N71-27142
NASA CR-115039.

FINAL REPORT

DESIGN, DEVELOPMENT AND PRODUCTION OF
PRESSURE SUIT SPECTACLES

PREPARED FOR

NASA MANNED SPACECRAFT CENTER
R & D PROCUREMENT BRANCH

CONTRACT NAS 9-9666

SUBMITTED BY

OMNITECH, DIVISION OF UNIVIS INC.
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March 31, 1971

CR-115039

S U M M A R Y

Under the terms of Contract #NAS9-9666, issued by NASA TO UNIVIS, INC., OMNITECH DIVISION; design, research and development tasks were carried out to develop and fabricate an Improved Protective Spectacle for use in the Apollo Pressure Suit. Basic design criteria were in accordance with EXHIBIT #"B", Statement of Work dated October 22, 1969, and a total of 150 such spectacles, of five different types, having various attenuative and transmissive characteristics in the ultraviolet, visible, and infra-red region of the spectrum were produced.

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INTRODUCTION

In a previous contract, (NAS9-8090), the OMNITECH DIVISION of UNIVIS developed an "all metal" pressure suit spectacle and had carried out extensive work to provide lenses having attenuative, and protective characteristics under the hostile conditions of space exposure. A total of 130 such spectacles of various types and attenuative characteristics were produced and submitted under the previous contract.

The present contract provides for the extension of this work, and has for its objective, the development, and sample production of a plastic wrap-around spectacle, made by injection molding procedures from high-impact polycarbonate. The structure represented by this goggle is unique, and incorporates the following:

1. Provision for firmly positioning, and securing within the spectacle, metal eyewires which retain corrective CR-39 lenses, and a means for adjusting said corrective lenses to required prescription interpupilary distances.

2. Use of removable, self adjusting rocking bridge for maximum comfort and best fit.

3. Incorporation of a brow bar as a part of the spectacle body, suitably padded with resilient elastomer, to serve as a sweat-deflecting means.

4. Development of the mold structure to provide lenses having optical characteristics as near plano as possible, i.e. with a minimum of refractive power, prism imbalance as worn, and best possible definition.

5. Application of a protective hardcoating to the polycarbonate surfaces, which will not degrade either the physical, or optical characteristics of the goggle, and which will provide significant mar protection to the polycarbonate or gold surface.

6. Fabrication of five types; as follows:

   A. Type I — Clear, uncolored spectacles.

   B. Type II — 10% visually transmitting, neutral density spectacles.

   C. Type III — 3% visually transmitting, neutral bidensity gold coated spectacles.

   D. Type IV — .1% neutral high density, gold coated spectacles.

   E. Type V — 5% visually transmitting, neutral intermediate density spectacles.

F. CR-39 lenses both plano and to required corrective prescription, mounted in retaining eyewires, and inserted as directed by the Technical Monitor, into selected types of spectacles.

A major function of this wrap-around, wide vision plastic spectacle is to provide ultimate in safety from impact, as well as to provide attenuative and occular refractive features. The scope of the project is detailed in EXHIBIT "B", dated October 22, 1969, comprising "Statement of Work for Development and Fabrication of Improved Protective Spectacles for use in the Apollo Pressure Suit.

PURPOSE AND SCOPE

I. GENERAL

Under the terms of this contract, we have conducted research development, tooling, and production activities in successive stages, to design, develop and fabricate wrap-around plastic pressure suit spectacles meeting the requirements of NASA, and have produced an evaluation quantity of 150 spectacles as required. To provide the foregoing, work was conducted as follows:

1. Develop a suitable design for spectacle configuration.
2. Fabricate and submit for comment and approval, in three phases, hand made models of the plastic spectacle.
3. Design, and fabricate an injection mold to produce the "Spectacle Fronts and Temples".
4. Produce and submit five types of pressure suit spectacles.

A. SPECTACLE DESIGN, STRUCTURE

A spectacle frame wrap-around structure was designed of geometry to meet fitting requirements to the Anthropometric 95 percentile head supplied by Wright Field for this purpose. This was designed to conform to EXHIBIT DB4/17 February, 1969, and to Figure #1 "WRAP AROUND FRAME, POLYCARBONATE

PLASTIC WITH METAL CORE-INTERCHANGEABLE FLOATING SADDLE BRIDGE".

Prior to fabricationof the mold, (#3 above), it was necessary that prototypes be made, studied and evaluated by NASA and finally approved for production, since the price of the mold represented the major portion of the contract cost. Starting with the foregoing design criteria, hand made prototypes were produced and submitted to NASA in three successive stages. The first prototype was delivered on August 21, 1969; the second on September 4, 1969; and the third on November 10, 1969. All three prototypes represented minor structural changes in materials, design, styling, strucutre, none of which altered the basic design or concept of the spectacle but which provided styling, flameproofness, better fit, etc.

Formal approval of the third prototype was received on November 19, 1969, and manufacture of the injection mold to produce one "front", and one pair of temples was authorized.

The final design to which the mold was fabricated is illustrated on Page17, Figure 2.

In final structure, the spectacle comprises a molded "front" which carries a slot for insertion and retension of the floating, self adjusting bridge. The front also has two swept-back, wide vision lenses, which have been power–and–prism compensated to provide "plano" optics. Incorporated at the top of the "front" is an extension, to which is attached a forehead-contacting pad, made of Fluorel, which is a fire retardent resilient elastomeric sponge, recommended by NASA, the function of which is to deflect sweat from the eyes. The front extension also has provision for the insertion, retension, and adjustment of metal eyewires which retain and position corrective occular CR–39 lenses.

Temples are of the spatula type, are molded from polycarbonate, and are attached to the front using molded–in hinge elements located in both front, and temple. The end of the temple carries a slot, through which an adjustable strap fastens, and secures the entire unit to the head. The strap is FRL–S–144 supplied by NASA in 1/2" width for this purpose.

The spectacle fronts are injection molded from polycarbonate in either clear, or neutral grey types, having different optical densities to meet the particular requirements for UV, visual, and infra–red transmittance. Two of the types are gold coated and all spectacles have a protective hardcoating applied to minimize abuse, and prevent marring. These are as follows:

TYPE I

Comprises a spectacle assembly as described, with "front" injection molded from clear, transparent pdy-carbonate, (LEXAN- Type 123-111) having high ultra-violet attenuation, and a visible transmission in the order of 88%. No significant infra-red attenuation. Spectacles are hard coated with protective OMNI-COAT - 77.

TYPE II

Comprises a spectacle assembly with plastic front and temples injection molded from tinted polycarbonate (LEXAN - Type 123-7610). This provides a lens having an essentially neutral color, visually transmitting a nominal 10%, with very high ultraviolet attenuation, and with IR attenuation averaging 47%. Spectacles are hard coated with protective Omnicoat-77.

