CHEMICAL SYSTEMS LABORATORY CONTRACTOR REPORT

ARCSL-CR-80057

ALTERNATE MATERIALS EVALUATION FOR XM-29 GAS MASK

FINAL REPORT

JULY 1980

ILC DOVER
BOX 266
Frederica, Delaware 19946

Contract DAAK11-79-C-0050

US ARMY ARMAMENT RESEARCH AND DEVELOPMENT COMMAND
Chemical Systems Laboratory
Aberdeen Proving Ground, Maryland 21010

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This report covers the evaluation of polyurethane elastomers for use as a lens in the XM-29 Gas Masks. The physical and chemical properties of several commercially available polyurethane resins and adhesives are presented. Thermoplastic polyethers showed the most promise among the polyurethanes investigated, and an Epon/Versamid adhesive showed the most promise among adhesives tested.

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PREFACE

The work performed for this development was required by contract DAAK11-79-C-0050, entitled "Alternate Materials Evaluation for XM-29 Gas Mask". It was carried out from March 1979 to March 1980.

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ALTERNATE MATERIALS EVALUATION FOR XM-29 GAS MASK

1. INTRODUCTION

This program was funded to investigate alternate materials with the objectives as stated below. The development effort expended in the performance of the contract has proven the feasibility of fabrication of acceptable gas masks from thermoplastic urethanes.

2. OBJECTIVES

The objectives of this program were as follows: (1) A major effort was to be directed to the study of materials for use in the XM-29 mask with the stated goal of eliminating all secondary post-molding operations other than hardware installation. (2) Concurrent with the materials investigation a similar effort was aimed at alternative modes of manufacture (separate lens and face-piece) based upon the characteristics of the specific materials being evaluated.

3. MATERIALS INVESTIGATION

Both material suppliers and processors were contacted to discuss the requirements of the XM-29 program. Both casting and molding grades were discussed. Details of these meetings are included in the trip reports in appendix A.

Of all the types of polyurethane elastomers commercially available, the thermoplastic polyether appeared to have the most promise. In an effort to obtain a lower durometer (softer) mask, two aliphatic polyethers were evaluated. Neither aliphatic resin could be used because the molded parts would not retain their shape after molding. One of these aliphatics was obtained from K. J. Quinn and the second was obtained from Bayer Fabrik.

Aromatic polyethers were evaluated from Uniroyal, Upjohn, and Mobay. All suppliers were able to provide materials which produced optical quality lenses with good clarity.

When the haze and light transmission was determined, the haze values exceeded the maximum allowed. After considerable experimentation, a procedure was developed to reduce the haze to acceptable values. This procedure involved a surface cleaning following a heating cycle and an ice water quench. The detailed procedure is defined in appendix B.

The theory has been advanced that the haze observed in the lenses after molding is caused by the mold release incorporated in the molding compound by the resin supplier. This mold release exudes to the surface of the part during molding and aids in the release of the part from the mold. Any residual release compound still in the part after molding can be expected to exude to the surface of the part when it is exposed to elevated temperatures. While this mold release is required in the resins that are available today, the polyurethane resin industry is progressing at such a rate that this hazing problem will diminish.

A transfer mold was obtained from Chemical Systems Laboratories which was modified for use as an injection mold. This mold was used to produce an injection molded polyurethane unimask. The resulting masks showed promise, but severe flashing occured during molding. Flash was excessive near the areas where inserts were placed in the molds such as the ends of the straps on the facepiece and around the metal inserts. This flashing precluded the "packing" found to be necessary to obtain satisfactory optics with polyurethane. Three urethane resins and a fluorosilicone were molded. The fluorosilicone, GE FS-Z620U, is an opaque elastomer that is reported to be agent resistant. Attempts to mold this compound were unsuccessful because the temperature required for cure of the compound exceeded the heating capacity of the tool. After a number of abortive attempts to mold a gas mask, the effort was discontinued.

One final attempt was made to obtain good optics by "packing" the mold. Packing is accomplished by injecting an excessive quantity of material into the mold and maintaining a high following pressure during the molding cycle. The flashing of the material was too much to produce good optics in the mask.

Transfer molding usually is used where the material being molded is a reactive material which cures to the configuration of the mold. In most cases heat is added to the mold to complete the cure. In injection molding, molten (plasticized) material is injected into a cool or cold mold and the material freezes into the configuration of the mold. It had been hoped that the transfer mold could be adapted for injection molding and in fact the mold did work well enough to prove feasibility of injection molding of urethane unimasks.

4 ADHESIVE DEVELOPMENT

In conjunction with the materials investigation, a program to develop an adhesive system which would provide a reliable method of attaching a polyurethane lens to a silicone rubber facepiece was initiated.

Adhesive suppliers were contacted for recommendations for adhesives and prebonding surface treatments. This search resulted in establishing a screening program for the candidate adhesives. Molded silicone slabs were obtained and polyurethane lenses of two thicknesses were molded. The free-flip mold resulted in lens thickness of .1 inch and the vari-view mold produced lenses of .08 inch thickness.

4.1 Surface Preparation

Prebonding surface preparations that were considered were:

(1) Solvent clean

(2) Abrasion

(3) Flame treating

(4) Plasma arc

(5) Corona discharge

Combinations of the above cleaning methods were also evaluated.

4.2 Adhesive Evaluation

A wide variety of adhesives were investigated, epoxies, urethanes and silicones. Some of the adhesives which were screened were: GE RTV 118, SWS RTV 951, Amicon TV 909, Resiweld 7004A, Epon 828/Versamid 125. The Epon/Versamid system showed the most promise and 25 masks were assembled and delivered to Chemical Systems Laboratories for evaluation.

5. DISCUSSION OF RESULTS

Performance of this contract resulted in the following findings:

(1) Optical quality lenses can be fabricated from thermoplastic resins. Lenses of optical quality were fabricated in two thicknesses of .08 inch and .1 inch. The molds used had been designed and fabricated to be used with polycarbonate, but the resulting lenses met or exceeded the light transmission and haze requirements established for the XM-29 mask. Both lenses exceeded the minimum of thickness required for agent resistance of .070 inch and as a result were stiffer than an optimum thickness lens would be. While stiffness is approximately a linear function of thickness for a given material, it is difficult to predict whether the additional 14 percent reduction in thickness will provide the valsalva capability required by the Air Force.

(2) Urethane lenses can be installed in peripheries of lower durometer. In the case of installation of urethane lenses into silicone peripheries, adhesives can be used successfully. An adhesive system can be used with other thermoset elastomers as well. In the instance where a thermoplastic periphery might be used, the lenses can be installed by welding or bonding.

(3) Thermoplastic polyurethanes can be molded into a satisfactory unimask. The urethane evaluations performed with the transfer mold have verified that the flow characteristics of polyurethane will fill a mold of the complexity of the unimask, and the material is of sufficient strength to be successfully demolded. The lenses molded in the polycarbonate injection molds were of excellent optical quality.

An injection mold designed for polyurethane to take advantage of its tensile strength and agent resistance would result in a lower weight mask.

This, coupled with polyurethane's significantly lower price, will result in a large cost reduction from either an all-silicone mask or a silicone periphery and urethane lens.

6 RECOMMENDATIONS

An injection mold should be specifically designed to mold polyurethane. Such a mold would incorporate reduced cross-sections wherever possible, specifically in the straps, face seal, and lens area. This reduced thickness will result in greater mask flexibility and weight. Also, continued evaluation of new, softer urethanes for unimasks should be followed. Investigate the possibility of injection molding softer urethanes for facepieces and installing urethane lenses in same.

APPENDIX A

CONFERENCE AND TRIP REPORTS

TRIP REPORT

TO: Chemical Systems Laboratories
USARRADCOM
Aberdeen Proving Grounds, MD 21010

DATE: April 3, 1979

On April 3, 1979 a conference was held at Edgewood Arsenal. Chemical Systems Laboratories, to discuss schedule and requirements for the urethane mask.

At that time, the requirements were for ILC Dover to deliver 25 mask assemblies plus 100 additional lenses during May and June, 1979. The mask assemblies were to be ILC fabricated lenses installed in GFM silicone peripheries. This delivery schedule would allow evalation tests to begin in June and be completed by August 31, 1979. Selection of vendor was to be made by September 30, 1979.

The Prototype mask was reviewed and the following deficiencies were discussed:

(1) Thickness of Lens -- The optical tool for the Free-Flip lens had been used to fabricate the first prototype lenses and the lens thickness was .1 inch. The thickness in itself would not have been objectionable except that the polyurethane is significantly harder (Shore A85) than the silicone (Shore A65). Since the agent resistance of the urethane would allow a lens thickness of as low as .065 inch, plans were made to mold lenses in a thinner mold.

(2) Blooming -- Plans were made to determine the cause of the blooming that was observed in the molded parts and develop a method to eliminate same.

(3) Discoloration from UV Exposure -- Polyurethane has a tendency to turn yellow during prolonged exposure to ultraviolet light. This characteristic is inherent in the base polymer and can be minimized by incorporating an ultraviolet stabilizer in the material.

TRIP REPORT

TO: Upjohn Company
CPR Division
410 Sackett Point Road
North Haven, CT 06473

DATE: April 4, 1979

A conference was held with personnel from Upjohn Company to discuss availability of materials and facilities for supporting the gas mask program.

APPENDIX A

TRIP REPORT

TO: K. J. Quinn & Company, Inc.
195 Canal Street
Malden, MA 02148

DATE: May 8, 1979

A trip was made to K. J. Quinn & Company, Inc. to discuss available materials to support the gas mask program. A sample of their PE 192, which had been flat die extruded was obtained. Their main application for this material is to laminate the urethane with glass to make bullet-proof glazing.

Quinn makes the Aliphatic in both ester and ether types. PE 192 is representative of the ether type, and compared to the ester type, exhibits less tear resistance but will not embrittle.

Since it is a member of the Aliphatic family, it enjoys the advantages, compared to the Aromatic family, of being very clear optically, superior in light stability, and long-term physical properties. Where the Aromatic will discolor, the Aliphatic will not discolor from UV (Ultra-Violet).

A further advantage of Aliphatic PE 192 is its inherent low durometer of Shore A75, the sample of which seams appreciably soft to the hand compared to the other urethanes. The physicals of the Aliphatic ether are as follows:

Tensile:	4500 psi
Modulus:	2100 psi at 300% Elongation
Total Elongation:	700% Overall
Tear Resistance:	Excellent
Light:	Excellent (Minimum 1,000 hours)
Cold:	-85°F
Hot:	180°F to 200°F

The only apparent drawback to the Aliphatic urethane is the area of the effect of UV on the polymer. Apparently with prolonged exposure of UV in excess of 1,000 hours, the material will begin to craze. It should be pointed out that the Vendor relates 100 hours in a lab Fadometer, (UV Flux) is equal to 1,200 hours or one year in the field. It is the oxidation in the UV Flux that precipitates the breakdown of the polymer in the form of crazing.

PE 192 is amenable to injection moding, but is a more difficult molding material in that it is inherently stickier, needs more time to set, and results in a longer molding cycle than the Aromatic urethanes.

APPENDIX A

TRIP REPORT

TO: Nypro Incorporated
101-T Union Street
Clinton, MA 01510

DATE: May 9, 1979

Nypro was included in our itinerary because of their reputation in injection molding. This company is indeed a first class injection molding house with unlimited machine capabilities. They are custom molders of high caliber precision parts to medical specifications and can handle extremely close tolerances. Most of their equipment is highly automated and the plant very well organized.

They seemed very interested in working with us on this project, and stated that they have had considerable experience with the softer grades (70 to 80 durometer). They routinely injection mold rigid urethane parts, however, and are willing to investigate schedule of June 4, 1979 through June 14, 1979.

APPENDIX A

TRIP REPORT

TO: Stevens Elastomeric & Plastic Products, Inc.
A Subsidiary of J. P. Stevens & Co., Inc.
6 Payson Avenue
Easthampton, MA 01027

DATE: May 10, 1979

Stevens Elastomeric are urethane molders and work with proprietary urethanes as delivered by Mobay, Upjohn, etc., and therefore, would be willing to injection-mold the K. J. Quinn PE 192 for us. They stated very candidly that the molding of soft durometer urethanes, such as the Aliphatics, presented problems in that it is a sticky material and can be difficult to cycle.

They have had good experience with the 80 to 85 durometer urethanes, but are nontheless willing to shoot the Quinn material for us. During the visit, Stevens personnel stated that Uniroyal E85SL is an aromatic of 85A Durometer, which thay have worked with and found to be very clear due to the fact that it uses no lubricant in the compound.

It is their opinion that neither Mobay or Upjohn has a 70A durometer with good optical clarity. They have a 300-ton press available with some open time, but they will require both the Woodland tool with the Quinn resin as soon as possible. They have open time now and for the next two weeks when he is currently sampling for someone else, and will advise accordingly upon our firm inquiry. They estimate their involvement for two to three daytime days.

Stevens also recommends Upjohn 2363-80AE and Mobay Texin MD85A, both of which are of medical grade and contain a low lubricant content resulting in good optical clarity. They also have a 12" x 12" test plate that is gauge-adjustable down to .060".

This is a center sprue mold with adjustable plates for gauge thickness and could be used to produce injection-mold flat stock. Since they also can extrude urethane in 18" wide sheets, they suggest investigating the thermoforming of a compound-curvature lens from sheet stock in a secondary operation. They will check to see if they have suitable plates for the above mold that can be polished for high optical clarity for a cost of approximately $250 if we are interested in working with sheet stock.

APPENDIX A

TRIP REPORT

TO: Upjohn Company
CPR Division
410 Sackett Point Road
North Haven, CT 06473

DATE: May 10, 1979

It is Upjohn's opinion that the 2103-80A shot that we did in Denver is not representative of the best results to be had from that polymer. The use of a better dryer of a dehumidifying hopper-type with -20°F capabilities is required, and that the material should be shot hotter than was used in Denver.

He said that Upjohn can go to about a 70 durometer but this is not a stable number and is tricky. 80 Durometer is more likely and safer. 2103-80A is recommended for our purpose. They cannot go into other grades nor modify the 2103 for us due to cost-economics of such a small run. He did state that it is possible to drop the durometer 5 Short A points by post-curing the lenses at 115°C for four hours in dry heat. However, he feels this would probably start the yellowing process. Upjohn cannot control the yellowing; it comes from the isocyonate that they purchase.

On the subject of Aliphatics, he feels that they are very unstable for UV during oxidation and confirms that 100 hours in QUV is the standard and equals 1,200 hours or one year in the field. The UV stability of Hylene W (DuPont). Upjohn states that the Aliphatics are presently only a laboratory investigation. Upjohn recommends, therefore, that we use 2103-80A but simply get it hotter and drier. It will not be possible for us to use the Upjohn laboratories this summer due to the fact that their schedule is too tight. They do not want to add any UV brightener since they feel it adds a new variable. Besides their lab is jammed and they feel that the 2103-80A is representative. Perhaps later they might be able to make a special run with additives to improve color. This would be a blue die aimed to correct the yellowness it now exhibits.

Upjohn also recommends a method to improve optics by shooting into a vapor-honed surface mold, then flame-polishing or THF solvent-polishing the part. This will smooth out the surface of the product and add clarity. This seems to be a labor intensive secondary operation to me.

They also suggested that urethane gas masks should be sealed in nitrogen in their storage cannisters to help with yellowing (aging) problem. It will not be necessary for us to order more material from them since we have enough in Frederica to ship to Woodland Tool for the trial run.

