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Precision Cleaning and Protection of Coated Optical Components for NIF Small Optics

J. Phelps

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Disclaimer

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SPECIFICATION

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LAWRENCE LIVERMORE NATIONAL LABORATORY
MECHANICAL ENGINEERING, LIVERMORE

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1 Purpose

The purpose of this procedure shall be to define the precision cleaning of finished, coated, small optical components for NIF at Lawrence Livermore National Laboratories. The term "small optical components" includes coated optics that are set into simple mounts, as well as coated, un-mounted optics.

2 Scope

The procedure describes the cleaning of small optics that have been subjected to the following conditions:

2.1 Optics that are being prepared for packaging and shipment at the vendor's establishment, usually after final inspection.

2.2 Optics that have been exposed to an atmosphere of Fed Std 209: Class 10,000 or numerically higher prior to final cleanroom packaging at the vendor's establishment.

2.3 Optics that have been removed from the packaging at NIF Receiving Inspection for testing or other purposes and may require recleaning, due to handling.

2.4 Optics needing recleaning after being on-line.

3 Reference Documents

The following documents form a part of this specification to the extent specified herein. Any conflict between this specification and the referenced document shall be brought to the attention of LLNL in writing for resolution before the seller takes any action.

3.1 *ASTM*[1] *D1193-91* Standard Specifications for Reagent Water

3.2 *FED-STD-209*[2] Airborne Particulate cleanliness classes in Cleanrooms and Clean Zones

3.3 *ISO 14644-1* Classification of Air Cleanliness[3]

3.4 *MEL02-018* Packaging of Coated, Precision Cleaned Optical Components for NIF Small Optics Production

3.5 *MIL-STD-1246* Product Cleanliness Levels and Contamination Control Program[4]

[1] ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428, Tel: (610) 832-9585 Fax: (610) 832-9555 www.astm.org.
[2] Institute of Environmental Sciences and Technology, 940 E. Northwest Highway, Mt. Prospect, IL 60056, Tel: (847) 255-1561.
[3] Institute of Environmental Sciences and Technology, 940 E. Northwest Highway, Mt. Prospect, IL 60056, Tel: (847) 255-1561.
[4] Institute of Environmental Sciences and Technology, 940 E. Northwest Highway, Mt. Prospect, IL 60056, Tel: (847) 255-1561.

4 Definitions

4.1 ***Clean Area:*** an enclosed area, with limited access, and able to maintain a high degree of air quality sufficient to allow coated optical components to be successfully cleaned to meet Section 4.3 ***Precision Clean Optical Verification***.

4.1.1 It is suggested, but not required, that cleaning and packaging be performed in a Class 1,000 cleanroom. A ***Clean Area*** is sufficient if it is supplemented by a Fed-Std 209: Class 100 workbench. The supplier should furnish a written description (protocol) of actual location and how they maintain their ***Clean Area***, upon request by NIF Procurement or Engineering.

4.1.2 A recommended cleanroom protocol is outlined in Section 10 Appendix B: Cleanroom Protocols

4.2 ***Precision Cleaning:*** A cleaning procedure used to achieve a level of product cleanliness greater than the level normally detected by visual means. Precision cleaning is performed in a controlled environment, and is intended to remove particles, films, biological forms, fibers and other forms of contaminants that are usually not visible, but which could degrade the product or process. The level of precision cleanliness should be verified and evidence of inspection and acceptance provided. Precision cleaned articles (optical components) should be packaged immediately after verification of cleanliness, or suitably protected prior to leaving the controlled environment. Ref. MIL-STD-1246C Appendix, paragraph 40.1.2

4.3 ***Precision Clean Optical Verification:*** An optical surface is verified as having been cleaned to a Precision Clean state when no surface artifacts, (e.g., particles, films, biological forms, or fibers), are present when viewed without optical aid by a person of normal visual acuity, natural or corrected at a viewing distance of 6" to 12" (15 to 30 cm), while surfaces are illuminated by light intensity of at least 4,000 foot candles (typically a microscope illuminator, halogen flashlight, or other high brightness light source).

NOTE: Darken the room or area to improve the contrast of the reflected beam. A dark background will improve the contrast between clean areas and scatter sites

See additional recommendations in Section 9 Appendix A: Recommended Surface Quality Inspection Techniques.