TYPE III

Comprises a "Bidensity" spectacle, in which Type II spectacles are gold coated on the outer surface to reduce the visual transmittance to 3%. A clear bottom or "bifocal" area is left at the bottom of the lens to provide better vision in the downward position. This structure provides high attenuation in the UV, and IR region, visually transmits 3% through the gold, and 10% through the portion not coated with gold. All spectacles are overcoated with OMNICOAT-77 protective hardcoat. IR transmittance through gold reduced to 4.6%.

TYPE IV

Comprises a "High Density" spectacle assembly which is injection molded from tinted polycarbonate. (LEXAN 123-718). This initially produces a molded part visually transmitting 5%. To this structure is applied gold by vacuum metallizing, and the visual transmittance reduced to .1%. This structure provides ultimate in IR attenuation, averaging .026% transmission. The spectacles are hard coated with OMNICOAT-77.

TYPE V

Comprises a "Medium Density" spectacle assembly, injection molded from tinted polycarbonate. (LEXAN 123-718). This produces high attenuation in UV, and an IR transmission of 29.9%. This unit has a visual transmittance of 5%. All spectacles hard coated with OMNICOAT-77.

II. TOOLING

Develop, design, and fabricate tooling required to injection mold and assemble the various components.

A. Injection Mold

Comprises a mold to produce one front, and two temples per "shot". This involved having the mold fabricated, conducting trial runs and making appropriate corrections to optical inserts in order to achieve desired optics in the molded part.

B. Slotting Jig

Holding jig used to mill retaining slots in "rocking" bridge.

C. Drill Jig

To retain temple and front in alignment, while drilling hinge hole.

D. Case Tooling

Patterns, milling fixtures, etc., to produce cases by aluminum casting.

III. PROGRAM PHASING

The work program was conducted in the following successive phases:

PHASE #1

Development, fabrication and submission of Prototype #1.

PHASE #2

Development, fabrication and submission of Prototype #2.

PHASE #2A

Development, fabrication and submission of Prototype #3.

PHASE #3

Fabrication of Injection Mold.

PHASE #4

Evaluation and alteration of mold.

PHASE #5

Production of:

50 each	Type I spectacles
50 each	Type II spectacles
25 each	Type III spectacles
15 each	Type IV spectacles
10 each	Type V spectacles

DETAIL

PHASE #1

Initial prototype model of the Wrap Around Pressure Suit Spectacle was fabricated in accordance with OMNITECH Drawings #B487001 to 487007. To illustrate this structure more effectively, this is further illustrated in Figure #1, which depicts this goggle in a break-away view.

Because of the vacuum forming method used to fabricate the prototype components, it was not possible to provide acceptable optics in the lenses and no attempt was made to do so. Fabrication of the prototype was for the purpose of illustrating structure, fit and design.

The PHASE #1 model prototype was delivered to Manned Spacecraft Center, National Aeronautics and Space Administration on August 21 of 1969.

A study of this prototype by NASA personnel indicated that the integrity, general design, structure and fit of the sample was deemed to be satisfactory. Minor changes in structure, to be incorporated in the Phase #2 sample were requested. These are listed as follows:

A. Use of molded polycarbonate temple, tapered from front to rear, being of compound curve shape for best temporal fit, and having the style and blend indicated in Drawing #487003.

PRESSURE SUIT SPECTACLE

PHASE #1 DESIGN

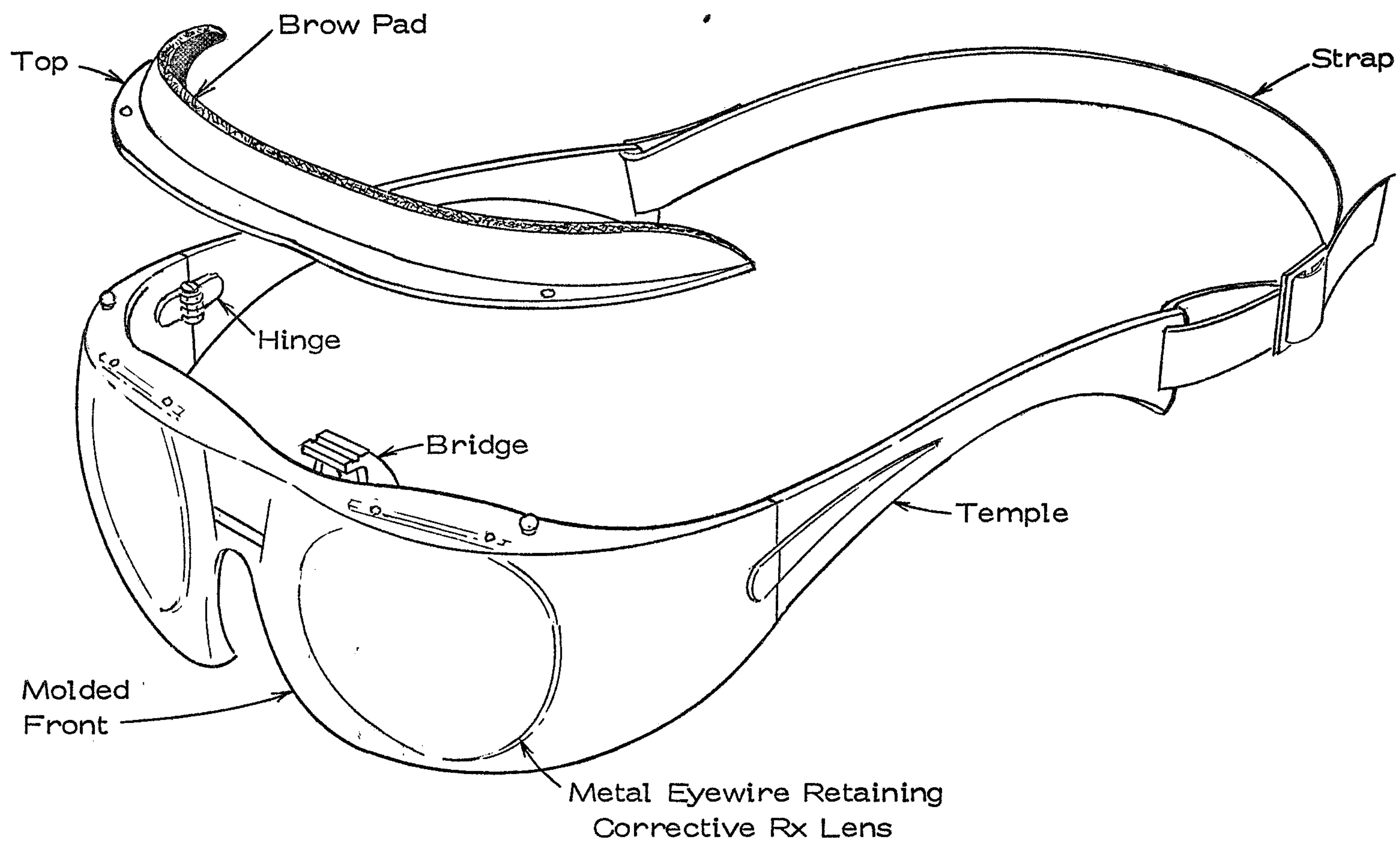


Figure #1

B. Use of a non-elastic, flight approved strap with take-up buckle in lieu of the elastic strap originally proposed. The approved strap material is FRL-S-144. This material available only from NASA and 100 feet, sufficient for 100 strap assemblies was subsequently provided as Government furnished material by NASA.