APPENDIX A

TRIP REPORT

TO: Mobay Chemical Company
Parkway W. & RTS. 22-30
Pittsburgh, PA 15205

DATE: May 11, 1979

Mobay has open time in their lab right now and will be happy to run 250 lbs. of their material on site at their Pittsburgh lab. They need only a Purchase Order for the 250 lbs. of their recommended Texin 985A. Its estimated cost is $2 per lb. in a 250 lb. lot.

They feel that a standard polyether with UV stabilizers should do as well for optics. They likewise agree that the soft durometer of 80A presents problems during injection-molding due to their stickiness and resultant cooling cycle. They admit to only limited experience with Aliphatics on the UV parameter, but estimate that they are probably OK for 1,200 hours before the crazing begins.

They plan to add a stabilizer system to their stock 985A and will modify the release agents to address the blomming problem.

APPENDIX A

TRIP REPORT

TO: Chemical Systems Laboratories
USARRADCOM
Aberdeen Proving Grounds, MD 21010

DATE: June 15, 1979

Our first prototype urethane/silicone mask was delivered. The urethane came from a .080" Vari View. Their comments included the following:

a.)	Appearance	-- Very Good	(Both MSA & Sierra have a flat straight line at the bottom of their visors where ours is scalloped around the hardware. The concensus was that ours had a better appearance).
b.)	Bend	-- Excellent	
c.)	Flexibility	--	The .080" urethane demonstrated much better flexibility than the previous .100" urethane from the Free-Flip. The .080" urethane is still less flexible than the silicone. A lower durometer urethane in the .080" thickness may be the answer.
d.)	Optics	-- Poor	The urethane visor had considerable cloudiness and some distortion.

APPENDIX A

TRIP REPORT

TO: Mobay Chemical Company
Parkway W. & RTS 22-30
Pittsburgh, PA 15205

DATE: July 12 & 13, 1979

The trip to Mobay was important for the following reasons:

Mobay arranged for us to witness the Vari-View mold being shot with a medical grade of Texin MD85A. This urethane has less lubricant that the standard 990A compound, and is therefore subject to less haze and blooming in the molded part. The engineer in charge, did the set-up and ran the shots. By late afternoon on July 12, 1979, the set-up was stabilized and the lenses shot from the 990A started looking good. It appeared to me that the haze was a little heavy or at least heavier than the Woodland shot. He then gradually introduced the MD85A without purging the 990A and lenses began to clear up somewhat.

The tooling discussions were held Friday morning, July 13, 1979. Representatives of Cambridge Tool & Die Company and Woodland Tool attended, along with Mobay's tool engineer.

The task was discussed and the CSL blueprints examined. All agreed that no conclusions could be drawn regarding the injection molding tool by review of the compression molding tool drawings. All agreed that the only area to be investigated on the CSL injection tool would be the gating and sprue configurations. Accordingly, ILC will make the CSL tool available to one of the vendors and he will inform the other of his findings for purpose of quotations.

I asked that two quotes be given:

(a) To modify the existing CSL tool.
(b) To construct a new tool for urethane use.

Both vendors will comply before September 1, 1979.

Regarding the availability of a compound of even lower modulus than 990A or MD85A, the following notes pertain and represent the sequence of steps that Mobay would follow:

(a) First, Mobay would have to conduct a conceptual feasibility study.

(b) There must be a clear understanding that this would be a specialty item and carry a premium price. (ea.: $3/lb range).

(c) Second, a pilot plant batch would have to be made. This would require the following:

    (1) A clear-cut definition of the required physicals and performance characteristics such as haze, clarity, etc.

(d) In order to indemnify Mobay from liability, the U.S. Government would have to provide any and all dermatological risk factor assurances in advance of Mobay's being involved.

(e) At this point Mobay would need an ILC contract definition. How many, how much, the contract spec, ILC's commitment to CSL, and hence, to Mobay.

(f) If Mobay agrees to any production run, Mobay might need capital equipment dollar recovery for material handling, packing, and storing equipment. Recovery could be seen in the price per pound with a minimum volume per year guaranteed in writing or by either ILC or U.S. Government providing the capital for the equipment in advance of any production run.

(g) A lower durometer polymer would very likely require a higher lubricity content to avoid pellet conglomeration in storage. This added lubricity could cause haze problems, of course. Mobay would work to meet or exceed the physicals of the silicone that ILC Dover have already supplied them.

APPENDIX B

PROCEDURES

PROCEDURE FOR DEHAZING LENSES

1 INTRODUCTION

One of the qualities necessary in the mask was that it had good optical quality. Two distinguishing factors are employed to gauge the optical quality of masks. These are its light transmission characteristics and its haze values. When the haze and light transmission of early samples was determined, the haze values exceeded the maximum allowable limit. Also, some other types of masks originally past haze tests, but after going through the desert aging test (160°F for nine days), the haze value in the urethane rose to unacceptable levels.

Since the mask had several other appealing attributes, it was determined that the haze problem should be tackled rather than abandoning that model of mask. The dehazing procedure which follows was developed in the program until it was proven to decrease the haze content to acceptable levels.

Hand contact with the urethane proved detrimental to the preservation of the optical quality of the mask. Fingerprints had to be removed by the tedious method described in the following section of this procedure. Due to this problem, a procedure for handling the masks was promulgated to insure the clean packing and handling of the mask.

2 CLEAN LENSES

(1) While wearing cotton gloves, dampen cheesecloth with ILC Cleaner D solution.

(2) Using an air gun blow off all particles on mask that could cause scratches.

(3) Gently wipe inside and outside surfaces of lenses.

(4) Rinse off cleaning solution.

(5) Pat surfaces with paper towel to remove large water beads.

(6) Gently wipe dry with cheesecloth.

3 HEAT LENSES

(1) Preheat oven to 245°F.

(2) Verify lenses are completely dry.

(3) Place lenses on rack in oven. If lenses have curled, two holes must be punched in the middle of the tracks of the sliding machanism on both ends of the lens. Insert a paper clip bent to form a hook into the hole and hang lenses in the oven.

(4) Heat for four hours.

(5) Fill a clean wax bucket with water and ice. Turn water to insure uniform water temperature.

(6) Remove lenses from oven and immediately place in bucket. Do not put any more than seven lenses in bucket at a time.

(7) Chill in water for 15 minutes.

(8) Remove lot from water.

(9) While wearing cotton gloves, dry large water droplets with paper towels and thoroughly dry with cheesecloth.

(10) Once dry, verify haze has been removed. If haze is still present, mix Sparkleen in a beaker of hot water. Thoroughly wash lens with solution and cheesecloth. Rinse and dry. Repeat procedure 1 through 10.

(11) Package lenses in accordance with procedure for handling and packaging or prepare for bonding.

(12) Before placing next set of lenses in bucket, verify that water is still cold. Add ice if necessary.

(13) Repeat procedures 1 through 12.

PROCEDURE FOR HANDLING URETHANE GAS MASK LENSES

1 HANDLING

In order to insure the optics of all urethane lenses acquired, no one is permitted to handle the lenses without wearing cotton gloves. All lenses are then only to be touched on unpolished surfaces. When lenses are not being worked with, the procedure for packaging in the following section is to be followed:

2 PACKAGING

All work surfaces must be covered with clean paper toweling or a soft cloth before placing lenses on surfaces.

(1) All flash that will fold back onto the lens must be trimmed off.

(2) A sheet of 20" x 40" paper towel (advance paper #00584) will be placed and folded onto both surfaces of the lens.

(3) Lenses can then be stacked together insuring all surfaces are protected by the towels.

(4) Package lenses in a clean sturdy full tote cardboard box, lined with Jiffy Wrap. Verify no surface of the lens touches the wrap without a sheet of toweling. Align one row of lenses within the box, do <u>not</u> jam tight. Fill any voids with Jiffy Wrap. Lay one layer of wrap on top.

(5) Secure the box flaps closed.

APPENDIX B

PROCEDURE FOR BONDING LENSES TO MASK

1 INTRODUCTION

Early in the program it became necessary to fabricate a two-piece mask. Urethane Vari-View masks were to be interfaced with a silicone periphery, which consisted of the cannister screw threaded adapters and six strap attachment fixtures. However, there was no sure-fire known adhesive to bond silicone to urethane. To overcome this problem, an expansive materials and procedures study was undertaken to solve this problem to two-piece masks. Details of this study are documented in Appendix D. The following procedure resulted from the study.

2 PREPARATION OF VARI-VIEW URETHANE LENSES

(1) Using a Crown #8011 Spray-Tool Power Pack and dispenser, spray one coat of Spraylat 4997 to the inner and outer surfaces of the Vari-View lens. Allow to dry and apply an additional two coats.

(2) Place a center mark on the dull finish of the lens, locating it in the middle of the sprue. (over the S in USA)

(3) Cut off the sprue and the two side tracks on the ends of the lens.

(4) Place the lens on the plaster marking fixture, locating the center of the lens over the centerline of the fixture.

(5) Take a flexible ruler and transfer the complete center line to the lens.

(6) Place the lens marking template to the inside of the lens, aligning its center line with that of the lens. Trace onto the lens.

(7) Carefully cut out the lens along this line using scissors. You can go outside but not inside the line.

3 PREPARATION OF THE MASK

(1) Using a 1/2" punch, punch out the corners of the mask as indicated in Figure 1 below.

(2) Position the voice emitter and fitting template over the latter, marking the scallops.

(3) With an Xacto knife, trim out these scallops. Trim the remaining portion of the lens staying 5/16" away from the inside ledge of the periphery of the visor.

(4) Grind down to within 1/16" of this ledge and smooth out the edge around the fittings.

4 MATCHING THE LENS TO THE MASK

(1) Place the mask onto the bonding fixture. Align properly, screwing the holding fixture into the threaded cannister fittings. Push the metal holding fixture under the lip at the top of the mask. Screw in place.

(2) Place the cut out lens to the mask. Hand fit this lens by grinding. An exact fit is not necessary or desirable around the outside lip area. On the outside surface mark the border around the lens that is to be bonded to the mask.

(3) Abrade this surface to be bonded, insuring that the Spraylat is peeled off to within a 1/64" of this.

(4) Abrade the bonding surface around the voicemitter and two-threaded cannister fittings. Blow off all dust.

(5) Dampen cheesecloth with MEK. Lightly wipe the abraded surface only of the lens and mask.

NOTE

The MEK will cause the Spraylat to peel and the Viton outside the bonding surface of the lens to be removed. Therefore, exercise extreme caution when using the MEK.

(6) Heat the oven to 150°F. Place lens on a beaker along with the mask into the oven.

5 ADHESIVE MIXTURE

(1) Place a small polyethylene beaker on a scale. Balance as required.

(2) Using a clean metal spatula, place seven grams of Epon 828 into the beaker. Using another clean metal spatula, place 11 grams of Versamid 125 into the beaker.

(3) Thoroughly blend the mixture together -- it should turn milky white.

(4) Let stand for 25 minutes.

(5) Remove mask and lens from oven -- one at a time. Using an acid brush quickly and neatly apply a thin coat of adhesive to the mask. Repeat for the lens. When the lens has been coated, place it, curved side down, to rest on a beaker. After letting the adhesive on the mask settle for approximately three minutes, observe for any separation or air bubbles that may have occurred. Apply more adhesive if necessary. Clean off whatever has dripped down the sides or onto the lens periphery.

(6) Let stand approximately for 20 minutes or until adhesive is tacky, barely leaving a fingerprint impression. Carefully place the lens onto the mask. Clamp in place with fixture.

NOTE

Each lens and clamp fits differently. Wooden shims should be used to assure that a slight pressure will be applied to all areas.

(7) A weight must be placed onto the top of the clamp. Clean off any adhesive that has oozed out from the lens.

(8) Let stand overnight.

(9) Place in oven at 150°F for two hours cure.

(10) Remove and allow to cure for two more days.

(11) Grind lens even with lip of mask.

(12) Remove all Spraylat and adhesive particles that have dripped onto the mask.

NOTE

If Spraylat or adhesive will not come off, soak in warm to hot water for removal.

(13) Clean mask with Sparkleen/water solution. Thoroughly dry. Polish lens with ILC Cleaner D.

APPENDIX C

HAZING STUDY

Initial readings were taken of the Upjohn 2103-80A lenses to determine how closely the material met the XM-29 silicone specification. Results are listed in Table I. The average light transmittance was 88.28 percent; average haze 9.4 percent. The haze was unacceptable when compared to the Spec requirements of 4.0 percent.

After discussions with Upjohn and experimenting in the lab, it was determined that heating would drive the lubricant out. However, the lubricant had to be dispersed from the surface in some manner to keep it from soaking back in. Table II lists the pre and post haze readings after treating in the various manner described.

Both trichlorethane and water yielded satisfactory haze readings. However, trichlorethane distorted the optical clarity if the sample has been overexposed.

Due to the excellent results exhibited by heat and water, it was decided to prove the following procedure:

Heat sample for four hours at 245°F.

Place in ice water for 15 minutes.

Table III lists the results.

This procedure was used to dehaze the lenses delivered to CSL. Occasionally a lot would remain cloudy. These were washed with a Sparkleen and water solution, then reheated. The haze would then be removed.

From this experimenting the procedure for dehazing was derived.

TABLE C-1. HAZE AND LIGHT TRANSMISSION

.080" Vari-View Visor -- Upjohn 2103-80A

Four measurements of haze and light transmssion in accordance with ASTM D1003.

SAMPLE	LIGHT TRANSMITTANCE	HAZE
1	88.8.%	8.65%
2	88.5%	9.0%
3	87.1%	11.5%
4	88.7%	8.46%

APPENDIX C

ILC DOVER
BOX 266 - FREDERICA, DE. 19946

TEST REQUEST

TEST NUMBER: 05F-01 9169-02

1. PROJECT NAME	2. CHARGE NUMBER	3. DATE
GAS MASK DEVELOPMENT	X06-891-500	6/18/79

4. TITLE

HAZE & LIGHT TRANSMISSION TEST
ACCORDING TO D1003

5. ARTICLE DESCRIPTION

.080 Upjohn 2103-80A Vari-View Visor from first Woodland Shot.

6. TEST DESCRIPTION

Take four (4) random readings in accordance with D1003 for haze and light transmittance.

7. TEST PROCEDURE ATTACHED ☐ YES ☐ NO

8. PHOTO DOCUMENTATION REQUIRED ☐ YES ☐ NO

9. DATE RESULTS NEEDED: 6/19 or 6/20

10. ORIGINATOR: Mary Valla

TEST COORDINATOR

PRIORITY	WITNESS	YES	NO
	Originator		
	Coordinator		
TEST LEVEL			

COMMENTS

Q & R REVIEW

Q&R WITNESS ☐ YES ☐ NO

DCASR WITNESS ☐ YES ☐ NO

Q&R CALIBRATION VERIFICATION ☐ YES ☐ NO

COMMENTS

Reviewed By	Date

TEST CONDUCTOR

SCHEDULE	APPROVAL TC	Q&R
DATE		
TIME		

COMMENTS

APPENDIX C

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ILC DOVER
BOX 266 - FREDERICA, DE. 19946

TEST RESULTS

TEST NUMBER: 05F-01 9169-02

PROJECT NAME	CHARGE NUMBER	DATE
GAS MASK DEVELOPMENT	X06-891-500	6/19/79

TEST EQUIPMENT USED: GARDNER AUTOMATIC PHOTOMETRIC UNIT

CALIBRATION OF TEST EQUIPMENT

VERIFIED BY	DATE
P. Fransisco	6/19/79

SAMPLE #	TRANSMITTANCE	HAZE
1	88.8%	8.65%
2	88.5%	9.0%
3	87.1%	11.5%
4	88.7%	8.46%

ENVIRONMENT DURING TEST: Room Ambient

RESULTS RECORDED BY: APPENDIX C

DATA APPROVED BY

NAME	TITLE	DATE

FORM NO. 2014 (11/69) White - Test Lab Yellow - Test Requester PRINTED IN USA

Table C-2. .080" VariView Lenses -- UpJohn 2103-80A; Test 9170-02

SAMPLE	PRE-TREATMENT HAZE	POST-TREATMENT HAZE	PRE-TREATMENT LIGHT TRANSMITTANCE	POST-THREATMENT LIGHT TRANSMITTANCE
1	6.8	2.95	89.5	
2	7.4	3.45	89.9	
3	8.85	11.6	88.8	89.6
4	7.1	2.4	90.0	90.0
5	7.6	9.35	89.5	91.0
6	6.8	2.1	89.6	90.0
7	7.1	3.6	89.6	89.6
8	7.35	2.0	89.8	90.0
9	6.1	1.9	89.8	89.0
10	10.2	4.6	89.8	89.3

SAMPLE TREATMENT TO REMOVE HAZE

1. 10 minutes at 250°F drop in water.
2. 45 minutes at 250°F place in trichlorethane.
3. 45 minutes at 250°F place in refrigerator.
4. 4 hours at 250°F -- Water overnight.
5. 4 hours at 250°F -- Trichlorethane overnight.
6. 2 hours at 250°F -- drop in water.
7. 3 1/2 hours at 250°F -- Trichlorethane
8. 3 1/2 hours at 250°F -- drop in water.
9. 9 hours at 250°F -- drop in water.
10. 9 hours at 250°F -- drop in trichlorethane.