5 Cleanroom Supplies / Consumables

5.1 ***Cleanroom Bag; Cleanroom Film***: UltraLOPlus Polyethylene Bags[5] or sheets, minimum thickness 0.004 inch, low-outgassing, particle-free.

5.2 ***Cleanroom Face Mask:*** Terra Universal[6]: BCR Cleanroom Mask 92.9%, P/N 5603-89.

5.3 ***Cleanroom Glove:*** The following is a list of approved gloves.

Safeskin Hypoclean Sterile Critical Nitrile gloves[7], HC611XX.
Safeskin Hypoclean Critical Nitrile gloves, HC6101X.
Barefoot Polyethylene glove[8] #BFP-PE-X.

5.4 ***Cleanroom Hair Cover:*** Terra Universal: Bouffant Hair Cover, white Tyvek P/N 1860-71.

5.5 ***Cleanroom Swab:*** Texwipe[9]: Clean Tips Polyester Series swab, (Polyester head with polypropylene handle)

5.6 ***Cleanroom Tape:*** Ultratape Industries, Inc[10] Medium tack tape #1164.

5.7 ***Dry Cleanroom Wiper:*** The following are approved dry cleanroom wipers.

Contec[11]: ProZorb (polyester)
Texwipe: Techni-cloth II

5.8 ***Optical Cleaning Solvents:***

5.8.1 Acetone: Use 99.99% pure.

5.8.2 Ethyl Alcohol (Ethanol): Use 99.99% pure.

5.8.3 Methyl Alcohol (Methanol): Use 99.99% pure.

5.9 ***PET-G Container***[12]: Custom designed container for packaging optics. Made from clear, amorphous polymer, gycol-modified polyethylene terephthalate (PET).

5.10 ***Presaturated Cleanroom Wiper:*** These are presaturated with 10% Isopropyl Alcohol - IPA. The following is a list of approved types.

Contec: SatWipe w/ 6%-9% Isopropyl Alcohol (IPA).

5.11 ***Solvent Dispenser Bottle:*** Use Fisher[13] - Barnstead/Thermolyne Low-profile Repipet Dispenser, 1 liter reservoir, 20 ml dispensing capacity. Distributed by Fisher Scientific (13-687-39) or equivalent, to dispense ***Optical Cleaning Solvents***.

5.12 ***Lens Cleaning Tissue:*** Texwipe[14] - Large M-wipe tissues TX504 **or** Lym-Tech[15] C-6 1212 (12”x12”).

[5] AeroPackaging, 523 Veneto Court, Tracy, CA 95377, 209-839-1647, 209-839-1648 fax, www.cleanfilm.com.
[6] Terra Universal, 700 North Harbor Blvd., Anaheim, CA 92805, 714-526-0100, 714-992-2179.
[7] Safeskin Corp, 12671 High Bluff Drive, San Diego, CA 92130, 800-462-9989 www.safeskin.com.
[8] Barefoot Products, 101 N. Adams St., Ritzville, WA 99169, 509-659-1829 www.barefootproducts.com.
[9] Texwipe Company, 650 East Crescent Ave., Upper Saddle River, NJ 07458; 201-327-9100.
[10] Ultratape Industries, 5675 Fruitland Rd, NE, Salem, OR 97301, 530-540-8946
[11] Contec, Contamination Control Technology, PO Box 530, Spartanburg, SC 29304, 864-503-8333, 864-503-8444 fax.
[12] Empire West, 800-521-4261, www.empirewest.com.
[13] Fisher Scientific, 800-766-7000, www.fishersci.com
[14] Texwipe Company, 650 East Crescent Ave., Upper Saddle River, NJ 07458, Tel: (201) 327-9100 www.texwipe.com

6 Preparation for the Precision Cleaning Process

6.1 Precision Cleaning: NIF small optical components shall be precision cleaned in a Class 1,000 or numerically lower cleanroom or a "Clean Area" supplemented with a Class 100 (ISO Class 5) laminar flow workbench.

6.2 All cleaning steps shall be performed while wearing approved ***Cleanroom Glove*** of choice (see Section 5.2). Wear approved ***Head Covers*** and ***Cleanroom Face Mask*** when working near the optics to avoid contamination by moisture from talking and sneezing.

- Use a ***Cleanroom Face Mask*** that covers the nose as well as the mouth. The ***Cleanroom Face Mask*** should have an efficiency rating of at least 92.9%.