C. Provision for permanently fastening the sweat-bar retainer, instead of having it removable. Sweat bar to be black, and made of polycarbonate.

D. Use of a flight approved spongy sweat-deflector band, in lieu of an absorptive sweat band. For this purpose, NASA recommended Fluorel, which was subsequently used for this purpose.

E. For cementing the sweat deflector band to its retainer, Hysol Epoxy Patching Kit was recommended and was used for samples and production quantities. This material is flight approved by NASA.

F. Further enclosure of nasal area by goggle front to reduce amount of stray light entering underneath the adjustable saddle bridge.

G. Carrying case to be fabricated from aluminum, instead of polycarbonate plastic. It is to be lined with flight approved material, - samples of which were supplied by NASA.

The foregoing changes A through G were authorized for incorporation into the PHASE #2 items.

PHASE #2

The second prototype of the plastic pressure suit spectacle was fabricated, and forwarded to NASA on September 4.

This prototype included all of the changes required as a result of the PHASE #1 evaluation.

Following a thorough evaluation of the PHASE #2 sample by NASA, additional and further modification and changes were indicated. These were as follows:

A. Increase the length of the temples by 1/4 inch, keeping exactly the same styling, configuration, and curvature used for the Phase #2 structure.

B. Eliminate metal hinges and use molded-in mating hinge elements on the temple and frame.

C. The Gold Filled Eyewires to be used as inner lens retainers are to be ebonized with a low luster, black finish to eliminate reflections.

D. Sweatband retainer to be designed as an integral part of the "front", with the sweat-deflecting padding made of flight tested black sponge, adhered with flight tested epoxy cement.

E. All edges to be "rolled" if possible - to eliminate sharp edges.

F. Reduce face-form tilt of inner lens retainer in order to place the corrective lens in a flatter plane before the eyes, and provide a more acceptable pantoscopic tilt.

G. Rocking pads to be produced in clear, and neutral grey colors, with clear to be used on all clear goggles and grey on all remaining goggles.

H. Provide a carrying case, fabricated from an aluminum casting and grey anodized. It is to be padded with flight tested sponge to prevent shifting of goggle, and marring of lens surfaces.

I. We were requested to fabricate a third prototype incorporating the modification and improvements outlined above.

PHASE #3 – Prototype

The third prototype, fabricated in accordance with Phase #2 recommendations, was submitted to NASA on November 10, 1969.

Formal approval of this sample was received by letter dated November 19, 1969.

This cleared the way for the preparation of final drawings and procurement of the injection mold, which will be used to mold the spectacle front, and one pair of temples.

The final drawing, illustrating the approved structure, and which was used as the basis for mold fabrication is #487-008. A break - away drawing of this structure is shown on Figure #2.

PRESSURE SUIT SPECTACLE

PHASE #3 DESIGN (Final)