ILC DOVER
BOX 266 - FREDERICA, DE. 19946

TEST REQUEST

TEST NUMBER: 05F-01 9170-02

1. PROJECT NAME: GAS MASK DEVELOPMENT	2. CHARGE NUMBER: X06-891-500	3. DATE: 6/19/80

4. TITLE

Percent Transmittance of Visor and Haze test on visors.

5. ARTICLE DESCRIPTION

10 sample pieces from visors.

.080 Upjohn 2103-80A Vari-View Visor from first Woodland shot.

6. TEST DESCRIPTION

Determine the haze and % transmittance readings from the 10 urethane samples.

7. TEST PROCEDURE ATTACHED ☐ YES ☐ NO

8. PHOTO DOCUMENTATION REQUIRED ☐ YES ☐ NO

9. DATE RESULTS NEEDED: 6/22/79

10. ORIGINATOR: Mary Valla

TEST COORDINATOR

PRIORITY	WITNESS	YES	NO
	Originator		
	Coordinator		
TEST LEVEL			

COMMENTS

Q & R REVIEW

Q&R WITNESS ☐ YES ☐ NO

DCASR WITNESS ☐ YES ☐ NO

Q&R CALIBRATION VERIFICATION ☐ YES ☐ NO

COMMENTS

Reviewed By	Date

TEST CONDUCTOR

SCHEDULE	APPROVAL TC	APPROVAL Q&R
DATE		
TIME		

COMMENTS

APPENDIX C

White - Test Lab   Yellow - Test Lab   Pink - Originator

PRINTED IN USA

ILC DOVER BOX 266 - FREDERICA, DE. 19946	TEST RESULTS	TEST NUMBER 05F-01 9170-02
PROJECT NAME GAS MASK DEVELOPMENT	CHARGE NUMBER X06-801-500	DATE 6/19/79
TEST EQUIPMENT USED GARDNER AUTOMATIC PHOTOMETRIC UNIT	CALIBRATION OF TEST EQUIPMENT VERIFIED BY P. Fransisco	DATE 6/19/79

SAMPLE #	HAZE	TRANSMITTANCE
1	6.8%	89.5%
2	7.4%	89.9%
3	8.85%	88.8%
4	7.1%	90%
5	7.6%	89.5%
6	6.8%	89.6%
7	7.1%	89.6%
8	7.35%	89.8%
9	6.1%	89.8%
10	10.2%	89.8%

ENVIRONMENT DURING TEST	DATA APPROVED BY		
Room Ambient	NAME	TITLE	DATE
RESULTS RECORDED BY			
APPENDIX C			

FORM NO. 2214 (1/59) White - Test Lab Yellow - Test Requester PRINTED IN U.S.A.

ILC DOVER
BOX 266 - FREDERICA, DE. 19946

TEST REQUEST

TEST NUMBER	95F-1 9172-01
1. PROJECT NAME	GAS MASK DEVELOPMENT
2. CHARGE NUMBER	X06-891-500
3. DATE	6/21/79
4. TITLE	Haze & Light Transmission Test
5. ARTICLE DESCRIPTION	2103-80A Urethane First Woodland Shot Samples #3-10 II - Texin 985A
6. TEST DESCRIPTION	ASTM D1003
7. TEST PROCEDURE ATTACHED	☐ YES ☐ NO
8. PHOTO DOCUMENTATION REQUIRED	☐ YES ☐ NO
9. DATE RESULTS NEEDED	6/21/79
10. ORIGINATOR	Mary Valla

TEST COORDINATOR

PRIORITY	WITNESS	YES	NO
	Originator		
	Coordinator		
TEST LEVEL			

COMMENTS

Q & R REVIEW

Q&R WITNESS ☐ YES ☐ NO

DCASR WITNESS ☐ YES ☐ NO

Q&R CALIBRATION VERIFICATION ☐ YES ☐ NO

COMMENTS

Reviewed By	Date

TEST CONDUCTOR

SCHEDULE	APPROVAL TC	APPROVAL Q&R
DATE		
TIME		

COMMENTS

APPENDIX C

White - Test Lab Yellow - Test Lab Pink - Originator

PRINTED IN USA

ILC DOVER BOX 266 – FREDERICA, DE. 19946	TEST RESULTS	TEST NUMBER 9172-01
PROJECT NAME GAS MASK DEVELOPMENT	CHARGE NUMBER X06-891-500	DATE 6/21/79
TEST EQUIPMENT USED GARDNER AUTOMATIC PHOTOMETRIC UNIT	CALIBRATION OF TEST EQUIPMENT VERIFIED BY P. Fransisco	DATE 6/21/79

SAMPLE #		% TRANSMITTANCE		% HAZE
			(Original)	
#1	10 min/250° - H_2O		6.8	2.95
#2	45 min/250° - Tri		7.4	3.45
#3	45 min/250° - Refrig.	89.6	8.85	11.60
#4	4 hrs/250° - H_2O overnight	90.0	7.10	2.40
#5	4 hrs/250° - Tri overnight	91.0	7.60	9.35
#6	2 hrs./250° - H_2O	90.0	6.80	2.10
#7	3.5 hrs/250° - Tri	89.6	7.10	3.60
#8	3.4 hrs/250° - H_2O	90.0	7.35	2.00
#9	9 hrs/250° - H_2O	89.9	6.10	1.90
#10	9 hrs/250° - Tri	89.3	10.20	4.60
#11	Texan 985A	91.0		6.75

ENVIRONMENT DURING TEST	DATA APPROVED BY		
Room Ambient	NAME	TITLE	DATE
RESULTS RECORDED BY APPENDIX C			

FORM NO. 2014 11/69 White - Test Lab Yellow - Test Requester PRINTED IN USA

Table C-3 .80" Vari-View Lens -- Upjohn 2103-80A; Test 9173-01

SAMPLE #	% TRANSMITTANCE	% HAZE
10	91.0	1.95
11	90.0	1.96
12	90.5	1.60
13	90.5	1.60
14	90.0	2.15
15	90.3	2.10
16	90.3	1.50
17	89.8	2.30
18	90.5	1.90
19	90.0	2.00
20	90.0	1.87
21	89.8	2.10
22	90.3	1.45
23	90.0	2.10
24	90.0	2.00
25	90.0	2.10
26	90.0	1.75
27	89.5	2.10
28	89.5	2.20
29	89.5	3.87

ILC DOVER

BOX 266 - FREDERICA, DE. 19946

TEST REQUEST

TEST NUMBER: 05F-1 9173-01

1. PROJECT NAME	2. CHARGE NUMBER	3. DATE
GAS MASK DEVELOPMENT	X05-891-500	6/22/79

4. TITLE

Haze and Light Transmission

5. ARTICLE DESCRIPTION

Upjohn 2103-80A urethane from second Wood land shot.

Samples 10-28
Texin 985A
Sample 29

6. TEST DESCRIPTION

ASTM D1003

NOTE: LENSES CAN ONLY BE HANDLED USING COTTON GLOVES.

7. TEST PROCEDURE ATTACHED ☐ YES ☐ NO

8. PHOTO DOCUMENTATION REQUIRED ☐ YES ☐ NO

9. DATE RESULTS NEEDED

6/22/79 or 6/23/79

10. ORIGINATOR

Mary Valla

TEST COORDINATOR

PRIORITY	WITNESS	YES	NO
	Originator		
	Coordinator		
TEST LEVEL			

COMMENTS

Q & R REVIEW

Q&R WITNESS ☐ YES ☐ NO

DCASR WITNESS ☐ YES ☐ NO

Q&R CALIBRATION VERIFICATION ☐ YES ☐ NO

COMMENTS

Reviewed By	Date

TEST CONDUCTOR

SCHEDULE	APPROVAL TC	APPROVAL Q&R
DATE		
TIME		

COMMENTS

APPENDIX C

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ILC DOVER BOX 266 - FREDERICA, DE. 19946	TEST RESULTS	TEST NUMBER 05F-1 9173-01
PROJECT NAME GAS MASK DEVELOPMENT	CHARGE NUMBER X06-891-500	DATE 6/23/79

TEST EQUIPMENT USED	CALIBRATION OF TEST EQUIPMENT VERIFIED BY	DATE
GARDNER AUTOMATIC PHOTOMETRIC UNIT	P. Fransisco	6/23/79

SAMPLE #	% TRANSMITTANCE	% HAZE
10	91.0	1.95
11	90.0	1.96
12	90.5	1.60
13	90.0	1.60
14	90.0	2.15
15	90.3	2.10
16	90.3	1.50
17	89.9	2.30
18	90.5	1.90
19	90.0	2.00
20	90.0	1.87
21	89.8	2.10
22	90.3	1.45
23	90.0	2.10
24	90.0	2.10
25	90.0	2.10
26	90.0	1.75
27	89.5	2.10
28	89.5	2.20
29	89.5	3.87

ENVIRONMENT DURING TEST	DATA APPROVED BY NAME	TITLE	DATE
Room Ambient			
RESULTS RECORDED BY APPENDIX C			

FORM NO. 2014 (11/69) White - Test Lab Yellow - Test Requester PRINTED IN USA

ILC DOVER
BOX 266-FREDERICA, DE. 19946

	TEST RESULTS	TEST NUMBER 05F-1 9208-04
PROJECT NAME: GAS MASK DEVELOPMENT	CHARGE NUMBER: X06-891-500	DATE: 7/27/79
TEST EQUIPMENT USED: GARDNER AUTOMATIC PHOTOMETRIC UNIT	CALIBRATION OF TEST EQUIPMENT — VERIFIED BY: P. Fransisco	DATE: 7/27/79

LIGHT TRANSMISSION	80.6%
HAZE	4.4%

ENVIRONMENT DURING TEST: Room Ambient

RESULTS RECORDED BY: APPENDIX C

DATA APPROVED BY

NAME	TITLE	DATE

FORM NO. 2014 (11/69) White - Test Lab Yellow - Test Requester PRINTED IN USA

ILC DOVER
BOX 266 - FREDERICA, DE. 19946

TEST REQUEST

TEST NUMBER: 05F-1 9208-04

1. PROJECT NAME	2. CHARGE NUMBER	3. DATE
GAS MASK DEVELOPMENT	X06-891-500	7/27/79

4. TITLE	5. ARTICLE DESCRIPTION
Light Transmittance and Haze	2" x 2" of Urethane 2103-80A

6. TEST DESCRIPTION

7. TEST PROCEDURE ATTACHED ☐ YES ☐ NO

8. PHOTO DOCUMENTATION REQUIRED ☐ YES ☐ NO

9. DATE RESULTS NEEDED
7/27/79

10. ORIGINATOR
Mary Valla

TEST COORDINATOR

PRIORITY	WITNESS	YES	NO
	Originator		
	Coordinator		
TEST LEVEL			

COMMENTS

Q & R REVIEW

Q&R WITNESS ☐ YES ☐ NO

DCASR WITNESS ☐ YES ☐ NO

Q&R CALIBRATION VERIFICATION ☐ YES ☐ NO

COMMENTS

Reviewed By	Date

TEST CONDUCTOR

SCHEDULE	APPROVAL	
	TC	Q&R
DATE		
TIME		

COMMENTS

APPENDIX C

White - Test Lab Pink - Originator PRINTED IN USA

GAS MASK LENS WEATHER TESTING

UPJOHN 2102-80A

AGING BEGIN 8/20/79

WK	SAMPLE #	% TRANSMISSION ASTM D1003	% HAZE ASTM D1003	COLOR Rd	COLOR a	COLOR b
1	1U	83.6	5.3	52.3	-0.4	+18.8
	2U	84.9	9.7	58.6	-1.0	+17.1
	3U	84.7	4.8	58.2	-1.3	+17.9
	4U	82.1	19.3	55.2	-0.7	+17.4
	5U	85.2	3.7	53.2	-0.7	+17.4
2	6U	84.2	7.9	56.4	-2.1	+22.4
	7U	84.0	9.6	56.7	-2.0	+22.4
	8U	83.9	10.4	56.1	-1.4	+22.4
	9U	83.5	10.6	51.4	-1.4	+22.9
	10U	82.8	4.3	48.1	-1.1	+22.7
3	11U	80.8	16.9	50.6	-1.5	+24.8
	12U	83.2	8.4	56.0	-2.5	+25.0
	13U	82.3	13.3	53.0	-2.1	+25.2
	14U	83.2	6.8	55.2	-2.0	+24.9
	15U	83.0	12.6	55.0	-2.7	+25.6
4	16U	80.3	19.9	50.5	-1.7	+24.9
	17U	VOID -- SAMPLE MISSING				
	18U	83.5	8.7	55.5	-2.5	+24.6
	19U	82.3	13.3	54.6	-2.1	+25.4
	20U	83.7	4.9	57.3	-2.3	+25.1
5	21U	83.2	5.8	55.6	-3.0	+26.9
	22U	80.6	19.2	51.3	-1.5	+26.0
	23U	81.2	19.2	52.7	-1.8	+25.7
	24U	83.4	5.1	56.2	-2.6	+25.5
	25U	81.6	14.8	53.6	-2.0	+25.3
6	26U	82.2	10.5	53.4	N/A	+25.9
	27U	83.3	6.5	51.0	N/A	+26.2
	28U	83.0	6.4	53.5	N/A	+27.1
	29U	82.3	10.0	55.0	N/A	+27.1
	30U	82.5	12.3	55.4	N/A	+27.1
7	31U	81.3	14.0	53.9	-2.4	+27.3
	32U	79.6	12.0	51.5	-1.7	+27.4
	33U	78.5	24.3	50.3	-1.6	+27.0
	34U	80.4	18.1	53.9	-2.3	+27.2
	35U	80.0	23.2	52.6	-2.1	+27.0
8	36U	81.7	8.8	54.6	-2.7	+26.8
	37U	80.8	12.3	53.7	-2.3	+27.0
	38U	82.0	9.7	55.7	-2.7	+27.0
	39U	82.4	7.8	55.9	-2.7	+26.8
	40U	82.8	12.7	54.4	-2.5	+27.0