- Approved cleanroom garments include ***Coveralls***, ***Cleanroom Hair Cover***, ***Cleanroom Gloves***, and shoe covers (booties).

6.3 Follow these precautions when cleaning optics:

- Protective eyewear must be worn when handling all cleaning solutions to avoid splashing them into the eyes.

- Use fresh solutions and lens cleaning tissue bundles for the cleaning of optics. Do not recycle the solution or the tissues.

- Only ***Lens Cleaning Tissues*** may be used to wipe optical surfaces with ***Optical Cleaning Solvents***. Do not wipe any optic with a dry lens cleaning tissue.

- When cleaning, handling, or packaging optical components, **Do Not** drag an optic across a dry surface. Instead, place the optic onto the dry surface by moving it perpendicular to the surface.

6.4 Precision cleaned optical components shall be packaged in accordance with MEL02-018 immediately after cleaning, and placed inside at least two layers of ***Cleanroom Bag*** before being removed from the cleanroom / clean area. Prepare the packaging materials prior to cleaning the optic to minimize unnecessary contamination. Cleaning of ***PET-G Containers***, the use of ***Cleanroom Bags*** as an alternate to the PET-G container and as outer packaging for the PET-G, and packaging labeling requirements are described in MEL02-018. The ***Cleanroom Bags*** shall be heat-sealed or sealed using ***Cleanroom Tape***. Ensure that the ***Cleanroom Tape*** does not contact any precision cleaned surfaces.

[15] Lym-Tech, 60 Depot Street, PO Box 157, Chicopee, MA 01014 (413) 592-4111. The C-6 lens tissue is distributed by CINTAS is San Jose as product 1131-5002, call (408) 286-9982 for further info. This tissue is also distributed by American CleanStat, 1552 S. Anaheim Blvd. Bldg C, Anaheim, CA 92805, 866-614-7828.

7 Precision Cleaning Process for Unmounted Optical Components

7.1 Blow off as much contamination as possible by using 99.99% pure dry nitrogen or pure air filtered at the point-of-use with a 5 μm absolute filter prior to starting a wet cleaning procedure. This will minimize scratching of the optic from abrasive contamination.

7.2 Unwrap and prepare the optic for cleaning by placing on a layer of protective ***Lens Cleaning Tissue*** or into a cleaning puck.

7.3 Select two sheets of lens tissue; stack one on top of the other. Fold in half in the long direction. Then fold in half again. Continue to fold until a convenient size to clean the part is formed.

7.4 Apply sufficient ***Optical Cleaning Solvent(s)*** (one of the solvents identified in Section 5.8 or a mixture thereof) to the ***Lens Cleaning Tissue*** bundle to dampen, not soak, the final folded edge of the cleaning wipe.

7.5 If size permits, hold the optic to be cleaned in a free hand. Ensure that the covered fingertips do not extend beyond the edge of the optic. For larger size optics, over three inches (76.2 mm) diameter, use a table mounted cleaning puck that has a recessed ledge that will prevent movement but will allow ease of surface contact for cleaning purposes. Gently wipe the surface of the optic with the moistened ***Lens Cleaning Tissue*** bundle.

- Dispose of the ***Lens Cleaning Tissue*** bundle whenever any dirt can be seen on it after wiping or after about 4 strokes across the optic. Continue procedure with a new ***Lens Cleaning Tissue*** bundle.

7.6 With a fresh ***Lens Cleaning Tissue*** and ***Optical Cleaning Solvent(s)***, repeat the cleaning as needed.

7.7 After the last cleaning, wipe the optic slowly with the wetted ***Lens Cleaning Tissue*** bundle to prevent streaking.

- There should be no *huffing* (moistening the optics with the breath) during this or any cleaning process.

- To complete the cleaning process, perform a ***Precision Clean Optical Verification.***

- Darken the room or area to improve the contrast of the reflected beam. A dark background will improve the contrast between clean areas and scatter sites.

- See additional recommendations in Section 9 Appendix A: Recommended Surface Quality Inspection Techniques.

NOTE: If the reverse side of the optic requires cleaning, repeat Section 7 in its entirety.

8 Cleaning of Mounted Optical Components (not installed in the laser system)

The following cleaning method shall be used for minor cleaning of mounted but not installed optics when it is not practical to remove an optic from its mount for more thorough cleaning. Unmounted optics can be cleaned more efficiently and effectively.

