polymers were compounded into cellular silicone materials using the catalyst A. These figures illustrate the poor performance of catalyst A, especially at elevated temperatures. The 70°C samples have practically no load retention properties left, which is an indication that the sample has taken a set. The complete stress relaxation results for all of the test periods for the 3223 type materials based

Table 8. Comparison of Compression Set Test Methods for 3223 Type Cellular Silicone Material

Lot Number	Standard B-3223 Temperature: 300°F Time: 22 Hours Compression: 40 Percent	B-50 Shim Temperature: 158°F Time: 72 Hours Compression: 40 Percent	Number of Samples
0117921	2.1 +/-0.8	0.0 +/-0.0	12
0205921	3.2 +/-1.4	1.8 +/-0.5	9
0309921	1.4 +/-0.5	0.7 +/-0.8	9
0429921	1.8 +/-0.5	0.0 +/-0.0	9
1001921	1.6 +/-0.0	1.0 +/-0.8	6
0118931	1.6 +/-0.0	0.4 +/-0.7	9
0118932	1.6 +/-0.0	0.0 +/-0.0	9
0119931	1.6 +/-0.0	0.8 +/-0.9*	9, 6*
0119932	1.6 +/-0.0	0.0 +/-0.0	9

*Only six results are available from the shim compression set test.

on silicone polymer A and silicone polymer D are shown in Appendix F.

Establishing Nomenclature and Material Standards for the New Cellular Silicone Materials Based on Silicone Polymer B

To be consistent and to aid in the understanding of the product designation, nomenclature previously developed will be used to identify the new cellular silicone materials. The previous example of the initial lot of silicone polymer B based 3223 type material compounded at the 0.64 g/cm³ density was designated as B-44, the B referring to the polymer used and the 44 an indication of the approximate percent porosity. The old product designation, material standard number and density converted to the new material

designation, and material standard number based on porosity are shown in Table 9. Also listed in Table 9 is the new cellular silicone density required to generate the same load deflection curve (contour) as the silicone polymer A materials.

Because there is such a major change in the type of materials used by Sandia National Laboratories/New Mexico, new material standards have been created for the new cellular silicone materials based on silicone polymer B. A preliminary copy of the new material standards is in Appendix G.

An Engineering Change Order will be written, rolling the suffix of parts that change from silicone polymer A to silicone polymer B based cellular silicone material. The change order will also indicate the

Figure 4. Stress Relaxation of 0.31 Weight Percent Vinyl Cellular Silicone Polymer B; 2002 Days; Thickness, 0.045 Inch; Density, 0.58 g/cm³; Compression, 20%

Figure 5. Stress Relaxation of 0.31 Weight Percent Vinyl Cellular Silicone Polymer B; 2002 Days; Thickness, 0.045 Inch; Density, 0.58 g/cm³; Compression, 35%

Figure 6. Stress Relaxation of 0.31 Weight Percent Vinyl Cellular Silicone Polymer B; 2002 Days; Thickness, 0.100 Inch; Density, 0.58 g/cm³; Compression, 20%

Figure 7. Stress Relaxation of 0.31 Weight Percent Vinyl Cellular Silicone Polymer B; 2002 Days; Thickness, 0.100 Inch; Density, 0.58 g/cm³; Compression, 35%

Figure 8. Stress Relaxation of 0.31 Weight Percent Vinyl Cellular Silicone Polymer B; 2002 Days; Thickness, 0.160 Inch; Density, 0.58 g/cm³; Compression, 20%

Figure 9. Stress Relaxation of 0.31 Weight Percent Vinyl Cellular Silicone Polymer B; 2002 Days; Thickness, 0.160 Inch; Density, 0.58 g/cm³; Compression, 35%

Figure 10. Stress Relaxation of B-3223 Cellular Silicone; 770 Days; Thickness, 0.045 Inch; Density, 0.64 g/cm³; Compression, 35%

Figure 11. Stress Relaxation of B-3223 Cellular Silicone; 770 Days; Thickness, 0.160 Inch; Density, 0.64 g/cm³; Compression, 35%

Figure 12. Stress Relaxation of S-3223 Cellular Silicone; 912 Days; Thickness, 0.045 Inch; Density, 0.64 g/cm³; Compression, 35%

Figure 13. Stress Relaxation of S-3223 Cellular Silicone; 912 Days; Thickness, 0.160 Inch; Density, 0.64 g/cm³; Compression, 35%

Table 9. Conversion Between Cellular Silicone Materials Based on Silicone Polymers A and B

Cellular Silicone Based on Silicone Polymer A		Cellular Silicone Based on Silicone Polymer B		
Product Designation	Density (g/cm ³)	Product Designation	Porosity (Percent)	Density (g/cm ³)
B-3223	0.63 - 0.65	B-47	47	0.615
B-3260	0.51 - 0.53	B-57	57	0.490*
B-3233	0.27 - 0.31	B-77	77	0.260

*Anticipated density will be slightly higher than the one development lot. The load at 30% deflection for the one lot was acceptable but slightly lower than nominal.

new material standard number for the appropriate material required.

Accomplishments

This project has completed the process characterization of the new cellular silicone materials compounded with silicone polymer B. Replacing silicone polymer A with silicone polymer B results in a cellular silicone material that has a lower density but a similar load deflection curve (contour). The curve is shifted slightly due to the lower density or the increase in porosity. The silicone polymer B and vinyl specific catalyst results in cellular silicone materials that are an improved cushion material over the silicone polymer A and catalyst A materials.

Future Work

Samples of the B-47 and B-77 cellular silicone materials have been placed in a stress relaxation aging study. The test scheme will be the same as the test completed: two thicknesses (0.045 and 0.160 inch), three temperatures (RT, 50°C,

and 70°C.), one compression of 35%, and three replicates. Using this test scheme for each material results in a total of 36 aging fixtures. Test results for this stress relaxation test will be published after a minimum of one year aging time.

Appendix A

Test Results for Vendor A Silicone Polymer C

Silicone polymer C was tested for molecular weight (wt average), tetramethyltetra vinyl-cyclotetrasiloxane (methylvinylsiloxane or vinyl), octaphenylcyclotetrasiloxane (diphenylsiloxane) contents, and atmospheric volatiles content, wt %. The weight average molecular weight was approximately 605,000 with a vinyl and phenyl content of 0.179 and 12.43 wt %, respectively. The main difference between silicone polymer A and silicone polymer C was the volatile content that was approximately 2.4% for the silicone polymer C compared to approximately 10% for silicone polymer A.

Appendix B

Formulation Sheets for the 3223 Type Material Based on Silicone Polymer B

CELLULAR SILICONE FORMULATION RECORD

LOT 1119911

Lot <u>0822911</u>	<u>17.3</u>	lbs.	ACC/REJ
Lot <u>0819911</u>	<u>65.7</u>	lbs.	DATE _____
Lot <u>1G100</u>	<u>26.6</u>	lbs. (total)	
Lot <u>K-17-8</u>	<u>5.0</u>	lbs.	SLABBED _____
Lot <u>0918HR122288</u>	<u>8.3</u>	lbs. (total)	T.O.M. <u>300</u> ° F

REMARKS _____

Starting Date of Bin Age _____		+ 28 days _____	
Hardness of	+ Catalyst _____	Weight Loss _____	

Heat Strip of	LOT <u>1119911</u>		
Date of Strip	<u>1/16/92</u>	Weight of Gum "In"	<u>30.0</u> lbs. (NOTE: 30 lbs. of
Hours of Strip	<u>18</u>	Weight of Gum "Out"	<u>29.1</u> lbs. material max. per oven)
		Weight Loss	<u>0.9</u> lbs.
		Percent Weight Loss	<u>3.0</u> %

Date of Strip	<u>1/16/92</u>	Weight of Gum "In"	<u>30.0</u> lbs.
Hours of Strip	<u>18</u>	Weight of Gum "Out"	<u>29.4</u> lbs.
		Weight Loss	<u>0.6</u> lbs.
		Percent Weight Loss	<u>2.0</u> %

