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July 11, 2011

Brian Sabart
Bill Macy
Stratasys, Inc.
7665 Commerce Way
Eden Prairie, MN 55344

RE: MIL STD 810G Method 508.6 Fungus

- Project # R 2011-151-1
- Date Samples Received: 6/7/11
- Date Testing Started: 6/10/11
- Date Testing Ended: 7/8/11
- Date Report Issued: 7/11/11

Dear Mr. Sabart and Mr. Macy,

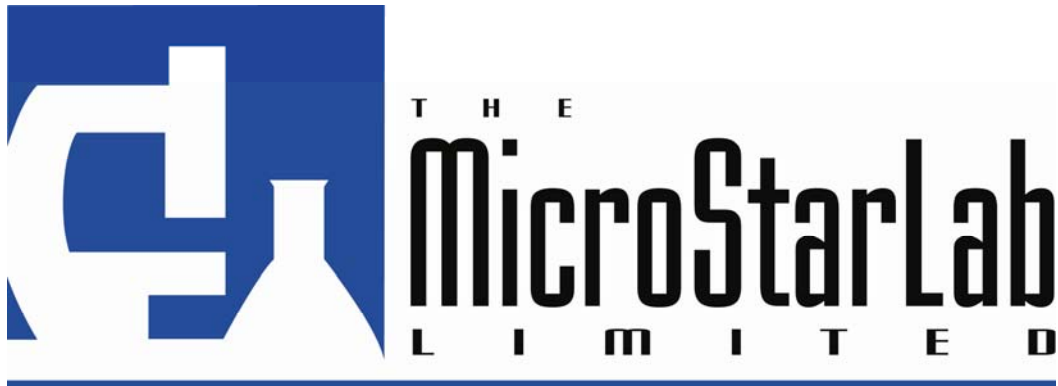
The final report for the MIL STD 810G Method 508.6 Fungus testing you requested is attached.

If you have any questions, please do not hesitate to call.

Best regards,

Judy LaZonby

President – The MicroStar Lab, Ltd



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Crystal Lake, IL 60014
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Final Report for:
Stratasys, Inc.
7665 Commerce Way
Eden Prairie, MN 55344

Test Method:
MIL STD 810G Method 508.6 Fungus

MSL Project # R 2011-151-1

Sample Received: 6/7/11

Testing Initiated: 6/10/11

Testing Completed: 7/8/11

Report Issued: 7/11/11

Judy LaZonby
President – The MicroStar Lab, Ltd





Objective:

The purpose of this test is to assess the extent to which materiel will support fungal growth. If the materiel is found to support fungal growth, the following will also be determined:

- The species of the fungi that is present
- How rapidly the fungus will grow on the materiel and a description of the growth
- Any affects the fungus may cause to the materiel, for example, any detrimental effects, physical interferences on performance, or health and aesthetic factors.
- If the materiel can be stored effectively in a field environment.
- Any reversal processes, for example, wiping off the fungal growth, if this is of interest to the customer.

Pre-test Documentation:

Seven various coupons samples were submitted for testing. The samples size was approximately 4" x 4" x 1" in size. The samples were identified as followed:

1. Sample A: FDM Ultem 9085 45°/45° raster fill with +0.010 air gap
2. Sample B: FDM Ultem 9085 0°/0° raster fill with -0.002 air gap
3. Sample C: FDM Ultem 9085-defaults
4. Sample D: FDM PPSF-defaults
5. Sample E: FDM Polycarbonate-ISO-defaults
6. Sample F: FDM Polycarbonate-defaults
7. Sample G: FDM ABS-M30-defaults

The test sequence, environmental test history, or pre-test operations were not specified prior to testing. Details are described below. Testing followed MIL STD 810G protocol.

The test chamber was a Forma Scientific Single Chamber Water Jacket Incubator, Model 3110. A small humidifier was attached to the inlet port to initially raise the relative humidity in the chamber at the beginning of the incubation period. The bottom of the chamber had a pan containing distilled water to maintain humidity for the duration of the test period. The test piece and controls were suspended using clips and cable ties attached to rods. Prior to testing, the chamber was decontaminated using hot water and a quaternary amine microbial decontaminant cleaner. The data logger for monitoring temperature and humidity was also placed into the chamber.