8.1 Blow off as much contamination as possible by using 99.99% pure dry nitrogen or pure air filtered at the point-of-use with a 5 μm absolute filter prior to starting a wet cleaning procedure. This will minimize scratching of the optic from abrasive contamination.

8.2 Prepare a ***Lens Cleaning Tissue*** bundle and soaked with an ***Optical Cleaning Solvent(s)*** as described in Section 7.

8.3 Thoroughly clean the edges of the optical mount initially to prevent future contamination of the ***Lens Cleaning Tissue*** bundle. This may require more than one ***Lens Cleaning Tissue*** bundle sequence.

- Dispose of the ***Lens Cleaning Tissue*** bundle whenever any dirt can be seen on it after wiping. Continue the procedure with new ***Lens Cleaning Tissue*** bundle.

8.4 Gently wipe the surface of the optic with a ***Lens Cleaning Tissue*** bundle dampened with ***Optical Cleaning Solvent(s)***.

8.5 Repeat the procedure with a new ***Lens Cleaning Tissue*** bundle and ***Optical Cleaning Solvent(s)*** as needed.

8.6 As the optic becomes cleaner, wipe more slowly to prevent streaking.

- To complete the cleaning process, perform a ***Precision Clean Optical Verification.***

- Darken the room or area to improve the contrast of the reflected beam. A dark background will improve the contrast between clean areas and scatter sites.

- See additional recommendations in Section 9 Appendix A: Recommended Surface Quality Inspection Techniques.

Caution: Solvents should not be used when it could “wick” into areas containing o-rings or plastic parts. In these cases, only blowing with clean, dry air or nitrogen gas is advised. Remove the optic from the mount, if more aggressive cleaning methods are required.

9 Appendix A: Recommended Surface Quality Inspection Techniques

This procedure describes the method used at Receiving Inspection to inspect surface quality of polished and coated small optics for the NIF Small Optics Production effort. This method will cover inspection of both transmissive and non-transmissive optical components.

9.1 Illumination Source: The illumination source used for examining NIF Small Optics is a high intensity lamp with:

- Halogen Lamp EYF-75W-12V-15°

9.2 Suppliers may use alternative light sources as long as the illumination intensity is at least 4,000 foot candles (typical of microscope illuminators).

9.3 Set Up

9.3.1 During observation, the main light beam (as opposed to the scattered light) should shine just below or just above the eyes. Do not look into or have the light shining directly into the eyes.

9.3.2 Optical components up to approximately 100 mm in diameter can be held by hand with ease. Components larger than 100 mm may be mounted in an inspection holder or "puck".

9.4 Instructions for Examination of Transmissive Optical Components

9.4.1 Set up the high intensity light source directly behind the optic to be examined. It is a requirement that this light source be used in front of a black or dark background. It is also highly recommended that ambient light be eliminated or reduced in order to increase contrast.

9.4.2 Hold the optical component so that the light is transmitted through the component at approximately normal incidence. Evaluate the surfaces by moving the component across the light beam, rocking it back and forth about 20°, as needed. For best observation, the light should shine through the optic at just above or below eye level.

9.4.3 There will be occasions when only the surface, which is illuminated, first can be properly evaluated. This is particularly the case with lenses but can apply to some flat optics as well. To evaluate the second surface, turn the component over.

9.4.4 The optimum distance for viewing is to hold the optic 6 to 12 inches (15 to 30 cm) from the light source but this distance may be adjusted as needed.

9.5 Instructions for Examination of Non-transmitting or Opaque Optical Components.

9.5.1 Set up the high intensity light source and the optical component so that the surface is being examined is normal to your eye and the light source is at a grazing incidence of about 60° from the normal viewing direction. As with the examination of transmissive optics, the part may be rocked back and forth approximately 20 degrees for the best inspection angle.

9.5.2 The inspection should be performed in an area with a black or dark background. It is also highly recommended that ambient light be eliminated or reduced in order to increase contrast.

10 Appendix B: Cleanroom Protocols

10.1 Cleanroom protocols: The following cleanroom procedures are presented as a recommendation and is based on standards set by ISO 14644-1 and format recommendations from the Institute of Environmental Sciences and Technology (IEST).

10.2 Introduction: A large portion of contamination can be traced directly to personnel. This personnel contamination is caused by two major sources: Particles shed from the human body or clothing and particles introduced into the environment by operating practices. Proper selection of garments and changing procedures will help reduce contamination caused by the body and clothing. Disciplined operating practices help reduce contamination from outside sources.

