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A wear analysis study of selected alternative foundry tooling materials using impact abrasion testing

L. Fred Vondra
University of Northern Iowa

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Vondra, L. Fred, D.I.T.

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U·M·I
300 N. Zeeb Rd.
Ann Arbor, MI 48106

A WEAR ANALYSIS STUDY OF SELECTED ALTERNATIVE FOUNDRY TOOLING MATERIALS USING IMPACT ABRASION TESTING

A Dissertation

Submitted

In Partial Fulfillment

of the Requirements for the Degree

Doctor of Industrial Technology

Approved:

Dr. M. F. Fahmy, Advisor

Dr. Scott C. Helzer, Co-Advisor

Dr. John T. Fecik

Dr. Robert H. Decker

Dr. Barry J. Wilson

L. Fred Vondra

University of Northern Iowa

December 1992

A WEAR ANALYSIS STUDY OF SELECTED ALTERNATIVE FOUNDRY TOOLING MATERIALS USING IMPACT ABRASION TESTING

An Abstract of a Dissertation

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Approved:

Faculty Advisor

Dean of the Graduate College

L. Fred Vondra

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ABSTRACT

The purpose of this study was to simulate the wear characteristics of foundry tooling using an impact abrasion test apparatus. The wear characteristic was exhibited by non-metallic materials and was measured as a function of percentage weight loss and was benchmarked against Class 30 gray iron. The research question focused on whether or not a non-metallic material exists that exhibits comparable or superior wear characteristics to Class 30 gray iron for possible consideration as tooling materials for foundry applications. The information obtained adds to knowledge and is useful to foundry professionals in making tooling decisions.

The 34 test materials were procured from leading non-metallic tooling manufacturers as well as from non-traditional sources. The test procedure used 2 samples of each material tested independently for 3 four hour cycles. The samples were cleaned and weighed and the abradant changed after each 4 hour cycle. The test apparatus was used in three previous studies to experiment on potential tooling materials.

Upon analysis of the data, a wear factor equation was developed to better interpret the tool life as compared to Class 30 gray iron. The development of this wear factor can indicate to a foundry professional how

long he/she can expect a tool to last as compared to cast iron.

Of the non-metallic materials tested there was a wide range in percentage weight loss numbers exhibited. The best performer in terms of percentage weight loss was the Conathane TU-900 exhibiting a 0.3440% weight loss and a wear factor of 2.97. The worst performer was the Ultralloy 40 demonstrating a 9.5043 percentage weight loss with a corresponding wear factor of 81.93.

It appears from the data generated in this study that there is no alternative non-metallic material that exhibits the wear resistance of Class 30 gray iron. However, comparing the results of other tests done previously, it is concluded that with new formulations it is only a matter of time before a non-metallic material will demonstrate the wear resistance of iron.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

THE PROBLEM

Introduction

In an effort to remain competitive, the cast metals industry must endeavor to control all aspects of their operation including costs. Foundries, members of the cast metals industry which use sand as the primary component for molds and cores, are no exception. One important and expensive segment of the overall foundry operation is the area of pattern and corebox tooling. Crowley (1988) stated, "In today's competitive environment foundry management must diligently control every aspect of their operations. And tooling costs, along with every other production cost, must be reviewed" (p. 30). Brown (1983) further stated that this area is critical if a foundry is undertaking modernization to remain competitive. A jobbing foundry can expect to pay as much as million dollars to install a high production molding machine with associated peripheral equipment. New patterns must be built to operate in conjunction with this expensive acquisition. Corresponding dollar amounts suggest a major investment on the part of production tooling for this equipment.

Historically, the material of choice in molding and corebox tooling has been cast iron, with some stainless steels, carbon steels and even bronze alloys. These

materials, although very expensive, are very durable and can withstand the severe foundry environment. They have been the most common tooling materials for hundreds of years.

In todays low bid environment new materials are being experimented with to reduce the cost of foundry tooling. Although some new materials are showing great promise, in general, they are not being taken seriously by the traditional foundry professionals.

One arena of tooling experimentation is in non-metallic materials. Some of these materials show great promise for foundry tooling applications. With the advent of new alternative materials, foundries must reexamine the potential economic advantages offered by this unique family of tooling materials.

A major area of concern with regard to non-metallic materials is the ability to resist wear. The foundry environment in which tooling performs is very abrasive. Sand, the primary foundry molding and coremaking material, is driven or blown under pressure onto the pattern or into the corebox. It is this pressure, which is needed to compact the sand and shape the mold or core. This pressure acts as a multiplier to the sand's already natural abrasiveness.

This research is focused on an analysis of wear rates of selected alternative tooling materials. It is theorized that some materials may exhibit wear resistance characteristics as good or better than cast iron. Such findings would contribute to the body of technical knowledge being generated for foundry use. The discovery of low cost non-traditional materials may help the foundry industry be more productive and competitive in the world economy.

Statement of the Problem

The problem of this study was to analyze the wear characteristics of selected alternative tooling materials. These materials have a potential use as alternative tooling equipment in the foundry for production operations.

Purpose of the Study

The purpose of this study was to simulate the wear characteristics of foundry tooling using an impact abrasion test apparatus. This wear characteristic will be measured as a function of percentage weight loss as exhibited by selected alternative tooling materials to be benchmarked against Class 30 gray iron.

Research Question

The research question that was addressed in this study focused on determining if there was an alternative tooling material that exhibited a comparable or superior wear rate,

as measured by impact abrasion testing, when compared to Class 30 gray iron. A second aspect of the research question addressed whether or not a mathematical indices or factor could be calculated to compare tooling life of the tested materials to Class 30 gray iron. For purposes of this research the tested materials were broken down into the following seven groups: Polyurethane Elastomers, Epoxies, Plastic Liquid Molding Compounds, Polymer Ceramic Composites, Stereolithography Photopolymer, Artificial Modeling Material, and Metallic Tooling Materials. A list of materials that were tested in this study can be found in Appendix A.

Importance of the Study

Cast iron has been the most commonly available and widely used material for foundry tooling. Reasons include: material availability, the relative ease in shaping into the desired configurations, the excellent wear characteristics, its ability to withstand foundry chemicals, and its ability to survive long production runs with very little dimensional change.

However, costs, including excessive tooling charges which are usually passed on as a transfer expense, are now being scrutinized by the consumer. Casting purchasers are much more involved in the processes used to make their product than in the past. Aylward (1988) stated "It is

essential to recognize that we are dealing with an increasingly sophisticated purchasing profession that knows exactly what it wants and will settle for nothing less" (p. 159). Foundries are no longer allowed to ship scrap and expect to forget about it. In many cases, the foundry is required to buy back scrap castings, paying the value added costs plus transportation and handling charges associated with getting it back to the plant. It is becoming imperative that finished castings are of the highest quality and lowest cost.

In many cases, the tooling used to make a customer's castings is owned by that client. To reduce a client's part costs, and enhance competitiveness, it is imperative that tooling costs be as low as possible but still provide high levels of quality.

There are some areas of concern regarding non-metallic tooling. In some cases, tooling life is shortened by the rough treatment experienced in the foundry. Non-metallic materials will break under severe bumping and dropping and can easily be damaged. Also, most non-metallic materials are intolerant of welding spatter and many chemicals found in normal foundry operations.

Construction of epoxy and polyurethane tooling requires special treatment also. Most epoxies and polyurethanes come in a two part system of resin and

hardener. Some of the individual resin and hardener parts release fumes that are toxic to humans. They also may cause a dermatitis reaction to the skin. However, after the two parts have been mixed and polymerization has occurred, they become inert and are no longer harmful. Therefore, special care in the form of proper ventilation and skin barrier protection must be provided when using these materials to construct tooling.

Storage can also be a problem for metallic as well as non-metallic tooling. Most metallic tooling materials can oxidize over time and may yield or creep because of internal stresses introduced during its manufacture, causing dimensional problems. Non-metallic tooling materials, while not suffering from potential oxidation or stress relieving phenomena, also have problems. If care is not taken in the rigging of non-metallic tooling the equipment can become damaged beyond use. Proper material handling must be taken into consideration when using non-metallic tooling.

Another area of concern for foundry clients is lead time. Although iron tooling has advantages in longevity and in other areas, it is a very expensive material to shape into the desired design. A fully machined iron tool can take months to deliver as well as being expensive and difficult to modify.

In this era of Just-In-Time (JIT) deliveries and low product inventories, a foundry's customers cannot afford to wait months to receive their first castings. Backens (1991) stated that in many cases a foundry's ability to receive work is predicated on how soon the customer can get castings. Print to casting time must be reduced to remain competitive (p. 2).

Assumptions

The research was conducted using the following assumptions:

1. That tooling wear can be simulated by the impact abrasion test apparatus.
2. That wear incurred under laboratory conditions is representative of the material loss in a production foundry environment.
3. That specimen preparation did not adversely affect the wear characteristics of the specimens.
4. That Class 30 gray iron can be considered a benchmark material for comparison.
5. That those samples tested represent the family of materials known as metallic and non-metallic tooling materials.

Limitations of the Study

The study was limited to:

1. The use of the impact abrasion apparatus as used in previous research at the University of Northern Iowa and Case Western Reserve University.

2. The use of 58-62 AFS grain fineness number (GFN) sub-angular to round silica sand as the abrasive.

3. The percentage weight loss incurred during the testing cycle.

4. The selected metallic and non-metallic materials including those conventionally used and some more recently developed.

5. The materials to be used as sampled regardless of surface preparation i.e. cast, cut, or machined to correct size.

6. The testing of materials containing no carcinogens.

Definition of Terms

The following terms are used in this study and are defined here for the purpose of clarity:

Acicular structure: A microstructure characterized by needle shaped constituents. (Sylvia, 1990, p. 300)

Corebox: Box with an opening in which the core is formed. (Sylvia, 1990, p. 310)

Epoxy: Containing oxygen attached to two different atoms already connected to a ring. A word often used by itself for epoxy resin. (American Foundrymen's Society, 1986, p. 306)

Jobbing Foundry: A foundry engaged in the manufacture of numerous types of castings not intended for use in its own product. Usually refers to a foundry making castings for many other companies. (Wieser, 1980, p. 19)

Pattern: Model of wood, metal, plaster, or other material used in making a mold. (Sylvia, 1990, p. 322)

Polymerization: The hardening or setting of plastic materials, as epoxy, urethane, when the resin and hardener are mixed together. (American Foundrymen's Society, 1986, p. 306)

Polyurethane: Synthetic resin polymer used for pattern material, ranging from dense elastomer to expanded, spongy, lightweight. (American Foundrymen's Society, 1986, p. 306)

Rigging: Equipment used for making a mold. (Sylvia, 1990, p. 325)

Urethane Elastomer: A resilient rubberlike pattern compound which has excellent abrasion resistance. It is a castable plastic requiring a hardener to complete polymerization. (American Foundrymen's Society, 1986, p. 307)

CHAPTER II

REVIEW OF RELATED LITERATURE

Introduction

This review of literature covers published articles and research pertaining to alternative tooling materials. Also, included is research in foundry competitiveness and those tests specifically designed to measure wear resistance of unconventional tooling materials.

Foundry tooling is an area that has not been thoroughly investigated to help foundries become more competitive. Huskonen (1987) stated:

> A necessary evil. That's the way some foundrymen view the patterns, coreboxes, and related equipment they need to produce castings.
>
> Unfortunately, that attitude tends to close off those foundrymen from a resource that they could well utilize in these very competitive times. (p. 40)

Foundry management is realizing the potential benefits of lowering tooling costs and reducing lead times. Backens (1991) stated: "Management of the John Deere Waterloo Foundry has determined that one way they could improve their competitiveness in the casting industry would be to find alternative materials for tooling" (p. 1).

Research being done on potential non-metallic tooling materials is not new. Burton (1961) investigated epoxy resins and isocyanates (polyurethanes) for foundry tooling as far back as 1961. He stated:

> Introduction of the epoxides to the foundry industry has greatly stimulated the imagination in pattern construction particularly where abrasion resistance is concerned, and is principally influenced by the versatility of the materials in liquid form. Complexity of shape or size is still further enhanced by the elimination of machining to the end product. This signifies to some extent that abrasion resistive materials may be introduced to the pattern or core box at indicated or anticipated wear sections with little or no effort on the part of the builder. (p. 304)

Materials

Wood is the original material used for foundry tooling. It has always been readily available, inexpensive and easily formed into the desired shape. Consequently, it is still in use today, especially for master and prototype tooling. However, it also has disadvantages. Wood, being a cellular material, has very poor wear resistance and also has a tendency to pick up moisture which causes distortion. Hence, it is typically not used as tooling for medium to long production runs.

Plastics are being used in more foundry tooling applications in recent years. Although any kind of transition to plastics as a tooling material is slow in coming, there is evidence that they have a place in tooling applications. Bex (1990a) stated:

> Wood is still widely used to fabricate master patterns for metal castings, and metal certainly retains its place as the pattern material of choice for high volume tooling such as that used in automotive production foundries. Increasingly, however, plastics are being selected as an alternative pattern material. Once a master reverse is constructed, plastic patterns can be

> duplicated and repaired quickly and easily. They also can save time and money. (p. 43)

Plastics are also being used more because of new formulations in their chemistry which give them advantages in such areas as wear resistance and chemical compatibility. These latest formulations are showing characteristics desirable as potential tooling materials. Bex (1990b) further stated:

> Plastics, particularly epoxies and polyurethanes make accurate and durable patterns. They are insensitive to moisture and many chemical mold sprays, offer superior dimensional stability, weigh less than metal counterparts and can be compounded to be extremely hard or highly flexible. (p. 46)

Of the plastic materials, epoxy resins have been in existence the longest. They are still the least expensive plastic material for constructing foundry tooling, are easier to work with and, in general, have a superior surface finish to polyurethanes. However, they have a disadvantage in that shrinkage during construction becomes a problem, especially in heavy cross sectional areas. Also, based on past studies, they do not possess the wear resistance characteristics of polyurethanes.

Materials that are becoming more common for use as alternative foundry tooling are polyurethane elastomers. Historically, polyurethanes designed for foundry applications were restricted to master patterns and prototype work. Bralower (1989) stated:

> In the 1980s, various improvements in polyurethane materials, equipment and processes have allowed plastics to move out of the pattern shop and onto the foundry shop floor. Once limited mostly to master patterns, plastics have moved further into production tooling. (p. 37)

New materials being experimented with include castable ceramics and fiberglass. Typically, fiberglass has been used in the foundry industry as a backing media to give strength and rigidity to unstable surface materials. It is with this purpose that fiberglass is used, in many cases, as a back up for castable ceramics.

Ceramics are being experimented on because of their perceived resistance to abrasion. It is only recently that ceramics have been available in castable form. These ceramics generally have an acicular free flowing structure which allows them to be cast into the desired shape. Therefore, they are starting to generate interest as with other castable materials, such as polyurethane elastomers, for use as foundry tooling.

Abrasion Tests

As discussed previously, it is advantageous to the foundry industry to find materials that are less expensive and have shorter construction lead times. It must also be realized that all metallic tools are shaped, or constructed, in a similar fashion. Metallic tooling is fabricated or machined using some form of metal removal operation to achieve the desired shape. Most non-metallic materials are

cast into shape thereby saving time and expense in making tooling.

In order to test metallic and non-metallic materials, and be able to translate the results into usable data for sound decision making, a test similar to actual foundry production conditions had to be devised. Well known, and highly used, mechanical tests i.e., hardness or tensile, do not give the desired data that correlates with abrasion resistance. Shah (1984) stated:

> Resistance to abrasion is significantly affected by factors, such as test conditions, type of abradant, and development and dissipation of heat during the test cycle. Many different types of abrasion-measuring equipment have been developed. However, the correlation between the test results and actual abrasion-related wear in real life remains very poor. The tests do, however, provide relative ranking of materials in certain order when performed under specified set of conditions. (p. 73)

The American Society for Testing and Materials (ASTM) defines resistance to abrasion as "the ability of a material to withstand mechanical action such as rubbing, scraping, or erosion, that tends progressively to remove material from its surface" (1991, p. 405).

Gouwens, in 1965, first recognized the need to simulate the abrasive conditions experienced by foundry tooling. He utilized two different testing apparatuses in an effort to simulate abrasion conditions. The two tests conducted were pressure abrasion and impact abrasion.

Pressure abrasion was conducted using a device known as the Haworth abrasive wear tester and has been used primarily for testing metallic materials. The equipment utilizes a segmented rubber wheel, under a load, which maintains a desired pressure on the sample. Sand is picked up by the wheel segments as it passes through a pan containing the abrasive and deposited on the sample. A rapid abrasion occurs as sand is carried between the rubber wheel and the sample. Gouwens (1965) stated: "The conditions of applied pressure, abrasive grain shape, and water or oil lubrication can be varied and thus replicate the abrasion encountered during pressurized abrasive conditions" (p. 402).

Impact abrasion was also tested in Gouwens' study. This type of test is completely different than the Haworth abrasive wear tester which uses contact pressure to actuate the abrasive media. Impact abrasion seems to more closely resemble the wearing action experienced by tooling, especially the process of core blowing. Gouwens (1965) stated:

> It is well known that abrasion under pressure, as accomplished in the Haworth test, may be quite different than abrasion by sand impact. Since core blowing is primarily an impact condition, a second test procedure was needed to replicate abrasive conditions encountered. (p. 402)

The impact abrasion test uses the contact energy of falling sand as it cascades into a high speed impeller to achieve the wearing action. Equipment used for this test

consists of: a 10 inch glass drum, a high speed impeller, a means of introducing a nitrogen atmosphere, and a variable speed drive mechanism. The drum rotates at a speed which allows the sand to fall from about the 10 o'clock position. The sand then falls into the high speed impeller, mounted inside the drum, where impact occurs. The nitrogen atmosphere was required to prevent oxidation of the primarily metal samples due to the moisture in the sand abrasive. Samples are mounted in the high speed fixture and act as the blades of an impeller.

The test itself consisted of three four hour segments. Each sample was weighed prior to and after each segment and the weights recorded. Gouwens had difficulty interpreting the results of these tests. This was due primarily because the plastics tested absorbed the core oil which was included as a part of his sand mixture. Volume loss, measured in cubic inches of material lost, was also recorded.

Gouwens (1965) also did field studies of wear resistance to compare his laboratory data to actual production runs. He utilized test bars designed as a truncated cone shape with a corner removed. These test bars were mounted in a corebox directly under a sand stream. The test bars were weighed and measured before and after a production run of cores. Observations were made of the test bars after production runs of 500, 1500, and 3500 cores.

Gouwens found that the results of his truncated cone tests were consistent with laboratory wear data with regards to the metals tested. However, the results from the truncated cone tests suffered the same problem as the laboratory data when comparing the non-metallics. This problem was the absorption of the core oils by the non-metallic materials during testing. The measurement of the actual absorption was not possible therefore his data was inconclusive.

Maier and Wallace (1977) duplicated Gouwens' experiment with a few exceptions. Essentially, the differences were in the sand used as the abrasive and the materials tested. They also did not conduct a truncated cone test. The sand used was a dry silica as compared to Gouwens' oil-bonded mixture of water, core oil, cereal binder, western bentonite, iron oxide, kerosene and Ottawa sand. Gouwens tested a few metallics (3), and existing non-metallic (6) materials. Maier and Wallace tested mostly metallics (15), with fewer non-metallics (9).

Maier and Wallace (1977) also categorized their samples in homogeneous and coated or plated materials. Also, they included average weight loss per specimen, the scatter or lowest and highest value in percentage weight loss among the specimens, and the rate of weight loss as well as percentage weight loss in their recordings. Of the 24 materials

tested, 16 were deemed acceptable as potential pattern materials. Maier and Wallace stated:

> The wear rate of 16 pattern materials, including all of the metals and one polymer, exhibited a weight loss of 1.6% or less in this severe test; the wear resistance of each of these materials could be adequate for most types of patterns. (p. 161)

Another study, conducted by Helzer (1988), further duplicated the research of Gouwens, Maier and Wallace. Essentially the same procedures were used as the aforementioned researchers. The only differences discovered were in AFS grain fineness of the sand used as the abrasive and the materials tested. Maier and Wallace used 69 AFS gfn silica sand, Helzer incorporated a silica sand of 58-64 AFS gfn. The materials tested was the other difference reported by the two studies. The majority of Maier and Wallace's materials tested were metallics, conversely Helzer studied mostly non-metallics.

Helzer further arranged his materials into four major groups. These include: metallic pattern materials, plated pattern materials, non-filled polymers, and filled polymers containing metal or ceramic fillers. Hardness tests of the metallic pattern materials were also incorporated into the study as well as an observation of dimensional changes. The conclusions observed in the study varied according to material. It was reported that similar materials, according

to group, behaved in an analogous manner. Helzer (1988) stated:

> A total of 45 pattern materials were tested in this study. The weight losses ranged from 0.026% to over 7% of the material weight. Most of the materials exhibited very good dimensional stability under testing. All of the pattern materials exhibited a very linear wear line. (p. 285)

Summary

It is apparent that a limited amount of literature pertaining to wear resistance of foundry tooling materials exists. An exhaustive literature search was made to review as many resources as possible during the course of this study.

From the literature reviewed, it is apparent that impact abrasion is the test deemed most similar to actual wear resistance as shown by the three studies analyzed. Another commonality between the three studies was the measurement criteria used, namely weight loss. Incentives for conducting the studies were based on finding materials that would function in the foundry environment. Also, finding materials that were cost effective and reasonably easy to construct, with short lead times, were desirable characteristics taken into consideration.

As new materials, particularly non-metallics, are being developed it is obvious that further research should be conducted to investigate their characteristics under the same conditions as previous studies. The results of this

research would help foundry management make sound tooling decisions that perhaps allows them to be more competitive and productive in the metal casting industry.

CHAPTER III

METHODOLOGY

Introduction

Research in foundry processes for the improvement of competitiveness and productivity is being done in many areas. Areas of intense research to assist foundries include: improving casting quality, reducing lead times for product deliveries, and automating certain processes.

It is the area of reducing casting construction lead times that has benefit from this research in the foundry industry. The non-metallic materials were selected for this study because of their ease of construction and reduced lead times. The metallic samples were selected as a means of comparison to the non-metallics and cast iron, the bench mark material.

Test Materials

The samples selected for this study were supplied by four leading industrial manufacturers of non-metallic tooling materials. In most cases the materials were furnished by the manufacturer to the desired size specifications. Also, some non-traditional materials were tested for experimental purposes to analyze their tooling applicability. Six of these non-metallics have never been used for foundry tooling materials. Also, three other metals that have been used for foundry tooling, besides

Class 30 gray iron, were tested to see how they compare to iron. Following is a description of each material, by major type, that was selected for this study. Further information about these materials in the form of Material Safety Data Sheets can be found in Appendix B.

Polyurethane Elastomers

6414-3 from Ciba-Geigy. This material is an amber or red colored two-component (Parts A & B) polyurethane elastomer with a 55-65 Shore D hardness. It is generally shaped by casting. The material is to be of a fairly consistent thickness from 0.06 in. to 0.12 in. The elastomer must be backed up with an appropriate filler material or metal to maintain dimensional integrity. Mixing ratios used were: Part A 100, Part B 60 by weight. Applications include both coreboxes and patterns.

TDP 186-1 from Ciba-Geigy. This material is a red colored two-component (Parts A & B) polyurethane elastomer with a 78 Shore D hardness. It is generally shaped by casting. The material is to be of a fairly consistent thickness not more than 0.12 in. The elastomer must be backed up with an appropriate filler material or metal for dimensional stability. Mixing ratios used were: Part A 100, Part B 60 by weight. Applications include both coreboxes and patterns.

Uralite 3156 from Hexcel. This material is an amber or black colored two-component (Parts A & B) polyurethane elastomer with a 60 Shore D hardness. It is generally applied by casting onto a prepared surface. The material is to be of a fairly consistent thickness not more than 0.12 in. The elastomer must be backed up with an appropriate filler material if it is not cast into shape. Mixing ratios used were: Part A 100, Part B 36 by weight or Part A 100, Part B 34 by volume. Applications include both coreboxes and patterns.

Uralite 3160 from Hexcel. This material is a brown colored two-component (Parts A & B) polyurethane elastomer with a 70 Shore D hardness. It is generally applied by casting onto a prepared surface. The material is to be of a fairly consistent thickness not more than 0.12 in. The elastomer must be backed up with an appropriate filler material if it is not cast into shape. Mixing ratios used were: Part A 100, Part B 60 by weight. Applications include both coreboxes and patterns.

Uralite 3500 from Hexcel. This material is a brown colored two-component (Parts A & B) polyurethane elastomer with a 70 Shore D hardness. It is generally applied by casting onto a prepared surface. The material is to be of a fairly consistent thickness not more than 0.12 in. The elastomer must be backed up with an appropriate filler

material or casting. Mixing ratios used were: Part A 100, Part B 60 by weight. Applications include both coreboxes and patterns.

Uralite 3501 from Hexcel. This material is an amber colored two-component (Parts A & B) polyurethane elastomer with a 60 Shore D hardness. It is generally applied by casting onto a prepared surface. The material is to be of a fairly consistent thickness not more than 0.12 in. The elastomer must be backed up with an appropriate filler material or casting. Mixing ratios used were: Part A 100, Part B 43 by weight and has a slightly shorter work life than the Uralite 3500. Applications include both coreboxes and patterns.

Uralite 3502 from Hexcel. This material is a brown colored two-component (Parts A & B) polyurethane elastomer with a 55-60 Shore D hardness. It is generally applied by casting onto a prepared surface. The material is to be of a fairly consistent thickness not more than 0.12 in. The elastomer should be backed up with an appropriate filler material or casting. Mixing ratios should be: Part A 100, Part B 60 by weight and has a significantly longer work life than the Uralite 3500 and 3501. Applications include both coreboxes and patterns.

Uralite 3503 from Hexcel. This material is a brown colored two-component (Parts A & B) polyurethane elastomer

with a 95 Shore A hardness. It is generally applied by casting onto a prepared surface. The material is to be of a fairly consistent thickness not more than 0.12 in. The elastomer must be backed up with an appropriate filler material or casting. Mixing ratios used were: Part A 100, Part B 60 by weight and has a significantly longer work life than the Uralite 3502. Applications include both coreboxes and patterns.

Uralite 3530 from Hexcel. This material is a red colored two-component (Parts A & B) polyurethane elastomer with a 65 Shore D hardness. It is generally applied by casting onto a prepared surface. The material is to be of a fairly consistent thickness not more than 0.12 in. The elastomer must be backed up with an appropriate filler material or casting. Mixing ratios used were: Part A 100, Part B 50 by weight. Applications can be considered for both coreboxes and patterns.

Uralite 3534 from Hexcel. This material is a red colored two-component (Parts A & B) polyurethane elastomer with a 95 Shore A hardness. It is generally applied by casting onto a prepared surface. The material is to be of a fairly consistent thickness not more than 0.12 in. The elastomer must be backed up with an appropriate filler material or casting. Mixing ratios used were: Part A 100,

Part B 28 by weight. Applications can be considered for both coreboxes and patterns.

Conathane TU-900 from Conap. This material is an amber colored two-component (Parts A & B) polyurethane elastomer with an 85-95 Shore A hardness. It is generally applied by casting onto a prepared surface. The material is to be of a fairly consistent thickness not more than 0.12 in. The elastomer must be backed up with an appropriate filler material or casting. Mixing ratios used were: Part A 100, Part B 38 by weight. Applications can be considered for both coreboxes and patterns.

Conathane TU-956 from Conap. This material is an amber colored two-component (Parts A & B) polyurethane elastomer with a 50-60 Shore D hardness. It is generally applied by casting onto a prepared surface. The material is to be of a fairly consistent thickness not more than 0.12 in. The elastomer must be backed up with an appropriate filler material or casting. Mixing ratios used were: Part A 100, Part B 28 by weight. Applications can be considered for both coreboxes and patterns.

Conathane TU-961 from Conap. This material is a dark red colored two-component (Parts A & B) polyurethane elastomer with a 60 Shore D hardness. It is generally applied by casting onto a prepared surface. The material is to be of a fairly consistent thickness not more than 0.12

in. The elastomer must be backed up with an appropriate filler material or casting. Mixing ratios used were: Part A 100, Part B 50 by weight. Applications can be considered for both coreboxes and patterns.

Conathane TU-981 from Conap. This material is an amber or black colored two-component (Parts A & B) polyurethane elastomer with a 60-70 Shore D hardness. It is generally applied by casting onto a prepared surface. The material is to be of a fairly consistent thickness not more than 0.12 in. The elastomer must be backed up with an appropriate filler material or casting. Mixing ratios used were: Part A 100, Part B 60 by weight. Applications can be considered for both coreboxes and patterns.

Hapflex 595 from Hapco. This material is a black colored two-component (Parts A & B) polyurethane elastomer with a 90-95 Shore A hardness. It is generally applied by casting, brushing or spraying onto a prepared surface. The material is to be of a fairly consistent thickness from 0.06 in. to 0.12 in. The elastomer must be backed up with an appropriate filler material or casting. Mixing ratios used were: Part A 100, Part B 100 by weight. Applications can be considered for both coreboxes and patterns.

Hapflex 595-HP from Hapco. This material is a black colored two-component (Parts A & B) polyurethane elastomer with a 90-95 Shore A hardness. It is generally applied by

casting, brushing or spraying onto a prepared surface. The material is to be of fairly consistent thickness from 0.06 in. to 0.12 in. The elastomer must be backed up with an appropriate filler material or casting. Mixing ratios used were: Part A 100, Part B 100 by weight. Applications can be considered for both coreboxes and patterns.

Hapflex 665 from Hapco. This material is a black colored two-component (Parts A & B) polyurethane elastomer with a 65 Shore D hardness. It is generally applied by casting, brushing or spraying onto a prepared surface. The material is to be of a fairly consistent thickness from 0.06 in. to 0.12 in. The elastomer must be backed up with an appropriate filler material or casting. Mixing ratios used were: Part A 100, Part B 100 by weight. Applications can be considered for both coreboxes and patterns.

Hapflex 665-HP from Hapco. This material is a black colored two-component (Parts A & B) polyurethane elastomer with a 65 Shore D hardness. It is generally applied by casting, brushing or spraying onto a prepared surface. The material is to be of a fairly consistent thickness from 0.06 in. to 0.12 in. The elastomer must be backed up with an appropriate filler material or casting. Mixing ratios used were: Part A 100, Part B 100 by weight. Applications can be considered for both coreboxes and patterns.

Steel Filled Polyurethane Elastomers

Hapcast 3730/7 from Hapco. This material is a steel filled plastic casting urethane system with a 90 Shore D hardness. The resin is mixed with hardeners at various ratios depending on desired characteristics of finished product. After mixing, the material is poured into a mold or cavity in a thin stream from a height of 8-12 in. The material can be cast in all thicknesses and cures in approximately 48 hr. Applications can be considered for no-bake coreboxes.

Elastomeric Surface Coats

Hapcoat 597 from Hapco. This material is a medium hardness (Shore A 90-95) elastomeric, abrasion resistant, thixotropic, surface coat. After mixing, the material is applied with a brush to a 0.06-0.12 in. thickness. The mixing ratios used were: Part A 100, Part B 75 by weight. Applications can include both coreboxes and patterns.

Hapcoat 667 from Hapco. This material is a Shore D 65 hardness surface coat. It is a thixotropic, abrasion resistant, elastomeric material. After mixing, the material is applied with a brush to a 0.06-0.12 in. thickness. The mixing ratios used were: Part A 100, Part B 75 by weight. Applications can include both coreboxes and patterns.

Polyurethane/Epoxy Alloy

Hapcast 5730 from Hapco. This material is a rigid, high impact, thermoset, Polymer Alloy. It is generally applied by casting onto a prepared surface. The alloy does not require a backing material and is easily machinable to required dimensions. The mixing ratios used were: Part A 100, Part B 13 by weight. Applications can include coreboxes and patterns.

Epoxies

301/308 Epoxical from U.S. Gypsum. This material is an aluminum filled epoxy resin system. It is generally applied by casting onto a prepared surface. The material has an 80 Shore D hardness. Mixing ratios should be: 7 Parts Resin to 1 Part Hardener. Applications can include prototype coreboxes and patterns.

Mastercast 703 from Kindt-Collins. This material is an aluminum filled epoxy system. It is generally applied by casting onto a prepared surface and has an 80 Shore D hardness. Mixing ratios used were: Part A 100, Part B 100 by weight. Applications can include prototype coreboxes and patterns.

Plastic Liquid Molding Compounds

Ultralloy 40 from Hapco. This material is a tough, fast curing, low shrinkage plastic. It is generally applied by casting onto a prepared surface and can be cast into thin

or thick sections. It has a 80 Shore D hardness. Mixing ratios used were: Part A 100, Part B 100 by weight. Applications include prototype and short run production coreboxes and patterns.

Ultralloy 50 from Hapco. This material is a tough, fast curing, low shrinkage plastic. It is generally applied by casting onto a prepared surface and can be cast into thin or thick sections. It has a 90 Shore D hardness. Mixing ratios used were: Part A 100, Part B 100 by weight. Applications can include prototype and short run production coreboxes and patterns.

Polymer Ceramic Composites

Plaz-Tec Ceramic from J & J Corporation. This material is a new castable ceramic composite with potential tooling applications. It is generally applied by casting or spraying onto a prepared surface. A rigid backing material is required for strength purposes. Mixing and hardness data is confidential to the manufacturer. It may have pattern and corebox tooling application.

Plaz-Tec Fiberglass backed Ceramic from J & J Corporation. This material is a new fiberglass backed castable ceramic composite with potential tooling applications. It is generally applied by spraying onto a prepared surface followed by a backing of fiberglass. Mixing and hardness data is confidential to the

manufacturer. It may have pattern and corebox tooling application.

Stereolithography Photopolymer

LMB 5086 Photopolymer from Ciba-Geigy for 3D Systems. This material is a one-component photo curable liquid resin system. The system requires a special processor with computer interface to create the desired tooling. Also, the system requires an ultraviolet laser attachment to activate the polymer. This is a very new technology which may have foundry tooling applications.

Artificial Modeling Material

Renshape 450 from Ciba-Geigy. This is an isotropic, easily machined, dimensionally stable master pattern material. It can be shaped using standard woodworking tools to desired dimensions. The material has a 65 Shore D hardness with no shrinkage problems. It should only be used for prototype and very short production runs. Applications can include patterns but is highly unlikely for coreboxes.

Metallic Tooling Materials

American Iron and Steel Institute (AISI) 1020 low carbon steel. This material is a plain carbon steel with 20 points (or 0.20%) of 1% carbon. Hot rolled 1020 steel has a tensile strength of 68,000 psi and a BHN of 135. Hardened 1020 steel has a 90,000 psi tensile with a 179 BHN. AISI 1020 low carbon steel is not used as extensively as gray

iron for tooling purposes. However, it does exhibit excellent wear characteristics.

304 stainless steel. This is an austenitic, chrome-nickel, tough alloy that can be cold worked. It is typically used for very high production tooling applications because of its excellent wear characteristics. It is also more expensive then most conventional tooling materials. General characteristics include a 61 RA hardness and an 80,000 psi tensile strength.

Silicon bronze. This is a high silicon non-ferrous metal with a 96% copper, 3% silicon and 1% manganese composition. It is a fairly frequently used material for foundry tooling applications because of its good wear characteristics and machinability. General characteristics include a 40-97 RB hardness with a 56,000 to 110,000 psi tensile strength.

Class 30 gray iron. This material is the bench mark substance for the study. A typical Class 30 iron has a tensile strength of 30,000 psi and a BHN of 215. A major reason for the use of gray iron for foundry tooling is its machinability; it can be shaped to desired dimension with relative ease, and it also has good wear characteristics.

Test Procedure

The abrasion testing equipment used in this research utilizes a pyrex drum, filled with 5 pounds of sand,

rotating at 82 rpm causing a cascading of the sand onto a fixture which holds the test specimens. The specimens are mounted at a 45 degree angle so as to act as an impeller to the cascading sand. The fixture itself rotates at approximately 1400 rpm in the same direction as the drum. As the sand cascades onto the spinning fixture, impact abrasion occurs to the test specimens. This apparatus was devised for Gouwen's study in the 1960s. A drawing of the impact abrasion test apparatus can be found in Figure 1.

Each specimen was tested for three four-hour cycles in the fixture. Two specimens of each sample material were tested at different times to conform with testing parameters designed earlier for previous studies. The material weights were recorded before the test began and after each four hour cycle. A Mettler Type H15 balance was used to weigh the samples. This balance is a 160 g capacity unit calibrated every 6 months to NIST #732/246690-#523/240932 standards. The 5 pounds of sand contained in the drum was replaced after each cycle to ensure that new media was impacting the specimens. This eliminated any fractured or rounded sand grains which may have lost abrasiveness during the cycle. The molding material used for this research was a 58-62 AFS GFN sub angular to round silica sand. Selected specimens were examined using scanning electron microscopy to investigate wear patterns.

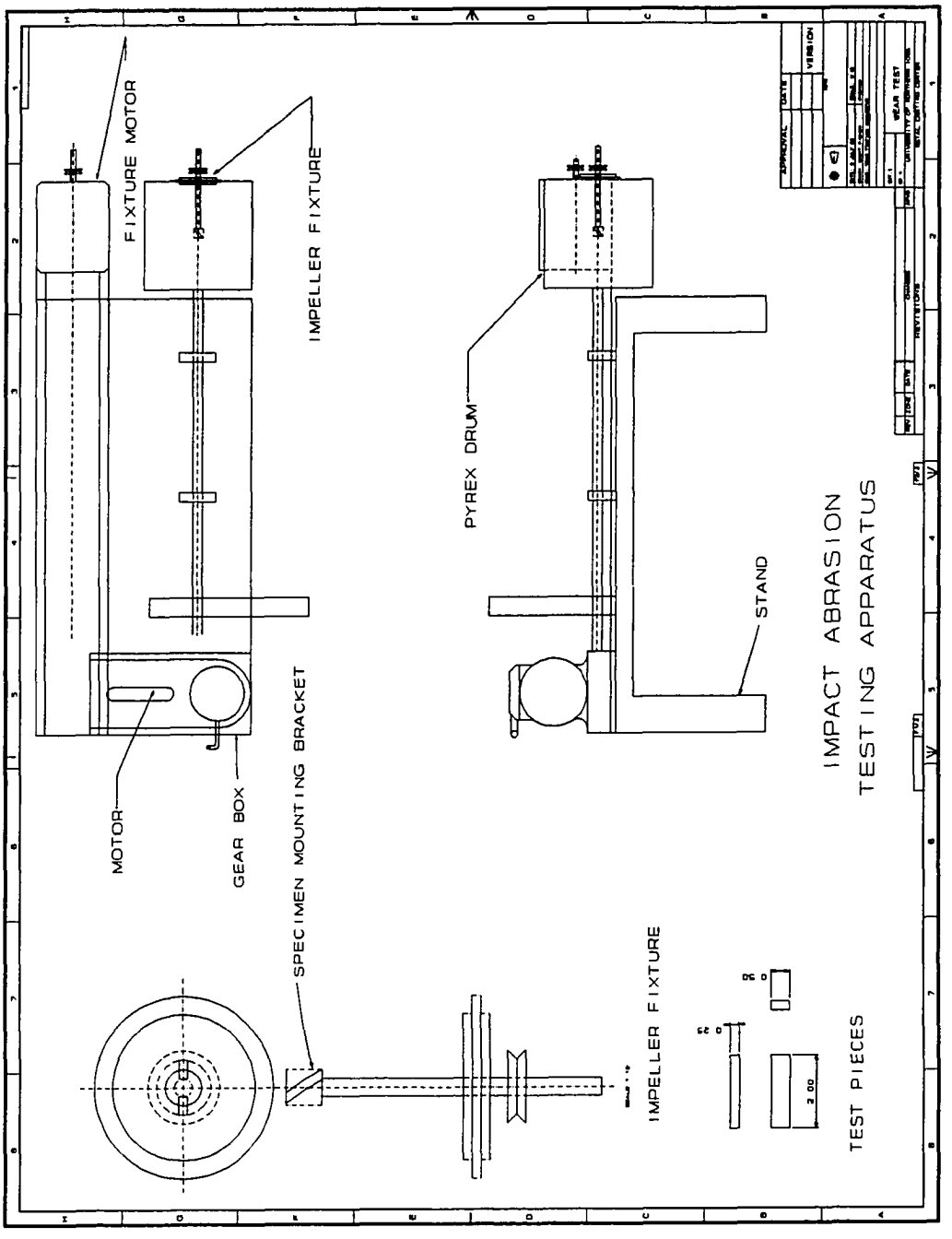

Figure 1. Drawing of impact abrasion testing apparatus.

Wear Factor

Upon analysis of the review of literature, it is apparent that foundry personnel lack a decision making tool, pertaining to wear resistance, for the analysis of data concerning potential tooling materials. Therefore, one intention of this study is to provide a mathematical device, a wear factor, which allows foundry personnel to make an informed decision pertaining to the wear resistance of potential tooling materials.

Cast iron being the bench mark of this study allows for a comparison to other materials. All materials were subjected to the same test procedures which draw a commonality and uniformity to all samples.

A major question asked by foundry professionals is; how well do these new tooling materials wear as compared to cast iron? In order to answer that question, a simple mathematical computation must be administered. The key element of this equation is percentage weight loss.

It was theorized that each material will experience at least some weight loss as a result of the sand abrasion. Because cast iron is the bench mark, it is the material to which all others were compared. Therefore, to arrive at the wear factor, each sample's percentage weight loss number was divided by cast iron's number. This resulting wear factor can indicate to a foundry professional how long he/she can

expect a tool to last in the foundry environment as compared to cast iron.

Electron Microscopy Analysis

To investigate the surface of the specimens after impact abrasion, selected materials were analyzed using scanning electron microscopy. In order to conduct this analysis the non-metallic materials had to be coated with a conductive material to facilitate observation. These materials were carbon coated using a Denton model DV-502A vacuum chamber located at a major midwest manufacturing facility. Micrographs of the four selected materials can be found in Figures 2-9.

The purpose of this investigation was to visually examine the erosive effects on the materials after the impact abrasion experience. A visual examination was made comparing the eroded surface to the before test surface. Also, an elemental analysis of two of the materials can be found in Figures 10-17.

A unique capability of the scanning electron microscope is its ability to image a field of view regardless of the surface condition. A microscope, which uses light imaging, shows a two dimensional representation of the viewed surface. Conversely, scanning electron imaging allows for surface observation in three dimensions.

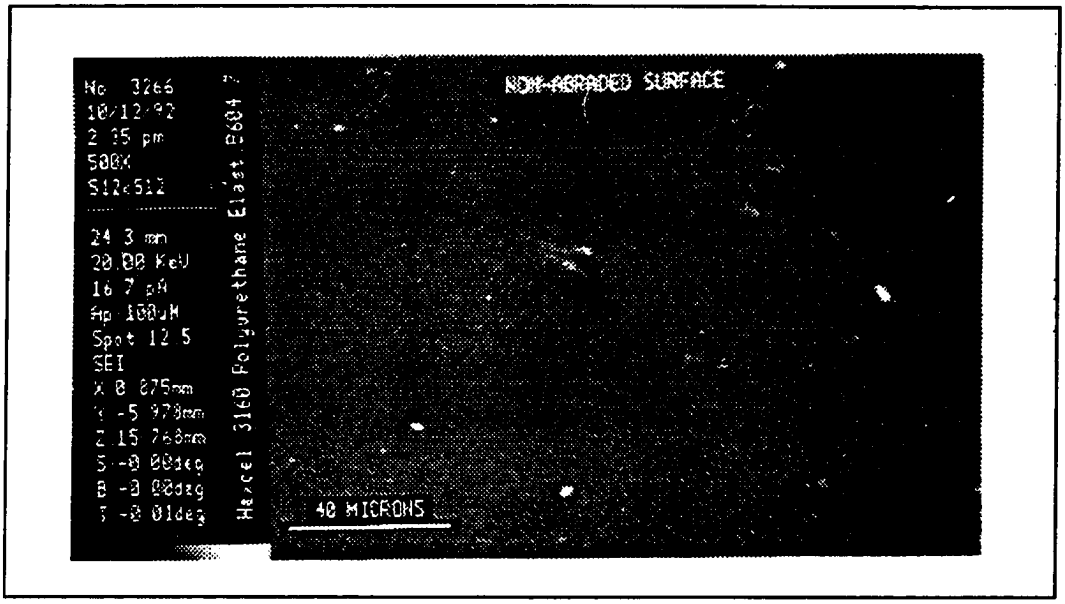

Figure 2. Non-abraded surface of Hexcel 3160.

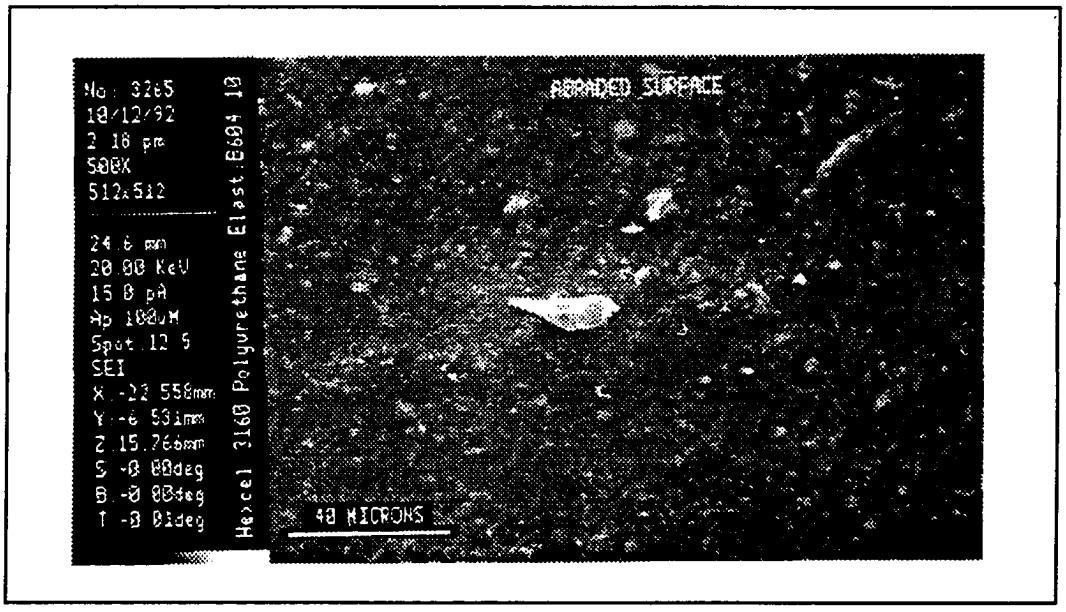

Figure 3. Abraded surface of Hexcel 3160.

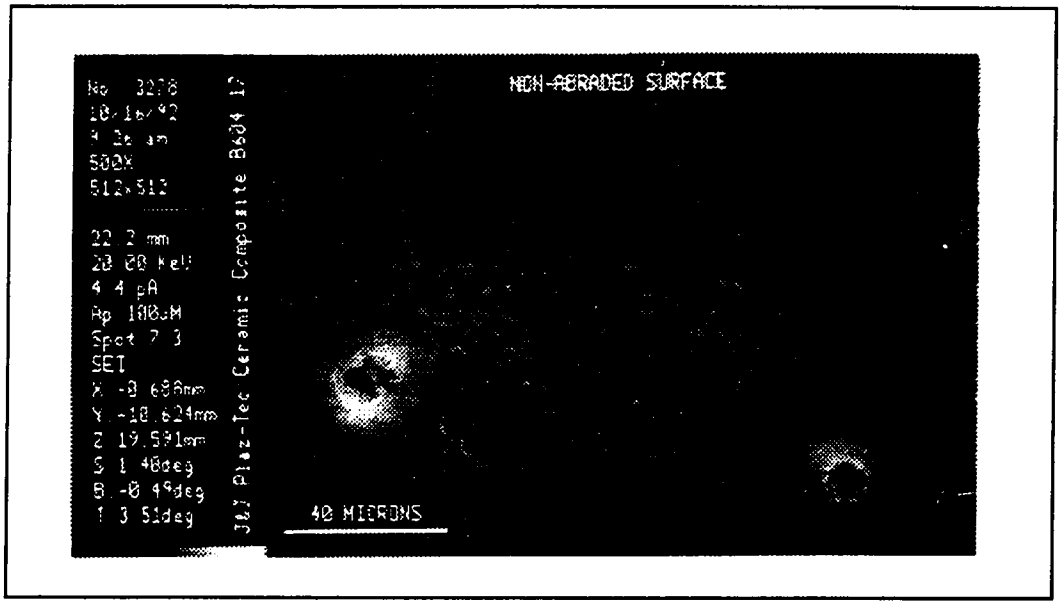

Figure 4. Non-abraded surface of J&J Plaz-Tec ceramic.

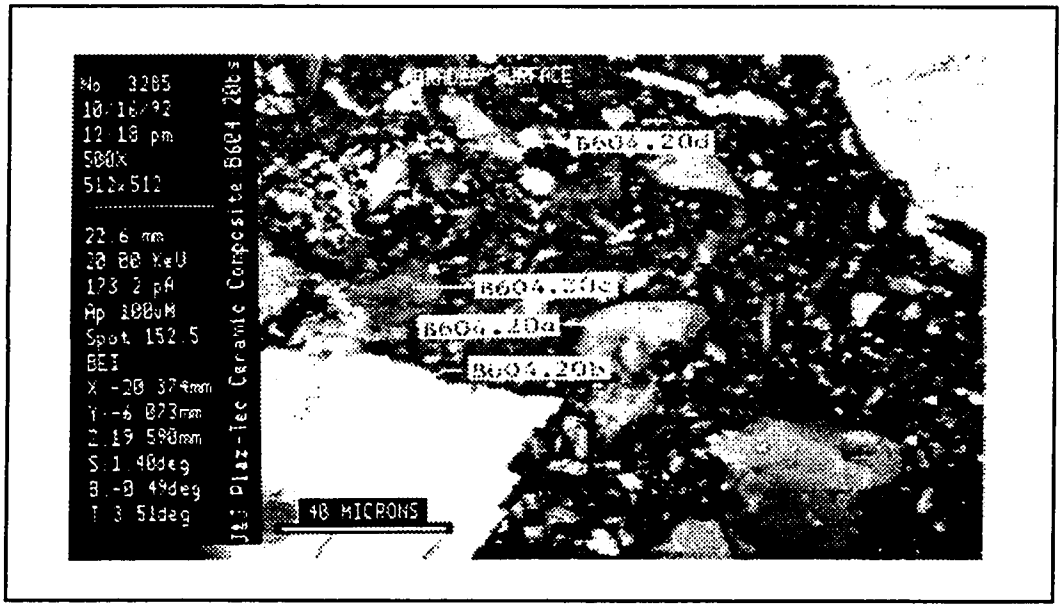

Figure 5. Abraded surface of J&J Plaz-Tec ceramic.

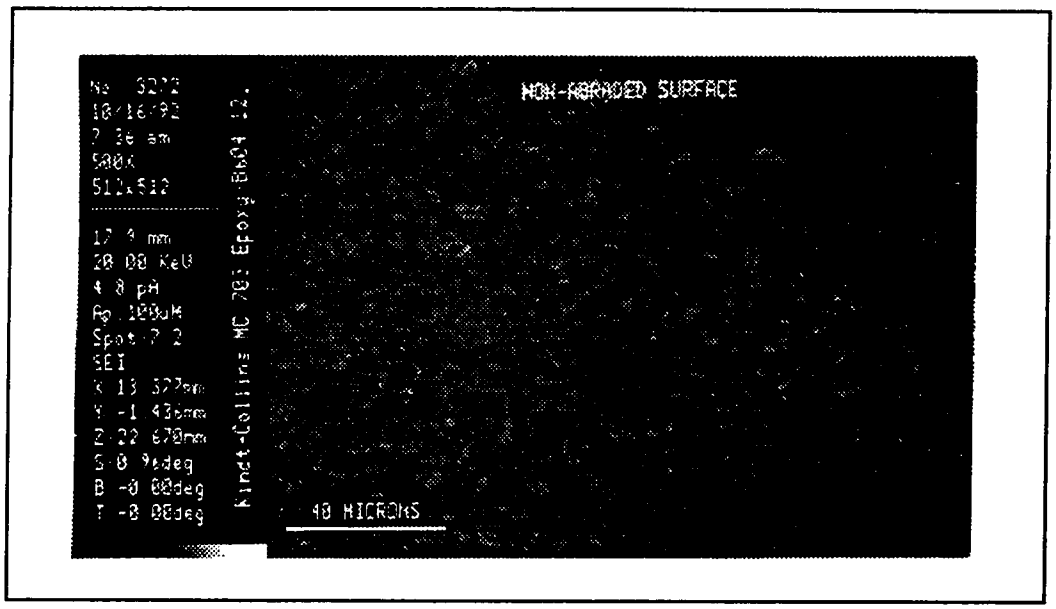

Figure 6. Non-abraded surface of Mastercast 703.

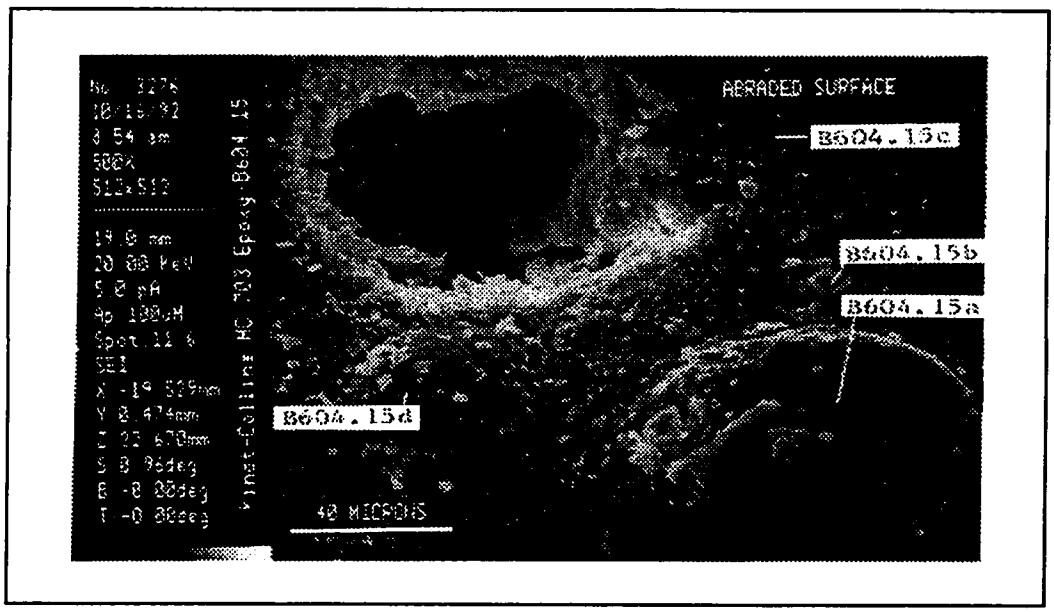

Figure 7. Abraded surface of Mastercast 703.

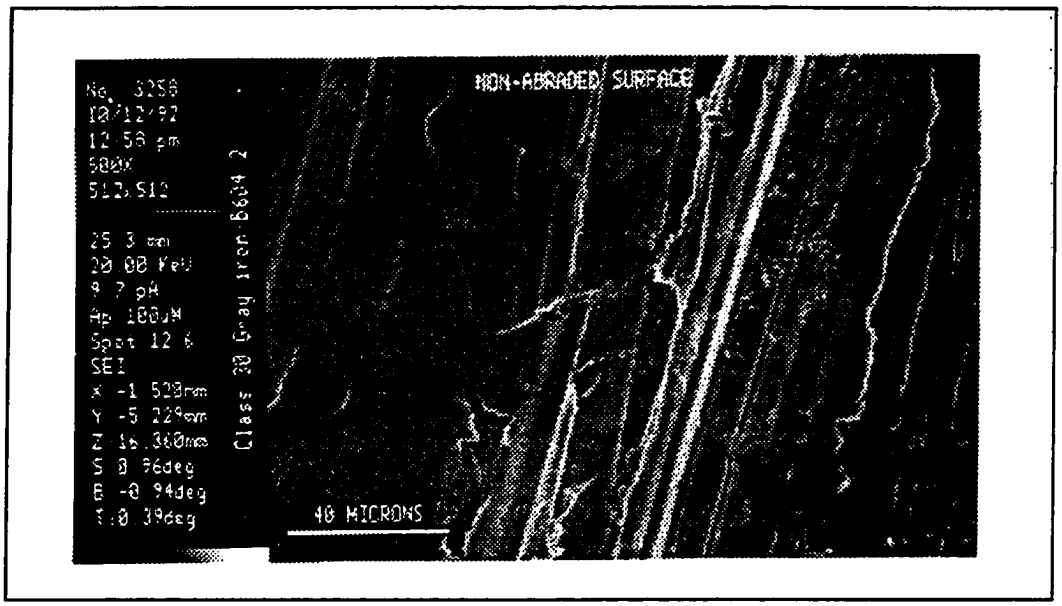

Figure 8. Non-abraded surface of Class 30 gray iron.

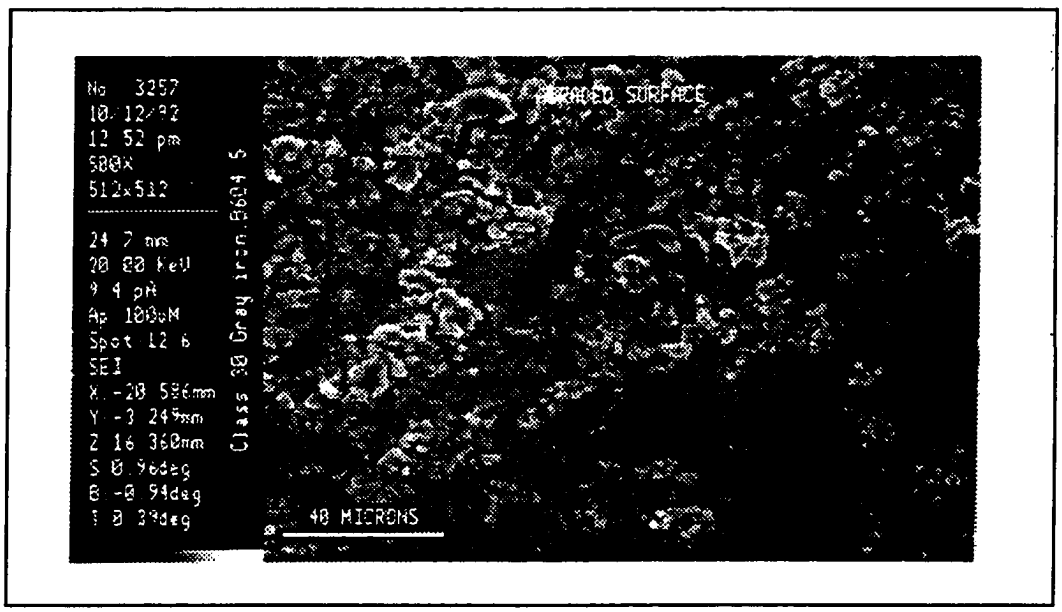

Figure 9. Abraded surface of Class 30 gray iron.

