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MINIMUM REQUIREMENTS FOR GARMENTS USED IN CLEANROOM ENVIRONMENTS FOR HAZARDOUS OPERATIONS

SPECIFICATION FOR

SAFETY, RELIABILITY AND QUALITY ASSURANCE DIRECTORATE

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SPECIFICATION FOR

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JOHN F. KENNEDY SPACE CENTER, NASA

ABBREVIATIONS AND ACRONYMS

ASTM	American Society for Testing and Materials
C	Celsius
F	Fahrenheit
FED	Federal
GP	General Publication (KSC)
JSCM	Lyndon B. Johnson Space Center Manual
kg	kilogram
KMI	KSC Management Instruction
KSC	John F. Kennedy Space Center
lbs	pounds
m	meter
mm	millimeter
MMA	Malfunction/Materials Analysis
NHB	NASA Handbook
oz	ounce
SPEC	Specification
sq	square
STD	Standard
TPS	Test Preparation Sheet
yd	yard

MINIMUM REQUIREMENTS FOR GARMENTS USED IN CLEANROOM ENVIRONMENTS FOR HAZARDOUS OPERATIONS SPECIFICATION FOR

1. SCOPE

This document provides the minimum requirements for garments used (coveralls, frocks, booties, caps, gloves) during hazardous operations (defined in KMI 1710.13) performed at the John F. Kennedy Space Center (KSC) or in KSC related cleanroom environments. It details the requirements of the KSC Ground Operations Safety Plan (GP-1098F, Section 2.16).

It is not the intent of this document to specify all nonsafety related requirements, but to allow the originator of a purchase specification to add his organization peculiar items to the minimum specifications. In this manner, it is intended that KSC organizations and vendors alike can change designs to meet overall requirements and still satisfy basic safety requirements.

2. APPLICABLE DOCUMENTS

The following documents form a part of this document to the extent specified herein. When this document is used for procurement, including solicitations, or is added to an existing contract, the specific revision levels, amendments, and approval dates of said documents shall be specified in an attachment to the Solicitation/State of Work/Contract.

2.1 Governmental.

2.1.1 Specifications.

John F. Kennedy Space Center (KSC), NASA

KSC-SPEC-P-0016 Garment Snap Fasteners Specifications

2.1.2 Standards.

Federal

FED-STD-751 Stitches, Seams and Stitching

2.1.3 Publications.

National Aeronautics and Space Administration (NASA)

NHB 8060.1	Flammability, Odor, And Offgassing Requirement And Test Procedures For Materials In Environments That Support Combustion

John F. Kennedy Space Center (KSC), NASA

KMI 1710.13	Technical Operating Procedures Policy
GP-1098	KSC Ground Operations Safety Plan
MMA-1985-79	Standard Test Method for Evaluating Triboelectric Charge Generations and Decay
TPS-SA6-072	Test Preparation Sheet, Bunny Suit Rescue Strap Life Strength Test

Lyndon B. Johnson Space Center (JSC), NASA

JSCM 5322	Contamination Control Program Requirements Manual

Military

U. S. Air Force Technical Order TO-00-25-203	Contamination Control of Aerospace Facilities

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specified procurement functions should be obtained from the procuring activity or as directed by the Contracting Officer.)

2.2 Non-Governmental.

American Society for Testing and Materials (ASTM)

ASTM F51-68 1984	Tentative Method for Sizing and Counting Particulate Contamination In and On Cleanroom Garments

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103)

3. REQUIREMENTS

3.1 Definition. - Cleanroom Protective Clothing consists of coveralls, frocks, booties, caps, and gloves.

3.2 Characteristics. - Performance and physical characteristics are specified in this section.

3.2.1 Physical Characteristics.

3.2.1.1 Weave. - The weave shall be 2/2 twill with 6 mm (1/4") raised grid of 1% minimum carbon yarn and 99% Nomex filament.

3.2.1.2 Weight. - The weight shall be 0.17 kg/m^2 (5 oz/yd^2) minimum through 0.20 kg/m^2 (6 oz/yd^2) maximum.

3.2.1.3 Color. - The color can be white or natural.

3.2.2 Performance Characteristics.

3.2.2.1 Laundering. - Laundering shall not cause discoloration.

3.2.2.2 Health. - Garments must be comfortable; must not exhibit objectionable odor normally nor when wet; must not irritate, react with, nor be abrasive to the skin.

3.2.3 Reliability.

3.2.3.1 Wear Life. - Garments shall be usable after at least 100 industrial washings.

3.2.3.2 Strength. - The contractor shall certify that tear and tensile strength is adequate for the wear life of the garment.

3.2.4 Maintainability.

Laundering. - Finished garments will be subjected to minimum of two washes and will be washable by aqueous laundering means. KSC will be responsible for garment laundering.