LOT <u>0117921</u>		D.O.M. <u>1/17/92</u>	
H.S.	Lot <u>1119911</u>	<u>27.0</u>	lbs.
	Lot <u>509-032F</u>	<u>57.6</u>	grams + 5.5 grs. of
H.S.	Lot <u>1119911</u>	<u>27.0</u>	lbs.
	Lot <u>509-032F</u>	<u>57.6</u>	grams + 5.5 grs. of

Hardness of	+ Catalyst	<u>42</u>	Weight Loss (%)	<u>3.1</u>
	Catalyzed Base	<u>52.0</u>	lbs.	Density (B) _____
	Screened Urea	<u>50.2</u>	lbs.	Density (F) <u>0.644 ± 0.6</u>
	Ratio	<u>1.036</u>		Porosity % _____

Test Slab Results: Load (psi) 31.10 ± 0.8, Comp. Set (%) 2.1 ± 0.8, Linear Shrink (%) 3.2 ± 0.2

REMARKS _____

T.O.M. _____ ° F TIME TO ADD UREA _____ minutes

Heat Strip of
 Date of Strip 1/20/92 LOT 1119911 Weight of Gum "In" 16.0 lbs. (NOTE: 30 lbs. of
 Hours of Strip 18 Weight of Gum "Out" 15.6 lbs. material max. per oven)
 Weight Loss 0.4 lbs.
 Percent Weight Loss 2.5 %

Date of Strip 1/20/92 Weight of Gum "In" 20.1 lbs.
 Hours of Strip 18 Weight of Gum "Out" 19.5 lbs.
 Weight Loss 0.6 lbs. Average Weight
 Percent Weight Loss 3.0 % Loss 2.6 %

LOT 0205921

D.O.M. 2/5/92

Lot 1119911 26.0 lbs.
 Lot 509-032F 55.5 grams + 5.5 grs. of
 Lot 1119911 14.0 lbs.
 Lot 1120911 12.0 lbs.
 Lot 509-032F 55.5 grams + 5.5 grs. of

Hardness of + Catalyst 41 Weight Loss (%) 2.9
 Catalyzed Base 50.0 lbs. Density (B) _____
 Screened Urea 55.0 lbs. Density (F) 0.61 ± 0.0
 Ratio 0.909 Porosity % _____

Test Slab Results: Load (psi) 25.27 ± 0.7, Comp. Set (%) 1.8 ± 0.5, Linear Shrink (%) 3.3 ± 0.2

REMARKS _____

T.O.M. _____ ° F TIME TO ADD UREA _____ minutes

CELLULAR SILICONE FORMULATION RECORD

LOT 0211921

Lot <u>0822911</u>	<u>17.3</u>	lbs.	ACC/REJ
Lot <u>0819911</u>	<u>65.7</u>	lbs.	DATE _____
Lot <u>1L121</u>	<u>26.6</u>	lbs. (total)	
Lot <u>K-17-8</u>	<u>5.0</u>	lbs.	SLABBED _____
Lot _____	<u>8.3</u>	lbs. (total)	T.O.M. <u>265</u> ° F

REMARKS _____

Starting Date of Bin Age <u>2/11</u>		+ 28 days <u>3/10</u>
Hardness of	+ Catalyst _____	Weight Loss _____
Heat Strip of	LOT _____	
Date of Strip _____	Weight of Gum "In" _____	lbs. (NOTE: 30 lbs. of material max. per oven)
Hours of Strip _____	Weight of Gum "Out" _____	lbs.
	Weight Loss _____	lbs.
	Percent Weight Loss _____	%
Date of Strip _____	Weight of Gum "In" _____	lbs.
Hours of Strip _____	Weight of Gum "Out" _____	lbs.
	Weight Loss _____	lbs.
	Percent Weight Loss _____	%

LOT <u>1001921</u>		D.O.M. <u>10/1/92</u>	
	Lot <u>0211921</u>	<u>26.0</u>	lbs.
	Lot <u>1406792A03</u>	<u>55.4</u>	grams + 5.5 grs. of
	Lot <u>0211921</u>	<u>26.0</u>	lbs.
	Lot <u>1406792A03</u>	<u>55.4</u>	grams + 5.5 grs. of
Hardness of	+ Catalyst <u>44</u>	Weight Loss (%) <u>4.6</u>	
	Catalyzed Base <u>50.3</u>	lbs.	Density (B) _____
	Screened Urea <u>54.7</u>	lbs.	Density (F) <u>0.62 ± 0.0</u>
	Ratio <u>0.919</u>		Porosity % _____
Test Slab Results: Load (psi)	<u>26.7 ± 0.8</u>	Comp. Set (%) <u>1.6 ± 0.0/1.0 ± 0.8</u>	Linear Shrink (%) <u>3.2</u>

REMARKS _____

T.O.M. _____ ° F TIME TO ADD UREA _____ minutes

CELLULAR SILICONE FORMULATION RECORD

LOT 0130921

Lot <u>0822911</u>	<u>17.3</u>	lbs.	ACC/REJ
Lot <u>0819911</u>	<u>65.7</u>	lbs.	DATE _____
Lot <u>1K161</u>	<u>26.6</u>	lbs. (total)	
Lot <u>K-17-8</u>	<u>5.0</u>	lbs.	SLABBED _____
Lot <u>0918HR122268</u>	<u>8.3</u>	lbs. (total)	T.O.M. <u>280</u> ° F

REMARKS _____

Starting Date of Bin Age _____		+ 28 days _____	
Hardness of	+ Catalyst _____	Weight Loss _____	
Heat Strip of LOT <u>0130921</u>			
Date of Strip	<u>3/2/92</u>	Weight of Gum "In"	<u>30.0</u> lbs. (NOTE: 30 lbs. of
Hours of Strip	<u>18</u>	Weight of Gum "Out"	<u>29.0</u> lbs. material max. per oven)
		Weight Loss	<u>1.0</u> lbs.
		Percent Weight Loss	<u>3.3</u> %
Date of Strip	<u>3/2/92</u>	Weight of Gum "In"	<u>30.0</u> lbs.
Hours of Strip	<u>18</u>	Weight of Gum "Out"	<u>29.3</u> lbs.
		Weight Loss	<u>0.7</u> lbs.
		Percent Weight Loss	<u>2.3</u> %

LOT <u>0309921</u>		D.O.M. <u>3/9/92</u>	
Lot	<u>0130921</u>	<u>26.0</u>	lbs.
Lot	<u>509-032F</u>	<u>55.5</u>	grams + 5.5 grs. of
Lot	<u>0130921</u>	<u>26.0</u>	lbs.
Lot	<u>509-032F</u>	<u>55.5</u>	grams + 5.5 grs. of
Hardness of	+ Catalyst <u>45</u>	Weight Loss (%) _____	
	Catalyzed Base <u>50.4</u>	lbs.	Density (B) <u>1.17</u>
	Screened Urea <u>54.6</u>	lbs.	Density (F) <u>0.617</u>
	Ratio <u>0.923</u>		Porosity % <u>47.3 ± 0.32</u>
Test Slab Results: Load (psi) <u>28.88 ± 0.4</u> , Comp. Set (%) <u>0.67±0.8/1.4 ± 0.5</u> , Linear Shrink (%) <u>3.27 ± 0.52</u>			

REMARKS _____

T.O.M. _____ ° F TIME TO ADD UREA _____ minutes

Heat Strip of		LOT 0130921			
Date of Strip	<u>4/2/92</u>	Weight of Gum "In"	<u>21.7</u>	lbs.	(NOTE: 30 lbs. of
Hours of Strip	<u>18</u>	Weight of Gum "Out"	<u>21.2</u>	lbs.	material max. per oven)
		Weight Loss	<u>0.5</u>	lbs.	
		Percent Weight Loss	<u>2.3</u>	%	
Date of Strip	<u>4/2/92</u>	Weight of Gum "In"	<u>19.6</u>	lbs.	
Hours of Strip	<u>18</u>	Weight of Gum "Out"	<u>19.2</u>	lbs.	
		Weight Loss	<u>0.4</u>	lbs.	
		Percent Weight Loss	<u>2.0</u>	%	Average Weight Loss <u>2.6</u> %