APPENDIX C

GAS MASK LENS WEATHER TESTING

UPJOHN 2102-80A

AGING BEGIN 8/20/79

SAMPLE #	% TRANSMISSION ASTM D1003	% HAZE ASTM D1003	COLOR Rd	a	b
Control 1- 5U	87.4	8.6	65.0	-0.7	+5.7
Control 6-10U	85.1	16.4	60.7	-0.1	+6.0
Control 11-15U	85.8	9.3	62.5	-0.8	+7.9
Control 16-20U	87.5	2.8	65.4	-0.9	+6.7
Control 21-25U	85.4	15.5	6.24	-0.7	+6.9
Control 26-30U	87.0	4.4	63.9	N/A	+5.1
Control 31-35U	85.2	11.2			
Control 36-40U	86.2	4.8	63.1	-1.0	+7.9

APPENDIX C

GAS MASK LENS WEATHER TESTING

MOBAY 985A
INITIAL READINGS

SAMPLE #	% TRANSMISSION ASTM D1003	% HAZE ASTM D1003	COLOR Rd	a	b
1M	88.7	3.0	66.8	-0.5	+3.0
2M	89.3	2.2	67.5	-0.5	+2.8
3M	88.9	6.7	66.4	-0.2	+2.6
4M	87.9	12.6	67.1	-0.5	+2.9
5M	88.7	2.4	66.5	-0.7	+2.8
6M	89.2	2.2	67.8	-0.6	+2.5
7M	88.2	9.2	66.0	-0.6	+3.2
8M	88.3	6.4	59.2	0	+2.6
9M	88.7	2.1	65.7	-0.2	+2.4
10M	88.8	2.5	66.7	-0.4	+2.5
11M	88.8	2.9	62.2	-0.4	+3.0
12M	88.4	2.4	64.9	-0.5	+2.6
13M	88.9	7.1	66.8	-0.3	+2.8
14M	89.1	2.2	68.8	-0.6	+2.5
15M	88.9	4.6	67.2	-0.5	+2.6
16M	88.8	2.6	67.1	-0.6	+2.7
17M	88.9	4.0	66.2	-0.4	+2.4
18M	89.0	5.9	66.9	-0.5	+2.5
19M	89.1	4.5	61.7	-0.6	+2.4
20M	88.8	2.0	67.3	-0.5	+3.4
21M	88.7	2.1	66.1	-0.4	+2.4
22M	87.5	8.9	60.6	-0.7	+2.8
23M	88.8	2.4	66.2	-0.5	+3.2
24M	88.7	2.3	65.4	-0.1	+2.2
25M	88.7	2.3	65.6	-0.4	+3.0
26M	88.7	2.3	67.2	-0.6	+3.2
27M	89.2	3.9	65.8	-0.4	+2.7
28M	88.8	2.2	66.9	-0.5	+3.0
29M	88.7	7.8	66.5	-0.5	+2.4
30M	89.3	2.5	67.6	-0.7	+2.4
31M	88.4	6.1	64.8	-0.7	+3.4
32M	88.7	6.1	66.8	-0.9	+3.4
33M	88.3	2.1	63.3	-0.6	+3.0
34M	88.5	7.4	67.5	-0.6	+3.2
35M	88.9	5.5	67.2	-0.6	+3.1
36M	89.0	4.2	67.4	-0.5	+2.9
37M	88.2	8.5	65.8	-0.6	+2.8
38M	85.0	11.6	67.3	-0.5	+3.0
39M	88.6	2.3	67.5	-0.7	+3.2
40M	88.8	2.8	67.8	-0.8	+3.4
Control 1- 5M	88.9	4.9	66.8	-0.8	+3.8
Control 6-10M	89.1	3.7	67.4	-0.7	+3.2
Control 11-15M	88.6	6.5	66.9	-0.6	+3.0
Control 16-20M	88.3	9.5	66.2	-0.6	+3.2
Control 21-25M	88.5	2.3	67.4	-0.6	+3.1
Control 26-30M	89.1	3.7	67.3	-0.4	+2.5
Control 31-35M	89.0	2.0	65.2	-0.5	+3.2
Control 36-40M	88.7	2.4	67.1	-0.3	+3.3

APPENDIX C

GAS MASK LENS WEATHER TESTING

MOBAY 985A

AGING BEGIN 8/20/79

WK	SAMPLE #	% TRANSMISSION ASTM D1003	% HAZE ASTM D1003	COLOR Rd	COLOR a	COLOR b
1	1M	86.2	4.4	61.8	-2.2	+17.7
	2M	85.7	8.4	59.6	-2.1	+17.4
	3M	85.6	12.2	60.3	-1.8	+17.9
	4M	84.8	14.4	60.6	-1.9	+17.7
	5M	85.9	14.6	60.4	-2.3	+18.0
2	6M	85.3	14.9	67.1	-3.3	+22.9
	7M	84.6	10.4	59.3	-3.3	+22.5
	8M	84.7	9.2	61.0	-3.4	+22.8
	9M	85.2	3.4	61.4	-3.3	+23.0
	10M	84.8	4.1	61.4	-3.3	+22.5
3	11M	83.4	7.2	56.9	-2.3	+25.8
	12M	83.6	11.9	56.3	-2.8	+25.8
	13M	84.2	7.7	56.0	-2.5	+25.6
	14M	83.7	7.8	58.8	-2.7	+25.3
	15M	84.0	5.9	56.5	-2.7	+25.3
4	16M	83.5	6.7	57.6	-2.5	+26.4
	17M	83.2	10.6	55.2	-2.3	+26.4
	18M	83.0	12.2	56.6	-2.4	+26.5
	19M	83.3	12.8	56.7	-2.5	+26.0
	20M	83.4	7.2	57.2	-2.3	+26.5
5	21M	83.1	5.6	55.4	-1.9	+26.6
	22M	82.8	11.3	54.0	-2.1	+26.7
	23M	83.4	4.8	55.6	-1.9	+26.7
	24M	83.8	4.3	56.0	-2.1	+26.8
	25M	83.4	5.8	56.2	-2.3	+26.7
6	26M	82.8	5.6	54.2	N/A	+27.4
	27M	83.0	6.6	54.5	N/A	+27.8
	28M	83.8	5.5	57.7	N/A	+27.4
	29M	82.8	11.0	54.4	N/A	+27.5
	30M	83.2	6.8	55.7	N/A	+27.5
7	31M	80.2	17.9	53.3	-2.0	+27.5
	32M	81.3	14.0	54.5	-2.4	+28.2
	33M	81.6	11.9	53.6	-2.4	+27.6
	34M	80.5	17.8	54.4	-2.2	+28.2
	35M	80.5	15.7	53.7	-2.2	+29.3
8	36M	82.6	9.5	55.3	-2.2	+28.3
	37M	81.4	13.8	53.2	-2.0	+28.5
	38M					
	39M	82.8	5.7	56.5	-2.5	+28.2
	40M	82.3	7.8	55.1	-2.3	+28.5

APPENDIX C

GAS MASK LENS WEATHER TESTING

MOBAY 985A

AGING BEGIN 8/20/79

SAMPLE #	% TRANSMISSION ASTM D1003	% HAZE ASTM D1003	COLOR Rd	COLOR a	COLOR b
Control 1- 5M	88.5	7.0	66.3	-0.2	+3.6
Control 6-10M	88.9	4.6	64.5	-1.2	+4.3
Control 11-15M	87.6	11.8	64.9	-0.1	+3.2
Control 16-20M	87.8	9.4	66.3	-0.7	+3.6
Control 21-25M	88.2	2.9	66.9	-0.7	+3.3
Control 26-30M	88.7	4.4	64.2	N/A	+2.4
Control 31-35M	88.7	2.9	67.5	-0.6	+3.3
Control 36-40M	88.3	4.1	66.0	-0.4	+3.3

APPENDIX C

GAS MASK LENS WEATHER TESTING

MOBAY MD85A
INITIAL READINGS

SAMPLE #	% TRANSMISSION ASTM D1003	% HAZE ASTM D1003	COLOR Rd	a	b
MD-1	89.1	2.2	67.9	-1.0	+4.5
MD-2	88.7	3.6	67.4	-0.7	+3.9
MD-3	89.0	2.2	67.5	-0.8	+3.8
MD-4	88.6	3.8	66.8	-0.9	+4.4
MD-5	89.4	2.2	68.5	-1.0	+4.3
MD-6	89.2	2.1	69.0	-1.1	+4.0
MD-7	88.9	3.3	68.9	-1.0	+4.2
MD-8	89.2	2.5	69.0	-1.1	+4.0
MD-9	89.2	2.5	68.7	-1.1	+3.7
MD-10	89.5	2.1	68.3	-1.4	+4.3
MD-11	88.8	2.5	66.4	-0.8	+3.9
MD-12	89.3	2.2	68.9	-1.0	+3.8
MD-13	89.6	2.0	64.7	-1.4	+5.0
MD-14	89.5	2.8	69.8	-1.7	+3.9
MD-15	89.2	2.5	68.7	-1.0	+3.9
MD-16	89.2	1.85	68.7	-1.1	+3.9
MD-17	89.7	2.2	70.0	-1.6	+4.7
MD-18	89.2	2.25	69.1	-1.6	+5.1
MD-19	88.8	2.8	69.0	-1.0	+3.6
MD-20	89.0	3.1	68.6	-0.9	+3.8
MD-21	89.2	2.6	68.6	-1.1	+4.2
MD-22	88.3	4.6	66.4	-0.6	+4.3
MD-23	89.1	2.4	68.9	-1.1	+3.9
MD-24	89.1	2.4	68.9	-1.0	+3.7
MD-25	89.0	2.6	68.2	-1.1	+4.1
MD-26	89.0	2.7	68.2	-1.1	+4.0
MD-27	90.0	2.8	68.1	-1.0	+4.3
MD-28	88.8	2.5	68.4	-1.2	+4.7
MD-29	89.0	2.5	67.8	-1.0	+4.4
MD-30	89.2	2.0	68.4	-0.9	+3.6
MD-31	88.9	2.4	66.8	-0.9	+4.2
MD-32	89.7	2.5	68.2	-1.1	+4.1
MD-33	89.8	2.0	69.1	-1.6	+4.8
MD-34	89.3	3.3	69.7	-1.5	+4.5
MD-35	89.1	2.8	67.3	-0.8	+4.1
MD-36	89.5	2.75	69.2	+1.6	+4.9
MD-37	89.4	2.65	69.6	-1.7	+5.2
MD-38	89.2	2.7	68.2	-1.0	+4.4
MD-39	89.1	2.2	68.2	-1.2	+4.6
MD-40	89.3	2.6			

APPENDIX C

GAS MASK LENS WEATHER TESTING

MOBAY MD85A
INITIAL READINGS

SAMPLE #	% TRANSMISSION ASTM D1003	% HAZE ASTM D1003	COLOR Rd	a	b
Control MD- 1 -MD- 5	88.8	2.5	68.2	-0.9	+4.2
Control MD- 6 -MD-10	89.7	2.0	69.7	-1.5	+4.2
Control MD-11 -MD-15	89.9	2.2	69.3	-1.4	+4.6
Control MD-16 -MD-20	89.1	2.7	68.6	-1.0	+3.7
Control MD-21 -MD-25	89.8	2.3	69.7	-1.4	+4.0
Control MD-26 -MD-30	89.2	2.2	68.7	-1.2	+4.1
Control MD-31 -MD-35	89.2	2.2	68.0	-1.1	+4.2
Controm MD-36 -MD-40	89.2	2.3	67.3	-0.9	+4.4

GAS MASK LENS WEATHER TESTING

MOBAY MD85A

WK	SAMPLE #	% TRANSMISSION ASTM D1003	% HAZE ASTM D1003	COLOR Rd	COLOR a	COLOR b
1	1MD	86.5	3.2	59.9	-2.3	+17.7
	2MD	86.4	3.2	58.7	-2.2	+17.8
	3MD	86.3	3.5	57.9	-2.2	+17.8
	4MD	86.3	3.7	61.4	-2.4	+17.6
	5MD	86.0	5.5	62.0	-2.4	+18.7
2	6MD	85.8	2.5	59.3	2.7	+22.7
	7MD	85.7	3.3	57.2	-2.1	+22.9
	8MD	85.9	2.6	50.6	-2.1	+21.9
	9MD	85.9	2.7	57.5	-1.9	+22.0
	10MD	86.1	3.2	58.4	-2.6	+22.7
3	11MD	84.8	43.	56.4	-3.1	+25.1
	12MD	84.7	6.0	59.3	-3.4	+25.1
	13MD	85.2	4.2	60.3	-3.5	+25.5
	14MD	85.1	4.6	60.7	-3.5	+25.7
	15MD	84.8	4.8	57.8	-3.2	+25.4
4	16MD	84.5	5.2	55.9	-2.6	+25.9
	17MD	84.8	5.0	60.3	-3.3	+26.5
	18MD	84.7	6.5	59.1	-3.1	+26.3
	19MD	84.5	6.0	59.2	-3.1	+26.1
	20MD	84.5	5.6	59.3	3.2	+26.5
5	21MD	84.0	5.2	58.5	-2.9	+26.5
	22MD	83.5	7.0	56.3	-2.7	+27.1
	23MD	84.2	6.0	58.9	-2.8	+27.0
	24MD	84.0	6.0	58.5	-2.9	+26.9
	25MD	83.9	6.3	59.0	-3.0	+26.8
6	26MD	84.0	5.3	56.3	N/A	+27.4
	27MD	84.1	5.6	51.3	N/A	+26.4
	28MD	83.6	7.5	57.0	N/A	+26.7
	29MD	84.1	5.0	50.3	N/A	+25.3
	30MD	83.8	5.6	57.0	N/A	+27.3
7	31MD	83.4	13.3	56.5	-2.8	+26.7
	32MD	83.1	15.3	55.1	-2.8	+26.6
	33MD	81.6	12.8	56.1	-2.8	+27.8
	34MD	82.4	11.7	56.9	-3.0	+27.6
	35MD	82.5	13.7	56.3	-2.9	+27.5
8	36DM	83.5	6.1	57.9	-3.1	+28.2
	37MD	83.9	6.3	57.3	-3.0	+27.5
	38MD	83.5	6.5	52.1	-2.0	+27.1
	39MD	83.7	5.0	56.3	-3.5	+30.2
	40MD	Sample Lost	Sample Lost	Sample Lost		Sample Lost

APPENDIX C

GAS MASK LENS WEATHER TESTING

MOBAY MD85A

SAMPLE #	% TRANSMISSION ASTM D1003	% HAZE ASTM D1003	COLOR Rd	COLOR a	COLOR b
Control 1- 5MD	88.8	3.3	68.2	-1.0	+4.2
Control 6-10MD	89.4	3.3	65.0	-0.6	+2.8
Control 11-15MD	89.1	5.5	67.3	-1.5	+5.0
Control 15-20MD	88.6	4.4	68.3	-0.9	+3.9
Control 21-25MD	89.3	3.6	68.8	-1.4	+3.8
Control 26-30MD	88.6	3.1	68.1	N/A	+4.4
Control 31-35MD	88.3	3.1	67.9	-1.1	+4.4
Control 36-40MD	88.5	3.8	67.5	-1.1	+4.5

GAS MASK LENS WEATHER TESTING

MOBAY MD85A
UV Stabilzied with Tint Overdose

WK	SAMPLE #	% TRANSMISSION ASTM D1003	% HAZE ASTM D1003	COLOR Rd	COLOR a	COLOR b
1	UV/MD-1	84.3	9.1	60.5	-0.7	+9.6
2	UV/MD-2	84.4	4.0			
3	UV/MD-3					
4	UV/MD-4					
5						
6						
7						
8						