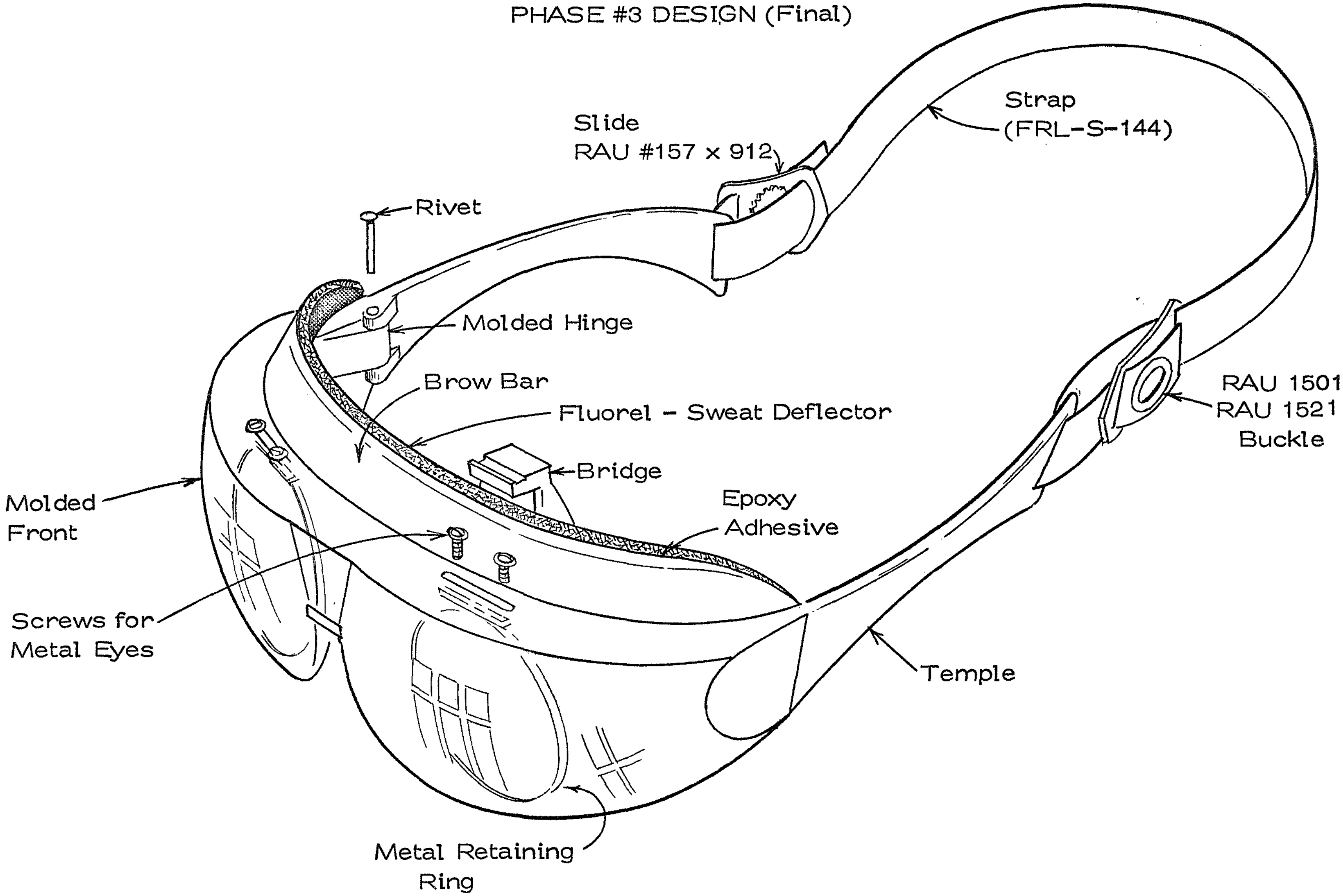


Figure #2

PLASTIC PRESSURE SUIT SPECTACLE

LENS DESIGN AND CONFIGURATION

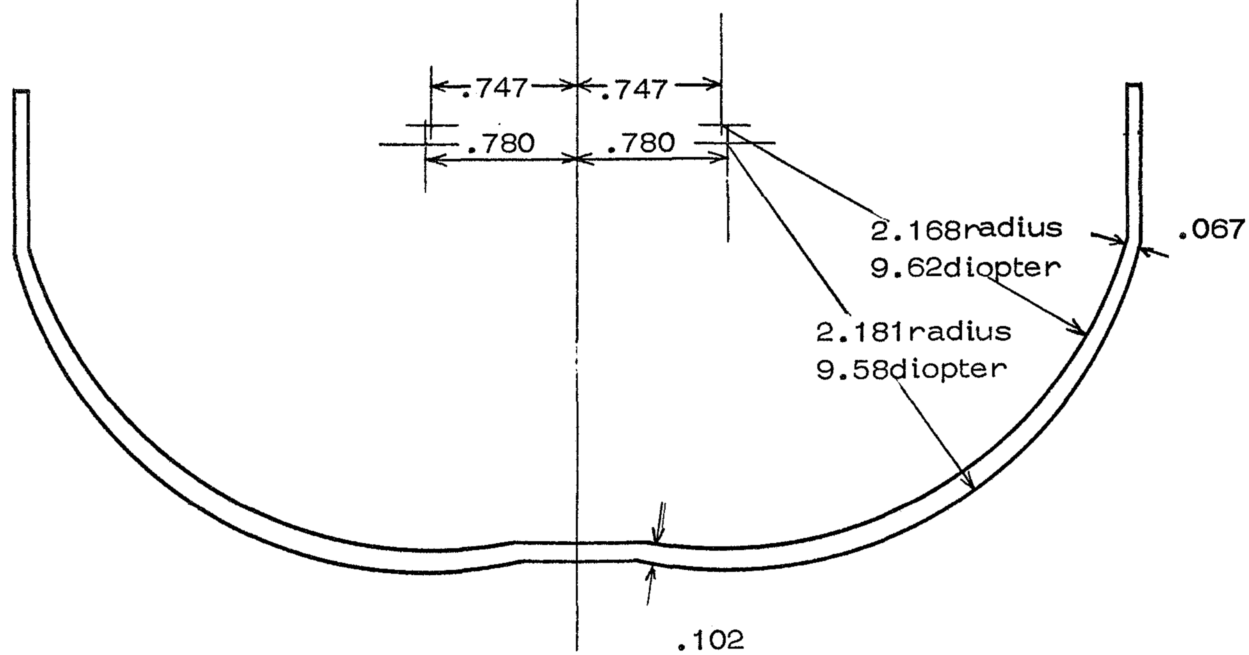


Figure #3

PRESSURE SUIT SPECTACLE CASE - FINAL STRUCTURE

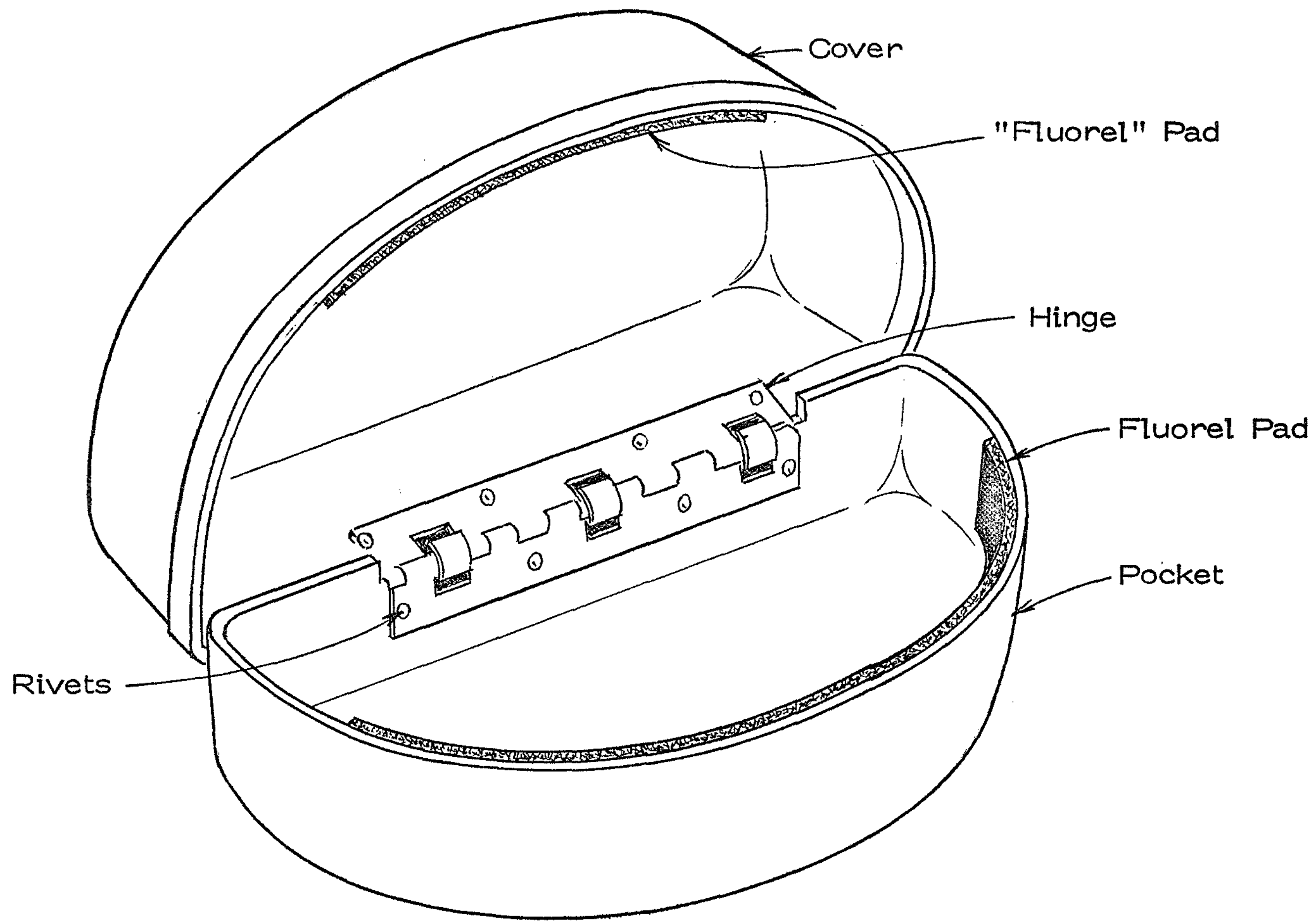


Figure #4

COVER AND POCKET OF
CAST ALUMINUM, GREY ANODIZED

PHASE #4

Mold Fabrication

Between the time this contract was accepted, and approval to construct the mold was received, loss of moldmakers in our shop required that fabrication of this mold be by a commercial moldmaker. In addition, the requirement for integrally molding the sweat-deflector retainer, and plastic hinges added immeasurably to the complexity of the mold. This resulted in doubling its cost.

When the mold was finally delivered, on June 12, 1970, and initial moldings made, it was very obvious that excessive power and prism would be present in the finished lens. It became necessary to conduct a series of changes, in a progressive and objective manner to correct this situation, meanwhile, being certain that these changes would not destroy or unalterably affect the mold. Over a period of four months, the male mold lens inserts were polished, placed in the mold, samples taken and measured for power and prismatic imbalance; then removed, decentered, reground and repolished, followed by resampling. This was repeated for a total of six times. We finally achieved a goggle structure in which the lenses had .04 diopter refractive power, and a prismatic imbalance of .36 prism diopter. This had improved from +.12 refractive power, and a prismatic imbalance greater than 1.25 prism diopters.

Although we had achieved optical requirements, incorporation of the required changes resulted in mechanical alterations to the mold which required correction. These were subsequently carried out and upon completion, molded parts were adjudged to be correct for production, having all the characteristics, and requirements needed.

One of the most important requirements as previously mentioned, was the necessity to evolve near plano optics in the part as worn. This required extensive trial and error adjustment of the mold elements as indicated. The reason for this is that the extreme sweep-back angle of the lenses normally induce excessive prism as worn; if, for example, the lenses are made using parallel curves. Our original calculations did not provide ultimate correction, and progressive, and corrective alterations were required. The lens structure, as it exists presently, and which gives near-plano optics, is depicted in Fig. #3. This gives a cross sectional view of the goggle, and shows the radii used for front, and back surfaces, together with the decentration for each curve. Because of the geometry indicated, the lens assumes a "wedge" shaped, being thicker in the nasal area, and thinner in the temporal area. For the particular radii used, and face-form relationship designed into this goggle, the structure in accordance with Fig. #3 produces a molded spectacle lens (structure) having the following characteristics:

Refractive Power - +.04 diopter
Prismatic Imbalance - .36 prism diopter

Definition, or clarity of image attained by fabricating those portions of the mold which form the lenses by optical polishing techniques. These sections of the mold are made as "inserts", from 420 stainless steel, X rayed and selected for lack of porosity, machined to correct mechanical dimensions, then optically ground and polished to ultimate in curvature, surface continuity and firmness of optical polish.

It must be pointed out that the specific geometry outlined in Fig. #3 provides near plano optics only when polycarbonate is used to mold the spectacles. In other words, this applies only when using a material having a refractive index of 1.586. If other materials, such as acrylics, or cellulosics are used in this mold, the power, and prism will be significantly different because of the difference in refractive index.