<u>LOT 0429921</u>		<u>D.O.M. 4/29/92</u>	
	Lot	<u>0130921</u>	<u>26.0</u> lbs.
	Lot	<u>509-032F</u>	<u>55.5</u> grams + 5.5 grs. of
	Lot	<u>0130921</u>	<u>21.1</u> lbs.
	Lot	<u>1120911</u>	<u>5.9</u> lbs.
	Lot	<u>509-032F</u>	<u>55.5</u> grams + 5.5 grs. of
Hardness of	+ Catalyst	Weight Loss (%)	
	Catalyzed Base	<u>50.2</u>	lbs. Density (B) _____
	Screened Urea	<u>54.8</u>	lbs. Density (F) <u>0.61 ± 0.0</u>
	Ratio	<u>0.916</u>	Porosity % _____

Test Slab Results: Load (psi) 27.38 ± 1.1, Comp. Set (%) 1.8 ± 0.5/0.0 ± 0.0, Linear Shrink (%) _____

REMARKS _____

T.O.M. 112 ° F TIME TO ADD UREA 8.5 minutes

CELLULAR SILICONE FORMULATION RECORD

LOT 0528921

Lot <u>0822911</u>	<u>18.8</u>	lbs.	ACC/REJ
Lot <u>1120911</u>	<u>64.2</u>	lbs.	DATE _____
Lot <u>1K161</u>	<u>26.6</u>	lbs. (total)	
Lot <u>K-17-8</u>	<u>5.0</u>	lbs.	SLABBED _____
Lot <u>2155SX081791</u>	<u>8.3</u>	lbs. (total)	T.O.M. _____ ° F

REMARKS _____

Starting Date of Bin Age 5/28 + 28 days 6/25

Hardness of _____ + Catalyst _____ Weight Loss _____

Heat Strip of	LOT <u>0528921</u>		
Date of Strip <u>1/13/93</u>	Weight of Gum "In" <u>30.0</u>	lbs.	(NOTE: 30 lbs. of
Hours of Strip <u>18</u>	Weight of Gum "Out" <u>29.4</u>	lbs.	material max. per oven)
	Weight Loss <u>0.6</u>	lbs.	
	Percent Weight Loss <u>2.0</u>	%	

Date of Strip <u>1/13/93</u>	Weight of Gum "In" <u>19.2</u>	lbs.
Hours of Strip <u>18</u>	Weight of Gum "Out" <u>18.8</u>	lbs.
	Weight Loss <u>0.4</u>	lbs.
	Percent Weight Loss <u>2.1</u>	%

LOT 0118931

D.O.M. _____

Lot <u>0528921</u>	<u>26.0</u>	lbs.
Lot <u>1406792A03</u>	<u>55.5</u>	grams + 5.5 grs. of
Lot <u>0528921</u>	<u>26.0</u>	lbs.
Lot <u>1406792A03</u>	<u>55.5</u>	grams + 5.5 grs. of

Hardness of	+ Catalyst <u>44</u>	Weight Loss (%) <u>2.3</u>
	Catalyzed Base <u>50.1</u>	lbs. Density (B) _____
	Screened Urea <u>54.8</u>	lbs. Density (F) _____
	Ratio <u>0.914</u>	Porosity % _____

Test Slab Results: Load (psi) _____, Comp. Set (%) _____, Linear Shrink (%) _____

REMARKS _____

T.O.M. 107 ° F TIME TO ADD UREA _____ minutes

Hardness of	+ Catalyst	<u>44</u>	Weight Loss (%)	<u>2.5</u>
	Catalyzed Base	<u>50.4</u>	lbs.	Density (B) _____
	Screened Urea	<u>54.6</u>	lbs.	Density (F) _____
	Ratio	<u>0.923</u>		Porosity % _____

REMARKS _____

CELLULAR SILICONE FORMULATION RECORD

LOT 0529921

Lot <u>0822911</u>	<u>18.8</u>	<u>lbs.</u>	ACC/REJ
Lot <u>1120911</u>	<u>64.2</u>	<u>lbs.</u>	DATE _____
Lot <u>1K161</u>	<u>26.6</u>	<u>lbs. (total)</u>	
Lot <u>K-17-8</u>	<u>5.0</u>	<u>lbs.</u>	SLABBED _____
Lot <u>2155081791</u>	<u>8.3</u>	<u>lbs. (total)</u>	T.O.M. _____ ° F

REMARKS _____

Starting Date of Bin Age 5/29 + 28 days 6/26

Hardness of _____ + Catalyst _____ Weight Loss _____

Heat Strip of	LOT <u>0529921</u>		
Date of Strip	<u>1/15/93</u>	Weight of Gum "In"	<u>30.0</u> lbs. (NOTE: 30 lbs. of
Hours of Strip	<u>18</u>	Weight of Gum "Out"	<u>29.3</u> lbs. material max. per oven)
		Weight Loss	<u>0.7</u> lbs.
		Percent Weight Loss	<u>2.3</u> %

Date of Strip	<u>1/15/93</u>	Weight of Gum "In"	<u>30.0</u> lbs.
Hours of Strip	<u>18</u>	Weight of Gum "Out"	<u>29.3</u> lbs.
		Weight Loss	<u>0.7</u> lbs.
		Percent Weight Loss	<u>2.3</u> %

LOT 0119931D.O.M. 1/19/93

Lot <u>0529921</u>	<u>26.0</u>	<u>lbs.</u>
Lot <u>1406792A03</u>	<u>55.5</u>	<u>grams + 5.5 grs. of</u>
Lot <u>0529921</u>	<u>26.0</u>	<u>lbs.</u>
Lot <u>1406792A03</u>	<u>55.5</u>	<u>grams + 5.5 grs. of</u>

Hardness of	+ Catalyst	<u>44</u>	Weight Loss (%)	<u>2.7</u>
	Catalyzed Base	<u>50.2</u>	lbs.	Density (B) _____
	Screened Urea	<u>54.7</u>	lbs.	Density (F) _____
	Ratio	<u>0.918</u>		Porosity % _____

Test Slab Results: Load (psi) _____, Comp. Set (%) _____, Linear Shrink (%) _____

REMARKS _____

T.O.M. 110 ° F TIME TO ADD UREA _____ minutes

Hardness of	+ Catalyst	<u>44</u>	Weight Loss (%)	<u>2.8</u>
	Catalyzed Base	<u>50.0</u>	lbs.	Density (B) <u> </u>
	Screened Urea	<u>55.0</u>	lbs.	Density (F) <u> </u>
	Ratio	<u>0.909</u>		Porosity % <u> </u>

REMARKS _____

Appendix C

**Complete Test Results for All Lots of 3223 Type Material
Based on Silicone Polymer B**

Complete lot acceptance test results for all of the 3223 type materials based on the silicone polymer.