APPENDIX C

GAS MASK LENS WEATHER TESTING

MOBAY MD85A
UV Stabilized & ILC Tint Additive
INITIAL READINGS

SAMPLE #	% TRANSMISSION ASTM D1003	% HAZE ASTM D1003	COLOR Rd	COLOR a	COLOR b
MD- 1	86.6	7.2			
MD- 2	86.5	10.7			
MD- 3	87.2	8.5			
MD- 4	87.3	7.8			
MD- 5	87.2	6.7			
MD- 6	87.1	5.9			
MD- 7	85.0	6.5			
MD- 8	85.6	7.5			
MD- 9	87.1	4.6			
MD-10	87.6	5.3			
MD-11	85.8	8.1			
MD-12	86.8	7.4			

APPENDIX C

GAS MASK LENS WEATHER TESTING

UPJOHN NEW COMPOUND
UV Stabilized & ILC Tint Additive
INITIAL READINGS

SAMPLE #	% TRANSMISSION ASTM D1003	% HAZE ASTM D1003	COLOR Rd	COLOR a	COLOR b
U- 1	87.4	10.5			
U- 2	86.4	10.7			
U- 3	86.0	9.7			
U- 4	86.0	10.6			
U- 5	85.3	7.5			
U- 6	86.7	6.6			
U- 7	86.7	7.1			
U- 8	86.0	7.8			
U- 9	86.9	5.8			
U-10	85.9	6.7			
U-11	86.5	6.3			
U-12	85.9	7.8			

APPENDIX C

WEATHERING TEST FIXTURE

SK79-0167

WEATHERING TEST FIXTURE

SK79-0167

WEATHERING TEST FIXTURE

SK79-0167

DAILY AVERAGE WEATHER DATA

(obtained from Department of the Air Force)
DOVER AIR FORCE BASE, DELAWARE

AS OF: 20-26 August 1979

DATE	AVERAGE HUMIDITY	AVERAGE TEMPERATURE	TOTAL PRECIPITATION	AVERAGE CLOUD COVER
8/20	90%	72	0	PARTLY SUNNY, HAZE
8/21	93%	68	.08	CLOUDY, RAIN
8/22	90%	69	0	MOSTLY SUNNY
8/23	92%	73	0	MOSTLY CLOUDY, HAZE
8/24	88%	78	.01	CLOUDY, HAZE, RAIN
8/25	85%	80	.84	MOSTLY CLOUDY, RAIN
8/26	93%	77	.02	MOSTLY CLOUDY, HAZE
WEEKLY AVERAGE:	90%	73.8°F	.14 per day	

DAILY AVERAGE WEATHER DATA

(obtained from Department of the Air Force)
DOVER AIR FORCE BASE, DELAWARE

AS OF: 27 August - 02 September 1979

DATE	AVERAGE HUMIDITY	AVERAGE TEMPERATURE	TOTAL PRECIPITATION	AVERAGE CLOUD COVER
8/27	85%	83	.05	MOSTLY CLOUDY
8/28	90%	77	.35	MOSTLY CLOUDY
8/29	84%	79	0	MOSTLY CLOUDY
8/30	87%	81	0	PARTLY CLOUDY, HAZY
8/31	80%	78	0	PARTLY CLOUDY, HAZY
9/01	88%	80	0	PARTLY CLOUDY, HAZY
9/02	80%	80	0	PARTLY CLOUDY
WEEKLY AVERAGE:	85%	79.9°F	.05 per day	

DAILY AVERAGE WEATHER DATA

(obtained from Department of the Air Force)
DOVER AIR FORCE BASE, DELAWARE

AS OF: - 03-09 September 1979

DATE	AVERAGE HUMIDITY	AVERAGE TEMPERATURE	TOTAL PRECIPITATION	AVERAGE CLOUD COVER
9/03	79%	76	T	PARTLY CLOUDY, HAZE
9/04	80%	75	.12	PARTLY CLOUDY, FOG
9/05	97%	74	1.34	CLOUDY, RAIN, FOG
9/06	86%	73	1.03	CLOUDY, RAIN, FOG
9/07	66%	74	0	MOSTLY CLEAR, HAZE
9/08	70%	67	0	PARTLY CLOUDY
9/09	72%	63	0	PARTLY CLOUDY
WEEKLY AVERAGE:	79%	72	.36 per day	

DAILY AVERAGE WEATHER DATA

(obtained from Department of the Air Force)
DOVER AIR FORCE BASE, DELAWARE

AS OF: - 10-16 September 1979

DATE	AVERAGE HUMIDITY	AVERAGE TEMPERATURE	TOTAL PRECIPITATION	AVERAGE CLOUD COVER
9/10	75%	64	0	PARTLY CLOUDY
9/11	79%	69	0	PARTLY CLOUDY, HAZY
9/12	75%	64	0	PARTLY CLOUDY, HAZY
9/13	81%	68	0	PARTLY CLOUDY, HAZY
9/14	85%	77	.09	MOSTLY CLOUDY
9/15	63%	63	0	PARTLY CLOUDY
9/15	62%	61	0	MOSTLY SUNNY
WEEKLY AVERAGE:	74%	67	.01 per day	

DAILY AVERAGE WEATHER DATA

(obtained from Department of the Air Force)
DOVER AIR FORCE BASE, DELAWARE

AS OF: - 17-23 September 1979

DATE	AVERAGE HUMIDITY	AVERAGE TEMPERATURE	TOTAL PRECIPITATION	AVERAGE CLOUD COVER
9/17	67%	63	0	PARTLY CLOUDY
9/18	70%	66	0	PARTLY CLOUDY
9/19	60%	67	T	PARTLY CLOUDY
9/20	58%	57	0	MOSTLY CLOUDY
9/21	75%	63	.49	MOSTLY CLOUDY
9/22	90%	66	1.20	MOSTLY CLOUDY, FOGGY
9/23	65%	59	.22	PARTLY CLOUDY
WEEKLY AVERAGE	69%	63	.27 per day	

DAILY AVERAGE WEATHER DATA

(obtained from Department of the Air Force)
DOVER AIR FORCE BASE, DELAWARE

AS OF: - 24-30 September 1979

DATE	AVERAGE HUMIDITY	AVERAGE TEMPERATURE	TOTAL PRECIPITATION	AVERAGE CLOUD COVER
9/24	67%	61	0	PARTLY CLOUDY
9/25	75%	63	T	MOSTLY CLOUDY
9/26	73%	66	0	MOSTLY CLOUDY, HAZY
9/27	66%	61	0	PARTLY CLOUDY
9/28	80%	69	0	MOSTLY CLOUDY, FOGGY
9/29	82%	72	.09	MOSTLY CLOUDY, FOGGY
9/30	87%	67	.07	MOSTLY CLOUDY, FOGGY
WEEKLY AVERAGE	76%	66	.02 per day	

WEATHERING TEST -- TENSILE STRENGTH

1 URETHANE

Sample lenses to be tested:

(a) 20 samples Mobay MD85A aged

17 samples Mobay MD85A controls

(b) 20 samples Mobay 985A aged

17 samples Mobay 985A controls

(c) 20 samples Upjohn 2103-80A aged

17 samples Upjohn 2103-80A controls

1. In accordance with ASTM D412, determine the thickness, breaking strength, elongation and modulus of five samples from each category.

2. Label remaining samples with a black Sharpie marker.

3. Tie aging samples to Weathering Test Fixture, ILC SK79-0167. Place controls into dark container.

4. Bring down five samples every other week and perform the tests outlined in 1. above. Remove three controls from the container every other week and perform the same tests.

2 URETHANE/SILICONE BOND

Sample lenses to be tested:

(a) 5 Mobay MD85A/Silicone

(b) 5 Mobay 985A/Silicone

(c) 5 Upjohn 2103-80A/Silicone

Each substrate is cut to 1" x 4" and bonded with a 1/4" overlap in accordance with ILC Bonding Specification.

1. Pull one sample from each group in accordance with ASTM D732 for peeling in shear mode.

2. Tie remaining samples on Weathering Test Fixture, ILC SK79-0167.

3. Take down one sample each week from each group and test as outlined in Step 1.

TABLE OF SHEAR STRENGTHS OF
AGED SILICONE/URETHANE BONDED SAMPLES

(Readings are lbs/in^2)

AGING BEGAN 8/27/79

SAMPLE	WEEKS: 0	1	2	3	4
MOBAY 985A	20	18.5	30	23	31
MOBAY MD85A	21	34.0	29	23.5	32
UPJOHN 2103A	28	35.0	27.5	26	24
AVERAGE:	23	29.0	28.8	24	29

APPENDIX C

ILC DOVER
BOX 266 - FREDERICA, DE. 19946

TEST REQUEST

TEST NUMBER		05F-1 9236-06
1. PROJECT NAME GAS MASK DEVELOPMENT	2. CHARGE NUMBER X06-891-500	3. DATE 8/24/79

4. TITLE

1. SHEAR TESTS
2. AGING OF SHEAR

5. ARTICLE DESCRIPTION

5 ea. Silicone/Upjohn 2103-80A
5 ea. Silicone/Mobay 985A
5 ea. Silicone/Mobay MD85A
All samples are bonded with 1/4" overlap in accordance with ILC Bonding size

6. TEST DESCRIPTION

1. Pull in shear mode 20 in/min
   Sample #1 from each of the three groups
2. Put the remaining 12 samples on the roof.
3. Bring in a sample each week from each group and perform shear.

7. TEST PROCEDURE ATTACHED ☐ YES ☐ NO

8. PHOTO DOCUMENTATION REQUIRED ☐ YES ☐ NO

9. DATE RESULTS NEEDED
8/27/79

10. ORIGINATOR
Mary Valla

TEST COORDINATOR

PRIORITY	WITNESS	YES	NO
	Originator		
	Coordinator		
TEST LEVEL			

COMMENTS

APPENDIX C

Q & R REVIEW

Q&R WITNESS ☐ YES ☐ NO

DCASR WITNESS ☐ YES ☐ NO

Q&R CALIBRATION VERIFICATION ☐ YES ☐ NO

COMMENTS

Reviewed By	Date
68	

TEST CONDUCTOR

SCHEDULE	APPROVAL TC	APPROVAL Q&R
DATE		
TIME		

COMMENTS

ILC DOVER

BOX 266-FREDERICA, DE. 19946

TEST RESULTS

TEST NUMBER	
05F-1 9236-06	

PROJECT NAME	CHARGE NUMBER	DATE
GAS MASK DEVELOPMENT	X06-891-500	9/26/79

TEST EQUIPMENT USED	CALIBRATION OF TEST EQUIPMENT VERIFIED BY	DATE
INSTRON	W. Ayrey	9/26/79

SAMPLE NUMBER

M	T-1	--	20 lbs.	
MD	T-1	--	21 lbs.	
UP	T-1	--	28 lbs.	
M	T-2	--	18.5 lbs.	
MD	T-2	--	34.0 lbs.	1 week
UP	T-2	--	35.0 lbs.	
M	T-3	--	30.0 lbs.	
MD	T-3	--	29.0 lbs.	2 weeks
UP	T-3	--	27.5 lbs.	
M	T-4	--	23.0 lbs.	
MD	T-4	--	23.5 lbs.	3 weeks
UP	T-4	--	26.0 lbs.	
M	T-5	--	31.0 lbs.	
MD	T-5	--	32.0 lbs.	4 weeks
UP	T-5	--	24.0 lbs.	

ENVIRONMENT DURING TEST

Room Ambient

RESULTS RECORDED BY

APPENDIX C

DATA APPROVED BY

NAME	TITLE	DATE

FORM NO. 2014 (11/69) White - Test Lab Yellow - Test Requestor PRINTED IN USA

APPENDIX D

BONDING STUDY

PHASE I -- INITIAL MASK FABRICATION

Urethane/Silicone masks have been delivered to Edgewood. Several attempts at bonding had resulted in five deliverables, which we believed were not representative of our best effort. Edgewood had requested five additional masks. Fabrication of these masks began using the following procedure:

<u>MASK I -- PROCEDURE</u>

1. Paint Spraylat on outside of Urethane lens.
2. Abrade edge of lens.
3. Clean mask and lens with Toluene removing Viton from mask.
4. Wipe over with Isopropyl Alcohol unitl it squeaks.
5. Flame the mask.
6. Mix 1.5 parts of Versamid 125 to 1 part of Residual 704 Part A.
7. Deaerate.
8. Apply cement to mask.
9. Attach lens.
10. Put in vacuum bag in oven at 150°F for two hours.

<u>RESULTS</u>

Lens could be ripped of mask. Cement had run onto inside of lens. It was felt that the running of adhesive into the visual area was a problem to be corrected.

MASK II -- PROCEDURE

1. The second mask and lens was prepared using the same procedure as the first with the following deviations.

(a) Mold was modified to include a narrow channel adjacent to bonding area to become a reservoir for excess cement.

(b) Lens was painted on inside and outside surface with Spraylat.

RESULTS

Voids in top bond.

It was felt an alternate Epoxy would yield better bonds with the Versamid.

MASK III -- PROCEDURE

1. The third mask and lens was prepared using the same procedure as the first with the following deviations:

(a) 1.5 parts of Versamid 125 to 1 part of Epon 828.

RESULTS

Voids along botton of mask.

Tiny air bubbles continually occurred. It was hypothesized that during the cure cycle the solvents, which had seeped into the silicone, were gassing off into the adhesive.

MASK IV -- PROCEDURE

1. Mask and lens cleaned with 50/50 solution of Toluene/IPA.

2. Mask and lens oven dried for 45 minutes at 150°F to degas remaining solvents from clenaing.

3. Flame mask and lens.
4. Mix 8 grams of Versamid 125 to 4 grams Epon 828.
5. Deaerate for five minutes.
6. Cement heated in waterbath at 130°F.
7. Dearreate.
8. Cement applied to mask with spatula.
9. Join together and place in vacuum.
10. Pull vacuum, rolling bonded area with a Teflon roller.
11. Cured at room temperature.

RESULTS

Lens was easily removed but there appeared to be inadequate adhesion.

PHASE II -- NARROWING SCOPE OF BONDING VARIABLES

At this point mask fabrication was stopped to begin test strips and develop an optimal procedure for bonding.

We first theorized the adhesive was too thin. Cabosil, a filler, was added to create a thixotropic mixture. Bonds were slightly improved but they had a cloudy appearance. This effort was discontinued to concentrate on achieving an effective mixture using a hardener and epoxy system.

Preliminary bonding samples were fabricated to determine the effects of time in the process. Induction and set-up times were varied to determine the pot life and effective use of the adhesive mixture. No pull tests were performed, only subjective hand pulling.

Table D-1. PRELIMINARY BONDING

No Pull Tests performed. Subjective Testing to narrow down variables.

1. Adhesive Mixture - Versamid/Epoxy 1:75:1

Mixed and deaerated for six (6) minutes.

SAMPLE	TIME FROM INDUCTION	PROCEDURE	RESULTS
A	30	Wiped with Toluene, Adhesive applied, joined	Bad
B	30	Wiped with IPA; Repeat A	Good
C	30	Wiped with MEK; Repeat A	Good
D,E,F	32	Applied adhesive to both surfaces; set for five minutes in oven; join	Good
G	82	Apply cement; join	Bad

Table D-2. Procedure 2.

11. Adhesive Mixture- Versamid/Epoxy 1.75:1

Heat in 120° WaterBath for Seven (7) Minutes.
Deaerate for six (6) minutes.

SAMPLE	TIME FROM INDUCTION	PROCEDURE	RESULTS
A	20	Apply to substrates; join	Good
B	26	Apply; Set at room temperature for 3 minutes; join	Good
C	45	Apply; place in oven for nine (9); minutes; join	Good

Table D-3. Procedure 3

III. Adhesive Mixture - Versamid/Epoxy 1.75:1

Put in Water Bath for eight (8) minutes.
Deaerate for six (6) minutes.