3.2.5 Environmental Conditions.

Linting Characteristics. - The garments must be able to meet ASTM F51-68 (1984), "Tentative Method for Sizing and Counting Particulate Contamination In and On Cleanroom Garments," or U.S. Air Force Technical Order, TO-00-25-203, "Contamination Control of Aerospace Facilities," and Johnson Space Center, JSCM 5322,

"Contamination Control Program Requirements Manual." The maximum permissible concentration of particles and fibers shall not exceed 2400 particles per square meter (2000 particles per square yard) of 5 microns and larger, with a maximum of 25 fibers.

3.3 Design and Construction.

3.3.1 Materials, Processes, and Parts.

3.3.1.1 Material Required - Material required shall be ninety nine percent continuous filament "Nomex" (Aramid) with approximately one percent conductive filament yarn (carbon conjugated). Sterns and Sterns Part, Chemstat 919, or equivalent.

3.3.1.2 Seams. - Main seams are to be continuous filament double needle felled seam by the following specification: FED-STD-751A, "Stitches, Seams and Stitching"; Seam Type LSc-2, Stitch Type 401, 6 mm (1/4") gauge. Nomex thread throughout.

3.3.1.3 Fasteners on Frocks. - Fasteners will be nonmetallic ("Delrin" or equal) zipper all the way up the front with adjustment at military collar and sleeves.

3.3.1.4 Fasteners on Coveralls. - Fasteners will be nonmetallic ("Delrin" or equal) zipper all the way up the front from the fly. Adjustments at neck, sleeves, and trouser legs.

3.3.1.5 Fasteners on Headwear. - Fasteners will have adjustments for size.

3.3.1.6 Fasteners on Gloves. - Not part of this specification.

3.3.1.7 Fasteners on Boots. - Fasteners on boots will be as required by the originator.

3.3.1.8 Sleeves. - Coveralls will have full length sleeves and leg coverings and full length sleeves on frocks.

3.3.1.9 Pockets. - None (except badge pocket permitted where required).

3.3.1.10 Openings. - None.

3.3.1.11 Tabs. - There shall be one tab (for badge) 2.5 cm x 5 cm (1" x 2") located on center of left breast 20 cm (8") down from the shoulder seam of coveralls and frocks or as required by originator.

3.3.1.12 Rescue Straps. - Green Nomex parachute grab straps suitable for rescue purposes and arranged as shown in Figure 1 will be provided on the legs, shoulders, torso and back of the garment. Straps will be 2.5 cm (1") minimum in width and withstand a pull of 900 newtons (200 lbs). Reference TPS SA6-072, March 1983, "Bunny Suit Rescue Strap Life Strength Test." Grab straps and garment underneath, with approval of originating organization, contain stainless steel grippers at spacing approximately 5 cm (2") between grippers or gripper and material stitching to prevent loose straps from catching on objects in the work location.

3.3.2 Electromagnetic Interference.

Static Dissipation. - The material must meet the KSC static dissipation requirement. Voltage must drop below 350 volts within 5 seconds at 45 + 5% relative humidity (maximum) and 24 °C (75 °F) (maximum). Reference NASA Materials Testing Branch Report, MMA-1985-79 and GP-1098. Testing will be performed at KSC.

3.3.3 Safety.

3.3.3.1 Combustibility. - The requirements of NASA Handbook NHB 8060.1B, "Flammability, Odor, and Offgassing Requirement and Test Procedures for Materials in Environments that Support Combustion," Test 1: less than 152 mm (6") sample consumed and no sparking, sputtering, or consumed and no sparking, sputtering, or dripping of flaming particles must be met. Testing will be performed at KSC.

3.3.3.2 Boot Sole Combustibility Criteria. - After ignition, the boot sole material must self-extinguish before 152 mm (6") of material is consumed. Minor sparking and sputtering is acceptable.

3.3.3.3 Propellant Compatibility. - Material shall not react exothermically with fuels, oxidizers, solvents, acids, or other chemicals normally used at KSC. Examples are:

Hydrogen	Hydrogen Peroxide
Oxygen	Alcohol
Nitrogen Textroxide	Nitric Acid
Hydrazine	Sulfuric Acid
Rocket Propellant #1	Ammonia
Methyl Ethyl Keytone	Freon 21

Testing will be performed at KSC.