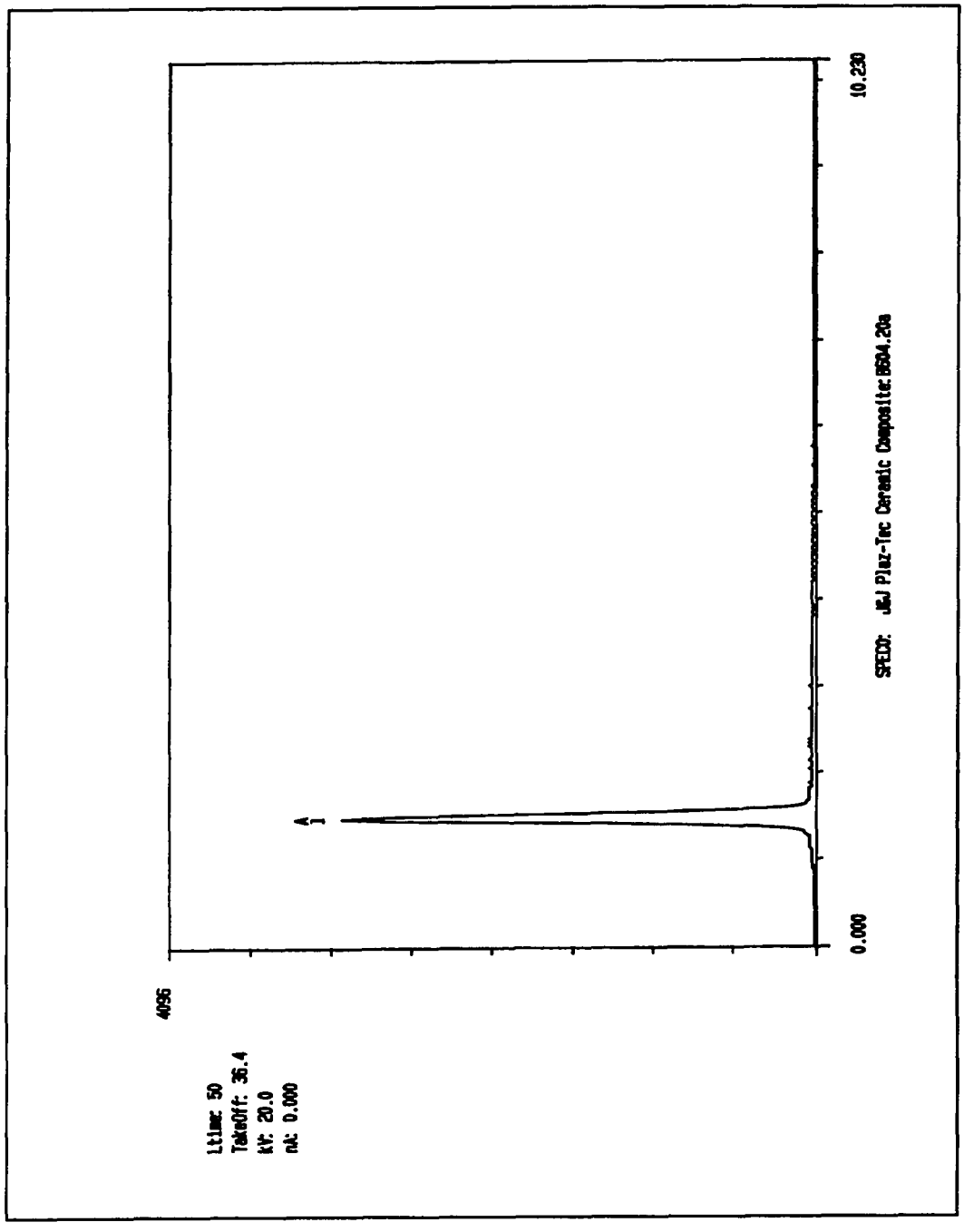

Figure 10. Elemental analysis of J&J Plaz-Tec Ceramic area B604.20a.

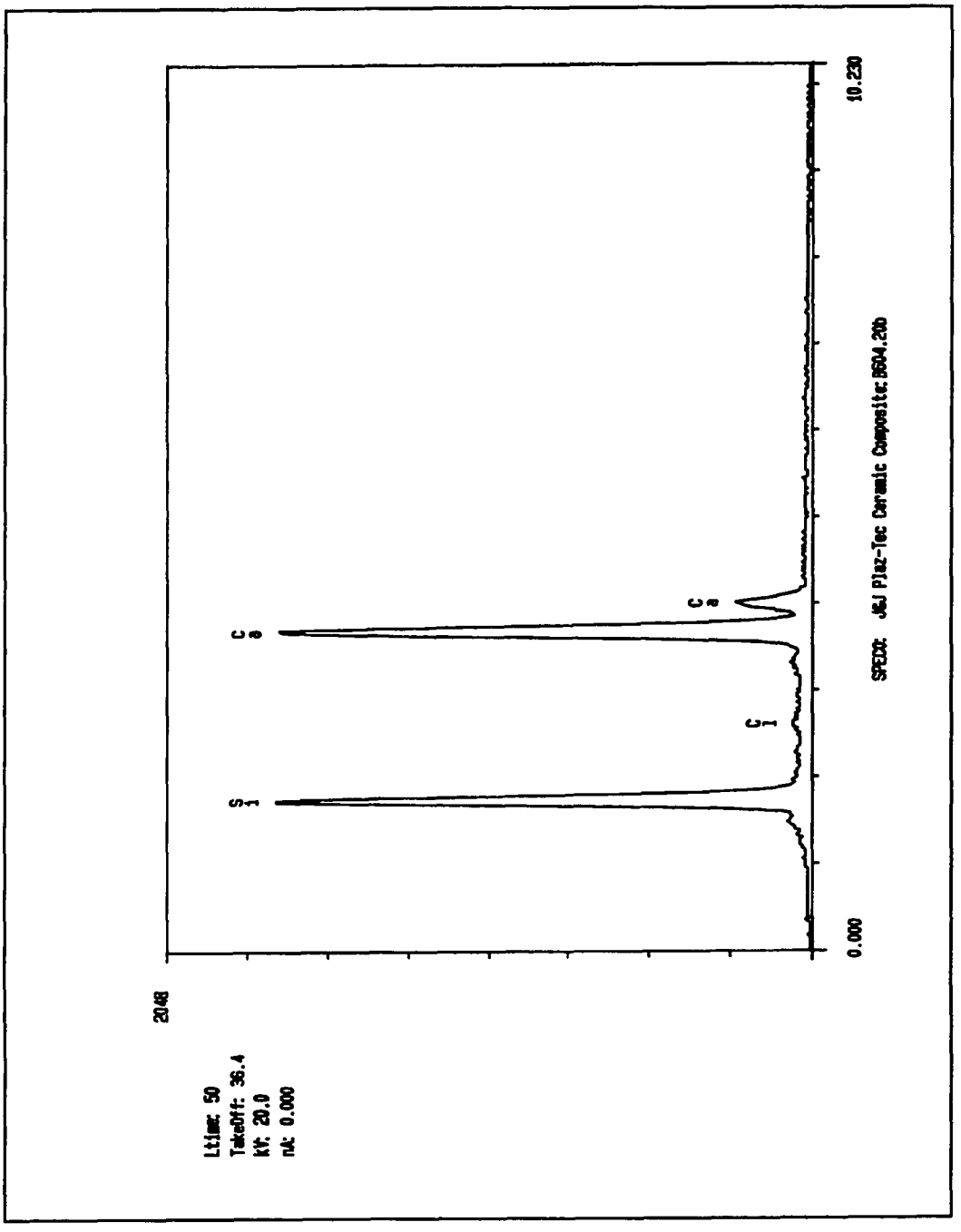

Figure 11. Elemental analysis of J&J Plaz-Tec ceramic area B604.20b.

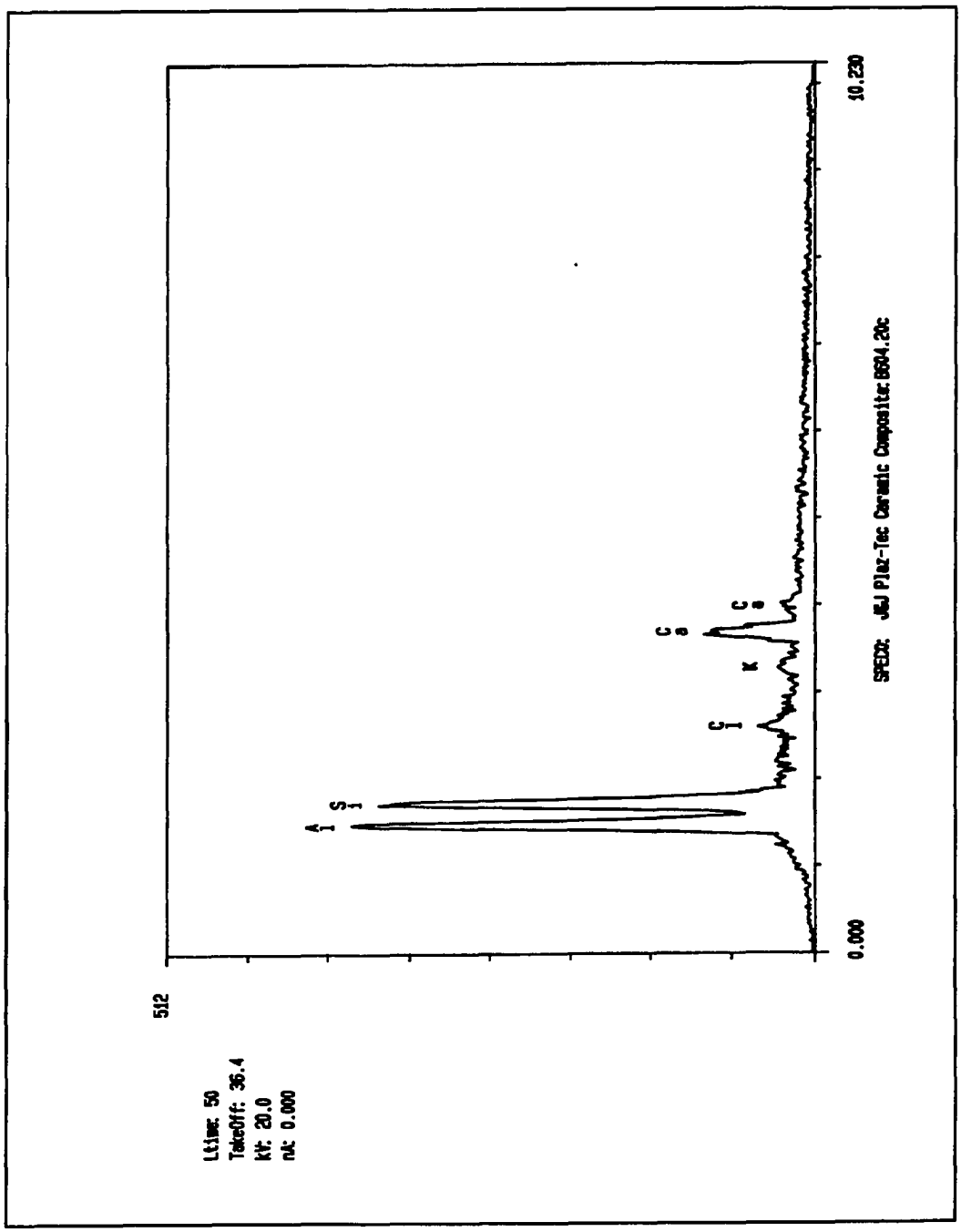

Figure 12. Elemental analysis of J&J Plaz-Tec ceramic area B604.20c.

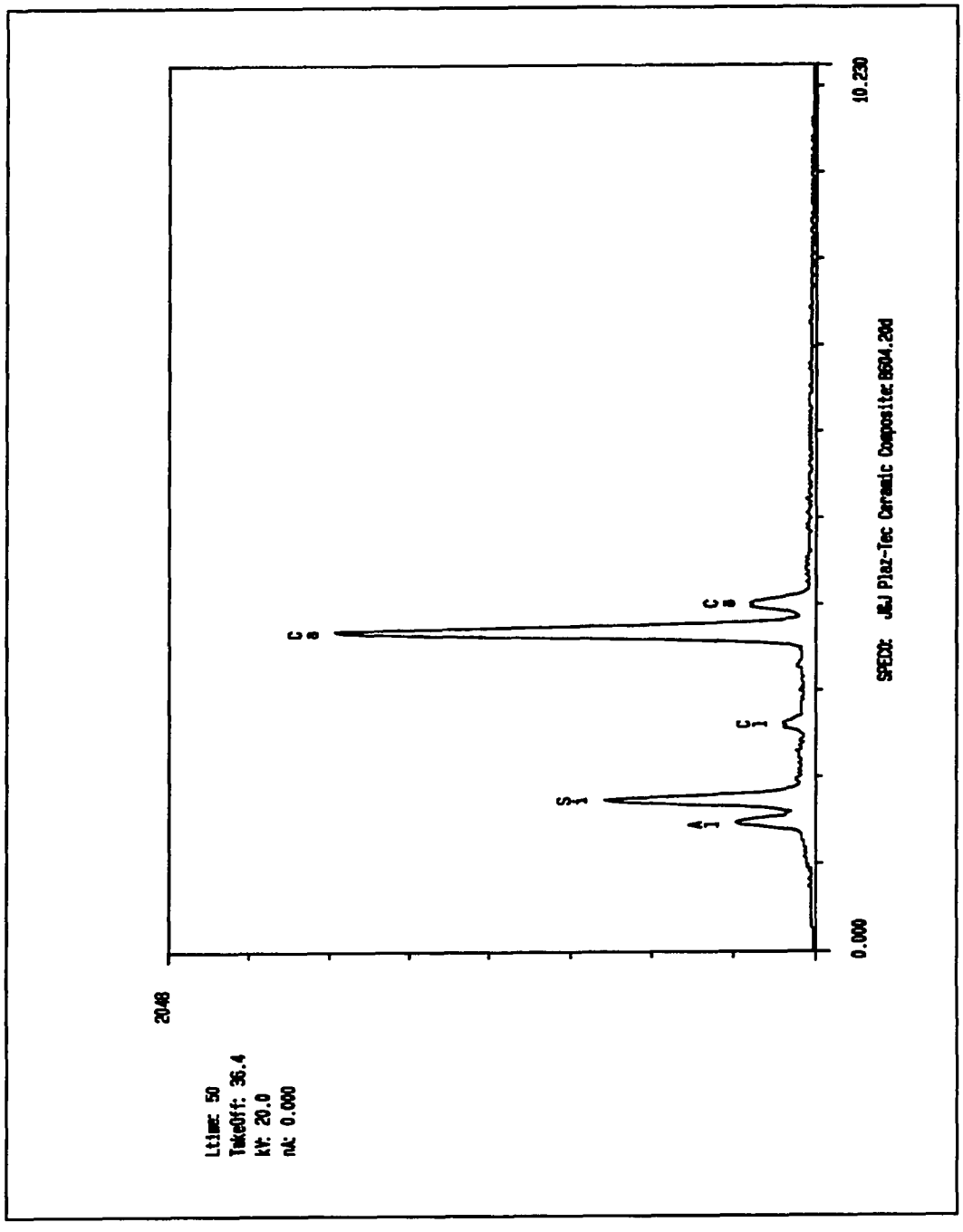

Figure 13. Elemental analysis of J&J Plaz-Tec ceramic area B604.20d.

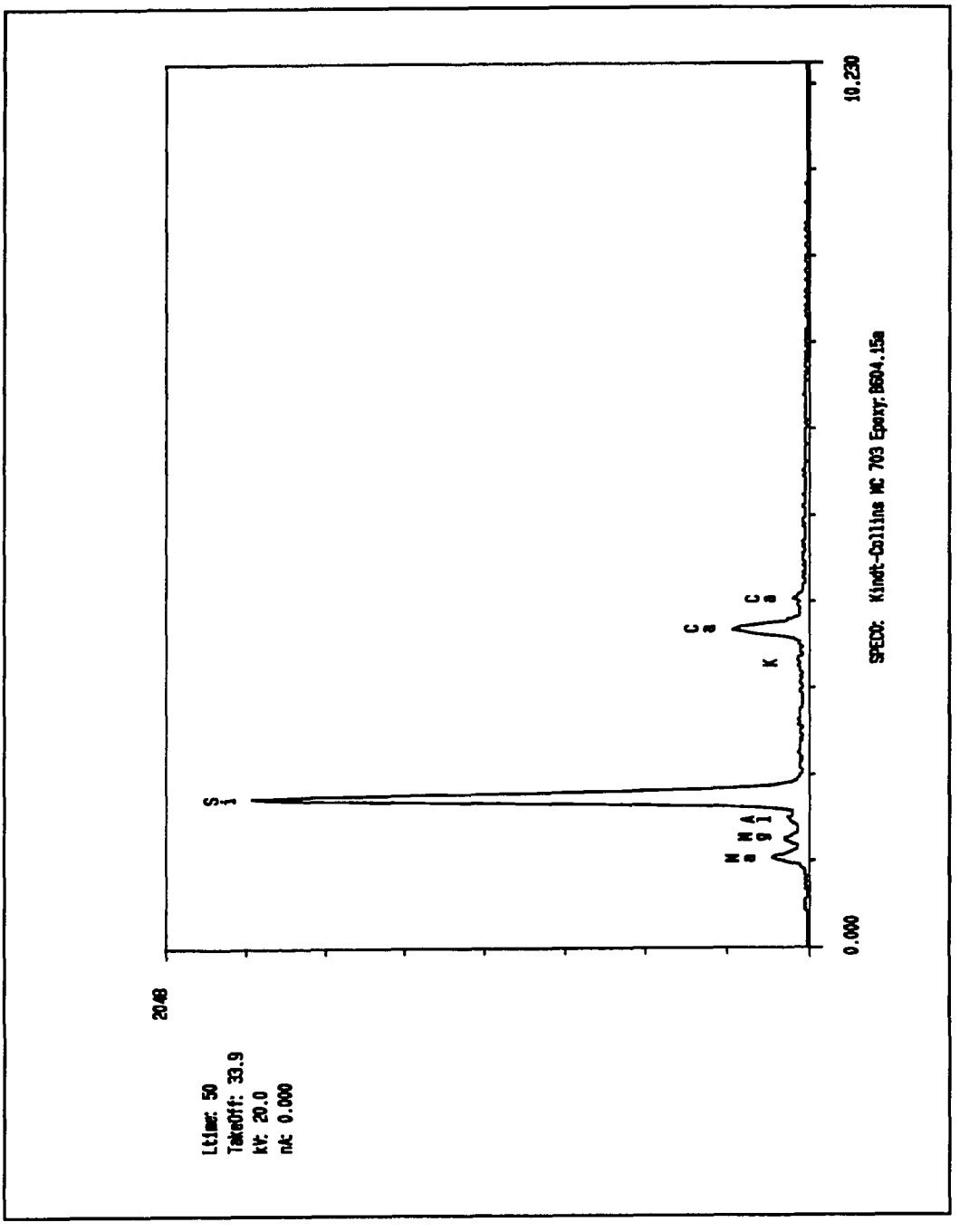

Figure 14. Elemental analysis of Mastercast 703 area B604.15a.

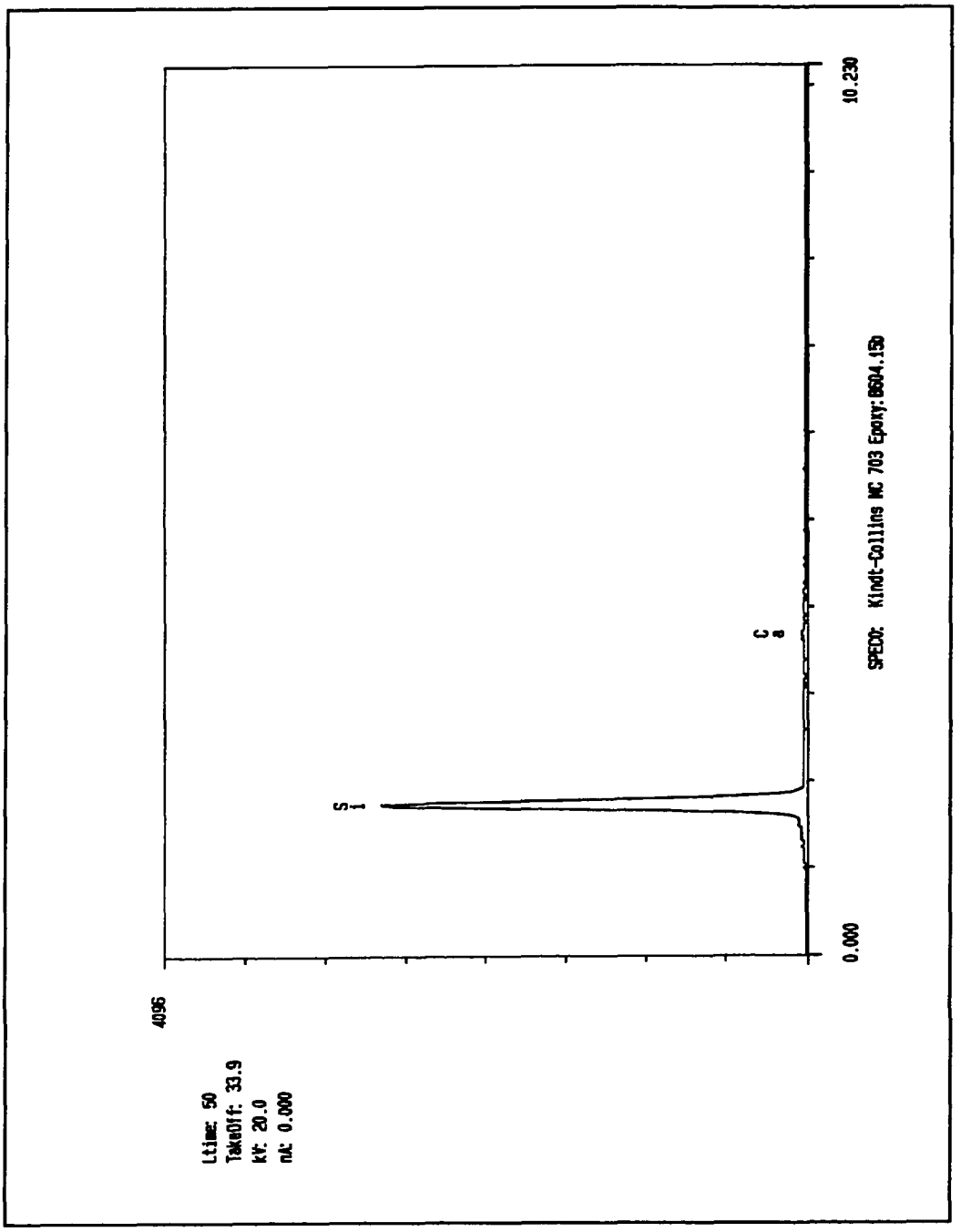

Figure 15. Elemental analysis of Mastercast 703 area B604.15b.

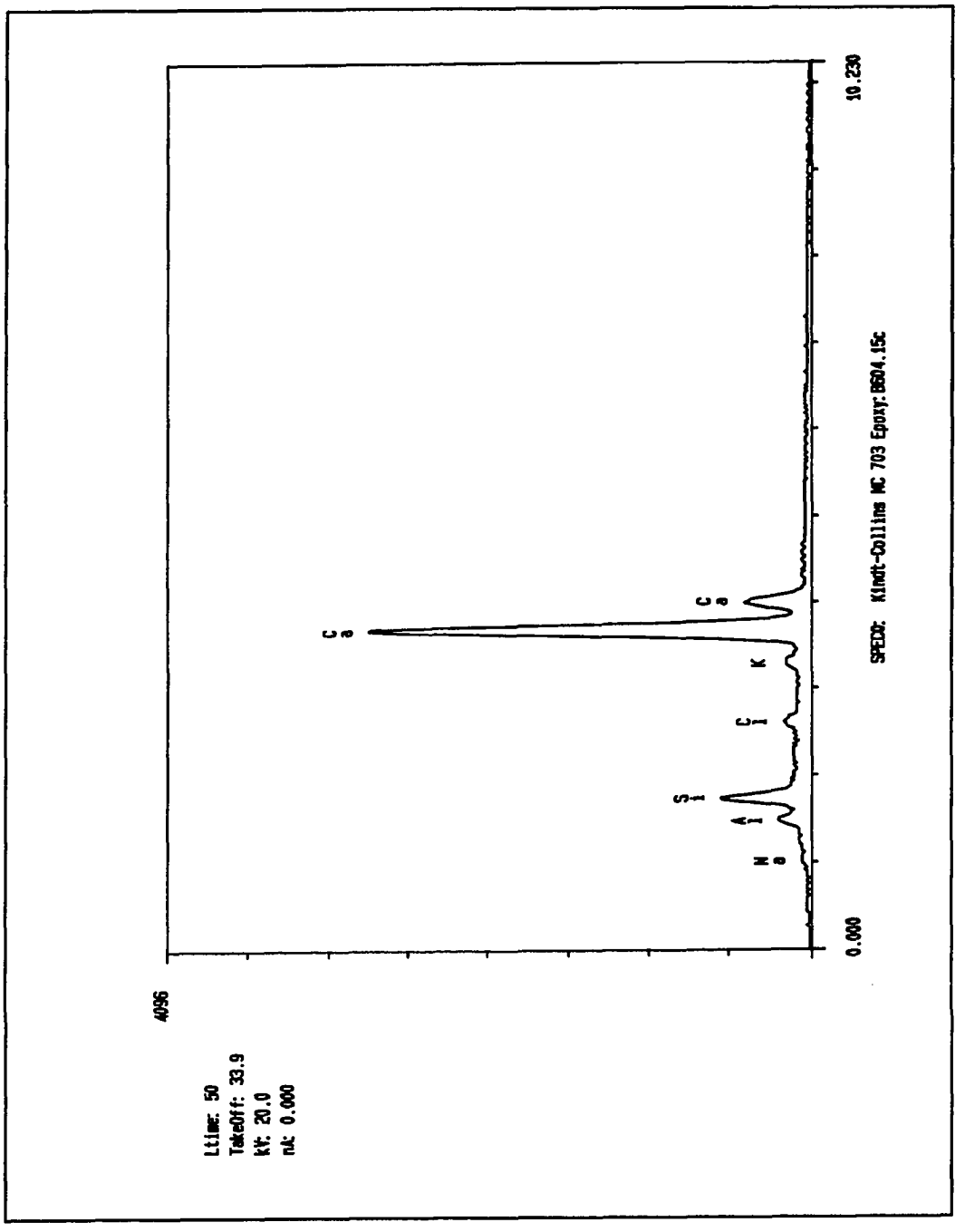

Figure 16. Elemental analysis of Mastercast 703 area B604.15c.

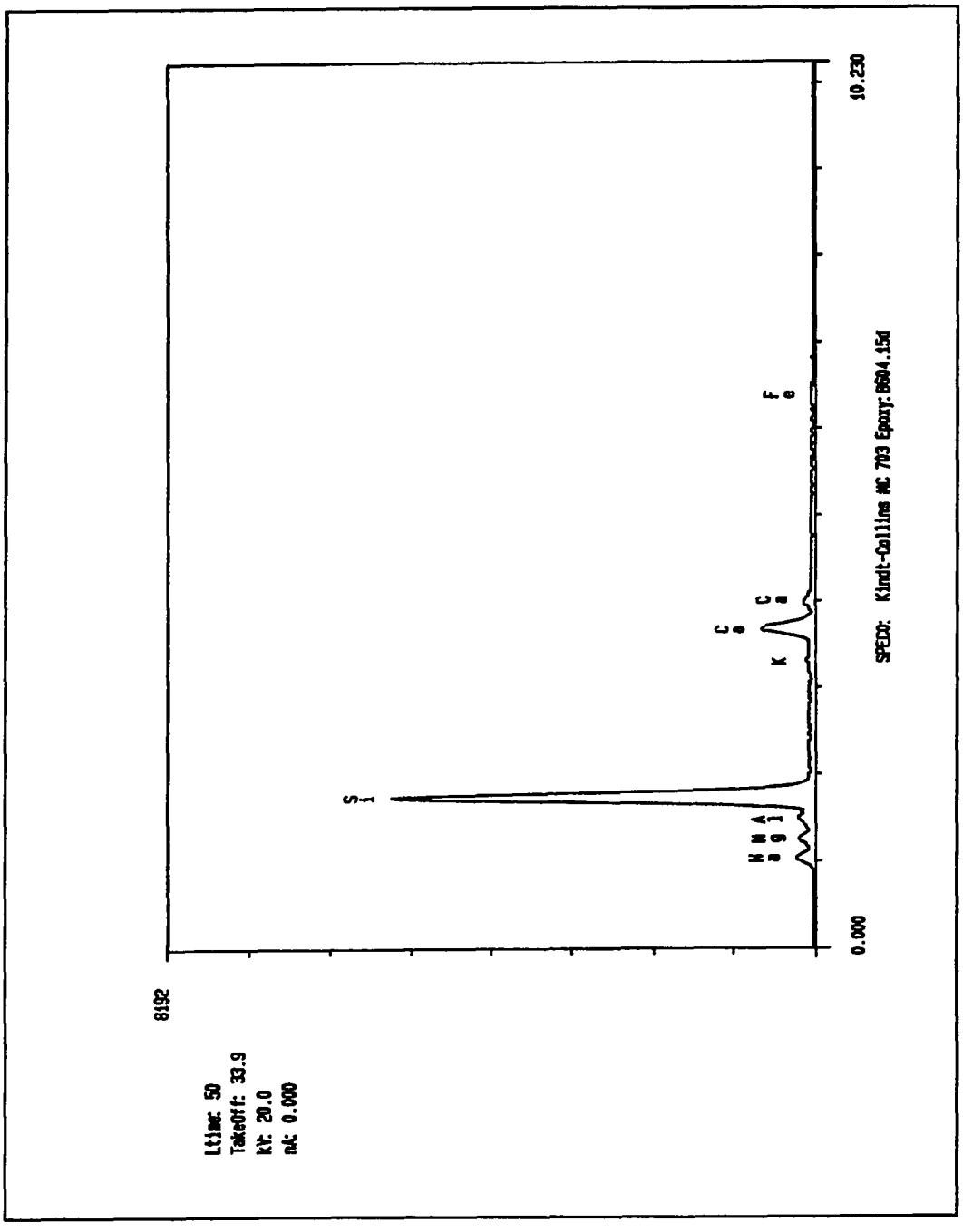

Figure 17. Elemental analysis of Mastercast 703 area B604.15d.

The Tracor Northern ADEM scanning electron microscope was used to examine the specimens. This equipment was also located at a large midwest manufacturing company.

CHAPTER IV

PRESENTATION OF DATA

The purpose of this chapter is to provide a meaningful presentation and interpretation of the data collected for this study. It is intended that the data generated be used by foundry personnel to aid in making tooling decisions.

Samples of the tested materials were obtained from a variety of sources. Some were received directly from the manufacturer for abrasion testing research, others were obtained by personnel from a large midwest foundry's Alternative Tooling Committee. The abrasion tests were conducted in conjunction with the Tooling Committee's task to explore new materials for foundry use.

A list of possible alternative tooling materials for evaluation was compiled from a review of literature. Materials no longer available from the manufacturer or containing known carcinogens were rejected for possible consideration in this study.

The final number of alternative tooling materials tested represented the commercially available substances that have potential as foundry tools. These materials, while not entirely safe to humans, can be handled safely with the proper equipment and precautions. Material Safety Data Sheets (MSDS), obtained from the manufacturers, are included in Appendix B. Impact Abrasion Test Data Sheets of

each individual material are included in Appendix C. When viewing Figures 18 through 32 the vertical axis range is not consistant. Following is an analysis of the materials tested by group.

Materials Tested

Polyurethane Elastomers

Of the 34 materials tested 22 are combined into the polyurethane elastomer group. Included in this group are the polyurethane elastomers, a steel filled polyurethane elastomer, and two elastomeric surface coats. This group is the largest because of the polyurethane elastomer's perceived compatibility with foundry tooling applications therefore, more of the materials were considered for testing. Some of these materials demonstrated the best wear resistance characteristics of all the non-metallic specimens tested. As mentioned previously all of the specimens tested were compared to Class 30 gray iron, the bench mark material.

The material that had the least percentage weight loss of the polyurethane elastomers tested was Conap's Conathane TU-900. See Figure 18 for the TU-900 visual slope comparison with Class 30 gray iron. Appendix D contains the remaining visual slope comparisons of the materials tested not included in this chapter.

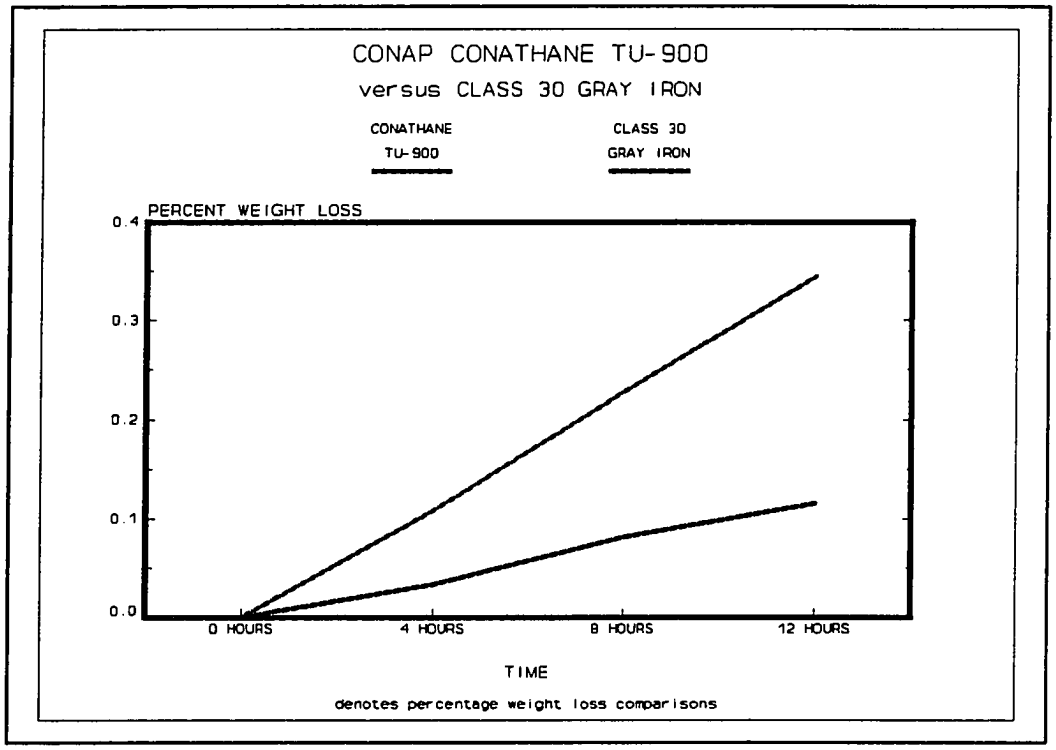

Figure 18. Slope comparison of TU-900 to gray iron.

This material exhibited the least percentage weight loss (0.3440%) under test conditions. However, one possible reason for its excellent wear resistance characteristics may be attributed to the material's relative hardness. This is a relatively soft material with a Shore A hardness of 85-95. It has been observed that some softer polyurethane elastomeric materials tended to exhibit lower erosion characteristics.

While displaying good wear characteristics, softer materials may have a disadvantage resisting blow and squeeze

pressures during core blowing and molding operations. These materials may have difficulty maintaining the necessary dimensional accuracies due to elastic deformation occurring during those pressures.

Another Conap material, Conathane TU-956, exhibited slightly inferior wear resistance compared to the TU-900 under test conditions. See Figure 19 for visual slope comparisons with Class 30 gray iron. However, this material is harder (50-60 Shore D) than TU-900 and may not suffer

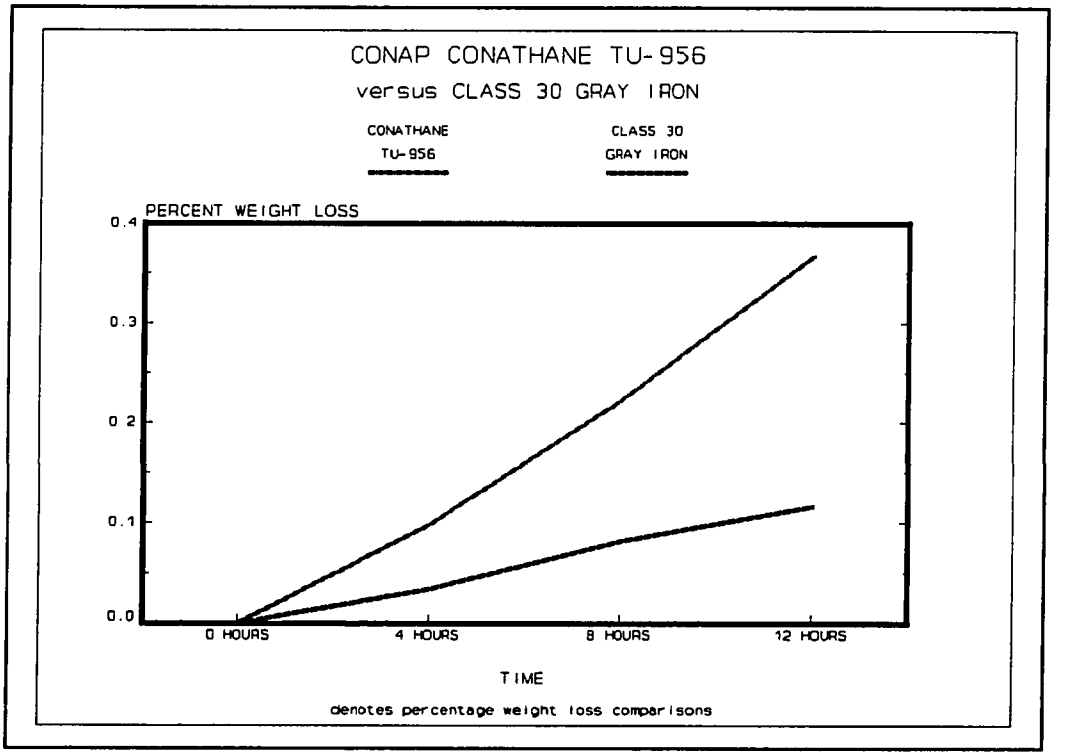

Figure 19. Slope comparison of TU-956 to gray iron.

from elastic deformation during coremaking and molding pressures. Of the medium hardness polyurethane elastomers tested this material exhibited the least percentage weight loss (0.3670%).

Conversely, the polyurethane elastomer with the greatest percentage weight loss under impact abrasion test conditions was Hexcel's Uralite 3530. This material is a medium hardness (65 Shore D) elastomer. It exhibited a 2.6088% weight loss during testing. See Figure 20 for visual slope comparisons with Class 30 gray iron.

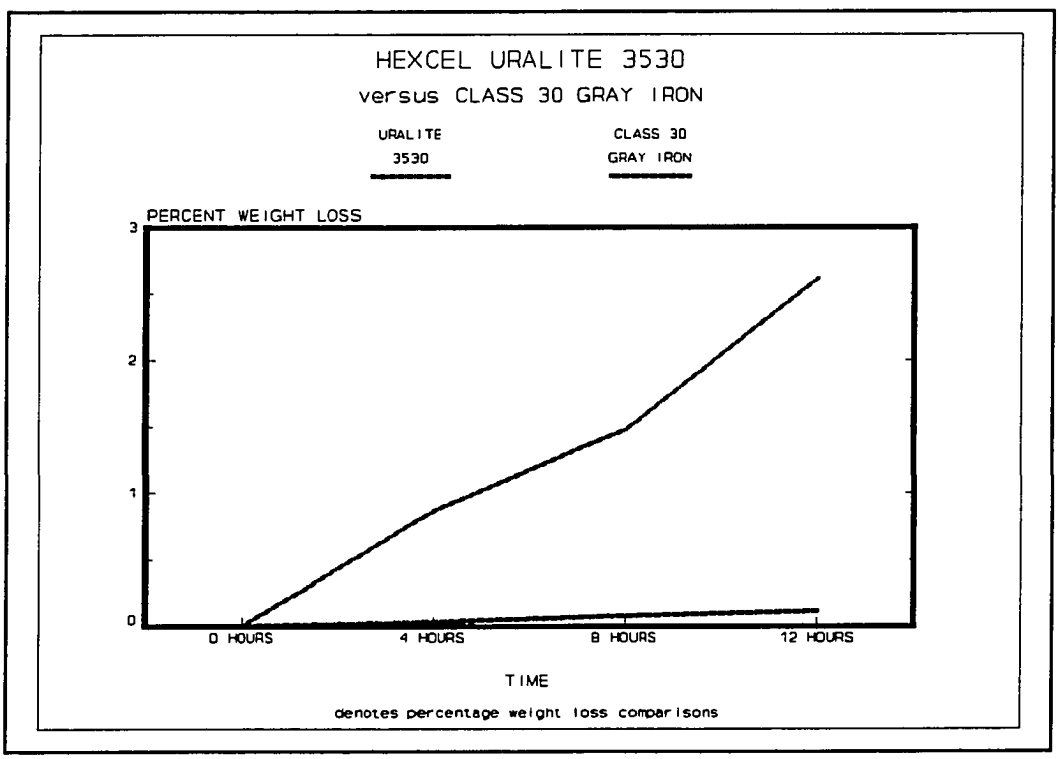

Figure 20. Slope comparison of Uralite 3530 to gray iron.

Epoxies

Three materials were included in the epoxy group. These include one polyurethane/epoxy alloy and two epoxies. All three materials exhibited inferior percentage weight loss reactions to the impact abrasion testing. Kindt-Collins' Mastercast 703 exhibited the lowest percentage weight loss within the group with a 2.5806%. Figure 21 shows the visual slope comparison with Class 30 gray iron.

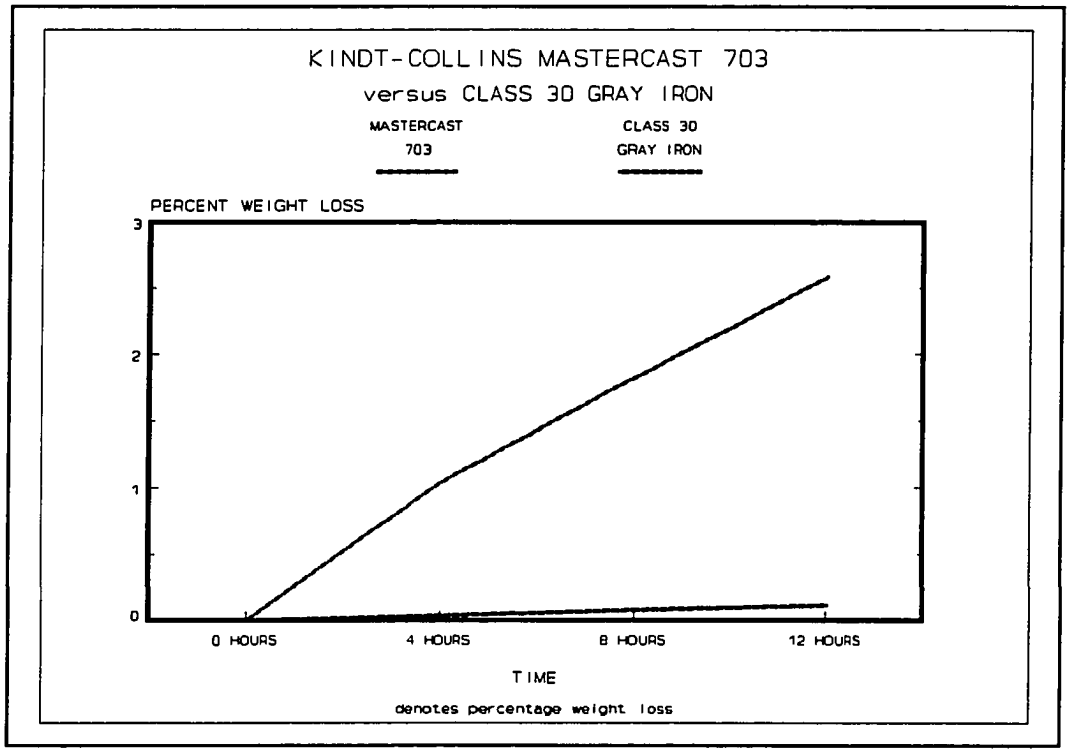

Figure 21. Slope comparison of Mastercast 703 to gray iron.

Following, within this group, was Hapco's Hapcast 5730 then U.S. Gypsum's 301/308 Epoxical with 3.9476% and 4.0448% weight loss respectively. See Figures 22 and 23 for visual slope comparisons with Class 30 gray iron.

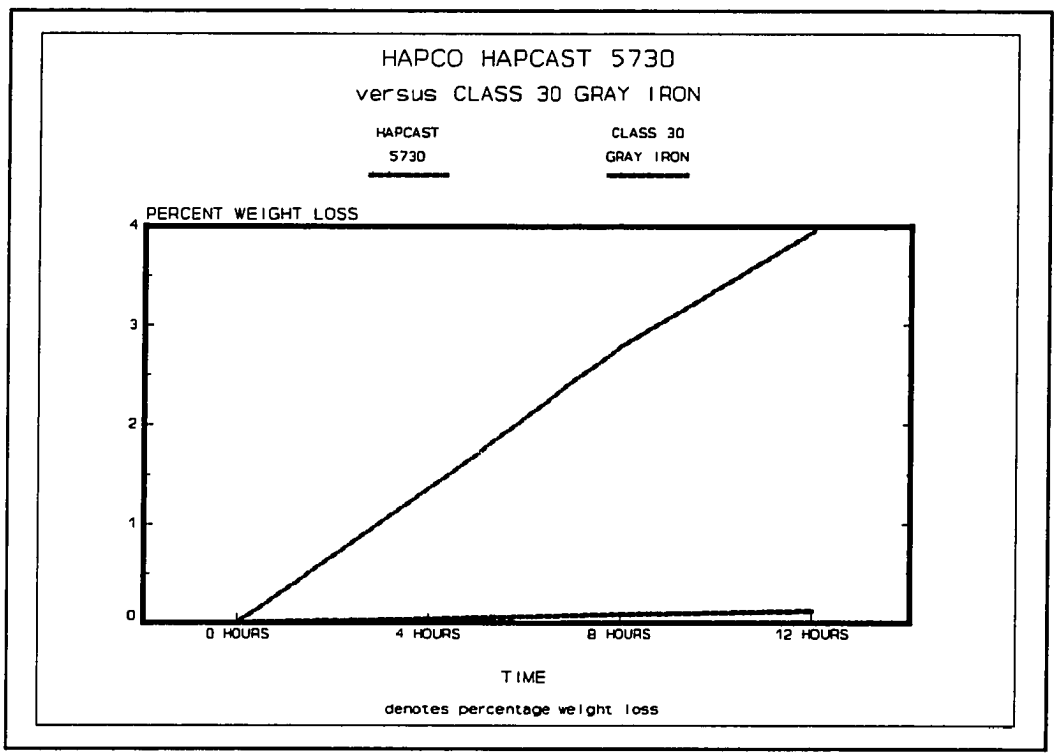

Figure 22. Slope comparison of Hapcast 5730 to gray iron.

Plastic Liquid Molding Compounds

Two materials were included in this group, Hapco's Ultralloy 40 and Ultralloy 50. These two materials demonstrated the greatest percentage weight loss of all the specimens tested in this study. Ultralloy 40 exhibited

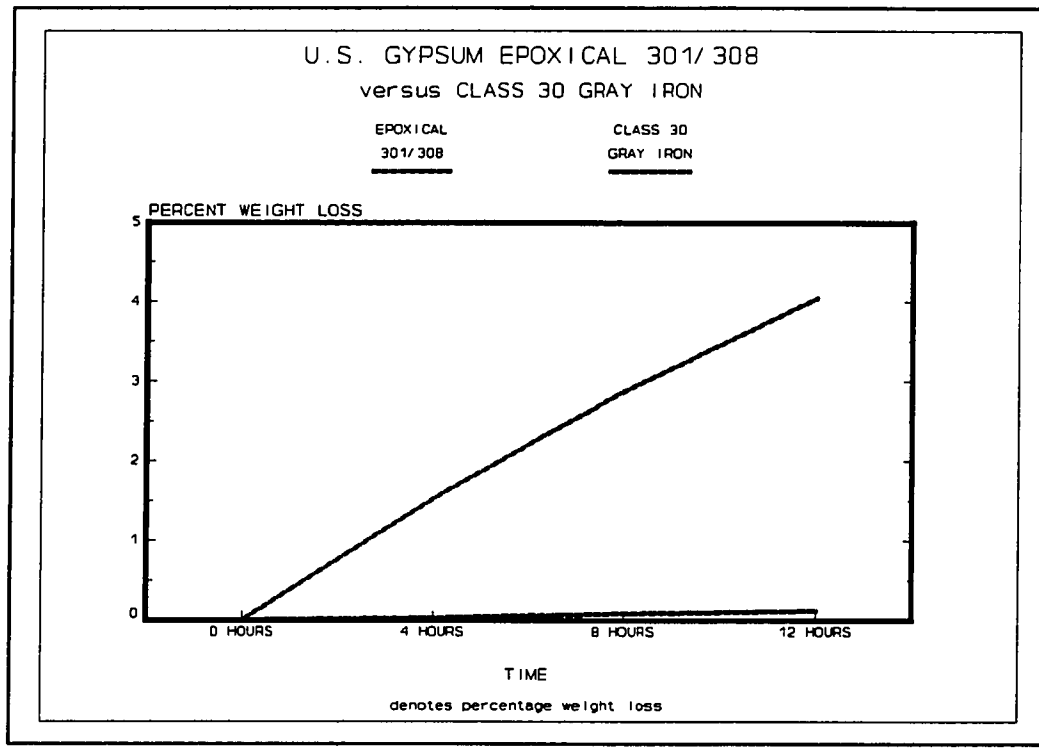

Figure 23. Slope comparison 301/308 Epoxical to gray iron.

9.5043% weight loss and Ultralloy 50 7.4140%. Figures 24 and 25 exhibit visual slope comparisons with Class 30 gray iron.

Polymer Ceramic Composites

J&J Corp's two ceramic materials, Plaz-Tec Ceramic and Plaz-Tec Fiberglass backed Ceramic, were included in this group. Both were composed of the same surface material with one having a fiberglass backing. It was observed that the fiberglass backed material exhibited inferior wear resistance after testing (4.7074%) compared to the pure

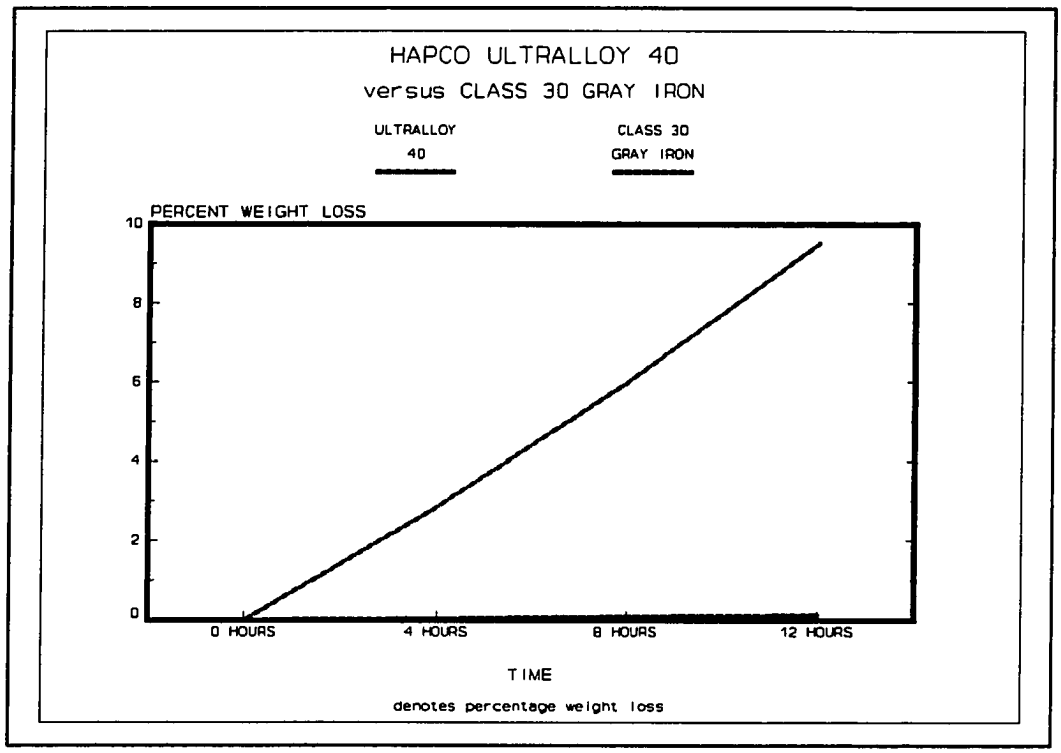

Figure 24. Slope comparison of Ultralloy 40 to gray iron.

ceramic composite (2.4957%). See Figures 26 and 27 for visual slope comparisons with Class 30 gray iron. This may have occurred due to the complete erosion of the ceramic surface which is heavier than the fiberglass backing. The fiberglass backing material also experienced erosion thereby possibly accounting for the greater percentage weight loss of the two ceramics.

Stereolithography Photopolymer

LMB 5086 was the only photopolymer tested in this study therefore, it was placed into a group of its own. It is a

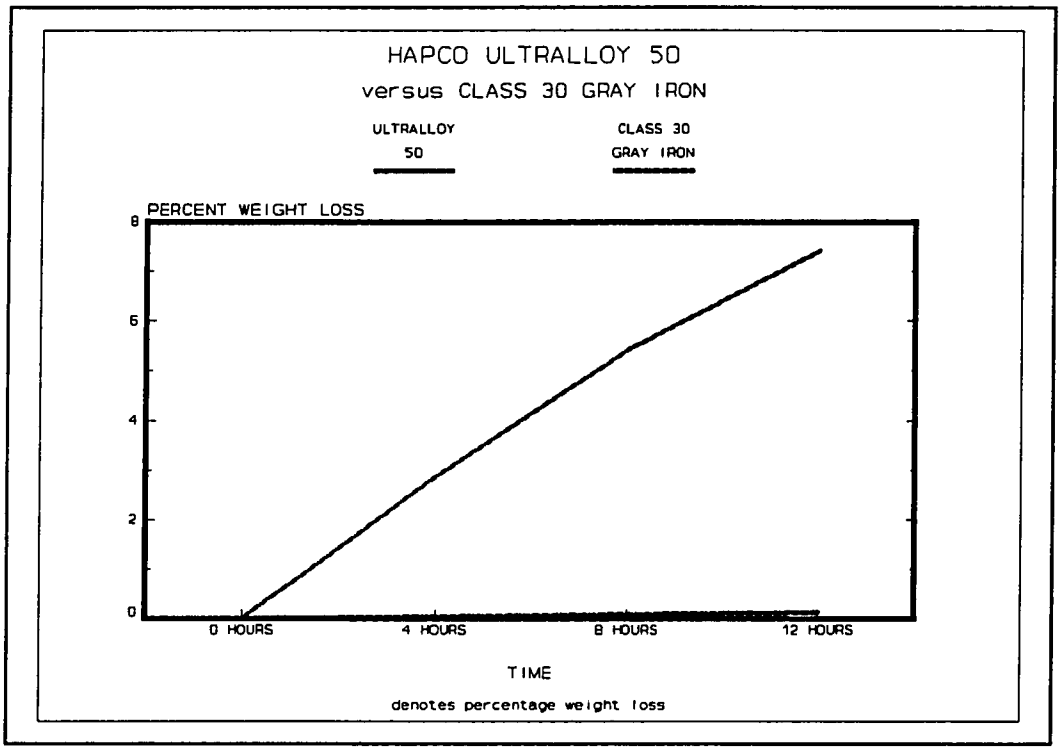

Figure 25. Slope comparison of Ultralloy 50 to gray iron.

very unique material, being activated and cured by ultraviolet radiation. This material is an early generation photopolymer which is already obsolete and no longer available from the manufacturer. LMB 5086 also demonstrated an inferior percentage weight loss (3.4850%), compared to the majority of test specimens under experimental conditions. See Figure 28 for visual slope comparisons with Class 30 gray iron.

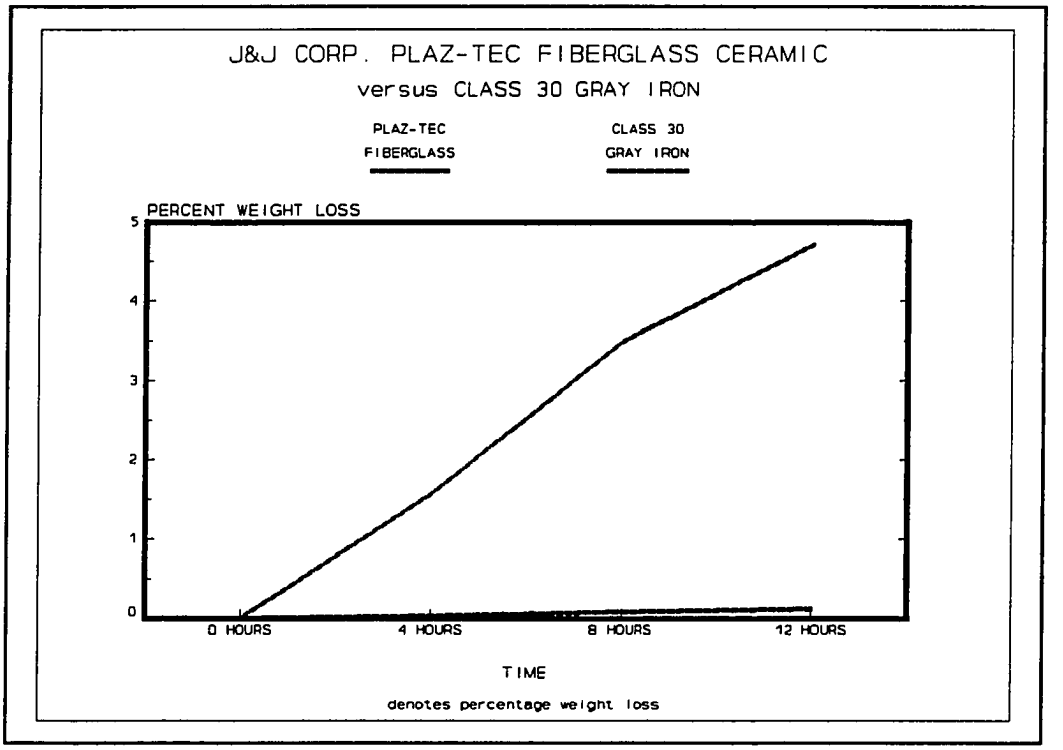

Figure 26. Slope comparison of fiberglass backed ceramic to gray iron.