Lot Number	Load Deflection (psi)	Density (g/cc)	Compression Set (Std. B-3223)	Compression Set (Std.)	Linear Shrinkage	Ratio Cat. Base / Urea
0117921	31.37	0.643	3.17	0.00	3.3	1.036
	30.57	0.643	3.17	0.00		
	31.76	0.645	1.58	0.00		
	32.30	0.642	3.17	0.00	3.1	
	30.40	0.648	1.58	0.00		
	31.55	0.645	1.61	0.00		
	29.91	0.643	3.17	0.00	3.4	
	31.67	0.645	1.61	0.00		
	30.98	0.644	1.61	0.00		
	31.06	0.645	1.58	0.00	3.1	
	29.86	0.639	1.58	0.00		
	31.79	0.649	1.58	0.00		
MEAN	31.10	0.644	2.12	0.00	3.2	
STD. DEV.	0.78	0.003	0.78	0.00	0.2	
0205921	26.52	0.612	1.60	1.61	3.1	0.909
	26.08	0.612	1.60	3.17		
	25.74	0.609	3.20	1.63		
	24.81	0.603	3.20	1.61	3.3	
	25.08	0.608	1.60	1.63		
	24.93	0.608	3.20	1.61		
	24.03	0.606	4.80	1.61	3.4	
	25.18	0.609	4.80	1.61		
	25.08	0.610	4.90	1.61		
MEAN	25.27	0.609	3.21	1.79	3.3	
STD. DEV.	0.74	0.003	1.40	0.52	0.2	
0309921	29.60	0.622	1.60	0.00	3.2	0.923
	29.24	0.625	0.00	0.00		
	29.11	0.615	1.60	0.00		
	28.67	0.623	1.60	0.00	2.9	
	28.80	0.614	1.60	0.00		
	28.41	0.616	1.60	1.50		
	28.75	0.614	1.60	1.50	3.7	
	28.92	0.614	1.60	1.50		
	28.43	0.613	1.60	1.50		
MEAN	28.88	0.617	1.42	0.67	3.3	
STD. DEV.	0.39	0.005	0.53	0.79	0.4	

0429921	27.98	0.614	1.60	0.00	2.6	0.916
	28.08	0.615	1.60	0.00		
	27.89	0.616	3.20	0.00		
	28.18	0.614	1.60	0.00	2.6	
	27.55	0.620	1.60	0.00		
	28.55	0.623	1.60	0.00		
	25.47	0.608	1.60	0.00	2.6	
	25.69	0.611	1.60	0.00		
	27.03	0.609	1.60	0.00		
MEAN	27.38	0.614	1.78	0.00	2.6	
STD. DEV.	1.11	0.005	0.53	0.00	0.0	
1001921	27.63	0.622	1.60	0.00	3.0	0.920
	27.26	0.620	1.60	1.50		
	27.24	0.620	1.60	0.00		
	25.82	0.614	1.60	1.50	3.4	
	26.14	0.620	1.60	1.50		
	26.00	0.612	1.60	1.50		
MEAN	26.68	0.618	1.60	1.00	3.2	
STD. DEV.	0.78	0.004	0.00	0.77	0.3	
0118931	25.21	0.611	1.60	1.60	2.5	0.914
	25.64	0.613	1.60	0.00		
	25.64	0.614	1.60	0.00		
	26.50	0.613	1.60	0.00	2.7	
	26.91	0.617	1.60	0.00		
	26.33	0.617	1.60	0.00		
	27.06	0.613	1.60	1.60	2.5	
	25.55	0.611	1.60	0.00		
	26.33	0.615	1.60	0.00		
MEAN	26.13	0.614	1.60	0.36	2.6	
STD. DEV.	0.65	0.002	0.00	0.71	0.1	
0118932	26.57	0.612	1.60	0.00	2.6	0.923
	26.64	0.617	1.60	0.00		
	27.25	0.619	1.60	0.00		
	25.35	0.618	1.60	0.00	2.7	
	25.89	0.617	1.60	0.00		
	25.99	0.617	1.60	0.00		
	26.98	0.611	1.60	0.00	2.4	
	26.57	0.610	1.60	0.00		
	26.72	0.609	1.60	0.00		
MEAN	26.44	0.614	1.60	0.00	2.6	
STD. DEV.	0.59	0.004	0.00	0.00	0.2	

0119931	25.13	0.610	1.60	N/A	2.4	0.918
	25.35	0.609	1.60	N/A		
	25.45	0.611	1.60	N/A		
	26.62	0.607	1.60	0.00	2.5	
	25.82	0.605	1.60	0.00		
	26.57	0.607	1.60	0.00		
	25.33	0.613	1.60	1.60	2.5	
	25.30	0.612	1.60	1.60		
	25.81	0.614	1.60	1.60		
MEAN	25.71	0.610	1.60	0.80	2.5	
STD. DEV.	0.55	0.003	0.00	0.88	0.1	
0119932	24.94	0.610	1.60	0.00	2.5	0.909
	25.74	0.612	1.60	0.00		
	26.01	0.612	1.60	0.00		
	25.21	0.609	1.60	0.00	2.8	
	25.64	0.608	1.60	0.00		
	25.64	0.607	1.60	0.00		
	25.47	0.601	1.60	0.00	2.7	
	25.40	0.610	1.60	0.00		
	24.89	0.614	1.60	0.00		
MEAN	25.44	0.609	1.60	0.00	2.7	
STD. DEV.	0.37	0.004	0.00	0.00	0.2	
TOTAL						
MEAN	26.48	0.613	1.62	0.74	2.8	
STD. DEV.	1.28	0.005	0.31	0.66	0.4	
	Less	Lot	0117921			
Wr	27.00	0.640	<15.0			
Require.	3.00	0.010				

Appendix D

Formulation Sheets for the 3260 and 3223 Type Materials Based on Silicone Polymer B

CELLULAR SILICONE FORMULATION RECORD

LOT 1120911

Lot <u>0822911</u>	<u>17.3</u>	lbs.	ACC/REJ
Lot <u>0819911</u>	<u>65.7</u>	lbs.	DATE _____
Lot <u>1G100</u>	<u>26.0</u>	lbs. (total)	
Lot <u>K-17-8</u>	<u>5.0</u>	lbs.	SLABBED _____
Lot <u>0918HR122288</u>	<u>8.3</u>	lbs. (total)	T.O.M. _____ ° F

REMARKS _____

Starting Date of Bin Age _____ + 28 days _____

Hardness of _____ + Catalyst 45/46 Weight Loss 5.6/5.4

Heat Strip of _____ LOT _____

Date of Strip _____ Weight of Gum "In" _____ lbs. (NOTE: 30 lbs. of

Hours of Strip _____ Weight of Gum "Out" _____ lbs. material max. per oven)

Weight Loss _____ lbs.

Percent Weight Loss _____ %

Date of Strip _____ Weight of Gum "In" _____ lbs.

Hours of Strip _____ Weight of Gum "Out" _____ lbs.

Weight Loss _____ lbs.

Percent Weight Loss _____ %

LOT 0202931 D.O.M. 2/2/93

Lot 1120911 19.0 lbs.

Lot 1406792A03 40.5 grams + 5.5 grs. of

Lot _____ lbs.

Lot _____ grams + 5.5 grs. of

Hardness of _____ + Catalyst _____ Weight Loss (%) _____

Catalyzed Base 18.5 lbs. Density (B) _____

Screened Urea 85.5 lbs. Density (F) _____

Ratio 0.213 Porosity % _____

Test Slab Results: Load (psi) _____, Comp. Set (%) _____, Linear Shrink (%) _____

REMARKS _____

T.O.M. 100 ° F TIME TO ADD UREA _____ minutes

CELLULAR SILICONE FORMULATION RECORD

LOT 0211921

Lot <u>0822911</u>	<u>17.3</u>	lbs.	ACC/REJ
Lot <u>0819911</u>	<u>65.7</u>	lbs.	DATE _____
Lot <u>1L121</u>	<u>26.6</u>	lbs. (total)	
Lot <u>K-17-8</u>	<u>5.0</u>	lbs.	SLABBED _____
Lot _____	<u>8.3</u>	lbs. (total)	T.O.M. <u>265</u> ° F

REMARKS _____

Starting Date of Bin Age 2/11 + 28 days 3/10

Hardness of _____ + Catalyst _____ Weight Loss _____

Heat Strip of _____	LOT _____		
Date of Strip _____	Weight of Gum "In" _____	lbs.	(NOTE: 30 lbs. of
Hours of Strip _____	Weight of Gum "Out" _____	lbs.	material max. per oven)
	Weight Loss _____	lbs.	
	Percent Weight Loss _____	%	
Date of Strip _____	Weight of Gum "In" _____	lbs.	
Hours of Strip _____	Weight of Gum "Out" _____	lbs.	
	Weight Loss _____	lbs.	
	Percent Weight Loss _____	%	

LOT 0203931

D.O.M. 2/3/93

Lot <u>0211932</u>	<u>19.4</u>	lbs.
Lot <u>1406792A03</u>	<u>41.4</u>	grams + 5.5 grs. of
Lot <u>0211921/1120911</u>	<u>2.2/17.2</u>	lbs.
Lot <u>1406792A03</u>	<u>41.4</u>	grams + 5.5 grs. of

Hardness of _____	+ Catalyst _____	Weight Loss (%) _____
Catalyzed Base	<u>37.7</u>	lbs.
Screened Urea	<u>64.3</u>	lbs.
Ratio	<u>0.586</u>	
		Density (B) _____
		Density (F) _____
		Porosity % _____

Test Slab Results: Load (psi) _____, Comp. Set (%) _____, Linear Shrink (%) _____

REMARKS _____

T.O.M. 100 ° F TIME TO ADD UREA _____ minutes

Appendix E

**Complete Test Results for the 3260 and 3233 Type Materials
Based on Silicone Polymer B**

Lot acceptance test results for the 3260 type cellular silicone material based on the silicone polymer.