10.3 Operating Rules: All personnel entering the gowning room must have successfully completed cleanroom training or be under direct escort of a trained employee.

10.3.1 Only personnel preparing to enter the cleanroom may enter the gowning room. This room is not to be used for transferring parts or for holding meetings.

10.3.2 The following may ***not*** be brought into the gowning rooms or cleanroom

1. Food and drinks
2. Cosmetics
3. Gum or candy
4. Tobacco products
5. Personal audio equipment
6. Abrasives and powders
7. Non-approved tools
8. Aerosol cans and spray bottles
9. Items made from wood, textiles, and other natural materials
10. Non-cleanroom paper
11. Newspaper and magazines
12. Cardboard and non-cleanroom packaging
13. Pencils or erasers
14. Purses or hand carried wallets
15. Ink correcting fluids
16. Personal medications, inhalers, etc.

10.3.3 Have all tools and equipment approved and appropriately cleaned before being brought into the cleanroom.

10.3.4 If required, a set of tools or holders designed for the cleaning of optical components, e.g., Delrin pucks, shall be set up in the cleanroom. These are not to leave the cleanroom.

10.3.5 If tools are made from metal, they are to be degreased by ultrasonic washing using hot water and a surfactant. After degreasing, the tools will be kept in clean trays and handled with ***Cleanroom Glove***.

10.3.6 Equipment brought into the cleanroom must be clean. Carts, chambers, stands, tools and other equipment will be free of oil, grease, and dust. All material entering a cleanroom must be cleaned by blow-off with clean compressed Dry Nitrogen (N_2) and wiped down with ***Presaturated Cleanroom Wipes***. Wheels on carts must also be cleaned.

10.3.7 Clean parts and vacuum chamber openings will be covered with ***Cleanroom Film*** at all times when work is not being performed on them. Clean tools shall also be covered in a like manner when they are not in use.

10.3.8 Do not leave airlock and pass-thru doors open. This will cause a loss of pressure and an undesirable movement of air. Proper entry requires personnel to wait until the first door of the airlock (or air shower) is closed before opening the next. Conversations may not be held with pass-thru or doors (air shower) open.

10.3.9 Move at a steady pace and avoid sharp or quick movements. This includes opening and closing doors and pass-throughs.

10.3.10 When working on product, be positioned correctly. Avoid leaning over components or assemblies. Do not allow garments, ***Cleanroom Wipers***, etc. to trail over the product.

10.3.11 All cleaning operations require that components be handled with ***Cleanroom Gloves*** on. Special effort must be used to keep these ***Cleanroom Glove*** free of contamination. Avoid touching cleanroom surfaces and garments with the ***Cleanroom Gloves***, themselves. Personnel should also be trained in the appropriate way to handle optical components for each operation to minimize the transfer of particles (even ***Cleanroom Gloves*** will leave particles on optical components).

10.3.12 ***Cleanroom Gloves*** may not be reused on re-entry into the cleanroom.

10.3.13 If ***Cleanroom Gloves*** or garments become soiled or damaged, go to the gowning room and change them immediately. Never unzip the coveralls or remove ***Cleanroom Gloves*** within the cleanroom.

10.3.14 Use ***Cleanroom Wipers*** properly. Do not lay ***Cleanroom Wipers*** down on work surfaces. Use appropriate ***Optical Cleaning Solvent(s)*** for the work being performed. Wiping should be performed with overlapping passes. Discard ***Cleanroom Wipers*** regularly and use new ones.

10.3.15 Store parts appropriately when not being actually cleaned. Do not leave them exposed and on work surfaces other than class 100 flow benches. Place in only approved containers (PET-G) to transfer them between workstations.

10.3.16 Prior to entering gowning area. Preparation for working in a cleanroom starts before entering the gowning room. Follow these guidelines.

10.3.17 Clean shoes at the doorway before entering. Use electric shoe brush provided.

10.3.18 Remove cosmetics and nail polish

10.3.19 Remove and store watches, rings and jewelry. Wedding rings that are smooth may be worn under ***Cleanroom Gloves***. Rings that are not smooth can be taped over to prevent them from tearing the ***Cleanroom Gloves***.