Artificial Modeling Material

Renshape 450 was the only artificial modeling material tested in this study. It is used extensively for master and prototype tooling. The material was selected for impact abrasion testing due to its extensive use in the foundry industry. While it is widely used for prototype and master tooling in the industry it is not appropriate for production due to its poor wear resistance characteristics, demonstrating a 5.8374% weight loss under test conditions.

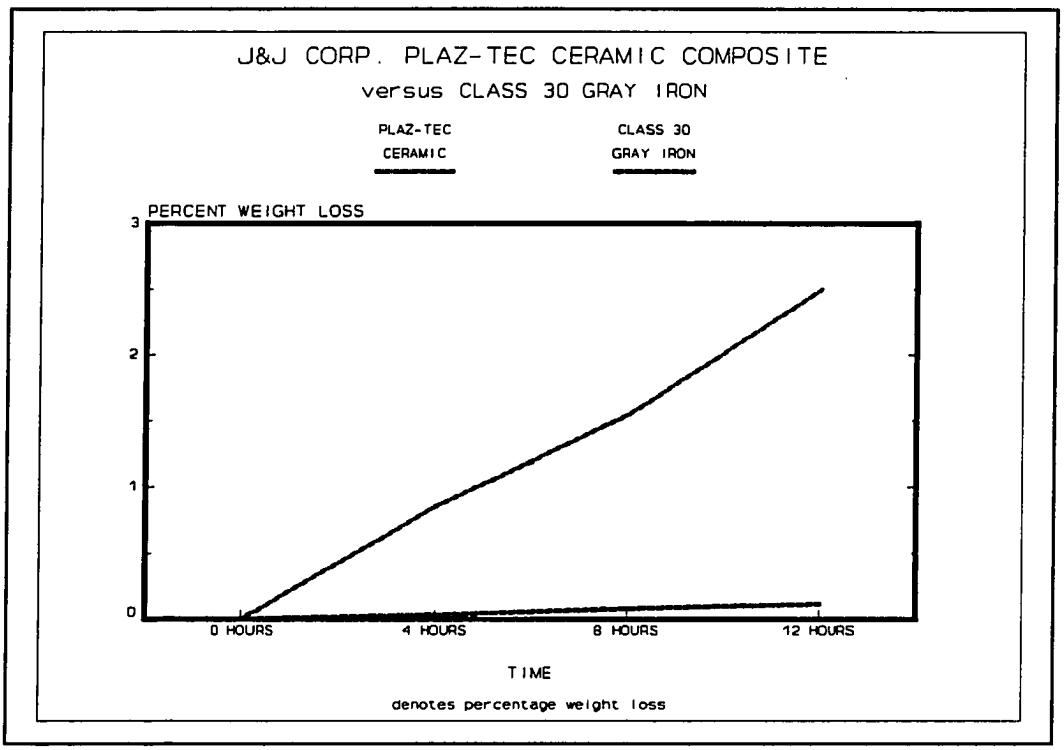

Figure 27. Slope comparison of ceramic to gray iron.

See Figure 29 for visual slope comparisons with Class 30 gray iron.

Metallic Tooling Materials

Three metallic materials were included in this study besides cast iron. These metallics were included in the study due to their popular use as tooling materials in the foundry industry. Of the four materials in this group only silicon bronze exhibited an inferior percentage weight loss (0.3622%), compared to Class 30 Gray Iron (0.1160%). See Figure 30 for visual slope comparisons of silicon bronze to

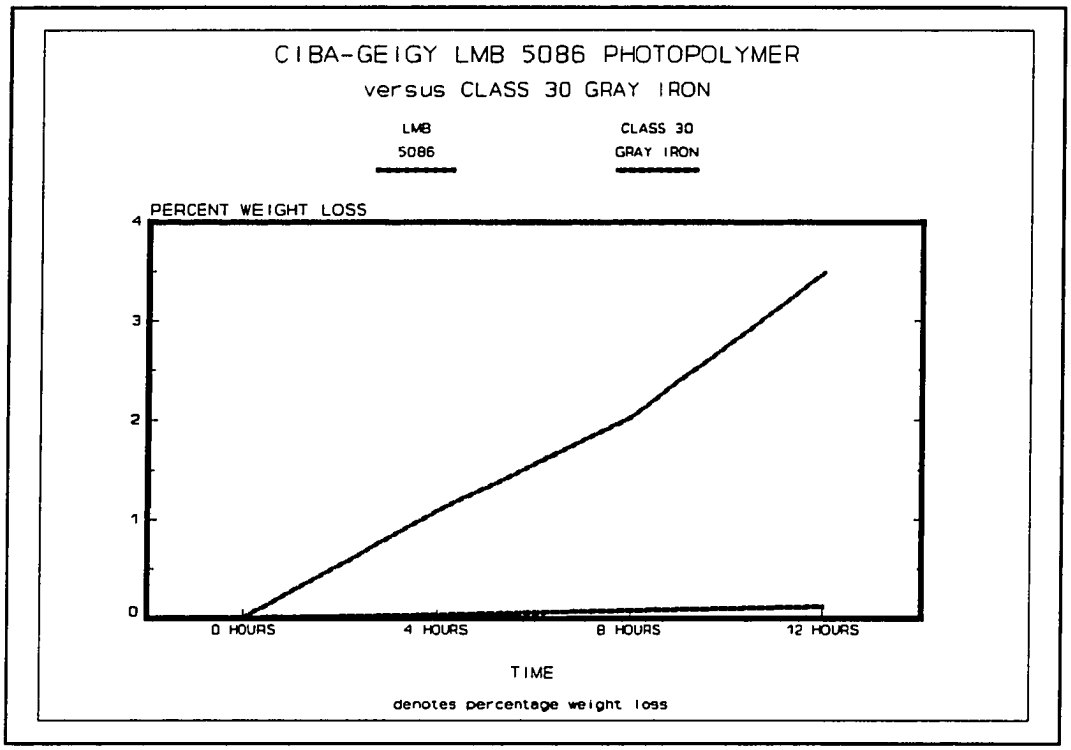

Figure 28. Slope comparison LMB 5086 to gray iron.

Class 30 gray iron. The other two metallics, AISI 1020 low carbon steel and 304 stainless steel, exhibiting (0.0313%) and (0.0310%) weight loss numbers respectively. See Figures 31 and 32 for visual slope comparisons with Class 30 gray iron.

Helzer, in his 1988 study, also tested AISI 1020 low carbon and 304 stainless steels. The results of the two studies exhibited parallel outcomes. This was to be expected as the same equipment and very similar abrasives were used in the two studies. This also confirms the

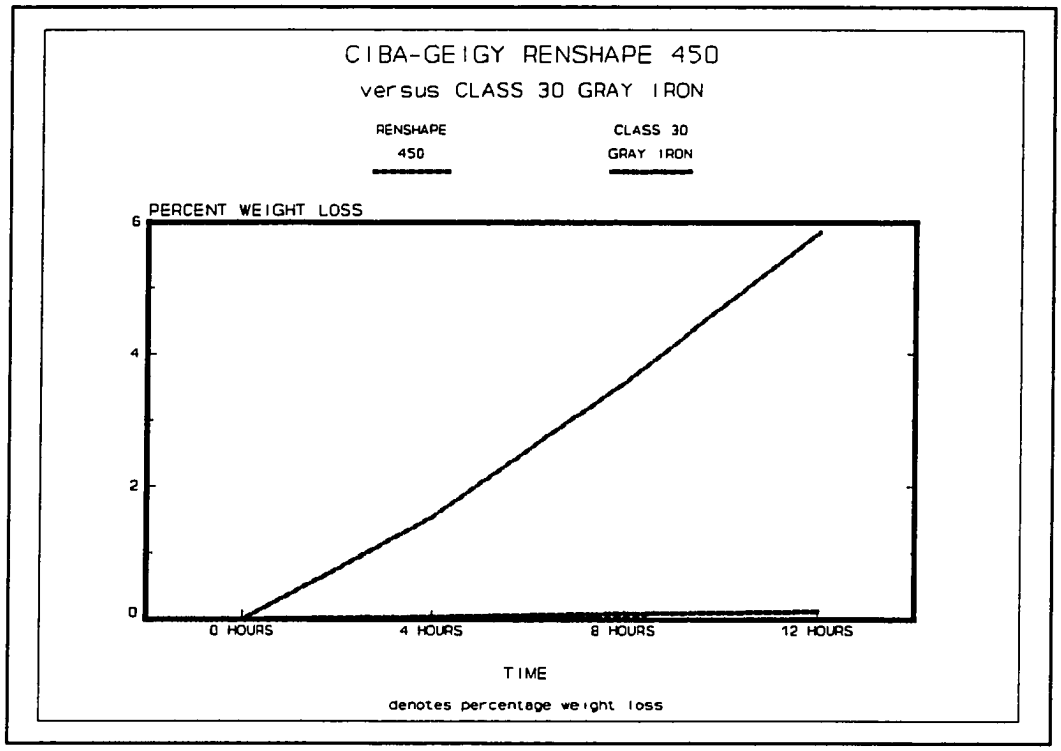

Figure 29. Slope comparison of Renshape 450 to gray iron.

reliability and repeatability of the test procedures used in this study.

Wear Factor Analysis

To further utilize the percentage weight loss numbers and be able to use them for tooling decision making it is necessary to calculate the wear factor conversion. Each final percentage weight loss number must be divided by Class 30 gray iron's integer to arrive at the desired conversion. See Table 1 for a list of all the materials, percentage weight loss numbers, and corresponding wear factors.

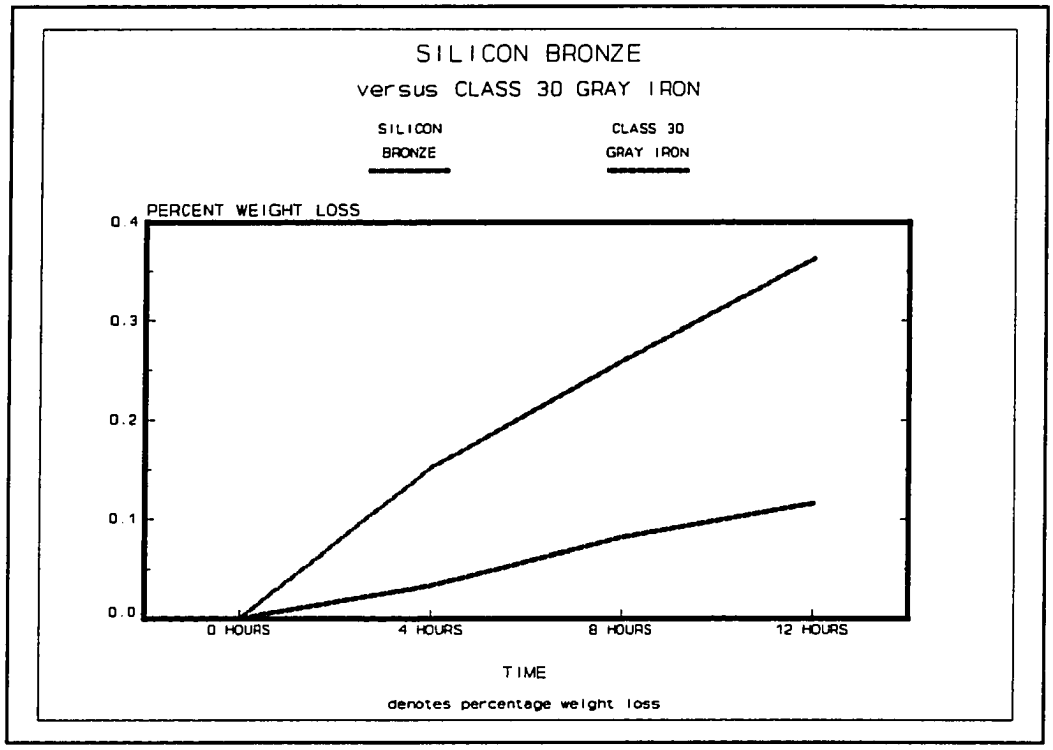

Figure 30. Slope of silicon bronze to gray iron.

Scanning Electron Microscopy Analysis

Scanning Electron Microscopy was used to visually inspect the surface condition of four test materials. Four materials were chosen primarily for general information purposes to observe the before and after impact abrasion surface condition. The specimens represented four of the material groups tested in this study namely: polyurethane elastomers, ceramics, epoxies, and metallics.

Two scans were taken of each of the materials. A before test condition labeled "non-abraded surface" and an

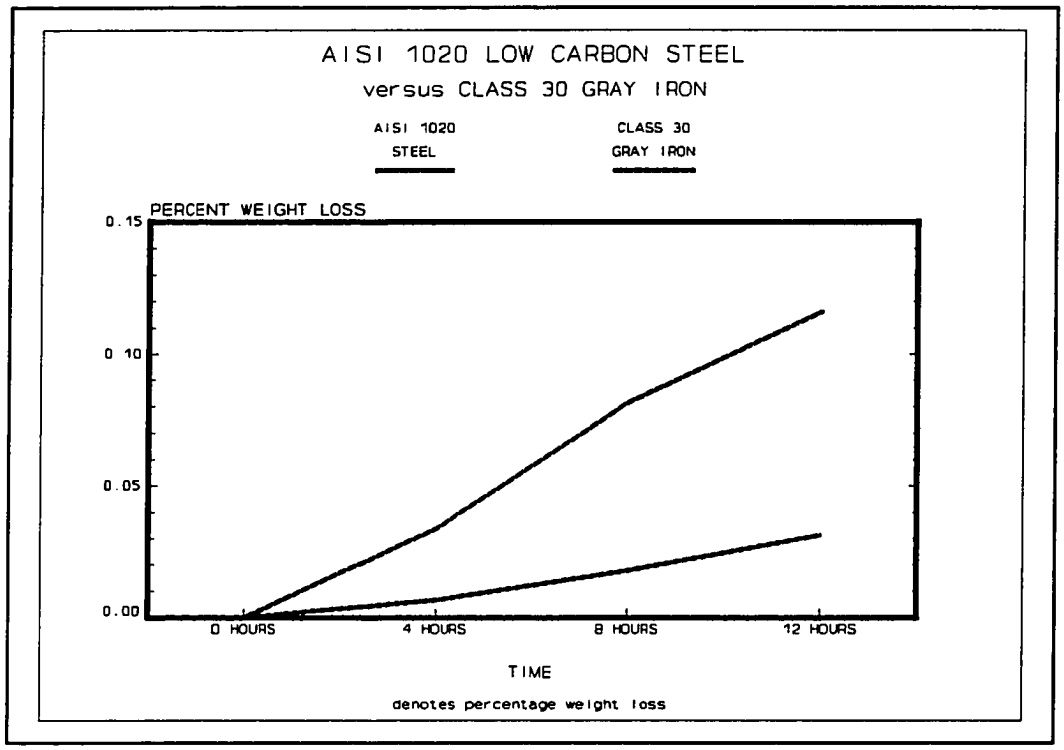

Figure 31. Slope comparison of 1020 low carbon steel to gray iron.

after trial status labeled "abraded surface" The micrographs were taken at 500X in order to magnify the surface well enough to see any potential damage. See Figures 2-9 for micrographs of the four materials scanned.

The micrograph (Figure 2) showing the non-abraded condition of the Hexcel 3160 polyurethane elastomer exhibited a very smooth surface before abrasion. Conversely, the surface after abrasion micrograph as seen in Figure 3 exhibited a rougher condition. There also appears

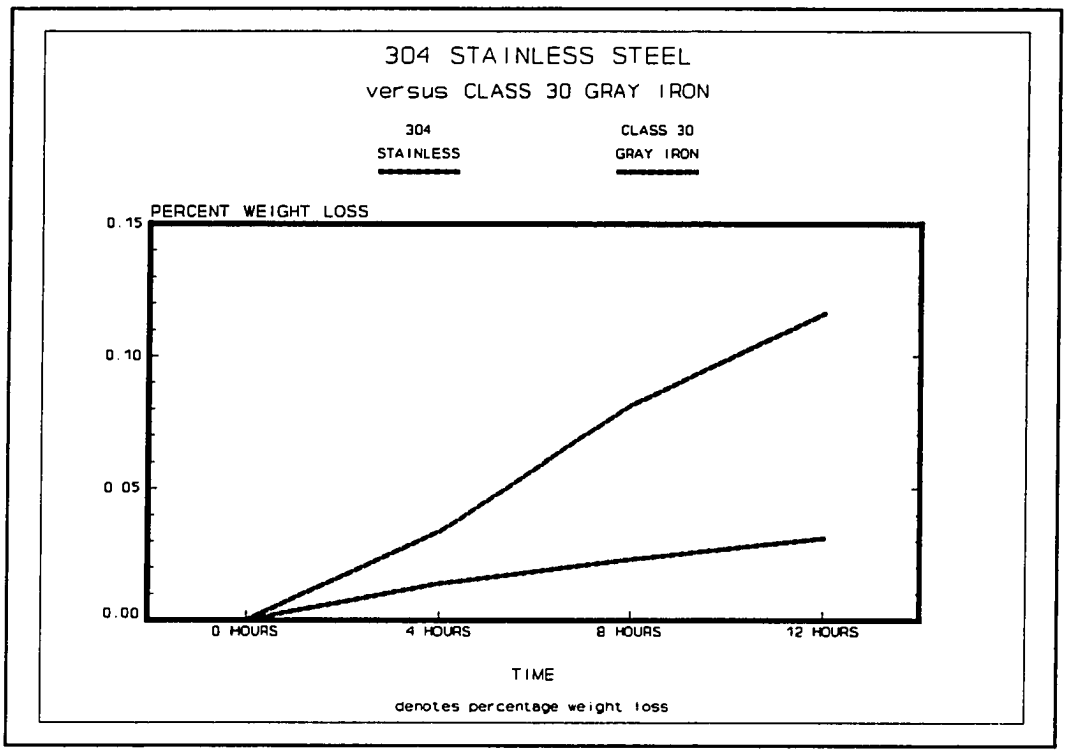

Figure 32. Slope comparison of 304 stainless to gray iron.

to be a lodged sand grain or chip imbedded in the material during the testing period.

The J&J Plaz-Tec ceramic material also exhibited a smooth surface before abrasion as displayed in the Figure 4 micrograph. There appears to be two small pockets of filler material on the surface also displayed in the non-abraded micrograph.

The abraded surface micrograph shown in Figure 5 displays a flake-like condition with uniform erosion occurring as shown in this back scatter image.

Table 1

Wear Analysis Table

Material	Percent Weight Loss	Wear Factor
Hapco Ultralloy 40	9.5043	81.93
Hapco Ultralloy 50	7.4140	63.91
Ciba-Geigy Renshape 450	5.8374	50.32
J&J Corp. Plaz-Tec Fiber Ceramic	4.7074	40.58
U.S. Gypsum 301/308 Epoxical	4.0448	34.86
Hapco Hapcast 5730	3.9476	34.03
Ciba-Geigy LMB 5086	3.4850	30.04
Hexcel Uralite 3530	2.6088	22.49
Kindt-Collins Mastercast 703	2.5806	22.25
J&J Corp. Plaz-Tec Ceramic	2.4957	21.51
Hexcel Uralite 3160	2.3614	20.36
Hapco Hapcast 3730/7	2.2911	19.75
Ciba-Geigy TDP 186-1	2.1114	18.20
Hexcel Uralite 3500	1.9733	17.01
Hexcel Uralite 3156	1.9446	16.76
Hapco Hapcoat 667	1.9055	16.43
Hapco Hapflex 665	1.7921	15.45
Hexcel Uralite 3503	1.6283	14.04
Hexcel Uralite 3502	1.5954	13.75
Hapco Hapflex 665 HP	1.5142	13.05
Conap Conathane TU-961	1.4832	12.79
Conap Conathane TU-981	1.4810	12.77
Hexcel Uralite 3501	1.3575	11.70
Hexcel Uralite 3534	1.0673	9.20
Hapco Hapflex 595 HP	1.0440	9.00
Ciba-Geigy 6414-3	0.9903	8.54
Hapco Hapflex 595	0.9834	8.48
Hapco Hapcoat 597	0.8775	7.56
Conap Conathane TU-956	0.3670	3.16
Silicon Bronze	0.3622	3.12
Conap Conathane TU-900	0.3440	2.97
Class 30 Gray Iron	0.1160	1.00
AISI 1020 Low Carbon Steel	0.0313	0.27
304 Stainless Steel	0.0310	0.27

An elemental analysis of four specific areas of the specimen, as shown in the micrograph in Figure 5 and denoted by the coding numbers B604.20a,b,c,and d, has also been conducted. The area analyzed, as shown in Figure 10, displays a high concentration of aluminum with no other sizable traces of other elements present. Figure 11 shows high concentrations of silicon and calcium with a small trace of chlorine. Figure 12 displays high concentrations of aluminum and silicon with smaller amounts of calcium, chlorine, and potassium present. Figure 13 exhibits a high concentration of calcium along with a smaller amount of silicon. Also, aluminum, calcium, and chlorine are present in trace amounts. The base material appears to contain high concentrations of aluminum, calcium, and silicon.

The Mastercast 703 epoxy material micrograph exhibits a smooth surface in its non-abraded condition as seen in Figure 6. The micrograph displaying the abraded surface, Figure 7, shows spheroidal filler material partially eroded. Also, it appears that a sphere of filler material has been gouged out of the surface due to impact abrasion.

Figure 7 also displays the four elemental analyses conducted on this material as denoted by the coding numbers B604.15a, b, c, and d. The specific area of the sample elementally analyzed in Figure 7, as shown in Figure 14, displays a high concentration of silicon with smaller traces

of calcium, sodium, magnesium, and aluminum. Figure 15 shows a high concentration of silicon. Figure 16 displays a high concentration of calcium with smaller amounts of silicon, aluminum, chlorine, potassium, and sodium. Figure 17 shows a high concentration of silicon with traces of sodium, magnesium, aluminum, potassium, calcium, and iron present.

The Class 30 gray iron sample micrograph displayed a smooth surface in its non-abraded condition as shown in Figure 8. The streaks displayed in the non-abraded micrograph appear to be machining or grinding marks from the specimen preparation.

The abraded surface micrograph as displayed in Figure 9 shows a uniform erosion of the base material. It appears the harder pearlitic substance withstood the abrasion well while the softer ferritic and graphite material exhibited greater erosion.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

This chapter provides a summary of findings, conclusions of the study, and recommendations for further research.

Restatement of the Problem and Purpose

The problem of this study was to analyze the wear characteristics of selected non-metallic tooling materials. The purpose of this study was to simulate the wear characteristics of foundry tooling using an impact abrasion test apparatus. This wear characteristic was measured as a function of percentage weight loss as exhibited by non-metallic materials to be benchmarked against Class 30 gray iron.

The following research question was addressed in two phases. First, is there a non-metallic material that exhibits comparable or superior wear rates compared to Class 30 gray iron that could be used as an alternative tooling material? Second, can a wear factor be developed to determine the tool life of the tested materials compared to Class 30 gray iron?

Summary of Findings

Of the materials tested, 22 were included in the polyurethane elastomer group. Some representatives of this group exhibited excellent wear resistance while others

demonstrated poor results after testing. The percentage weight loss range consisted of 0.3440% (Conathane TU-900) to 2.6088% (Uralite 3530). Of all the materials examined, only the polyurethane elastomers and metallics ranked in the top half of those specimens tested.

The Epoxy group, which consisted of three materials, all performed rather poorly under impact abrasion testing. The poorest (301/308 Epoxical), exhibited 4.0448% percentage weight loss, while the best within this group (Mastercast 703) demonstrated a 2.5806%. All three materials ranked in the lower half of those specimens tested.

The poorest materials, exhibiting the highest percentage weight loss numbers, were the two plastic liquid molding compounds. Ultralloy 40 exhibited the poorest percentage weight loss numbers, 9.5043%, while Ultralloy 50 demonstrated the next most unfavorable, 7.4140%.

The Polymer Ceramic materials also exhibited poor percentage weight loss data. The Plaz-Tec fiberglass backed material displayed a 4.7074% weight loss, whereas the pure Plaz-Tec Ceramic exhibited 2.4957%. These two materials have never been used for foundry production tooling.

The LMB 5086 Stereolithography Photopolymer also ranked poorly of the materials tested. It demonstrated a 3.4850% weight loss with only six materials displaying worse wear

resistance in the test. This material was also not designed as a production tooling media.

Renshape 450 Artificial Modeling Material is specifically designed for master and prototype tooling. Consequently, it fared poorly under impact abrasion testing. This material exhibited a 5.8374% weight loss, the third worst tested.

Of the metallic materials tested, two performed better than Class 30 gray iron. These were AISI 1020 low carbon steel and 304 stainless steel. The AISI 1020 demonstrated a 0.0313% weight loss, while the 304 stainless displayed 0.0310%.

Conclusions

It appears from the data generated in this study that there is no non-metallic alternative material that exhibits the wear resistance of Class 30 gray iron from a percentage weight loss criteria. Although, a polyurethane elastomer, Conathane TU-900, displayed better wear resistance than silicon bronze. This is the first indication that a non-metallic approaches the wear resistance of a metal included in the study. Of the non-metallic materials studied by Helzer (1988), and Maier and Wallace (1977), there was no indication of a non-metallic material approaching the wear resistance of a metal other than aluminum, which was not included in this study. The Gouwens (1965) study was not

referenced because of fundamental differences in methodology.

Maier and Wallace (1977) stated that a material which exhibited a 1.6% weight loss or more would not be a suitable material for the construction of production tooling in the foundry industry. Upon further examination of the data in an ordinal progression as presented in Maier and Wallace a natural break point division in the data occurred at 1.6%. The next ordinal measurement in the data occurred at 3.15%. Building on this research foundation the following observations were made in relation to this study.

Of the 34 materials tested in this study 16 met the 1.6% or less criteria for weight loss. Of these, 12 were polyurethane elastomers and 4 were metals. Polyurethane elastomers finished in the top 75% of all the materials tested. The bottom 25% were generally not common tooling materials used in production facilities. Ceramics, while not a common tooling material, may under new formulations have future potential in a production foundry. This is also true for photopolymers with new formulations constantly being developed.

It has also been determined that classifying the materials into type groups for comparison purposes to Class 30 gray iron was a reasonable indicator of performance. Although, some overlap in percentage weight loss and wear

factor did occur between the polyurethane elastomer, ceramic and epoxy groups.

The corresponding wear factors displayed some interesting results in relation to percentage weight loss. The Wear Analysis Table lists percentage weight loss and corresponding wear factors. The wear factor indicates the number of tools required to match the wear resistance of Class 30 gray iron. For example, it would take nine tools made of Hapflex 595 HP to equal the wear resistance of one Class 30 gray iron tool. Correspondingly, it would take approximately 82 tools of Ultralloy 40 to equal the wear resistance of Class 30 gray iron. It is also determined that it is possible to mathematically calculate a wear factor that can predict tool life compared to a benchmark material.

The visual slope comparisons of each of the materials varied widely between specimens. Of the 33 materials compared to Class 30 gray iron 14 displayed an upward increase in slope. As the abrasion cycle progressed the percentage weight loss increased over time. This phenomenon may be as a result of the material losing its outer resilient surface exposing the subsurface to the abrasion activity.

Some of the specimens exhibited relatively linear percentage weight loss over time. Of the 33 materials

tested against gray iron 11 displayed this phenomenon. This linear wear characteristic may be attributed to specimen preparation or a consistent physical matrix throughout the material.

The remaining 8 specimens displayed a leveling off or downward trend in the visual slope line. This usually occurs after the first 4 hour wear cycle. A possible reason for this phenomenon may be that the subsurface matrix is more resilient than the outer surface. Once the outer layer is removed a stabilization of material removal occurs.

Recommendations

Based on the findings of this study, it is recommended that tooling materials exhibiting 1.6% weight loss or less, and a corresponding 14 or less wear factor, should be considered as potential tooling for foundry applications. Those materials displaying greater wear factors and percentage weight loss may still have potential tooling application for prototype and short run production.

Further research is recommended to:

1. Study the effects of different sized sand grains, as abrasive media, on potential tooling materials.

2. Repeat the tests conducted in this study with new materials once they are available from the manufacturer.

3. Conduct a cost comparison study to analyze the expenses required to construct non-metallic versus metallic tooling.

4. Conduct a study to compare lead times of constructing non-metallic versus metallic tooling.

5. Study the effects of hardness on wear resistance using impact abrasion testing.

6. Study the effects of foundry chemicals on non-metallic tooling.

7. Compare wear analysis data to dimensional change of tooling materials.

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APPENDIX A

LIST OF MATERIALS TESTED

Polyurethane Elastomers
- 6414-3 from Ciba-Geigy
- TDP 186-1 from Ciba-Geigy
- Uralite 3156 from Hexcel
- Uralite 3160 from Hexcel
- Uralite 3500 from Hexcel
- Uralite 3501 from Hexcel
- Uralite 3502 from Hexcel
- Uralite 3503 from Hexcel
- Uralite 3530 from Hexcel
- Uralite 3534 from Hexcel
- Conathane TU-900 from Conap
- Conathane TU-956 from Conap
- Conathane TU-961 from Conap
- Conathane TU-981 from Conap
- Hapflex 595 from Hapco
- Hapflex 595-HP from Hapco
- Hapflex 665 from Hapco
- Hapflex 665-HP from Hapco
- Hapcast 3730/7 from Hapco
- Hapcoat 597 from Hapco
- Hapcoat 667 from Hapco

Epoxies
- Hapcast 5730 from Hapco
- 301/308 Epoxical from U.S. Gypsum
- Mastercast 703 from Kindt-Collins

Plastic Liquid Molding Compounds
- Ultralloy 40 from Hapco
- Ultralloy 50 from Hapco

Polymer Ceramic Composites
- Plaz-Tec Ceramic from J&J Corporation
- Plaz-Tec Fiberglass backed Ceramic from J&J Corporation

Stereolithography Photopolymer
- LMB 5086 Photopolymer from Ciba-Geigy for 3D Systems

Artificial Modeling Material
- Renshape 450 from Ciba-Geigy

Metallic Tooling Materials
- AISI 1020 low carbon steel
- 304 stainless steel
- Silicon Bronze
- Class 30 gray iron

APPENDIX B

MATERIAL SAFETY DATA SHEETS (MSDS)

MATERIAL SAFETY DATA SHEET

CIBA-GEIGY CORPORATION FORMULATED SYSTEMS GROUP 4917 DAWN AVE EAST LANSING, MI 48823 (517) 351-5900	EMERGENCY PHONE NUMBER: (800) 888-8372

SECTION I-IDENTITY INFORMATION

IDENTITY (TRADENAME): RP 6414-3 RESIN

FAMILY/CHEMICAL NAME:
ISOCYANATE
PRODUCT TYPE:
POLYURETHANE
IMPORTANT:

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* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
*     THIS MATERIAL WILL NOT BE SOLD FOR USE IN PRODUCTS          *
* FOR WHICH PROLONGED CONTACT WITH MUCOUS MEMBRANES OR            *
* ABRADED SKIN, OR IMPLANTATION WITHIN THE HUMAN BODY, IS         *
* SPECIFICALLY INTENDED.  BECAUSE OF THE WIDE RANGE OF            *
* SUCH POTENTIAL USES, CIBA-GEIGY CORPORATION IS NOT ABLE         *
* TO RECOMMEND THIS MATERIAL AS SAFE AND EFFECTIVE FOR            *
* SUCH USES AND ASSUMES NO LIABILITY FOR ANY SUCH USES.           *
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
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HAZARD STATEMENT :

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* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
*       THIS MATERIAL SAFETY DATA SHEET (MSDS) HAS BEEN           *
*  PREPARED IN COMPLIANCE WITH THE FEDERAL OSHA HAZARD           *
*  COMMUNICATION STANDARD  29 CFR 1910.1200.                     *
*       THIS PRODUCT IS CONSIDERED TO BE A HAZARDOUS             *
*  CHEMICAL UNDER THAT STANDARD.                                 *
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
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SECTION II-HAZARDOUS INGREDIENTS

CHEMICAL NAME: ISOPHORONE DIISOCYANATE
COMMON NAME : ISOPHORONE DIISOCYANATE
CAS NUMBER : 004098-71-9
EXPOSURE LIMITS:
ACGIH TLV : 0.005 PPM AIR TWA (SKIN)

OSHA PEL : 0.005 PPM AIR TWA (SKIN)
OSHA STEL : 0.02 PPM AIR (SKIN)
CARCINOGENICITY: THIS MATERIAL IS NOT CONSIDERED TO BE A CARCINOGEN BY NTP, IARC, OR OSHA.

* * *

CHEMICAL NAME: METHYLENE BIS(4-CYCLOHEXYLISOCYANATE)
COMMON NAME : HYDROGENATED MDI
CAS NUMBER : 005124-30-1
EXPOSURE LIMITS:
ACGIH TLV : 0.055 MG/M3 AIR TWA
OSHA CEILING : 0.11 MG/M3 AIR
CARCINOGENICITY: THIS MATERIAL IS NOT CONSIDERED TO BE A CARCINOGEN BY NTP, IARC, OR OSHA.

* * *

CHEMICAL NAME: CYCLOALIPHATIC ISOCYANATE PREPOLYMER
COMMON NAME : CYCLOALIPHATIC ISOCYANATE PREPOLYMER
CAS NUMBER : PMN 88-638
CARCINOGENICITY: THIS MATERIAL IS NOT CONSIDERED TO BE A CARCINOGEN BY NTP, IARC, OR OSHA.

* * *

SECTION III-PHYSICAL DATA

APPEARANCE AND ODOR:
TRANSLUCENT LIQUID WITH SLIGHT ODOR
BOILING POINT:
NOT DETERMINED.
EVAPORATION RATE:
NOT DETERMINED.
PERCENT VOLATILE:
NEGLIGIBLE.
VAPOR DENSITY:
> 1.0% (AIR = 1)
VAPOR PRESSURE:
NOT ESTABLISHED
SOLUBILITY IN WATER:
REACTS WITH WATER
PH:
NOT DETERMINED.
SPECIFIC GRAVITY:
1.04 (WATER = 1)

SECTION IV-FIRE AND EXPLOSION HAZARD DATA

FLASH POINT:
> 300F (EST)
FLAMMABLE LIMITS IN AIR-LOWER:
NOT ESTABLISHED.
FLAMMABLE LIMITS IN AIR-UPPER:
NOT ESTABLISHED.
EXTINGUISHING MEDIA:
CARBON DIOXIDE, DRY CHEMICAL, FOAM, WATER.
FIRE FIGHTING PROCEDURES-SPECIAL:

RP 6414-3 RESIN

USE SELF-CONTAINED BREATHING APPARATUS.
UNUSUAL FIRE AND EXPLOSION HAZARDS:
DECOMPOSITION AND COMBUSTION PRODUCTS MAY BE TOXIC.
AVOID WATER CONTAMINATION IN CLOSED CONTAINERS OR CONFINED SPACES. CARBON DIOXIDE EVOLVED.

SECTION V-REACTIVITY DATA

STABILITY:
STABLE.
CONDITIONS TO AVOID:
AVOID PROLONGED HEATING OVER 160F OR STORING BELOW 75F. AVOID WATER CONTAMINATION.
INCOMPATIBILITY:
WATER, ALCOHOLS, STRONG OXIDIZING AGENTS, STRONG BASES, METAL-ORGANIC COMPOUNDS.
HAZARDOUS DECOMPOSITION PRODUCTS:
COMBUSTION MAY FORM TOXIC MATERIALS. CARBON MONOXIDE, CARBON DIOXIDE, BENZENE, TOLUENE, OXIDES OF NITROGEN, HYDROGEN CYANIDE.
HAZARDOUS POLYMERIZATION:
MAY OCCUR.
CONDITIONS TO AVOID:
CONTAMINATION WITH MOISTURE AND OTHER PRODUCTS THAT REACT WITH ISOCYANATES.

SECTION VI-HEALTH HAZARD DATA

PRIMARY ROUTES OF EXPOSURE:
DERMAL; HEATED PRODUCT MAY PRODUCE INHALABLE VAPORS.
SKIN IRRITATION:
IRRITANT.
EYE IRRITATION:
REGARD AS CORROSIVE
SENSITIZATION:
CAUSES ALLERGIC SKIN AND RESPIRATORY REACTIONS.
OVEREXPOSURE EFFECTS:
CONTACT WITH LIQUID CAUSES EYE AND SKIN IRRITATION. IF INHALED CAUSES BREATHLESSNESS, CHEST DISCOMFORT, AND REDUCED PULMONARY FUNCTION.
MAY CAUSE ALLERGIC SKIN AND RESPIRATORY REACTIONS IN SOME INDIVIDUALS, LEADING TO ASTHMA TYPE SPASMS OF THE BRONCHIAL TUBES AND DIFFICULTY IN BREATHING.
MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE:
PERSONS WITH ASTHMATIC-TYPE CONDITIONS, CHRONIC BRONCHITIS, OTHER CHRONIC RESPIRATORY DISEASES, EYE CONDITIONS OR RECURRENT SKIN ECZEMA OR SENSITIZATION SHOULD BE EXCLUDED FROM WORKING WITH ISOCYANATES.
EMERGENCY AND FIRST AID PROCEDURES-EYES:
IMMEDIATELY FLUSH EYES WITH WATER FOR AT LEAST 15 MINUTES. CALL A PHYSICIAN.
EMERGENCY AND FIRST AID PROCEDURES-SKIN:
WASH WITH SOAP AND WATER. REMOVE CONTAMINATED CLOTHING AND

LAUNDER BEFORE RE-USE.

EMERGENCY AND FIRST AID PROCEDURES-INGESTION:
IF CONSCIOUS, GIVE PLENTY OF WATER TO DRINK. DO NOT INDUCE VOMITING. CALL A PHYSICIAN.

EMERGENCY AND FIRST AID PROCEDURES-INHALATION:
REMOVE TO FRESH AIR. GIVE OXYGEN AND/OR ARTIFICIAL RESPIRATION, IF NEEDED. CALL A PHYSICIAN.

EMERGENCY AND FIRST AID PROCEDURES-OTHER:
REFERRAL TO A PHYSICIAN IS RECOMMENDED IF THERE IS ANY QUESTION ABOUT THE SERIOUSNESS OF ANY INJURY.

SECTION VII-SPILL OR LEAK PROCEDURES

SPILL PROCEDURES:
ABSORB WITH ABSORBENT MATERIAL AND PLACE IN OPEN TOP CONTAINER. UNDER GOOD VENTILATION, DECONTAMINATE ABSORBANT AND SPILL AREA WITH A MIXTURE OF 90% WATER, 8% AMMONIA AND 2% DETERGENT (EXOTHERMIC REACTION). LEAVE VENTILATED 24 HOURS BEFORE DISPOSAL. AVOID CONTACT.

WASTE DISPOSAL METHODS:
CONSULT QUALIFIED LOCAL OR CORPORATE PERSONNEL FOR METHOD THAT WILL COMPLY WITH LOCAL, STATE AND FEDERAL HEALTH AND ENVIRONMENTAL REGULATIONS.

SECTION VIII-SPECIAL PROTECTION INFORMATION

VENTILATION:
GENERAL MECHANICAL AND LOCAL EXHAUST IN ACCORDANCE WITH ACGIH RECOMMENDATIONS.

PROTECTIVE GLOVES:
IMPERVIOUS SYNTHETIC GLOVES.

EYE PROTECTION:
WEAR SPLASH-PROOF CHEMICAL GOGGLES.

RESPIRATORY PROTECTION:
ORGANIC VAPOR RESPIRATOR IF TLV IS NOT EXCEEDED. FOR EXPOSURES IN EXCESS OF THE TLV, AN AIR SUPPLIED RESPIRATOR WOULD BE REQUIRED.

SECTION IX-SPECIAL PRECAUTIONS

HMIS CODE:
HEALTH : 2 FIRE : 1 REACTIVITY : 0

HANDLING, SHIPPING AND STORING PRECAUTIONS:
DANGER CORROSIVE - CAUSES EYE BURNS AND SKIN IRRITATION. HARMFUL IF INHALED. MAY CAUSE ALLERGIC SKIN AND RESPIRATORY REACTION.
DO NOT GET IN EYES. AVOID CONTACT WITH SKIN AND CLOTHING. AVOID BREATHING VAPOR OR MIST. AVOID PROLONGED OR REPEATED CONTACT WITH SKIN. KEEP CONTAINER CLOSED. USE WITH ADEQUATE VENTILATION. WASH THOROUGHLY AFTER HANDLING.

HANDLING PRECAUTIONS:

RP 6414-3 RESIN

NUISANCE DUST MAY BE GENERATED WHEN SANDING OR SAWING CURED MATERIAL.

SECTION X- REGULATORY INFORMATION

DOT PROPER SHIPPING NAME:
LIQUID PLASTIC, N.O.I.
DOT CLASS:
NOT REGULATED.
DOT NUMBER:
GROUP III POISON FOR IATA/IMO SHIPMENTS.
NOT REGULATED BY DOT.
RCRA STATUS:
NOT SPECIFICALLY LISTED AS HAZARDOUS WASTE UNDER RCRA (40 CFR 261). HOWEVER, IT IS STRONGLY RECOMMENDED THAT COMPOUND BE TREATED AS A HAZARDOUS WASTE AND DISPOSED OF ACCORDINGLY.
SARA/TITLE III - TOXIC CHEMICALS LIST:
THIS PRODUCT DOES NOT CONTAIN A TOXIC CHEMICAL FOR ROUTINE ANNUAL 'TOXIC CHEMICAL RELEASE REPORTING' UNDER SEC. 313 (40 CFR 372).
TSCA INVENTORY STATUS:
CHEMICAL COMPONENTS LISTED ON TSCA INVENTORY.
PENNSYLVANIA RIGHT-TO-KNOW ACT:
THE FOLLOWING IS REQUIRED COMPOSITION INFORMATION

CHEMICAL NAME : CYCLOALIPHATIC ISOCYANATE PREPOLYMER
CAS NUMBER : PMN 88-638
COMMENTS : NOT ON PENNSYLVANIA HAZARDOUS SUBSTANCE LIST.
* * *
CHEMICAL NAME : METHYLENE BIS (4-CYCLOHEXYLISOCYANATE)
CAS NUMBER : 05124-30-1
COMMENTS : HAZARDOUS SUBSTANCE.
* * *
CHEMICAL NAME : ISOPHORONE DIISOCYANATE
CAS NUMBER : 04098-71-9
COMMENTS : HAZARDOUS SUBSTANCE.
* * *

ISSUE DATE: 05/30/89 REVISION: 02C ISSUED BY: M. MUNSELL
FOR FURTHER INFORMATION, PLEASE CONTACT: PRODUCT SAFETY DIR

THE INFORMATION AND RECOMMENDATIONS CONTAINED HEREIN ARE BASED UPON DATA BELIEVED TO BE CORRECT. HOWEVER, NO GUARANTEE OR WARRANTY OF ANY KIND EXPRESSED OR IMPLIED IS MADE WITH RESPECT TO THE INFORMATION CONTAINED HEREIN.

RP 6414-3 RESIN

MATERIAL SAFETY DATA SHEET

CIBA-GEIGY CORPORATION FORMULATED SYSTEMS GROUP 4917 DAWN AVE EAST LANSING, MI 48823 (517) 351-5900	EMERGENCY PHONE NUMBER: (800) 888-8372

SECTION I-IDENTITY INFORMATION

IDENTITY (TRADENAME): RP 6414-3 HARDENER

FAMILY/CHEMICAL NAME:
AMINE
PRODUCT TYPE:
POLYURETHANE HARDENER
IMPORTANT:

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* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
*     THIS MATERIAL WILL NOT BE SOLD FOR USE IN PRODUCTS              *
* FOR WHICH PROLONGED CONTACT WITH MUCOUS MEMBRANES OR                *
* ABRADED SKIN, OR IMPLANTATION WITHIN THE HUMAN BODY, IS             *
* SPECIFICALLY INTENDED.  BECAUSE OF THE WIDE RANGE OF               *
* SUCH POTENTIAL USES, CIBA-GEIGY CORPORATION IS NOT ABLE             *
* TO RECOMMEND THIS MATERIAL AS SAFE AND EFFECTIVE FOR               *
* SUCH USES AND ASSUMES NO LIABILITY FOR ANY SUCH USES.              *
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
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HAZARD STATEMENT :

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* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
*       THIS MATERIAL SAFETY DATA SHEET (MSDS) HAS BEEN               *
*  PREPARED IN COMPLIANCE WITH THE FEDERAL OSHA HAZARD               *
*  COMMUNICATION STANDARD  29 CFR 1910.1200.                         *
*       THIS PRODUCT IS CONSIDERED TO BE A HAZARDOUS                 *
*  CHEMICAL UNDER THAT STANDARD.                                     *
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
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SECTION II-HAZARDOUS INGREDIENTS

CHEMICAL NAME: DI-N-BUTYL PHTHALATE
COMMON NAME : DIBUTYL PHTHALATE
CAS NUMBER : 000084-74-2
EXPOSURE LIMITS:
ACGIH TLV : 5 MG/M3 AIR TWA

OSHA PEL : 5 MG/M3 AIR TWA
CARCINOGENICITY: THIS MATERIAL IS NOT CONSIDERED TO BE A CARCINOGEN BY NTP, IARC, OR OSHA.

* * *

CHEMICAL NAME: 4,4'-METHYLENEBIS (O-ETHYL-)ANILINE)
COMMON NAME : AROMATIC AMINE
CAS NUMBER : 019900-65-3
CARCINOGENICITY: THIS MATERIAL IS NOT CONSIDERED TO BE A CARCINOGEN BY NTP, IARC, OR OSHA.

* * *

CHEMICAL NAME: BENZENEDIAMINE,AR,AR-DIETHYL-AR-METHYL-
COMMON NAME : DIETHYL TOLUENE DIAMINE
CAS NUMBER : 068479-98-1
CARCINOGENICITY: THIS MATERIAL IS NOT CONSIDERED TO BE A CARCINOGEN BY NTP, IARC, OR OSHA.

* * *

SECTION III-PHYSICAL DATA

APPEARANCE AND ODOR:
DARK RED LIQUID WITH AMMONIACAL ODOR
BOILING POINT:
590F
EVAPORATION RATE:
NOT DETERMINED.
PERCENT VOLATILE:
< 1%.
VAPOR DENSITY:
NOT DETERMINED.
VAPOR PRESSURE:
NOT DETERMINED
SOLUBILITY IN WATER:
SLIGHT.
PH:
NOT DETERMINED.
SPECIFIC GRAVITY:
1.05 (WATER = 1)

SECTION IV-FIRE AND EXPLOSION HAZARD DATA

FLASH POINT:
> 200F (EST)
FLAMMABLE LIMITS IN AIR-LOWER:
NOT ESTABLISHED.
FLAMMABLE LIMITS IN AIR-UPPER:
NOT ESTABLISHED.
EXTINGUISHING MEDIA:
CARBON DIOXIDE, DRY CHEMICAL, FOAM, WATER.
FIRE FIGHTING PROCEDURES-SPECIAL:
USE SELF-CONTAINED BREATHING APPARATUS.
UNUSUAL FIRE AND EXPLOSION HAZARDS:
DECOMPOSITION AND COMBUSTION PRODUCTS MAY BE TOXIC.

RP 6414-3 HARDENER

SECTION V-REACTIVITY DATA

STABILITY:
STABLE.
CONDITIONS TO AVOID:
EXCESSIVE HEAT FOR PROLONGED PERIODS OF TIME.
INCOMPATIBILITY:
STRONG OXIDIZING AGENTS, ACIDS, METAL-ORGANIC COMPOUNDS.
HAZARDOUS DECOMPOSITION PRODUCTS:
COMBUSTION MAY FORM TOXIC MATERIALS, SUCH AS CARBON DIOXIDE, CARBON MONOXIDE.
HAZARDOUS POLYMERIZATION:
WILL NOT OCCUR.

SECTION VI-HEALTH HAZARD DATA

PRIMARY ROUTES OF EXPOSURE:
DERMAL; HEATED PRODUCT MAY PRODUCE INHALABLE VAPORS.
THRESHOLD LIMIT VALUE:
NONE ESTABLISHED FOR THIS PRODUCT. SEE THE HAZARDOUS INGREDIENTS SECTION.
SKIN IRRITATION:
IRRITANT.
EYE IRRITATION:
CORROSIVE. CAUSES BURNS.
SENSITIZATION:
POSSIBLE IN SUSCEPTIBLE INDIVIDUALS.
OVEREXPOSURE EFFECTS:
DANGER CORROSIVE. CAUSES EYE BURNS AND SKIN IRRITATION. MAY CAUSE ALLERGIC SKIN AND RESPIRATORY REACTIONS. ABSORPTION THROUGH SKIN OR INGESTION MAY CAUSE NAUSEA, VOMITING, OR OTHER ILLNESS. INHALATION OF VAPORS MAY CAUSE ASTHMA-LIKE SYMPTOMS SUCH AS WHEEZING, COUGHING, AND SHORTNESS OF BREATH.
MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE:
SKIN AND EYE CONDITIONS.
EMERGENCY AND FIRST AID PROCEDURES-EYES:
IMMEDIATELY FLUSH EYES WITH WATER FOR AT LEAST 15 MINUTES. CALL A PHYSICIAN.
EMERGENCY AND FIRST AID PROCEDURES-SKIN:
WASH WITH SOAP AND WATER. REMOVE CONTAMINATED CLOTHING AND LAUNDER BEFORE RE-USE.
EMERGENCY AND FIRST AID PROCEDURES-INGESTION:
IF CONSCIOUS, GIVE PLENTY OF WATER TO DRINK. DO NOT INDUCE VOMITING. CALL A PHYSICIAN.
EMERGENCY AND FIRST AID PROCEDURES-INHALATION:
REMOVE TO FRESH AIR. GIVE OXYGEN AND/OR ARTIFICIAL RESPIRATION, IF NEEDED. CALL A PHYSICIAN.
EMERGENCY AND FIRST AID PROCEDURES-OTHER:
REFERRAL TO A PHYSICIAN IS RECOMMENDED IF THERE IS ANY QUESTION ABOUT THE SERIOUSNESS OF ANY INJURY.

SECTION VII-SPILL OR LEAK PROCEDURES

SPILL PROCEDURES:
REMOVE SPILLAGE BY ABSORBING IN ABSORBENT MATERIAL.
AVOID CONTACT.
WASTE DISPOSAL METHODS:
CONSULT QUALIFIED LOCAL OR CORPORATE PERSONNEL FOR METHOD THAT WILL COMPLY WITH LOCAL, STATE AND FEDERAL HEALTH AND ENVIRONMENTAL REGULATIONS.

SECTION VIII-SPECIAL PROTECTION INFORMATION

VENTILATION:
GENERAL MECHANICAL AND LOCAL EXHAUST IN ACCORDANCE WITH ACGIH RECOMMENDATIONS.
PROTECTIVE GLOVES:
IMPERMEABLE GLOVES AND PROTECTIVE CLOTHING.
EYE PROTECTION:
FULL FACE SHIELD.
RESPIRATORY PROTECTION:
USE NIOSH APPROVED ORGANIC VAPOR CARTRIDGE RESPIRATOR WHEN VAPOR/MIST EXPOSURE IS LIKELY.

SECTION IX-SPECIAL PRECAUTIONS

HMIS CODE:
HEALTH : 2 FIRE : 1 REACTIVITY : 0
HANDLING, SHIPPING AND STORING PRECAUTIONS:
DANGER CORROSIVE - CAUSES EYE BURNS AND SKIN IRRITATION. HARMFUL IF SWALLOWED, IF ABSORBED THROUGH SKIN, OR IF INHALED. MAY CAUSE ALLERGIC SKIN REACTION. DO NOT GET IN EYES. AVOID BREATHING VAPOR OR MIST. AVOID CONTACT WITH SKIN AND CLOTHING. KEEP CONTAINER CLOSED. USE WITH ADEQUATE VENTILATION. WASH THOROUGHLY AFTER HANDLING.

HANDLING PRECAUTIONS:
NUISANCE DUST MAY BE GENERATED WHEN SANDING OR SAWING CURED MATERIAL.
PLEASE NOTE:
THIS PRODUCT CONTAINS DIBUTYL PHTHALATE WHICH MAY CAUSE ADVERSE REPRODUCTIVE EFFECTS IN LABORATORY ANIMALS. THE RELEVANCE TO HUMANS IS NOT KNOWN.

SECTION X- REGULATORY INFORMATION

DOT PROPER SHIPPING NAME:
LIQUID PLASTIC, N.O.I.
DOT CLASS:
NOT REGULATED.
RCRA STATUS:
NOT A HAZARDOUS WASTE UNDER RCRA (40 CFR 261).

RP 6414-3 HARDENER

MATERIAL SAFETY DATA SHEET

CIBA-GEIGY CORPORATION FORMULATED SYSTEMS GROUP 4917 DAWN AVE EAST LANSING, MI 48823 (517) 351-5900	EMERGENCY PHONE NUMBER: (800) 888-8372

SECTION I-IDENTITY INFORMATION

IDENTITY (TRADENAME): TDT 186-1 RESIN

FAMILY/CHEMICAL NAME:
ISOCYANATE
PRODUCT TYPE:
CLEAR CASTABLE URETHANE
IMPORTANT:

* *
* THIS MATERIAL WILL NOT BE SOLD FOR USE IN PRODUCTS *
* FOR WHICH PROLONGED CONTACT WITH MUCOUS MEMBRANES OR *
* ABRADED SKIN, OR IMPLANTATION WITHIN THE HUMAN BODY, IS *
* SPECIFICALLY INTENDED. BECAUSE OF THE WIDE RANGE OF *
* SUCH POTENTIAL USES, CIBA-GEIGY CORPORATION IS NOT ABLE *
* TO RECOMMEND THIS MATERIAL AS SAFE AND EFFECTIVE FOR *
* SUCH USES AND ASSUMES NO LIABILITY FOR ANY SUCH USES. *
* *

HAZARD STATEMENT :

* *
* THIS MATERIAL SAFETY DATA SHEET (MSDS) HAS BEEN *
* PREPARED IN COMPLIANCE WITH THE FEDERAL OSHA HAZARD *
* COMMUNICATION STANDARD 29 CFR 1910.1200. *
* THIS PRODUCT IS CONSIDERED TO BE A HAZARDOUS *
* CHEMICAL UNDER THAT STANDARD. *
* *

SECTION II-HAZARDOUS INGREDIENTS

CHEMICAL NAME: METHYLENE BIS(4-CYCLOHEXYLISOCYANATE)
COMMON NAME : HYDROGENATED MDI
CAS NUMBER : 005124-30-1
EXPOSURE LIMITS:
ACGIH TLV : 0.055 MG/M3 AIR TWA

OSHA CEILING : 0.11 MG/M3 AIR
CARCINOGENICITY: THIS MATERIAL IS NOT CONSIDERED TO BE A CARCINOGEN BY NTP, IARC, OR OSHA.

* * *

CHEMICAL NAME: N,N,N',N'-TETRAKIS (4-ISOCYANATOCYCLOHEXYL-1,1'-METHYLENECYCLOHEXYL-4'-CARBAMOYL)-2-OXYPROPYL ETHYLENEDIAMINE
COMMON NAME : CYCLOALIPHATIC ISOCYANATE PREPOLYMER
CAS NUMBER : 56929
CARCINOGENICITY: THIS MATERIAL IS NOT CONSIDERED TO BE A CARCINOGEN BY NTP, IARC, OR OSHA.

* * *

SECTION III-PHYSICAL DATA

APPEARANCE:
CLEAR COLORLESS LIQUID.
BOILING POINT:
NOT DETERMINED.
MELTING POINT:
66 F - 73 F
EVAPORATION RATE:
NOT DETERMINED.
PERCENT VOLATILE:
NEGLIGIBLE.
VAPOR DENSITY:
> 1.0% (AIR = 1)
VAPOR PRESSURE:
@ 25C .000925 MMHG.
SOLUBILITY IN WATER:
REACTS WITH WATER
PH:
NOT DETERMINED.
SPECIFIC GRAVITY:
1.07 - 1.09 (WATER = 1)

SECTION IV-FIRE AND EXPLOSION HAZARD DATA

FLASH POINT:
> 300F (PMCC)
FLAMMABLE LIMITS IN AIR-LOWER:
NOT ESTABLISHED.
FLAMMABLE LIMITS IN AIR-UPPER:
NOT ESTABLISHED.
EXTINGUISHING MEDIA:
CARBON DIOXIDE, DRY CHEMICAL, FOAM, WATER.
FIRE FIGHTING PROCEDURES-SPECIAL:
USE SELF-CONTAINED BREATHING APPARATUS.
UNUSUAL FIRE AND EXPLOSION HAZARDS:
DECOMPOSITION AND COMBUSTION PRODUCTS MAY BE TOXIC.
AVOID WATER CONTAMINATION IN CLOSED CONTAINERS OR CONFINED SPACES. CARBON DIOXIDE EVOLVED.

---------- SECTION V-REACTIVITY DATA ----------

STABILITY:
STABLE.
CONDITIONS TO AVOID:
AVOID PROLONGED HEATING OVER 160F OR STORING BELOW 75F. AVOID WATER CONTAMINATION.
INCOMPATIBILITY:
WATER, ALCOHOLS, STRONG OXIDIZING AGENTS, STRONG BASES, METAL-ORGANIC COMPOUNDS.
HAZARDOUS DECOMPOSITION PRODUCTS:
COMBUSTION MAY FORM TOXIC MATERIALS. CARBON MONOXIDE, CARBON DIOXIDE, BENZENE, TOLUENE, OXIDES OF NITROGEN, HYDROGEN CYANIDE.
HAZARDOUS POLYMERIZATION:
MAY OCCUR.
CONDITIONS TO AVOID:
CONTAMINATION WITH MOISTURE AND OTHER PRODUCTS THAT REACT WITH ISOCYANATES.

---------- SECTION VI-HEALTH HAZARD DATA ----------

PRIMARY ROUTES OF EXPOSURE:
DERMAL; HEATED PRODUCT MAY PRODUCE INHALABLE VAPORS.
SKIN IRRITATION:
IRRITANT.
EYE IRRITATION:
IRRITANT.
SENSITIZATION:
CAUSES ALLERGIC SKIN AND RESPIRATORY REACTIONS.
OVEREXPOSURE EFFECTS:
CONTACT WITH LIQUID CAUSES EYE AND SKIN IRRITATION. IF INHALED CAUSES BREATHLESSNESS, CHEST DISCOMFORT, AND REDUCED PULMONARY FUNCTION.
MAY CAUSE ALLERGIC SKIN AND RESPIRATORY REACTIONS IN SOME INDIVIDUALS, LEADING TO ASTHMA TYPE SPASMS OF THE BRONCHIAL TUBES AND DIFFICULTY IN BREATHING.
MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE:
PERSONS WITH ASTHMATIC-TYPE CONDITIONS, CHRONIC BRONCHITIS, OTHER CHRONIC RESPIRATORY DISEASES, EYE CONDITIONS OR RECURRENT SKIN ECZEMA OR SENSITIZATION SHOULD BE EXCLUDED FROM WORKING WITH ISOCYANATES.
EMERGENCY AND FIRST AID PROCEDURES-EYES:
IMMEDIATELY FLUSH EYES WITH WATER FOR AT LEAST 15 MINUTES. CALL A PHYSICIAN.
EMERGENCY AND FIRST AID PROCEDURES-SKIN:
WASH WITH SOAP AND WATER. REMOVE CONTAMINATED CLOTHING AND LAUNDER BEFORE RE-USE.
EMERGENCY AND FIRST AID PROCEDURES-INGESTION:
IF CONSCIOUS, GIVE PLENTY OF WATER TO DRINK. DO NOT INDUCE VOMITING. CALL A PHYSICIAN.
EMERGENCY AND FIRST AID PROCEDURES-INHALATION:

REMOVE TO FRESH AIR. GIVE OXYGEN AND/OR ARTIFICIAL RESPIRATION, IF NEEDED. CALL A PHYSICIAN.