All test pieces were cleaned prior to testing with 70% isopropyl alcohol. All cleaned test pieces were allowed to air dry for 72 hours before proceeding with testing.





Forma Scientific Single Chamber Water Jacket Incubator

The inoculum was prepared from pure fungal stock cultures incubated at $30 \pm 1^\circ\text{C}$ for 10 to 21 days. Per customer request both U.S. and European group test fungi were used.

The following U.S. group test fungi were used:

1. *Aspergillus flavus* ATCC 9643
2. *Aspergillus versicolor* ATCC 11 730
3. *Penicillium funiculosum* ATCC 11 797
4. *Chaetomium globosum* ATCC 6205
5. *Aspergillus niger* ATCC 9642

The following European group test fungi were used:

1. *Aspergillus terreus* ATCC 10690
2. *Trichoderme viride* ATCC 9645
3. *Penicillium funiculosum* ATCC 36839
4. *Scopulariopsis brevicaulis* ATCC 36840
5. *Penicillium ochro-chloron* ATCC 9112
6. *Paecilomyces varioti* ATCC 18502
7. *Aspergillus niger* ATCC 6275





Spore suspensions containing $1,000,000 \pm 20\%$ spores per milliliter as determined with a counting chamber were prepared for each organism. The viability of the spore suspensions were verified by inoculating the entire surface of Potato Dextrose Agar plates and checking for growth after 7 to 10 days incubation at $30 \pm 1^\circ\text{C}$. See results below in Table #1. Equal volumes of the individual fungal cultures were blended to obtain the mixed spore suspension to be used for inoculation of test item.

Control strips of unbleached, plain weave cotton cloth cut into 3 cm X 4 inch strips were dipped into the solution described within the method and allowed to dry. These strips were hung within the chamber close to and bracketing the test items to ensure that the test strips and test items experienced the same test environment. The test chamber containing the test pieces and control strips were held in the test facility for 4 hours prior to inoculation to equilibrate to $30 \pm 1^\circ\text{C}$ and a relative humidity of greater than 90% and less than 100%.

The test items and each control strip were inoculated with the mixed spore suspension by spraying them with a fine mist from a sterile atomizer. They were covered completely with the spore suspension on both sides, spraying until drops began to form on the surface. Immediately after spraying, the test items and control strips were suspended from rods in the test chamber. The test chamber contained water to maintain the desired relative humidity required by the test method of greater than 90% and less than 100%. The temperature within the test chamber was maintained at $30 \pm 1^\circ\text{C}$ for the duration of testing as required by the test method.

Humidity and temperature probes and sensors are checked using the following equipment:

- Relative humidity is verified using a Vaisala Humidity and Temperature Meter and Probe MI70/HMP75B. The relative humidity reading of the equipment is internally validated to NIST traceable standards using K_2SO_4 saturated salts, FINAS Certificate of Calibration #K008-U00038.
- Temperature is verified using a Vaisala Humidity and Temperature Meter and Probe MI70/HMP75. Temperature equipment is internally validated to NIST traceable standards using an externally calibrated Cole Palmer Thermometer, Serial #4463; A2LA accredited ISO 17025 Cert. #1746.01.
- Veriteq Data Logger, NIST traceable certificate # 0174220, Serial # 09102096

See Table # 2 for the record of critical components for this test.

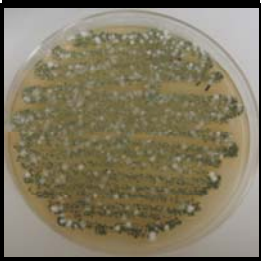


After 7 days, the growth on the control strips was inspected. The control strips were checked again at the end of testing for an increase in fungal growth. See results below. Provided the control strips and viability of spore suspensions were acceptable, the test was continued for 28 days incubation. At the end of the incubation, the samples were examined for fungal growth. Results are described in the Post Test Documentation section below. The assigned ratings were determined using the rating scheme in Table #3 that is listed in the method.