PHASE #5 - Production of Parts

A. SELECTION OF MATERIALS

As required, all goggles are injection molded from polycarbonate and hard-coated to provide mar resistance. The requirement for five (5) different types of goggles required the development and selection of three different base materials in order to give the transmittance required in the ultraviolet, visible and infra-red region of the spectrum. All materials used were evolved and provided by the General Electric Company to our specifications.

Three different grades of "LEXAN" Polycarbonate were procured, identified as:

#1	123-111
#2	123-7610
#3	123-718

The prefix "123" indicates that the basic resin provides very high ultraviolet attenuation. A fact that was well established, and presented later in the detailed spectrophotometric analysis of these materials.

#1 - (123-111)

This is a clear, transparent material, natural grade, with no tints added to achieve ultimate in visual transmittance. As molded into the TYPE #I space spectacles, the visual transmittance is 88%.

#2 - (123-7610)

This is a neutral grey material so selected and developed that for an average lens thickness of .104 (through the viewing area) the visual transmittance will be a nominal 10%. This is used to produce the TYPE II spectacles. This material is also used to produce the TYPE III spectacles, in which gold is applied to reduce the visual transmission to a nominal 3%.

#3 - (123-718)

This is a neutral grey material, selected and developed to provide a nominal 5% visual transmittance. This material is used to produce the TYPE V spectacles. By application of gold to reduce the 5% visual transmittance to .1%, it is also used to produce the TYPE IV spectacles.

Contract requirements also authorized OMNITECH to conduct evaluation and investigation of infra-red absorbing materials to give effective attenuation via the route of internal additives.

Considerable time was devoted to this investigation. There are many additives to polycarbonate, which are effective in the UV and visible spectral range, however, use of such materials to achieve the ultimate in IR absorption is not yet technically feasable. The most promising approach is through the use of dye additives developed by American Cyanamid, and currently in commercial use by their Glendale Optical division. This particular material is an absorbing material, organic in nature, which can be added to acrylics; made by casting and to vinyl and cellulosic molding materials; but which cannot yet be added to polycarbonate. Samples of items molded in cellulose propionate were evaluated. These very effectively attenuated in the infra-red region, but the plastic material was very soft, and totally unsatisfactory for our use. In addition, the visual color was a deep green, which would grossly distort color perception.

Our investigation revealed that at the present stage in development, the American Cyanamid attenuating material cannot be made compatable with polycarbonate because:

1. The high mixing and molding temperatures required with polycarbonate result in the thermal destruction of the IR additive (polycarbonate must be treated to 540° F to mold properly, against 400° F for cellulosics).
2. Chemically, the polycarbonate, and IR additives are not compatable - something in the polycarbonate reacts with and destroys the IR additive over a period of time.

Both (1) and (2) need to be solved before polycarbonate can be used with the American Cyanamid material. Cyanamid would have gladly entered into an R & D contract to attempt the development of such a material; however, a minimum price, with no guarantees of any sort, was $50,000 which precluded our entering into such an arrangement.