10.3.20 Remove and store clothing that will not be worn under the cleanroom garments.

10.3.21 Wash the hands

10.3.22 Smokers should take a drink of water and wash hands before entering the cleanroom.

10.3.23 Dispose of any waste materials, food, gum, etc.

10.3.24 Visitors with a skin condition or illness that could cause excessive contamination should not enter the cleanroom. (notify cleanroom operator)

10.3.25 Pull the tacky mat if it is dirty. The mat should be pulled daily, but it may need to be changed more often.

10.3.26 Apply each shoe to the tacky mat at least three times (or until no more visible particles are left on the mat), prior to entering the gowning room.

10.4 Gowning Procedure: Everyone entering the cleanroom shall wear cleanroom garments suitable for the classification. In this case, full suits (coveralls), boots, ***Cleanroom Hair Cover***, ***Cleanroom Face Mask*** and ***Cleanroom Gloves*** are required. Garments shall be constructed of monofilament polyethylene, Tyvek, or Gore Tex.

10.4.1 Prior to putting on each garment, check it visually for tears, dirt, and stains.

10.4.2 If a fresh garment is used, check the outer package for tears and faulty heat seals. Then cut the ***Cleanroom Bag*** open with scissors (tearing the ***Cleanroom Bag*** can create particles that contaminate the garment).

10.4.3 Avoid touching the outside of the cleanroom garment with the bare hands while changing. Also, do not allow the garment to drag on the floor.

10.4.4 Immediately upon entering the gowning room put on shoe covers, a ***Cleanroom Hair Cover*** and a beard cover, if needed. This will help keep the gowning room clean and reduce contamination of the cleanroom garments.

10.4.5 Put on ***Cleanroom Face Mask***. The facemask is worn over the nose. This will prevent contamination of the outside of the ***Cleanroom Face Mask***. Optionally, the beard cover may be worn over the nose and mouth.

10.4.6 Put on a pair of ***Cleanroom Gloves***.

10.4.7 Put on hood.

10.4.8 Put on coveralls.

10.4.9 Put on boots.

10.4.10 Put on safety glasses.

10.4.11 Put on a second pair of ***Cleanroom Gloves***. Grip the ***Cleanroom Gloves*** at the edge of the cuff to prevent contamination of the outside work surface of the ***Cleanroom Gloves***.

10.5 Checking of Garment

10.5.1 Inspect the garments and gowning in the mirror. Only the face should be showing.

10.5.2 Is all hair covered?

10.5.3 Do cleanroom garments cover all street clothes?

10.5.4 Is the hood tucked into the coveralls with no gaps?

10.5.5 Do the ***Cleanroom Gloves*** overlap the sleeves? If not, use ***Cleanroom Tape*** to tape the ***Cleanroom Gloves*** to the sleeves.

10.5.6 Check the garment for tears, rips, dirt or stains.

10.5.7 Make adjustments as needed.

10.5.8 Prior to entering the cleanroom, apply each boot to another tacky mat at least three times.

10.6 Degowning Procedure:

10.6.1 If garments are to be used for re-entry, remove them so that the outsides of the garments are handled as little as possible, to avoid contamination. Handle the garments from the inside and do not allow them to touch the ground. Garments for re-use may be hung on a hook beside the gowning bench while preparing to hang them up on the rack.

10.6.2 Safety glasses may be removed at any time in this process.

10.6.3 Remove the boots.

10.6.4 Remove the coveralls.

10.6.5 Remove the hood.

10.6.6 Inspect garments for wear, dirt or stains. If required, put garments in laundry.

10.6.7 Hang up garments to be reused. After hanging up the coveralls, the boots can be snapped together and draped over the hanger, provided the soles are not dirty. If the soles of the boots are dirty, put them in the laundry. The hood can be snapped to the cuff of the coverall.

10.6.8 Remove and dispose of the ***Cleanroom Face Mask***.

10.6.9 Just prior to leaving the gowning room, remove and dispose of the ***Cleanroom Gloves***, shoe covers, ***Cleanroom Hair Cover,*** and beard cover.

10.7 Re-use of Garments:

10.7.1 Personnel that work in the cleanroom every day need to change garments at least two times per week. Personnel that are in the cleanroom occasionally only need to launder garments weekly, or when soiled.

11 Revision History

Revision History							
Rev	**Description**	**Author**	**Date**	**Reviewed By**	**Date**	**Approved By**	**Date**
OB	Revised per ECR-6422	Jim Phelps	6/25/03	Robert Chow John Taylor Jim Pryatel	6/25/03	Irving Stowers	6/25/03