EMERGENCY AND FIRST AID PROCEDURES-OTHER:
REFERRAL TO A PHYSICIAN IS RECOMMENDED IF THERE IS ANY QUESTION ABOUT THE SERIOUSNESS OF ANY INJURY.

SECTION VII-SPILL OR LEAK PROCEDURES

SPILL PROCEDURES:
ABSORB WITH ABSORBENT MATERIAL AND PLACE IN OPEN TOP CONTAINER. UNDER GOOD VENTILATION, DECONTAMINATE ABSORBANT AND SPILL AREA WITH A MIXTURE OF 90% WATER, 8% AMMONIA AND 2% DETERGENT (EXOTHERMIC REACTION). LEAVE VENTILATED 24 HOURS BEFORE DISPOSAL. AVOID CONTACT.

WASTE DISPOSAL METHODS:
CONSULT QUALIFIED LOCAL OR CORPORATE PERSONNEL FOR METHOD THAT WILL COMPLY WITH LOCAL, STATE AND FEDERAL HEALTH AND ENVIRONMENTAL REGULATIONS.

SECTION VIII-SPECIAL PROTECTION INFORMATION

VENTILATION:
GENERAL MECHANICAL AND LOCAL EXHAUST IN ACCORDANCE WITH ACGIH RECOMMENDATIONS.

PROTECTIVE GLOVES:
IMPERVIOUS SYNTHETIC GLOVES.

EYE PROTECTION:
WEAR SPLASH-PROOF CHEMICAL GOGGLES.

RESPIRATORY PROTECTION:
ORGANIC VAPOR RESPIRATOR IF TLV IS NOT EXCEEDED. FOR EXPOSURES IN EXCESS OF THE TLV, AN AIR SUPPLIED RESPIRATOR WOULD BE REQUIRED.

SECTION IX-SPECIAL PRECAUTIONS

HMIS CODE:
HEALTH : 2 FIRE : 1 REACTIVITY : 0

HANDLING, SHIPPING AND STORING PRECAUTIONS:
WARNING HARMFUL IF INHALED. CAUSES SKIN AND EYE IRRITATION. CAUSES ALLERGIC SKIN AND RESPIRATORY REACTION. AVOID CONTACT WITH EYES, SKIN, AND CLOTHING. AVOID BREATHING VAPOR OR MIST. AVOID PROLONGED OR REPEATED CONTACT WITH SKIN. KEEP CONTAINER CLOSED. USE WITH ADEQUATE VENTILATION. WASH THOROUGHLY AFTER HANDLING.

HANDLING PRECAUTIONS:
NUISANCE DUST MAY BE GENERATED WHEN SANDING OR SAWING CURED MATERIAL.

SECTION X- REGULATORY INFORMATION

DOT PROPER SHIPPING NAME:

TDT 186-1 RESIN

LIQUID PLASTIC, N.O.I.

DOT CLASS:
NOT REGULATED.

DOT NUMBER:
GROUP III POISON FOR IATA/IMO SHIPMENTS;
NOT REGULATED BY DOT.

RCRA STATUS:
NOT SPECIFICALLY LISTED AS HAZARDOUS WASTE UNDER RCRA (40 CFR 261). HOWEVER, IT IS STRONGLY RECOMMENDED THAT COMPOUND BE TREATED AS A HAZARDOUS WASTE AND DISPOSED OF ACCORDINGLY.

SARA/TITLE III - TOXIC CHEMICALS LIST:
THIS PRODUCT DOES NOT CONTAIN A TOXIC CHEMICAL FOR ROUTINE ANNUAL 'TOXIC CHEMICAL RELEASE REPORTING' UNDER SEC. 313 (40 CFR 372).

TSCA INVENTORY STATUS:
CHEMICAL COMPONENTS LISTED ON TSCA INVENTORY.

PENNSYLVANIA RIGHT-TO-KNOW ACT:
THE FOLLOWING IS REQUIRED COMPOSITION INFORMATION.

CHEMICAL NAME : N,N,N',N'-TETRAKIS(4-ISOCYANATOCYCLOHEXYL-1 ,1'-METHYLENE CYCLOHEXYL-4'-CARBAMOYL)-2-OXY PROPYL)ETHYLENEDIAMINE
CAS NUMBER : NOT AVAILABLE
COMMENTS : NOT ON PENNSYLVANIA HAZARDOUS SUBSTANCE LIST.

* * *

CHEMICAL NAME : CYCLOHEXANE, 1,1'-METHYLENEBIS 4-ISOCYANATO-
CAS NUMBER : 5124-30-1
COMMENTS : HAZARDOUS SUBSTANCE.

* * *

ISSUE DATE: 06/01/89 REVISION: 05C ISSUED BY: PETER HENIGE
FOR FURTHER INFORMATION, PLEASE CONTACT: PRODUCT SAFETY DIR

THE INFORMATION AND RECOMMENDATIONS CONTAINED HEREIN ARE BASED UPON DATA BELIEVED TO BE CORRECT. HOWEVER, NO GUARANTEE OR WARRANTY OF ANY KIND EXPRESSED OR IMPLIED IS MADE WITH RESPECT TO THE INFORMATION CONTAINED HEREIN.

TDT 186-1 RESIN

MATERIAL SAFETY DATA SHEET

CIBA-GEIGY CORPORATION FORMULATED SYSTEMS GROUP 4917 DAWN AVE EAST LANSING, MI 48823 (517) 351-5900	EMERGENCY PHONE NUMBER: (800) 888-8372

SECTION I-IDENTITY INFORMATION

IDENTITY (TRADENAME): TDT 186-1 HARDENER

FAMILY/CHEMICAL NAME:
POLYOL
PRODUCT TYPE:
CLEAR CASTABLE URETHANE
IMPORTANT:

* *

THIS MATERIAL WILL NOT BE SOLD FOR USE IN PRODUCTS FOR WHICH PROLONGED CONTACT WITH MUCOUS MEMBRANES OR ABRADED SKIN, OR IMPLANTATION WITHIN THE HUMAN BODY, IS SPECIFICALLY INTENDED. BECAUSE OF THE WIDE RANGE OF SUCH POTENTIAL USES, CIBA-GEIGY CORPORATION IS NOT ABLE TO RECOMMEND THIS MATERIAL AS SAFE AND EFFECTIVE FOR SUCH USES AND ASSUMES NO LIABILITY FOR ANY SUCH USES.

* *

HAZARD STATEMENT :

* *

THIS MATERIAL SAFETY DATA SHEET (MSDS) HAS BEEN PREPARED IN COMPLIANCE WITH THE FEDERAL OSHA HAZARD COMMUNICATION STANDARD 29 CFR 1910.1200.

THIS PRODUCT IS NOT CONSIDERED TO BE A HAZARDOUS CHEMICAL UNDER THAT STANDARD.

* *

SECTION II-HAZARDOUS INGREDIENTS

THE COMPONENTS OF THIS PRODUCT ARE NOT CONSIDERED TO BE HAZARDOUS AS DEFINED BY THE OSHA HAZARD COMMUNICATION STANDARD FOUND IN 29 CFR 1910.1200.

---------- SECTION III-PHYSICAL DATA ----------

APPEARANCE:
CLEAR COLORLESS LIQUID.
BOILING POINT:
NOT DETERMINED.
EVAPORATION RATE:
NOT DETERMINED.
PERCENT VOLATILE:
NEGLIGIBLE.
VAPOR DENSITY:
NOT DETERMINED.
VAPOR PRESSURE:
@ 25C .12 MMHG.
SOLUBILITY IN WATER:
MODERATE.
PH:
NOT DETERMINED.
SPECIFIC GRAVITY:
1.03 - 1.05 (WATER = 1)

---------- SECTION IV-FIRE AND EXPLOSION HAZARD DATA ----------

FLASH POINT:
> 300F (PMCC)
FLAMMABLE LIMITS IN AIR-LOWER:
NOT ESTABLISHED.
FLAMMABLE LIMITS IN AIR-UPPER:
NOT ESTABLISHED.
EXTINGUISHING MEDIA:
CARBON DIOXIDE, DRY CHEMICAL, FOAM, WATER.
FIRE FIGHTING PROCEDURES-SPECIAL:
USE SELF-CONTAINED BREATHING APPARATUS.
UNUSUAL FIRE AND EXPLOSION HAZARDS:
DECOMPOSITION AND COMBUSTION PRODUCTS MAY BE TOXIC.

---------- SECTION V-REACTIVITY DATA ----------

STABILITY:
STABLE.
CONDITIONS TO AVOID:
EXCESSIVE HEAT FOR PROLONGED PERIODS OF TIME.
INCOMPATIBILITY:
STRONG OXIDIZERS, ACIDS AND BASES.
HAZARDOUS DECOMPOSITION PRODUCTS:
COMBUSTION MAY FORM TOXIC MATERIALS, SUCH AS CARBON DIOXIDE,
CARBON MONOXIDE.
HAZARDOUS POLYMERIZATION:
WILL NOT OCCUR.

---------- SECTION VI-HEALTH HAZARD DATA ----------

TDT 186-1 HARDENER

PRIMARY ROUTES OF EXPOSURE:
DERMAL; HEATED PRODUCT MAY PRODUCE INHALABLE VAPORS.
THRESHOLD LIMIT VALUE:
NONE ESTABLISHED FOR THIS PRODUCT. SEE THE HAZARDOUS INGREDIENTS SECTION.
MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE:
SKIN AND EYE CONDITIONS.
EMERGENCY AND FIRST AID PROCEDURES-EYES:
IMMEDIATELY FLUSH EYES WITH WATER FOR AT LEAST 15 MINUTES. CALL A PHYSICIAN.
EMERGENCY AND FIRST AID PROCEDURES-SKIN:
WASH WITH SOAP AND WATER. REMOVE CONTAMINATED CLOTHING AND LAUNDER BEFORE RE-USE.
EMERGENCY AND FIRST AID PROCEDURES-INGESTION:
IF CONSCIOUS, GIVE PLENTY OF WATER TO DRINK. DO NOT INDUCE VOMITING. CALL A PHYSICIAN.
EMERGENCY AND FIRST AID PROCEDURES-INHALATION:
REMOVE TO FRESH AIR. GIVE OXYGEN AND/OR ARTIFICIAL RESPIRATION, IF NEEDED. CALL A PHYSICIAN.
EMERGENCY AND FIRST AID PROCEDURES-OTHER:
REFERRAL TO A PHYSICIAN IS RECOMMENDED IF THERE IS ANY QUESTION ABOUT THE SERIOUSNESS OF ANY INJURY.

SECTION VII-SPILL OR LEAK PROCEDURES

SPILL PROCEDURES:
REMOVE SPILLAGE BY ABSORBING IN ABSORBENT MATERIAL.
WASTE DISPOSAL METHODS:
CONSULT QUALIFIED LOCAL OR CORPORATE PERSONNEL FOR METHOD THAT WILL COMPLY WITH LOCAL, STATE AND FEDERAL HEALTH AND ENVIRONMENTAL REGULATIONS.

SECTION VIII-SPECIAL PROTECTION INFORMATION

VENTILATION:
GENERAL MECHANICAL AND LOCAL EXHAUST IN ACCORDANCE WITH ACGIH RECOMMENDATIONS.
PROTECTIVE GLOVES:
WEAR IMPERMEABLE GLOVES.
EYE PROTECTION:
WEAR SPLASH-PROOF CHEMICAL GOGGLES.
RESPIRATORY PROTECTION:
USE NIOSH APPROVED ORGANIC VAPOR CARTRIDGE RESPIRATOR WHEN VAPOR/MIST EXPOSURE IS LIKELY.

SECTION IX-SPECIAL PRECAUTIONS

HMIS CODE:
HEALTH : 1 FIRE : 1 REACTIVITY : 0
HANDLING, SHIPPING AND STORING PRECAUTIONS:
CAUTION IN ACCORD WITH GOOD INDUSTRIAL PRACTICE, HANDLE WITH DUE CARE. AVOID CONTACT WITH EYES, SKIN, AND CLOTHING. WASH THOROUGHLY AFTER HANDLING.

TDT 186-1 HARDENER

HANDLING PRECAUTIONS:
NUISANCE DUST MAY BE GENERATED WHEN SANDING OR SAWING CURED MATERIAL.

---------- SECTION X- REGULATORY INFORMATION ----------

DOT PROPER SHIPPING NAME:
LIQUID PLASTIC, N.O.I.
DOT CLASS:
NOT REGULATED.
RCRA STATUS:
NOT A HAZARDOUS WASTE UNDER RCRA (40 CFR 261).
SARA/TITLE III - TOXIC CHEMICALS LIST:
THIS PRODUCT DOES NOT CONTAIN A TOXIC CHEMICAL FOR ROUTINE ANNUAL 'TOXIC CHEMICAL RELEASE REPORTING' UNDER SEC. 313 (40 CFR 372).
TSCA INVENTORY STATUS:
CHEMICAL COMPONENTS LISTED ON TSCA INVENTORY.
PENNSYLVANIA RIGHT-TO-KNOW ACT:
THE FOLLOWING IS REQUIRED COMPOSITION INFORMATION.

CHEMICAL NAME	:	2-PROPANOL, 1,1',1'',1'''-(1,2-ETHANEDIYLDIN ITRILO)TETRAKIS-
CAS NUMBER	:	102-60-3
COMMON NAME	:	TETRA(HYDROXYPROPYL)ETHYLENE DIAMINE
COMMENTS	:	NOT ON PENNSYLVANIA HAZARDOUS SUBSTANCE LIST.

* * *

CHEMICAL NAME	:	POLY OXY(METHYL-1,2-ETHANEDIYL) , .ALPHA.,.A LPHA.',.ALPHA.''-1,2,3-PROPANETRIYLTRIS .OME GA.-HYDROXY-
CAS NUMBER	:	25791-96-2
COMMENTS	:	NOT ON PENNSYLVANIA HAZARDOUS SUBSTANCE LIST.

* * *

CHEMICAL NAME	:	OXIRANE, METHYL-, POLYMER WITH OXIRANE, ETHE R WITH 1,2,3-PROPANETRIOL (3:1)
CAS NUMBER	:	9082-00-2
COMMENTS	:	NOT ON PENNSYLVANIA HAZARDOUS SUBSTANCE LIST.

* * *

ISSUE DATE: 12/10/88 REVISION: 04C ISSUED BY: PETER HENIGE
FOR FURTHER INFORMATION, PLEASE CONTACT: PRODUCT SAFETY DIR

THE INFORMATION AND RECOMMENDATIONS CONTAINED HEREIN ARE BASED UPON DATA BELIEVED TO BE CORRECT. HOWEVER, NO GUARANTEE OR WARRANTY OF ANY KIND EXPRESSED OR IMPLIED IS MADE WITH RESPECT TO THE INFORMATION CONTAINED HEREIN.

TDT 186-1 HARDENER

HEXCEL Resins Group

HMIS-Rating
Health 2
Flammability 1
Reactivity 1

MATERIAL SAFETY DATA SHEET

URALITE 3156-3158 PART A

SECTION I - IDENTIFICATION

COMPANY NAME..... HEXCEL CORPORATION - RESINS GROUP
20701 Nordhoff Street, PO Box 2197
Chatsworth, CA 91311
(818) 882-3022
EMERGENCY PHONE NUMBER..... (800) 433-5072 (except California)
(800) 343-4467 (Canada)
CALIFORNIA EMERGENCY PHONE NUMBER.. (800) 367-7527
PRODUCT IDENTIFIER..... URALITE 3156-3158 PART A
CHEMICAL FAMILY..... URETHANE PREPOLYMER

SECTION II - HAZARDOUS INGREDIENTS

HAZARDOUS INGREDIENTS	HAZARDOUS INGREDIENT PERCENT	TLV (Units)	CAS NUMBER
Dicyclohexylmethane-4,4' diisocyanate (aka H_{12} MDI)	10-30	.01 ppm	5124-30-1
Polypropylene Polyethylene Polyglycol/ H_{12}MDI Polymer	70-90	Not Established	68310-52-1

SECTION III - PHYSICAL DATA

BOILING POINT..... Not available MELTING POINT.....Not available
VOC (grams/liter)..... Not Applicable DENSITY (g/ml).....1.06
APPEARANCE AND ODOR... Clear liquid with a faint sweet odor

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

FLASHPOINT AND METHOD OF DETERMINATION.. 302°F Cleveland Open Cup
MEANS OF EXTINCTION..... Use CO_2 or dry chemical for small fires. Use water and foam for large ones.
FOR FIRE..... Since vapors are exceedingly irritating when inhaled, a self-contained breathing apparatus should be available to firemen.

	HMIS-Rating
	Health 2
	Flammability 1
MATERIAL SAFETY DATA SHEET	Reactivity 1

EMERGENCY RESPONSE..... NOT LISTED IN THE 1990 DOT EMERGENCY RESPONSE GUIDEBOOK.

SECTION V - HEALTH HAZARD DATA

OVEREXPOSURE EFFECTS..... Skin exposure may cause irritation. Repeated or prolonged exposure can result in dermatitis and skin sensitization (allergic effects). Vapors are exceedingly irritating to mucous membrane and eyes. Can cause acute temporary chest discomfort and breathing difficulty. Vapors can cause respiratory sensitization in suspectible people. Risk of explosion by shock, friction, fire or other sources of ignition. Ingestion may cause gastro-intestinal burning and discomfort. Possibly severe irritation and/or sensitization can result from overexposure to this product. Pre-existing eye, skin, and respiratory disorders may be aggravated by exposure.

SPECIFIC FIRST AID PROCEDURES..... EYES: In case of eye contact, immediately flush eyes with plenty of water for at least 15 minutes. Get medical attention.

SKIN CONTACT: In case of contact, immediately wash skin with soap and plenty of water. Wash contaminated clothing before re-use and destroy contaminated shoes.

INHALATION: If inhaled, remove to fresh air. If not breathing, give artificial respiration, preferably mouth-to-mouth. If breathing is difficult, give oxygen. Get medical attention.

INGESTION: If swallowed, get medical attention immediately. Induce vomiting ONLY upon the advice of a physician.

SECTION VI - REACTIVITY DATA

CHEMICAL STABILITY..... Stable

INCOMPATIBLE MATERIALS... Avoid contact with water, alcohols, strong bases, metal compounds or surface active materials.

HAZARDOUS DECOMPOSITION PRODUCTS..... Carbon dioxide, carbon monoxide, and nitrogen oxides. Isocyanate vapors and mists may also evolve.

HAZARDOUS POLYMERIZATION. Will not occur.

CONDITIONS TO AVOID..... STORE IN A COOL, WELL VENTILATED AREA IN TIGHTLY CLOSED CONTAINERS. AVOID MOISTURE CONTAMINATION.

SECTION VII - SPILL OR LEAK PROCEDURE

RCRA WASTE NUMBER..... None

		HMIS-Rating
		Health 2
		Flammability 1
	MATERIAL SAFETY DATA SHEET	Reactivity 1

WASTE DISPOSAL..... Controlled incineration or buried landfill disposal should be in accordance with all federal, state and local environmental control regulations.

LEAK AND SPILL PROCEDURES In case of spill, contain with a suitable diking material. Ventilate the area thoroughly. Keep all unnecessary people away. Spilled material should be absorbed in sawdust, sand or other absorbant. Place in an open-top container. Neutralize with a solution of 90-95% water, 5-8% concentrated ammonia and 1-2% detergent before disposal. Keep container open for at least 12 hours so that evolved carbon dioxide can escape.

SECTION VIII - SPECIAL PROTECTION

PERSONAL PROTECTION..... HMIS CODE C- SAFETY GLASSES, GLOVES AND SYNTHETIC APRON.

VENTILATION..... If handled indoors, provide mechanical exhaust ventilation.

HANDLING PROCEDURES AND EQUIPMENT..... Avoid breathing vapors. Keep away from heat, sparks, and open flames. Use adequate ventilation. Wash thoroughly after handling.

SECTION IX - SHIPPING INFORMATION

HAZARD CLASS..... N/A
DOT SHIPPING NAME..... NOT REGULATED BY THE DEPARTMENT OF TRANSPORTATION.
REPORTABLE QUANTITY (RQ). N/A
UN NUMBER..... N/A
NA #..... N/A

SECTION X - STORAGE INFORMATION

STORE IN A COOL DRY AREA IN TIGHTLY CLOSED CONTAINERS. AVOID MOISTURE CONTAMINATION.

SECTION XI - REGULATORY INFORMATION

NOTICE: The information herein is presented in good faith and believed to be accurate as of the preparation date shown below. However, no warranty, expressed or implied, is given. Regulatory requirements are subject to change and may differ from one location to another; it is the buyer's responsibility to ensure that its activities comply with federal, state and local laws. The following specific information is made for the purpose of complying with numerous federal, state and local laws and regulations. THIS INFORMATION IS NOT MEANT TO BE ALL-INCLUSIVE. SELECTED REGULATIONS ARE PRESENTED.

SARA 313 INFO: This product contains the following substances subject to the

HMIS-Rating	
Health	2
Flammability	1
Reactivity	1

MATERIAL SAFETY DATA SHEET

reporting requirements of Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 and 40 CFR Part 372.

H_{12} MDI is considered an Immediate Health Hazard, Delayed Health Hazard and Reactive Hazard under Sections 311/312 of SARA Title III.

CALIFORNIA PROPOSITION 65:
To the best of our knowledge, this product contains no levels of listed substances, which the state of California has found to cause cancer, birth defects or other reproductive effects.

NEW JERSEY:
The following are listed on the New Jersey Hazardous Substance List:

Dicyclohexylmethane-4,4'-diisocyanate

PENNSYLVANIA:
The following are on the Pennsylvania Hazardous Substance List:
Dicyclohexylmethane-4,4'-diisocyanate

PREPARED BY..... Deirdre S. Crutchfield
DATE PREPARED..... 06/01/91
PHONE NUMBER OF PREPARER. (818) 882-3022

FOOT NOTES

REFERENCES

DISCLAIMER: To the best of our knowledge, the information contained herein is accurate. However, no liability whatsoever is assumed for the accuracy of the information contained herein. Final determination or suitability of a material is the sole responsibility of the user. All material may present unknown health hazards and should be used with caution. Although certian hazards are described herein, we cannot guarantee that these are the only hazards that exist.

THE PRODUCT FORMULATION INFORMATION CONTAINED HEREIN IS ONLY FOR OCCUPATIONAL SAFETY AND HEALTH RELATED USAGE. ANY MISUSE OF THIS INFORMATION, INCLUDING DIVULGENCE TO THIRD PARTIES OR USE TO GAIN A COMPETITIVE ADVANTAGE IS STRICTLY PROHIBITED.

HEXCEL Resins Group

HMIS-Rating
Health 3
Flammability 1
Reactivity 0

MATERIAL SAFETY DATA SHEET

URALITE 3156 PART B

SECTION I - IDENTIFICATION

COMPANY NAME.....	HEXCEL CORPORATION - RESINS GROUP 20701 Nordhoff Street, PO Box 2197 Chatsworth, CA 91311 (818) 882-3022
EMERGENCY PHONE NUMBER.....	(800) 433-5072 (except California) (800) 343-4467 (Canada)
CALIFORNIA EMERGENCY PHONE NUMBER..	(800) 367-7527
PRODUCT IDENTIFIER.....	URALITE 3156 PART B
CHEMICAL FAMILY.....	URETHANE CURATIVE

SECTION II - HAZARDOUS INGREDIENTS

HAZARDOUS INGREDIENTS	HAZARDOUS INGREDIENT PERCENT	TLV (Units)	CAS NUMBER
4,4' Methylene Dianiline	35-45	0.1 ppm	101-77-9
Polymethylene Polyphenyl (Polyalkylphenyl) Amine	15-35	Not Established	252-14-70-4 69178-40-1
Cyclic Amide	20-40	TWA 100 ppm (estimated)	872-50-4
Phenyl Mercuric Alkyl Carboxylate	.03	Not established (0.1mg(Hg)/m^3 recommended)	103-27-5

SECTION III - PHYSICAL DATA

BOILING POINT.....	Not available	MELTING POINT.....	Not avaliable
VOC (grams/liter).....	Not Applicable	DENSITY (g/ml).....	1.12
APPEARANCE AND ODOR...	Amber liquid with a faint amine odor		

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

FLASHPOINT AND METHOD OF DETERMINATION..	204°F Cleveland Open Cup
MEANS OF EXTINCTION.....	Use CO_2 or dry chemical for small fires. Use water and foam for large ones.

HMIS-Rating
==========
Health 3
Flammability 1
Reactivity 0
==========

MATERIAL SAFETY DATA SHEET

FOR FIRE.....	Since vapors are exceedingly irritating when inhaled, a self-contained breathing apparatus should be available to firemen.
EMERGENCY RESPONSE.....	Not listed in the DOT 1990 EMERGENCY RESPONSE GUIDEBOOK.

SECTION V - HEALTH HAZARD DATA

OVEREXPOSURE EFFECTS.....	SUSPECTED CANCER HAZARD: Contains 4,4'-Methylene-dianiline which may cause cancer. The risk depends on the length and level of exposure. Chronic contact or inhalation may also cause liver damage and breathing problems. DANGER: May be fatal if swallowed! Vapors are exceedingly irritating to mucous membranes and eyes. Repeated exposure may cause skin irritation, leading to sensitization and dermatitis. Eye contact may cause extreme irritation and/or burning. Possibly severe irritation and/or sensitization can result from overexposure to this product. Pre-existing eye, skin, and respiratory disorders may be aggravated by exposure.
SPECIFIC FIRST AID PROCEDURES.....	EYES: In case of eye contact, immediately flush eyes with plenty of water for at least 15 minutes. Get medical attention. SKIN CONTACT: In case of contact, immediately wash skin with soap and plenty of water. Wash contaminated clothing before re-use and destroy contaminated shoes. INHALATION: If inhaled, remove to fresh air. If not breathing, give artificial respiration, preferably mouth-to-mouth. If breathing is difficult, give oxygen. Get medical attention. INGESTION: If swallowed, get medical attention immediately. Induce vomiting ONLY upon the advice of a physician.

SECTION VI - REACTIVITY DATA

CHEMICAL STABILITY.....	Stable
INCOMPATIBLE MATERIALS...	Avoid contact with strong oxidizers.
HAZARDOUS DECOMPOSITION PRODUCTS.....	Carbon dioxide, carbon monoxide, and nitrogen oxides.
HAZARDOUS POLYMERIZATION.	Will not occur.
CONDITIONS TO AVOID.....	Avoid contact with water, alcohols, strong bases, metal compounds or surface active materials.

HMIS-Rating

Health	3
Flammability	1
Reactivity	0

MATERIAL SAFETY DATA SHEET

SECTION VII - SPILL OR LEAK PROCEDURE

RCRA WASTE NUMBER.....	None
WASTE DISPOSAL.....	Controlled incineration or buried landfill disposal should be in accordance with all federal, state and local environmental control regulations.
LEAK AND SPILL PROCEDURES	In case of spill, contain with a suitable diking material. Ventilate the area thoroughly. Keep all unnecessary people away. Spilled material should be absorbed in sawdust, sand or other absorbant. Place into open-topped containers and cover loosely; store for at least 12 hours before sealing container.

SECTION VIII - SPECIAL PROTECTION

PERSONAL PROTECTION.....	HMIS CODE C- SAFETY GLASSES, GLOVES AND SYNTHETIC APRON.
VENTILATION.....	If handled indoors, provide mechanical exhaust ventilation.
HANDLING PROCEDURES AND EQUIPMENT.....	Avoid breathing vapors. Keep away from heat, sparks, and open flames. Use adequate ventilation. Wash thoroughly after handling.

SECTION IX - SHIPPING INFORMATION

HAZARD CLASS.....	N/A
DOT SHIPPING NAME.....	NOT REGULATED BY THE DEPARTMENT OF TRANSPORTATION.
REPORTABLE QUANTITY (RQ).	N/A
UN NUMBER.....	N/A
NA #.....	N/A

SECTION X - STORAGE INFORMATION

STORE IN A COOL DRY AREA IN TIGHTLY CLOSED CONTAINERS. AVOID MOISTURE CONTAMINATION.

SECTION XI - REGULATORY INFORMATION

NOTICE: The information herein is presented in good faith and believed to be accurate as of the preparation date shown below. However, no warranty, expressed or implied, is given. Regulatory requirements are subject to change and may differ from one location to another; it is the buyer's responsibility to ensure that its activities comply with federal, state and local laws. The following specific information is made for the purpose of complying with numerous federal, state and local laws and regulations. THIS INFORMATION IS NOT MEANT TO BE ALL-INCLUSIVE. SELECTED REGULATIONS ARE PRESENTED.

HMIS-Rating	
Health	3
Flammability	1
Reactivity	0

MATERIAL SAFETY DATA SHEET

SARA 313 INFO: This product contains the following substances subject to the reporting requirements of Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 and 40 CFR Part 372.

Methylene Dianiline

CALIFORNIA PROPOSITION 65:
The following substances are known to the state of California to cause cancer:
Methylene Dianiline

PREPARED BY..... Deirdre S. Crutchfield
DATE PREPARED..... 06/01/91
PHONE NUMBER OF PREPARER. (318) 862-3022

FOOT NOTES

REFERENCES

DISCLAIMER: To the best of our knowledge, the information contained herein is accurate. However, no liability whatsoever is assumed for the accuracy of the information contained herein. Final determination or suitability of a material is the sole responsibility of the user. All material may present unknown health hazards and should be used with caution. Although certian hazards are described herein, we cannot guarantee that these are the only hazards that exist.

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HEXCEL Resins Group

HMIS-Rating	
Health	2
Flammability	1
Reactivity	1

MATERIAL SAFETY DATA SHEET

URALITE 3160 PART A

SECTION I - IDENTIFICATION

COMPANY NAME.....	HEXCEL CORPORATION - RESINS GROUP 20701 Nordhoff Street, PO Box 2197 Chatsworth, CA 91311 (818) 882-3022
EMERGENCY PHONE NUMBER.....	(800) 433-5072 (except California) (800) 343-4467 (Canada)
CALIFORNIA EMERGENCY PHONE NUMBER..	(800) 367-7527
PRODUCT IDENTIFIER.....	URALITE 3160 PART A
CHEMICAL FAMILY.....	URETHANE PREPOLYMER

SECTION II - HAZARDOUS INGREDIENTS

HAZARDOUS INGREDIENTS	HAZARDOUS INGREDIENT PERCENT	TLV (Units)	CAS NUMBER
Dicyclohexylmethane-4,4' diisocyanate (aka H_{12} MDI)	20-30	.01 ppm	5124-30-1
Polyglycol/H_{12}MDI Polymer	70-80	Not Established	68310-52-1

SECTION III - PHYSICAL DATA

BOILING POINT.....	Not available	MELTING POINT.....	Not available
VOC (grams/liter).....	Not Applicable	DENSITY (g/ml).....	1.06
APPEARANCE AND ODOR...	Clear to pale yellow liquid with a faintly sweet odor		

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

FLASHPOINT AND METHOD OF DETERMINATION..	>300°F Cleveland Open Cup
MEANS OF EXTINCTION.....	Use CO_2 or dry chemical for small fires. Use water and foam for large ones.
FOR FIRE.....	Since vapors are exceedingly irritating when inhaled, a self-contained breathing apparatus should be available to firemen.

HMIS-Rating	
Health	2
Flammability	1
Reactivity	1

MATERIAL SAFETY DATA SHEET

EMERGENCY RESPONSE..... NOT LISTED IN THE 1990 DOT EMERGENCY RESPONSE GUIDEBOOK.

SECTION V - HEALTH HAZARD DATA

OVEREXPOSURE EFFECTS..... Skin exposure may cause irritation. Repeated or prolonged exposure can result in dermatitis and skin sensitization (allergic effects). Vapors are exceedingly irritating to mucous membrane and eyes. Can cause acute temporary chest discomfort and breathing difficulty. Vapors can cause respiratory sensitization in suspectible people. Risk of explosion by shock, friction, fire or other sources of ignition. Ingestion may cause gastro-intestinal burning and discomfort.

SPECIFIC FIRST AID PROCEDURES..... EYES: In case of eye contact, immediately flush eyes with plenty of water for at least 15 minutes. Get medical attention.

SKIN CONTACT: In case of contact, immediately wash skin with soap and plenty of water. Wash contaminated clothing before re-use and destroy contaminated shoes.

INHALATION: If inhaled, remove to fresh air. If not breathing, give artificial respiration, preferably mouth-to-mouth. If breathing is difficult, give oxygen. Get medical attention.

INGESTION: If swallowed, get medical attention immediately. Induce vomiting ONLY upon the advice of a physician.

SECTION VI - REACTIVITY DATA

CHEMICAL STABILITY..... Stable

INCOMPATIBLE MATERIALS... Avoid contact with water, alcohols, strong bases, metal compounds or surface active materials.

HAZARDOUS DECOMPOSITION PRODUCTS..... Carbon dioxide, carbon monoxide, and nitrogen oxides. Isocyanate vapors and mists may also evolve.

HAZARDOUS POLYMERIZATION. Will not occur.

CONDITIONS TO AVOID..... STORE IN A COOL, WELL VENTILATED AREA IN TIGHTLY CLOSED CONTAINERS. AVOID MOISTURE CONTAMINATION.

SECTION VII - SPILL OR LEAK PROCEDURE

RCRA WASTE NUMBER..... None

WASTE DISPOSAL..... Controlled incineration or buried landfill disposal should be in accordance with all federal, state and local environmental control regulations.

		HMIS-Rating
		Health 2
		Flammability 1
	MATERIAL SAFETY DATA SHEET	Reactivity 1

LEAK AND SPILL PROCEDURES: In case of spill, contain with a suitable diking material. Ventilate the area thoroughly. Keep all unnecessary people away. Spilled material should be absorbed in sawdust, sand or other absorbant. Place in an open-top container. Neutralize with a solution of 90-95% water, 5-8% concentrated ammonia and 1-2% detergent before disposal. Keep container open for at least 12 hours so that evolved carbon dioxide can escape.

SECTION VIII - SPECIAL PROTECTION

PERSONAL PROTECTION.....	HMIS CODE C- SAFETY GLASSES, GLOVES AND SYNTHETIC APRON.
VENTILATION.....	If handled indoors, provide mechanical exhaust ventilation.
HANDLING PROCEDURES AND EQUIPMENT.....	Avoid breathing vapors. Keep away from heat, sparks, and open flames. Use adequate ventilation. Wash thoroughly after handling.

SECTION IX - SHIPPING INFORMATION

HAZARD CLASS.....	N/A
DOT SHIPPING NAME.....	NOT REGULATED BY THE DEPARTMENT OF TRANSPORTATION.
REPORTABLE QUANTITY (RQ).	N/A
UN NUMBER.....	N/A
NA #.....	N/A

SECTION X - STORAGE INFORMATION

STORE IN A COOL DRY AREA IN TIGHTLY CLOSED CONTAINERS. AVOID MOISTURE CONTAMINATION.

SECTION XI - REGULATORY INFORMATION

NOTICE: The information herein is presented in good faith and believed to be accurate as of the preparation date shown below. However, no warranty, expressed or implied, is given. Regulatory requirements are subject to change and may differ from one location to another; it is the buyer's responsibility to ensure that its activities comply with federal, state and local laws. The following specific information is made for the purpose of complying with numerous federal, state and local laws and regulations. THIS INFORMATION IS NOT MEANT TO BE ALL-INCLUSIVE. SELECTED REGULATIONS ARE PRESENTED.

SARA 313 INFO: This product contains the following substances subject to the reporting requirements of Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 and 40 CFR Part 372.

HMIS-Rating	
Health	2
Flammability	1
Reactivity	1

MATERIAL SAFETY DATA SHEET

H.. MDI is considered an Immediate Health Hazard, Delayed Health Hazard and Reactive Hazard under Sections 311/312 of SARA Title III.

CALIFORNIA PROPOSITION 65:
To the best of our knowledge, this product contains no levels of listed substances, which the state of California has found to cause cancer, birth defects or other reproductive effects.

NEW JERSEY:
The following are listed on the New Jersey Hazardous Substance List:

Dicyclohexylmethane-4,4'-diisocyanate

PENNSYLVANIA:
The following are on the Pennsylvania Hazardous Substance List:
Dicyclohexylmethane-4,4'-diisocyanate

PREPARED BY..... Deirdre S. Crutchfield
DATE PREPARED..... 06/01/91
PHONE NUMBER OF PREPARER. (818) 882-3022

FOOT NOTES

REFERENCES

DISCLAIMER: To the best of our knowledge, the information contained herein is accurate. However, no liability whatsoever is assumed for the accuracy of the information contained herein. Final determination or suitability of a material is the sole responsibility of the user. All material may present unknown health hazards and should be used with caution. Although certian hazards are described herein, we cannot guarantee that these are the only hazards that exist.

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HEXCEL CORPORATION
Resins Group Division

HMIS-Rating	
Health	3
Flammability	1
Reactivity	0

MATERIAL SAFETY DATA SHEET

URALITE 3160 PART B

SECTION I - IDENTIFICATION

COMPANY NAME.....	HEXCEL CORPORATION - RESINS GROUP 20701 Nordhoff Street, PO Box 2197 Chatsworth, CA 91311 (818) 882-3022
EMERGENCY PHONE NUMBER.....	(800) 433-5072 (except California) (800) 343-4467 (Canada)
CALIFORNIA EMERGENCY PHONE NUMBER..	(800) 367-7527
PRODUCT IDENTIFIER.....	URALITE 3160 PART B
CHEMICAL FAMILY.....	URETHANE CURATIVE

SECTION II - HAZARDOUS INGREDIENTS

HAZARDOUS INGREDIENTS	HAZARDOUS INGREDIENT PERCENT	TLV (Units)	CAS NUMBER
4,4' Methylene Dianiline	2-10	0.1 ppm	101-77-9
Polymethylene Polyphenyl & Polyalkylphenyl Amine	40-65	Not Established	252-14-70-4 69178-40-1
Aromatic Alkyl Ester	25-40	5 mg/m^3	84-74-2
Cyclic Amide	2-10	TWA 100 ppm (estimated)	872-50-4

SECTION III - PHYSICAL DATA

BOILING POINT..... Not available MELTING POINT.....Not Avaliable
VOC (grams/liter)..... Not Applicable DENSITY (g/ml).....1.06
APPEARANCE AND ODOR... Amber liquid with a faint odor

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

FLASHPOINT & METHOD OF DETERMINATION....	Greater than $300^{o}F$
MEANS OF EXTINCTION.....	Use CO_2 or dry chemical for small fires, and water and foam for large ones.
FOR FIRE.....	Since vapors are exceedingly irritating when inhaled, a self-contained breathing apparatus should be available to firemen.

HEXCEL CORPORATION
Resins Group Division

MATERIAL SAFETY DATA SHEET

HMIS-Rating	
Health	3
Flammability	1
Reactivity	0

EMERGENCY RESPONSE..... Not listed in the DOT 1990 EMERGENCY RESPONSE GUIDEBOOK.

SECTION V - HEALTH HAZARD DATA

OVEREXPOSURE EFFECTS..... SUSPECTED CANCER HAZARD: Contains 4,4'-Methylene-dianiline which may cause cancer. The risk depends on the length and level of exposure. Chronic contact or inhalation may also cause liver damage and breathing problems.

DANGER: May be fatal if swallowed! Vapors are exceedingly irritating to mucous membranes and eyes. Repeated exposure may cause skin irritation, leading to sensitization and dermatitis. Eye contact may cause extreme irritation and/or burning. Severe irritation and/or sensitization may result from overexposure to this product. Pre-existing eye, skin, and respiratory disorders may be aggravated by exposure.

SPECIFIC FIRST AID PROCEDURES..... EYES: In case of eye contact, immediately flush eyes with plenty of water for at least 15 minutes. Get medical attention.

SKIN CONTACT: In case of contact, immediately wash skin with soap and plenty of water. Wash contaminated clothing before re-use and destroy contaminated shoes.

INHALATION: If inhaled, remove to fresh air. If not breathing, give artificial respiration, preferably mouth-to-mouth. If breathing is difficult, give oxygen. Get medical attention.

INGESTION: If swallowed, get medical attention immediately. Induce vomiting ONLY upon the advice of a physician.

SECTION VI - REACTIVITY DATA

CHEMICAL STABILITY..... Stable
INCOMPATIBLE MATERIALS... Avoid contact with strong oxidizers.
HAZARDOUS DECOMPOSITION PRODUCTS..... Carbon dioxide, carbon monoxide, and nitrogen oxides.
HAZARDOUS POLYMERIZATION. Will not occur.
CONDITIONS TO AVOID..... Avoid contact with water, alcohols, strong bases, metal compounds or surface active materials.

SECTION VII - SPILL OR LEAK PROCEDURE

RCRA WASTE NUMBER..... None

HEXCEL CORPORATION
Resins Group Division

HMIS-Rating
==========
Health 3
Flammability 1
Reactivity 0
==========

MATERIAL SAFETY DATA SHEET

WASTE DISPOSAL..... Controlled incineration or buried landfill disposal should be in accordance with all federal, state and local environmental control regulations.

LEAK AND SPILL PROCEDURES In case of spill, contain with a suitable diking material. Ventilate the area thoroughly. Keep all unnecessary people away. Spilled material should be absorbed in sawdust, sand or other absorbant. Place into open-topped containers and cover loosely; store for at least 12 hours before sealing container.

SECTION VIII - SPECIAL PROTECTION

PERSONAL PROTECTION..... HMIS CODE C- SAFETY GLASSES, GLOVES AND SYNTHETIC APRON.

VENTILATION..... If handled indoors, provide mechanical exhaust ventilation.

HANDLING PROCEDURES AND EQUIPMENT..... Avoid breathing vapors. Keep away from heat, sparks, and open flames. Use adequate ventilation. Wash thoroughly after handling.

SECTION IX - SHIPPING INFORMATION

HAZARD CLASS..... N/A
DOT SHIPPING NAME..... NOT REGULATED BY THE DEPARTMENT OF TRANSPORTATION.
UN NUMBER..... N/A
NA #..... N/A

SECTION X - STORAGE INFORMATION

STORE IN A COOL DRY AREA IN TIGHTLY CLOSED CONTAINERS. AVOID MOISTURE CONTAMINATION.

SECTION XI - REGULATORY INFORMATION

NOTICE: The information herein is presented in good faith and believed to be accurate as of the preparation date shown below. However, no warranty, expressed or implied, is given. Regulatory requirements are subject to change and may differ from one location to another; it is the buyer's responsibility to ensure that its activities comply with federal, state and local laws. The following specific information is made for the purpose of complying with numerous federal, state and local laws and regulations. THIS INFORMATION IS NOT MEANT TO BE ALL-INCLUSIVE. SELECTED REGULATIONS ARE PRESENTED.

SARA 313 INFO: This product contains the following substances subject to the reporting requirements of Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 and 40 CFR Part 372.

HEXCEL CORPORATION
Resins Group Division

HMIS-Rating	
Health	3
Flammability	1
Reactivity	0

MATERIAL SAFETY DATA SHEET

Methylene Dianiline

CALIFORNIA PROPOSITION 65:
The following substances are known to the state of California to cause cancer, birth defects or other reproductive effects:
Methylene Dianiline

PREPARED BY..... Deirdre S. Crutchfield
DATE PREPARED..... 06/01/91
PHONE NUMBER OF PREPARER. (818) 882-3022

FOOT NOTES

REFERENCES

DISCLAIMER: The information contained herein is accurate to the best of our knowledge, but no liability whatsoever is assumed. Final determination or suitability of a material is the sole responsibility of the user. All material may present unknown health hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.

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HEXCEL Resins Group

HMIS-Rating
Health 3
Flammability 1
Reactivity 1

MATERIAL SAFETY DATA SHEET

URALITE 3500 PART A

SECTION I - IDENTIFICATION

COMPANY NAME	HEXCEL CORPORATION - RESINS GROUP 20701 Nordhoff Street, PO Box 2197 Chatsworth, CA 91311 (818) 882-3022
EMERGENCY PHONE NUMBER	(800) 433-5072 (except California) (800) 343-4467 (Canada)
CALIFORNIA EMERGENCY PHONE NUMBER	(800) 367-7527
PRODUCT IDENTIFIER	URALITE 3500 PART A
CHEMICAL FAMILY	URETHANE PREPOLYMER

SECTION II - HAZARDOUS INGREDIENTS

HAZARDOUS INGREDIENTS	HAZARDOUS INGREDIENT PERCENT	TLV (Units)	CAS NUMBER
Dicyclohexylmethane-4,4' diisocyanate (aka H_{12} MDI)	20-35	.01 ppm	5124-30-1
Polyether Glycol/ H_{12}MDI Polymer	65-80	Not Established	52292-18-9

SECTION III - PHYSICAL DATA

BOILING POINT	Not available	MELTING POINT	Not available
VOC (grams/liter)	Not Applicable	DENSITY (g/ml)	1.085
APPEARANCE AND ODOR	Clear to pale yellow liquid with a faint sweet odor		

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

FLASHPOINT AND METHOD OF DETERMINATION	>350°F Pensky-Martens Closed Cup
MEANS OF EXTINCTION	Use CO_2 or dry chemical for small fires. Use water and foam for large ones.
FOR FIRE	Since vapors are exceedingly irritating when inhaled, a self-contained breathing apparatus should be available to firemen.

	HMIS-Rating
	Health 3
	Flammability 1
MATERIAL SAFETY DATA SHEET	Reactivity 1

EMERGENCY RESPONSE..... NOT LISTED IN THE 1990 DOT EMERGENCY RESPONSE GUIDEBOOK.

SECTION V - HEALTH HAZARD DATA

OVEREXPOSURE EFFECTS..... Skin exposure may cause irritation. Repeated or prolonged exposure can result in dermatitis and skin sensitization (allergic effects). Vapors are exceedingly irritating to mucous membrane and eyes. Can cause acute temporary cnest discomfort and breathing difficulty. Vapors can cause respiratory sensitization in suspectible people. Risk of explosion by shock, friction, fire or other sources of ignition. Ingestion may cause gastro-intestinal burning and discomfort. Possibly severe irritation and/or sensitization can result from overexposure to this product. Pre-existing eye, skin, and respiratory disorders may be aggravated by exposure.

SPECIFIC FIRST AID PROCEDURES..... EYES: In case of eye contact, immediately flush eyes with plenty of water for at least 15 minutes. Get medical attention.
SKIN CONTACT: In case of contact, immediately wash skin with soap and plenty of water. Wash contaminated clothing before re-use and destroy contaminated shoes.
INHALATION: If inhaled, remove to fresh air. If not breathing, give artificial respiration, preferably mouth-to-mouth. If breathing is difficult, give oxygen. Get medical attention.
INGESTION: If swallowed, get medical attention immediately. Induce vomiting ONLY upon the advice of a physician.

SECTION VI - REACTIVITY DATA

CHEMICAL STABILITY..... Stable
INCOMPATIBLE MATERIALS... Avoid contact with water, alcohols, strong bases, metal compounds or surface active materials.
HAZARDOUS DECOMPOSITION PRODUCTS..... Carbon dioxide, carbon monoxide, and nitrogen oxides. Isocyanate vapors and mists may also evolve.
HAZARDOUS POLYMERIZATION. Will not occur.
CONDITIONS TO AVOID..... STORE IN A COOL, WELL VENTILATED AREA IN TIGHTLY CLOSED CONTAINERS. AVOID MOISTURE CONTAMINATION.

SECTION VII - SPILL OR LEAK PROCEDURE

RCRA WASTE NUMBER..... None

HMIS-Rating
==========
Health 3
Flammability 1
Reactivity 1
==========

MATERIAL SAFETY DATA SHEET

WASTE DISPOSAL..... Controlled incineration or buried landfill disposal should be in accordance with all federal, state and local environmental control regulations.

LEAK AND SPILL PROCEDURES In case of spill, contain with a suitable diking material. Ventilate the area thoroughly. Keep all unnecessary people away. Spilled material should be absorbed in sawdust, sand or other absorbant. Place in an open-top container. Neutralize with a solution of 90-95% water, 5-8% concentrated ammonia and 1-2% detergent before disposal. Keep container open for at least 12 hours so that evolved carbon dioxide can escape.

SECTION VIII - SPECIAL PROTECTION

PERSONAL PROTECTION..... HMIS CODE H- SPLASH GOGGLES, GLOVES, SYNTHETIC APRON AND ORGANIC VAPOR RESPIRATOR

VENTILATION..... If handled indoors, provide mechanical exhaust ventilation.

HANDLING PROCEDURES AND EQUIPMENT..... Avoid breathing vapors. Keep away from heat, sparks, and open flames. Use adequate ventilation. Wash thoroughly after handling.

SECTION IX - SHIPPING INFORMATION

HAZARD CLASS..... N/A
DOT SHIPPING NAME..... NOT REGULATED BY THE DEPARTMENT OF TRANSPORTATION.
REPORTABLE QUANTITY (RQ). N/A
UN NUMBER..... N/A
NA #..... N/A

SECTION X - STORAGE INFORMATION

STORE IN A COOL DRY AREA IN TIGHTLY CLOSED CONTAINERS. AVOID MOISTURE CONTAMINATION.

SECTION XI - REGULATORY INFORMATION

NOTICE: The information herein is presented in good faith and believed to be accurate as of the preparation date shown below. However, no warranty, expressed or implied, is given. Regulatory requirements are subject to change and may differ from one location to another; it is the buyer's responsibility to ensure that its activities comply with federal, state and local laws. The following specific information is made for the purpose of complying with numerous federal, state and local laws and regulations. THIS INFORMATION IS NOT MEANT TO BE ALL-INCLUSIVE. SELECTED REGULATIONS ARE PRESENTED.

SARA 313 INFO: This product contains the following substances subject to the

HMIS-Rating	
Health	3
Flammability	1
Reactivity	1

MATERIAL SAFETY DATA SHEET

reporting requirements of Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 and 40 CFR Part 372.

H_{12} MDI is considered an Immediate Health Hazard, Delayed Health Hazard and Reactive Hazard under Sections 311/312 of SARA Title III.

CALIFORNIA PROPOSITION 65:
To the best of our knowledge, this product contains no levels of listed substances, which the state of California has found to cause cancer, birth defects or other reproductive effects.

NEW JERSEY:
The following are listed on the New Jersey Hazardous Substance List:

Dicyclohexylmethane-4,4'-diisocyanate

PENNSYLVANIA:
The following are on the Pennsylvania Hazardous Substance List:
Dicyclohexylmethane-4,4'-diisocyanate

PREPARED BY..... Deirdre S. Crutchfield
DATE PREPARED..... 06/01/91
PHONE NUMBER OF PREPARER. (818) 882-3022

FOOT NOTES

REFERENCES

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HEXCEL CORPORATION
Resins Group Division

HMIS-Rating	
Health	2
Flammability	1
Reactivity	0

MATERIAL SAFETY DATA SHEET

URALITE 3500 PART B

SECTION I - IDENTIFICATION

COMPANY NAME.....	HEXCEL CORPORATION - RESINS GROUP 20701 Nordhoff Street, PO Box 2197 Chatsworth, CA 91311 (818) 882-3022
EMERGENCY PHONE NUMBER.....	(800) 433-5072 (except California) (800) 343-4467 (Canada)
CALIFORNIA EMERGENCY PHONE NUMBER..	(800) 367-7527
PRODUCT IDENTIFIER.....	URALITE 3500 PART B
CHEMICAL FAMILY.....	URETHANE CURATIVE

SECTION II - HAZARDOUS INGREDIENTS

HAZARDOUS INGREDIENTS	HAZARDOUS INGREDIENT PERCENT	TLV (Units)	CAS NUMBER
Polymethylene Polyalkylphenyl Amine	55-70	Not Established	19900-65-3
Aliphatic Phosphorus Ester	25-40	2.5 mg/m^3	126-73-8

SECTION III - PHYSICAL DATA

BOILING POINT.....	Not Available	MELTING POINT.....	Not Available
VOC (grams/liter).....	Not Applicable	DENSITY (g/ml).....	1.032
APPEARANCE AND ODOR...	Transparent amber liquid with a faint odor.		

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

FLASHPOINT & METHOD OF DETERMINATION....	>250°F Pensky-Martens Closed Cup
MEANS OF EXTINCTION.....	Use CO_2 or dry chemical for small fires, and water and foam for large ones.
FOR FIRE.....	Since vapors are exceedingly irritating when inhaled, a self-contained breathing apparatus should be available to firemen.
EMERGENCY RESPONSE.....	Not listed in the DOT 1990 EMERGENCY RESPONSE GUIDEBOOK.

HEXCEL CORPORATION
Resins Group Division

MATERIAL SAFETY DATA SHEET

HMIS-Rating
Health 2
Flammability 1
Reactivity 0

SECTION V - HEALTH HAZARD DATA

OVEREXPOSURE EFFECTS.....	Skin exposure may cause irritation. Repeated or prolonged exposure can result in dermatitis and skin sensitization (allergic effects). Ingestion may cause gastro-intestinal burning and discomfort. Eye contact may cause extreme irritation and/or burning. Severe irritation and/or sensitization may result from overexposure to this product. Pre-existing eye, skin, and respiratory disorders may be aggravated by exposure.
SPECIFIC FIRST AID PROCEDURES.....	EYES: In case of eye contact, immediately flush eyes with plenty of water for at least 15 minutes. Get medical attention. SKIN CONTACT: In case of contact, immediately wash skin with soap and plenty of water. Wash contaminated clothing before re-use and destroy contaminated shoes. INHALATION: If inhaled, remove to fresh air. If not breathing, give artificial respiration, preferably mouth-to-mouth. If breathing is difficult, give oxygen. Get medical attention. INGESTION: If swallowed, get medical attention immediately. Induce vomiting ONLY upon the advice of a physician.

SECTION VI - REACTIVITY DATA

CHEMICAL STABILITY.....	Stable
INCOMPATIBLE MATERIALS...	Avoid contact with strong oxidizers.
HAZARDOUS DECOMPOSITION PRODUCTS.....	Carbon dioxide, carbon monoxide, and nitrogen oxides.
HAZARDOUS POLYMERIZATION.	Will not occur.
CONDITIONS TO AVOID.....	Avoid strong oxidizers.

SECTION VII - SPILL OR LEAK PROCEDURE

RCRA WASTE NUMBER.....	None
WASTE DISPOSAL.....	Controlled incineration or buried landfill disposal should be in accordance with all federal, state and local environmental control regulations.
LEAK AND SPILL PROCEDURES	In case of spill, contain with a suitable diking material. Ventilate the area thoroughly. Keep all unnecessary people away. Spilled material should be absorbed in sawdust, sand or other absorbant. Place into open-topped containers and cover loosely; store for at least 12 hours before sealing container.

HEXCEL CORPORATION
Resins Group Division

HMIS-Rating
Health 2
Flammability 1
Reactivity 0

MATERIAL SAFETY DATA SHEET

SECTION VIII - SPECIAL PROTECTION

PERSONAL PROTECTION.....	HMIS CODE B- SAFETY GLASSES AND GLOVES.
VENTILATION.....	If handled indoors, provide mechanical exhaust ventilation.
HANDLING PROCEDURES AND EQUIPMENT.....	Avoid breathing vapors. Keep away from heat, sparks, and open flames. Use adequate ventilation. Wash thoroughly after handling.

SECTION IX - SHIPPING INFORMATION

HAZARD CLASS.....	N/A
DOT SHIPPING NAME.....	NOT REGULATED BY THE DEPARTMENT OF TRANSPORTATION.
UN NUMBER.....	N/A
NA #.....	N/A

SECTION X - STORAGE INFORMATION

STORE IN A COOL DRY AREA IN TIGHTLY CLOSED CONTAINERS. AVOID MOISTURE CONTAMINATION.

SECTION XI - REGULATORY INFORMATION

NOTICE: The information herein is presented in good faith and believed to be accurate as of the preparation date shown below. However, no warranty, expressed or implied, is given. Regulatory requirements are subject to change and may differ from one location to another; it is the buyer's responsibility to ensure that its activities comply with federal, state and local laws. The following specific information is made for the purpose of complying with numerous federal, state and local laws and regulations. THIS INFORMATION IS NOT MEANT TO BE ALL-INCLUSIVE. SELECTED REGULATIONS ARE PRESENTED.

SARA 313 INFO: This product contains the following substances subject to the reporting requirements of Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 and 40 CFR Part 372.

None

CALIFORNIA PROPOSITION 65:
To the best of our knowledge, this product contains no levels of listed substances, which the state of California has found to cause cancer, birth defects or other reproductive effects.

PREPARED BY..... Deirdre S. Crutchfield
DATE PREPARED..... 06/01/91

HEXCEL CORPORATION
Resins Group Division

HMIS-Rating
==========
Health 2
Flammability 1
Reactivity 0
==========

MATERIAL SAFETY DATA SHEET

PHONE NUMBER OF PREPARER. (818) 882-3022

FOOT NOTES

REFERENCES

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HEXCEL Resins Group

HMIS-Rating
Health 3
Flammability 1
Reactivity 1

MATERIAL SAFETY DATA SHEET

URALITE 3501 PART A

SECTION I - IDENTIFICATION

COMPANY NAME	HEXCEL CORPORATION - RESINS GROUP 20701 Nordhoff Street, PO Box 2197 Chatsworth, CA 91311 (818) 882-3022
EMERGENCY PHONE NUMBER	(800) 433-5072 (except California) (800) 343-4467 (Canada)
CALIFORNIA EMERGENCY PHONE NUMBER	(800) 367-7527
PRODUCT IDENTIFIER	URALITE 3501 PART A
CHEMICAL FAMILY	URETHANE PREPOLYMER

SECTION II - HAZARDOUS INGREDIENTS

HAZARDOUS INGREDIENTS	HAZARDOUS INGREDIENT PERCENT	TLV (Units)	CAS NUMBER
Dicyclohexylmethane-4,4' diisocyanate (aka H_{12} MDI)	15-35	.01 ppm	5124-30-1
Polyether Glycol/ H_{12}MDI Polymer	65-85	Not Established	52292-18-9

SECTION III - PHYSICAL DATA

BOILING POINT..... Not available
MELTING POINT.....Not available
VOC (grams/liter)..... Not Applicable
DENSITY (g/ml).....1.074
APPEARANCE AND ODOR... Clear to pale yellow liquid with a faint sweet odor

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

FLASHPOINT AND METHOD OF DETERMINATION	>300°F Cleveland Open Cup
MEANS OF EXTINCTION	Use CO_2 or dry chemical for small fires. Use water and foam for large ones.
FOR FIRE	Since vapors are exceedingly irritating when inhaled, a self-contained breathing apparatus should be available to firemen.