We worked with General Electric Company in an attempt to get the best possible IR attenuation. The neutral grey materials finally specified are evolved from materials used by General Electric for "solar" panels. As infra-red absorbers, they are moderately effective. These were the best materials commercially available at this time.

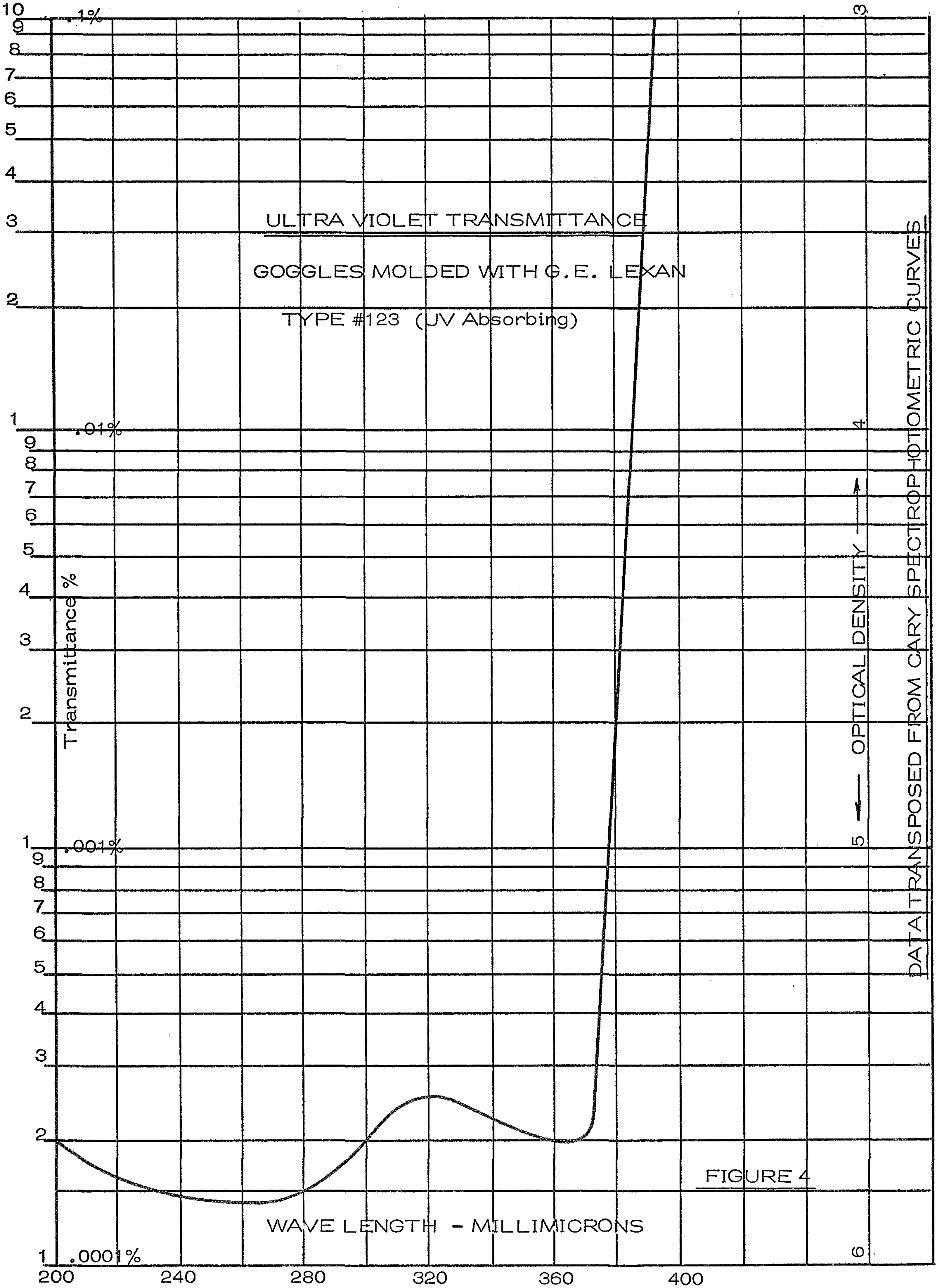
It is known, of course, that the deposition of a thin, transparent gold film provides the capacity for very efficient reflection of infra-red energy. TYPE III and TYPE IV goggles both use gold for this purpose, and are very effective in the infra-red region.

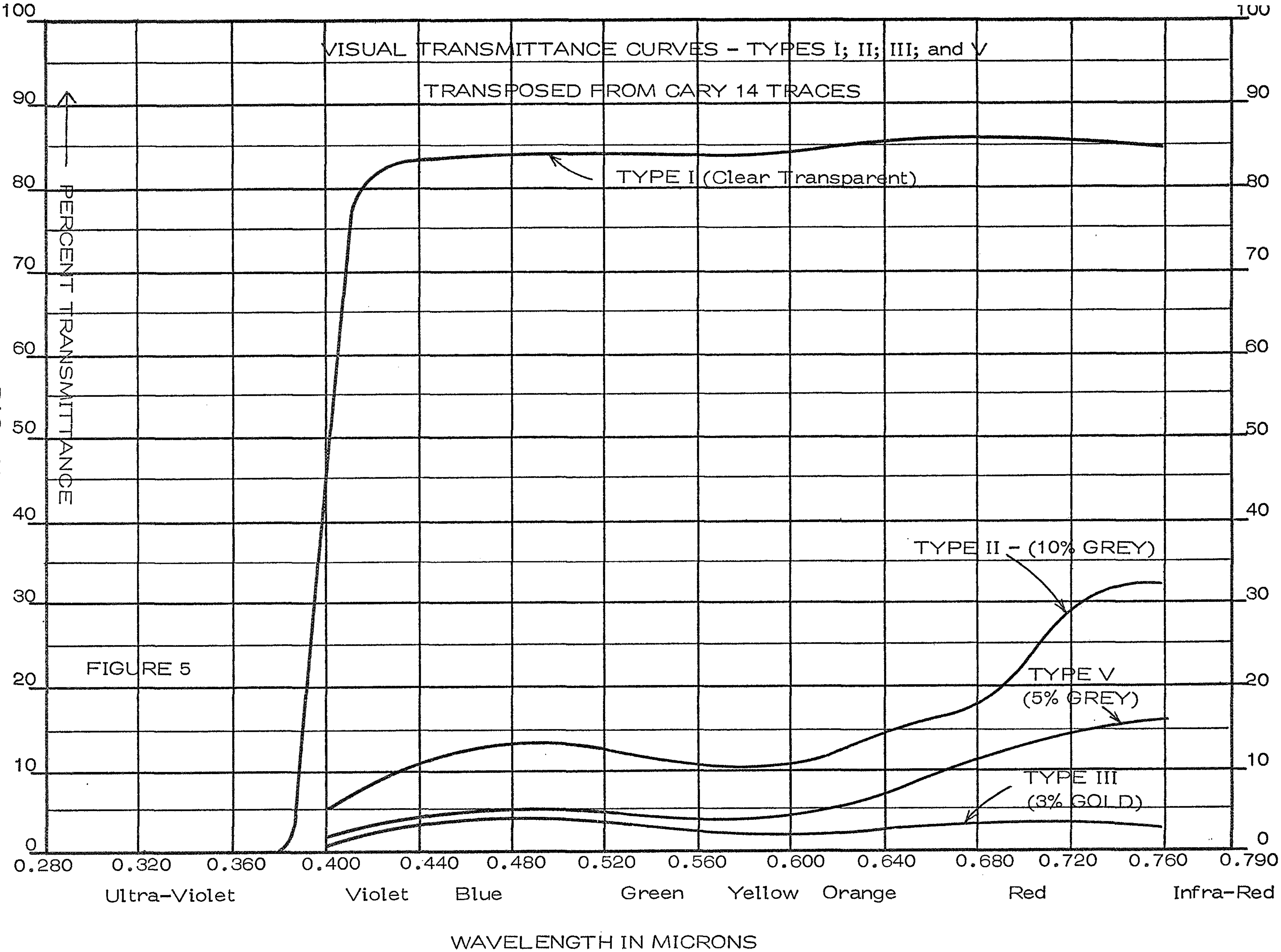
The following series of charts show the UV, Visible, and IR attenuation of TYPE I through TYPE V.