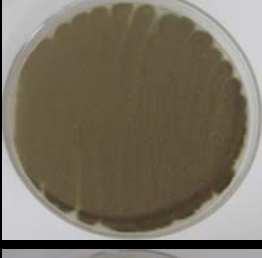
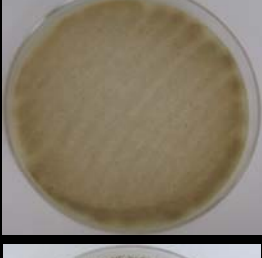

During Test Documentation:

Table # 1 Viability of Individual Spore Suspensions

| Organism | Percent Coverage | Viability Plate at 7 Days Incubation | |
|--|------------------|--------------------------------------|--|
| <i>Aspergillus niger</i> ATCC # 9642 | 100% | |  |
| <i>Aspergillus flavus</i> ATCC # 9643 | 100% | |  |
| <i>Aspergillus versicolor</i> ATCC # 11730 | 100% | |  |
| <i>Penicillium funiculosum</i> ATCC # 11797 | 100% | |  |
| <i>Chaetomium globosum</i> ATCC # 6205 | 100% | |  |
| <i>Aspergillus terreus</i> ATCC 10690 | 100% | |  |





| | | | | |
|--|------|--|--|--|
| <i>Trichoderme viride</i> ATCC 9645 | 100% | |  | |
| <i>Penicillium funiculosum</i> ATCC 36839 | 100% | |  | |
| <i>Scopulariopsis brevicaulis</i> ATCC 36840 | 100% | |  | |
| <i>Penicillium ochrochloron</i> ATCC 9112 | 100% | |  | |
| <i>Paecilomyces varioti</i> ATCC 18502 | 100% | |  | |
| <i>Aspergillus niger</i> ATCC 6275 | 100% | |  | |





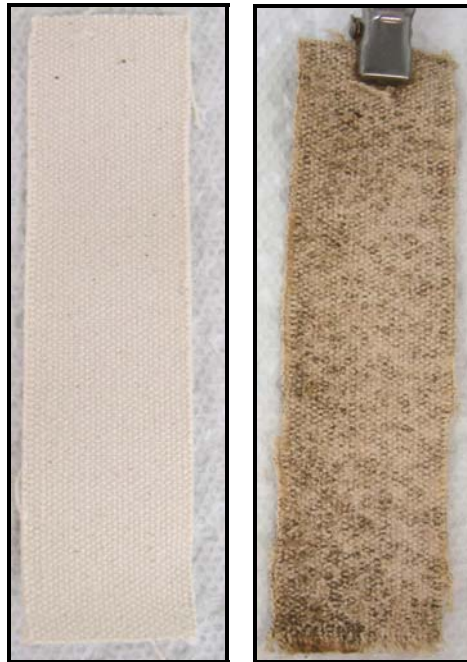
Temperature and Humidity were maintained throughout the entire test period. See Table # 2 and attached chart.

Table # 2 Record of Critical Components

| Critical Component | Pre-Condition | Week 1 (6/17) | Week 2 (6/24) | Week 3 (7/1) | Week 4 (7/8) |
|--|---------------|---------------|---------------|--------------|--------------|
| Temperature ($30 \pm 1^\circ\text{C}$) | 30.5 | 30.4 | 30.3 | 30.3 | 30.2 |
| Humidity (>90% and <100%) | 94.2 | 92.9 | 93.3 | 93.4 | 93.2 |

MIL STD 810 G Method 508.6 Critical Component Requirements:

- Temperature cannot exceed 40°C
- Temperature cannot exceed 32°C for 4 hours or more
- Temperature cannot go below 28°C and have a drop in humidity to less than 90%.
- If temperature does fall below the test parameters (29°C) but humidity has been maintained at 90% or greater, reestablish test conditions and continue test at the point the test fell below the prescribed tolerances.
- Relative humidity cannot drop below 50%
- Relative humidity cannot drop below 70% for 4 or more hours
- If there is evidence of deterioration of fungal growth on the control strips that may be due to test interruptions which affected the temperature and humidity, the test must be restarted.



