Cleanroom Garment Silicone Contamination

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• Background
  – GSFC
    • Facilities
    • Hardware
  – Why silicones are bad
  – Cleanroom Garments

• Actions Taken
• Lessons Learned
• Results
• Questions
Background

• Facilities
  – SSDIF
  – Others

• Projects
  – HST
  – WFC Build Up
  – New Horizons
  – STEREO
  – JWST
Background

- Why silicones are bad
  - Creeping
  - Outgassing
  - Removal
Background

- Particle contamination Impact
- Molecular contamination impact
Background

• Type of garments we rent & number
• Distribution Process
• Gowning procedure
Background

- Cleanroom garment vendor was changed in December 2004
- In mid March 2005 one customer’s off handed remark about an odor on the cleanroom garments prompted a rinse request
- Silicones have no odor, request was an effort to be difficult?
- Without any previous experience sampling garments, a random rinse of the material was performed
- Consulted materials branch at GSFC for procedure
- Additional rinses showed silicone
- “Crude” transfer test was performed also showing silicone
Actions Taken

Meetings were initiated with GSFC's Contamination Engineering Group and other interested parties
  • Twice daily with 20-30 participants

2-3 different cleaning procedures were suggested by the laundry company but none proved successful
4 washes
Orange Cleaner
Dry Cleaning

10% of each batch of cleaned garments were rinsed
  • Acceptable levels were undetermined

Garments were removed from facilities except DDL (no concern for silicone contamination)
  • Signs posted warning of the issue

Samples of gowning rooms and other areas possibly contaminated were taken
  • No evidence of contamination by garments
Additional Actions

- Other initiatives pursued
  - Samples from other converters and laundries were requested and tested
  - Industry expert was put under contract
  - Disposable garments secured and tested
    - ESD Characteristics were in question
    - Other contaminants/residuals may be of concern
  - Old COG garments tested negative for silicone and put into service
Continuing Actions

• As efforts continued
  – Small group of team members visited laundry looking for issues with their process and “smoking gun”
  – Work instruction to standardize sampling was initiated
  – Smaller “Tiger Team” was identified to facilitate process and decisions
  – Dry clean wash suggested and results were promising
  – 10% of 2 batches were tested and results negative
  – Last batch of 10% all were positive
Turning Point (5/23/05)

- All new, silicone free garments were requested from laundry service
- Samples from our laundry company's in house stock and other converters were tested
- ESD requirements were addressed
- "Tiger Team" concluded with identification of garments from an acceptable vendor that met silicone and ESD tests.
- On-site audit was conducted at converter with laundry service to observe process
- We have a verification procedure
- Last batch of booties were positive
Lessons Learned

- Investigation teams should be established with 6-8 members
  - Initial meetings with 20-30 members were difficult to manage
  - Comments and concerns from others in the organization should be funneled through team members
  - Members of the team should be from appropriate organizations
Lessons Learned (cont.)

• Never Checked transfer test to very level B
Lessons Learned (cont.)

• Ask the experts
  – We took the lead to investigate this matter and too many attempts were made to clean the garments at our request and direction
  – Laundry and industry expert advice and involvement is key and must be kept up
Lessons Learned (cont.)

- Sampling & cleaning plans & protocols should be established in a methodical and controlled manner and the capacity of the testing facilities assessed objectively
  - Facility cleaning procedure was ready for implementation when new information required a procedure rewrite
  - Standard sampling plan was not developed and implemented until well into the investigation process
  - Laboratory that normally processed 2-3 samples per day went to more than 20 per day overnight, without the infrastructure for the increase
Lessons Learned (cont.)

- Silicone issues in laundry were not well known at GSFC and in aerospace industry
  - Appears to be well known in other industries such as disk manufacturing
Lessons Learned (cont.)

- Establish limits
  - Only one project CC manager established an acceptable limit
  - Our criteria is "undetectable by FTIR"
Lessons Learned (cont.)

- Be prepared to examine all aspects associated with the initial problem
  - Disposable garments were not approved for use in ESD sensitive areas
  - ESD testing of proposed replacements had to be initiated
  - COG garments found unacceptable for ESD while more in depth testing of disposables revealed they were acceptable
  - Disposables had other contaminants such as DOP
Lessons Learned (cont.)

- Silicones are ubiquitous!
  - Hair gel, skin lotions, "Return to Flight" & other charitable organization wrist bands
  - Some adhesives and materials used on flight hardware
  - In consumables
Results

• Awareness of silicone issues in laundry and in other aspects of hardware processing was raised at GSFC
• Infrastructure and support of testing lab will be increased
• Protocol to verify garments at different stages will be instituted: from converter, during laundering, and upon arrival at GSFC
• Closer work with laundry and converter will result from the monitoring
Results

- Specification for laundry services and garments will be strengthened, including not only silicone contamination, but ESD as well as particulate generation.
- All consumables will be tested for NVR before use in GSFC cleanrooms, including gloves, wipes, solvents, etc.
- Silicone found on face masks, we had a process to deal with them and it worked.