Lot Number	Load Deflection (psi)	Density (g/cc)	Compression Set (Std. B-3260)	Compression Set (Std.)	Linear Shrinkage	Ratio Cat. Base / Urea
0203931	13.08	0.487	1.60	0.00	3.2	0.586
	13.06	0.488	1.60	0.00		
	13.11	0.490	1.60	1.60		
	13.25	0.487	1.60	N/A	3.3	
	13.16	0.487	1.60	N/A		
	13.20	0.486	1.60	N/A		
	13.30	0.490	1.70	N/A	3.2	
	12.91	0.489	1.70	N/A		
	12.91	0.490	3.30	N/A		
MEAN	13.11	0.488	1.81	0.53	3.2	
STD. DEV.	0.14	0.002	0.56	0.92	0.1	
WR	15.00	0.520	< 20.0			
Require.	3.00	0.010				

Lot acceptance test results for the 3233 type cellular silicone material based on the silicone polymer.

Lot Number	Load Deflection (psi)	Density (g/cc)	Compression Set (Std. B-3233)	Compression Set (Std.)	Linear Shrinkage	Ratio Cat. Base / Urea
0202931	3.90	0.258	5.00	0.00	3.7	0.213
	3.78	0.254	5.00	0.00		
	4.05	0.257	6.60	0.00		
	4.10	0.256	5.00	1.60	4.0	
	4.20	0.257	1.70	1.60		
	4.22	0.259	1.70	0.00		
	4.39	0.257	5.00	1.50	3.6	
	4.22	0.259	3.40	1.60		
	4.00	0.259	3.40	0.00		
MEAN	4.10	0.257	4.09	0.70	3.8	
STD. DEV.	0.19	0.002	1.66	0.83	0.2	
WR	3.50	0.290	< 15.0			
Require.	0.50	0.020				

Appendix F

Stress Relaxation Aging Study Data for the S-3223 and B-3223 Cellular Silicone Materials

TABLE ADS3223 (S3223 #1-18.3 AND B3223 #21-38)

#	THICK	DENS	COMP	TEMP	TOOL NUMBER	INT LOAD LBF	LOADED	TESTED 1	ET 1	LBF 1	RET 1	MEAN 1	SD 1	TESTED 2
1.0	0.045	0.64	35 %	RT	7A444-002-254	232.50	90/10/01	90/11/01	31	178.00	76.56	-	-	91/01/03
2.0	0.045	0.64	35 %	RT	7A444-002-255	232.00	90/10/01	90/11/01	31	177.00	76.29	-	-	91/01/04
3.0	0.045	0.64	35 %	RT	7A444-002-256	199.00	90/10/01	90/11/01	31	148.00	74.37	75.7	1.2	91/01/04
7.0	0.045	0.64	35 %	50 C	7A444-002-260	176.00	90/10/01	90/11/01	31	122.00	69.32	-	-	91/01/03
8.0	0.045	0.64	35 %	50 C	7A444-002-262	187.00	90/10/01	90/11/01	31	135.00	72.19	-	-	91/01/03
9.0	0.045	0.64	35 %	50 C	7A444-002-263	209.00	90/10/01	90/11/01	31	142.00	67.94	69.8	2.2	91/01/03
9.1	0.045	0.64	35 %	70 C	7A444-002-257	213.00	90/10/01	90/11/01	31	122.00	57.28	-	-	91/01/03
9.2	0.045	0.64	35 %	70 C	7A444-002-258	213.50	90/10/01	90/11/01	31	118.00	55.27	-	-	91/01/03
9.3	0.045	0.64	35 %	70 C	7A444-002-259	239.00	90/10/01	90/11/01	31	129.00	53.97	55.5	1.7	91/01/03
10.0	0.160	0.64	35 %	RT	7A444-002-335	127.50	90/10/01	90/11/01	31	105.00	82.35	-	-	91/01/04
11.0	0.160	0.64	35 %	RT	7A444-002-337	136.50	90/10/01	90/11/01	31	112.00	82.05	-	-	91/01/04
12.0	0.160	0.64	35 %	RT	7A444-002-338	136.00	90/10/01	90/11/01	31	115.00	84.56	83.0	1.4	91/01/04
16.0	0.160	0.64	35 %	50 C	7A444-002-342	125.00	90/10/01	90/11/01	31	92.75	74.20	-	-	91/01/03
17.0	0.160	0.64	35 %	50 C	7A444-002-343	123.75	90/10/01	90/11/01	31	93.00	75.15	-	-	91/01/03
18.0	0.160	0.64	35 %	50 C	7A444-002-344	124.25	90/10/01	90/11/01	31	93.50	75.25	74.9	0.6	91/01/03
18.1	0.160	0.64	35 %	70 C	7A444-002-339	103.25	90/10/01	90/11/01	31	78.50	76.03	-	-	91/01/03
18.2	0.160	0.64	35 %	70 C	7A444-002-340	129.25	90/10/01	90/11/01	31	81.00	62.67	0.0	0.0	91/01/03
18.3	0.160	0.64	35 %	70 C	7A444-002-341	122.50	90/10/01	90/11/01	31	77.75	63.47	63.1	0.6	91/01/03
18.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-
19.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
19.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
19.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
19.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
21.0	0.045	0.64	35 %	RT	7A444-002-019	180.00	91/02/20	91/03/27	35	135.00	75.00	-	-	91/05/20
22.0	0.045	0.64	35 %	RT	7A444-002-020	171.50	91/02/20	91/03/27	35	129.00	75.21	-	-	91/05/20
23.0	0.045	0.64	35 %	RT	7A444-002-021	174.00	91/02/20	91/03/27	35	132.00	75.86	75.4	0.4	91/05/20
24.0	0.045	0.64	35 %	50 C	7A444-002-022	221.50	91/02/20	91/03/26	34	148.00	66.81	-	-	91/05/20
25.0	0.045	0.64	35 %	50 C	7A444-002-023	190.00	91/02/20	91/03/26	34	123.00	64.73	-	-	91/05/20
26.0	0.045	0.64	35 %	50 C	7A444-002-024	218.00	91/02/20	91/03/26	34	141.00	64.67	65.4	1.2	91/05/20
27.0	0.045	0.64	35 %	70 C	7A444-002-025	206.00	91/02/20	91/03/26	34	110.00	53.39	-	-	91/05/20
28.0	0.045	0.64	35 %	70 C	7A444-002-026	287.00	91/02/20	91/03/26	34	138.00	48.08	-	-	91/05/20
29.0	0.045	0.64	35 %	70 C	7A444-002-027	234.50	91/02/20	91/03/26	34	125.00	53.30	51.6	3.0	91/05/20
30.0	0.160	0.64	35 %	RT	7A444-002-028	140.00	91/02/20	91/03/27	35	112.00	80.00	-	-	91/05/20
31.0	0.160	0.64	35 %	RT	7A444-002-029	145.00	91/02/20	91/03/27	35	116.00	80.00	-	-	91/05/20
32.0	0.160	0.64	35 %	RT	7A444-002-030	138.25	91/02/20	91/03/27	35	111.00	80.28	80.1	0.2	91/05/20
33.0	0.160	0.64	35 %	50 C	7A444-002-031	143.50	91/02/20	91/03/26	34	105.00	73.17	-	-	91/05/20
34.0	0.160	0.64	35 %	50 C	7A444-002-032	140.00	91/02/20	91/03/26	34	101.50	72.50	-	-	91/05/20
35.0	0.160	0.64	35 %	50 C	7A444-002-033	138.00	91/02/20	91/03/26	34	100.00	72.46	72.7	0.4	91/05/20
36.0	0.160	0.64	35 %	70 C	7A444-002-034	138.50	91/02/20	91/03/26	34	83.50	60.28	-	-	91/05/20
37.0	0.160	0.64	35 %	70 C	7A444-002-035	132.00	91/02/20	91/03/26	34	78.00	59.09	-	-	91/05/20
38.0	0.160	0.64	35 %	70 C	7A444-002-036	132.75	91/02/20	91/03/26	34	80.00	60.26	59.9	0.7	91/05/20