	HMIS-Rating
	Health 3
	Flammability 1
MATERIAL SAFETY DATA SHEET	Reactivity 1

EMERGENCY RESPONSE..... NOT LISTED IN THE 1990 DOT EMERGENCY RESPONSE GUIDEBOOK.

SECTION V - HEALTH HAZARD DATA

OVEREXPOSURE EFFECTS..... Skin exposure may cause irritation. Repeated or prolonged exposure can result in dermatitis and skin sensitization (allergic effects). Vapors are exceedingly irritating to mucous membrane and eyes. Can cause acute temporary chest discomfort and breathing difficulty. Vapors can cause respiratory sensitization in suspectible people. Risk of explosion by shock, friction, fire or other sources of ignition. Ingestion may cause gastro-intestinal burning and discomfort. Possibly severe irritation and/or sensitization can result from overexposure to this product. Pre-existing eye, skin, and respiratory disorders may be aggravated by exposure.

SPECIFIC FIRST AID PROCEDURES..... EYES: In case of eye contact, immediately flush eyes with plenty of water for at least 15 minutes. Get medical attention.

SKIN CONTACT: In case of contact, immediately wash skin with soap and plenty of water. Wash contaminated clothing before re-use and destroy contaminated shoes.

INHALATION: If inhaled, remove to fresh air. If not breathing, give artificial respiration, preferably mouth-to-mouth. If breathing is difficult, give oxygen. Get medical attention.

INGESTION: If swallowed, get medical attention immediately. Induce vomiting ONLY upon the advice of a physician.

SECTION VI - REACTIVITY DATA

CHEMICAL STABILITY..... Stable

INCOMPATIBLE MATERIALS... Avoid contact with water, alcohols, strong bases, metal compounds or surface active materials.

HAZARDOUS DECOMPOSITION PRODUCTS..... Carbon dioxide, carbon monoxide, and nitrogen oxides. Isocyanate vapors and mists may also evolve.

HAZARDOUS POLYMERIZATION. Will not occur.

CONDITIONS TO AVOID..... STORE IN A COOL, WELL VENTILATED AREA IN TIGHTLY CLOSED CONTAINERS. AVOID MOISTURE CONTAMINATION.

SECTION VII - SPILL OR LEAK PROCEDURE

RCRA WASTE NUMBER..... None

		HMIS-Rating
		Health 3
		Flammability 1
	MATERIAL SAFETY DATA SHEET	Reactivity 1

WASTE DISPOSAL..... Controlled incineration or buried landfill disposal should be in accordance with all federal, state and local environmental control regulations.

LEAK AND SPILL PROCEDURES In case of spill, contain with a suitable diking material. Ventilate the area thoroughly. Keep all unnecessary people away. Spilled material should be absorbed in sawdust, sand or other absorbant. Place in an open-top container. Neutralize with a solution of 90-95% water, 5-8% concentrated ammonia and 1-2% detergent before disposal. Keep container open for at least 12 hours so that evolved carbon dioxide can escape.

SECTION VIII - SPECIAL PROTECTION

PERSONAL PROTECTION..... HMIS CODE H- SPLASH GOGGLES, GLOVES, SYNTHETIC APRON AND ORGANIC VAPOR RESPIRATOR

VENTILATION..... If handled indoors, provide mechanical exhaust ventilation.

HANDLING PROCEDURES AND EQUIPMENT..... Avoid breathing vapors. Keep away from heat, sparks, and open flames. Use adequate ventilation. Wash thoroughly after handling.

SECTION IX - SHIPPING INFORMATION

HAZARD CLASS..... N/A
DOT SHIPPING NAME..... NOT REGULATED BY THE DEPARTMENT OF TRANSPORTATION.
REPORTABLE QUANTITY (RQ). N/A
UN NUMBER..... N/A
NA #..... N/A

SECTION X - STORAGE INFORMATION

STORE IN A COOL DRY AREA IN TIGHTLY CLOSED CONTAINERS. AVOID MOISTURE CONTAMINATION.

SECTION XI - REGULATORY INFORMATION

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SARA 313 INFO: This product contains the following substances subject to the

HMIS-Rating	
Health	3
Flammability	1
Reactivity	1

MATERIAL SAFETY DATA SHEET

reporting requirements of Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 and 40 CFR Part 372.

H_{12} MDI is considered an Immediate Health Hazard, Delayed Health Hazard and Reactive Hazard under Sections 311/312 of SARA Title III.

CALIFORNIA PROPOSITION 65:
To the best of our knowledge, this product contains no levels of listed substances, which the state of California has found to cause cancer, birth defects or other reproductive effects.

NEW JERSEY:
The following are listed on the New Jersey Hazardous Substance List:

Dicyclohexylmethane-4,4'-diisocyanate

PENNSYLVANIA:
The following are on the Pennsylvania Hazardous Substance List:
Dicyclohexylmethane-4,4'-diisocyanate

PREPARED BY..... Deirdre S. Crutchfield
DATE PREPARED..... 06/01/91
PHONE NUMBER OF PREPARER. (818) 882-3022

FOOT NOTES

REFERENCES

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HEXCEL CORPORATION
Resins Group Division

HMIS-Rating	
Health	2
Flammability	1
Reactivity	0

MATERIAL SAFETY DATA SHEET

URALITE 3501 PART B

SECTION I - IDENTIFICATION

COMPANY NAME	HEXCEL CORPORATION - RESINS GROUP 20701 Nordhoff Street, PO Box 2197 Chatsworth, CA 91311 (818) 882-3022
EMERGENCY PHONE NUMBER	(800) 433-5072 (except California) (800) 343-4467 (Canada)
CALIFORNIA EMERGENCY PHONE NUMBER	(800) 367-7527
PRODUCT IDENTIFIER	URALITE 3501 PART B
CHEMICAL FAMILY	URETHANE CURATIVE

SECTION II - HAZARDOUS INGREDIENTS

HAZARDOUS INGREDIENTS	HAZARDOUS INGREDIENT PERCENT	TLV (Units)	CAS NUMBER
Polymethylene Polyalkylphenyl Amine	60-75	Not Established	19900-65-3
Aliphatic Phosphorus Ester	25-40	2.5 mg/m^3	126-73-8

SECTION III - PHYSICAL DATA

BOILING POINT	Not Available
MELTING POINT	Not Available
VOC (grams/liter)	Not Applicable
DENSITY (g/ml)	1.040
APPEARANCE AND ODOR	Transparent amber liquid with a faint odor.

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

FLASHPOINT & METHOD OF DETERMINATION	>300°F Cleveland Closed Cup
MEANS OF EXTINCTION	Use CO_2 or dry chemical for small fires, and water and foam for large ones.
FOR FIRE	Since vapors are exceedingly irritating when inhaled, a self-contained breathing apparatus should be available to firemen.
EMERGENCY RESPONSE	Not listed in the DOT 1990 EMERGENCY RESPONSE GUIDEBOOK.

HEXCEL CORPORATION
Resins Group Division

MATERIAL SAFETY DATA SHEET

HMIS-Rating	
Health	2
Flammability	1
Reactivity	0

SECTION V - HEALTH HAZARD DATA

OVEREXPOSURE EFFECTS.....	Skin exposure may cause irritation. Repeated or prolonged exposure can result in dermatitis and skin sensitization (allergic effects). Ingestion may cause gastro-intestinal burning and discomfort. Eye contact may cause extreme irritation and/or burning. Severe irritation and/or sensitization may result from overexposure to this product. Pre-existing eye, skin, and respiratory disorders may be aggravated by exposure.
SPECIFIC FIRST AID PROCEDURES.....	EYES: In case of eye contact, immediately flush eyes with plenty of water for at least 15 minutes. Get medical attention. SKIN CONTACT: In case of contact, immediately wash skin with soap and plenty of water. Wash contaminated clothing before re-use and destroy contaminated shoes. INHALATION: If inhaled, remove to fresh air. If not breathing, give artificial respiration, preferably mouth-to-mouth. If breathing is difficult, give oxygen. Get medical attention. INGESTION: If swallowed, get medical attention immediately. Induce vomiting ONLY upon the advice of a physician.

SECTION VI - REACTIVITY DATA

CHEMICAL STABILITY.....	Stable
INCOMPATIBLE MATERIALS...	Avoid contact with strong oxidizers.
HAZARDOUS DECOMPOSITION PRODUCTS.....	Carbon dioxide, carbon monoxide, and nitrogen oxides.
HAZARDOUS POLYMERIZATION.	Will not occur.
CONDITIONS TO AVOID.....	Avoid strong oxidizers.

SECTION VII - SPILL OR LEAK PROCEDURE

RCRA WASTE NUMBER.....	None
WASTE DISPOSAL.....	Controlled incineration or buried landfill disposal should be in accordance with all federal, state and local environmental control regulations.
LEAK AND SPILL PROCEDURES	In case of spill, contain with a suitable diking material. Ventilate the area thoroughly. Keep all unnecessary people away. Spilled material should be absorbed in sawdust, sand or other absorbant. Place into open-topped containers and cover loosely; store for at least 12 hours before sealing container.

HEXCEL CORPORATION
Resins Group Division

HMIS-Rating
Health 2
Flammability 1
Reactivity 0

MATERIAL SAFETY DATA SHEET

SECTION VIII - SPECIAL PROTECTION

PERSONAL PROTECTION.....	HMIS CODE B- SAFETY GLASSES AND GLOVES.
VENTILATION.....	If handled indoors, provide mechanical exhaust ventilation.
HANDLING PROCEDURES AND EQUIPMENT.....	Avoid breathing vapors. Keep away from heat, sparks, and open flames. Use adequate ventilation. Wash thoroughly after handling.

SECTION IX - SHIPPING INFORMATION

HAZARD CLASS.....	N/A
DOT SHIPPING NAME.....	NOT REGULATED BY THE DEPARTMENT OF TRANSPORTATION.
UN NUMBER.....	N/A
NA #.....	N/A

SECTION X - STORAGE INFORMATION

STORE IN A COOL DRY AREA IN TIGHTLY CLOSED CONTAINERS. AVOID MOISTURE CONTAMINATION.

SECTION XI - REGULATORY INFORMATION

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SARA 313 INFO: This product contains the following substances subject to the reporting requirements of Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 and 40 CFR Part 372.

None

CALIFORNIA PROPOSITION 65:
To the best of our knowledge, this product contains no levels of listed substances, which the state of California has found to cause cancer, birth defects or other reproductive effects.

PREPARED BY..... Deirdre S. Crutchfield
DATE PREPARED..... 06/01/91

HEXCEL CORPORATION
Resins Group Division

HMIS-Rating	
Health	2
Flammability	1
Reactivity	0

MATERIAL SAFETY DATA SHEET

PHONE NUMBER OF PREPARER. (818) 882-3022

FOOT NOTES

REFERENCES

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HEXCEL CORPORATION
Resins Group Division

HMIS-Rating	
Health	3
Flammability	1
Reactivity	1

MATERIAL SAFETY DATA SHEET

URALITE 3502 PART A

SECTION I - IDENTIFICATION

COMPANY NAME.....	HEXCEL CORPORATION - RESINS GROUP 20701 Nordhoff Street, PO Box 2197 Chatsworth, CA 91311 (818) 882-3022
EMERGENCY PHONE NUMBER.....	(800) 433-5072 (except California) (800) 343-4467 (Canada)
CALIFORNIA EMERGENCY PHONE NUMBER..	(800) 367-7527
PRODUCT IDENTIFIER.....	URALITE 3502 PART A
CHEMICAL FAMILY.....	URETHANE PREPOLYMER

SECTION II - HAZARDOUS INGREDIENTS

HAZARDOUS INGREDIENTS	HAZARDOUS INGREDIENT PERCENT	TLV (Units)	CAS NUMBER
Dicyclohexylmethane-4,4' diisocyanate (aka H_{12} MDI)	10-30	.01 ppm	5124-30-1
Polyether Polyglycol/ H_{12}MDI Polymer	85-85	Not Established	52292-18-9
Aromatic Alkyl Ester	2-10	5 mg/m^3	84-74-2

SECTION III - PHYSICAL DATA

BOILING POINT.....	Not Available	MELTING POINT.....	Not Available
VOC (grams/liter).....	Not Applicable	DENSITY (g/ml).....	1.065
APPEARANCE AND ODOR...	Clear liquid with a faint sweet odor		

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

FLASHPOINT & METHOD OF DETERMINATION....	>300°F Cleveland Open Cup
MEANS OF EXTINCTION.....	Use CO_2 or dry chemical for small fires, and water and foam for large ones.
FOR FIRE.....	Since vapors are exceedingly irritating when inhaled, a self-contained breathing apparatus should be available to firemen.

HEXCEL CORPORATION
Resins Group Division

HMIS-Rating
Health 3
Flammability 1
Reactivity 1

MATERIAL SAFETY DATA SHEET

EMERGENCY RESPONSE..... NOT LISTED IN THE 1990 DOT EMERGENCY RESPONSE GUIDEBOOK.

SECTION V - HEALTH HAZARD DATA

OVEREXPOSURE EFFECTS..... Skin exposure may cause irritation. Repeated or prolonged exposure can result in dermatitis and skin sensitization (allergic effects). Vapors are exceedingly irritating to mucous membrane and eyes, causing acute temporary chest discomfort and breathing difficulty. Vapors can cause respiratory sensitization in suspectible people. WARNING: CONTAINS 2-ETHYOXYETHANOL. HARMFUL IF INHALED OR ABSORBED THROUGH THE SKIN. BASED ON TESTS WITH LABORATORY ANIMALS, OVEREXPOSURE MAY CAUSE BIRTH DEFECTS, REPRODUCTIVE DISORDERS AND BLOOD DISORDERS.

Ingestion may cause gastro-intestinal burning and discomfort. Severe irritation and/or sensitization may result from overexposure to this product. Pre-existing eye, skin, and respiratory disorders may be aggravated by exposure.

SPECIFIC FIRST AID PROCEDURES..... EYES: In case of eye contact, immediately flush eyes with plenty of water for at least 15 minutes. Get medical attention.

SKIN CONTACT: In case of contact, immediately wash skin with soap and plenty of water. Wash contaminated clothing before re-use and destroy contaminated shoes.

INHALATION: If inhaled, remove to fresh air. If not breathing, give artificial respiration, preferably mouth-to-mouth. If breathing is difficult, give oxygen. Get medical attention.

INGESTION: If swallowed, get medical attention immediately. Induce vomiting ONLY upon the advice of a physician.

SECTION VI - REACTIVITY DATA

CHEMICAL STABILITY..... Stable

INCOMPATIBLE MATERIALS... Avoid contact with water, alcohols, strong bases, metal compounds or surface active materials.

HAZARDOUS DECOMPOSITION PRODUCTS..... Carbon dioxide, carbon monoxide, and nitrogen oxides. Isocyanate vapors and mists may also evolve.

HAZARDOUS POLYMERIZATION. Will not occur.

CONDITIONS TO AVOID..... STORE IN A COOL, WELL VENTILATED AREA IN TIGHTLY CLOSED CONTAINERS. AVOID MOISTURE CONTAMINATION.

HEXCEL CORPORATION
Resins Group Division

HMIS-Rating	
Health	3
Flammability	1
Reactivity	1

MATERIAL SAFETY DATA SHEET

SECTION VII - SPILL OR LEAK PROCEDURE

RCRA WASTE NUMBER.....	None
WASTE DISPOSAL.....	Controlled incineration or buried landfill disposal should be in accordance with all federal, state and local environmental control regulations.
LEAK AND SPILL PROCEDURES	In case of spill, contain with a suitable diking material. Ventilate the area thoroughly. Keep all unnecessary people away. Spilled material should be absorbed in sawdust, sand or other absorbant. Place in an open-top container. Neutralize with a solution of 90-95% water, 5-8% concentrated ammonia and 1-2% detergent before disposal. Keep container open for at least 12 hours so that evolved carbon dioxide can escape.

SECTION VIII - SPECIAL PROTECTION

PERSONAL PROTECTION.....	HMIS CODE H- SPLASH GOGGLES, GLOVES, SYNTHETIC APRON AND ORGANIC VAPOR RESPIRATOR
VENTILATION.....	If handled indoors, provide mechanical exhaust ventilation.
HANDLING PROCEDURES AND EQUIPMENT.....	Avoid breathing vapors. Keep away from heat, sparks, and open flames. Use adequate ventilation. Wash thoroughly after handling.

SECTION IX - SHIPPING INFORMATION

HAZARD CLASS.....	N/A
DOT SHIPPING NAME.....	NOT REGULATED BY THE DEPARTMENT OF TRANSPORTATION.
UN NUMBER.....	N/A
NA #.....	N/A

SECTION X - STORAGE INFORMATION

STORE IN A COOL DRY AREA IN TIGHTLY CLOSED CONTAINERS. AVOID MOISTURE CONTAMINATION.

SECTION XI - REGULATORY INFORMATION

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HEXCEL CORPORATION
Resins Group Division

HMIS-Rating
==========
Health 3
Flammability 1
Reactivity 1
==========

MATERIAL SAFETY DATA SHEET

SARA 313 INFO: This product contains the following substances subject to the reporting requirements of Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 and 40 CFR Part 372.

Aromatic Alkyl Ester

NOTE: H_{12} MDI is considered an Immediate Health Hazard, Delayed Health Hazard and Reactive Hazard under Sections 311/312 of SARA Title III.

CALIFORNIA PROPOSITION 65:
To the best of our knowledge, this product contains no levels of listed substances, which the state of California has found to cause cancer, birth defects or other reproductive effects.

NEW JERSEY:
The following are listed on the New Jersey Hazardous Substance List:
Dicyclohexylmethane-4,4'-diisocyanate

PENNSYLVANIA:
The following are on the Pennsylvania Hazardous Substance List:
Dicyclohexylmethane-4,4'-diisocyanate

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PREPARED BY..... Deirdre S. Crutchfield
DATE PREPARED..... 06/01/91
PHONE NUMBER OF PREPARER. (818) 882-3022

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FOOT NOTES

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REFERENCES

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HEXCEL CORPORATION
Resins Group Division

HMIS-Rating	
Health	2
Flammability	1
Reactivity	0

MATERIAL SAFETY DATA SHEET

URALITE 3502 PART B

SECTION I - IDENTIFICATION

COMPANY NAME.....	HEXCEL CORPORATION - RESINS GROUP 20701 Nordhoff Street, PO Box 2197 Chatsworth, CA 91311 (818) 882-3022
EMERGENCY PHONE NUMBER.....	(800) 433-5072 (except California) (800) 343-4467 (Canada)
CALIFORNIA EMERGENCY PHONE NUMBER..	(800) 367-7527
PRODUCT IDENTIFIER.....	URALITE 3502 PART B
CHEMICAL FAMILY.....	URETHANE CURATIVE

SECTION II - HAZARDOUS INGREDIENTS

HAZARDOUS INGREDIENTS	HAZARDOUS INGREDIENT PERCENT	TLV (Units)	CAS NUMBER
Polymethylene Polyalkylphenyl Amine	40-60	Not Established	19900-65-3
Aromatic Alkyl Ester	40-60	5 mg/m^3	84-74-2

SECTION III - PHYSICAL DATA

BOILING POINT.....	Not Available	MELTING POINT.....	Not Available
VOC (grams/liter).....	Not Applicable	DENSITY (g/ml).....	1.05

APPEARANCE AND ODOR... Amber liquid with a faint odor.

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

FLASHPOINT & METHOD OF DETERMINATION....	>300°F Cleveland Open Cup
MEANS OF EXTINCTION.....	Use CO_2 or dry chemical for small fires, and water and foam for large ones.
FOR FIRE.....	Since vapors are exceedingly irritating when inhaled, a self-contained breathing apparatus should be available to firemen.
EMERGENCY RESPONSE.....	Not listed in the DOT 1990 EMERGENCY RESPONSE GUIDEBOOK.

HEXCEL CORPORATION
Resins Group Division

HMIS-Rating
Health 2
Flammability 1
Reactivity 0

MATERIAL SAFETY DATA SHEET

SECTION V - HEALTH HAZARD DATA

OVEREXPOSURE EFFECTS.....	Skin exposure may cause irritation. Repeated or prolonged exposure can result in dermatitis and skin sensitization (allergic effects). Ingestion may cause gastro-intestinal burning and discomfort. Eye contact may cause extreme irritation and/or burning. Severe irritation and/or sensitization may result from overexposure to this product. Pre-existing eye, skin, and respiratory disorders may be aggravated by exposure.
SPECIFIC FIRST AID PROCEDURES.....	EYES: In case of eye contact, immediately flush eyes with plenty of water for at least 15 minutes. Get medical attention. SKIN CONTACT: In case of contact, immediately wash skin with soap and plenty of water. Wash contaminated clothing before re-use and destroy contaminated shoes. INHALATION: If inhaled, remove to fresh air. If not breathing, give artificial respiration, preferably mouth-to-mouth. If breathing is difficult, give oxygen. Get medical attention. INGESTION: If swallowed, get medical attention immediately. Induce vomiting ONLY upon the advice of a physician.

SECTION VI - REACTIVITY DATA

CHEMICAL STABILITY.....	Stable
INCOMPATIBLE MATERIALS...	Avoid contact with strong oxidizers.
HAZARDOUS DECOMPOSITION PRODUCTS.....	Carbon dioxide, carbon monoxide, and nitrogen oxides.
HAZARDOUS POLYMERIZATION.	Will not occur.
CONDITIONS TO AVOID.....	Avoid strong oxidizers.

SECTION VII - SPILL OR LEAK PROCEDURE

RCRA WASTE NUMBER.....	None
WASTE DISPOSAL.....	Controlled incineration or buried landfill disposal should be in accordance with all federal, state and local environmental control regulations.
LEAK AND SPILL PROCEDURES	In case of spill, contain with a suitable diking material. Ventilate the area thoroughly. Keep all unnecessary people away. Spilled material should be absorbed in sawdust, sand or other absorbant. Place into open-topped containers and cover loosely; store for at least 12 hours before sealing container.

HEXCEL CORPORATION
Resins Group Division

HMIS-Rating
Health 2
Flammability 1
Reactivity 0

MATERIAL SAFETY DATA SHEET

SECTION VIII - SPECIAL PROTECTION

PERSONAL PROTECTION.....	HMIS CODE B- SAFETY GLASSES AND GLOVES.
VENTILATION.....	If handled indoors, provide mechanical exhaust ventilation.
HANDLING PROCEDURES AND EQUIPMENT.....	Avoid breathing vapors. Keep away from heat, sparks, and open flames. Use adequate ventilation. Wash thoroughly after handling.

SECTION IX - SHIPPING INFORMATION

HAZARD CLASS.....	N/A
DOT SHIPPING NAME.....	NOT REGULATED BY THE DEPARTMENT OF TRANSPORTATION.
UN NUMBER.....	N/A
NA #.....	N/A

SECTION X - STORAGE INFORMATION

STORE IN A COOL DRY AREA IN TIGHTLY CLOSED CONTAINERS. AVOID MOISTURE CONTAMINATION.

SECTION XI - REGULATORY INFORMATION

NOTICE: The information herein is presented in good faith and believed to be accurate as of the preparation date shown below. However, no warranty, expressed or implied, is given. Regulatory requirements are subject to change and may differ from one location to another; it is the buyer's responsibility to ensure that its activities comply with federal, state and local laws. The following specific information is made for the purpose of complying with numerous federal, state and local laws and regulations. THIS INFORMATION IS NOT MEANT TO BE ALL-INCLUSIVE. SELECTED REGULATIONS ARE PRESENTED.

SARA 313 INFO: This product contains the following substances subject to the reporting requirements of Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 and 40 CFR Part 372.

Aromatic Alkyl Ester

CALIFORNIA PROPOSITION 65:
To the best of our knowledge, this product contains no levels of listed substances, which the state of California has found to cause cancer, birth defects or other reproductive effects.

PREPARED BY.....	Deirdre S. Crutchfield
DATE PREPARED.....	06/01/91
PHONE NUMBER OF PREPARER.	(818) 882-3022

HEXCEL CORPORATION
Resins Group Division

MATERIAL SAFETY DATA SHEET

HMIS-Rating	
Health	2
Flammability	1
Reactivity	0

FOOT NOTES

REFERENCES

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HEXCEL CORPORATION
Resins Group Division

HMIS Rating	
Health	3
Flammability	1
Reactivity	1

MATERIAL SAFETY DATA SHEET

URALITE 3503 PART A

SECTION I - IDENTIFICATION

COMPANY NAME..... HEXCEL CORPORATION - RESINS GROUP
20701 Nordhoff Street, PO Box 2197
Chatsworth, CA 91311
(818) 882-3022
EMERGENCY PHONE NUMBER..... (800) 433-5072 (except California)
(800) 343-4467 (Canada)
CALIFORNIA EMERGENCY PHONE NUMBER. (800) 367-7527
PRODUCT IDENTIFIER..... URALITE 3503 PART A
CHEMICAL FAMILY..... URETHANE PREPOLYMER

SECTION II - HAZARDOUS INGREDIENTS

HAZARDOUS INGREDIENTS	PERCENT	TLV (Units)	CAS NUMBER
Dicyclohexylmethane-4,4' Diisocyanate (aka H_{12} MDI)	10-20	.01 ppm ceiling (OSHA) .005 ppm TWA (ACGIH)	5124-30-1
Polyether Glycol/ H_{12}MDI Polymer	70-80	Not Established	68310-52-1

CARCINOGEN LISTINGS BY OSHA, NTP OR IARC NO SPECIFIC LISTINGS

SECTION III - PHYSICAL DATA

BOILING POINT..... Not available MELTING POINT.....Not available
VOC (grams/liter)..... Not Applicable DENSITY (g/ml).....1.07
APPEARANCE AND ODOR... Clear to pale yellow liquid with a faint sweet odor

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

FLASHPOINT & METHOD OF DETERMINATION. >300°F Cleveland Open Cup
EMERGENCY RESPONSE..... NOT LISTED IN THE 1990 DOT EMERGENCY RESPONSE GUIDEBOOK.
MEANS OF EXTINCTION..... Use dry chemical or CO_2 for small fires and water & foam for large ones.
SPECIAL FIRE HAZARDS..... Since vapors are exceedingly irritating when inhaled, a self-contained breathing apparatus should be available to firemen.

HEXCEL CORPORATION
Resins Group Division

MATERIAL SAFETY DATA SHEET

HMIS Rating
Health 3
Flammability 1
Reactivity 1

SECTION V - HEALTH HAZARD DATA

PRIMARY ROUTES OF EXPOSURE.....	SKIN CONTACT-yes INHALATION-yes INGESTION-no
OVEREXPOSURE EFFECTS..	Skin exposure may cause irritation. Repeated or prolonged exposure can result in dermatitis and skin sensitization (allergic effects). Vapors are exceedingly irritating to mucous membrane and eyes, causing acute temporary chest discomfort and breathing difficulty. Vapors can cause respiratory sensitization in suspectible people. Severe irritation and/or sensitization may result from overexposure to this product. Pre-existing eye, skin and respiratory disorders may be aggravated by exposure. Ingestion may cause gastro-intestinal burning and discomfort. Severe irritation and/or sensitization may result from overexposure to this product. Pre-existing eye, skin, and respiratory disorders may be aggravated by exposure.
SPECIFIC FIRST AID PROCEDURES.....	EYES: In case of eye contact, immediately flush eyes with plenty of water for at least 15 minutes. Get medical attention. SKIN CONTACT: In case of contact, immediately wash skin with soap and plenty of water. Wash contaminated clothing before re-use and destroy contaminated shoes. INHALATION: If inhaled, remove to fresh air. If not breathing, give artificial respiration, preferably mouth-to-mouth. If breathing is difficult, give oxygen. Get medical attention. INGESTION: If swallowed, get medical attention immediately. Induce vomiting ONLY upon the advice of a physician.

SECTION VI - REACTIVITY DATA

CHEMICAL STABILITY.....	Stable
INCOMPATIBLE MATERIALS...	Avoid contact with water, alcohols, strong bases, metal compounds or surface active materials.
HAZARDOUS DECOMPOSITION PRODUCTS.....	Carbon dioxide, carbon monoxide, and nitrogen oxides. Isocyanate vapors and mists may also evolve.
HAZARDOUS POLYMERIZATION.	Will not occur.
CONDITIONS TO AVOID.....	Moisture contamination may result in carbon dioxide gas pressure.

SECTION VII - SPILL OR LEAK PROCEDURE

RCRA WASTE NUMBER..... None

HEXCEL CORPORATION
Resins Group Division

HMIS Rating
==========
Health 3
Flammability 1
Reactivity 1
==========

MATERIAL SAFETY DATA SHEET

WASTE DISPOSAL..... Controlled incineration or buried landfill disposal should be in accordance with all federal, state and local environmental control regulations.

LEAK AND SPILL PROCEDURES In case of spill, contain with a suitable diking material. Ventilate the area thoroughly. Keep all unnecessary people away. Spilled material should be absorbed in sawdust, sand or other absorbant. Place in an open-top container. Neutralize with a solution of 90-95% water, 5-8% concentrated ammonia and 1-2% detergent before disposal. Keep container open for at least 12 hours so that evolved carbon dioxide can escape.

SECTION VIII - SPECIAL PROTECTION

PERSONAL PROTECTION..... HMIS CODE H- Splash Goggles, Gloves, Synthetic Apron and Organic Vapor Respirator. AN APPROVED POSITIVE PRESSURE AIR-SUPPLED RESPIRATOR IS REQUIRED WHENEVER AIRBORNE ISOCYANATE LEVELS EXCEED PERMISSIBLE EXPOSURE LIMITS.

VENTILATION..... If handled indoors, provide mechanical exhaust ventilation.

HANDLING PROCEDURES AND EQUIPMENT..... Avoid breathing vapors. Keep away from heat, sparks, and open flames. Use adequate ventilation. Wash thoroughly after handling.

SECTION IX - SHIPPING INFORMATION

UN NUMBER..... N/A NA #.....N/A
DOT SHIPPING NAME... NOT REGULATED BY THE DEPARTMENT OF TRANSPORTATION.
HAZARD CLASS..... N/A

SECTION X - STORAGE INFORMATION

STORE IN A COOL, WELL VENTILATED AREA IN TIGHTLY CLOSED CONTAINERS. AVOID MOISTURE CONTAMINATION.

SECTION XI - REGULATORY INFORMATION

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HEXCEL CORPORATION
Resins Group Division

HMIS Rating	
Health	3
Flammability	1
Reactivity	1

MATERIAL SAFETY DATA SHEET

SARA 313 INFORMATION: This product contains the following substances subject to the reporting requirements of Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 and 40 CFR Part 372. H_{12} MDI is considered an Immediate Health Hazard, Delayed Health Hazard and Reactive Hazard under Sections 311/312 of SARA Title III.

CALIFORNIA PROPOSITION 65:
To the best of our knowledge, this product contains no levels of listed substances, which the state of California has found to cause cancer, birth defects or other reproductive effects.

NEW JERSEY:
The following are listed on the New Jersey Hazardous Substance List:
Dicyclohexylmethane-4,4'-diisocyanate

PENNSYLVANIA:
The following are on the Pennsylvania Hazardous Substance List:
Dicyclohexylmethane-4,4'-diisocyanate

PREPARED BY..... Deirdre S. Crutchfield
DATE PREPARED..... 01/07/92
PHONE NUMBER OF PREPARER. (818) 882-3022

FOOT NOTES

REFERENCES

DISCLAIMER: The information contained herein is accurate to the best of our knowledge, but no liability whatsoever is assumed. Final determination or suitability of a material is the sole responsibility of the user. All material may present unknown health hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.
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HEXCEL CORPORATION
Resins Group Division

HMIS Rating	
Health	2
Flammability	1
Reactivity	0

MATERIAL SAFETY DATA SHEET

URALITE 3503 PART B

SECTION I - IDENTIFICATION

COMPANY NAME.....	HEXCEL CORPORATION - RESINS GROUP 20701 Nordhoff Street, PO Box 2197 Chatsworth, CA 91311 (818) 882-3022
EMERGENCY PHONE NUMBER.....	(800) 433-5072 (except California) (800) 343-4467 (Canada)
CALIFORNIA EMERGENCY PHONE NUMBER.	(800) 367-7527
PRODUCT IDENTIFIER.....	URALITE 3503 PART B
CHEMICAL FAMILY.....	URETHANE CURATIVE

SECTION II - HAZARDOUS INGREDIENTS

HAZARDOUS INGREDIENTS	PERCENT	TLV (Units)	CAS NUMBER
Polymethylene Polyalkylphenyl Amine	60-75	Not Established	19900-65-3
Aromatic Alkyl Ester	25-40	5 mg/m^3	84-74-2

CARCINOGEN LISTINGS BY OSHA, NTP OR IARC NO SPECIFIC LISTINGS

SECTION III - PHYSICAL DATA

BOILING POINT..... Not Available MELTING POINT.....Not available
VOC (grams/liter)..... Not Applicable DENSITY (g/ml).....1.03
APPEARANCE AND ODOR... Transparent amber liquid with a faint odor.

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

FLASHPOINT & METHOD OF DETERMINATION.	>300°F Cleveland Open Cup
EMERGENCY RESPONSE.....	Not listed in the DOT 1990 EMERGENCY RESPONSE GUIDEBOOK.
MEANS OF EXTINCTION.....	Use dry chemical or CO_2 for small fires and water & foam for large ones.
SPECIAL FIRE HAZARDS.....	Since vapors are exceedingly irritating when inhaled, a self-contained breathing apparatus should be available to firemen.

SECTION V - HEALTH HAZARD DATA

HEXCEL CORPORATION
Resins Group Division

HMIS Rating
Health 2
Flammability 1
Reactivity 0

MATERIAL SAFETY DATA SHEET

PRIMARY ROUTES OF EXPOSURE.....	SKIN CONTACT-yes INHALATION-yes INGESTION-no
OVEREXPOSURE EFFECTS..	Skin exposure may cause irritation. Repeated or prolonged exposure can result in dermatitis and skin sensitization (allergic effects). Ingestion may cause gastro-intestinal burning and discomfort. Eye contact may cause extreme irritation and/or burning. Severe irritation and/or sensitization may result from overexposure to this product. Pre-existing eye, skin, and respiratory disorders may be aggravated by exposure.
SPECIFIC FIRST AID PROCEDURES.....	EYES: In case of eye contact, immediately flush eyes with plenty of water for at least 15 minutes. Get medical attention. SKIN CONTACT: In case of contact, immediately wash skin with soap and plenty of water. Wash contaminated clothing before re-use and destroy contaminated shoes. INHALATION: If inhaled, remove to fresh air. If not breathing, give artificial respiration, preferably mouth-to-mouth. If breathing is difficult, give oxygen. Get medical attention. INGESTION: If swallowed, get medical attention immediately. Induce vomiting ONLY upon the advice of a physician.

SECTION VI - REACTIVITY DATA

CHEMICAL STABILITY.....	Stable
INCOMPATIBLE MATERIALS...	Avoid contact with strong oxidizers.
HAZARDOUS DECOMPOSITION PRODUCTS.....	Carbon dioxide, carbon monoxide, and nitrogen oxides.
HAZARDOUS POLYMERIZATION.	Will not occur.
CONDITIONS TO AVOID.....	Avoid strong oxidizers.

SECTION VII - SPILL OR LEAK PROCEDURE

RCRA WASTE NUMBER.....	None
WASTE DISPOSAL.....	Controlled incineration or buried landfill disposal should be in accordance with all federal, state and local environmental control regulations.
LEAK AND SPILL PROCEDURES	In case of spill, contain with a suitable diking material. Ventilate the area thoroughly. Keep all unnecessary people away. Spilled material should be absorbed in sawdust, sand or other absorbant. Place into open-topped containers and cover loosely; store for at least 12 hours before sealing container.

HEXCEL CORPORATION
Resins Group Division

HMIS Rating	
Health	2
Flammability	1
Reactivity	0

MATERIAL SAFETY DATA SHEET

SECTION VIII - SPECIAL PROTECTION

PERSONAL PROTECTION.....	HMIS CODE B- Safety Glasses and Gloves.
VENTILATION.....	If handled indoors, provide mechanical exhaust ventilation.
HANDLING PROCEDURES AND EQUIPMENT.....	Avoid breathing vapors. Keep away from heat, sparks, and open flames. Use adequate ventilation. Wash thoroughly after handling.

SECTION IX - SHIPPING INFORMATION

UN NUMBER..... N/A NA #.....N/A
DOT SHIPPING NAME... NOT REGULATED BY THE DEPARTMENT OF TRANSPORTATION.
HAZARD CLASS..... N/A

SECTION X - STORAGE INFORMATION

STORE IN A COOL, WELL VENTILATED AREA IN TIGHTLY CLOSED CONTAINERS. AVOID MOISTURE CONTAMINATION.

SECTION XI - REGULATORY INFORMATION

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SARA 313 INFORMATION: This product contains the following substances subject to the reporting requirements of Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 and 40 CFR Part 372.
Aromatic Alkyl Ester

CALIFORNIA PROPOSITION 65:
To the best of our knowledge, this product contains no levels of listed substances, which the state of California has found to cause cancer, birth defects or other reproductive effects.

PREPARED BY..... Deirdre S. Crutchfield
DATE PREPARED..... 01/07/92
PHONE NUMBER OF PREPARER. (818) 882-3022

FOOT NOTES

HEXCEL CORPORATION
Resins Group Division

MATERIAL SAFETY DATA SHEET

HMIS Rating	
Health	2
Flammability	1
Reactivity	0

REFERENCES

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HEXCEL chemical products

** EPA Title III, Section 313 Chemicals **
Subject to reporting requirements of Emergency Planning & Community Right to Know Act of 1986 and of 40 CFR 372. See ingredients in Section II enclosed in rackets and underlined [ ]

Section I: MATERIAL AND MANUFACTURER IDENTIFICATION

Manufacturer: D-U-N-S No. 00911-8553
HEXCEL CORPORATION - Chemical Products Division
20701 Nordhoff Street - PO Box 2197
Chatsworth, CA 91311

Emergency Telephone Numbers:
818/882-3022
800/433-5072 (Except Ca)
800/367-7527 (California only)

Chemical Name/Synonyms:	Chemical Family:	Formula:	Trade Name/Synonyms:
	Prepolymer/Amine Curing Agent	100-A:50-B	URALITE 3530

DOT Status:	Shipping Nomenclature:	Hazard Class	UN/NA Number
Not regulated by DOT	Plastic, Liquid, NOI	None	None

Section II: HAZARDOUS INGREDIENTS

CAS No(s)	Part A	%	PEL/TLV (Units)	CAS No(s)	Part B	%	PEL/TLV (Units)
5124-30-1	Free Monomeric Dicyclohexyl Methane 4,4' Diisocyanate	18-28	0.01 ppm	19900-65-3	Polymethylene Polyalkylphenyl Amine	58-70	Not est.
69310-52-1	Polyoxypropylene Glycol/Dicyclohexyl methane 4,4'diisocyanate Polymer	62-78	Not est.	[84-74-2	Aromatic Alkyl-Ester]	24-38]	5 mg/m^3
	Inert Filler			1345-89-1	Red Pigment	1- 5	
7631-86-9	Silicon Dioxide	2-10	Not app.				

Section III: PHYSICAL DATA

Boiling Point (°F): Not available

Specific Gravity (H_2O = 1): Part A: 1.21
Part B: 1.29

Vapor Pressure (mm Hg.):
Part A: < 0.0005 at 75°F
Part B: < 0.00001 at 75°F

Percent Volatile (by volume):
Part A: < 0.01
Part B: < 0.03

Vapor Density (air = 1) Not available

Evaporation Rate:(=1) Not applicable

Solubility in Water: Part A: Reactive
Part B: Very slightly soluble

Appearance/Odor: Part A: Translucent faint amber paste - sweet odor
Part B: Red liquid - faint odor

Part A FLAMMABILITY (NFPA) - 1 SECTION IV: FIRE AND EXPLOSION HAZARD DATA Part B: FLAMMABILITY (NFPA) - 1

Flash Point (Method Used): Part A: > 300°F - COC
Part B: > 300°F - COC

Flammable Limits: (in Air - % by volume) Unknown

Extinguishing Media Water spray, alcohol foam, CO_2, dry chemicals

Special Fire Fighting Procedures: Vapors and/or combustion products are toxic and exceedingly irritating when inhaled. self-contained breathing apparatus and the usual fireman's body protection garments should be worn.

Unusual Fire and Explosion Hazards: None

URALITE 3530

Part A HEALTH (NFPA) 2-3 SECTION V: HEALTH HAZARD DATA Part B: (NFPA) -1

Threshold Limit Value: Part A: Not established Part B: Not established

Conditions to Avoid: Prevent skin and eye contact. Do not breathe vapors.

Primary Routes of Entry: Inhalation, skin contact.

Effects of Overexposure: Part A: Prolonged skin contact may cause dermatitis. Eye contact is very irritating. Prolonged exposure to vapors may cause chest discomfort, coughing, and reduced pulmonary function. Ingestion is very harmful and may cause poisoning. Part B: Fever, chills, anorexia, vomiting. May cause temporary liver damage and methemoglobinemia (cyanosis).

Aggravated Medical Conditions: Pre-existing eye, skin, and respiratory disorders may be aggravated by exposure to this product.

Emergency and First Aid Procedures: Skin Contact Prompt washing with soap and water. Ingestion Call a physician at once. Induce vomiting only on a physician's advice. Eye Contact Irrigate promptly with clear water for 15 minutes and call a physician.

Part A REACTIVITY(NFPA) -1 SECTION VI:REACTIVITY DATA Part B: REACTIVITY (NFPA) - 0

Conditions to Avoid: Avoid heat.

STABILITY: Stable

Incompatibility (Materials to Avoid): Avoid contact with water, alcohols, strong bases, metal compounds, and surface active materials.

Hazardous Decomposition Products: Combustion may result in carbon monoxide, carbon dioxide, and oxides of nitrogen, oxides of phosphorus.

HAZARDOUS POLYMERIZATION Will not occur: X

Conditions to Avoid: Moisture contamination may form CO_2 gas pressure.

SECTION VII: SPILL OR LEAK PROCEDURES

Steps to be Taken in Case Material is Released or Spilled: Ventilate area thoroughly. Spilled compound should be absorbed in sawdust or other absorbents. Store temporarily in an open container. Absorbed Part A should be treated with a solution of water, ammonia, and isopropanol before disposal.

Waste Disposal Method: Contain in sealed containers. Dispose of in chemical waste landfill or use controlled incineration. Disposal must be in accordance with all federal, state, and local environmental control regulations with respect to health, water, land, or air pollution. If questions arise, consult a certified environmental waste disposal contractor. RCRA Hazardous Waste Number: None

SECTION VIII: SPECIAL PROTECTION INFORMATION

Respiratory Protection (specify type): Any thorough ventilation system is adequate. In closed environment use respirator with organic vapor cannister.

VENTILATION: Local Exhaust: X

If handled indoors provide local mechanical exhaust ventilation. It should be sufficient to remove any possible fumes generated in the work area.

Mechanical Exhaust: Preferred.

Protective Gloves: Heavy disposable rubber gloves or butyl rubber gloves are best when contact and handling is frequent. Use cotton linings.

Eye Protection: Safety glasses with side shields or plastic goggles.

Other Protective Equipment: Protective hand creams and routine change of disposable work bench covering (e.g. Kraft paper) suggested especially if staining due to contact is a frequent possibility.

SECTION IX: SPECIAL PRECAUTIONS

Precautions to be Taken in Handling and Storing: Store in cool, dry area in tightly closed containers.

Other Precautions: Avoid contact with skin or clothing. Contaminated clothing must be laundered before wearing. Contaminated shoes must be thoroughly cleaned or discarded.

Prepared by: P. W. Cuthbert Date: April 10, 1989

HEXCEL chemical products

SARA Title III Section 313 Chemicals
Subject to reporting requirements of Emergency Planning & Community Right to Know Act of 1986 and of 40 CFR 372. See ingredients in Section II enclosed in asterisks and underlined [ ]

HEXCEL CORPORATION has provided the product formulation information contained herein only for occupational safety and health related usage. Any misuse of this information including divulgence to third parties or use to gain a competitive advantage is strictly prohibited.

Section I: MATERIAL AND MANUFACTURER IDENTIFICATION

Manufacturer: D-U-N-S No. 0931-8553
HEXCEL CORPORATION - Chemical Products Division
23701 Norcroft Street - PO Box 2197
Chatsworth, CA 91311

Emergency Telephone Numbers:
818/882-3022
800/433-5972 (Except Ca)
800/367-7527 (California only)

Chemical Name/Synonyms:	Chemical Family:	Formula:	Trade Name/Synonyms:
	Prepolymer/Amine Curing Agent	100-A:28-B	URALITE 3538

DOT Status:	Shipping Nomenclature:	Hazard Class	UN/NA Number
Not regulated by DOT	Plastic, Liquid, NOI	None	None

Section II: HAZARDOUS INGREDIENTS

CAS No(s)	Part A	%	PEL/TLV (Units)	CAS No(s)	Part B	%	PEL/TLV (Units)
5124-30-1	Free Monomeric Dicyclohexyl Methane 4,4' Diisocyanate	10-22	0.01 ppm	19900-65-3	Polyethylene Polyalkylphenyl Amine	60-75	Not est.
68310-52-1	Polyoxypropylene Glycol/Dicyclohexyl methane 4,4'diisocyanate Polymer	65-85	Not est.	[84-74-2	Aromatic Alkyl-Ester]	25-40]	5 mg/m^3
	Inert Filler			1345-89-1	Red Pigment	Trace	Not app.
				Not avail.	Silicone Resin	2-10	Not est.
7631-86-9	Silicon Dioxide	2- 8	Not app.	7631-86-9	Silicon Dioxide	2- 8	Not app.

Section III: PHYSICAL DATA

Boiling Point ($^{\circ}$F): Not available

Specific Gravity (H_2O = 1): Part A: 1.21
Part B: 1.29

Vapor Pressure (mm Hg.):
Part A: < 0.0005 at 75°F
Part B: < 0.00001 at 75°F

Percent Volatile (by volume):
Part A: < 0.01
Part B: < 0.03

Vapor Density (air = 1) Not available

Evaporation Rate:(=1) Not applicable

Solubility in Water: Part A: Reactive
Part B: Very slightly soluble

Appearance/Odor: Part A: Translucent faint amber paste - sweet odor
Part B: Red paste - faint odor

Part A FLAMMABILITY (NFPA) - 1 SECTION IV: FIRE AND EXPLOSION HAZARD DATA Part B FLAMMABILITY (NFPA) - 1

Flash Point (Method Used): Part A: > 300°F - COC
Part B: > 300°F - COC

Flammable Limits: (in Air - % by volume) Unknown

Extinguishing Media CO_2, dry chemicals for small fires. Water and foam for large fires.

Special Fire Fighting Procedures: Vapors and/or combustion products are toxic and exceedingly irritating when inhaled. self-contained breathing apparatus and the usual fireman's body protection garments should be worn..

Unusual Fire and Explosion Hazards: None

USALITE 3534

Part A HEALTH (NFPA) 2-3 SECTION V: HEALTH HAZARD DATA Part B: (NFPA) -1

Threshold Limit Value: Part A: Not established Part B: Not established

Conditions to Avoid: Prevent skin and eye contact. Do not breathe vapors.

Primary Routes of Entry: Inhalation, skin contact.

Effects of Overexposure: Part A: Prolonged skin contact may cause dermatitis. Eye contact is very irritating. Prolonged exposure to vapors may cause chest discomfort, coughing, and reduced pulmonary function. Ingestion is very harmful and may cause poisoning. Part B: Fever, chills, anorexis, vomiting. May cause temporary liver damage and methemoglobinemia (cyanosis).

Aggravated Medical Conditions: Pre-existing eye, skin, and respiratory disorders may be aggravated by exposure to this product.

Emergency and First Aid Procedures: Skin Contact Prompt washing with soap and water. Ingestion Call a physician at once. Induce vomiting only on a physician's advice. Eye Contact Irrigate promptly with clear water for 15 minutes and call a physician.

Part A REACTIVITY(NFPA) -1 SECTION VI:REACTIVITY DATA Part B: REACTIVITY (NFPA) - 0

Conditions to Avoid: Avoid heat.

STABILITY: Stable

Incompatibility (Materials to Avoid): Avoid contact with water, alcohols, strong bases, metal compounds, and surface active materials.

Hazardous Decomposition Products: Combustion may result in carbon monoxide, carbon dioxide, and oxides of nitrogen, oxides of phosphorus.

HAZARDOUS POLYMERIZATION Will not occur: X

Conditions to Avoid: Moisture contamination may form CO_2 gas pressure.

SECTION VII: SPILL OR LEAK PROCEDURES

Steps to be Taken in Case Material is Released or Spilled: Ventilate area thoroughly. Spilled compound should be absorbed in sawdust or other absorbents. Store temporarily in an open container. Absorbed Part A should be treated with a solution of water, ammonia, and isopropanol before disposal.

Waste Disposal Method: Contain in sealed containers. Dispose of in chemical waste landfill or use controlled incineration. Disposal must be in accordance with all federal, state, and local environmental control regulations with respect to health, water, land, or air pollution. If questions arise, consult a certified environmental waste disposal contractor. RCRA Hazardous Waste Number: None

SECTION VIII: SPECIAL PROTECTION INFORMATION

Respiratory Protection (specify type): Any thorough ventilation system is adequate. In closed environment use respirator with organic vapor cannister.

VENTILATION: Local Exhaust: X
If handled indoors provide local mechanical exhaust ventilation. It should be sufficient to remove any possible fumes generated in the work area.
Mechanical Exhaust: Preferred.

Protective Gloves: Heavy disposable rubber gloves or butyl rubber gloves are best when contact and handling is frequent. Use cotton linings.

Eye Protection: Safety glasses with side shields or plastic goggles.

Other Protective Equipment: Protective hand creams and routine change of disposable work bench covering (e.g. Kraft paper) suggested especially if staining due to contact is a frequent possibility.

SECTION IX: SPECIAL PRECAUTIONS

Precautions to be Taken in Handling and Storing: Store in cool, dry area in tightly closed containers.

Other Precautions: Avoid contact with skin or clothing. Contaminated clothing must be laundered before wearing. Contaminated shoes must be thoroughly cleaned or discarded.

Prepared by: P. W. Cuthbert Date: April 10, 1989

C O N A P I N C.
1405 Buffalo St.
Olean, New York 14760
716/372-9650

========== MATERIAL SAFETY DATA SHEET ==========
Note: This form is to be used to comply with OSHA's Hazard Communication Standard, 29 CFR 1910.1200. Blank spaces are not permitted.

========== I. IDENTIFICATION ==========
Trade Name: CONATHANE* TU-900 Part A Date:7/25/90
Chemical Name, common name: Complex Mixture Polyurethane Prepolymer

========== II. HAZARDOUS INGREDIENTS ==========

Chemical Names	CAS No.	%	ACGIH(TLV)	OSHA(PEL)	Other
Dicyclohexylmethane-4,4'-Diisocyanate	5124-30-1	<10%	.01ppm 0.005ppm ceiling		NA

Material may present a dust hazard if cut, ground or machined after curing.

========== III. PHYSICAL DATA ==========
Boiling Point: ND !Specific Gravity (H2O=1): 1.06
Vapor Pressure, mm Hg @ 25C: .001
Vapor Density (air=1): >1
Melting Pt./Range: ND !Evaporation rate (Ether=1): ND
Solubility in Water: REACTS !Physical State: LIQUID
Percent volatile by volume: NIL
Appearance and Odor: CLEAR VISCOUS LIQUID, NO DISTINCT ODOR

========== IV. FIRE AND EXPLOSION DATA ==========
Flash Point, F (Method): > 395 CC
Flammable Limits: ND LEL: ND UEL: ND
Extinguishing Materials:
-XX-Water Spray -XX-Dry Chemical -XX-Carbon Dioxide
-XX-Foam -ND-Other:
Special Firefighting Procedures:
Fire fighters should wear self contained breathing apparatus.
Unusual Fire and Explosion Hazards:
Toxic gases may be present as a result of thermal decomposition or combustion. Closed container may explode when exposed to extreme heat. Use cold water spray to cool fire exposed containers to reduce the risk of rupture.
Closed container may also burst if contaminated with water due to CO2 evolved.

========== V. HEALTH HAZARD INFORMATION ==========
ACUTE TOXICITY (Routes of entry)
Inhalation:
Lowest Lethal Concentration of dicyclohexyl methane diisocyanate 200 mg/m3 (19 ppm) 4 hrs.-rat.
Inhalation of dust and vapors at concentrations above the TLV can irritate (burning sensation) the mucous membranes in the respiratory tract (nose, throat, lungs) causing runny nose, sore throat, coughing, chest discomfort, shortness of

breath and reduced lung function (breathing obstruction). Persons with a preexisting, nonspecific bronchial hyperreactivity can respond to concentrations below the intended TLV with similar symptoms as well as an asthma attack. Exposure well above the TLV may lead to bronchitis, bronchial spasm and pulmonary edema (fluid in the lungs). These effects are usually reversible. Chemical or hypersensitive pneumonitis, with flu-like symptoms (e.g.fever, chills),has also been reported.
Ingestion:
(Acute Exposure) Can result in irritation and corrosive action in the mouth, stomach tissue and digestive tract.
Eye Contact:
Mild irritant; reversible- rabbit
(Acute Exposure) Liquid, aerosols or vapors are irritating and can cause tearing, reddening and swelling.
Skin Contact:
Skin irritant and sensitizer - Guinea Pig
Isocyanates react with skin protein and moisture and can cause irritation which may include the following symptoms: reddening, swelling, rash, scaling or blistering. Cured material is difficult to remove. Experience indicates that direct skin contact is the route of exposure most likely to cause sensitization. Once sensitized, an individual may react even to airborne levels below the TLV with the following symptoms; itching and tingling of the earlobes and neck, rash, hives, swelling of the arms and legs or other symptoms common to allergic dermatitis, These symptoms may be immediate of delayed several hours.
Skin Absorption: ND

CHRONIC TOXICITY
Carcinogenicity:-XXX-No
Not listed as a carcinogen.
-NA-Yes: ---NA-NTP --NA--IARC -NA-Federal OSHA
Target Organ Affected:
Specific target organ information not available at this time.

Effects of Overexposure:
Material is a primary skin irritant and potent skin sensitizer. Experience indicates that direct skin contact is the route of exposure most likely to cause sensitization. Once sensitized an individual may react to airborne levels below the TLV with the following symptoms; itching and tingling of the earlobe and neck, rash, hives, swelling of the arms and legs or symptoms common to allergy dermatitis (rash). Inhalation of vapors or spray mist may also cause irritation of the respiratory tract (dry throat, cough, shortness of breath, chest tightness). These symptoms could be immediate or delayed up to several hours. Similar to many non-specific asthmatic responses,there are reports that once sensitized an individual can experience these symptoms upon exposure to dust, cold air or other irritants. This increased lung sensitivity can persist for weeks and in severe cases for several years.Chronic overexposure to

isocyanate has also been reported to cause lung damage (including decrease in lung function) which may be permanent. Sensitization can either be temporary or permanent.

Medical Conditions Aggravated By Exposure:
Existing lung conditions and dermal conditions may be aggravated by use of this material.

FIRST AID: EMERGENCY PROCEDURES
Eye Contact:
Flush with clean, lukewarm water (low pressure) for at least 15 minutes, occasionally lifting eye lids. Obtain immediate medical attention.
Skin Contact:
Remove contaminated clothing. Wash skin promptly and thoroughly with soap and water. After Washing, cover affected areas with polyethylene glycol (300-500 mol.wt.) and wash again with soap and water. Wash contaminated clothing thoroughly before reuse. Allergic dermatitis should be treated by a physician to relieve the symptoms. For severe exposures , get under safety shower after removing clothing. Seek medical attention if irritation or allergic dermatitis symptoms develop, or if gross exposure occurs.
Inhalation: Move to an area free from further risk of exposure. Administer oxygen or artificial respiration as needed. Obtain medical attention. Asthmatic-type symptoms may develop and may be immediate or delayed up to several hours. Treatment is essentially symptomatic. Consult physician
Ingested:
DO NOT INDUCE VOMITING. Give 1 too 2 cups of milk or water to drink. DO NOT GIVE ANYTHING BY MOUTH TO AN UNCONSCIOUS OR CONVULSING PERSON. Consult a physician.
Recommendations to Physician:
Eyes: Stain for evidence of corneal injury. If cornea is burned, instill antibiotic steroid preparation frequently. Workplace vapors have produced reversible corneal epithelial edema impairing vision. This compound is a known skin sensitizer. Treat symptomatically as for contact dermatitis or thermal burns. There is no specific antidote for ingestion treat symptomatically. Inducing vomiting is contraindicated because of the irritating nature of this compound. Inhalation treatment is essentially symptomatic.
An individual having a dermal or pulmonary sensitization reaction to this material should be removed from exposure to any isocyanate.

========== VI. REACTIVITY DATA ==========

Stability: -XXX-Stable: ----Unstable
Conditions to Avoid:
Contact with moisture and other materials which react with isocyanates. Temperatures above maximum storage temperature.
Incompatibility (materials to avoid):
Moisture and other materials that react with isocyanates.
Hazardous Decomposition Products

Oxides of nitrogen, hydrogen cyanide, carbon dioxide and carbon monoxide.
Hazardous Polymerization: --May Occur X-Will not occur
Conditions to avoid: Temperatures above maximum storage temperatures.

======== VII. SPILL, LEAK AND DISPOSAL PROCEDURES =======

Steps to be taken if material is released or spilled:
Consult section VIII for proper protective equipment. Evacuate non essential personnel. Ventilate the area. Dike or impound spilled material and control further spillage if feasible. Notify appropriate authorities if necessary. Cover spill with sawdust, vermiculite, Fuller's earth or other absorbent material; pour liquid decontaminant over spillage -- allow to react at least ten min., collect material in open containers -- add further amounts of decontaminant solution. Remove containers to safe place -- cover LOOSELY. Wash down area with decontaminant and flush area with water.
Decontamination solutions: Ammonium hydroxide (0-10%), detergent (2-5%) and balance water; or solution of Union Carbide's Tergitol TMN-10 (20%) and water (80%).
Waste Disposal Method:
-XX-Incinerate -NA-Landfill according to any Local, State and Federal Regulations.
Incineration is method of choice. Empty containers must be handled with care due to product residue. decontamination of containers prior to disposal is usually recommended. Contact your disposal company for details.