The picture on the left is a chamber control strip at Day 0. The picture on the right is a chamber control strip at Day 28. At Day 7, all control strips had acceptable fungal growth to confirm the viability of the spore suspension and that the environment was suitable for fungal growth. At Day 28, all chamber controls had an increase in fungal growth as compared to Day 7 as required by the test method. All chamber controls performed as expected confirming the validity of the test.





Post Test Documentation:

Seven test samples and six control samples were tested for 28 days. The testing was performed without interruption. Performance data was not required.

Upon removal from the chamber at Day 28, the test pieces were evaluated following the rating scheme listed below in Table # 3. Test pieces were first examined with an unaided eye and then more closely inspected with a stereoscope. Any possible fungal growth was examined by tape preparation and microscopic evaluation. Fungal growth was determined to be test organisms or non-test organisms. Since samples are not sterile prior to testing, it is not uncommon non-test organisms that are native to the test samples will appear.

Table # 3 – Evaluation Scheme for Visible Effects and Test Sample Ratings

| Amount of Growth | Rating | Comments |
|------------------|--------|--|
| None | 0 | Substrate devoid of microbial growth |
| Trace | 1 | Scattered, sparse or very restricted microbial growth |
| Light | 2 | Intermittent infestations or loosely spread microbial colonies on substrate surface. Includes continuous filamentous growth extending over the entire surface, but underlying surfaces are still visible |
| Medium | 3 | Substantial amount of microbial growth. Substrate may exhibit visible structural change |
| Heavy | 4 | Massive microbial growth |

Results

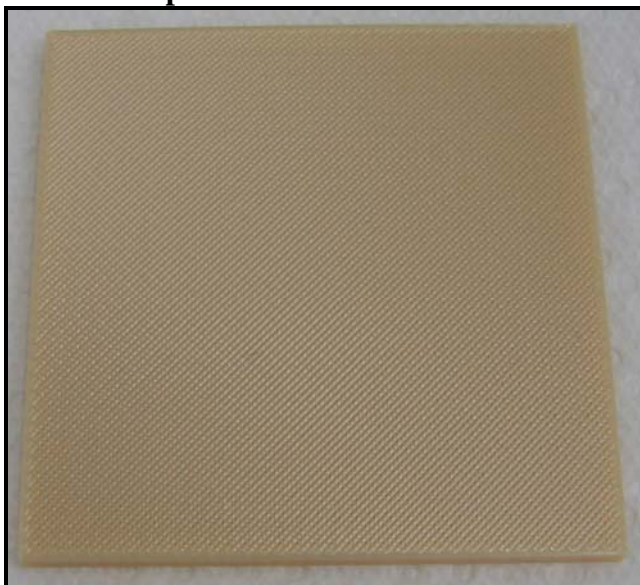
| Sample | Grade | Description of Growth |
|--|-------|---|
| Sample A: FDM Ultem 9085 45°/45° raster fill with +0.010 air gap | 0 | No fungal growth was found. Substrate devoid of microbial growth |
| Sample B: FDM Ultem 9085 0°/0° raster fill with -0.002 air gap | 0 | No fungal growth was found. Substrate devoid of microbial growth |
| Sample C: FDM Ultem 9085-defaults | 0 | No fungal growth was found. Substrate devoid of microbial growth |
| Sample D: FDM PPSF-defaults | 0 | No fungal growth was found. Substrate devoid of microbial growth |
| Sample E: FDM Polycarbonate-ISO-defaults | 0 | No fungal growth was found. Substrate devoid of microbial growth |