SUMMARY OF TRANSMITTANCE DATA

	UV Transmittance		Visual Transmittance		IR Transmittance	
	210 to 310mm		350 to 750mm		750 to 1500mm	
	Actual - Desired Optical Density		Actual - Desired		Actual - Desired	
TYPE I	> 5	>5	86.7%	85%	84.4%	-
TYPE II	>5	>5	11.5%	10± 2.5%	47.5%	10%
TYPE III						
a. Top	>5	>5	3.2%	3± 1%	4.6%	3%
b. Bottom	>5	>5	11.5%	10± 2.5%	47.5	-
TYPE IV	>5	>5	.1	.1 ± .05	.026%	.1%
TYPE V	>5	>5	4.7%	-	29.9%	-

Desired contractural requirements for transmittance in the ultra-violet, and visible range were attained. For infra-red attenuation, however, existing technology within the scope of this contract did not allow for attainment of all objectives. It was understood that this would be on a best of effort basis, and existing technology allowed attainment for TYPE I and TYPE IV only, with TYPE III almost attained.


ULTRA VIOLET TRANSMITTANCE
GOGGLES MOLDED WITH G.E. LEXAN
TYPE #123 (UV Absorbing)
Transmittance %
OPTICAL DENSITY
DATA TRANSPOSED FROM CARY SPECTROPHOTOMETRIC CURVES
.1%
.01%
.001%
.0001%
3
4
5
6
200
240
280
320
360
400
WAVE LENGTH - MILLIMICRONS
FIGURE 4


VISUAL TRANSMITTANCE CURVES - TYPES I; II; III; and V
TRANSPOSED FROM CARY 14 TRACES
FIGURE 5
PERCENT TRANSMITTANCE
TYPE I (Clear Transparent)
TYPE II - (10% GREY)
TYPE V
(5% GREY)
TYPE III
(3% GOLD)
100
90
80
70
60
50
40
30
20
10
0
0.280
0.320
0.360
0.400
0.440
0.480
0.520
0.560
0.600
0.640
0.680
0.720
0.760
0.790
Ultra-Violet
Violet
Blue
Green
Yellow
Orange
Red
Infra-Red
WAVELENGTH IN MICRONS

VISUAL TRANSMITTANCE OF PRESSURE SUIT GOGGLES

TYPES I, II, III, IV, and V

The visual transmittance curves for the five types are shown on Figure 5 , Page 29.

The percentage visual transmittance was calculated from CARY-14 Spectrophotometric data obtained for each goggle. The calculations were made using the Computation Form for Illuminant "A" found on Page 11 (Table 4(a) of the National Bureau of Standards Monograph #104 on Colorimetry.

TYPE #	Calculated Visual Trans.	Nominal Requirements
TYPE I	86.7%	88%
TYPE II	11.5%	10%
TYPE III		
a. Gold Coated Top Section	3.2%	3%
b. Uncoated Bottom Section	11.5%	10%
TYPE IV	.1%	.1%
TYPE V	4.7%	5%

Direct visual transmittance measurements were also taken using a direct reading photometer of all but TYPE IV. Correlation between calculated and measured values were within .2%. In the case of TYPE IV, the photometer did not have sufficient accuracy at this degree of transmittance to obtain a reading of significance.

INFRA-RED TRANSMITTANCE

	TRANSMITTANCE - PERCENT				
Wavelength Millimicrons	Type I	Type II	Type III	Type IV	Type V
750	85	33.5	3.7	.017	18.0
775	85	36.0	3.7	.021	18.5
800	85	36.5	3.7	.023	19.5
825	84.5	37.5	3.7	.026	20.5
850	84.5	38.5	3.7	.029	21.2
875	84.5	40.0	3.8	.030	22.0
900	84.5	41.0	3.9	.032	23.0
925	85.0	42.5	4.0	.033	24.1
950	86.0	43.5	4.1	.034	25.0
975	85.5	44.1	4.2	.035	25.2
1000	85.0	46.0	4.25	.035	26.0
1025	85.0	46.5	4.38	.034	27.5
1050	85.0	47.0	4.5	.033	28.2
1075	85.2	48.0	4.6	.033	29.0
1100	85.0	48.5	4.7	.032	30.0
1125	84.9	49.0	4.8	.031	30.5
1150	84.5	49.5	4.9	.029	31.5
1175	84.4	50.0	5.0	.028	32.2
1200	84.0	50.5	5.1	.028	33.0
1225	84.0	51.0	5.17	.027	33.9
1250	83.8	51.5	5.38	.026	34.5
1275	83.8	52.0	5.35	.025	35.0
1300	83.7	52.4	5.38	.024	35.5
1325	83.7	53.0	5.38	.023	35.9
1350	83.7	53.2	5.35	.022	36.2
1375	83.6	53.5	5.3	.019	37.0
1400	83.5	54.0	5.25	.019	37.5
1425	83.5	54.7	5.18	.018	38.0
1450	83.5	55.1	5.05	.018	39.0
1475	83.4	56.0	4.88	.0175	39.6
1500	83.1	56.8	4.72	.017	40.2
Average IR Transmittance	84.4%	47.5%	4.6%	.026%	29.9%