========== VIII. SPECIAL HANDLING INFORMATION ==========

Respiratory Protection:
A respirator that is recommended or approved for use in isocyanate containing environments (air purifying or fresh air supplied) may be necessary. The use of a positive pressure supplied air respirator is mandatory when: airborne isocyanate concentrations are not known or exceed 0.005 ppm; operations are performed in a confined space or area with limited ventilation; material is heated. An air-purifying respirator is not generally recommended due to the poor warning properties,(e.g.odor or irritation, of this material. By the time the worker would detect leakage of the face seal or breakthrough of the filter cartridge, his exposure could be well above the TLV. Consider the type of application, airborne isocyanate concentrations and materials being used concurrently when determining respirator use and selection. Observe OSHA regulations for respirator use (29CFR 1910.134).
Ventilation:
Exhaust ventilation sufficient to keep the airborne concentration below the TLV must be utilized. Exhaust ventilation should be provided in accordance with the guidelines in INDUSTRIAL VENTILATION published by the American Conference of Governmental Hygienists.
Local exhaust: Recommended
Exhaust air may need to be cleaned by scrubbers or filters

to reduce environmental contamination.
Skin Protection:
Chemical resistant gloves. Cover as much of the exposed skin area as possible with appropriate clothing, If skin creams are used, keep the area protected only by the cream to a minimum. When there is potential for a major splash directly onto the skin, such as when breaking into lines, a full acid suit is required. When the application may result in airborne vapor or mist, a full, permeation resistant, protective suit including head covering and face shield, gloves, and overshoes is required.
Eye Protection:
Chemical workers goggles. Safety glasses with side shields.
Other Protective Clothing or Equipment:
Apron and face shield. Safety showers and eye wash stations should be available. Cover as much of exposed skin area as necessary with appropriate clothing.
Work Practices, hygienic practices: Use good hygiene.
========== IX SPECIAL PRECAUTIONS ==========
Handling and Storage:
Storage temperature (min/max): 32F(0C) / 122F (50C)
Other Precautions:
Keep away from heat, sparks and open flame. Store in tightly closed container and protect from moisture and foreign materials.
========== X Additional Information ==========
SARA Title III Requirements:

Chemical Name	Section: 302	CERCLA	313
Materials Not Listed			

T.S.C.A. Status: On Inventory

CALIFORNIA SCAQMD RULE 443.1 VOC'S:

Volatile Organic Components (VOC'S)=Substances with vapor pressure of =>0.5mmHg at 104'C (219.2'F).

This product contains <1g/liter VOC'S and
<1g/liter VOC'S (less water and exempt compounds)

Name(print):George C. Karpin !This formulation is subject
Signature: [signature] !to change without notice.
Title:Toxicological Coordinator!In case of accident use the
Date of last revision7/25/90!phone number provided.

To the best of our knowledge, the information contained therein is accurate and meets all State and Federal Guidelines. However, CONAP INC. does not assume any liability whatsoever for the accuracy or completeness of the information contained herein. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot

guarantee that these are the only hazards which exist.
Final determination of the suitability of any material is
the sole responsibility of the user.
//
*CONATHANE is a Registered Trademark of CONAP, INC.

Date approved 7/25/90 Approved:---

ND=Not Determined
NA=Not Applicable

7/26/90 Approved:---

C O N A P I N C .
1405 Buffalo St.
Olean, New York 14760
716/372-9650

========== MATERIAL SAFETY DATA SHEET ==========
Note: This form is to be used to comply with OSHA's Hazard Communication Standard, 29 CFR 1910.1200. Blank spaces are not permitted.

========== I. IDENTIFICATION ==========
Trade Name: CONATHANE* TU-900 Part B Date: 05/01/91
Chemical Name, common name: Complex Mixture 110

========== II. HAZARDOUS INGREDIENTS ==========

Chemical Names	CAS No.	%	ACGIH(TLV)	OSHA(PEL)	Other
Diethyltoluene diamine	68479-98-1	20-30%	ND	ND	ND
Polyalkoxylated Polyol	25322-69-4	<10%	ND	ND	ND

Material may present a dust hazard if cut, ground, or machined after curing.

========== III. PHYSICAL DATA ==========
Boiling Point: ND !Specific Gravity (H2O=1): 1.01
Vapor Pressure,mm Hg: ND !Vapor Density (air=1): ND
Melting Pt./Range: ND !Evaporation rate (Ether=1): ND
Solubility in Water: ND !Physical State: LIQUID
Percent volatile by volume: Nil
Appearance and Odor: Amber colored liquid.

========== IV. FIRE AND EXPLOSION DATA ==========
Flash Point,F (Method): > 275 F (TCC)
Flammable Limits: LEL: ND UEL: ND
Extinguishing Materials:
(X)-Water Spray (X)-Dry Chemical (X)-Carbon Dioxide
(X)-Foam -ND-Other:
Special Firefighting Procedures: None
Unusual Fire and Explosion Hazards: None

========== V. HEALTH HAZARD INFORMATION ==========
ACUTE TOXICITY (Routes of entry)
Inhalation:
Not expected to be a route of exposure due to low volatility at room temperature. However, if heated material may give off significant amounts of vapor.
Ingestion: Toxic by ingestion. Do not ingested material.
Eye Contact:
Severe irritation. Material may cause eye damage that is reversible.
Skin Contact:
Skin irritant. Expected to be toxic by dermal absorption.
Skin Absorption: Expected to be toxic.

CHRONIC TOXICITY
Carcinogenicity:--X--No
Not listed as a carcinogen.
--NA-NTP ---NA-IARC --NAFederal OSHA

Target Organ Affected:
A two year feading study in rats is in progress. Preliminary data from this study indicates that Diethyltoluene diamine causes pancreatic effects, liver, thyroid and possibly the adrenal glands and eyes in laboratory animals. An increase in the number of tumors in the live and thyroid of male rats was found.
Diethyltoluenediamine has been tested in an extensive battery of in vivo and in vitro short term assays. The results of the battery as a whole predict that Diethyltoluene diamine will not exhibit carcinogenic activity in and animal bioassay. Nonreproducible activity was demonstrated by Diethyltoluene diamine in the Ames test and BALB/3T3 cell point mutation assay. Mutagenic activity has also been reported in the in vitro cytogenetics assay.
There are increased incidents of liver tumors (hepatocellular carcinomas) and thyroid tumors (follicular cell adenomas) in male rats at the highest dose level (70ppm in the diet). These are not rare tumors in the strain of rats tested in the study, but are usually found at a low level. No increase in pancreatic tumors was found even though the pancreas was the target organ in suchronic tests. Toxic effects were found in the pancreas and liver of the high dose male rats. Effects may also have been found in the adrenal glands and eyes of these rats. Evaluation of tissues from the control and high dose female rats is underway.

Effects of Overexposure:
Severe eye irritant. In rare instances, sensitization to DETA has been reported to occur in humans.

Medical Conditions Aggravated By Exposure: ND

FIRST AID: EMERGENCY PROCEDURES
Eye Contact:
Begin immediate eye irrigation with cool water. Consult a physician if irritation persists.
Skin Contact:
Flush skin with water. Wash skin with soap and water. Remove contaminated clothing and shoes. Clean contaminated clothing thoroughly before reuse.
Inhalation:
Remove victim to fresh air. If breathing is difficult administer oxygen. If victim has stopped breathing administer artificial respiration. Do not give anything by mouth to an unconscious person. Get medical attention.
Ingested:
Induce vomiting immediately by giving two glasses of water and sticking finger down throat. Never give anything by mouth to an unconscious person.
Recommendations to Physician: Follow standard procedures.
========== REACTIVITY DATA ==========
Stability: --X--Stable --NA-Unstable
Conditions to Avoid: None
Incompatibility (materials to avoid): None

Hazardous Decomposition Products:
Carbon dioxide, oxides of nitrogen, carbon monoxide.
Hazardous Polymerization: NA-May Occur X-Will not occur
Conditions to avoid: None

======== VII. SPILL, LEAK AND DISPOSAL PROCEDURES =======

Steps to be taken if material is released or spilled:
Consult section VIII for proper protective equipment.
Contain any spills with dikes or absorbents to prevent migration and entry into sewer and streams. Take up small spills with dry chemical absorbent. Large spills may be taken up with pump or vacuum and finished off with dry chemical absorbent. May require excavation of contaminated soil.
Waste Disposal Methods:
This material may contain leachable elemental mercury as determined by the Toxic Chemical Leaching Procedure (TCLP). The levels of mercury are in sufficient quantity to classify this material as a D009 Hazardous Waste.
Dispose of in accordance with all applicable local State and Federal regulations.

========== VIII. SPECIAL HANDLING INFORMATION ==========

Respiratory Protection:
NIOSH approved organic respirator when exposed to heated vapors. Observe OSHA regulations for respirator use (29 CFR 1910.134).
Ventilation:
Local exhaust-At source of heated vapors.
Mechanical-Recommended
Protective Gloves: Resistant to chemical penetration.
Eye Protection: Chemical goggles.
Other Protective Clothing or Equipment:If skin contact or contamination of clothing is likely, protective clothing should be worn.
Work Practices, hygienic practices:
Use good industrial hygiene.

=============== IX SPECIAL PRECAUTIONS ==================

Handling and Storage: None
Other Precautions: None.

================ X ADDITIONAL INFORMATION ================

SARA Title III Requirements:

Chemical Name	Section: 302	CERCLA	313
Materials not listed.			

T.S.C.A. Status: On Inventory

==========

Name(print):George C. Karpin !This formulation is subject
Signature: George C. Karpin !to change without notice.
Title:Toxicological Coordinator!In case of accident use the
Date last revision5/1/91 !phone number provided.

To the best of our knowledge, the information contained herein is accurate and meets all State and Federal guidelines. However, CONAP INC. does not assume any

liability what so ever for the accuracy or completeness of the information contained herein. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards which exist. Final determination of the suitability of any material is the sole responsibility of the user.
//
*CONATHANE IS A REGISTERED TRADEMARK OF CONAP, INC.

Date approved: 5/6/91 Approved: [signature]
ND=Not Determined
NA=Not Applicable
Date approved: 5/6/91 Approved: [signature]

C O N A P I N C.
1405 Buffalo St.
Olean, New York 14760
716/372-9650

========== MATERIAL SAFETY DATA SHEET ==========
Note: This form is to be used to comply with OSHA's Hazard Communication Standard, 29 CFR 1910.1200. Blank spaces are not permitted.

========== I. IDENTIFICATION ==========
Trade Name: CONATHANE* TU-956 Part A Date:9/21/89
Chemical Name, common name: Polyurethane Prepolymer

========== II. HAZARDOUS INGREDIENTS ==========

Chemical Names	CAS No.	%	ACGIH(TLV)	OSHA(PEL)	Other
Dicyclohexylmethane-4,4'-Diisocyanate	5124-30-1	<10%	0.005ppm	.01ppm Ceiling	ND

Material may present a dust hazard if cut, ground or machined after curing.

========== III. PHYSICAL DATA ==========
Boiling Point: ND !Specific Gravity (H2O=1): 1.06
Vapor Pressure,mm Hg @25C .001
Vapor Density (air=1): >1
Melting Pt./Range: ND !Evaporation rate (Ether=1): ND
Solubility in Water: REACTS !Physical State: LIQUID
Percent volatile by volume: NIL
Appearance and Odor: CLEAR VISCOUS LIQUID, NO DISTINCT ODOR

========== IV. FIRE AND EXPLOSION DATA ==========
Flash Point,F (Method): > 395 CC
Flammable Limits: ND LEL: ND UEL: ND
Extinguishing Materials:
-XX-Water Spray -XX-Dry Chemical -XX-Carbon Dioxide
-XX-Foam -ND-Other:
Special Firefighting Procedures:
Fire fighters should wear self contained breathing apparatus.
Unusual Fire and Explosion Hazards:
Toxic gases may be present as a result of thermal decomposition or combustion. Closed container may explode when exposed to extreme heat. Use cold water spray to cool fire exposed containers to reduce the risk of rupture.
Closed container may also burst if contaminated with water due to CO2 evolved.

========== V. HEALTH HAZARD INFORMATION ==========
ACUTE TOXICITY (Routes of entry)
Inhalation:
Lowest Lethal Concentration of dicyclohexyl methane diisocyanate 200 mg/m3 (19 ppm) 4 hrs.-rat.
Inhalation of dust and vapors at concentrations above the

TLV can irritate (burning sensation) the mucous membranes in the respiratory tract (nose, throat, lungs) causing runny nose, sore throat, coughing, chest discomfort, shortness of breath and reduced lung function (breathing obstruction). Persons with a preexisting, nonspecific bronchial hyperreactivity can respond to concentrations below the intended TLV with similar symptoms as well as an asthma attack. Exposure well above the TLV may lead to bronchitis. Bronchial spasm and pulmonary edema (fluid in the lungs). These effects are usually reversible. Chemical or hypersensitive pneumonitis, with flu-like symptoms (e.g.fever, chills),has also been reported.
Ingestion:
(Acute Exposure) Can result in irritation and corrosive action in the mouth, stomach tissue and digestive tract.
Eye Contact:
Mild irritant; reversible- rabbit
(Acute Exposure) Liquid, aerosols or vapors are irritating and can cause tearing, reddening and swelling.
Skin Contact:
Skin irritant and sensitizer - Guinea Pig
Isocyanates react with skin protein and moisture and can cause irritation which may include the following symptoms: reddening, swelling, rash, scaling or blistering. Cured material is difficult to remove. Experience indicates that direct skin contact is the route of exposure most likely to cause sensitization. Once sensitized, an individual may react even to airborne levels below the TLV with the following symptoms; itching and tingling of the earlobes and neck, rash, hives, swelling of the arms and legs or other symptoms common to allergic dermatitis, These symptoms may be immediate of delayed several hours.
Skin Absorption:
ND

CHRONIC TOXICITY
Carcinogenicity:-XXX-No
-NA-Yes: ---NA-NTP --NA--IARC -NA-Federal OSHA
Target Organ Affected:
Specific target organ information not available at this time.

Effects of Overexposure:
Material is a primary skin irritant and potent skin sensitizer. Experience indicates that direct skin contact is the route of exposure most likely to cause sensitization. Once sensitized an individual may react to airborne levels below the TLV with the following symptoms; itching and tingling of the earlobe and neck, rash, hives, swelling of the arms and legs or symptoms common to allergy dermatitis (rash). Inhalation of vapors or spray mist may also cause

irritation of the respiratory tract (dry throat, cough, shortness of breath, chest tightness). These symptoms could be immediate or delayed up to several hours. Similar to many non-specific asthmatic responses,there are reports that once sensitized an individual can experience these symptoms upon exposure to dust, cold air or other irritants. This increased lung sensitivity can persist for weeks and in severe cases for several years.Chronic overexposure to isocyanate has also been reported to cause lung damage (including decrease in lung function) which may be permanent. Sensitization can either be temporary or permanent.

Medical Conditions Aggravated By Exposure:
Existing lung conditions and dermal conditions may be aggravated by use of this material.

FIRST AID: EMERGENCY PROCEDURES
Eye Contact:
Flush with clean, lukewarm water (low pressure) for at least 15 minutes, occasionally lifting eye lids. Obtain immediate medical attention.
Skin Contact:
Remove contaminated clothing. Wash skin promptly and thoroughly with soap and water. After Washing, cover affected areas with polyethylene glycol (300-500 mol.wt.) and wash again with soap and water. Wash contaminated clothing thoroughly before reuse . Allergic dermatitis should be treated by a physician to relieve the symptoms. For severe exposures , get under safety shower after removing clothing. Seek medical attention if irritation or allergic dermatitis symptoms develop, or if gross exposure occurs.
Inhalation:
Move to an area free from further risk of exposure. Administer oxygen or artificial respiration as needed. Obtain medical attention. Asthmatic-type symptoms may develop and may be immediate or delayed up to several hours. Treatment is essentially symptomatic. Consult physician
Ingested:
DO NOT INDUCE VOMITING. Give 1 to 2 cups of milk or water to drink. DO NOT GIVE ANYTHING BY MOUTH TO AN UNCONSCIOUS OR CONVULSING PERSON. Consult a physician.
Recommendations to Physician:
Eyes: Stain for evidence of corneal injury. If cornea is burned, instill antibiotic steroid preparation frequently. Workplace vapors have produced reversible corneal epithelial edema impairing vision. This compound is a known skin sensitizer. Treat symptomatically as for contact dermatitis or thermal burns. There is no specific antidote for ingestion treat symptomatically. Inducing vomiting is

contraindicated because of the irritating nature of this compound. Inhalation treatment is essentially symptomatic. An individual having a dermal or pulmonary sensitization reaction to this material should be removed from exposure to any isocyanate.

========== VI. REACTIVITY DATA ==========

Stability: -XXX-Stable: ----Unstable

Conditions to Avoid:

Contact with moisture and other materials which react with isocyanates. Temperatures above maximum storage temperature.

Incompatibility (materials to avoid):

Moisture and other materials that react with isocyanates.

Hazardous Decomposition Products:

Oxides of nitrogen, hydrogen cyanide, carbon dioxide and carbon monoxide.

Hazardous Polymerization: --May Occur X-Will not occur

Conditions to avoid:

Temperatures above maximum storage temperatures.

========== VII. SPILL, LEAK AND DISPOSAL PROCEDURES ==========

Steps to be taken if material is released or spilled:

Consult section VIII for proper protective equipment. Evacuate non essential personnel. Ventilate the area. Dike or impound spilled material and control further spillage if feasible. Notify appropriate authorities if necessary. Cover spill with sawdust, vermiculite, Fuller's earth or other absorbent material; pour liquid decontaminant over spillage -- allow to react at least ten min., collect material in open containers -- add further amounts of decontaminant solution. Remove containers to safe place -- cover LOOSELY. Wash down area with decontaminant and flush area with water.

Decontamination solutions: Ammonium hydroxide (0-10%), detergent (2-5%) and balance water; or solution of Union Carbide's Tergitol TMN-10 (20%) and water (80%).

Waste Disposal Method:

-XX-Incinerate -NA-Landfill according to any Local, State and Federal Regulations.

Incineration is method of choice. Empty containers must be handled with care due to product residue. decontamination of containers prior to disposal is usually recommended. Contact your disposal company for details.

========== VIII. SPECIAL HANDLING INFORMATION ==========

Respiratory Protection:

A respirator that is recommended or approved for use in isocyanate containing environments (air purifying or fresh air supplied) may be necessary. The use of a positive pressure supplied air respirator is mandatory when: airborne isocyanate concentrations are not known or exceed 0.005 ppm; operations are performed in a confined space or area with limited ventilation; material is heated. An

air-purifying respirator is not generally recommended due to the poor warning properties,(e.g.odor or irritation, of this material. By the time the worker would detect leakage of the face seal or breakthrough of the filter cartridge, his exposure could be well above the TLV. Consider the type of application, airborne isocyanate concentrations and materials being used concurrently when determining respirator use and selection. Observe OSHA regulations for respirator use (29CFR 1910.134).
Ventilation:
Exhaust ventilation sufficient to keep the airborne concentration below the TLV must be utilized. Exhaust ventilation should be provided in accordance with the guidelines in INDUSTRIAL VENTILATION published by the American Conference of Governmental Hygienists.
Local exhaust:Recommended
Exhaust air may need to be cleaned by scrubbers or filters to reduce environmental contamination.
Skin Protection:
Chemical resistant gloves. Cover as much of the exposed skin area as possible with appropriate clothing, If skin creams are used, keep the area protected only by the cream to a minimum. When there is potential for a major splash directly onto the skin, such as when breaking into lines, a full acid suit is required. When the application may result in airborne vapor or mist, a full, permeation resistant, protective suit including head covering and face shield, gloves, and overshoes is required.
Eye Protection:
Chemicai workers goggles. Safety glasses with side shields.
Other Protective Clothing or Equipment:
Apron and face shield. Safety showers and eye wash stations should be available. Cover as much of exposed skin area as necessary with appropriate clothing.
Work Practices, hygienic practices
Use good hygiene.

========== IX SPECIAL PRECAUTIONS ==========

Handling and Storage:
Storage temperature (min/max): 32F(0C) / 122F (50C)
Other Precautions:
Keep away from heat, sparks and open flame. Store in tightly closed container and protect from moisture and foreign materials.

========== X Additional Information ==========

SARA Title III Requirements:

Chemical Name	Section: 302	CERCLA	313
Materials Not Listed			

T.S.C.A. Status: On Inventory

==========

Name(print):George C. Karpin	!This formulation is subject
Signature: George C. Karpin	!to change without notice.
Title:Toxicological Coordinator	!In case of accident use the
Date of last revision9/21/89	!phone number provided.

To the best of our knowledge, the information contained therein is accurate and meets all State and Federal Guidelines. However, CONAP INC. does not assume any liability whatsoever for the accuracy or completeness of the information contained herein. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards which exist. Final determination of the suitability of any material is the sole responsibility of the user.

//

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Date approved 9/21/89 Approved:----------

ND=Not Determined

NA=Not Applicable 9/22/89 Approved:----------

C O N A P I N C .
1405 Buffalo St.
Olean, New York 14760
716/372-9650

========== MATERIAL SAFETY DATA SHEET ==========
Note: This form is to be used to comply with OSHA's Hazard Communication Standard, 29 CFR 1910.1200. Blank spaces are not permitted.

========== I. IDENTIFICATION ==========
Trade Name: CONATHANE* TU-956 Part B 1Date:5/10/91
Chemical Name, common name: Complex Mixture 110

========== II. HAZARDOUS INGREDIENTS ==========

Chemical Names	CAS No.	%	ACGIH(TLV)	OSHA(PEL)	Other
Diethyltoluene diamine	68479-98-1	50-60%	ND	ND	ND
Oxypropylated Polyether	25791-96-2	<10%	ND	ND	ND
Polyether Diol	25322-69-4	<20%	ND	ND	ND
2,2-Dimethyl-1,3-propanediol	126-30-7	<5%	ND	ND	ND

Material may present a dust hazard if cut, ground, or machined after curing.

========== III. PHYSICAL DATA ==========
Boiling Point: ND !Specific Gravity (H2O=1): ND
Vapor Pressure, mm Hg: ND !Vapor Density (air=1): ND
Melting Pt./Range: ND !Evaporation rate (Ether=1): ND
Solubility in Water: ND !Physical State: LIQUID
Percent volatile by volume: Nil
Appearance and Odor: Amber colored liquid.

========== IV. FIRE AND EXPLOSION DATA ==========
Flash Point,F (Method): > 275 F (TCC)
Flammable Limits: LEL: ND UEL: ND
Extinguishing Materials:
(X)-Water Spray (X)-Dry Chemical (X)-Carbon Dioxide
(X)-Foam -ND-Other:
Special Firefighting Procedures: None
Unusual Fire and Explosion Hazards: None

========== V. HEALTH HAZARD INFORMATION ==========
ACUTE TOXICITY (Routes of entry)
Inhalation: No data available.
Ingestion: Expected to be toxic. Do Not ingest.
Eye Contact: May cause minor irritation.
Skin Contact: Mild skin irritant.
Skin Absorption: Expected to be toxic.

CHRONIC TOXICITY
Carcinogenicity:--X--No
Not listed as a carcinogen.
--NA-NTP ---NA-IARC --NAFederal OSHA
Target Organ Affected:
A two year feading study in rats is in progress.

Preliminary data from this study indicates that Diethyltoluene diamine causes pancreatic effects in laboratory animals.
Diethyltoluenediamine has been tested in an extensive battery of in vivo and in vitro short term assays. The results of the battery as a whole predict that Diethyltoluene diamine will not exhibit carcinogenic activity in and animal bioassay. Nonreproducible activity was demonstrated by Diethyltoluene diamine in the Ames test and BALB/3T3 cell point mutation assay. Mutagenic activity has also been reported in the in vitro cytogenetics assay.
There are increased incidence of liver tumors (hepatocellular carcinomas) and thyroid tumors (follicular cell adenomas) in male rats at the highest dose level (70ppm in the diet). These are not rare tumors in the strain of rats tested in the study, but are usually found at a low level. No increase in pancreatic tumors was found even though the pancreas was the target organ in subchronic tests. Toxic effects were found in the pancreas and liver of the high dose male rats. Effects may also have been found in the adrenal glands and eyes of these rats. Evaluation of tissues from the control and high dose female rats is underway.

Effects of Overexposure:
Mild eye irritant.; In rare instances, sensitization to DETA has been reported to occur in humans.

Medical Conditions Aggravated By Exposure: ND

FIRST AID: EMERGENCY PROCEDURES
Eye Contact:
Begin immediate eye irrigation with cool water. Consult a physician if irritation persists.
Skin Contact:
Flush skin with water. Wash skin with soap and water. Remove contaminated clothing and shoes. Clean contaminated clothing thoroughly before reuse.
Inhalation:
Remove victim to fresh air. If breathing is difficult administer oxygen. If victim has stopped breathing administer artificial respiration. Do not give anything by mouth to an unconscious person. Get medical attention.
Ingested:
Induce vomiting immediately by giving two glasses of water and sticking finger down throat. Never give anything by mouth to an unconscious person.
Recommendations to Physician: Follow standard procedures.

========== REACTIVITY DATA ==========

Stability: --X--Stable --NA-Unstable
Conditions to Avoid: None
Incompatibility (materials to avoid): None
Hazardous Decomposition Products:
Carbon dioxide, oxides of nitrogen, carbon monoxide.
Hazardous Polymerization: NA-May Occur X-Will not occur
Conditions to avoid: None

======== VII. SPILL, LEAK AND DISPOSAL PROCEDURES =======
Steps to be taken if material is released or spilled:
Consult section VIII for proper protective equipment.
Contain any spills with dikes or absorbents to prevent migration and entry into sewer and streams. Take up small spills with dry chemical absorbent. Large spills may be taken up with pump or vacuum and finished off with dry chemical absorbent. May require excavation of contaminated soil.
Waste Disposal Methods:
This material may contain leachable elemental mercury as determined by the Toxic Chemical Leaching Procedure (TCLP). The levels of mercury are in sufficient quantity to classify this material as a D009 Hazardous Waste.
Dispose of in accordance with all applicable local State and Federal regulations.
========== VIII. SPECIAL HANDLING INFORMATION ==========
Respiratory Protection:
NIOSH approved organic respirator when exposed to heated vapors. Observe OSHA regulations for respirator use (29 CFR 1910.134).
Ventilation: Local exhaust-At source of heated vapors.
Mechanical-Recommended
Protective Gloves: Resistant to chemical penetration.
Eye Protection: Chemical goggles.
Other Protective Clothing or Equipment:If skin contact or contamination of clothing is likely, protective clothing should be worn.
Work Practices, hygienic practices: Use good industrial hygiene.
=============== IX SPECIAL PRECAUTIONS ================
Handling and Storage: None
Other Precautions: None.
================ X ADDITIONAL INFORMATION ================
SARA Title III Requirements:

Chemical Name	Section: 302	CERCLA	313
Materials not listed.			

T.S.C.A. Status: On Inventory

Name(print): George C. Karpin | This formulation is subject
Signature: George C. Karpin | to change without notice.
Title:Toxicological Coordinator | In case of accident use the
Date last revision5/10/91 | phone number provided.

To the best of our knowledge, the information contained herein is accurate and meets all State and Federal guidelines. However, CONAP INC. does not assume any liability what so ever for the accuracy or completeness of the information contained herein. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee

that these are the only hazards which exist. Final determination of the suitability of any material is the sole responsibility of the user.
//
*CONATHANE is a Registered Trademark of CONAP, INC..

Date approved: 5/10/91 Approved:
ND=Not Determined
NA=Not Applicable
Date approved: 5/13/91 Approved:

C O N A P I N C.
1405 Buffalo St.
Olean, New York 14760
716/372-9650

========== MATERIAL SAFETY DATA SHEET ==========

Note: This form is to be used to comply with OSHA's Hazard Communication Standard, 29 CFR 1910.1200. Blank spaces are not permitted.

========== I. IDENTIFICATION ==========

Trade Name CONATHANE* TU-961 Part A Date:4/3/91
Chemical Name, common name: Polyurethane Prepolymer

========== II. HAZARDOUS INGREDIENTS ==========

Chemical Names	CAS No.	%	ACGIH(TLV)	OSHA(PEL)	Other
Dicyclohexylmethane-4,4'-Diisocyanate	5124-30-1	<10%	0.005ppm	.01ppm	Ceiling
Di n-Butyl Phthalate	84-74-2	<10%	5mg/m3	5mg/m3	ND

Material may present a dust hazard if cut, ground or machined after curing.

========== III. PHYSICAL DATA ==========

Boiling Point: ND !Specific Gravity (H2O=1): 1.05
Vapor Pressure, mm Hg @25C: .001
Vapor Density (air=1) >1
Melting Pt./Range ND !Evaporation rate (Ether=1): ND
Solubility in Water: REACTS !Physical State: LIQUID
Percent volatile by volume: NIL
Appearance and Odor: CLEAR VISCOUS LIQUID, NO DISTINCT ODOR

========== IV. FIRE AND EXPLOSION DATA ==========

Flash Point,F (Method): > 395 CC
Flammable Limits: ND LEL: ND UEL: ND
Extinguishing Materials:
-XX-Water Spray -XX-Dry Chemical -XX-Carbon Dioxide
-XX-Foam -ND-Other:
Special Firefighting Procedures:
Fire fighters should wear self contained breathing apparatus.
Unusual Fire and Explosion Hazards:
Toxic gases may be present as a result of thermal decomposition or combustion. Closed container may explode when exposed to extreme heat. Use cold water spray to cool fire exposed containers to reduce the risk of rupture. Closed container may also burst if contaminated with water due to CO2 evolved.

========== V. HEALTH HAZARD INFORMATION ==========

ACUTE TOXICITY (Routes of entry)
Inhalation:
Lowest Lethal Concentration of dicyclohexyl methane diisocyanate 200 mg/m3 (19 ppm) 4 hrs.-rat.
Inhalation of dust and vapors at concentrations above the TLV can irritate (burning sensation) the mucous membranes in the respiratory tract (nose, throat, lungs) causing runny nose, sore throat, coughing, chest discomfort, shortness of breath and reduced lung function(breathing

obstruction). Persons with a preexisting, nonspecific bronchial hyperreactivity can respond to concentrations below the intended TLV with similar symptoms as well as an asthma attack. Exposure well above the TLV may lead to bronchitis. Bronchial spasm and pulmonary edema (fluid in the lungs). These effects are usually reversible. Chemical or hypersensitive pneumonitis, with flu-like symptoms (e.g.fever, chills),has also been reported.
Ingestion:
(Acute Exposure) Can result in irritation and corrosive action in the mouth, stomach tissue and digestive tract.
Eye Contact: Mild irritant; reversible - rabbit
(Acute Exposure) Liquid, aerosols or vapors are irritating and can cause tearing, reddening and swelling.
Skin Contact: Skin irritant and sensitizer - Guinea Pig. Isocyanates react with skin protein and moisture and can cause irritation which may include the following symptoms: reddening, swelling, rash, scaling or blistering. Cured material is difficult to remove. Experience indicates that direct skin contact is the route of exposure most likely to cause sensitization. Once sensitized, an individual may react even to airborne levels below the TLV with the following symptoms: itching and tingling of the earlobes and neck, rash, hives, swelling of the arms and legs or other symptoms common to allergic dermatitis, These symptoms may be immediate of delayed several hours.
Skin Absorption: ND

CHRONIC TOXICITY
Carcinogenicity:-XXX-No
Not considered a carcinogen.
-NA-Yes: ---NA-NTP --NA--IARC -NA-Federal OSHA
Target Organ Affected:
High doses of Di n-butyl Pthalate administered in the diet to mice throughout gestation have bee associated with embryotoxic and possibly teratogentic effects in this species.

Effects of Overexposure:
Material is a primary skin irritant and potent skin sensitizer. Experience indicates that direct skin contact is the route of exposure most likely to cause sensitization. Once sensitized an individual may react to airborne levels below the TLV with the following symptoms: itching and tingling of the earlobe and neck, rash, hives, swelling of the arms and legs or symptoms common to allergy dermatitis (rash). Inhalation of vapors or spray mist may also cause irritation of the respiratory tract (dry throat, cough, shortness of breath, chest tightness). These symptoms could be immediate or delayed up to several hours. Similar to many non-specific asthmatic responses,there are reports that once sensitized an individual can experience these symptoms upon exposure to dust, cold air or other irritants. This increased lung sensitivity can persist for weeks and in severe cases for several years. Chronic overexposure to isocyanate has also been reported to cause lung damage

(including decrease in lung function) which may be permanent. Sensitization can either be temporary or permanent.

Medical Conditions Aggravated By Exposure:
Existing lung conditions and dermal conditions may be aggravated by use of this material.

FIRST AID: EMERGENCY PROCEDURES
Eye Contact:
Flush with clean, lukewarm water (low pressure) for at least 15 minutes, occasionally lifting eye lids. Obtain immediate medical attention.
Skin Contact:
Remove contaminated clothing. Wash skin promptly and thoroughly with soap and water. After washing, cover affected areas with polyethylene glycol (300-500 mol.wt.) and wash again with soap and water. Wash contaminated clothing thoroughly before reuse. Allergic dermatitis should be treated by a physician to relieve the symptoms. For severe exposures, get under safety shower after removing clothing. Seek medical attention if irritation or allergic dermatitis symptoms develop, or if gross exposure occurs.
Inhalation:
Move to an area free from further risk of exposure. Administer oxygen or artificial respiration as needed. Obtain medical attention. Asthmatic-type symptoms may develop and may be immediate or delayed up to several hours. Treatment is essentially symptomatic. Consult physician
Ingested:
DO NOT INDUCE VOMITING. Give 1 to 2 cups of milk or water to drink. DO NOT GIVE ANYTHING BY MOUTH TO AN UNCONSCIOUS OR CONVULSING PERSON. Consult a physician.
Recommendations to Physician:
Eyes: Stain for evidence of corneal injury. If cornea is burned, instill antibiotic steroid preparation frequently. Workplace vapors have produced reversible corneal epithelial edema impairing vision. This compound is a known skin sensitizer. Treat symptomatically as for contact dermatitis or thermal burns. There is no specific antidote for ingestion treat symptomatically. Inducing vomiting is contraindicated because of the irritating nature of this compound. Inhalation treatment is essentially symptomatic. An individual having a dermal or pulmonary sensitization reaction to this material should be removed from exposure to any isocyanate.

========== VI. REACTIVITY DATA ==========

Stability: -XXX-Stable: ----Unstable
Conditions to Avoid:
Contact with moisture and other materials which react with isocyanates. Temperatures above maximum storage temperature.
Incompatibility (materials to avoid):
Moisture and other materials that react with isocyanates.
Hazardous Decomposition Products:
Oxides of nitrogen, hydrogen cyanide, carbon dioxide and

carbon monoxide.
Hazardous Polymerization: --May Occur X-Will not occur
Conditions to avoid: Temperatures above maximum storage temperatures.
======== VII. SPILL, LEAK AND DISPOSAL PROCEDURES =======
Steps to be taken if material is released or spilled:
Consult section VIII for proper protective equipment. Evacuate non essential personnel. Ventilate the area. Dike or impound spilled material and control further spillage if feasible. Notify appropriate authorities if necessary. Cover spill with sawdust, vermiculite, Fuller's earth or other absorbent material; pour liquid decontaminant over spillage -- allow to react at least ten min., collect material in open containers -- add further amounts of decontaminant solution. Remove containers to safe place -- cover LOOSELY. Wash down area with decontaminant and flush area with water.
Decontamination solutions: Ammonium hydroxide (0-10%), detergent (2-5%) and balance water; or solution of Union Carbide's Tergitol TMN-10 (20%) and water (80%).
Waste Disposal Method:
-XX-Incinerate -NA-Landfill according to any Local, State and Federal Regulations.
Incineration is method of choice. Empty containers must be handled with care due to product residue. Decontamination of containers prior to disposal is usually recommended. Contact your disposal company for details.
========== VIII. SPECIAL HANDLING INFORMATION ==========
Respiratory Protection:
A respirator that is recommended or approved for use in isocyanate containing environments (air purifying or fresh air supplied) may be necessary. The use of a positive pressure supplied air respirator is mandatory when: airborne isocyanate concentrations are not known or exceed 0.005 ppm; operations are performed in a confined space or area with limited ventilation; material is heated. An air-purifying respirator is not generally recommended due to the poor warning properties,(e.g.odor or irritation, of this material. By the time the worker would detect leakage of the face seal or breakthrough of the filter cartridge, his exposure could be well above the TLV. Consider the type of application, airborne isocyanate concentrations and materials being used concurrently when determining respirator use and selection. Observe OSHA regulations for respirator use (29CFR 1910.134).
Ventilation:
Exhaust ventilation sufficient to keep the airborne concentration below the TLV must be utilized. Exhaust ventilation should be provided in accordance with the guidelines in INDUSTRIAL VENTILATION published by the American Conference of Governmental Hygienists.
Local exhaust: Recommended
Exhaust air may need to be cleaned by scrubbers or filters to reduce environmental contamination.

Skin Protection:
Chemical resistant gloves. Cover as much of the exposed skin area as possible with appropriate clothing. If skin creams are used, keep the area protected only by the cream to a minimum. When there is potential for a major splash directly onto the skin, such as when breaking into lines, a full acid suit is required. When the application may result in airborne vapor or mist, a full, permeation resistant, protective suit including head covering and face shield, gloves, and overshoes is required.
Eye Protection:
Chemical workers goggles. Safety glasses with side shields.
Other Protective Clothing or Equipment:
Apron and face shield. Safety showers and eye wash stations should be available. Cover as much of exposed skin area as necessary with appropriate clothing.
Work Practices, hygienic practices: Use good hygiene.

========== IX SPECIAL PRECAUTIONS ==========

Handling and Storage:
Storage temperature (min/max): 32F(0C) / 122F (50C)
Other Precautions:
Keep away from heat, sparks and open flame. Store in tightly closed container and protect from moisture and foreign materials.

========== X ADDITIONAL INFORMATION ==========

SARA Title III Requirements:

Chemical Name	Section: 302	CERCLA	313
Di n-butyl Phthalate	NA	10lb	Listed

T.S.C.A. Status: On Inventory

Name(print):George C. Karpin !This formulation is subject
Signature: !to change without notice.
Title: Toxicological Coordinator!In case of accident use the
Date of last revision4/3/91!phone number provided.

To the best of our knowledge, the information contained therein is accurate and meets all State and Federal Guidelines. However,CONAP INC.does not assume any liability whatsoever for the accuracy or completeness of the information contained herein. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards which exist. Final determination of the suitability of any material is the sole responsibility of the user.

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Date approved 4 / 5 /91 Approved:
ND=Not Determined
NA=Not Applicable 4/3/91 Approved:

C O N A P I N C .
1405 Buffalo St.
Olean, New York 14760
716/372-9650

========== MATERIAL SAFETY DATA SHEET ==========
Note: This form is to be used to comply with OSHA's Hazard Communication Standard, 29 CFR 1910.1200. Blank spaces are not permitted.

========== I. IDENTIFICATION ==========
Trade Name:CONATHANE* TU-961 Part B Date:4/3/91
Chemical Name, common name: Complex mixture 110

========== II. HAZARDOUS INGREDIENTS ==========

Chemical Names	CAS No.	%	ACGIH(TLV)	OSHA(PEL)	Other
Di n-Butyl Phthalate	84-74-2	40-50%	5 mg/m3	5 mg/m3	ND
Methylene Bis Anilines	ND	50-60%	ND	ND	ND

Material may present a dust hazard if cut, ground, or machined after curing.

========== III. PHYSICAL DATA ==========

Boiling Point:	ND	!Specific Gravity (H2O=1):	ND
Vapor Pressure,mm Hg:	ND	!Vapor Density (air=1):	ND
Melting Pt./Range:	ND	!Evaporation rate (Ether=1):	ND
Solubility in Water:	> 25%	!Physical State:	LIQUID

Percent volatile by volume: Nil
Appearance and Odor: Liquid; No distinct odor

========== IV. FIRE AND EXPLOSION DATA ==========
Flash Point,F (Method): > 200 F
Flammable Limits: ND LEL: ND UEL: ND
Extinguishing Materials:
-XX-Water Spray -XX-Dry Chemical -XX-Carbon Dioxide
-XX-Foam -ND-Other:
Special Firefighting Procedures:
Use standard turnout equipment. A self contained breathing apparatus is recommended.
Unusual Fire and Explosion Hazards: None

========== V. HEALTH HAZARD INFORMATION ==========
ACUTE TOXICITY (Routes of entry)
Inhalation:
Not considered a route of entry. However, if the product is heated, misted or sprayed, it may cause irritation to the eyes, nose, throat and upper respiratory tract.
Ingestion:
Based on Di n-Butyl Phthalate Oral toxicity not established, but based on basis of similar compositions believed very low. Initial symptoms may be delayed and may include nausea, vomiting and dizziness. Additional symptoms may include. headache, pain and irritation to the eyes, tearing, conjunctivitis and photophobia. The chronic health effects of this product have not been fully determined.
Eye Contact: May cause eye irritation.

Skin Contact: May cause skin irritation and sensitization.
Skin Absorption: ND

CHRONIC TOXICITY
Carcinogenicity:- X -No
Not listed as a carcinogen
---NA-NTP --NA--IARC -NA-Federal OSHA
Target Organ Affected:
High doses of Di Butyl Phthalate administered in the diet to mice throughout gestation have been associated with embryotoxic and possibly teratogenic effects in this species. The dietary administration of Di Butyl Phthalate has produced severe testicular atrophy in rats.
Effects of Overexposure:
Eyes: Mildly irritating.
Ingestion: Non toxic
Skin: Mildly irritating
Inhalation: May be mildly irritating at temperatures above 160 F.

Medical Conditions Aggravated By Exposure: None currently known.

FIRST AID: EMERGENCY PROCEDURES
Eye Contact:
Flush with water for at least 15 minutes. If irritation persists consult physician.
Skin Contact: Wash with soap and water.
Inhalation: Remove person to fresh air.
Ingested: Dilute with 12 oz. of water; consult physician.
Recommendations to Physician: Treat symptoms.
========== VI. REACTIVITY DATA ==========
Stability: - X -Stable -ND--Unstable
Conditions to Avoid: ND
Incompatibility (materials to avoid):
Strong oxidizers, acids, strong bases
Hazardous Decomposition Products:
From fire and excessive heat: Carbon dioxide and carbon monoxide.
Hazardous Polymerization: ND May Occur X-Will not occur
Conditions to avoid: None
======== VII. SPILL, LEAK AND DISPOSAL PROCEDURES =======
Steps to be taken if material is released or spilled:
Consult section VIII for proper protective equipment.
Soak up product in absorbent material, remove to container for disposal.
Waste Disposal Method:
Dispose according to any Local, State and Federal Regulations.
========== VIII. SPECIAL HANDLING INFORMATION ==========
Respiratory Protection: None needed under normal conditions.
Ventilation:
Local exhaust--ND------- Mechanical--- XXX - Special-----
Protective Gloves: Impervious plastic or rubber.
Eye Protection: Glasses with side shields.

Other Protective Clothing or Equipment:Eye wash stations.
Work Practices, hygienic practices: Wash after handling material.

========== IX SPECIAL PRECAUTIONS ==========

Handling and Storage: Protect material from moisture.
Other Precautions: None

========== X ADDITIONAL INFORMATION ==========

SARA Title III Requirements:

Chemical Name	Section: 302	CERCLA	313
Di n-Butyl Phthalate	NA	10lb	Listed

T.S.C.A. Status: On Inventory

==========

Name(print):George C. Karpin !This formulation is subject
Signature: [signature] !to change without notice.
Title:Toxicological Coordinator!In case of accident use the
Date last revision4/3/91 !phone number provided.

To the best of our knowledge, the information contained herein is accurate and meets all State and Federal guidelines. However,CONAP INC.does not assume any liability what so ever for the accuracy or completeness of the information contained herein. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards which exist. Final determination of the suitability of any material is the sole responsibility of the user.

//

*CONATHANE is a Registered Trademark of CONAP, INC.

Date approved: 4/5/91 Approved: [signature]
ND=Not Determined
NA=Not Applicable
Date approved: 4/5/91 Approved: [signature]

C O N A P I N C .
1405 Buffalo St.
Olean, New York 14760
716/372-9650

========== MATERIAL SAFETY DATA SHEET ==========
Note: This form is to be used to comply with OSHA's Hazard Communication Standard, 29 CFR 1910.1200. Blank spaces are not permitted.

========== I. IDENTIFICATION ==========
Trade Name: CONATHANE* TU-981 Part A Date:2/6/91
Chemical Name, common name: Polyurethane Prepolymer

========== II. HAZARDOUS INGREDIENTS ==========

Chemical Names	CAS No.	%	ACGIH(TLV)	OSHA(PEL)	Other
Dicyclohexylmethane-4,4'-Diisocyanate	5124-30-1	<10%	0.005ppm	NA	NA
Meta Tetramethyl Xylene Diisocyanate	2778-42-9	<10%	ND	ND	ND

Material may present a dust hazard if cut, ground or machined after curing.

========== III. PHYSICAL DATA ==========
Boiling Point: ND !Specific Gravity (H2O=1): 1.05
Vapor Pressure, mm Hg @25C .001
Vapor Density (air=1): >1
Melting Pt./Range: ND !Evaporation rate (Ether=1): ND
Solubility in Water: REACTS !Physical State: LIQUID
Percent volatile by volume: NIL
Appearance and Odor: CLEAR VISCOUS LIQUID, NO DISTINCT ODOR

========== IV. FIRE AND EXPLOSION DATA ==========
Flash Point,F (Method): > 395 CC
Flammable Limits: ND LEL: ND UEL: ND
Extinguishing Materials:
-XX-Water Spray -XX-Dry Chemical -XX-Carbon Dioxide
-XX-Foam -ND-Other:
Special Firefighting Procedures:
Fire fighters should wear self contained breathing apparatus.
Unusual Fire and Explosion Hazards:
Toxic gases may be present as a result of thermal decomposition or combustion. Closed container may explode when exposed to extreme heat. Use cold water spray to cool fire exposed containers to reduce the risk of rupture. Closed container may also burst if contaminated with water due to CO2 evolved.

========== V. HEALTH HAZARD INFORMATION ==========
ACUTE TOXICITY (Routes of entry)
Inhalation:
Lowest Lethal Concentration of dicyclohexyl methane diisocyanate 200 mg/m3 (19 ppm) 4 hrs.-rat.
Inhalation of dust and vapors at concentrations above the TLV can irritate (burning sensation) the mucous membranes in the respiratory tract (nose, throat, lungs) causing

runny nose, sore throat, coughing, chest discomfort, shortness of breath and reduced lung function(breathing obstruction). Persons with a preexisting, nonspecific bronchial hyperreactivity can respond to concentrations below the intended TLV with similar symptoms as well as an asthma attack. Exposure well above the TLV may lead to bronchitis. bronchial spasm and pulmonary edema (fluid in the lungs). These effects are usually reversible. Chemical or hypersensitive pneumonitis, with flu-like symptoms (e.g.fever, chills),has also been reported.
Ingestion:
(Acute Exposure) Can result in irritation and corrosive action in the mouth, stomach tissue and digestive tract.
Eye Contact:
Mild irritation was produced with TMXDI during irritation studies.
(Acute Exposure) Liquid, aerosols or vapors are irritating and can cause tearing, reddening and swelling.
Skin Contact:
Skin irritant and sensitizer - Guinea Pig
Isocyanates react with skin protein and moisture and can cause irritation which may include the following symptoms: reddening, swelling, rash, scaling or blistering. Cured material is difficult to remove. Experience indicates that direct skin contact is the route of exposure most likely to cause sensitization. Once sensitized, an individual may react even to airborne levels below the TLV with the following symptoms; itching and tingling of the earlobes and neck, rash, hives, swelling of the arms and legs or other symptoms common to allergic dermatitis, These symptoms may be immediate of delayed several hours.
Skin Absorption:
ND

CHRONIC TOXICITY
Carcinogenicity:-XXX-No
-NA-Yes: ---NA-NTP --NA--IARC -NA-Federal OSHA
Target Organ Affected:
Specific target organ information not available at this time.

Effects of Overexposure:
Material is a primary skin irritant and potent skin sensitizer. Experience indicates that direct skin contact is the route of exposure most likely to cause sensitization. Once sensitized an individual may react to airborne levels below the TLV with the following symptoms; itching and tingling of the earlobe and neck, rash, hives, swelling of the arms and legs or symptoms common to allergy dermatitis (rash). Inhalation of vapors or spray mist may also cause irritation of the respiratory tract (dry throat, cough, shortness of breath, chest tightness). These symptoms could be immediate or delayed up to several hours. Similar to many non-specific asthmatic responses,there are reports that once

sensitized an individual can experience these symptoms upon exposure to dust, cold air or other irritants. This increased lung sensitivity can persist for weeks and in severe cases for several years.Chronic overexposure to isocyanate has also been reported to cause lung damage (including decrease in lung function) which may be permanent. Sensitization can either be temporary or permanent.

Medical Conditions Aggravated By Exposure:
Existing lung conditions and dermal conditions may be aggravated by use of this material.

FIRST AID: EMERGENCY PROCEDURES
Eye Contact:
Flush with clean, lukewarm water (low pressure) for at least 15 minutes, occasionally lifting eye lids. Obtain immediate medical attention.
Skin Contact:
Remove contaminated clothing. Wash skin promptly and thoroughly with soap and water. After Washing, cover affected areas with polyethylene glycol (300-500 mol.wt.) and wash again with soap and water. Wash contaminated clothing thoroughly before reuse. Allergic dermatitis should be treated by a physician to relieve the symptoms. For severe exposures, get under safety shower after removing clothing. Seek medical attention if irritation or allergic dermatitis symptoms develop, or if gross exposure occurs.
Inhalation:
Move to an area free from further risk of exposure. Administer oxygen or artificial respiration as needed. Obtain medical attention. Asthmatic-type symptoms may develop and may be immediate or delayed up to several hours. Treatment is essentially symptomatic. Consult physician
Ingested:
DO NOT INDUCE VOMITING. Give 1 too 2 cups of milk or water to drink. DO NOT GIVE ANYTHING BY MOUTH TO AN UNCONSCIOUS OR CONVULSING PERSON. Consult a physician.
Recommendations to Physician:
Eyes: Stain for evidence of corneal injury. If cornea is burned, instill antibiotic steroid preparation frequently. Workplace vapors have produced reversible corneal epithelial edema impairing vision. This compound is a known skin sensitizer. Treat symptomatically as for contact dermatitis or thermal burns. There is no specific antidote for ingestion treat symptomatically. Inducing vomiting is contraindicated because of the irritating nature of this compound. Inhalation treatment is essentially symptomatic. An individual having a dermal or pulmonary sensitization reaction to this material should be removed from exposure to any isocyanate.

========== VI. REACTIVITY DATA ==========

Stability: -XXX-Stable: ----Unstable
Conditions to Avoid:

Contact with moisture and other materials which react with isocyanates. Temperatures above maximum storage temperature.
Incompatibility (materials to avoid):
Moisture and other materials that react with isocyanates.
Hazardous Decomposition Products:
Oxides of nitrogen, hydrogen cyanide, carbon dioxide and carbon monoxide.
Hazardous Polymerization: --May Occur X-Will not occur
Conditions to avoid:
Temperatures above maximum storage temperatures.

======== VII. SPILL, LEAK AND DISPOSAL PROCEDURES =======

Steps to be taken if material is released or spilled:
Consult section VIII for proper protective equipment. Evacuate non essential personnel. Ventilate the area. Dike or impound spilled material and control further spillage if feasible. Notify appropriate authorities if necessary. Cover spill with sawdust, vermiculite, Fuller's earth or other absorbent material; pour liquid decontaminant over spillage -- allow to react at least ten min., collect material in open containers -- add further amounts of decontaminant solution. Remove containers to safe place -- cover LOOSELY. Wash down area with decontaminant and flush area with water.
Decontamination solutions: Ammonium hydroxide (0-10%), detergent (2-5%) and balance water; or solution of Union Carbide's Tergitol TMN-10 (20%) and water (80%).
Waste Disposal Method:
-XX-Incinerate -NA-Landfill according to any Local, State and Federal Regulations.
Incineration is method of choice. Empty containers must be handled with care due to product residue. Decontamination of containers prior to disposal is usually recommended. Contact your disposal company for details.

========== VIII. SPECIAL HANDLING INFORMATION ==========

Respiratory Protection:
A respirator that is recommended or approved for use in isocyanate containing environments (air purifying or fresh air supplied) may be necessary. The use of a positive pressure supplied air respirator is mandatory when: airborne isocyanate concentrations are not known or exceed 0.005 ppm; operations are performed in a confined space or area with limited ventilation; material is heated. An air-purifying respirator is not generally recommended due to the poor warning properties,(e.g.odor or irritation, of this material. By the time the worker would detect leakage of the face seal or breakthrough of the filter cartridge, his exposure could be well above the TLV. Consider the type of application, airborne isocyanate concentrations and materials being used concurrently when determining respirator use and selection. Observe OSHA regulations for respirator use (29CFR 1910.134).
Ventilation:
Exhaust ventilation sufficient to keep the airborne concentration below the TLV must be utilized. Exhaust

ventilation should be provided in accordance with the guidelines in INDUSTRIAL VENTILATION published by the American Conference of Governmental Hygienists.
Local exhaust: Recommended
Exhaust air may need to be cleaned by scrubbers or filters to reduce environmental contamination.
Skin Protection:
Chemical resistant gloves. Cover as much of the exposed skin area as possible with appropriate clothing, If skin creams are used, keep the area protected only by the cream to a minimum. When there is potential for a major splash directly onto the skin, such as when breaking into lines, a full acid suit is required. When the application may result in airborne vapor or mist, a full, permeation resistant, protective suit including head covering and face shield, gloves, and overshoes is required.
Eye Protection:
Chemical workers goggles. Safety glasses with side shields.
Other Protective Clothing or Equipment:
Apron and face shield. Safety showers and eye wash stations should be available. Cover as much of exposed skin area as necessary with appropriate clothing.
Work Practices, hygienic practices:
Use good hygiene.
EXPOSURE CONTROL METHODS:
Where a closed system is not used, good enclosure and local exhaust ventilation should be provided to minimize exposure. Food, beverages, tobacco products should not be carried, stored or consumed where this chemical is in use. Before eating, drinking or smoking wash face and hands with soap and water.
========== IX SPECIAL PRECAUTIONS ==========
Handling and Storage:
Storage temperature (min/max): 32F(0C) / 122F (50C)
Other Precautions:
Keep away from heat, sparks and open flame. Store in tightly closed container and protect from moisture and foreign materials.
========== X Additional Information ==========
SARA Title III Requirements:

Chemical Name	Section: 302	CERCLA	313
Materials Not Listed			

T.S.C.A. Status: Not On Inventory
==========
Name(print): George C. Karpin !This formulation is subject
Signature: George C. Karpin !to change without notice.
Title: Toxicological Coordinator!In case of accident use the
Date of last revision2/6/91!phone number provided.

To the best of our knowledge, the information contained therein is accurate and meets all State and Federal

Guidelines. However, CONAP INC. does not assume any liability whatsoever for the accuracy or completeness of the information contained herein. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards which exist. Final determination of the suitability of any material is the sole responsibility of the user.

//

*CONATHANE is a Registered Trademark of CONAP, INC.

Date approved 2 / 2 / 91 Approved:-[signature]---------
ND=Not Determined
NA=Not Applicable 2/7/91 Approved:-[signature]---------

C O N A P I N C .
1405 Buffalo St.
Olean, New York 14760
716/372-9650

========== MATERIAL SAFETY DATA SHEET ==========
Note: This form is to be used to comply with OSHA's Hazard Communication Standard, 29 CFR 1910.1200. Blank spaces are not permitted.

========== I. IDENTIFICATION ==========
Trade Name:CONATHANE* TU-981 Part B Date:3/5/90
Chemical Name, common name: Complex mixture 110

========== II. HAZARDOUS INGREDIENTS ==========

Chemical Names	CAS No.	%	ACGIH(TLV)	OSHA(PEL)	Other
Di n-Butyl Phthalate	84-74-2	40-50%	5mg/m3	5mg/m3	ND
Methylene Bis orthoethylAniline	19900-65-3	50-70%	ND	ND	ND

Material may present a dust hazard if cut, ground, or machined after curing.

========== III. PHYSICAL DATA ==========
Boiling Point: ND !Specific Gravity (H2O=1): 1.06
Vapor Pressure,mm Hg: ND !Vapor Density (air=1): ND
Melting Pt./Range: ND !Evaporation rate (Ether=1): ND
Solubility in Water: > 25% !Physical State: LIQUID
Percent volatile by volume: Nil
Appearance and Odor: Liquid; No distinct odor

========== IV. FIRE AND EXPLOSION DATA ==========
Flash Point,F (Method): > 200 F
Flammable Limits: ND LEL: ND UEL: ND
Extinguishing Materials:
-XX-Water Spray -XX-Dry Chemical -XX-Carbon Dioxide
-XX-Foam -ND-Other:
Special Firefighting Procedures:
Use standard turnout equipment. A self contained breathing apparatus is recommended.
Unusual Fire and Explosion Hazards:
None

========== V. HEALTH HAZARD INFORMATION ==========
ACUTE TOXICITY (Routes of entry)
Inhalation:
Inhalation will cause irritation to the respiratory tract.
Ingestion:
Based on Di n-Butyl Phthalate Oral toxicity not established, but based on basis of similar compositions believed very low. Initial symptoms may be delayed and may include nausea, vomiting and dizziness, Additional symptoms may include. headache, pain and irritation to the eyes, tearing, conjunctivitis and photophobia. The chronic health effects of this product have not been fully determined.
Eye Contact:
Will cause severe eye irritation.

Skin Contact:
May cause skin irritation and sensitization.
Skin Absorption:
ND

CHRONIC TOXICITY
Carcinogenicity:- X -No
Not listed as a carcinogen
---NA-NTP --NA--IARC -NA-Federal OSHA
Target Organ Affected:
High doses of Di Butyl Phthalate administered in the diet to mice throughout gestation have been associated with embryotoxic and possibly teratogenic effects in this species. The dietary administration of Di Butyl Phthalate has produced severe testicular atrophy in rats.
Effects of Overexposure:
Eyes: Severely irritating.
Ingestion: Non toxic
Skin: Mildly irritating may cause sensitization.
Inhalation: May cause respiratory tract irritation.

Medical Conditions Aggravated By Exposure:
None currently known.

FIRST AID: EMERGENCY PROCEDURES
Eye Contact:
Flush with water for at least 15 minutes. If irritation persists consult physician.
Skin Contact:
Wash with soap and water.
Inhalation:
Remove person to fresh air.
Ingested:
Dilute with 12 oz. of water; consult physician.
Recommendations to Physician:
Treat symptoms.
========== VI. REACTIVITY DATA ==========
Stability: - X -Stable -ND--Unstable
Conditions to Avoid:ND
Incompatibility (materials to avoid):
Strong oxidizers, acids, strong bases
Hazardous Decomposition Products:
From fire and excessive heat: Carbon dioxide and carbon monoxide.
Hazardous Polymerization: ND May Occur X-Will not occur
Conditions to avoid: None
======== VII. SPILL, LEAK AND DISPOSAL PROCEDURES =======
Steps to be taken if material is released or spilled:
Consult section VIII for proper protective equipment.
Soak up product in absorbent material, remove to container for disposal.
Waste Disposal Method:
Dispose according to any Local, State and Federal Regulations.