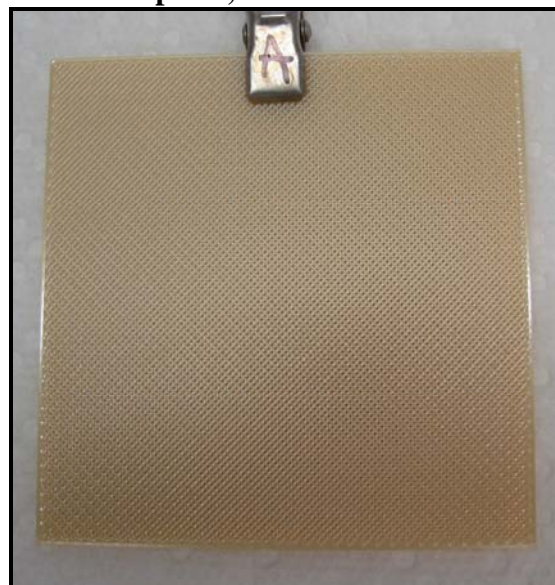


| | | |
|--------------------------------------|---|---|
| Sample F: FDM Polycarbonate-defaults | 0 | No fungal growth was found. Substrate devoid of microbial growth |
| Sample G: FDM ABS-M30-defaults | 0 | No fungal growth was found. Substrate devoid of microbial growth |