LIST OF MATERIALS

PRESSURE SUIT SPECTACLE

TYPE I

No. Required	Description	Materials	Material Specification	Finish
2	Metal Eyes	Gold Filled	1/10-12 K (Ni Base)	Black Lacquer (dull)
1	Brow Pad	Rubber	Fluorel 1062	Mosite Rubber Co.
1	Strap	Fabric	FRL-S-144 Lot #397-251	Obtained from NASA
2	Fastener	Brass	RAU #1521	Ni. Plate
2	Fastener - Front	Brass	RAU #1501	Ni. Plate
2	Slide	Brass	RAU #157 x 912	Ni. Plate
2	End Piece Rivet - Round Head	Brass	.060 x 11/16	Black - Japan
4	Screws for Metal Eyes	10% Ni. Silver	.046 x 90P	Optical Screws with washers
-	Epoxy	Hysol Epoxy Patch Kit		
1	Bridge, Small	Lexan 123-7610	Gray	
1	Bridge, Medium	Lexan 123-7610	Gray	
1	Front - TYPE I	Lexan 123-111	Clear	Omnicoat 77
2	Temples	Lexan 123-111	Clear	None

LIST OF MATERIALS

PRESSURE SUIT SPECTACLE

TYPE II

No. Required	Description	Materials	Material Specification	Finish
2	Metal Eyes	Gold Filled	1/10-12 K (Ni.base)	Black Lacquer (dull
1	Brow Pad	Rubber	Fluorel 1062	Mosite Rubber Co.
1	Strap	Fabric	FRL-S-144 Lot #397-251	Obtained from NASA
2	Fastener	Brass	RAU #1521	Ni. Plate
2	Fastener - Front	Brass	RAU #1501	Ni. Plate
2	Slide	Brass	RAU #157 x 912	Ni. Plate
2	End Piece Rivet - Round Head	Brass	.060 x 11/16	Black - Japan
4	Screws for Metal Eyes	10% Ni. Silver	.046 x 90P	Optical Screws with washers
-	Epoxy	Hysol Epoxy Patch Kit		
1	Bridge, Small	Lexan 123-7610	Gray	
1	Bridge, Medium	Lexan 123-7610	Gray	
1	Front - TYPE II	Lexan 123-7610	Grey - 10% trans.	Omnicoat 77
2	Temples	Lexan 123-7610	--	--

LIST OF MATERIALS

PRESSURE SUIT SPECTACLE

TYPE III

No. Required	Description	Materials	Material Specification	Finish
2	Metal Eyes	Gold Filled	1/10-12 K (Ni.Base)	Black Lacquer (dull)
1	Brow Pad	Rubber	Fluorel 1062	Mosite Rubber Co.
1	Strap	Fabric	FRL-S-144 Lot #397-251	Obtained from NASA
2	Fastener	Brass	RAU #1521	Ni. Plate
2	Fastener - Front	Brass	RAU #1501	Ni. Plate
2	Slide	Brass	RAU #157 x 912	Ni. Plate
2	End Piece Rivet - Round Head	Brass	.060 x 11/16	Black - Japan
4	Screws for Metal Eyes	10% Ni. Silver	.046 x 90^p	Optical Screws with washers
-	Epoxy	Hysol Epoxy Patch Kit		
1	Bridge, Small	Lexan 123-7610	Gray	
1	Bridge, Medium	Lexan 123-7610	Gray	
1	Front, TYPE III	Lexan 123-7610	3% Trans. with gold	Omnicoat 77
2	Temples	Lexan 123-7610	None	none

LIST OF MATERIALS

PRESSURE SUIT SPECTACLE

TYPE IV

No. Required	Description	Materials	Material Specification	Finish
2	Metal Eyes	Gold Filled	1/10-12 K (Ni.Base)	Black Lacquer(dull)
1	Brow Pad	Rubber	Fluorel 1062	Mosite Rubber Co.
1	Strap	Fabric	FRL-S-144 Lot #397-251	Obtained from NASA
2	Fastener	Brass	RAU #1521	Ni. Plate
2	Fastener - Front	Brass	RAU #1501	Ni. Plate
2	Slide	Brass	RAU #157 x 912	Ni. Plate
2	End Piece Rivet - Round Head	Brass	.060 x 11/16	Black - Japan
4	Screws for Metal Eyes	10% Ni. Silver	.046 x 90^p	Optical Screws with washers
-	Epoxy	Hysol Epoxy Patch Kit		
1	Bridge, Small	Lexan 123-7610	Gray	
1	Bridge, Medium	Lexan 123-7610	Gray	
1	Front - TYPE IV	Lexan 123-718	1/10% of 1% with gold	Omnicoat 77
2	Temples	Lexan 123-7610	Gray	

LIST OF MATERIALS

PRESSURE SUIT SPECTACLE

TYPE V

No. Required	Description	Materials	Material Specification	Finish
2	Metal Eyes	Gold Filled	1/10-12 K (Ni.base)	Black Lacquer (dull)
1	Brow Pad	Rubber	Fluorel 1062	Mosite Rubber Co.
1	Strap	Fabric	FRL-S-144 Lot #397-251	Obtained from NASA
2	Fastener	Brass	RAU #1521	Ni. Plate
2	Fastener - Front	Brass	RAU #1501	Ni. Plate
2	Slide	Brass	RAU #157 x 912	Ni. Plate
2	End Piece Rivet - Round Head	Brass	.060 x 11/16	Black - Japan
4	Screws for Metal Eyes	10% Ni. Silver	.046 x 90^p	Optical Screws and washers
-	Epoxy	Hysol Epoxy Patch Kit		
1	Bridge, Small	Lexan 123-7610	Gray	
1	Bridge, Medium	Lexan 123-7610	Gray	
1	Front - TYPE V	Lexan 123-718	5% Trans.	Omnicoat 77
2	Temples	Lexan 123-7610	Gray	

LIST OF MATERIALS

PRESSURE SUIT SPECTACLE

CASES

No. Required	Description	Material	Material Specification	Finish
1	Cover	Aluminum casting		Clear, Anodized
1	Pocket	Aluminum casting		Clear, Anodized
1	Pad, Lens Protecting (cover)	Rubber	Fluorel 1062	Mosite Rubber Co.
1	Pad, Lens Protecting (pocket)	Rubber	Fluorel 1062	Mosite Rubber Co.
8	Rivets 3/32 x 3/16 round head	Aluminum AN 430 A3-3	Aluminum Co. of America	Clear, Anodized
1	Hinge 1 1/8 x 3 5/8	Steel	H3600 M3 Royal Hinge Co.	Black Ox.