SAMPLE	TIME FROM INDUCTION	PROCEDURE	RESULTS
A	42	Apply; place in oven for 19 minutes; join.	Bad
B	45	Apply; set at room temperature for 26 minutes	Good
C	48	Apply; adhesive and nylon scrim; join	Good
D	63	Apply; set for six minutes. join	Bad
E	76	Apply; set for 10 minutes; join	Bad

The following observation were made:

A. INDUCTION TIME

The initial mixing of the Versamid and Epon produced a cloudy, white mixture. After deaeration and a set-up time of 15 minutes, the adhesive cleared. The two substances need a time to react and cannot be used until then. The mixture could not easily be deaerated in the vacuum. Heating after induction, then deaerating accelerated the clearing up of the mixture and also set-up time.

B. POT LIFE

The samples joined one hour after induction did not bond well. This appears to be the useful pot life of the adhesive.

C. SOLVENT WIPING

At this time it appears the Viton has some effect on adhesion. Since Viton resists adhesion it appears beneficial that it be removed. The solvents used to clean the substrates also contributed. MEK, Toluene, and IPA are the candidates. IPA does not remove the Viton. Toluene can adversely affect the silicone. MEK is a solvent for Viton and has yielded satisfactory results.

D. SURFACE TREATMENT

Both abrading and flaming are contributory variables. At this time there is insufficient data to determine the effect.

E. ADHESIVE APPLICATION

Until now cement had only been applied to the silicone. Since most of the bonds peeled away from the urethane, it appears that there is insufficient cement for both substrates to react and adhere. Adhesive should be applied to both substrates.

F. RECOMMENDED SURFACE TREATMENT & CEMENT MIXTURE

1. Prepare Surfaces
   - (a) Abrade the urethane bonding surface.
   - (b) Clean silicone and urethane with MEK, removing the Viton from the Silicone.
   - (c) Oven dry at 150°F for one hour.
   - (d) Flame silicone and urethane.
2. Cement Mixture
   - (a) Mix seven grams of Versamid 125 with four grams of Epon 828.
   - (b) Stir with a glass rod.
   - (c) Heat in water bath at 130°F for seven minutes.
   - (d) Deaerate in vacuum for six minutes.

PHASE III

FORMULATION OF BONDING PROCEDURE

SAMPLE SET #1

1"x 4" samples of the substrates were bonded together in a 1-1/2" area according to the procedure outlined in Phase II. After a two (2) day cure the samples were tested in accordance with ASTM D1876-61T, Peel Resistance of Adhesives -- T-Peel Test.

The major purpose of this first sample set was to determine the useful pot life and epoxy lapse time. Test strips were prepared varying induction time from 30, 40, 50 and 60 minutes. The solvent wipe and abrading of substrates also varied. Samples of urethane were bonded to (a) silicone that had been treated and (b) silicone that had not been treated.

Two lots were run: the first allowing a three minutes set-up after application, the second was a five minute set-up. Table 4 lists the results. Table 5 gives the matrix of samples which experienced total separation.

Twelve of the 32 samples exhibited as silicone failure at the bond. Eighteen of the 32 totally separated. Force at separation varied from 3.4 to 31.5 lbs. At this time the only variable not rigidly controlled was the flaming of the samples. This is hypothesized to be a contributor to the erratic bonds.

ILC DOVER
BOX 266 - FREDERICA, DE. 19946

TEST REQUEST

TEST NUMBER: 05F-1 9100-03

1. PROJECT NAME: GAS MASK DEVELOPMENT	2. CHARGE NUMBER: X06-891-500	3. DATE: 4/10/79
4. TITLE: PEEL TESTS	5. ARTICLE DESCRIPTION: Strip #'s 1-36 1st SET OF BONDS	

6. TEST DESCRIPTION

Samples are identified

Note on charge # identified

7. TEST PROCEDURE ATTACHED ☐ YES ☐ NO

8. PHOTO DOCUMENTATION REQUIRED ☐ YES ☐ NO

9. DATE RESULTS NEEDED: 4/11/79

10. ORIGINATOR: Mary Valla

TEST COORDINATOR

PRIORITY	WITNESS	YES	NO
3	Originator X		
	Coordinator		
TEST LEVEL			

COMMENTS

Q & R REVIEW

Q&R WITNESS ☐ YES ☐ NO

DCASR WITNESS ☐ YES ☐ NO

Q&R CALIBRATION VERIFICATION ☐ YES ☐ NO

COMMENTS

Reviewed By	Date

TEST CONDUCTOR

	SCHEDULE	APPROVAL TC	APPROVAL Q&R
DATE			
TIME			

COMMENTS

APPENDIX D

White - Test Lab Yellow - Test Lab Pink - Originator PRINTED IN USA

ILC DOVER BOX 266-FREDERICA, DE. 19946	TEST RESULTS	TEST NUMBER 05F-1 9100-03
PROJECT NAME GAS MASK DEVELOPMENT	CHARGE NUMBER X06-891-500	DATE 4/10/79
TEST EQUIPMENT USED INSTRON	CALIBRATION OF TEST EQUIPMENT VERIFIED BY W. Ayrey	DATE 4/10/79

SAMPLE #	ULTIMATE PULL (LBS/IN)	FAILURE MODE
1	25.5 lbs/in	Material
2	6.0	Material
3	16.0	Material
4	13.6	Material
5	10.4	Material
6	8.0	Material
7	4.4	Material
8	10.0	Material
9	Separated on delivery	Adhesive
10	Separated on delivery	Adhesive
11	4.0	Adhesive
12	3.4	Adhesive
13	23.5	Adhesive
14	31.5 (Excellent)	Material
15	25.0	Material
16	31.5 (Small area together)	Material
17	20.0	Material
18 (very difficult to to peel)	16.0 (Bond contact)	Material
19	7.0	Material
20	23.5 (Excellent)	Material
21	4.4	Adhesive
22	7.2	Adhesive
23	20.0	Material
24	11.6	Adhesive
25	19.4	Adhesive
26	11.4 lbs/in	Adhesive
27	11.4	Adhesive
28	4.2	Adhesive
29	33.0	Material
30	35.0	Material

ENVIRONMENT DURING TEST ROOM AMBIENT	DATA APPROVED BY NAME	TITLE	DATE
RESULTS RECORDED BY APPENDIX D			

FORM NO. 20 [illegible] White - Test Use Yellow - Test Requestor PRINTED IN USA

ILC DOVER BOX 266-FREDERICA, DE. 19946	TEST RESULTS	TEST NUMBER 05F-1 9100-03
PROJECT NAME GAS MASK DEVELOPMENT	CHARGE NUMBER X06-891-500	DATE 4/10/79
TEST EQUIPMENT USED INSTRON	CALIBRATION OF TEST EQUIPMENT — VERIFIED BY W. Ayrey	DATE 4/10/79

SAMPLE #	ULTIMATE PULL (LBS/IN)	FAILURE MODE
31 (pulled off Urethane)	9.6 (bad bond)	Material
32	30.0	Material
33	19.0	Material
34	19.0	Material
35	35.0	Material
36	20.5	Material

ENVIRONMENT DURING TEST	DATA APPROVED BY		
ROOM AMBIENT	NAME	TITLE	DATE
RESULTS RECORDED BY			
APPENDIX D			

TABLE D-4
Results of Sample Set #1 Controlled Bonding

	TOLUENL WIPED	MEK WIPED	BOTH ABRADED MEK WIPED	NON-VITON SILICONE MED WIPED	TOLUENE WIPED	MEK WIPED	BOTH ABRADED MEK WIPED	NON-VITON SILICONE
	SAMPLE #1 25.5 lbs.	SAMPLE #5 10.4 lbs.	SAMPLE #9	SAMPLE # 13 23.5 .bs.	SAMPLE #17 20.0 lbs.	SAMPLE #21 4.4 lbs.	SAMPLE #25 19.4 lbs.	SAMPLE #29 33.0 lbs.
10	Separated for 1" Stayed bonded for 1/2". Excellent Broke at Bond	Separated 3/4". broke; remaining is excellent bond	Did Not bond; Sample curves were opposite	Total Separation	Total Separation	Total Separation	Total Separation	Separation 3/4". broke; Excellent bond.
	SAMPLE #2 6.0 lbs.	SAMPLE #6 8.0 lbs.	SAMPLE #10	SMAPLE #14 31.5 lbs.	SAMPLE #18 16.0 lbs.	SAMPLE #22 7.2 lbs.	SAMPLE #26 11.4 lbs.	SAMPLE #30 35.9 lbs.
40	Did not Separate Excellent 1" bond; Broke at bond.	Separated	Did not bond; Sample Curves were opposite	Broke at bond; Excellent bonded area	Total Separation	Total Separation	Total Separation	Broke at Bond; Excellent
	SAMPLE #3 16.0 lbs	SAMPLE #7 4.4 lbs.	SAMPLE #11 4.3 lbs.	SAMPLE #15 25.0 lbs.	SAMPLE #19 7.0 lbs.	SAMPLE #23 20.0 lbs.	SAMPLE #27 11.4 lbs.	SAMPLE #31 9.6 lbs.
50	Separated 1" broke; Stayed bonded 1/2"; fair bond	Separated 3/4" broke; Excellent bond	Separated; poor sample	Separated leaving Silicone pieces; broke at 3/4"; Excellent bond.	Broke at bond Partial Separation into bond	Total Separation	Total Separation	Total Separation
	SAMPLE #4 13.6 lbs.	SAMPLE #8 10.0 lbs.	SAMPLE #12 3.4 lbs.	SAMPLE #16 31.5 lbs.	SAMPLE #20 23.5 lbs.	SAMPLE # 24 11.6 lbs.	SAMPLE 28 4.2 lbs.	SAMPLE 32 30.0 lbs.
60	Total Separation	Separated 3/4" broke; remaining bond peeled	Separated; Poor sample	Total Separation	Broke at bond: remaining excellent.	Total Separation	Total Separation	Total Separation

TABLE D-5

Bonds of Sample Set #1 Exhibiting Total Separation

	3 MINUTES				5 MINUTES			
	TOLUENE WIPED	MEK WIPED	BOTH ABRADED MEK WIPED	NON-VITON SILICONE MEK	TOLUENE WIPED	MEK WIPED	BOTH ABRADED MEK WIPED	NON-VITON SILICONE MEK
30				#13 23.5	#17 20.0 #	#21 4.4 #	#25 19.4 #	
40		#6 8.0			#18 16.0 #	#22 7.2 #	#26 11.4 #	
50			#11 4.3			#23 20.0 #	#27 11.4 #	#31 9.6 #
60	#4 13.6		#12 3.4	#16 31.5		#24 11.6 #	#28 4.2 #	#32 30.0 #

SAMPLE SET #2

No direct pattern existed correlating the induction time with optimal bond adhesion. Ths most desirable results appeared 40 minutes after induction with a three minute lapse time after epoxy application. These times were held constant for the third set of bonds. The erratic results from the first set of bonds were attributed to the flame treatment. Flaming is the only variable that had not yet been rigidly controlled for this set. The blue flame remained 1 inch in length and was passed over the substrate impinging a 1/2" inch to 1 inch diameter flame to the surfaces.

The effects of the Viton finish were studied under this lot:

A. Viton was totally removed with MEK.

B. Viton is removed by abrading.

C. Silicone that was never Viton coated.

D. Viton remains on Silicone.

An alternate hypothesis is that not enough epoxy is present to bond the two surfaces. Samples were run with a spacer between:

a) cheesecloth scrim

b) nylon scrim

Silicone/Silicone and Urethane/Urethane samples were also prepared to determine from which substrate the bond failed. Results of these bonds are reported in Table 6. The samples which proved to be superior were those with the Viton removed. The use of a scrim spacer did not prove necessary or desirable.

ILC DOVER BOX 266 - FREDERICA, DE. 19946	TEST REQUEST	TEST NUMBER 05F-1 9110-01

1. PROJECT NAME	2. CHARGE NUMBER	3. DATE
GAS MASK DEVELOPMENT	X06-891-500	4/20/79

4. TITLE	5. ARTICLE DESCRIPTION
PEEL TESTS	1" SAMPLES #1-22 23-30 35-41

6. TEST DESCRIPTION	
	7. TEST PROCEDURE ATTACHED ☐ YES ☐ NO
	8. PHOTO DOCUMENTATION REQUIRED ☐ YES ☐ NO
	9. DATE RESULTS NEEDED 4/23/79
	10. ORIGINATOR Mary Valla

TEST COORDINATOR

PRIORITY	WITNESS	YES	NO
2	Originator		X
	Coordinator	X	
TEST LEVEL			
C			

COMMENTS

APPENDIX D

C & R REVIEW

C&R WITNESS ☐ YES ☐ NO

DCASR WITNESS ☐ YES ☐ NO

C&R CALIBRATION VERIFICATION ☐ YES ☐ NO

COMMENTS

Reviewed By	Date

TEST CONDUCTOR

SCHEDULE	APPROVAL	
	TC	C&R
DATE		
TIME		

COMMENTS

ILC DOVER BOX 266 - FREDERICA, DE. 19946	TEST RESULTS	TEST NUMBER 05F-1 9110-01
PROJECT NAME GAS MASK DEVELOPMENT	CHARGE NUMBER X06-891-500	DATE 4/10/79
TEST EQUIPMENT USED INSTRON	CALIBRATION OF TEST EQUIPMENT — VERIFIED BY W. Ayrey	DATE 4/20/79

SAMPLE #	ULTIMATE PULL (LBS/IN)	FAILURE MODE
1	17.2	Material
2	18.4	Material
3	MATERIAL SLIT ON DELIVERY	
4	34.0	Material
5	10.8	Adhesive
6	MATERIAL SLIT ON DELIVERY	
7	14.0	Adhesive
8	11.4	Adhesive
9	8.0	Material
10	5.2	Material
11	7.6	Material
12	5.4	Adhesive
13	7.0	Adhesive
14	7.0	Material
15	9.4	Adhesive
16	14.4	Adhesive
17	5.9	Adhesive
18	4.4	Adhesive
19	6.0	Material
20	4.0	Adhesive
21	10.4	Adhesive
22	15.6	Material
23	Material Slit on Delivery	
24	Entire Sample Cemented Together	
25	14.0	Material
26	10.9	Material
27	12.8	Adhesive
28	9.1	Adhesive
29	11.4	Adhesive
30	9.4	Adhesive

ENVIRONMENT DURING TEST

ROOM AMBIENT

RESULTS RECORDED BY

APPENDIX D

DATA APPROVED BY

NAME	TITLE	DATE

FORM NO. 2014 (11/93) White - Test Lab Yellow - Test Requester PRINTED IN USA

ILC DOVER BOX 266-FREDERICA, DE. 19946	TEST RESULTS	TEST NUMBER 05F-1 9110-01
PROJECT NAME GAS MASK DEVELOPMENT	CHARGE NUMBER X06-891-500	DATE 4/20/79
TEST EQUIPMENT USED INSTRON	CALIBRATION OF TEST EQUIPMENT VERIFIED BY W. Ayrey	DATE 4/20/79

SAMPLE #	ULTIMATE PULL (LBS/IN)	FAILURE MODE
35	19.4	Adhesive
36	16.5	Adhesive
37	12.7	Adhesive
38	25.5	Material
39	12.0	Adhesive
40	22.0	Material
41	16.0	Adhesive

ENVIRONMENT DURING TEST	DATA APPROVED BY		
ROOM AMBIENT	NAME	TITLE	DATE
RESULTS RECORDED BY APPENDIX D			

FORM NO. 2214 (1/99) White - Test Lab Yellow - Test Requester PRINTED IN USA

TABLE D-6
Results of Sample Set #2 Controlled Bonding

BONDING METHOD: 1.75 VERSAMID: 1 EPON 828

MIX; HEAT IN H_2O AT 130°F FOR SEVEN (7) MINUTES; DEAERATION FOR EIGHT (8) MINUTES; SET; FLAME TREAT SURFACES WITH FLAME 1" LONG, ABOUT /12" TO 1" DIAMETER FLAME IMPENGED IN SURFACE; APPLY EPOXY 40 MINUTES AFTER INDUCTION WITH NEEDLE; SET FOR 3 MIN.; PLACE TOGETHER; OVEN CURE AT 150°F FOR 2 HRS.