========== VIII. SPECIAL HANDLING INFORMATION ==========
Respiratory Protection:
Organic vapor respirator.
Ventilation:
Local exhaust--ND------- Mechanical--- XXX - Special-----
Protective Gloves:Impervious plastic or rubber.
Eye Protection:Glasses with side shields.
Other Protective Clothing or Equipment:Eye wash stations.
Work Practices, hygienic practices;
Wash after handling material.
========== IX SPECIAL PRECAUTIONS ==========
Handling and Storage:
Protect material from moisture.
Other Precautions:
None
========== X Additional Information ==========
SARA Title III Requirements:

Chemical Name	Section: 302	CERCLA	313
Di n-Butyl Phthalate	NA	10lb	Listed

T.S.C.A. Status: On Inventory

Name(print): George C. Karpin !This formulation is subject
Signature: [signature] !to change without notice.
Title: Toxicological Coordinator!In case of accident use the
Date last revision3/5/90 !phone number provided.

To the best of our knowledge, the information contained herein is accurate and meets all State and Federal guidelines. However, CONAP INC. does not assume any liability what so ever for the accuracy or completeness of the information contained herein. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards which exist. Final determination of the suitability of any material is the sole responsibility of the user.

* CONATHANE is a Registered Trademark of CONAP, INC.
Date approved: 3 / 5 /90 Approved: [signature]
ND=Not Determined
NA=Not Applicable
Date approved: 3/6 /90 Approved: [signature]

HAPCO INC
353 Circuit Street
Hanover, MA 02339
617-826-8801

Date Issued: 4/92

MATERIAL SAFETY DATA SHEET

IDENTIFICATION

Trade Name: HAPFLEX 595 A

SPECIAL REGULATORY HAZARDS

Ingredient:	CAS#:	(ACGIH TLV) Exposure limit
Methylene Bis (4-cyclohexylisocyanate)	5124-30-1	.01

Hazard assessment based on available data.

PHYSICAL DATA

Appearance and Odor: Colorless, low viscosity liquid- very slight odor

Solubility: Insoluble	Specific Gravity (H_2O=1) 1.1
Melting Point: NA	Vapor Pressure @ 20°C NA
Boiling Point: 165° C	Vapor Density (Air=1) 1

NA= Not Applicable ND= Not Determined (opt)=optional
MT= more than LT= less than

pg. a Hoffly 5958

REACTIVITY DATA
Stability: Stable
Incompatibility: Al, Zn, strong oxidizers, water, alcohols, amines, strong bases, metal compounds or surface active materials
Decomposition Products: Oxides of carbon and nitrogen under burning conditions.

FIRE AND EXPLOSION HAZARD DATA
Flash Point: NA
Extinguishing Media: CO_2 Foam, or dry chemical
Special Fire Fighting Procedures: Water may be ineffective

SPECIAL PROTECTION INFORMATION
Ventilation: May be necessary. Keep container closed when not in use.
Personal Protection: Eye protection, impervious gloves
Good housekeeping practices are recommended.

STORAGE, SPILLS AND DISPOSAL INFORMATION
Storage: Store away form sources of direct heat in a dry area.
Spills: Large spills - Dike up and pump into appropriate containers.
Small spills - Dilute with water and recover or use non-combustible absorbent material/sand and shovel into suitable containers.
Disposal: Incinerate in accordance with local, state, and federal regulations. Keep out of public water supplies.

HEALTH RELATED DATA
Specific Hazard(s): Prolonged or repeated exposure may cause irritation or other allergic responses.
Primary Route(s) of Entry: Skin contact, eye contact, inhalation

pg. 3 595HFA

HEALTH RELATED DATA (cont)

First Aid Procedures:

Eye contact:	Flush with water for 15 minutes. Get medical attention.
Skin contact:	Wipe excess. Wash with rubbing alcohol, if available, followed by soap and water. Discard shoes if contaminated.
Inhalation:	Remove to fresh air.

Information given herein is offered in good faith as accurate, but without guarantee. Conditions of use and suitability of the product for particular uses are beyond our control; all risks of use of the product are therefore assumed by the user and we expressly disclaim all warranties of every kind and nature, including warranties of merchantability and fitness for a particular purpose in respect to the use or suitability of the product. Appropriate warnings and safe handling procedures should be provided to handlers and users.

HAPCO INC
353 Circuit Street
Hanover, MA 02339
617-826-8801

Date Issued: 4/92

MATERIAL SAFETY DATA SHEET

IDENTIFICATION

Trade Name: HAPFLEX 595 B

SPECIAL REGULATORY HAZARDS

Ingredients	CAS#:	(ACGIH TLV) Exposure Limit
4,4'Diaminodiphenyl methane	101-77-9	0.1ppm
1,2-Benzene Dicarboxylic acid dibutyl ester	8.-74-2	5ppm

Hazard assessment based on available data.

PHYSICAL DATA

Appearance and Odor: Black Low viscosity liquid, slight odor

Solubility:	Specific Gravity (H_2O=1) 1.1
Melting Point: NA	Vapor Pressure @ 20°C NA
Boiling Point: NA	Vapor Density (Air=1) NA

NA= Not Applicable ND= Not Determined (opt)=optional
MT= more than LT = less than

pg. 2 595B

REACTIVITY DATA
Stability: Stable
Incompatibility: Strong oxidizing agents
Decomposition Products: Oxides of carbon and nitrogen under burning conditions.

FIRE AND EXPLOSION HAZARD DATA
Flash Point: NA
Extinguishing Media: CO_2 Foam, or dry chemical
Special Fire Fighting Procedures: Water may be ineffective

SPECIAL PROTECTION INFORMATION
Ventilation: May be necessary. Keep container closed when not in use.
Personal Protection: Eye protection, impervious gloves
Good housekeeping practices are recommended.

STORAGE, SPILLS AND DISPOSAL INFORMATION
Storage: Store away form sources of direct heat in a dry area.
Spills: Large spills - Dike up and pump into appropriate containers.
Small spills - Dilute with water and recover or use non-combustible absorbent material/sand and shovel into suitable containers.
Disposal: Incinerate in accordance with local, state, and federal regulations. Keep out of public water supplies.

HEALTH RELATED DATA
Specific Hazard(s): Prolonged or repeated exposure may cause irritation or other allergic responses.
Primary Route(s) of Entry: Skin contact, eye contact, inhalation

Pg. 3 595 B

HEALTH RELATED DATA (cont)

First Aid Procedures:

Eye contact:	Flush with water for 15 minutes. Get medical attention.
Skin contact:	Wipe excess. Wash with rubbing alcohol, if available, followed by soap and water. Discard shoes if contaminated.
Inhalation:	Remove to fresh air.

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HAPCO INC
383 Circuit Street
Hanover, MA 02339
617-826-8801

Date Issued: 2/92

MATERIAL SAFETY DATA SHEET

IDENTIFICATION

Trade Name: HAPFLEX 665 A

SPECIAL REGULATORY HAZARDS

Ingredient:	CAS#:	(ACGIH TLV) Exposure limit
Methylene Bis (4-Cyclohexylisocyanate)	5124-30-1	.01ppm

Hazard assessment based on available data.

PHYSICAL DATA

Appearance and Odor: Colorless, low viscosity liquid- very slight odor

Solubility: Insoluble
Specific Gravity (H_2O=1) 1.1
Melting Point: NA
Vapor Pressure @ 20°C NA
Boiling Point: 165° C
Vapor Density (Air=1) 1

NA= Not Applicable ND= Not Determined (opt)=optional
MT= more than LT= less than

pg. 2 665A

REACTIVITY DATA
Stability: Stable
Incompatibility: Al, Zn, strong oxidizers, water, alcohols, amines, strong bases, metal compounds or surface active materials
Decomposition Products: Oxides of carbon and nitrogen under burning conditions.

FIRE AND EXPLOSION HAZARD DATA
Flash Point: NA
Extinguishing Media: CO_2 Foam, or dry chemical
Special Fire Fighting Procedures: Water may be ineffective

SPECIAL PROTECTION INFORMATION
Ventilation: May be necessary. Keep container closed when not in use.
Personal Protection: Eye protection, impervious gloves
Good housekeeping practices are recommended.

STORAGE, SPILLS AND DISPOSAL INFORMATION
Storage: Store away form sources of direct heat in a dry area.
Spills: Large spills - Dike up and pump into appropriate containers.
Small spills - Dilute with water and recover or use non-combustible absorbent material/sand and shovel into suitable containers.
Disposal: Incinerate in accordance with local, state, and federal regulations. Keep out of public water supplies.

HEALTH RELATED DATA
Specific Hazard(s): Prolonged or repeated exposure may cause irritation or other allergic responses.
Primary Route(s) of Entry: Skin contact, eye contact, inhalation

Pg. 3 666A

HEALTH RELATED DATA (cont)

First Aid Procedures:

Eye contact:	Flush with water for 15 minutes. Get medical attention.
Skin contact:	Wipe excess. Wash with rubbing alcohol, if available, followed by soap and water. Discard shoes if contaminated.
Inhalation:	Remove to fresh air.

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HAPCO INC
353 Circuit Street
Hanover, MA 02339
617-826-8801

Date Issued: 2/92

MATERIAL SAFETY DATA SHEET

IDENTIFICATION

Trade Name: HAPFLEX 665 B

SPECIAL REGULATORY HAZARDS

Ingredient:	CAS#:	(ACGIH TLV) Exposure Limit
4,4' Diaminodiphenyl methane	101-77-8	0.1ppm
1,2-Benzene Dicarboxylic acid Dibutyl ester	84-74-2	5ppm

Hazard assessment based on available data.

PHYSICAL DATA

Appearance and Odor: black, low viscosity liquid, slight odor

Solubility:	Specific Gravity (H_2O=1) 1:1
Melting Point:	Vapor Pressure @ 20°C NA
Boiling Point: NA	Vapor Density (Air=1) NA

NA= Not Applicable ND= Not Determined (opt)=optional
MT= more than LT= less than

Pg. 2 605 B

REACTIVITY DATA
Stability: Stable
Incompatibility: Strong oxidizing agents
Decomposition Products: Oxides of carbon and nitrogen under burning conditions.

FIRE AND EXPLOSION HAZARD DATA
Flash Point: NA
Extinguishing Media: CO_2 Foam, or dry chemical
Special Fire Fighting Procedures: Water may be ineffective

SPECIAL PROTECTION INFORMATION
Ventilation: May be necessary. Keep container closed when not in use.
Personal Protection: Eye protection. impervious gloves
Good housekeeping practices are recommended.

STORAGE, SPILLS AND DISPOSAL INFORMATION
Storage: Store away form sources of direct heat in a dry area.
Spills: Large spills - Dike up and pump into appropriate containers.
Small spills - Dilute with water and recover or use non-combustible absorbent material/sand and shovel into suitable containers.
Disposal: Incinerate in accordance with local, state, and federal regulations. Keep out of public water supplies.

HEALTH RELATED DATA
Specific Hazard(s): Prolonged or repeated exposure may cause irritation or other allergic responses.
Primary Route(s) of Entry: Skin contact, eye contact.inhalation

HAPCO INC.
353 Circuit Street
Hanover, MA 02339
617-826-8801

Date Issued: 5/92

MATERIAL SAFETY DATA SHEET

IDENTIFICATION

Trade Name: HAPCAST 3730

SPECIAL REGULATORY HAZARDS

Ingredient:	CAS#:	(ACGIH TLV) Exposure Limit
Diglycidyl ether of bisphenol A	25068-38-6	--
Tetrahydro-2-Furancarbinol	97-99-4	--

Hazard assessment based on available data.

PHYSICAL DATA

Appearance and Odor: Black, medium viscosity liquid

Solubility:	Very Slightly	Specific Gravity (H_2O=1)	2.43
Melting Point:	NA	Vapor Pressure @ 20°C	0.3
Boiling Point:	450°F	Vapor Density (Air=1)	NA

NA= Not Applicable ND= Not Determined (opt)=optional
MT= more than LT = less than

REACTIVITY DATA

Stability: Stable

Incompatibility: Strong oxidizing agents

Decomposition Products: Oxides of carbon and nitrogen under burning conditions.

FIRE AND EXPLOSION HAZARD DATA

Flash Point: 200°F TCT

Extinguishing Media: CO_2 Foam, or dry chemical

Special Fire Fighting Procedures: Water may be ineffective

SPECIAL PROTECTION INFORMATION

Ventilation: May be necessary. Keep container closed when not in use.

Personal Protection: Eye protection, impervious gloves

Good housekeeping practices are recommended.

STORAGE, SPILLS AND DISPOSAL INFORMATION

Storage: Store away form sources of direct heat in a dry area.

Spills: Large spills - Dike up and pump into appropriate containers.

Small spills - Dilute with water and recover or use non-combustible absorbent material/sand and shovel into suitable containers.

Disposal: Incinerate in accordance with local, state, and federal regulations. Keep out of public water supplies.

HEALTH RELATED DATA

Specific Hazard(s): Prolonged or repeated exposure may cause irritation or other allergic responses.

Primary Route(s) of Entry: Skin contact, eye contact, inhalation

HEALTH RELATED DATA (cont)

First Aid Procedures:

Eye contact:	Flush with water for 15 minutes
	Get medical attention
Skin contact:	Wipe excess. Wash with rubbing alcohol, if
	available, followed by soap and water.
	Discard shoes if contaminated.
Inhalation:	Remove to fresh air.

Information given herein is offered in good faith as accurate, but without guarantee. Conditions of use and suitability of the product for particular uses are beyond our control; all risks of use of the product are therefore assumed by the user and we expressly disclaim all warranties of every kind and nature, including warranties of merchantability and fitness for a particular purpose in respect to the use or suitability of the product. Appropriate warnings and safe handling procedures should be provided to handlers and users.

HAPCO INC .
353 Circuit Street
Hanover, MA 02339
617-826-8801

Date Issued: 8/91

MATERIAL SAFETY DATA SHEET

IDENTIFICATION

Trade Name: Hapcoat 597 A

SPECIAL REGULATORY HAZARDS

Ingredient:	CAS#:	(ACGIH TLV) Exposure Limit
Methylene Bis (4-Cyclohexylisocyanate)	5124-30-1	.01 ppm

Hazard assessment based on available data.

PHYSICAL DATA

Appearance and Odor: Colorless, med. viscosity liquid, very slight odor.

Solubility:	insoluble	Specific Gravity (H_2O=1)	1.16
Melting Point:	n/a	Vapor Pressure @ 20°C	n/a
Boiling Point:	165° C	Vapor Density (Air=1)	1

NA= Not Applicable ND= Not Determined (opt)=optional
MT= more than LT = less than

REACTIVITY DATA

Stability: Stable

Incompatibility. Al, Zn, strong oxidizers, water, alcohols, amines, strong bases, metal compounds or surface active materials

Decomposition Products: Oxides of carbon and nitrogen under burning conditions

FIRE AND EXPLOSION HAZARD DATA

Flash Point: n/a

Extinguishing Media: CO_2 Foam, or dry chemical

Special Fire Fighting Procedures: Water may be ineffective

SPECIAL PROTECTION INFORMATION

Ventilation: May be necessary Keep container closed when not in use.

Personal Protection: Eye protection, impervious gloves

Good housekeeping practices are recommended

STORAGE, SPILLS AND DISPOSAL INFORMATION

Storage: Store away form sources of direct heat in a dry area.

Spills: Large spills - Dike up and pump into appropriate containers.

Small spills - Dilute with water and recover or use non-combustible absorbent material/sand and shovel into suitable containers.

Disposal: Incinerate in accordance with local, state, and federal regulations. Keep out of public water supplies.

HEALTH RELATED DATA

Specific Hazard(s): Prolonged or repeated exposure may cause irritation or other allergic responses.

Primary Route(s) of Entry: Skin contact, eye contact, inhalation

HEALTH RELATED DATA (cont)

First Aid Procedures:

Eye contact:	Flush with water for 15 minutes. Get medical attention.
Skin contact:	Wipe excess. Wash with rubbing alcohol, if available, followed by soap and water. Discard shoes if contaminated
Inhalation:	Remove to fresh air.

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HAPCO INC.
353 Circuit Street
Hanover, MA 02339
617-826-8801

Date Issued: 2/91

MATERIAL SAFETY DATA SHEET

IDENTIFICATION

Trade Name: Hapcoat 597 B

SPECIAL REGULATORY HAZARDS

Ingredient:	CAS#:	(ACGIH TLV) Exposure Limit
4,4' Diaminodiphenyl methane	101-77-9	0.1 ppm
1,2 Benzene Carboxylic acid dibutyl ester	84-74-2	5 ppm

Hazard assessment based on available data.

PHYSICAL DATA

Appearance and Odor: White, High vicosity paste, slight odor

Solubility:		Specific Gravity (H_2O=1)	1.1
Melting Point: n/a		Vapor Pressure @ 20°C	n/a
Boiling Point: n/a		Vapor Density (Air=1)	n/a

NA= Not Applicable ND= Not Determined (opt)=optional
MT= more than LT = less than

REACTIVITY DATA

Stability: Stable

Incompatibility: Strong oxidizing agents

Decomposition Products: Oxides of carbon and nitrogen under burning conditions

---

FIRE AND EXPLOSION HAZARD DATA

Flash Point: n/a

Extinguishing Media: CO_2 Foam, or dry chemical

Special Fire Fighting Procedures: Water may be ineffective

SPECIAL PROTECTION INFORMATION

Ventilation: May be necessary Keep container closed when not in use.

Personal Protection: Eye protection, impervious gloves

Good housekeeping practices are recommended.

STORAGE, SPILLS AND DISPOSAL INFORMATION

Storage: Store away form sources of direct heat in a dry area.

Spills: Large spills - Dike up and pump into appropriate containers

Small spills - Dilute with water and recover or use non-combustible absorbent material/sand and shovel into suitable containers.

Disposal: Incinerate in accordance with local, state, and federal regulations. Keep out of public water supplies

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HEALTH RELATED DATA

Specific Hazard(s): Prolonged or repeated exposure may cause irritation or other allergic responses.

Primary Route(s) of Entry: Skin contact, eye contact, inhalation

HEALTH RELATED DATA (cont)

First Aid Procedures:

Eye contact:	Flush with water for 15 minutes.
	Get medical attention
Skin contact:	Wipe excess. Wash with rubbing alcohol, if
	available, followed by soap and water.
	Discard shoes if contaminated
Inhalation:	Remove to fresh air.

Information given herein is offered in good faith as accurate, but without guarantee. Conditions of use and suitability of the product for particular uses are beyond our control; all risks of use of the product are therefore assumed by the user and we expressly disclaim all warranties of every kind and nature, including warranties of merchantability and fitness for a particular purpose in respect to the use or suitability of the product. Appropriate warnings and safe handling procedures should be provided to handlers and users.

HAPCO INC
363 Circuit Street
Hanover, MA 02339
617-826-8801

Date Issued: 8/91

MATERIAL SAFETY DATA SHEET

IDENTIFICATION

Trade Name: HAPCOAT 667 A

SPECIAL REGULATORY HAZARDS

Ingredient:	CAS#:	(ACGIH TLV) Exposure Limit
Methylene Bis (4-Cyclohexylisocyanate)	5124-30-1	.01ppm

Hazard assessment based on available data.

PHYSICAL DATA

Appearance and Odor: Colorless, low viscosity liquid- very slight odor

Solubility: Insoluble

Specific Gravity (H_2O=1) 1.1

Melting Point: NA

Vapor Pressure @ 20°C NA

Boiling Point: 165° C

Vapor Density (Air=1) 1

NA= Not Applicable ND= Not Determined (opt)=optional
MT= more than LT= less than

Pg. 2 667 A

REACTIVITY DATA

Stability: Stable

Incompatibility: Al, Zn, strong oxidizers, water, alcohols, amines, strong bases, metal compounds or surface active materials

Decomposition Products: Oxides of carbon and nitrogen under burning conditions.

FIRE AND EXPLOSION HAZARD DATA

Flash Point: NA

Extinguishing Media: CO_2 Foam, or dry chemical

Special Fire Fighting Procedures: Water may be ineffective

SPECIAL PROTECTION INFORMATION

Ventilation: May be necessary. Keep container closed when not in use.

Personal Protection: Eye protection, impervious gloves

Good housekeeping practices are recommended.

STORAGE, SPILLS AND DISPOSAL INFORMATION

Storage: Store away form sources of direct heat in a dry area.

Spills: Large spills - Dike up and pump into appropriate containers.

Small spills - Dilute with water and recover or use non-combustible absorbant material/sand and shovel into suitable containers.

Disposal: Incinerate in accordance with local, state, and federal regulations. Keep out of public water supplies.

HEALTH RELATED DATA

Specific Hazard(s): Prolonged or repeated exposure may cause irritation or other allergic responses.

Primary Route(s) of Entry: Skin contact, eye contact, inhalation

pg. 3 667 A

HEALTH RELATED DATA (cont)

First Aid Procedures:

Eye contact:	Flush with water for 15 minutes. Get medical attention.
Skin contact:	Wipe excess. Wash with rubbing alcohol, if available, followed by soap and water. Discard shoes if contaminated.
Inhalation:	Remove to fresh air.

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HAPCO INC
353 Circuit Street
Hanover, MA 02339
617-826-8801

Date Issued: 8/91

MATERIAL SAFETY DATA SHEET

IDENTIFICATION

Trade Name: HAPCOAT 687 B

SPECIAL REGULATORY HAZARDS

Ingredient:	CAS#:	(ACGIH TLV) Exposure Limit
4,4' Diaminodiphenyl methane	101-77-9	0.1ppm
1,2-Benzene Dicarboxylic acid Dibutyl ester	84-74-2	5ppm

Hazard assessment based on available data.

PHYSICAL DATA

Appearance and Odor: white, thixotropic paste.

Solubility:	Specific Gravity (H_2O=1) 1.1
Melting Point:	Vapor Pressure @ 20°C NA
Boiling Point: NA	Vapor Density (Air=1) NA

NA= Not Applicable ND= Not Determined (opt)=optional
MT= more than LT= less than

pg. 2 6678

REACTIVITY DATA

Stability: Stable

Incompatibility: Strong oxidizing agents

Decomposition Products: Oxides of carbon and nitrogen under burning conditions.

FIRE AND EXPLOSION HAZARD DATA

Flash Point: NA

Extinguishing Media: CO_2 Foam, or dry chemical

Special Fire Fighting Procedures: Water may be ineffective

SPECIAL PROTECTION INFORMATION

Ventilation: May be necessary. Keep container closed when not in use.

Personal Protection: Eye protection, impervious gloves

Good housekeeping practices are recommended

STORAGE, SPILLS AND DISPOSAL INFORMATION

Storage: Store away form sources of direct heat in a dry area.

Spills: Large spills - Dike up and pump into appropriate containers.

Small spills - Dilute with water and recover or use non-combustible absorbent material/sand and shovel into suitable containers.

Disposal: Incinerate in accordance with local, state, and federal regulations. Keep out of public water supplies.

HEALTH RELATED DATA

Specific Hazard(s): Prolonged or repeated exposure may cause irritation or other allergic responses.

Primary Route(s) of Entry: Skin contact, eye contact, inhalation

Pg.3 6678

HEALTH RELATED DATA (cont)

First Aid Procedures:

Eye contact:	Flush with water for 15 minutes. Get medical attention.
Skin contact:	Wipe excess. Wash with rubbing alcohol, if available, followed by soap and water. Discard shoes if contaminated.
Inhalation:	Remove to fresh air.

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HAFCO INC
353 Circuit Street
Hanover, MA 02339
617-826-8801

Date Issued: 5/91

MATERIAL SAFETY DATA SHEET

IDENTIFICATION

Trade Name: Hapcast 5730 A

SPECIAL REGULATORY HAZARDS

Ingredient:	CAS#:	(ACGIH TLV) Exposure Limit
1,1,2,2,3 Pentamethyl butylphenol	84852-15-3	---
Tetrahydro-2-Furancarbinol	97-99-4	---
Diglycidylether Bisphenol A	25068-38-6	---

Hazard assessment based on available data.

PHYSICAL DATA

Appearance and Odor: Aluminum color, medium/high viscosity liquid, slight odor

Solubility: Insoluble		Specific Gravity (H2O=1)	1.2-1.5
Melting Point: N/A		Vapor Pressure @ 20°C	N/A
Boiling Point: MT400°F		Vapor Density (Air=1)	N/A

NA= Not Applicable ND= No Determined (opt)=optional
MT= more than LT= less than

REACTIVITY DATA

Stability: Stable

Incompatibility: Al, Zn, strong oxidizers, water, alcohols, amines, strong bases, metal compounds or surface active materials

Decomposition Products: Oxides of carbon and nitrogen under burning conditions.

FIRE AND EXPLOSION HAZARD DATA

Flash Point: MT 400°F

Extinguishing Media: CO_2 Foam, or dry chemical

Special Fire Fighting Procedures: Water may be ineffective

SPECIAL PROTECTION INFORMATION

Ventilation: May be necessary. Keep container closed when not in use.

Personal Protection: Eye protection, impervious gloves

Good housekeeping practices are recommended.

STORAGE, SPILLS AND DISPOSAL INFORMATION

Storage: Store away form sources of direct heat in a dry area.

Spills: Large spills - Dike up and pump into appropriate containers.
Small spills - Dilute with water and recover or use non-combustible absorbent material/sand and shovel into suitable containers.

Disposal: Incinerate in accordance with local, state, and federal regulations. Keep out of public water supplies.

HEALTH RELATED DATA

Specific Hazard(s): Prolonged or repeated exposure may cause irritation or other allergic responses.

Primary Route(s) of Entry: Skin contact, eye contact, inhalation

HEALTH RELATED DATA (cont)

First Aid Procedures:

Eye contact:	Flush with water for 15 minutes. Get medical attention.
Skin contact:	Wipe excess. Wash with rubbing alcohol, if available, followed by soap and water. Discard shoes if contaminated.
Inhalation:	Remove to fresh air.

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HAPCO INC
353 Circuit Street
Hanover, MA 02339
617-826-5801

Date Issued: 3/91

MATERIAL SAFETY DATA SHEET

IDENTIFICATION

Trade Name: Hapcast 5730 B

SPECIAL REGULATORY HAZARDS

Ingredient:	CAS#:	(ACGIH TLV) Exposure Limit
Triethylenetetramine	000112-24-3	--
N,N'bis (2-aminoethyl) piperazine	006531-38-0	--
Piperazinyl-ethylenediamine	024028-46-4	--
Trisaminoethylamine	004097-89-6	--
Bis (para-aminocyclohexyl)	1761-71-3	--
B-Hydroxylalkyl Diamines (mixture)	NA	--

Hazard assessment based on available data.

PHYSICAL DATA

Appearance and Odor: Amber color, low viscosity liquid, slight amine odor

Solubility: Slightly soluble		Specific Gravity (H2O=1)	.95
Melting Point: NA		Vapor Pressure @ 20°C	LT 1
Boiling Point: MT 500° F		Vapor Density (Air=1)	MT 5

NA= Not Applicable ND= Not Determined (opt)=optional
MT= more than LT = less than

REACTIVITY DATA
Stability: Stable
Incompatibility: Strong oxidizing agents
Decomposition Products: Oxides of carbon and nitrogen under burning conditions.

FIRE AND EXPLOSION HAZARD DATA
Flash Point: 245°F PMCC

Extinguishing Media: CO_2 Foam, or dry chemical
Special Fire Fighting Procedures: Water may be ineffective

SPECIAL PROTECTION INFORMATION
Ventilation: May be necessary. Keep container closed when not in use.
Personal Protection: Eye protection, impervious gloves
Good housekeeping practices are recommended.

STORAGE. SPILLS AND DISPOSAL INFORMATION
Storage: Store away form sources of direct heat in a dry area.

Spills: Large spills - Dike up and pump into appropriate containers.
Small spills - Dilute with water and recover or use non-combustible absorbent material/sand and shovel into suitable containers.

Disposal: Incinerate in accordance with local, state, and federal regulations. Keep out of public water supplies.

HEALTH RELATED DATA
Specific Hazard(s): Prolonged or repeated exposure may cause irritation or other allergic responses.
Primary Route(s) of Entry: skin contact, eye contact, inhalation

HEALTH RELATED DATA (Cont.)

First Aid Procedures:

Eye contact:	Flush with water for 15 minutes. Get medical attention.
Skin contact:	Wipe excess. Wash with rubbing alcohol, if available, followed by soap and water. Discard shoes if contaminated.
Inhalation:	Remove to fresh air.

Information given herein is offered in good faith as accurate, but without guarantee. Conditions of use and suitability of the product for particular uses are beyond our control; all risks of use of the product are therefore assumed by the user and we expressly disclaim all warranties of every kind and nature, including warranties of merchantability and fitness for a particular purpose in respect to the use or suitability of the product. Appropriate warnings and safe handling procedures should be provided to handlers and users.

Material Safety Data Sheet

Dap Inc.
P.O. Box 277
Dayton, Ohio 45401-0277

Product: EPOXICAL 301 THICK SECTION CASTING RESIN
Internal ID: 71262

MSDS No: DAP / 71262
Revision: 3
Date: September 30, 1988

National Paint and Coatings Association Hazardous Material Identification System

HEALTH HAZARD	2 - Moderate
FLAMMABILITY HAZARD	2 - Moderate
REACTIVITY HAZARD	1 - Slight
PERSONAL PROTECTION	D - Face Shield, Gloves, Apron

SECTION I. MATERIAL IDENTIFICATION

Trade/Material Name: EPOXICAL 301 THICK SECTION CASTING RESIN

Description: EPOXY RESIN

CAS: Mixture

MSDS REVISION DATE: December 27, 1990

Shipping Name (49 CFR 172.101): Plastic Liquid n.o.s.
D.O.T. ID No. (49 CFR 172.101): None
D.O.T. label required (49 CFR 172.101): None
EPA Hazard Class - if discarded (40 CFR 261): D001 - Ignitable

Manufacturer: Dap Inc.
P.O. Box 277
Dayton, OH 45401-0277

Phone: 1-800-543-3840
In Ohio 1-513-667-4461

SECTION II. INGREDIENTS AND HAZARDS

Ingredient Name:	CAS Number:	Percent:	Exposure Limits:
Bisphenol A diglycidyl ether polymer	25068-38-6	<35	NE
n-Butyl glycidyl ether	2426-08-6	<25	ACGIH TLV: 25ppm OSHA PEL: 50ppm TWA

Remaining ingredients are not regulated by OSHA and are considered to be trade secrets.

SECTION III. PHYSICAL DATA

Appearance & Odor: Viscous, aluminum colored liquid

Boiling point: 327 °F
Vapor pressure: 3 mm Hg @ 25 °C
Water solubility (%): Slight
Vapor density (air=1): 4.5
Evaporation rate: NE
Specific gravity (H_2O=1): 2.1
% volatile by volume: NE

 PHYSICAL DATA continues on page 2

Dap Inc.
P.O. Box 277
Dayton, Ohio 45401-0277

Product: EPOXICAL 301 THICK SECTION CASTING RESIN
Internal ID: 71262

MSDS No: DAP / 71262
Revision: 3
Date: September 30, 1988

PHYSICAL DATA continued from page 1

During Application and Curing:
VOC less water less volatile solvent (g/liter): 0
VOC material (g/liter): 0

SECTION IV. FIRE AND EXPLOSION DATA

Flash Point (method): >120 °F (PMCC) **Limits: LEL %:** NE **UEL %:** NE

Extinguishing Media: Foam, carbon dioxide, dry chemical, water fog

Unusual fire or explosion hazards: Containers may explode if exposed to extreme heat. Eliminate sources of ignition: electrical equipment, sparks and flame. Do not put in contact with caustics or oxidizing materials.

Special fire-fighting procedures: Full protective equipment, including self-contained breathing apparatus, is recommended to protect from combustion products. Cool exposed surfaces with water.

SECTION V. REACTIVITY DATA

Material is stable Hazardous polymerization will not occur

Chemical incompatibilities: Strong oxidizers

Conditions to avoid: Excessive heat and freezing

Hazardous decomposition Products: Carbon Monoxide, Carbon Dioxide, Aldehydes

SECTION VI. HEALTH HAZARD INFORMATION

This product is NOT considered a carcinogen by the NTP, IARC and OSHA.

Medical conditions which may be aggravated by contact: Allergy, eczema or skin conditions.

Primary entry route(s): Skin contact

Acute effects: May irritate eyes, skin and respiratory tract.

Chronic effect(s): May cause sensitization. May cause defatting of the skin leading to dermatitis.

First aid:

Eye contact: Flush with large amounts of water for 15 minutes. Contact a physician immediately.

Skin contact: Wash with soap and water.

Dap Inc.
P.O. Box 277
Dayton, Ohio 45401-0277

Product: EPOXICAL 301 THICK SECTION CASTING RESIN
Internal ID: 71262

MSDS No: DAP / 71262
Revision: 3
Date: September 30, 1988

HEALTH HAZARD INFORMATION continued from page 2

Inhalation: Remove to fresh air. Contact physician immediately.

Ingestion: Do not induce vomiting. Dilute by giving water or milk to drink if victim is concious. Contact physician or Regional Poison Control Center immediately.

SECTION VII. SPILL, LEAK AND DISPOSAL PROCEDURES

Spill / Leak procedures: Use absorbent material or scrape up dried material and place into containers.

Waste management / Disposal: Dispose of according to federal, state and local standards. Do not reuse empty containers. Liquids cannot be disposed of in a landfill.

SECTION VIII. SPECIAL PROTECTION INFORMATION

Personal protective equipment:

Goggles: Wear full face shield.

Gloves: Impervious gloves.

Respirator: If 8-hour exposure limit or value is exceeded use an approved NIOSH/OSHA respirator. Consult your safety equipment supplier and the OSHA regulation, 29 CFR 1910.134 for respirator requirements.

Workplace considerations:

Ventilation: Provide sufficient mechanical ventilation (local or general exhaust) to maintain exposure below PEL and TLV.

Safety stations:
Provide eyewash and impervious apron if body contact with product may occur. Barrier creams may be used.

Contaminated equipment:
Wash contaminated clothing before reuse.

SECTION IX. SPECIAL PRECAUTIONS

Storage segregation: Store away from oxidizers.

Special handling / storage: Keep containers tightly closed when not in use. Keep containers from excessive heat and freezing. Provide ventilation in storage area. Keep out of reach of children. Do not store at temperatures above 120 °F.

This data is offered in good faith as typical values and not as a product specification. No warranty, either expressed or implied, is hereby made. The recommended industrial hygiene and safe handling procedures are believed to be generally applicable. However, each user should review these recommendations in the specific context of the intended use and detemine whether they are appropriate.

Material Safety Data Sheet

DAP Inc.
P.O. Box 277
Dayton, Ohio 45401-0277

Product: EPOXICAL 308 MASS CASTING HARDENER
Internal ID: 71276

MSDS No: DAP / 71276
Revision: 1
Date: November 7, 1988

National Paint and Coatings Association

Hazardous Material Identification System

HEALTH HAZARD	3 - Serious
FLAMMABILITY HAZARD	1 - Slight
REACTIVITY HAZARD	0 - Minimal
PERSONAL PROTECTION	D - Face Shield, Gloves, Apron

SECTION I. MATERIAL IDENTIFICATION

Trade/Material Name: EPOXICAL 308 MASS CASTING HARDENER

Description: EPOXY HARDENER

CAS: Mixture

Shipping Name (49 CFR 172.101): Corrosive Liquid, n.o.s. (polyethylene polyamines)
D.O.T. Hazard Class (49 CFR 172.101): Corrosive Material
D.O.T. ID No. (49 CFR 172.101): UN 1760
D.O.T. label required (49 CFR 172.101): Corrosive
EPA Hazard Class - if discarded (40 CFR 261): Corrosive D-002

Manufacturer: DAP Inc.
P.O. Box 277
Dayton, OH 45401-0277

Phone: 1-800-543-3840
In Ohio 1-513-667-4461

SECTION II. INGREDIENTS AND HAZARDS

Ingredient Name:	CAS Number:	Percent:	Exposure Limits:
Tall Oil Fatty Acids, Reaction Products with Polyethylene Polyamines.	68910-93-0	45-55	NE
Unsaturated Dimer Acids, Reaction Products with Polyethylene Polyamines	68410-23-1	45-55	NE

Remaining ingredients are not regulated by OSHA and are considered trade secrets.

SECTION III. PHYSICAL DATA

Appearance & Odor: Amber liquid with amine odor

Boiling point: NE
Vapor pressure: NE
Water solubility (%): Nil
Vapor density (air=1): NE
Evaporation rate: NE
Specific gravity (H_2O=1): 0.99
% volatile by volume: Nil

VOC less water less volatile solvent (g/liter): 0
VOC material (g/liter): 0

Material Safety Data Sheet

DAP Inc.
P.O. Box 277
Dayton, Ohio 45401-0277

Product: EPOXICAL 308 MASS CASTING HARDENER
Internal ID: 71276

MSDS No: DAP / 71276
Revision: 1
Date: November 7, 1988

SECTION IV. FIRE AND EXPLOSION DATA

Flash Point (method): >275 °F (PMCC) Limits: LEL %: NE UEL %: NE

Extinguishing Media: Chemical foam, carbon dioxide, dry chemical and water fog

Unusual fire or explosion hazards: Containers may explode if exposed to extreme heat. Eliminate sources of ignition: electrical equipment, sparks and flame.

Special fire-fighting procedures: Full protective equipment, including self-contained breathing apparatus, is recommended to protect from combustion products. Cool exposed surfaces with water.

SECTION V. REACTIVITY DATA

Material is stable . Hazardous polymerization will not occur

Chemical incompatibilities: Strong oxidizing agents

Hazardous decomposition Products: Nitrogen oxides, carbon monoxide, carbon dioxide and aldehydes.

SECTION VI. HEALTH HAZARD INFORMATION

This product is not considered a carcinogen by NTP, IARC or OSHA. *

Medical conditions which may be aggravated by contact: Allergies

Primary entry route(s): Skin contact and inhalation of vapors

Acute effects: Will cause burns to eyes and skin. High concentrations of vapors can cause severe eye and respiratory tract irritation. Liquid causes severe damage to mucous membranes if swallowed.

Chronic effect(s): Prolonged or repeated exposure may cause asthma and skin sensitization or other allergic response.

First aid:

Eye contact: Flush with large amounts of water for 15 minutes. CONTACT PHYSICIAN IMMEDIATELY.

Skin contact: Immediately flush skin with water for 15 minutes while removing contaminated clothing. Contact physician immediately.

Inhalation: Remove to fresh air. Contact physician immediately.

Ingestion: Do not induce vomiting. Dilute by giving water or milk to drink if victim is concious. CONTACT PHYSICIAN OR REGIONAL POISON CONTROL CENTER IMMEDIATELY.

MSDS 71276 continues on page 3

Material Safety Data Sheet

DAP Inc.
P.O. Box 277
Dayton, Ohio 45401-0277

Product: EPOXICAL 308 MASS CASTING HARDENER
Internal ID: 71276

MSDS No: DAP / 71276
Revision: 1
Date: November 7, 1988

SECTION VII. SPILL, LEAK AND DISPOSAL PROCEDURES

Spill / Leak procedures: Dike spill area. Use absorbent material and place into containers.

Waste management / Disposal: Dispose of according to federal, state and local standards. Do not reuse empty containers. Discarded material should be incinerated at a permitted facility. Liquids cannot be disposed of in a landfill.

SECTION VIII. SPECIAL PROTECTION INFORMATION

Personal protective equipment:

Goggles: Wear full face shield

Gloves: Impervious gloves

Respirator: NIOSH/OSHA approved respiratory protection required in the absence of proper environmental control. For emergencies a full-face respirator or self-contained breathing apparatus is recommended.

Workplace considerations:

Ventilation: Breathing of vapors must be avoided. Ventilation must be sufficient to control vapors. This material should be confined as far as possible within sealed or covered equipment in which case normal ventilation should be adequate. Special (local) ventilation will be needed in areas where vapors are expected to be vented.

Safety stations:
Provide eyewash and impervious apron if body contact with product may occur. Barrier creams may be used.

Contaminated equipment:
Wash contaminated clothing before reuse. Discard contaminated leather goods.

SECTION IX. SPECIAL PRECAUTIONS

Storage segregation: Store away from strong oxidizers.

Special handling / storage: Keep containers tightly closed when not in use. Keep containers from excessive heat and freezing. Provide ventilation in storage area. Keep out of reach of children. Do not store at temperatures above 275 °F

DOT Class: Corrosive Material

This data is offered in good faith as typical values and not as a product specification. No warranty, either expressed or implied, is hereby made. The recommended industrial hygiene and safe handling procedures are believed to be generally applicable. However, each user should review these recommendations in the specifc context of the intended use and determine if they are appropriate.

End of MSDS 71276 — Page 3

(MA P/N: 29-082-008
PAGE 1 OF 3

MATERIAL SAFETY DATA SHEET

MASTERCAST 703 A ALTERNATIVE TO OSHA-20 FORM

MANUFACTURED FOR:
THE KINDT COLLINS COMPANY
12651 ELMWOOD AVENUE
CLEVELAND, OH 44111
(216) 252 4122

EMERGENCY INFORMATION:
ROCKY MOUNTAIN POISON AND DRUG CENTER
645 BANNOCK STREET
DENVER, COLORADO 80204-4507
EMERGENCY TELEPHONE: (303) 623-5716

****

SECTION I - PRODUCT IDENTIFICATION

TRADE NAME AND SYNONYMS: MASTERCAST 703 A (OR MASTERCAST 703 PART A)

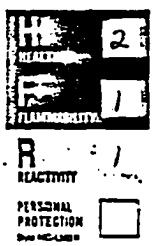
CHEMICAL FAMILY: POLYMETHYLENE POLYPHENYL ISOCYANATE SOLUTION

FORMULA: PROPRIETARY COMPLEX MIXTURE * TRADE SECRET

****

SECTION II - HAZARDOUS INGREDIENTS

(NOTE: SEE FINAL PAGE OF MSDS FOR DEFINITIONS OF ABBREVIATIONS AND SYMBOLS.)



PIGMENTS	50-70%	TLV UNITS N.A.
VEHICLE PMPPI	17-30%	TLV UNITS .02 PPM
	(VAPOR PRESSURE <0.00001 MMHG @ 25 DEGREES C.)	
ADDITIVES	5-15%	TLV UNITS .5PPM
	(VAPOR PRESSURE <0.1 MMHG @ 25 DEGREES C.)	

PROPRIETARY MIXTURE * TRADE SECRET
EXISTING C.A.S. NOS. AVAILABLE ON ALL INGREDIENTS ON AN EMERGENCY BASIS.
THE MIXTURE CONTAINS NO KNOWN CARCINOGENS.

****

SECTION III - PHYSICAL DATA

BOILING POINT: >300 DEGREES F.

VAPOR PRESSURE: <1 MMHG @ 25 DEGREES C.
VAPOR DENSITY: (AIR=1) APPROXIMATELY 8.0
SPECIFIC GRAVITY: (WATER =1) 1.6
SOLUBILITY IN WATER: REACTS WITH WATER
PERCENT VOLATILE BY VOLUME: 5-10%
EVAPORATION RATE: (BUTYL ACETATE = 1) <1
APPEARANCE AND ODOR: BROWN LIQUID, SLIGHT AROMATIC ODOR

****

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

FLASH POINT: >300 DEGREES F.
FLAMMABLE LIMITS: N.E.
EXTINGUISHING MEDIA: USE TYPE ABC EXTINGUISHER
SPECIAL FIRE-FIGHTING PROCEDURE: FIREFIGHTERS SHOULD WEAR SELF-CONTAINED BREATHING APPARATUS IN ADDITION TO NORMAL PROTECTIVE TURNOUT CLOTHING.

UNUSUAL FIRE AND EXPLOSION HAZARDS: AVOID WATER CONTAMINATION IN CLOSED CONTAINERS OR CONFINED AREAS. (CARBON DIOXIDE EVOLVED -

MATERIAL SAFETY DATA SHEET

MASTERCAST 703 A ALTERNATIVE TO OSHA-20 FORM

****

SECTION V - HEALTH HAZARD DATA

THRESHOLD LIMIT VALUE: .02 PPM ON PMPPI, MIXTURE N.E.

EFFECTS OF ACUTE EXPOSURE:

EYES - MAY CAUSE TEARING

SKIN - MINOR IRRITATION MAY OCCUR

INHALATION - BREATHLESSNESS, SEVERE COUGHING, CHEST DISCOMFORT

EFFECTS OF CHRONIC EXPOSURE: NONE KNOWN

EMERGENCY AND FIRST AID PROCEDURES:

EYES: FLUSH WITH COPIOUS AMOUNTS OF WATER FOR 15 MINUTES; CONTACT PHYSICIAN

SKIN: WASH WITH SOAP AND WATER.

INGESTION: INDUCE VOMITING, CONTACT PHYSICIAN IMMEDIATELY.

IF ANY IRRITATION OR OTHER SYMPTOMS PERSIST, SEE A PHYSICIAN.

****

SECTION VI - CHEMICAL REACTIVITY

STABILITY: STABLE UNDER NORMAL CONDITIONS

CONDITIONS TO AVOID: AVOID TEMPERATURES ABOVE 120 DEGREES F.

INCOMPATABILITY (MATERIALS TO AVOID): WATER, STRONG BASES, ALCOHOLS, METAL COMPOUNDS

HAZARDOUS DECOMPOSITION PRODUCTS: @ 500 DEGREES F - CARBON MONOXIDE, NITROGEN OXIDES, TRACES OF HYDROGEN CYANIDE.

HAZARDOUS POLYMERIZATION: MAY OCCUR

CONDITIONS TO AVOID: CONTAMINATION BY MOISTURE, CONTAMINATED CONTAINERS SHOULD BE LEFT VENTED

****

SECTION VII - SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN: ABSORB ON ABSORBENT MATERIAL.

WASTE DISPOSAL: INCINERATE OR DISPOSE IN A HAZARDOUS WASTE LANDFILL WHICH COMPLIES WITH LOCAL, STATE, AND FEDERAL REGULATIONS. DO NOT DISCHARGE INTO PUBLIC WATERWAYS OR SEWERS.

MATERIAL SAFETY DATA SHEET

MASTERCAST 703 A ALTERNATIVE TO OSHA-20 FORM

****

SECTION VIII - SPECIAL PROTECTION AND PROCEDURES

RESPIRATORY PROTECTION: USE NIOSH APPROVED EQUIPMENT IF AIRBORNE EXPOSURE IS EXCESSIVE.

VENTILATION: FACE VELOCITY - 60 FPM; USE ONLY WITH ADEQUATE VENTILATION.

PROTECTIVE EQUIPMENT: CHEMICAL RESISTANT PROTECTIVE GLOVES; FOR EYE AND FACE PROTECTION A FACE SHIELD IS RECOMMENDED. A CHEMICAL RESISTANT APRON AND OTHER PROTECTIVE GEAR MAY BE USED AS NEEDED TO REDUCE CHANCES OF CONTACT.

****

SECTION IX - SPECIAL PRECAUTIONS

HANDLING AND STORAGE: USE GOOD INDUSTRIAL HYGIENE AND SAFETY PRACTICES EMPLOYED WITH ANY INDUSTRIAL CHEMICAL.

WORKPLACE: PRACTICE GOOD HOUSEKEEPING. CLEAN UP SPILLS PROMPTLY.

DISPOSAL: SEE WASTE DISPOSAL.

PERSONAL HYGIENE: GOOD PERSONAL HYGIENE IS MOST IMPORTANT. WASH THOROUGHLY WITH SOAP AND WATER BEFORE EATING, AFTER EACH SHIFT, OR AFTER ANY POSSIBLE CONTACT WITH PRODUCT. LAUNDER WORK CLOTHES FREQUENTLY.

NOTE: SMALL % OF POPULATION MAY DEVELOP ALLERGIC SENSITIVITY LEADING TO ASTHMA-LIKE SYMPTOMS ON SUBSEQUENT EXPOSURES BELOW THE TLV OF PMPPI.

NPCA HMIS RATING: HEALTH 2; FLAMMABILITY 1; REACTIVITY 1; PERSONAL PROTECTION F.
DUST RESPIRATORS ARE ONLY NECESSARY WHEN PERFORMING OPERATIONS SUCH AS GRINDING, MACHINING, OR POLISHING THE CAST PRODUCT.

****

SYMBOLS AND ABBREVIATIONS

N.A.: NOT APPLICABLE
N.E.: NOT ESTABLISHED
>: GREATER THAN
<: LESS THAN
C.A.S. NO.: CHEMICAL ABSTRACT SERVICE NUMBER
TLV: THPESHOLD LIMIT VALUE (UNITS)
PPM: PARTS PER MILLION
PMPPI: POLYMETHYLENE POLYPHENYL ISOCYANATE
MMHG: MILLIMETERS OF MERCURY
FPM: FEET PER MINUTE
NIOSH: NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
NPCA: NATIONAL PAINT & COATINGS ASSOCIATION
HMIS: HAZARDOUS MATERIAL IDENTIFICATION SYSTEM

REVISION DATE: 05/30/86 REVIEWED BY: TOM MCLAUGHLIN
REPLACING DATE OF: 04/30/86 APPROVED BY: JERRY WILSON

(MA P/N: 99-082-008)
PAGE 1 OF 3

MATERIAL SAFETY DATA SHEET

MASTERCAST 703 B ALTERNATIVE TO OSHA-20 FORM

MANUFACTURED FOR:
THE KINDT COLLINS COMPANY
12651 ELMWOOD AVENUE
CLEVELAND, OH 44111
(216) 252 4122

EMERGENCY INFORMATION:
ROCKY MOUNTAIN POISON AND DRUG CENTER
645 BANNOCK STREET
DENVER, COLORADO 80204-4507
EMERGENCY TELEPHONE: (303) 623-5716

SECTION I - PRODUCT IDENTIFICATION

TRADE NAME AND SYNONYMS: MASTERCAST 703 B (OR MASTERCAST 703 PART B)

CHEMICAL FAMILY: POLYETHER POLYOL SOLUTION

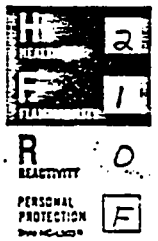
FORMULA: PROPRIETARY COMPLEX MIXTURE * TRADE SECRET

SECTION II - HAZARDOUS INGREDIENTS

(NOTE: SEE FINAL PAGE OF MSDS FOR DEFINITIONS OF ABBREVIATIONS AND SYMBOLS.)

PIGMENTS	50-70%	TLV UNITS	N.A.
CATALYST	<1%	TLV UNITS	N.E.
VEHICLE	15-25%	TLV UNITS	N.E.
SOLVENTS	5-15%	TLV UNITS	50 PPM
ADDITIVES	5-15%	TLV UNITS	.5PPM

(VAPOR PRESSURE < 0.1 MMHG @ 25 DEGREES C.)



PROPRIETARY MIXTURE * TRADE SECRET
EXISTING C.A.S. NO.S AVAILABLE ON ALL INGREDIENTS ON AN EMERGENCY BASIS.
THE MIXTURE CONTAINS NO KNOWN CARCINOGENS.

SECTION III - PHYSICAL DATA

BOILING POINT: >300 DEGREES F.
VAPOR PRESSURE: <1 MMHG @ 25 DEGREES C.
VAPOR DENSITY: (AIR=1) N.E.
SPECIFIC GRAVITY: (WATER =1) 1.6
SOLUBILITY IN WATER: 15-25%
PERCENT VOLATILE BY VOLUME: 5-10%
EVAPORATION RATE: (BUTYL ACETATE = 1) <1
APPEARANCE AND ODOR: GRAY LIQUID, SLIGHT AROMATIC ODOR

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

FLASH POINT: >300 DEGREES F.
FLAMMABLE LIMITS: N.E.
EXTINGUISHING MEDIA: USE TYPE ABC EXTINGUISHER
SPECIAL FIRE-FIGHTING PROCEDURE: FIREFIGHTERS SHOULD WEAR SELF-CONTAINED BREATHING APPARATUS IN ADDITION TO NORMAL PROTECTIVE TURNOUT CLOTHING.

MATERIAL SAFETY DATA SHEET

MASTERCAST 703 B ALTERNATIVE TO OSHA-20 FORM

****

SECTION V - HEALTH HAZARD DATA

THRESHOLD LIMIT VALUE: N.E.; 50 PPM RECOMMENDED ON MIXTURE

EFFECTS OF ACUTE EXPOSURE:

EYES - MAY CAUSE TEARING

SKIN - MINOR IRRITATION MAY OCCUR

INGESTION - N.E.

INHALATION - N.E.

EFFECTS OF CHRONIC EXPOSURE: NONE KNOWN

EMERGENCY AND FIRST AID PROCEDURES:

EYES: FLUSH WITH COPIOUS AMOUNTS OF WATER FOR 15 MINUTES; CONTACT PHYSICIAN.

SKIN: WASH WITH SOAP AND WATER.

INGESTION: INDUCE VOMITING; CONTACT PHYSICIAN IMMEDIATELY.

INHALATION: REMOVE FROM CONTAMINATED AREA; ADMINISTER OXYGEN.

IF ANY IRRITATION OR OTHER SYMPTOMS PERSIST, SEE A PHYSICIAN.

****

SECTION VI - CHEMICAL REACTIVITY

STABILITY: STABLE UNDER NORMAL CONDITIONS

CONDITIONS TO AVOID: AVOID TEMPERATURES ABOVE 120 DEGREES F.

INCOMPATABILITY (MATERIALS TO AVOID): ISOCYANATES

HAZARDOUS DECOMPOSITION PRODUCTS: SMOKE, FUMES, CARBON MONOXIDE

HAZARDOUS POLYMERIZATION: NONE KNOWN

CONDITIONS TO AVOID: CONTAMINATION BY ISOCYANATES

****

SECTION VII - SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN: ABSORB ON ABSORBENT MATERIAL.

WASTE DISPOSAL: INCINERATE OR DISPOSE IN A HAZARDOUS WASTE LANDFILL WHICH COMPLIES WITH LOCAL, STATE, AND FEDERAL REGULATIONS. DO NOT DISCHARGE INTO PUBLIC WATERWAYS OR SEWERS.

MATERIAL SAFETY DATA SHEET

MASTERCAST 703 B ALTERNATIVE TO OSHA-20 FORM

****

SECTION VIII - SPECIAL PROTECTION AND PROCEDURES

RESPIRATORY PROTECTION: USE NIOSH APPROVED EQUIPMENT IF AIRBORNE EXPOSURE IS EXCESSIVE.

VENTILATION: FACE VELOCITY - 60 FPM; USE ONLY WITH ADEQUATE VENTILATION

PROTECTIVE EQUIPMENT: CHEMICAL RESISTANT PROTECTIVE GLOVES; FOR EYE AND FACE PROTECTION A FACE SHIELD IS RECOMMENDED. A CHEMICAL RESISTANT APRON AND OTHER PROTECTIVE GEAR MAY BE USED AS NEEDED TO REDUCE CHANCES OF CONTACT.

****

SECTION IX - SPECIAL PRECAUTIONS

HANDLING AND STORAGE: USE GOOD INDUSTRIAL HYGIENE AND SAFETY PRACTICES EMPLOYED WITH ANY INDUSTRIAL CHEMICAL.

WORKPLACE: PRACTICE GOOD HOUSEKEEPING. CLEAN UP SPILLS PROMPTLY.

DISPOSAL: SEE WASTE DISPOSAL.

PERSONAL HYGIENE: GOOD PERSONAL HYGIENE IS MOST IMPORTANT. WASH THOROUGHLY WITH SOAP AND WATER BEFORE EATING, AFTER EACH SHIFT, OR AFTER ANY POSSIBLE CONTACT WITH PRODUCT. LAUNDER WORK CLOTHES FREQUENTLY.

NPCA HMIS RATING: HEALTH 2; FLAMMABILITY 1; REACTIVITY 0; PERSONAL PROTECTION F.
DUST RESPIRATORS ARE ONLY NECESSARY WHEN PERFORMING OPERATIONS SUCH AS GRINDING, MACHINING, OR POLISHING THE CAST PRODUCTS.

****

SYMBOLS AND ABBREVIATIONS

N.A.: NOT APPLICABLE
N.E.: NOT ESTABLISHED
>: GREATER THAN
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C.A.S. NO.: CHEMICAL ABSTRACT SERVICE NUMBER
TLV: THRESHOLD LIMIT VALUE (UNITS)
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FPM: FEET PER MINUTE
NIOSH: NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
NPCA: NATIONAL PAINT & COATINGS ASSOCIATION
HMIS: HAZARDOUS MATERIAL IDENTIFICATION SYSTEM

REVISION DATE: 05/30/86 REVIEWED BY: TOM MCLAUGHLIN
REPLACING DATE OF: 04/30/86 APPROVED BY: JERRY WILSON

HAPCO INC
353 Circuit Street
Hanover, MA 02339
617-826-8801

Date Issued: 4/91

MATERIAL SAFETY DATA SHEET

IDENTIFICATION

Trade Name: Ultralloy 44 A

SPECIAL REGULATORY HAZARDS

Ingredient:	CAS#:	(ACGIH TLV) Exposure Limit
4,4 Diphenylmethane Diisocyanate	000101-68-8	0.02
Other ingredients are not considered to be hazardous as defined by the Osha Hazard, found in 29 CFR 1910.1200, and are considered 'Trade Secrets' by Hapco.		--

Hazard assessment based on available data.

PHYSICAL DATA

Appearance and Odor: Amber clear/white, low viscosity liquid, slight odor

Solubility:	Water Reacts	Specific Gravity (H_2O=1)	1.1-1.2
Melting Point:	NA	Vapor Pressure @ 20°C	.0002
Boiling Point:	NA	Vapor Density (Air=1)	MT 1.0

NA= Not Applicable ND= Not Determined (opt)=optional
MT= more than LT = less than

REACTIVITY DATA

Stability: Stable

Incompatibility: Al, Zn, strong oxidizers, water, alcohols, amines, strong bases, metal compounds or surface active materials

Decomposition Products: Oxides of carbon and nitrogen under burning conditions.

FIRE AND EXPLOSION HAZARD DATA

Flash Point: MT 200°C

Extinguishing Media: CO_2 Foam, or dry chemical

Special Fire Fighting Procedures: Water may be ineffective

SPECIAL PROTECTION INFORMATION

Ventilation: May be necessary. Keep container closed when not in use.

Personal Protection: Eye protection, impervious gloves

Good housekeeping practices are recommended.

STORAGE, SPILLS AND DISPOSAL INFORMATION

Storage: Store away form sources of direct heat in a dry area.

Spills: Large spills - Dike up and pump into appropriate containers.
Small spills - Dilute with water and recover or use non-combustible absorbent material/sand and shovel into suitable containers.

Disposal: Incinerate in accordance with local, state, and federal regulations. Keep out of public water supplies.