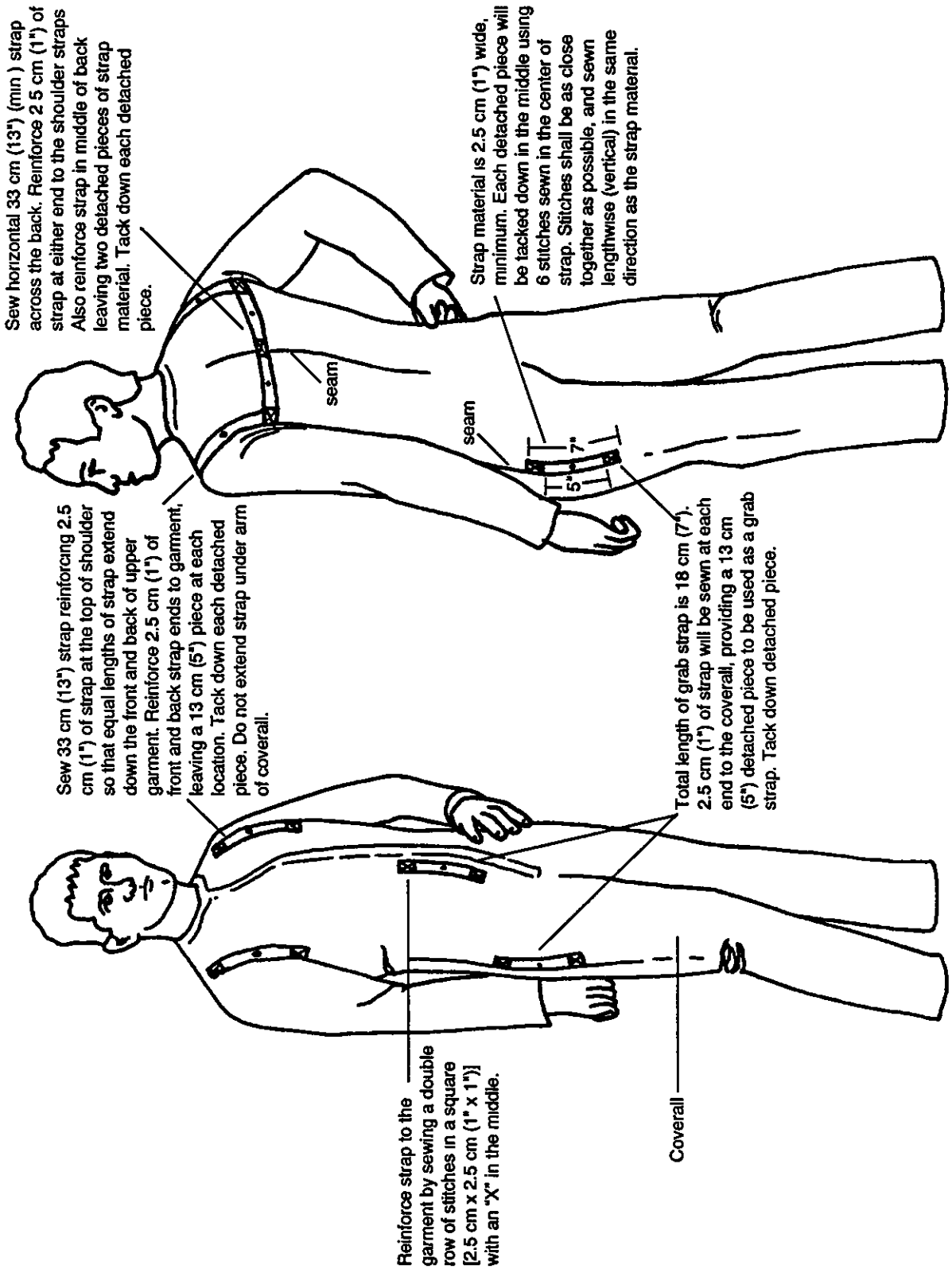

Figure 1. Normex Grab Strap Details

4. QUALITY ASSURANCE PROVISIONS

The Quality Assurance provisions shall meet the provisions required by the procurement document.

5. PREPARATION FOR DELIVERY

The preparation for delivery shall meet the provisions required by the procurement document.

6. NOTES

6.1 Intended Use. - This specification is intended to establish the minimum requirements for garments worn by personnel during hazardous operations and/or in cleanroom environments at KSC.

6.2 Use of Grippers. - When grippers are used they shall comply with the following:

a. Use of stainless steel grippers (snaps) must be approved by originating procurement authority.

b. Grippers, if used, will be protected from contact with the skin.

c. Grippers, if used, will be in accordance with KSC-SPEC-P-016, "Garment Snap Fasteners Specifications."

d. Grippers, if used, will be randomly tested following machine setting in accordance with KSC-SPEC-P-0016, Appendix A (pinch setting test).

e. Grippers, if used, will be pull tested in accordance with KSC-SPEC-P-0016, Appendix B.

NOTICE. When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

Custodian:	Preparing Activity:
NASA - John F. Kennedy Space Center	John F. Kennedy Space Center Industrial Safety Engineering Branch Safety Operations Engineering Division Safety, Reliability and Quality Assurance Directorate