MEK WIPED TREATMENT	MEK WIPED CHEESE CLOTH	VITON REMAINS ON SILICONE	SILICONE IS ABRADED TO REMOVE VITON	VITON REMOVED WITH MEK SCRIM APPLIED	MEK WIPED	SILICONE TO	URETHANE TO URETHANE ABRADED	MASKS NOT VITON COATED
SAMPLE #1 17.2 lbs/in Excellent Material break at bond	SAMPLE #5 10.8 lbs/in Separated	SAMPLE #9 8.0 lbs/in Silicone Break at bond; OK bond; could peel with hand	SAMPLE #12 5.4 lbs/in Separated	SAMPLE #16 14.4 lbs/in Separated	SAMPLE # 20 4.9 lbs/in Separated	SAMPLE #23 Bad Sample	SAMPLE #27 12.8 lbs/in Total Separation	SAMPLE #35 19.4 lbs/in Separated SAMPLE #36 16.3 lbs/in Separated
SAMPLE #2 18.4 lbs/in Excellent	SAMPLE #6 Bad Sample Separated	SAMPLE #10 5.2 lbs/in Silicone break at bond; OK bond; could peel with hand	SAMPLE 13 7.0 lbs/in Separated	SAMPLE #17 5.9 lbs/in Separated	SAMPLE #21 10.4 lbs/in Separated	SAMPLE #24 Bad Sample	SAMPLE #28 9.1 lbs/in Total Separation	SAMPLE #37 12.7 lbs/in Separated SAMPLE #38 20.5 lbs/in
SAMPLE #3 Bad Sample	SAMPLE #7 14.0 lbs/in Separated	SAMPLE #11 7.6 lbs/in Silicone break at bond; OK bond	SAMPLE #14 7.0 lbs/in Material break at bond; OK bond	SAMPLE #18 4.4 lbs/in Separated peel bond	SAMPLE #22 15.6 lbs/in Broke at bond; Could	SAMPLE #25 14.0 lbs/in Broke at bond	SAMPLE #29 11.4 lbs/in Total Separation	SAMPLE #39 12.0 lbs/in SAMPLE #40 22.0 lbs/in Broke at bond
SAMPLE #4 3.4 lbs/in Excellent	SAMPLE #8 11/4 lbs/in Separated		SAMPLE #15 9.4 lbs/in Separated	SAMPLE #19 6.0 lbs/in Separated		SAMPLE #26 10.9 lbs/in Broke at bond	SAMPLE #30 9.4 lbs/in Total Separation	SAMPLE #41 16.0 lbs/in Separated

SAMPLE SET #3

From the previous sets of samples the following procedure was adopted:

Viton removed from Silicone using MEK. Urethane abraded then wiped with MEK. Samples degassed in oven for one hour at 150°F.

1.75 VERSAMID 1 EPON 828

Mix; heat in H_2O at 130°F for seven minutes; deaeration for eight minutes; set; flame treat surfaces with flame 1 inch long, about 1/2 inch to 1 inch diameter flame impenged in surface; apply epoxy 40 minutes after induction with needle; set for three minutes; place together; oven cure at 150°F for two hours.

The purpose of this sample set was to determine the effects of pressure onto the bond. A sample mask and lens was prepared and put together using a viscous blue silicone as cement out. It was felt that since we were working with a clear cement. we were not seeing the full displacement of the adhesive mixture.

Samples were set up using the following weights and also scrims spacers. See Table 7 for these results. The amount of pressure had a definite affect on adhesive displacement and resulting bond.

It was felt at this time the optimal condition would be for the adhesive to be tacky.

ILC DOVER
BOX 266 - FREDERICA, DE. 19946

TEST REQUEST

TEST NUMBER: 05F-1 9121-03

1. PROJECT NAME	2. CHARGE NUMBER	3. DATE
GAS MASK DEVELOPMENT	X06-891-500	5/01/79

4. TITLE	5. ARTICLE DESCRIPTION
PEEL TESTS	SAMPLE #'s 1-25

6. TEST DESCRIPTION

7. TEST PROCEDURE ATTACHED ☐ YES ☐ NO

8. PHOTO DOCUMENTATION REQUIRED ☐ YES ☐ NO

9. DATE RESULTS NEEDED: 5/03/79

10. ORIGINATOR: Mary Valla

TEST COORDINATOR

PRIORITY	WITNESS	YES	NO
2	Originator		X
	Coordinator	X	
TEST LEVEL: C			

COMMENTS

APPENDIX D

Q & R REVIEW

Q&R WITNESS ☐ YES ☐ NO

DCASR WITNESS ☐ YES ☐ NO

Q&R CALIBRATION VERIFICATION ☐ YES ☐ NO

COMMENTS

Reviewed By	Date

TEST CONDUCTOR

SCHEDULE	APPROVAL TC	Q&R
DATE		
TIME		

COMMENTS

White - Test Lab Yellow - Test Lab Pink - Originator PRINTED IN USA

ILC DOVER BOX 266-FREDERICA, DE. 19946	TEST RESULTS	TEST NUMBER 05F-1 9121-03
PROJECT NAME GAS MASK DEVELOPMENT	CHARGE NUMBER X06-891-500	DATE 5/01/79
TEST EQUIPMENT USED INSTRON	CALIBRATION OF TEST EQUIPMENT VERIFIED BY: W. Ayrey	DATE 5/01/79

SAMPLES # 1-25
PEEL TEST

SAMPLES #	RESULTS (LB/IN)	FAILURE MODE
1	10.2	Material
23	11.2	Material
21	14.3	Material
24	9.7	Material
25	10.5	Material
20	20.0	Material
19	21.0	Material
9	6.7	Material
8	18.5	Material
15	6.8	Material
16	9.2	Material
17	23.7	Material
18	25.0	Material
10	6.0	Adhesive
7	20.0	Material
6	7.9	Material
2	17.2	Material
14	13.2	Material
12	19.2	Material
11	8.6	Material
5	6.1	Material
4	6.7	Material
3	3.7	Material
13	19.6	Material

ENVIRONMENT DURING TEST	DATA APPROVED BY		
ROOM AMBIENT	NAME	TITLE	DATE
RESULTS RECORDED BY APPENDIX D			

FORM NO. 2214 (1/93) White - Test Lab Yellow - Test Requestor PRINTED IN USA

TABLE D-7
Results of Sample Set #3 Controlled Bonding
(Bonding Method: Per Table 6)

Use 143g Pressure	Use 143g & Netting	Use 100g Pressure	Use 100g & Netting	Use 125g Pressure	Vacuum Pressure
1 10.2 Separated Thickness .214	7 20.0 Broke at Bond Excellent	11 8.60 Broke at Bond Excellent	15 6.80 Broke at Bond Excellent	19 21.0 Broke at Bond Excellent	21 14.3 Broke at Bond Excellent
2 17.2 Broke at Bond Very Good Thickness. 223	8 18.5 Separated	12 19.2 Broke at Bond Excellent	16 9.20 Broke at Bond Excellent	20 20.0 Broke at Bond Excellent	22
3 3.70 Broke at Bond Excellent Thickness .235	9 6.70 Broke at Bond Excellent	13 19.6 Separated	17 23.7 Separated		23 11.2 Broke at Bond Excellent
4 6.70 Separated Thickness.228	10 6.00 Separated	14 13.2 Broke at Bond Excellent	18 25.0 Separated		24 9.70 Broke At Bond Excellent
5 6.10 Broke at Bond Excellent Thickness .221					25 10.5 Broke at Bond Excellent
6 7.90 Separated Thickness .246					

SAMPLE SET #4

The purpose of this set was two-fold.

a) Work with the Versamid to achieve a tacky surface that would give a satisfactory bond.

b) Locate an alternate contact adhesive system.

Samples 1 through 8 and 15 through 24 of Sample Set #4 were all joined after a longer induction and waiting period after application. All but sample 20 had excellent peel strength. Until now mixture ratio has been held fairly constant. These ratios were varied according to the difference in volume between the epoxy and hardener.

ILC DOVER BOX 266 - FREDERICA, DE. 19946	**TEST REQUEST**	TEST NUMBER 05F-1 9151-04
1. PROJECT NAME GAS MASK DEVELOPMENT	2. CHARGE NUMBER X06-891-500	3. DATE 5/31/79
4. TITLE PULL TESTS AT 12" SPEED	5. ARTICLE DESCRIPTION TEST STRIPS #1-24	

6. TEST DESCRIPTION Record Breaking Strengths	7. TEST PROCEDURE ATTACHED ☐ YES ☐ NO
	8. PHOTO DOCUMENTATION REQUIRED ☐ YES ☐ NO
	9. DATE RESULTS NEEDED 6/01/79
	10. ORIGINATOR Mary Valla

TEST COORDINATOR

PRIORITY	WITNESS	YES	NO
3	Originator		X
	Coordinator	X	
TEST LEVEL			
C			

COMMENTS

APPENDIX D

Q & R REVIEW

Q&R WITNESS ☐ YES ☐ NO

DCASR WITNESS ☐ YES ☐ NO

Q&R CALIBRATION VERIFICATION ☐ YES ☐ NO

COMMENTS

Reviewed By	Date
95	

TEST CONDUCTOR

SCHEDULE	APPROVAL TC	APPROVAL Q&R
DATE		
TIME		

COMMENTS

ILC DOVER BOX 266-FREDERICA, DE. 19946	TEST RESULTS	TEST NUMBER 05F-1 9151-04
PROJECT NAME GAS MASK DEVELOPMENT	CHARGE NUMBER X06-891-500	DATE 6/01/79
TEST EQUIPMENT USED INSTRON	CALIBRATION OF TEST EQUIPMENT VERIFIED BY W. Ayrey	DATE 6/01/79

PEEL TEST #'s 1-14

* MATERIAL FAILED ON ALL SAMPLES EXCEPT FOR SAMPLE #20 WHERE THERE WAS ADHESIVE FAILURE.

SAMPLE NUMBER	UNTIMATE PEEL * (LBS)
1	33
2	35.6
3	28.4
4	31.5
5	45.2
6	30.5
7	30.0
8	18.5
9	26.6
10	19.5
11	20.7
12	15.7
13	3.4
14	6.5
15	30.5
16	22.0
17	39.5
18	25.5
19	25.0
20	2.0
21	28.5
22	45.5
23	39.0
24	27.6

ENVIRONMENT DURING TEST	DATA APPROVED BY		
ROOM AMBIENT	NAME	TITLE	DATE
RESULTS RECORDED BY APPENDIX D			

FORM NO. 2014 (11/69) White - Test Lab Yellow - Test Requester PRINTED IN USA

RESULTS OF SAMP'.E SET #4 CONTROLLED BONDING

RATIO 1:1
INDUCTION: 25 min.
WAIT: 50 min.

#1 - Abraded
33

#2 - Abraded
35.6

#3 - 28.4

#4 - 31.5

RATIO 1:25:1
INDUCTION: 25 min.
WAIT: 35 min.

#5 - Abraded
45.2

#6 - Abraded
30.5

#7 - 30.0

#8 - 18.5

BOSTIK 7119:BOSCODUR
32:1

#9 - 26.6

#10 - 19.5

BOSTIK 7119:BOSCODUR:MEK
32:1:16

#11 - 20.7

#12 - 15.7

BOSTIK 7119:BOSCODUR
MEK/CYCLOHEXANONE

#13- 3.4

#14 - 6.5

RATION 1:25:1

INDUCTION: 20 min.
WAIT: 60 min.

#15 - 30.5

#16 - 22.0

INDUCTION: 25 min.
WAIT: 65 min.

#17 - 39.5

#18 - 25.5

INDUCTION: 30 min.
WAIT: 70 min.

#19 - 25.0

#20 - 20.0

INDUCTION: 90 min.

#21 - 28.5

#22 - 45.5

#23 - 39.0

#24 - 27.6

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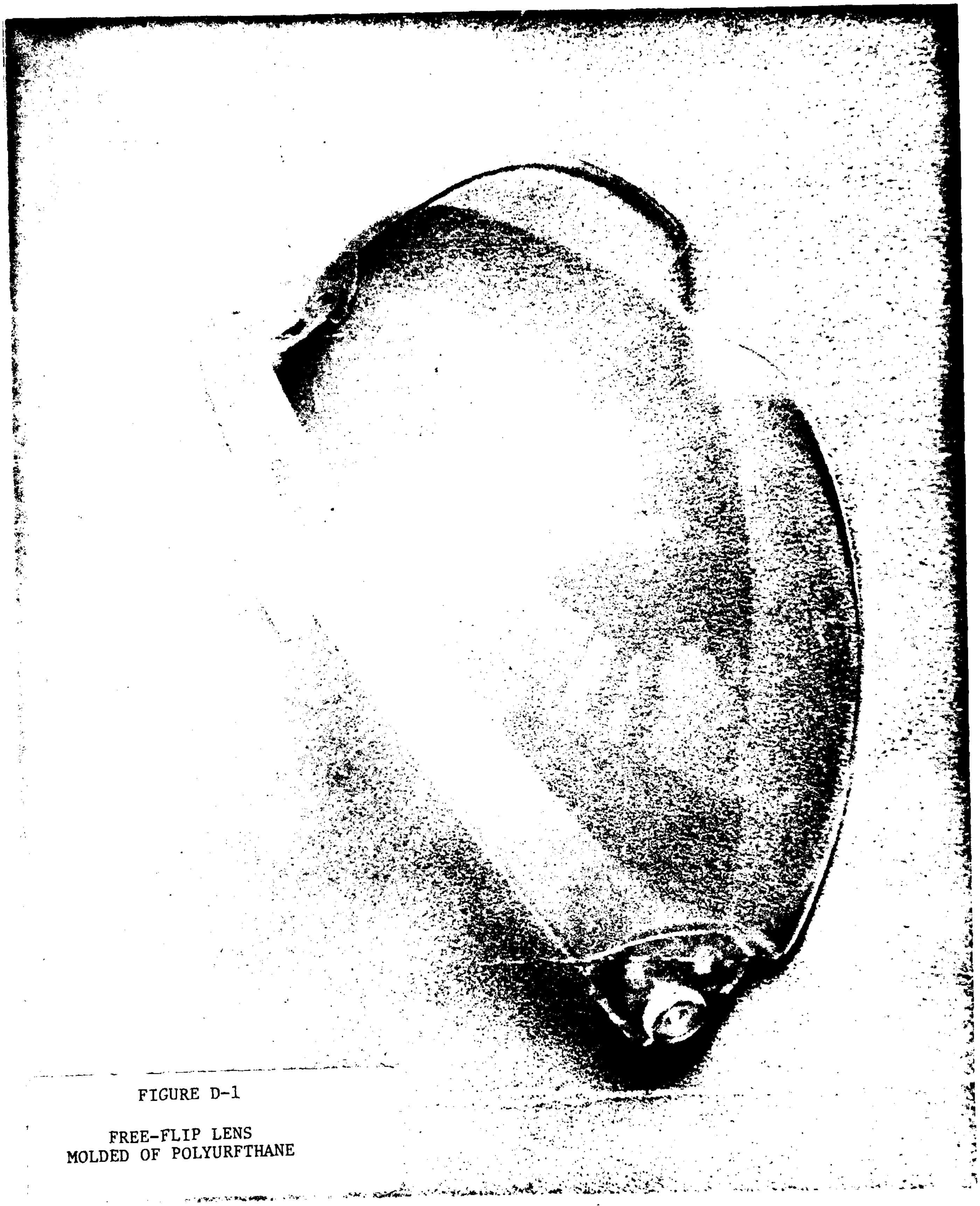