HEALTH RELATED DATA

Specific Hazard(s): Prolonged or repeated exposure may cause irritation or other allergic responses.

Primary Route(s) of Entry: Skin contact, eye contact, inhalation

HAPCO INC
353 Circuit Street
Hanover, MA 02339
617-826-8801

Date Issued: 4/91

MATERIAL SAFETY DATA SHEET

IDENTIFICATION

Trade Name: Ultralloy 44 B

SPECIAL REGULATORY HAZARDS

Ingredient:	CAS#:	(ACGIH TLV) Exposure Limit
Substituted aromatics	68477-30-5	---

Other ingredients are not regulated and are not considered to be hazardous as defined by OSHA Hazards, found in 29 CFR 1910.1200, and are considered by Hapco, 'Trade Secrets'.

Hazard assessment based on available data.

PHYSICAL DATA

Appearance and Odor: White translucent, low viscosity liquid, slight to no odor

Solubility: Slight	Specific Gravity (H_2O=1)	1.0
Melting Point: NA	Vapor Pressure @ 20°C	MT 1
Boiling Point: ND	Vapor Density (Air=1)	ND

NA= Not Applicable ND= Not Determined (opt)=optional
MT= more than LT = less than

HEALTH RELATED DATA (cont)

First Aid Procedures:

Eye contact:	Flush with water for 15 minutes. Get medical attention.
Skin contact:	Wipe excess. Wash with rubbing alcohol, if available, followed by soap and water. Discard shoes if contaminated.
Inhalation:	Remove to fresh air.

Information given herein is offered in good faith as accurate, but without guarantee. Conditions of use and suitability of the product for particular uses are beyond our control; all risks of use of the product are therefore assumed by the user and we expressly disclaim all warranties of every kind and nature, including warranties of merchantability and fitness for a particular purpose in respect to the use or suitability of the product. Appropriate warnings and safe handling procedures should be provided to handlers and users.

REACTIVITY DATA

Stability: Stable

Incompatibility: Al, Zn, strong oxidizers, water, alcohols, amines, strong bases, metal compounds or surface active materials

Decomposition Products: Oxides of carbon and nitrogen under burning conditions.

FIRE AND EXPLOSION HAZARD DATA

Flash Point: MT 200°C

Extinguishing Media: CO_2 Foam, or dry chemical

Special Fire Fighting Procedures: Water may be ineffective

SPECIAL PROTECTION INFORMATION

Ventilation: May be necessary. Keep container closed when not in use.

Personal Protection: Eye protection, impervious gloves

Good housekeeping practices are recommended.

STORAGE, SPILLS AND DISPOSAL INFORMATION

Storage: Store away form sources of direct heat in a dry area.

Spills: Large spills - Dike up and pump into appropriate containers.
Small spills - Dilute with water and recover or use non-combustible absorbent material/sand and shovel into suitable containers.

Disposal: Incinerate in accordance with local, state, and federal regulations. Keep out of public water supplies.

HEALTH RELATED DATA

Specific Hazard(s): Prolonged or repeated exposure may cause irritation or other allergic responses.

Primary Route(s) of Entry: Skin contact, eye contact, inhalation

HEALTH RELATED DATA (cont)

First Aid Procedures:

Eye contact:	Flush with water for 15 minutes. Get medical attention.
Skin contact:	Wipe excess. Wash with rubbing alcohol, if available, followed by soap and water. Discard shoes if contaminated.
Inhalation:	Remove to fresh air.

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HAPCO INC
353 Circuit Street
Hanover, MA 02339
617-826-8801

Date Issued: 4/91

MATERIAL SAFETY DATA SHEET

IDENTIFICATION

Trade Name: Ultralloy 45 B

SPECIAL REGULATORY HAZARDS

Ingredient:	CAS#:	(ACGIH TLV) Exposure Limit
Substituted aromatics	68477-30-6	---

Other ingredients are not regulated and are not considered to be hazardous as defined by OSHA Hazards, found in 29 CFR 1910.1200, and are considered by Hapco, 'Trade Secrets'.

Hazard assessment based on available data.

PHYSICAL DATA

Appearance and Odor: White translucent, low viscosity liquid, slight to no odor

Solubility: Slight		Specific Gravity (H_2O=1)	1.0
Melting Point: NA		Vapor Pressure @ 20°C	MT 1
Boiling Point: ND		Vapor Density (Air=1)	ND

NA= Not Applicable ND= Not Determined (opt)=optional
MT= more than LT = less than

REACTIVITY DATA

Stability: Stable

Incompatibility: Strong oxidizing agents

Decomposition Products: Oxides of carbon and nitrogen under burning conditions.

FIRE AND EXPLOSION HAZARD DATA

Flash Point: MT 125°C

Extinguishing Media: CO_2 Foam, or dry chemical

Special Fire Fighting Procedures: Water may be ineffective

SPECIAL PROTECTION INFORMATION

Ventilation: May be necessary. Keep container closed when not in use.

Personal Protection: Eye protection, impervious gloves

Good housekeeping practices are recommended.

STORAGE, SPILLS AND DISPOSAL INFORMATION

Storage: Store away form sources of direct heat in a dry area.

Spills: Large spills - Dike up and pump into appropriate containers.
Small spills - Dilute with water and recover or use non-combustible absorbent material/sand and shovel into suitable containers.

Disposal: Incinerate in accordance with local, state, and federal regulations. Keep out of public water supplies.

HEALTH RELATED DATA

Specific Hazard(s): Prolonged or repeated exposure may cause irritation or other allergic responses.

Primary Route(s) of Entry: Skin contact, eye contact, inhalation

HEALTH RELATED DATA (cont)

First Aid Procedures:

Eye contact:	Flush with water for 15 minutes. Get medical attention.
Skin contact:	Wipe excess. Wash with rubbing alcohol, if available, followed by soap and water. Discard shoes if contaminated.
Inhalation:	Remove to fresh air.

Information given herein is offered in good faith as accurate; but without guarantee. Conditions of use and suitability of the product for particular uses are beyond our control: all risks of use of the product are therefore assumed by the user and we expressly disclaim all warranties of every kind and nature, including warranties of merchantability and fitness for a particular purpose in respect to the use or suitability of the product. Appropriate warnings and safe handling procedures should be provided to handlers and users.

MATERIAL SAFETY DATA SHEET

MC-X 01046 (3-85)

SPEC./MSDS NUMBER	DATE
200	05-09-88

PRODUCT IDENTIFICATION

TRADE NAME: PLAZ-TEC	GENERIC NAME: WOLLASTONITE, SURFACE MODIFIED
MANUFACTURER'S NAME: J & J CORPORATION	CAS NUMBER: 13983-17-0
ADDRESS (STREET): 4301 6TH STREET SW	PHONE NUMBER (EMERGENCY): (319) 366-8666
CITY: CEDAR RAPIDS STATE: IOWA ZIP: 52404	CHEMICAL STRUCTURE: $CaSiO_3$ CALCIUM METASILICATE

I • PRODUCT INGREDIENTS

CHEMICAL AND/OR COMMON NAME	CAS NUMBER	%	TLV/PEL
PROPRIETARY TREATMENTS	NOT APPLICABLE	1	NOT APPLICABLE
WOLLASTONITE	13983-17-0	99	NONE ASSIGNED
TREAT AS NUISANCE DUST, TLV= 10mg/m³, 8HR. TWA (TOTAL DUST)			

II • PHYSICAL DATA

DESCRIPTION: ACICULAR, FREE FLOWING, NON-METALLIC MINERAL POWDER

SOLUBILITY IN WATER	SPECIFIC GRAVITY	PERCENT VOLATILE	MELTING POINT
0.01 gm/100cc (wollastonite)	2.9	LESS THAN 1WT. %	1540° C

APPEARANCE AND ODOR: WHITE POWDER, FAINT ODOR

III • FIRE AND EXPLOSION DATA

FLASH POINT	FLAMMABLE LIMITS	FLAMMABLE LIMITS	LEL	UEL
NONE		NONE		

EXTINGUISHING MEDIA: NOT APPLICABLE

SPECIAL FIREFIGHTING PROCEDURES: NOT APPLICABLE

UNUSUAL FIRE OR EXPLOSION HAZARDS: NOT APPLICABLE

IV • HEALTH HAZARD INFORMATION

HAZARD BY ROUTES OF EXPOSURE

INHALATION: LONG-TERM CUMULATIVE INHALATION OF HEAVY CONCENTRATIONS OF WOLLASTONITE MAY CAUSE RESTRICTION OF THE LARGE AIRWAYS.

INGESTION: NONE KNOWN

EYE: NONE KNOWN

SKIN CONTACT/ABSORPTION: MAY CAUSE MINOR SKIN IRRITATION

SIGNS AND SYMPTOMS ASSOCIATED WITH EXPOSURE OVER TLV: NO TLV ASSIGNED

MEDICAL CONDITIONS WHICH MAY BE AGGRAVATED: NONE KNOWN

ANY OF PART I LISTED AS CARCINOGENS? (NTP, IARC, OSHA)

NO

V • HEALTH HAZARD INFORMATION (Continued)

EMERGENCY/FIRST AID PROCEDURES

INHALATION
INHALE FRESH AIR

INGESTION
NONE KNOWN

EYE CONTACT
FLUSH EYES THOROUGHLY. IF IRRITATION PERSISTS, SEE A PHYSICIAN.

SKIN CONTACT
GENTLY WASH WITH SOAP AND WATER. IF IRRITATION PERSISTS, SEE A PHYSICIAN.

SKIN ABSORPTION
NONE KNOWN

VI • RECOMMENDATIONS FOR HANDLING

RESPIRATORY PROTECTION
USE OF AN APPROVED RESPIRATOR FOR NUISANCE DUST IS RECOMMENDED.

EYE PROTECTION
USE OF SAFETY GOGGLES IS RECOMMENDED.

PROTECTIVE GLOVES
USE OF GLOVES IS RECOMMENDED.

OTHER PROTECTIVE CLOTHING/EQUIPMENT
PROTECTION OF SKIN FROM EXPOSURE IS RECOMMENDED.

VENTILATION REQUIREMENTS
MECHANICAL VENTILATION IS RECOMMENDED TO MAINTAIN A DUST-FREE WORK PLACE.

VII • REACTIVITY DATA

STABILITY	CONDITIONS TO AVOID
SURFACE TREATMENTS MAY OXIDIZE OR DECOMPOSE AT ELEVATED TEMPERATURES.	NONE KNOWN.

DECOMPOSITION PRODUCTS
BURNING MAY PRODUCE MINOR AMOUNTS OF OXIDES OF CARBON, SILICON, NITROGEN OR SULFER.

VIII • CLEAN UP AND DISPOSAL

STEPS TO BE TAKEN IF MATERIAL IS SPILLED
SWEEP OR SHOVEL AND PLACE IN A SUITABLE CONTAINER.

WASTE DISPOSAL METHOD
TO COMPLY WITH FEDERAL, STATE AND LOCAL REGULATIONS.

RCRA REGULATED	RCRA NUMBER	CERCLA (Superfund) REPORTABLE QUANTITY	
☐ Yes ☒ No	NONE	NONE	
DOT REGULATED	**DOT PROPER SHIPPING NAME**	**DOT HAZARD CLASS**	**DOT NUMBER**
☐ Yes ☒ No	WOLLASTONITE	NONE	13983-17-0

IX • SPECIAL PRECAUTIONS

SPECIAL PRECAUTIONS FOR HANDLING AND STORAGE
KEEP DRY AND COOL IN ORIGINAL SHIPPING CONTAINERS UNTIL USE.

OTHER PRECAUTIONS
NONE KNOWN

PREPARED BY	PHONE NO	TITLE
KENNETH J. SOLLMAN	(518) 963-4262	HEALTH AND SAFETY OFFICER

While the information and recommendations set forth herein are believed to be accurate as of the date hereof, THE MANUFACTURER MAKES NO WARRANTY WITH RESPECT THERETO AND DISCLAIMS ALL LIABILITY FROM RELIANCE THEREON

XB 5149

MATERIAL SAFETY DATA SHEET

CIBA-GEIGY CORPORATION FURANE PRODUCTS 5121, SAN FERNANDO ROAD WEST LOS ANGELES, CALIFORNIA 900391	EMERGENCY PHONE NUMBERS: SAFETY/HEALTH: (818) 247-6210 24 HOURS: (800) 888-8372

****

SECTION I IDENTITY

****

PRODUCT NAME:
XB 5149 (FORMERLY CG 2117 HC)

PRODUCT CODE:
FPC6030

CHEMICAL NAME OR SYNONYMS:
Acrylate ester blend

MSDS CODE:
DL1288

DATE ISSUED:
03/09/92

HAZARD RATING:
TOXICITY: 2 FIRE: 1 REACTIVITY: 2 SPECIAL:

4 = EXTREME; 3 = HIGH; 2 = MODERATE; 1 = SLIGHT; 0 = SIGNIFICANT;
* = SEE SECTION V;

****

SECTION II INGREDIENT

****

CHEMICAL IDENTITY	CAS NO:	OCCUPATIONAL EXPOSURE TLV LIMITS FPC	OSHA	ACGIH
Aliphatic urethane acrylate resin	TRD SECRET	NE	NE	NE
Dimethacrylate ester	TRD SECRET	NE	NE	NE
Diacrylate ester	TRD SECRET	NE	NE	NE

These chemicals are not considered to be carcinogenic by NTP, IARC, or OSHA.
COMMENTS: NE - NOT ESTABLISHED.

****

SECTION III PHYSICAL PROPERTIES

****

APPEARANCE AND ODOR:
Clear colorless to faint yellow color liquid, Acrylate odor

VISCOSITY:
~3,000 @ 25° C

VAPOR PRESSURE (mm Hg):
< 1 @ 20° C

VAPOR DENSITY (AIR = 1):
> 1

SOLUBILITY IN WATER:
Insoluble

XB 5149

PERCENT VOLATILE (BY WEIGHT):
~0.5
SPECIFIC GRAVITY (WATER = 1):
1.14
EVAPORATION RATE (BUTYL ACETATE = 1):
< 1

****
SECTION IV FIRE AND EXPLOSION HAZARD INFORMATION
****

FLASH POINT:
129° C Closed Cup
EXTINGUISHING MEDIA:
Foam, CO_2, Dry chemical, Water.
SPECIAL FIRE FIGHTING PROCEDURES:
Wear breathing apparatus (MSHA/NIOSH-approved, pressure demand, self-contained or equivalent.) and full protective gear.
UNUSUAL FIRE AND EXPLOSION HAZARDS:
Heat/Inhibitor depilation/Exposure to radiation/oxidizers can cause spontaneous polymerization generating heat and pressure. Sealed containers can explodes. Decomposition and combustion products may be toxic. Avoid the use of a stream of water to control fire since frothing can occur.

****
SECTION V HEALTH HAZARD INFORMATION
****

PRIMARY ROUTES OF EXPOSURE:
Dermal and Inhalation
EFFECT OF OVEREXPOSURE:
INHALATION:
Vapor or mist can cause irritation to the nose and throat.
EYE CONTACT:
Liquid or vapor can cause substantial irritation to eyes.
SKIN CONTACT:
Substance can cause moderate irritation to skin.
INGESTION:
Possibly harmful if swallowed.
DELAYED EFFECTS:
Prolonged or repeated exposure can cause central nervous depression, nausea, headache and dizziness. Also, substance can cause allergic reaction.
MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE:
Allergy, eczema or skin conditions.
EMERGENCY AND FIRST AID PROCEDURES:
INHALATION:
Move subject to fresh air. Give artificial respiration if breathing has stopped.

EYE AND SKIN CONTACT:
Flush eyes with large amount of water for at least 15 minutes. Get prompt medical attention. Wash skin thoroughly with soap and water. Remove and wash clothing before reuse.
INGESTION:
If swallowed dilute by giving 2 glasses of water to drink. See a physician. Never give anything by mouth to an unconscious person.

****
SECTION VI REACTIVITY INFORMATION
****
STABILITY:
Unstable
CONDITION TO AVOID:
Heat, direct Sunlight
HAZARDOUS DECOMPOSITION PRODUCTS:
Carbon monoxide, carbon dioxide, oxides of nitrogen
HAZARDOUS POLYMERIZATION:
May occur.
CONDITION TO AVOID HAZARDOUS POLYMERIZATION:
Heat, UV radiation, free radical initiators, inert gases
INCOMPATIBILITY (MATERIALS TO AVOID):
Strong oxidizing materials, inert gases.
****
SECTION VII SPILL AND LEAK PROCEDURE INFORMATION
****
STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED:
Evacuate the spill area. Wear protective clothing. Dike and absorb spill with inert material. Transfer to containers suitable for disposal. Remove contaminated clothing promptly and wash affected skin areas with soap and water. If spill on a porous surface, ground water contamination must be considered.
WASTE DISPOSAL METHODS:
Incinerate liquid; landfill or incinerate contaminated diking material in accordance with local, state, and federal regulations.
****
SECTION VIII SPECIAL PROTECTION INFORMATION
****
VENTILATION TYPE:
Mechanical local exhaust ventilation at point of contaminant release.
RESPIRATORY PROTECTION:
Wear respirator (MSHA/NIOSH-approved) suitable for concentrations and types of air contaminants encountered.
PROTECTIVE GLOVES:
Impervious gloves
EYE PROTECTION:
Chemical splash goggles (ANSI Z-87.1)
OTHER PROTECTIVE EQUIPMENT:
Protective clothing, eyewash facility, safety shower.

****
SECTION IX STORAGE AND HANDLING INFORMATION
****
STORAGE TEMPERATURE:
MAXIMUM 35° C
Avoid all skin contact. May cause allergic reaction. Store indoors in a cool, dry area with adequate ventilation. Store out of direct Sunlight. PLEASE READ TECHNICAL DATA SHEET BEFORE HANDLING THIS PRODUCT.
****
SECTION X TOXICITY INFORMATION
****
IRRITATION:
EYES - Substantial
SKIN - Moderate
****
SECTION XI MISCELLANEOUS INFORMATION
****
NOTE TO PHYSICIAN:
Allergic dermatitis or respiratory response in susceptible individuals may be delayed. It may appear after weeks or even months of frequent and prolonged contact.
DOT/IATA SHIPPING/PACKAGING INFORMATION:
DOT PROPER SHIPPING NAME:
Not Restricted, Plastic Liquids
DOT HAZARD CLASS:
Not Regulated
DOT/UN NUMBER:
Not Available
PACKAGING GROUP:
Not Applicable
RCRA STATUS:
Not a hazardous waste under RCRA (40 CFR 261)
CERCLA STATUS:
Not listed
SARA TITLE III - TOXIC CHEMICAL LIST:
This product does not contain toxic chemicals subject to the routine annual "Toxic Chemical Release Notification" under Section 313 (40 CFR 372).
PENNSYLVANIA RIGHT TO KNOW ACT:
The following is required composition information.
This product contains:
(1) Aliphatic urethane acrylate resin (TRD SECRET)
(2) Dimethacrylate ester (TRD SECRET)
(3) Diacrylate ester (TRD SECRET)
TOXIC SUBSTANCE CONTROL ACT (TSCA):
INVENTORY STATUS:
Chemical components listed on TSCA inventory.

XB 5149

CALIFORNIA SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT RULE 443.1:
VOLATILE ORGANIC COMPOUNDS:

This product contains 6 mg/liter volatile Organic Compounds. VOC is Based on Theoratical calculation.

ISSUE DATE: 03/09/92 REVISION: 00M SUPERSEDES DATE: NA
ISSUED BY: RAJESH S. PATEL
FOR FURTHER INFORMATION, PLEASE CONTACT: PRODUCT SAFETY DIRECTOR

****

IMPORTANT MESSAGE!!!
THE INFORMATION CONTAINED HEREIN IS BASED ON DATA CONSIDERED ACCURATE. HOWEVER, NO WARRANTY IS EXPRESSED OR IMPLIED REGARDING THE ACCURACY OF THESE DATA OR THE RESULTS TO BE OBTAINED FROM THE THEREOF.

CIBA-GEIGY CORPORATION ASSUMED NO RESPONSIBILITY FOR PERSONAL INJURY OR PROPERTY DAMAGE TO VENDEES, USERS, OR THIRD PARTIES CAUSED BY THE MATERIAL. SUCH VENDEES OR USERS ASSUME ALL RISKS ASSOCIATED WITH THE USE OF THE MATERIAL.

****

HAZARD STATEMENT!!!
THIS MATERIAL SAFETY DATA SHEET (MSDS) HAS BEEN PREPARED IN COMPLIANCE WITH THE FEDERAL OSHA HAZARD COMMUNICATION STANDARD 29 CFR 1910.1200.

THIS PRODUCT IS CONTINUED TO BE A HAZARDOUS CHEMICAL UNDER THAT STANDARD.

****

MATERIAL SAFETY DATA SHEET

CIBA-GEIGY CORPORATION FORMULATED SYSTEMS GROUP 4917 DAWN AVE EAST LANSING, MI 48823 (517) 351-5900	EMERGENCY PHONE NUMBER: (800) 888-8372

SECTION I-IDENTITY INFORMATION

IDENTITY (TRADENAME): REN SHAPE (R) 450

FAMILY/CHEMICAL NAME:
CURED POLYURETHANE
PRODUCT TYPE:
MODELING STOCK
IMPORTANT:

```
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
*     THIS MATERIAL WILL NOT BE SOLD FOR USE IN PRODUCTS  *
* FOR WHICH PROLONGED CONTACT WITH MUCOUS MEMBRANES OR    *
* ABRADED SKIN, OR IMPLANTATION WITHIN THE HUMAN BODY, IS *
* SPECIFICALLY INTENDED.  BECAUSE OF THE WIDE RANGE OF    *
* SUCH POTENTIAL USES, CIBA-GEIGY CORPORATION IS NOT ABLE *
* TO RECOMMEND THIS MATERIAL AS SAFE AND EFFECTIVE FOR    *
* SUCH USES AND ASSUMES NO LIABILITY FOR ANY SUCH USES.   *
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
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HAZARD STATEMENT :

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* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
*      THIS MATERIAL SAFETY DATA SHEET (MSDS) HAS BEEN    *
*  PREPARED IN COMPLIANCE WITH THE FEDERAL OSHA HAZARD    *
*  COMMUNICATION STANDARD 29 CFR 1910.1200.               *
*      THIS PRODUCT IS NOT CONSIDERED TO BE A HAZARDOUS   *
*  CHEMICAL UNDER THAT STANDARD.                          *
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
```

SECTION III-PHYSICAL DATA

APPEARANCE:
BROWN SOLID.
PERCENT VOLATILE:
0%
0 GRAMS/LITER VOC (STATE OF CALIFORNIA)
SOLUBILITY IN WATER:

REN SHAPE (R) 450

INSOLUBLE.
SPECIFIC GRAVITY:
0.67 (WATER = 1)

---------- SECTION IV-FIRE AND EXPLOSION HAZARD DATA ----------

EXTINGUISHING MEDIA:
CARBON DIOXIDE, DRY CHEMICAL, FOAM, WATER.
FIRE FIGHTING PROCEDURES-SPECIAL:
USE SELF-CONTAINED BREATHING APPARATUS.
UNUSUAL FIRE AND EXPLOSION HAZARDS:
DECOMPOSITION AND COMBUSTION PRODUCTS MAY BE TOXIC.

---------- SECTION V-REACTIVITY DATA ----------

STABILITY:
STABLE.
CONDITIONS TO AVOID:
EXCESSIVE HEAT FOR PROLONGED PERIODS OF TIME.
INCOMPATIBILITY:
STRONG OXIDIZERS, ACIDS AND BASES.
HAZARDOUS DECOMPOSITION PRODUCTS:
COMBUSTION MAY FORM TOXIC MATERIALS. CARBON MONOXIDE, CARBON DIOXIDE, BENZENE, TOLUENE, OXIDES OF NITROGEN, HYDROGEN CYANIDE.
HAZARDOUS POLYMERIZATION:
WILL NOT OCCUR.

---------- SECTION VI-HEALTH HAZARD DATA ----------

PRIMARY ROUTES OF EXPOSURE:
DERMAL OR INHALATION
THRESHOLD LIMIT VALUE:
THIS ARTICLE IS NOT CONSIDERED TO BE HAZARDOUS.
EYE IRRITATION:
DUST DUE TO MACHINING MAY CAUSE IRRITATION.
OVEREXPOSURE EFFECTS:
CURED POLYURETHANE RESINS ARE PRACTICALLY INERT SUBSTANCES WITH NO DEGREE OF TOXICITY.
MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE:
SKIN AND EYE CONDITIONS.
EMERGENCY AND FIRST AID PROCEDURES-EYES:
IMMEDIATELY FLUSH EYES WITH WATER FOR AT LEAST 15 MINUTES. CALL A PHYSICIAN.
EMERGENCY AND FIRST AID PROCEDURES-SKIN:
WASH WITH SOAP AND WATER. REMOVE CONTAMINATED CLOTHING AND LAUNDER BEFORE RE-USE.
EMERGENCY AND FIRST AID PROCEDURES-INGESTION:
IF CONSCIOUS, GIVE PLENTY OF WATER TO DRINK. DO NOT INDUCE VOMITING. CALL A PHYSICIAN.
EMERGENCY AND FIRST AID PROCEDURES-INHALATION:
REMOVE TO FRESH AIR. GIVE OXYGEN AND/OR ARTIFICIAL RESPIRATION, IF NEEDED. CALL A PHYSICIAN.

REN SHAPE (R) 450

EMERGENCY AND FIRST AID PROCEDURES-OTHER:
REFERRAL TO A PHYSICIAN IS RECOMMENDED IF THERE IS ANY QUESTION ABOUT THE SERIOUSNESS OF ANY INJURY.

SECTION VII-SPILL OR LEAK PROCEDURES

SPILL PROCEDURES:
SWEEP UP INTO APPROVED DISPOSAL CONTAINER.
THOROUGHLY VACUUM AREA. DO NOT CREATE DUSTY CONDITION.
WASTE DISPOSAL METHODS:
CONSULT QUALIFIED LOCAL OR CORPORATE PERSONNEL FOR METHOD THAT WILL COMPLY WITH LOCAL, STATE AND FEDERAL HEALTH AND ENVIRONMENTAL REGULATIONS.

SECTION VIII-SPECIAL PROTECTION INFORMATION

VENTILATION:
GENERAL MECHANICAL AND LOCAL EXHAUST IN ACCORDANCE WITH ACGIH RECOMMENDATIONS.
PROTECTIVE GLOVES:
WEAR GLOVES AS A STANDARD HANDLING PROCEDURE.
EYE PROTECTION:
WEAR CHEMICAL GOGGLES TO PROTECT AGAINST DUST PARTICLES.
RESPIRATORY PROTECTION:
USE NIOSH APPROVED DUST MASK, IF REQUIRED.

SECTION IX-SPECIAL PRECAUTIONS

HMIS CODE:
HEALTH : 0 FIRE : 1 REACTIVITY : 0
HANDLING, SHIPPING AND STORING PRECAUTIONS:
CAUTION AVOID DUSTY CONDITIONS. USE WITH ADEQUATE VENTILATION. AVOID BREATHING DUST. IN ACCORD WITH GOOD INDUSTRIAL PRACTICE, HANDLE WITH DUE CARE. AVOID CONTACT WITH EYES, SKIN, AND CLOTHING. WASH THOROUGHLY AFTER HANDLING.

HANDLING PRECAUTIONS:
NUISANCE DUST MAY BE GENERATED WHEN SANDING OR SAWING CURED MATERIAL.

SECTION X- REGULATORY INFORMATION

DOT PROPER SHIPPING NAME:
SOLID PLASTIC MASS, N.O.I.
DOT CLASS:
NOT REGULATED.
RCRA STATUS:
NOT A HAZARDOUS WASTE UNDER RCRA (40 CFR 261).
SARA/TITLE III - TOXIC CHEMICALS LIST:
THIS PRODUCT DOES NOT CONTAIN A TOXIC CHEMICAL FOR ROUTINE ANNUAL 'TOXIC CHEMICAL RELEASE REPORTING' UNDER SEC. 313 (40 CFR 372).

REN SHAPE (R) 450

TSCA INVENTORY STATUS:
CHEMICAL COMPONENTS LISTED ON TSCA INVENTORY.
PENNSYLVANIA RIGHT-TO-KNOW ACT:
THE FOLLOWING IS REQUIRED COMPOSITION INFORMATION.

CHEMICAL NAME	:	SPECIFIC CHEMICAL IDENTITY OF THIS COMPONENT IS BEING WITHHELD AS TRADE SECRET.
GENERIC NAME	:	CURED POLYURETHANE BOARD.
COMMENTS	:	NOT ON PENNSYLVANIA HAZARDOUS SUBSTANCE LIST.

* * *

ISSUE DATE: 12/10/88 REVISION: 04C ISSUED BY: M. MUNSELL
FOR FURTHER INFORMATION, PLEASE CONTACT: PRODUCT SAFETY DIR

THE INFORMATION AND RECOMMENDATIONS CONTAINED HEREIN ARE BASED UPON DATA BELIEVED TO BE CORRECT. HOWEVER, NO GUARANTEE OR WARRANTY OF ANY KIND EXPRESSED OR IMPLIED IS MADE WITH RESPECT TO THE INFORMATION CONTAINED HEREIN.

REN SHAPE (R) 450

APPENDIX C

IMPACT ABRASION TEST DATA SHEETS

Impact Abrasion Test Data Sheet

Material: CIBA-GEIGY 6414-3

Material Coding Name: CG6414_3

Sample 1:	**Grams**	**%WL**	**Sample 2:**	**Grams**	**%WL**
Start weight:	4.4977		Start weight:	4.1261	
4 Hours:	4.4842	.3002	4 Hours:	4.1153	.2617
8 Hours:	4.4705	.6048	8 Hours:	4.0959	.7319
12 Hours:	4.4558	.9316	12 Hours:	4.0826	1.0543

Sample Average:	**Grams**
Start weight:	4.3119
4 Hours:	4.2998
8 Hours:	4.2832
12 Hours:	4.2692

Time	**% of Start Weight**	**% Weight Loss**
4 Hours	**99.7194%**	**.2806%**
8 Hours	**99.3344%**	**.6656%**
12 Hours	**99.0097%**	**.9903%**

Impact Abrasion Test Data Sheet

Material: CIBA-GEIGY TDP 186-1

Material Coding Name: CGTDP186

Sample 1:	**Grams**	**%WL**	**Sample 2:**	**Grams**	**%WL**
Start weight:	4.4258		Start weight:	4.3552	
4 Hours:	4.3955	.6846	4 Hours:	4.3253	.6865
8 Hours:	4.3718	1.2201	8 Hours:	4.3015	1.2330
12 Hours:	4.3299	2.1668	12 Hours:	4.2657	2.0550

Sample Average:	**Grams**
Start weight:	4.3905
4 Hours:	4.3604
8 Hours:	4.3367
12 Hours:	4.2978

Time	**% of Start Weight**	**% Weight Loss**
4 Hours	**99.3144%**	**.6856%**
8 Hours	**98.7746%**	**1.2254%**
12 Hours	**97.8886%**	**2.1114%**

Impact Abrasion Test Data Sheet

Material: URALITE 3156 from Hexcel

Material Coding Name: URAL3156

Sample 1:	**Grams**	**%WL**	**Sample 2:**	**Grams**	**%WL**
Start weight:	4.3097		Start weight:	4.4737	
4 Hours:	4.2826	.6288	4 Hours:	4.4484	.5655
8 Hours:	4.2587	1.1834	8 Hours:	4.4306	.9634
12 Hours:	4.2257	1.9491	12 Hours:	4.3868	1.9425

Sample Average:	**Grams**
Start weight:	4.3917
4 Hours:	4.3655
8 Hours:	4.3447
12 Hours:	4.3063

Time	**% of Start Weight**	**% Weight Loss**
4 Hours	**99.4034%**	**.5966%**
8 Hours	**98.9298%**	**1.0702%**
12 Hours	**98.0554%**	**1.9446%**

Impact Abrasion Test Data Sheet

Material: URALITE 3160 from Hexcel

Material Coding Name: URAL3160

Sample 1:	**Grams**	**%WL**	**Sample 2:**	**Grams**	**%WL**
Start weight:	4.4609		Start weight:	4.0848	
4 Hours:	4.4255	.7936	4 Hours:	4.0483	.8936
8 Hours:	4.3974	1.4235	8 Hours:	4.0265	1.4272
12 Hours:	4.3495	2.4973	12 Hours:	3.9945	2.2106

Sample Average:	**Grams**
Start weight:	4.2729
4 Hours:	4.2369
8 Hours:	4.2120
12 Hours:	4.1720

Time	**% of Start Weight**	**% Weight Loss**
4 Hours	**99.1575%**	**.8425%**
8 Hours	**98.5747%**	**1.4253%**
12 Hours	**97.6386%**	**2.3614%**

Impact Abrasion Test Data Sheet

Material: URALITE 3500 from Hexcel

Material Coding Name: URAL3500

Sample 1:	**Grams**	**%WL**	**Sample 2:**	**Grams**	**%WL**
Start weight:	4.4205		Start weight:	4.2757	
4 Hours:	4.3959	.5565	4 Hours:	4.2428	.7695
8 Hours:	4.3553	1.4749	8 Hours:	4.2144	1.4337
12 Hours:	4.3256	2.1468	12 Hours:	4.1989	1.7962

Sample Average:	**Grams**
Start weight:	4.3481
4 Hours:	4.3194
8 Hours:	4.2849
12 Hours:	4.2623

Time	**% of Start Weight**	**% Weight Loss**
4 Hours	**99.3399%**	**.6601%**
8 Hours	**98.5465%**	**1.4535%**
12 Hours	**98.0267%**	**1.9733%**

Impact Abrasion Test Data Sheet

Material: URALITE 3501 from Hexcel

Material Coding Name: URAL3501

Sample 1:	**Grams**	**%WL**	**Sample 2:**	**Grams**	**%WL**
Start weight:	4.5068		Start weight:	4.1705	
4 Hours:	4.4786	.6257	4 Hours:	4.1556	.3573
8 Hours:	4.4502	1.2559	8 Hours:	4.1468	.5683
12 Hours:	4.4302	1.6997	12 Hours:	4.1294	.9855

Sample Average:	**Grams**
Start weight:	4.3387
4 Hours:	4.3171
8 Hours:	4.2985
12 Hours:	4.2798

Time	**% of Start Weight**	**% Weight Loss**
4 Hours	**99.5022%**	**.4978%**
8 Hours	**99.0735%**	**.9265%**
12 Hours	**98.6425%**	**1.3575%**

Impact Abrasion Test Data Sheet

Material: URALITE 3502 from Hexcel

Material Coding Name: URAL3502

Sample 1:	**Grams**	**%WL**	**Sample 2:**	**Grams**	**%WL**
Start weight:	4.2192		Start weight:	4.3178	
4 Hours:	4.2021	.4053	4 Hours:	4.2878	.6948
8 Hours:	4.1915	.6565	8 Hours:	4.2585	1.3734
12 Hours:	4.1651	1.2822	12 Hours:	4.2356	1.9037

Sample Average:	**Grams**
Start weight:	4.2685
4 Hours:	4.2450
8 Hours:	4.2250
12 Hours:	4.2004

Time	**% of Start Weight**	**% Weight Loss**
4 Hours	**99.4495%**	**.5505%**
8 Hours	**98.9809%**	**1.0191%**
12 Hours	**98.4046%**	**1.5954%**

Impact Abrasion Test Data Sheet

Material: URALITE 3503 from Hexcel

Material Coding Name: URAL3503

Sample 1:	**Grams**	**%WL**	**Sample 2:**	**Grams**	**%WL**
Start weight:	4.1190		Start weight:	3.8769	
4 Hours:	4.0984	.5001	4 Hours:	3.8631	.3560
8 Hours:	4.0582	1.4761	8 Hours:	3.8517	.6500
12 Hours:	4.0253	2.2748	12 Hours:	3.8404	.9415

Sample Average:	**Grams**
Start weight:	3.9980
4 Hours:	3.9808
8 Hours:	3.9550
12 Hours:	3.9329

Time	**% of Start Weight**	**% Weight Loss**
4 Hours	**99.5698%**	**.4302%**
8 Hours	**98.9245%**	**1.0755%**
12 Hours	**98.3717%**	**1.6283%**

Impact Abrasion Test Data Sheet

Material: URALITE 3530 from Hexcel

Material Coding Name: URAL3530

Sample 1:	**Grams**	**%WL**	**Sample 2:**	**Grams**	**%WL**
Start weight:	4.5612		Start weight:	4.3164	
4 Hours:	4.5334	.6095	4 Hours:	4.2675	1.1329
8 Hours:	4.5096	1.1313	8 Hours:	4.2370	1.8395
12 Hours:	4.4673	2.0587	12 Hours:	4.1786	3.1925

Sample Average:	**Grams**
Start weight:	4.4388
4 Hours:	4.4005
8 Hours:	4.3733
12 Hours:	4.3230

Time	**% of Start Weight**	**% Weight Loss**
4 Hours	**99.1372%**	**.8628%**
8 Hours	**98.5244%**	**1.4756%**
12 Hours	**97.3912%**	**2.6088%**

Impact Abrasion Test Data Sheet

Material: URALITE 3534 from Hexcel

Material Coding Name: URAL3534

Sample 1:	**Grams**	**%WL**	**Sample 2:**	**Grams**	**%WL**
Start weight:	4.3279		Start weight:	3.9923	
4 Hours:	4.3199	.1848	4 Hours:	3.9735	.4709
8 Hours:	4.3108	.3951	8 Hours:	3.9688	.5886
12 Hours:	4.2891	.8965	12 Hours:	3.9422	1.2549

Sample Average:	**Grams**
Start weight:	4.1601
4 Hours:	4.1467
8 Hours:	4.1398
12 Hours:	4.1157

Time	**% of Start Weight**	**% Weight Loss**
4 Hours	**99.6779%**	**.3221%**
8 Hours	**99.5120%**	**.4880%**
12 Hours	**98.9327%**	**1.0673%**

Impact Abrasion Test Data Sheet

Material: CONATHANE TU-900 from Conap

Material Coding Name: COPTU900

Sample 1:	**Grams**	**%WL**	**Sample 2:**	**Grams**	**%WL**
Start weight:	3.8594		Start weight:	4.0469	
4 Hours:	3.8552	.1088	4 Hours:	4.0427	.1038
8 Hours:	3.8506	.2280	8 Hours:	4.0378	.2249
12 Hours:	3.8459	.3498	12 Hours:	4.0333	.3361

Sample Average:	**Grams**
Start weight:	3.9532
4 Hours:	3.9489
8 Hours:	3.9442
12 Hours:	3.9396

Time	**% of Start Weight**	**% Weight Loss**
4 Hours	**99.8912%**	**.1088%**
8 Hours	**99.7723%**	**.2277%**
12 Hours	**99.6560%**	**.3440%**

Impact Abrasion Test Data Sheet

Material: CONATHANE TU-956 from Conap

Material Coding Name: COPTU956

Sample 1:	**Grams**	**%WL**	**Sample 2:**	**Grams**	**%WL**
Start weight:	4.1456		Start weight:	4.4112	
4 Hours:	4.1415	.0984	4 Hours:	4.4069	.0975
8 Hours:	4.1363	.2243	8 Hours:	4.4016	.2176
12 Hours:	4.1305	.3642	12 Hours:	4.3949	.3695

Sample Average:	**Grams**
Start weight:	4.2784
4 Hours:	4.2742
8 Hours:	4.2689
12 Hours:	4.2627

Time	**% of Start Weight**	**% Weight Loss**
4 Hours	**99.9018%**	**.0982%**
8 Hours	**99.7780%**	**.2220%**
12 Hours	**99.6330%**	**.3670%**

Impact Abrasion Test Data Sheet

Material: CONATHANE TU-961 from Conap

Material Coding Name: COPTU961

Sample 1:	**Grams**	**%WL**	**Sample 2:**	**Grams**	**%WL**
Start weight:	4.4546		Start weight:	4.4184	
4 Hours:	4.4367	.4018	4 Hours:	4.3966	.4934
8 Hours:	4.4209	.7565	8 Hours:	4.3776	.9234
12 Hours:	4.3897	1.4569	12 Hours:	4.3516	1.5119

Sample Average:	**Grams**
Start weight:	4.4365
4 Hours:	4.4167
8 Hours:	4.3993
12 Hours:	4.3707

Time	**% of Start Weight**	**% Weight Loss**
4 Hours	**99.5537%**	**.4463%**
8 Hours	**99.1615%**	**.8385%**
12 Hours	**99.5168%**	**1.4832%**

Impact Abrasion Test Data Sheet

Material: CONATHANE TU-981 from Conap

Material Coding Name: COPTU981

Sample 1:	**Grams**	**%WL**	**Sample 2:**	**Grams**	**%WL**
Start weight:	4.1594		Start weight:	3.9570	
4 Hours:	4.1382	.5097	4 Hours:	3.9368	.5105
8 Hours:	4.1154	1.0578	8 Hours:	3.9152	1.0564
12 Hours:	4.0978	1.4810	12 Hours:	3.8984	1.4809

Sample Average:	**Grams**
Start weight:	4.0582
4 Hours:	4.0375
8 Hours:	4.0153
12 Hours:	3.9981

Time	**% of Start Weight**	**% Weight Loss**
4 Hours	**99.4899%**	**.5101%**
8 Hours	**98.9429%**	**1.0571%**
12 Hours	**98.5190%**	**1.4810%**

Impact Abrasion Test Data Sheet

Material: HAPFLEX 595 from Hapco

Material Coding Name: HPF595

Sample 1:	**Grams**	**%WL**	**Sample 2:**	**Grams**	**%WL**
Start weight:	4.4341		Start weight:	4.4734	
4 Hours:	4.3963	.8525	4 Hours:	4.4603	.2928
8 Hours:	4.3856	1.0938	8 Hours:	4.4536	.4426
12 Hours:	4.3795	1.2314	12 Hours:	4.4404	.7377

Sample Average:	**Grams**
Start weight:	4.4538
4 Hours:	4.4283
8 Hours:	4.4196
12 Hours:	4.4100

Time	**% of Start Weight**	**% Weight Loss**
4 Hours	**99.4275%**	**.5725%**
8 Hours	**99.2321%**	**.7679%**
12 Hours	**99.0166%**	**.9834%**

Impact Abrasion Test Data Sheet

Material: HAPFLEX 595 HP from Hapco

Material Coding Name: HPF595HP

Sample 1:	**Grams**	**%WL**	**Sample 2:**	**Grams**	**%WL**
Start weight:	4.3519		Start weight:	4.3648	
4 Hours:	4.3342	.4067	4 Hours:	4.3501	.3392
8 Hours:	4.3245	.6296	8 Hours:	4.3363	.6554
12 Hours:	4.3083	1.0019	12 Hours:	4.3175	1.0861

Sample Average:	**Grams**
Start weight:	4.3584
4 Hours:	4.3422
8 Hours:	4.3304
12 Hours:	4.3129

Time	**% of Start Weight**	**% Weight Loss**
4 Hours	**99.6283%**	**.3717%**
8 Hours	**99.3576%**	**.6424%**
12 Hours	**98.9560%**	**1.0440%**

Impact Abrasion Test Data Sheet

Material: HAPFLEX 665 from Hapco

Material Coding Name: HPF665

Sample 1:	**Grams**	**%WL**	**Sample 2:**	**Grams**	**%WL**
Start weight:	4.4741		Start weight:	4.5319	
4 Hours:	4.4416	.7264	4 Hours:	4.5115	.4501
8 Hours:	4.4273	1.0460	8 Hours:	4.4773	1.2048
12 Hours:	4.3944	1.7814	12 Hours:	4.4502	1.8028

Sample Average:	**Grams**
Start weight:	4.5030
4 Hours:	4.4766
8 Hours:	4.4523
12 Hours:	4.4223

Time	**% of Start Weight**	**% Weight Loss**
4 Hours	**99.4137%**	**.5863%**
8 Hours	**98.8741%**	**1.1259%**
12 Hours	**98.2079%**	**1.7921%**

Impact Abrasion Test Data Sheet

Material: HAPFLEX 665 HP from Hapco

Material Coding Name: HPF665HP

Sample 1:	**Grams**	**%WL**	**Sample 2:**	**Grams**	**%WL**
Start weight:	4.3217		Start weight:	4.4621	
4 Hours:	4.3181	.0833	4 Hours:	4.4382	.5356
8 Hours:	4.2968	.5762	8 Hours:	4.4189	.9682
12 Hours:	4.2744	1.0945	12 Hours:	4.3763	1.9229

Sample Average:	**Grams**
Start weight:	4.3919
4 Hours:	4.3782
8 Hours:	4.3579
12 Hours:	4.3254

Time	**% of Start Weight**	**% Weight Loss**
4 Hours	**99.6881%**	**.3119%**
8 Hours	**99.2258%**	**.7742%**
12 Hours	**98.4858%**	**1.5142%**

Impact Abrasion Test Data Sheet

Material: HAPCAST 3730/7 from Hapco

Material Coding Name: HP3730_7

Sample 1:	**Grams**	**%WL**	**Sample 2:**	**Grams**	**%WL**
Start weight:	10.0536		Start weight:	9.7970	
4 Hours:	9.9655	.8763	4 Hours:	9.6905	1.0871
8 Hours:	9.8861	1.6661	8 Hours:	9.6246	1.7597
12 Hours:	9.8257	2.2668	12 Hours:	9.5701	2.3160

Sample Average:	**Grams**
Start weight:	9.9253
4 Hours:	9.8280
8 Hours:	9.7554
12 Hours:	9.6979

Time	**% of Start Weight**	**% Weight Loss**
4 Hours	**99.0197%**	**.9803%**
8 Hours	**98.2882%**	**1.7118%**
12 Hours	**97.7089%**	**2.2911%**

Impact Abrasion Test Data Sheet

Material: HAPCOAT 597 from Hapco

Material Coding Name: HPCT597

Sample 1:	**Grams**	**%WL**	**Sample 2:**	**Grams**	**%WL**
Start weight:	4.4453		Start weight:	4.7630	
4 Hours:	4.4342	.2497	4 Hours:	4.7514	.2435
8 Hours:	4.4224	.5152	8 Hours:	4.7403	.4766
12 Hours:	4.4073	.8548	12 Hours:	4.7203	.8965

Sample Average:	**Grams**
Start weight:	4.6042
4 Hours:	4.5928
8 Hours:	4.5814
12 Hours:	4.5638

Time	**% of Start Weight**	**% Weight Loss**
4 Hours	**99.7524%**	**.2476%**
8 Hours	**99.5048%**	**.4952%**
12 Hours	**99.1225%**	**.8775%**

Impact Abrasion Test Data Sheet

Material: HAPCOAT 667 from Hapco

Material Coding Name: HPCT667

Sample 1:	**Grams**	**%WL**	**Sample 2:**	**Grams**	**%WL**
Start weight:	4.7866		Start weight:	4.7015	
4 Hours:	4.7699	.3489	4 Hours:	4.6742	.5807
8 Hours:	4.7385	1.0049	8 Hours:	4.6457	1.1869
12 Hours:	4.6953	1.9074	12 Hours:	4.6121	1.9015

Sample Average:	**Grams**
Start weight:	4.7441
4 Hours:	4.7221
8 Hours:	4.6921
12 Hours:	4.6537

Time	**% of Start Weight**	**% Weight Loss**
4 Hours	**99.5363%**	**.4637%**
8 Hours	**98.9039%**	**1.0961%**
12 Hours	**98.0945%**	**1.9055%**

Impact Abrasion Test Data Sheet

Material: HAPCAST 5730 from Hapco

Material Coding Name: HPCS5730

Sample 1:	**Grams**	**%WL**	**Sample 2:**	**Grams**	**%WL**
Start weight:	5.9419		Start weight:	5.8627	
4 Hours:	5.8405	1.7065	4 Hours:	5.8034	1.0115
8 Hours:	5.7516	3.2027	8 Hours:	5.7232	2.3794
12 Hours:	5.6984	4.0980	12 Hours:	5.6401	3.7969

Sample Average:	**Grams**
Start weight:	5.9023
4 Hours:	5.8220
8 Hours:	5.7374
12 Hours:	5.6693

Time	**% of Start Weight**	**% Weight Loss**
4 Hours	**98.6395%**	**1.3605%**
8 Hours	**97.2062%**	**2.7928%**
12 Hours	**96.0524%**	**3.9476%**

Impact Abrasion Test Data Sheet

Material: 301/308 EPOXICAL from U.S. GYPSUM

Material Coding Name: EPOXICAL

Sample 1:	**Grams**	**%WL**	**Sample 2:**	**Grams**	**%WL**
Start weight:	4.9507		Start weight:	5.3588	
4 Hours:	4.8811	1.4059	4 Hours:	5.2710	1.6384
8 Hours:	4.8205	2.6299	8 Hours:	5.1921	3.1108
12 Hours:	4.7855	3.3369	12 Hours:	5.1070	4.6988

Sample Average:	**Grams**
Start weight:	5.1548
4 Hours:	5.0761
8 Hours:	5.0063
12 Hours:	4.9463

Time	**% of Start Weight**	**% Weight Loss**
4 Hours	**98.4733%**	**1.5267%**
8 Hours	**97.1192%**	**2.8808%**
12 Hours	**95.9552%**	**4.0448%**

Impact Abrasion Test Data Sheet

Material: MASTER CAST 703 from Kindt-Collins

Material Coding Name: MASTR703

Sample 1:	**Grams**	**%WL**	**Sample 2:**	**Grams**	**%WL**
Start weight:	6.2124		Start weight:	6.5286	
4 Hours:	6.1427	1.1219	4 Hours:	6.4664	.9527
8 Hours:	6.1050	1.7288	8 Hours:	6.4037	1.9131
12 Hours:	6.0595	2.4612	12 Hours:	6.3526	2.6958

Sample Average:	**Grams**
Start weight:	6.3705
4 Hours:	6.3046
8 Hours:	6.2544
12 Hours:	6.2061

Time	**% of Start Weight**	**% Weight Loss**
4 Hours	**98.9655%**	**1.0345%**
8 Hours	**98.1775%**	**1.8225%**
12 Hours	**97.4194%**	**2.5806%**

Impact Abrasion Test Data Sheet

Material: ULTRALLOY 40 from Hapco

Material Coding Name: ULTRAL40

Sample 1:	**Grams**	**%WL**	**Sample 2:**	**Grams**	**%WL**
Start weight:	4.6496		Start weight:	4.6355	
4 Hours:	4.4669	3.9294	4 Hours:	4.5505	1.8337
8 Hours:	4.3151	7.1942	8 Hours:	4.4105	4.8538
12 Hours:	4.1663	10.3944	12 Hours:	4.3266	6.6638

Sample Average:	**Grams**
Start weight:	4.6412
4 Hours:	4.5087
8 Hours:	4.3628
12 Hours:	4.2465

Time	**% of Start Weight**	**% Weight Loss**
4 Hours	**97.1451%**	**2.8549%**
8 Hours	**94.0016%**	**5.9984%**
12 Hours	**91.4957%**	**9.5043%**

Impact Abrasion Test Data Sheet

Material: ULTRALLOY 50 from Hapco

Material Coding Name: ULTRAL50

Sample 1:	**Grams**	**%WL**	**Sample 2:**	**Grams**	**%WL**
Start weight:	4.6645		Start weight:	4.7258	
4 Hours:	4.5046	3.4280	4 Hours:	4.6158	2.3276
8 Hours:	4.3703	6.3072	8 Hours:	4.5105	4.5558
12 Hours:	4.2797	8.2495	12 Hours:	4.4145	6.5872

Sample Average:	**Grams**
Start weight:	4.6952
4 Hours:	4.5602
8 Hours:	4.4404
12 Hours:	4.3471

Time	**% of Start Weight**	**% Weight Loss**
4 Hours	**97.1247%**	**2.8753%**
8 Hours	**94.5732%**	**5.4268%**
12 Hours	**92.5860%**	**7.4140%**

Impact Abrasion Test Data Sheet

Material: PLAZ-TEC CERAMIC COMPOSITE from J&J Corp.

Material Coding Name: CERAMIC

Sample 1:	**Grams**	**%WL**	**Sample 2:**	**Grams**	**%WL**
Start weight:	7.2754		Start weight:	7.2213	
4 Hours:	7.2184	.7835	4 Hours:	7.1541	.9306
8 Hours:	7.1661	1.5023	8 Hours:	7.1069	1.5842
12 Hours:	7.0866	2.5950	12 Hours:	7.0483	2.3957

Sample Average:	**Grams**
Start weight:	7.2484
4 Hours:	7.1863
8 Hours:	7.1365
12 Hours:	7.0675

Time	**% of Start Weight**	**% Weight Loss**
4 Hours	**99.1433%**	**.8567%**
8 Hours	**98.4562%**	**1.5438%**
12 Hours	**97.5043%**	**2.4957%**

Impact Abrasion Test Data Sheet

Material: PLAZ-TEC FIBERGLASS CERAMIC from J&J Corp.

Material Coding Name: FIBERCER

Sample 1:	**Grams**	**%WL**	**Sample 2:**	**Grams**	**%WL**
Start weight:	5.2422		Start weight:	5.1329	
4 Hours:	5.1680	1.4154	4 Hours:	5.0445	1.7222
8 Hours:	5.0557	3.5577	8 Hours:	4.9574	3.4191
12 Hours:	4.9994	4.6316	12 Hours:	4.8874	4.7829

Sample Average:	**Grams**
Start weight:	5.1876
4 Hours:	5.1063
8 Hours:	5.0066
12 Hours:	4.9434

Time	**% of Start Weight**	**% Weight Loss**
4 Hours	**98.4328%**	**1.5672%**
8 Hours	**96.5109%**	**3.4891%**
12 Hours	**95.2926%**	**4.7074%**

Impact Abrasion Test Data Sheet

Material: PHOTOPOLYMER LMB 5086 from Ciba-Geigy

Material Coding Name: LMB5086

Sample 1:	**Grams**	**%WL**	**Sample 2:**	**Grams**	**%WL**
Start weight:	4.5708		Start weight:	4.5653	
4 Hours:	4.5258	.9845	4 Hours:	4.5105	1.2004
8 Hours:	4.4856	1.8640	8 Hours:	4.4652	2.1926
12 Hours:	4.4170	3.3648	12 Hours:	4.4008	3.6033

Sample Average:	**Grams**
Start weight:	4.5681
4 Hours:	4.5182
8 Hours:	4.4754
12 Hours:	4.4089

Time	**% of Start Weight**	**% Weight Loss**
4 Hours	**98.9076%**	**1.0924%**
8 Hours	**97.9707%**	**2.0293%**
12 Hours	**96.5150%**	**3.4850%**

Impact Abrasion Test Data Sheet

Material: RENSHAPE from Ciba-Geigy

Material Coding Name: RENSHAPE

Sample 1:	**Grams**	**%WL**	**Sample 2:**	**Grams**	**%WL**
Start weight:	2.7040		Start weight:	2.6854	
4 Hours:	2.6493	2.0229	4 Hours:	2.6568	1.0650
8 Hours:	2.5922	4.1346	8 Hours:	2.6046	3.0089
12 Hours:	2.5464	5.8284	12 Hours:	2.5284	5.8464

Sample Average:	**Grams**
Start weight:	2.6947
4 Hours:	2.6531
8 Hours:	2.5984
12 Hours:	2.5374

Time	**% of Start Weight**	**% Weight Loss**
4 Hours	**98.4562%**	**1.5438%**
8 Hours	**96.4263%**	**3.5737%**
12 Hours	**94.1626%**	**5.8374%**

Impact Abrasion Test Data Sheet

Material: AISI 1020 LOW CARBON STEEL

Material Coding Name: AISI1020

Sample 1:	**Grams**	**%WL**	**Sample 2:**	**Grams**	**%WL**
Start weight:	32.5832		Start weight:	31.3188	
4 Hours:	32.5809	.0071	4 Hours:	31.3169	.0061
8 Hours:	32.5788	.0135	8 Hours:	31.3118	.0224
12 Hours:	32.5729	.0316	12 Hours:	31.3091	.0310

Sample Average:	**Grams**
Start weight:	31.9510
4 Hours:	31.9489
8 Hours:	31.9453
12 Hours:	31.9410

Time	**% of Start Weight**	**% Weight Loss**
4 Hours	**99.9934%**	**.0066%**
8 Hours	**99.9822%**	**.0178%**
12 Hours	**99.9687%**	**.0313%**

Impact Abrasion Test Data Sheet

Material: 304 STAINLESS STEEL

Material Coding Name: SS304

Sample 1:	**Grams**	**%WL**	**Sample 2:**	**Grams**	**%WL**
Start weight:	28.1174		Start weight:	28.0050	
4 Hours:	28.1131	.0153	4 Hours:	28.0015	.0125
8 Hours:	28.1108	.0235	8 Hours:	27.9986	.0229
12 Hours:	28.1086	.0313	12 Hours:	27.9964	.0307

Sample Average:	**Grams**
Start weight:	28.0612
4 Hours:	28.0573
8 Hours:	28.0547
12 Hours:	28.0525

Time	**% of Start Weight**	**% Weight Loss**
4 Hours	**99.9861%**	**.0139%**
8 Hours	**99.9768%**	**.0232%**
12 Hours	**99.9690%**	**.0310%**

Impact Abrasion Test Data Sheet

Material: SILICON BRONZE

Material Coding Name: SILIBRON

Sample 1:	**Grams**	**%WL**	**Sample 2:**	**Grams**	**%WL**
Start weight:	32.8718		Start weight:	33.0597	
4 Hours:	32.8203	.1567	4 Hours:	33.0108	.1479
8 Hours:	32.7906	.2470	8 Hours:	32.9699	.2716
12 Hours:	32.7574	.3480	12 Hours:	32.9353	.3763

Sample Average:	**Grams**
Start weight:	32.9658
4 Hours:	32.9156
8 Hours:	32.8803
12 Hours:	32.8464

Time	**% of Start Weight**	**% Weight Loss**
4 Hours	**99.8477%**	**.1523%**
8 Hours	**99.7406%**	**.2594%**
12 Hours	**99.6378%**	**.3622%**

Impact Abrasion Test Data Sheet

Material: CLASS 30 GRAY IRON

Material Coding Name: CASTIRON

Sample 1:	**Grams**	**%WL**	**Sample 2:**	**Grams**	**%WL**
Start weight:	28.5813		Start weight:	30.0221	
4 Hours:	28.5737	.0266	4 Hours:	30.0098	.0410
8 Hours:	28.5624	.0661	8 Hours:	29.9932	.0963
12 Hours:	28.5553	.0910	12 Hours:	29.9801	.1399

Sample Average:	**Grams**
Start weight:	29.3017
4 Hours:	29.2918
8 Hours:	29.2778
12 Hours:	29.2677

Time	**% of Start Weight**	**% Weight Loss**
4 Hours	**99.9662%**	**.0338%**
8 Hours	**99.9184%**	**.0816%**
12 Hours	**99.8840%**	**.1160%**

APPENDIX D

SLOPE COMPARISONS OF REMAINING MATERIALS