TABLE ADS3223 (S3223 #1-18.3 AND B3223 #21-38)

ET 2	LBF 2	RET 2	MEAN 2	SD 2	TESTED 3	ET 3	LBF 3	RET 3	MEAN 3	SD 3	TESTED 4	ET 4	LBF 4	RET 4
94	160.00	68.82	-	-	91/04/05	186	165.00	70.97	-	-	91/06/18	259	156.00	67.09
95	169.50	73.06	-	-	91/04/08	189	166.50	71.77	-	-	91/06/17	258	162.00	69.82
95	147.50	74.12	72.0	2.8	91/04/08	189	141.00	70.85	71.2	0.5	91/06/19	260	136.50	68.59
94	102.00	57.95	-	-	91/04/05	186	107.00	60.80	-	-	91/06/17	258	102.00	57.95
94	114.00	60.96	-	-	91/04/05	186	117.00	62.57	-	-	91/06/17	258	111.00	59.35
94	130.00	62.20	60.4	2.2	91/04/05	186	122.50	58.61	60.7	2.0	91/06/17	258	116.50	55.74
94	91.75	43.08	-	-	91/04/05	186	75.00	35.21	-	-	91/06/17	258	64.00	30.04
94	90.00	42.15	-	-	91/04/05	186	74.00	34.66	-	-	91/06/17	258	62.00	29.03
94	93.50	39.12	41.5	2.1	91/04/05	186	72.00	30.13	33.3	2.8	91/06/17	258	61.20	25.60
95	102.00	80.00	-	-	91/04/08	189	98.50	77.25	-	-	91/06/17	258	96.25	75.49
95	110.00	80.59	-	-	91/04/08	189	106.00	77.66	-	-	91/06/17	258	104.25	76.37
95	110.00	80.88	80.5	0.4	91/04/08	189	106.25	78.13	77.7	0.4	91/06/18	259	104.00	76.47
94	81.00	64.80	-	-	91/04/05	186	80.50	64.40	-	-	91/06/17	258	77.80	62.24
94	88.50	71.52	-	-	91/04/05	186	81.00	65.45	-	-	91/06/17	258	77.15	62.34
94	87.50	70.42	68.9	3.6	91/04/05	186	81.00	65.19	65.0	0.5	91/06/17	258	77.60	62.45
94	66.75	64.65	-	-	91/04/05	186	57.00	55.21	-	-	91/06/17	258	53.50	51.81
94	69.00	53.38	0.0	0.0	91/04/05	186	58.00	44.87	0.0	0.0	91/06/17	258	51.10	39.53
94	67.00	54.69	54.0	0.9	91/04/05	186	56.50	46.12	45.5	0.9	91/06/17	258	50.75	41.42
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
89	125.75	69.86	-	-	91/06/19	119	123.00	68.33	-	-	91/09/04	196	132.50	73.61
89	126.00	73.47	-	-	91/06/19	119	124.00	72.30	-	-	91/09/04	196	120.00	69.97
89	131.00	75.29	72.9	2.8	91/06/19	119	129.50	74.42	71.7	3.1	91/09/04	196	127.50	73.27
89	142.50	64.33	-	-	91/06/18	118	133.50	60.27	-	-	91/09/04	196	127.50	57.56
89	120.00	63.16	-	-	91/06/18	118	114.00	60.00	-	-	91/09/04	196	108.50	57.10
89	134.00	61.47	63.0	1.4	91/06/18	118	127.50	58.48	59.6	1.0	91/09/04	196	122.00	55.96
89	95.75	46.48	-	-	91/06/18	118	90.00	43.68	-	-	91/09/04	196	79.50	38.59
89	126.50	44.08	-	-	91/06/18	118	125.00	43.55	-	-	91/09/04	196	119.00	41.46
89	108.00	46.06	45.5	1.3	91/06/18	118	101.50	43.28	43.5	0.2	91/09/04	196	88.50	37.73
89	109.00	77.86	-	-	91/06/19	119	110.50	78.92	-	-	91/09/04	196	104.00	74.28
89	113.00	77.93	-	-	91/06/19	119	109.75	75.68	-	-	91/09/04	196	108.25	74.65
89	108.50	78.48	78.1	0.3	91/06/19	119	105.00	75.94	76.8	1.8	91/09/04	196	103.00	74.50
89	98.50	68.64	-	-	91/06/18	118	93.25	64.98	-	-	91/09/04	196	88.50	61.67
89	97.00	69.29	-	-	91/06/18	118	92.25	65.89	-	-	91/09/04	196	86.50	61.78
89	94.00	68.12	68.7	0.6	91/06/18	118	90.50	65.57	65.5	0.5	91/09/04	196	84.50	61.23
89	69.25	50.00	-	-	91/06/18	118	64.00	46.20	-	-	91/09/04	196	65.00	46.93
89	65.25	49.43	-	-	91/06/18	118	60.85	46.09	-	-	91/09/04	196	51.40	38.93
89	67.50	50.85	50.1	0.7	91/06/18	118	61.95	46.66	46.3	0.3	91/09/04	196	52.00	39.17

TABLE ADS3223 (S3223 #1-18.3 AND B3223 #21-38)