FIGURE D-1

FREE-FLIP LENS
MOLDED OF POLYURFTHANE

FIGURE D-2

VARI-VIEW LENS
MOLDED OF POLYURETHANE

FIGURE D-3
BONDING FIXTURE FOR
XM-30 GAS MASK

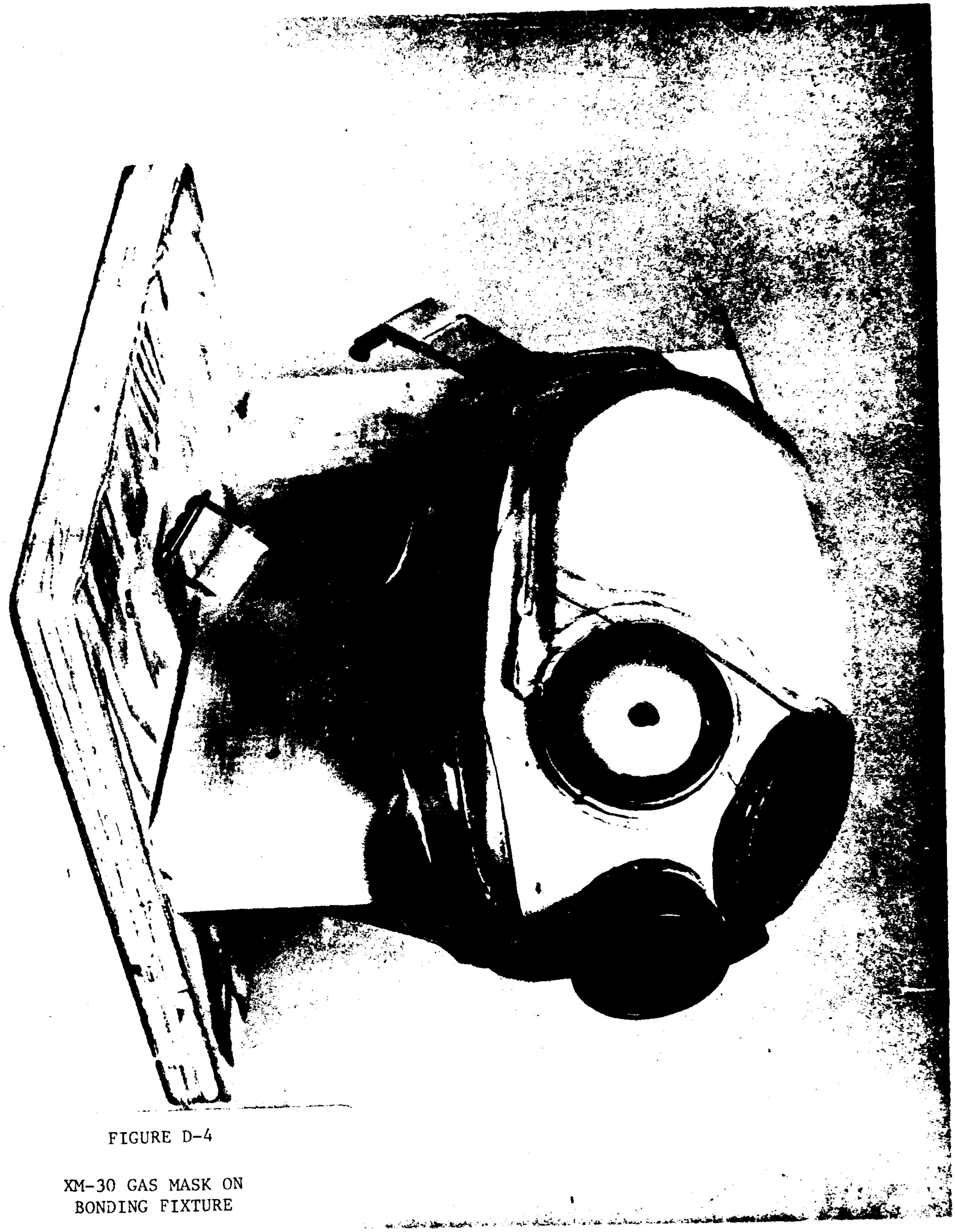

FIGURE D-4

XM-30 GAS MASK ON
BONDING FIXTURE

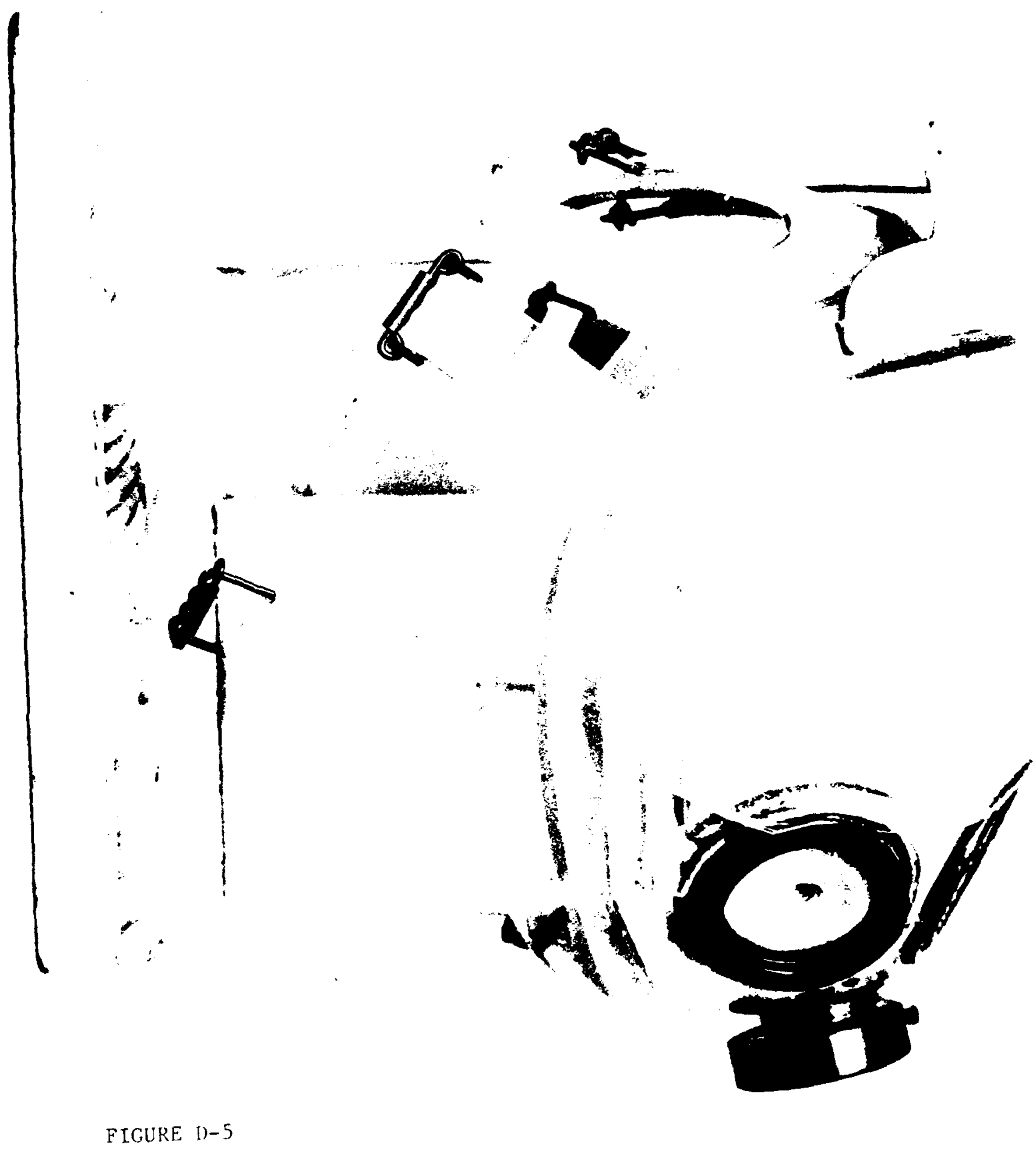

FIGURE D-5

XM-30 GAS MASK ON
BONDING FIXTURE:
ANOTHER VIEW

APPENDIX E

LOW TEMPERATURE FLEXIBILITY-OF-BOND STUDY

After the meeting at Henkel Corporation, the following samples were made:

a) 25°F -- Versamid/Epon
10g/5

b) 2:5:1 -- Versamid/Epon
10g/4 -- cracked

- 1 part Dibutyl Phthalate
  - ° 7g Epon
  - ° 11g Versamid
  - ° 9g DBP

- 2 parts Dibutyl Phthalate
  - ° 7g Epon
  - ° 11g Versamid
  - ° 3.6g DBP

- 10% Benzyl Alcohol
  - ° 7g Epon
  - ° 11g Versamid
  - ° 1.8g Benzyl Alcohol

- 20% Benxyl Alcohol
  - ° 7g Epon
  - ° 11g Versamid
  - ° 3.6 Benzyl Alcohol

- 10% DBP
  - ° 7g Epon
  - ° 11g Versamid
  - ° 1.8g DBP

- 20% DBP

  - 7g Epon
  - 11g Versamid
  - 3.6g DBP

-
  - 7g Epon
  - 11g Versamid
  - 1g DBP

Dibutyl phthalate is a very slippery chemical. These samples held up the best. However, all the samples did crack. A bead of adhesive usually extruded out. All cracks began at this thick adhesive line and propogated through. Another set of samples were fabricated taking caution to eliminate the build up.

The following companies were contacted to find alternate solutions:

Shell Chemical

No flexibilizer per se; However, the following are suggestions:

- Mix 20 parts per 100 maximum of Dibutyl Pthalate in the system.
- Use Shell 872 (more flexible) to replace 828. (Sample to be sent.)
- Mix 828 and 872 to use as one part.

Miller Stephenson Chemical

Suggested equalizing epoxy-resin ratio.

Thiokol (215) 968-5911

LP3 Flexibilizer being sent. This is a polysulfide polymer added to the polyamide. The LP3 is the least viscous. However, there is an LP33.

NL Industries (609) 433-2200

Pale 170 being sent.

The following samples were fabricated using Thiokol and DBP:

EPON 828	VERSAMID 125	DBP
14	22	.5
14	22	2.0
		THIOKOL
14	22	14
14	22	7
14	22	3.5

The Thiokol creates a rubbery mixture. These samples were placed in the freezer and flexed only in the direction of the lens curvature. These did not crack. However, when flexed in the opposite direction, cracking occurred.

All samples were fabricated from untreated silicone. No samples adhered together. This prompted an investigation process of treating the silicone lens. After reviewing some older correspondence from Dow Corning, it was determined the silicone is primed with designated QZ-8-5069. We had a five year old sample in-house which was used to coat slabs. Samples that were allowed to set up did show a marked improvement in adhesion.

APPENDIX F

AGING STUDY

WEATHERING TESTS--OPTICAL CLARITY

Sample Lenses to be Tested:

a) 40 Upjohn 2103-80A -- 8 Controls

b) 40 Mobay 985A Aged -- 8 Controls

c) 40 Mobay MD85A Aged -- 8 Controls

d) 4 Mobay 85A UV Stabilized and ILC Tint Overdose

e) 8 Mobay 85 UV Stabilized and correct mixture of ILC Tint

Procedure for Weathering -- ASTM D1435 (Adaptation)

1. In accordance with ASTM Specification D1003, determine the percent transmission and percent haze of all the samples.

2. Record the data and the date on lens testing sheets.

3. Send the samples to International Playtex for color evaluation using a colormeter and spectrophotometer in accordance with Specification.

4. Tie all samples onto the weathering test fixture, ILC SK79-0167.

5. On Tuesday morning of each week bring in five samples from each category. Determine haze and light transmission at ILC; yellowing at Playtex.

6. The following weather characteristics must be specified on the data sheets.

   a. Temperature

   b. Humidity

   c. Cloud cover

   d. Precipitation

The above should be weekly average measurements compiled for daily readings.

7. Retain the samples in a dark container.

8. Repeat Steps 4 and 5 above until eight weeks have elapsed.

GAS MASK LENS WEATHER TESTING

UPJOHN 2103-80A
INITIAL READINGS

SAMPLES	%TRAMSISSION ASTM D1003	% HAZE ASTM D1003	COLOR RD	a	b
1U	86.6	3.28	62.4	0	+5.2
2U	87.1	9.6	64.6	-0.2	+5.3
3U	87.0	4.0	65.2	-0.8	+7.0
4U	84.9	10.68	60.3	-0.5	+8.2
5U	87.6	2.5	65.0	-0.9	+6.6
6U	87.5	9.5	63.8	-0.4	+4.6
7U	87.2	10.3	64.2	-0.4	+4.5
8U	87.4	9.2	64.0	0	+4.6
9U	86.7	13.8	61.8	-0.6	+5.7
10U	85.7	4.3	59.8	-0.2	+5.6
11U	84.5	19.9	60.2	-0.7	+8.1
12U	88.2	8.4	63.7	-0.8	+6.7
13U	86.1	15.4	61.7	-0.5	+7.3
14U	86.7	2.8	62.4	-0.8	+4.7
15U	87.0	12.9	63.0	-0.2	+5.3
16U	84.9	16.3	60.3	-0.2	+6.0
17U	85.4	13.4	61.8	-0.8	+8.0
18U	87.7	7.2	64.3	-0.9	+6.6
19U	85.6	13.7	62.6	-0.7	+7.0
20U	87.6	2.6	64.8	-0.1	+4.9
21U	87.6	2.8	62.3	-0.6	+5.4
22U	84.8	19.2	58.9	-0.3	+6.2
23U	84.6	17.8	60.8	-0.6	+8.1
24U	87.5	2.3	65.1	-1.1	+6.6
25U	86.0	12.5	61.5	-0.6	+7.2
26U	87.3	11.3	63.9	-0.4	+5.3
27U	87.7	2.4	64.7	-0.2	+5.0
28U	87.8	2.7	64.5	-0.2	+5.3
29U	87.8	6.1	65.4	-0.4	+4.8
30U	87.6	9.9	65.0	-0.4	+5.5
31U	87.2	9.2	64.1	-0.2	+5.3
32U	86.3	3.3	61.9	0	+5.9
33U	84.4	17.1	60.4	-0.6	+8.1
34U	89.1	10.9	64.1	-0.8	+6.7
35U	86.4	15.4	63.4	-0.7	+6.8
36U	87.5	3.6	64.3	-0.7	+4.6
37U	85.3	10.2	63.1	-0.8	+7.5
38U	87.7	2.9	65.5	-1.0	+6.5
39U	87.8	2.9	65.7	-0.9	+4.8
40U	88.0	5.3	64.1	-0.2	+4.8
Control 1- 5U	87.6	8.6	64.2	-0.7	+5.0
Control 6-10U	85.4	16.0	59.6	-0.3	+5.0
Control 11-15U	85.5	9.6	62.7	-0.7	+7.6
Control 16-20U	87.6	2.9	63.9	-0.7	+6.4
Control 21-25U	86.2	13.9	62.9	-0.6	+6.8
Control 26-30U	87.2	4.2	63.9	-0.4	+4.5
Control 31-35U	86.1	9.5	61.2	-0.5	+5.1
Control 35-40U	86.5	4.0	61.6	-0.6	+7.7

APPENDIX F

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