MEAN 4	SD 4	TESTED 5	ET 5	LBF 5	RET 5	MEAN 5	SD 5	TESTED 6	ET 6	LBF 6	RET 6	MEAN 6	SD 6	TESTED 7
-	-	91/10/03	367	160.00	68.81	-	-	92/03/09	525	151.00	64.94	-	-	92/10/05
-	-	91/10/03	367	160.50	69.18	-	-	92/03/09	525	154.00	66.37	-	-	92/10/05
68.5	1.4	91/10/03	367	131.00	65.82	67.9	1.8	92/03/09	525	128.50	64.57	65.3	1.0	92/10/05
-	-	91/10/03	367	96.00	54.54	-	-	92/03/09	525	90.00	51.13	-	-	92/10/05
-	-	91/10/03	367	101.00	54.01	-	-	92/03/09	525	92.50	49.46	-	-	92/10/05
57.7	1.8	91/10/03	367	108.00	51.67	53.4	1.5	92/03/09	525	96.50	46.17	48.9	2.5	92/10/05
-	-	91/10/03	367	50.00	23.47	-	-	92/03/09	525	47.00	22.06	-	-	92/10/05
-	-	91/10/03	367	51.00	23.88	-	-	92/03/09	525	40.50	18.96	-	-	92/10/05
28.2	2.3	91/10/03	367	50.50	21.12	22.8	1.5	92/03/09	525	41.00	17.15	19.4	2.5	92/10/05
-	-	91/10/03	367	95.00	74.50	-	-	92/03/09	525	92.50	72.54	-	-	92/10/06
-	-	91/10/03	367	102.50	75.09	-	-	92/03/09	525	99.00	72.52	-	-	92/10/06
76.1	0.5	91/10/03	367	102.50	75.36	75.0	0.4	92/03/09	525	99.50	73.16	72.7	0.4	92/10/06
-	-	91/10/03	367	74.25	59.40	-	-	92/03/09	525	67.85	54.28	-	-	92/10/05
-	-	91/10/03	367	74.00	59.79	-	-	92/03/09	525	67.35	54.42	-	-	92/10/05
62.3	0.1	91/10/03	367	73.75	59.35	59.5	0.2	92/03/09	525	67.25	54.12	54.3	0.2	92/10/05
-	-	91/10/03	367	40.50	39.22	-	-	92/03/09	525	33.15	32.10	-	-	92/10/05
-	-	91/10/03	367	43.50	33.65	-	-	92/03/09	525	35.45	27.42	-	-	92/10/06
40.5	1.3	91/10/03	367	44.50	36.32	36.4	2.8	92/03/09	525	35.90	29.30	29.6	2.4	92/10/06
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	91/11/18	271	125.00	69.44	-	-	92/03/10	384	117.00	65.00	-	-	92/09/03
-	-	91/11/18	271	121.00	70.55	-	-	92/03/10	384	115.50	67.34	-	-	92/09/03
72.3	2.0	91/11/18	271	125.75	72.27	70.8	1.4	92/03/10	384	122.00	70.11	67.5	2.6	92/09/03
-	-	91/11/18	271	123.00	55.53	-	-	92/03/10	384	119.00	53.72	-	-	92/09/03
-	-	91/11/18	271	111.00	58.42	-	-	92/03/10	384	105.00	55.26	-	-	92/09/03
56.9	0.8	91/11/18	271	118.00	54.12	56.0	2.2	92/03/10	384	115.00	52.75	53.9	1.3	92/09/03
-	-	91/11/18	271	67.50	32.76	-	-	92/03/10	384	57.50	27.91	-	-	92/09/03
-	-	91/11/18	271	94.50	32.92	-	-	92/03/10	384	56.25	19.59	-	-	92/10/07
39.3	2.0	91/11/18	271	96.25	41.04	35.6	4.7	92/03/10	384	69.00	29.42	25.6	5.3	92/10/07
-	-	91/11/18	271	101.75	72.67	-	-	92/03/10	384	100.00	71.42	-	-	92/09/03
-	-	91/11/18	271	105.00	72.41	-	-	92/03/10	384	102.50	70.68	-	-	92/09/03
74.5	0.2	91/11/18	271	100.00	72.33	72.5	0.2	92/03/10	384	98.50	71.24	71.1	0.4	92/09/03
-	-	91/11/18	271	82.50	57.49	-	-	92/03/10	384	75.00	52.26	-	-	92/09/03
-	-	91/11/18	271	80.00	57.14	-	-	92/03/10	384	70.00	50.00	-	-	92/09/03
61.6	0.3	91/11/18	271	79.50	57.60	57.4	0.2	92/03/10	384	74.00	53.62	52.0	1.8	92/09/03
-	-	91/11/18	271	47.00	33.93	-	-	92/03/10	384	37.30	26.93	-	-	92/09/03
-	-	91/11/18	271	43.90	33.25	-	-	92/03/10	384	35.00	26.51	-	-	92/10/07
41.7	4.6	91/11/18	271	45.70	34.42	33.9	0.6	92/03/10	384	36.95	27.83	27.1	0.7	92/10/07

TABLE ADS3223 (S3223 #1-18.3 AND B3223 #21-38)

ET 7	LBF 7	RET 7	MEAN 7	SD 7	TESTED 8	ET 8	LBF 8	RET 8	MEAN 8	SD 8	TESTED 9	ET 9	LBF 9	RET 9
735	150.50	64.73	-	-	93/03/31	912	142.00	61.07	-	-	-	-	-	-
735	150.50	64.87	-	-	93/03/31	912	148.00	63.79	-	-	-	-	-	-
735	124.50	62.56	64.1	1.3	93/03/31	912	123.00	61.80	62.2	1.4	-	-	-	-
735	80.00	45.45	-	-	93/03/31	912	75.00	42.61	-	-	-	-	-	-
735	85.00	45.45	-	-	93/03/31	912	80.20	42.88	-	-	-	-	-	-
735	87.30	41.77	44.2	2.1	93/03/31	912	84.50	40.43	42.0	1.3	-	-	-	-
735	37.50	17.60	-	-	93/03/31	912	22.50	10.56	-	-	-	-	-	-
735	36.50	17.09	-	-	93/03/31	912	20.00	9.36	-	-	-	-	-	-
735	33.00	13.80	16.2	2.1	93/03/31	912	15.00	6.27	8.7	2.2	-	-	-	-
736	90.75	70.78	-	-	93/03/31	912	88.00	69.01	-	-	-	-	-	-
736	99.00	72.52	-	-	93/03/31	912	94.25	69.04	-	-	-	-	-	-
736	102.50	75.36	72.9	2.3	93/03/31	912	97.50	71.69	69.9	1.5	-	-	-	-
735	60.95	48.76	-	-	93/03/31	912	57.00	45.60	-	-	-	-	-	-
735	62.00	50.10	-	-	93/03/31	912	57.85	46.74	-	-	-	-	-	-
735	61.60	49.57	49.5	0.7	93/03/31	912	57.40	46.19	46.2	0.6	-	-	-	-
735	27.50	26.63	-	-	93/03/31	912	20.40	19.75	-	-	-	-	-	-
736	32.90	25.45	-	-	93/03/31	912	23.75	18.37	-	-	-	-	-	-
736	33.75	27.55	26.5	1.1	93/03/31	912	24.75	20.20	19.4	1.0	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
561	120.00	66.66	-	-	93/02/24	735	118.00	65.55	-	-	93/04/01	770	113.00	62.77
561	115.00	67.05	66.9	0.3	93/02/24	735	109.00	63.55	-	-	93/04/01	770	111.00	64.72
561	145.50	83.62	0.0	0.0	93/02/24	735	114.00	65.51	64.9	1.1	93/04/01	770	117.00	67.24
561	108.00	48.75	-	-	93/02/24	735	109.00	49.20	-	-	93/04/01	770	100.00	45.14
561	90.00	47.36	-	-	93/02/24	735	97.00	51.05	-	-	93/04/01	770	92.00	48.42
561	105.00	48.16	48.1	0.7	93/02/24	735	102.00	46.78	49.0	2.1	93/04/01	770	101.00	46.33
561	46.10	22.37	-	-	93/02/24	735	48.10	23.34	-	-	93/04/01	770	40.50	19.66
595	66.00	22.99	-	-	93/02/24	735	56.00	19.51	-	-	93/04/01	770	56.00	19.51
595	53.75	22.92	22.8	0.3	93/02/24	735	54.00	23.02	22.0	2.1	93/04/01	770	52.25	22.28
561	97.00	69.28	-	-	93/02/24	735	93.50	66.78	-	-	93/04/01	770	94.00	67.14
561	100.00	68.96	-	-	93/02/24	735	96.75	66.72	-	-	93/04/01	770	97.25	67.06
561	94.00	67.99	68.7	0.7	93/02/24	735	89.00	64.37	66.0	1.4	93/04/01	770	93.00	67.26
561	67.50	47.03	-	-	93/02/24	735	63.10	43.97	-	-	93/04/01	770	60.25	41.98
561	60.00	42.85	-	-	93/02/24	735	57.00	40.71	-	-	93/04/01	770	53.00	37.85
561	65.00	47.10	45.7	2.4	93/02/24	735	63.15	45.76	43.5	2.6	93/04/01	770	61.00	44.20
561	25.90	18.70	-	-	93/02/24	735	23.25	16.78	-	-	93/04/01	770	20.20	14.58
595	20.00	15.15	-	-	93/02/24	735	22.00	16.66	-	-	93/04/01	770	19.50	14.77
595	25.00	18.83	17.6	2.1	93/02/24	735	23.50	17.70	17.0	0.6	93/04/01	770	22.00	16.57

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Appendix G

**Preliminary Copy of the Material Standard
for the New Cellular Silicone Materials
Based on Silicone Polymer B**

MOLDING COMPOUND, SILICONE, CELLULAR (U)

Page	1	2	3	4	5	6
Issue	A	A	A	A	A	A

Drawing Call Out: Molding Compound per (1), (2).

(1) Insert applicable Material Specification Number from 1.2.

(2) Insert Control Number suffix.

Design Agency
Control Number

Issue

Release/
Change Number

Date

A

0X/XX/93

2TIE
DRC

Preliminary Copy

Issue A
Page 2

1. GENERAL.

- 1.1 Scope. This specification covers urea filled cellular silicone molding compounds, which are made from blended and polymer.

- 1.2 Material Spec. Number Nominal Cured Density
- 0.615
0.495
0.255

- 1.3 Definition /M/ is a symbol placed adjacent to a section or paragraph to designate requirements or information pertinent only to KCD, its suppliers and subcontractors.

2. DOCUMENTS.

The following documents form a part of this specification to the extent stated herein.

	Silicone Rubber Base Urea Cellular Silicone Grade, Screened t-Butyl per 2-Methylbenzoate, Mineral Spirit Solution, Cellular Silicone Grade Apparent Density Determination for Cellular Elastomers Compression Test Method for Elastomers Compression Set Determination for Cellular Silicone Specific Gravity and Density of Plastics by Displacement Test for Rubber Property - Durometer Hardness Dataform for Cellular Silicone Material
ASTM-D-792	
ASTM-D-2240	
/M/	

3. REQUIREMENTS

- 3.1 Approved Products. The material shall be one of the following:

Material	Product
<u>Spec. No.</u>	<u>Designation</u> <u>Company</u>
	AlliedSignal, KCD
	AlliedSignal, KCD
	AlliedSignal, KCD

Preliminary Copy

Issue A

Page 3

- 3.2 Molding Compound Formulation. The molding compound shall have the following composition as listed in Table 1.

TABLE 1

Ingredient	Weight Percent			Weight Tolerance (+ or -)
Silicone Base	47.64	36.79	17.71	0.1 lb
Urea, Screened	52.14	63.04	82.21	3.0 lb
Peroxide	0.22	0.17	0.08	0.1 gram

- 3.2.1 Up to 20.0 grams, total, of may be mixed with the peroxide to form a paste to aid incorporation of the peroxide into the silicone base

- 3.3 Physical and Mechanical Properties. The physical and mechanical properties of cushion test slabs made from these molding compounds shall be as listed in Table 2.

TABLE 2

Property	VALUE			Test Method
Load at 30% Deflection, psi	27 +/- 3	15 +/- 3	4 +/- 1	4.4.5
Density, g/cc	0.60 - 0.63	0.48 - 0.51	0.24 - 0.27	4.4.2
Porosity, Percent	Determine and Report	Determine and Report	Determine and Report	4.4.4
Compression Set, Percent, maximum	10	10	10	
Shrinkage, Percent /M/	Determine and Report	Determine and Report	Determine and Report	4.4.6
Hardness, Shore A-2 (from catalyst addition) /M/	Determine and Report	Determine and Report	Determine and Report	ASTM-D-2240

4. **QUALITY ASSURANCE PROVISIONS.**

4.1 **Lot Definition.** A lot shall be a homogeneous quantity of material.

4.2 **Lot Inspection and Testing.** A representative sample from each lot shall be inspected and tested for conformance with the requirements listed in Table 2. To verify lot homogeneity, two cellular test slabs shall be molded from non-adjacent locations within the cellular molding compound lot.

4.3 **Reported Data.** All test values reported as an average shall include the standard deviation of the measurement.

4.4 **Test and Inspection Methods.**

4.4.1 **Test Specimens**

- a. Test specimens shall be cut from molded test slabs approximately 12 inches by 12 inches by 0.150 to 0.160 inches thick. Test slabs shall be compression molded for 120+/-5 minutes at 250+/-3 Deg. F. Slabs shall be leached in water at a minimum of 150 Deg. F for a sufficient time to insure conformance to density requirements, and post cured 24+/-0.5 hours at 400+/-5 Deg. F.
- b. Results from both cellular test slabs shall be used separately to verify conformance with the requirements of 3.3. If either or both of the slabs fail, the lot shall be rejected.

4.4.2 **Apparent Density.** Apparent density determination shall be in accordance with modified as follows:

- a. The specimens shall be approximately 2 inches in diameter.
- b. Three specimens shall be tested, and the results averaged.
- c. The average value shall not be rounded off.

4.4.3 **Catalyzed Base Density.** The density of the batch of catalyzed base for the cellular molding compound shall be determined in accordance with ASTM-D-792. A cured slab from both halves of the catalyzed base batch shall be measured and the results averaged. The average shall not be rounded off.

4.4.4 **Porosity.** The porosity of each cellular test slab shall be calculated with the following formula. The porosity of each slab shall be reported. If either or both of the slabs fail, the lot shall be rejected.

Preliminary Copy

Issue A
Page 5

$$P = (1 - (A/B))(100)$$

Where:

P = Porosity, percent

A = Apparent Density, g/cc (see 4.4.2)

B = Catalyzed Base Density, g/cc (see 4.4.3)

The porosity of each cellular slab shall be rounded to the nearest 0.1 percent as follows:

If the figure in the hundredths place is four or less, retain unchanged the figure in the tenths place. If the figure in the hundredths place is five or more, increase by one the figure in the tenths place.

4.4.5 Load Deflection. Load deflection tests shall be performed on each test slab per Test temperature shall be 75 Deg. +/- 5 Deg. F. The test specimen shall not be confined or restrained. Load shall be applied to the test specimen until it reaches 40 percent deflection. The load value at 30 percent deflection from the third cycle shall be used to determine conformance with the load requirement of Table 2 as follows: Three specimens shall be tested and the results averaged; the average for each slab shall be reported.

4.4.6 Linear Shrinkage. Two sets of bench marks shall be molded onto a test slab in accordance with 4.4.1. After each slab has cooled to room temperature, the distance between the inside edges of both sets of bench marks shall be measured. Care should be taken to lay the slab unstressed on a flat surface. Calculate shrinkage as follows:

$$S = (d \text{ sub } 1 - d \text{ sub } 2)(100)/d \text{ sub } 1$$

where:

S = Linear Shrinkage, percent

d sub 1 = 5.0 inches

d sub 2 = Distance between bench marks after processing.

Report the average of the two readings, for each slab, to the nearest 0.1 percent.

4.5/M/Dataform. All appropriate test values required by section 3 shall be recorded on the appropriate dataform,

4.6 Environment. Unless otherwise specified, sample preparation and testing shall be done at 18 to 30 Degrees C and 0 to 65 percent relative humidity.

Preliminary Copy

Issue A
Page 6

5./M/ PACKAGING.

- 5.1 Package or Container Identification. Each individual container of material shall be marked with at least the following information:

Material Specification Number
Product Designation
Lot Number
Date of Manufacture
Shelf Life: 3 months from date of manufacture.

- 5.2 Safety and Material Damage Precautions. This material shall be stored at a temperature of 35 Deg. F to 90 Deg. F.

- 5.3 Shelf Life. When stored at 35 to 90 Deg. F, this material has a shelf life of 3 months from date of manufacture. Material exceeding this age shall be tested before use for conformance with the requirements of Table 2. If it meets all the requirements, the shelf life may be extended an additional 1 month; if it fails any requirement, it shall be scrapped. By retesting, the shelf life may be extended for 1-month intervals, but not to exceed a total shelf life of 6 months from date of manufacture. Any material exceeding the maximum shelf life shall be scrapped.

6./M/ Historical information, for informational purposes only.

Cellular Silicone Based on (UCC)		Material Densities (g/cc)	Cellular Silicone Based on (Bendix, AlliedSignal)		Cellular Silicone Based on (AlliedSignal)	
Product Designation	Material Standard		Product Designation	Material Standard	Product Designation	Material Standard
		0.63 - 0.65	B-3223			
		0.51 - 0.53	B-3260			
		0.27 - 0.31	B-3233			
		0.33 - 0.36	B-3333*		-	-
		0.46 - 0.51	B-3337*		-	-

*Material never compounded at Bendix, AlliedSignal.

and
reinforced base material.

were the product designations for the heat stripped silica

END OF TEXT

DATE

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