Test sample A before inoculation



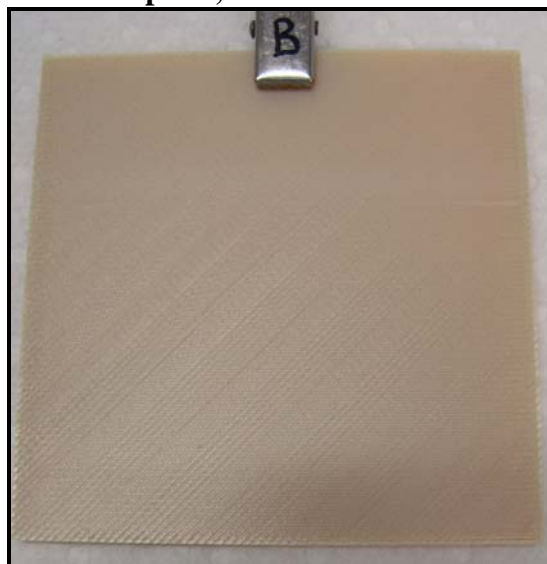
Test sample A, after 4 weeks incubation



Test sample B before inoculation



Test sample B, after 4 weeks incubation

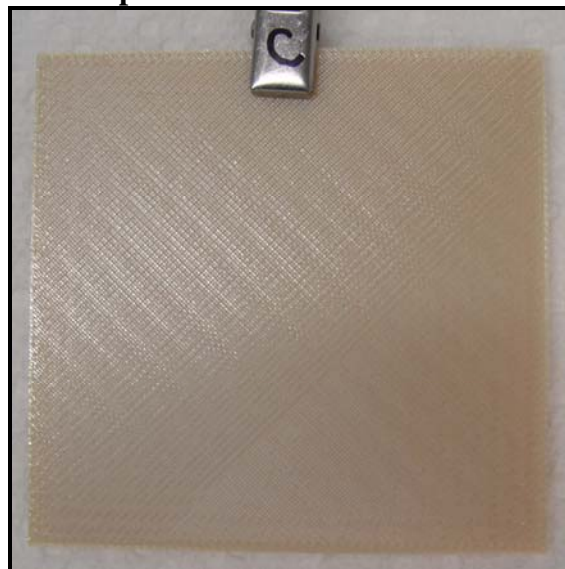




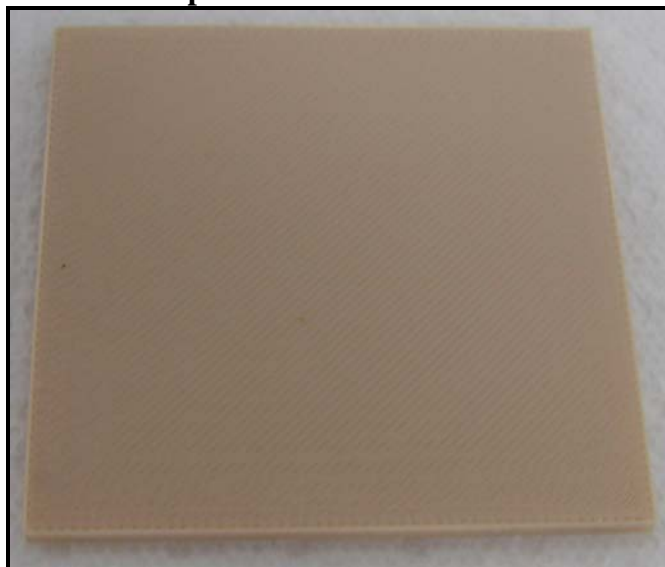
Test sample C before inoculation



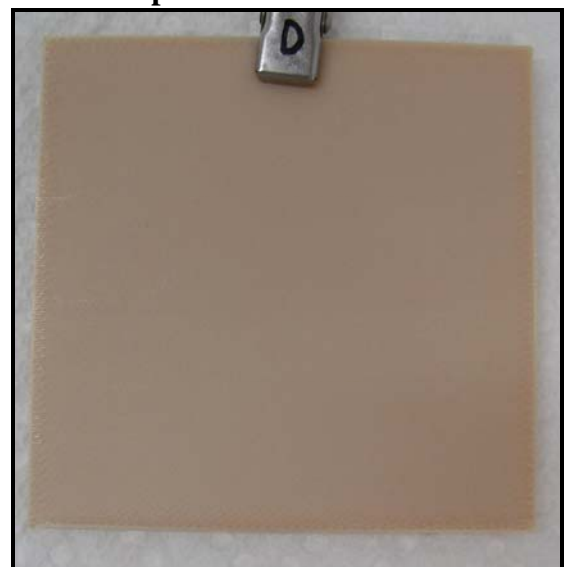
Test sample C after 4 weeks incubation



Test sample D before inoculation

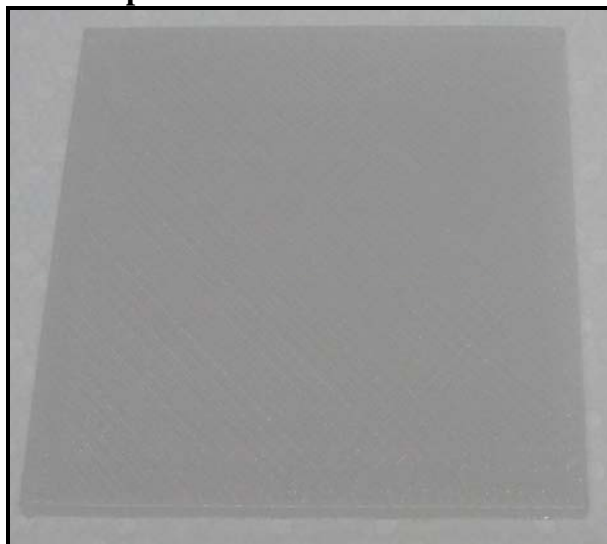


Test sample D after 4 weeks incubation

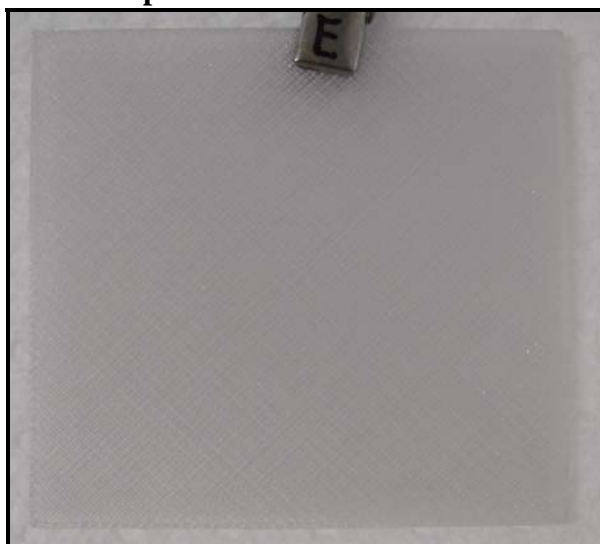




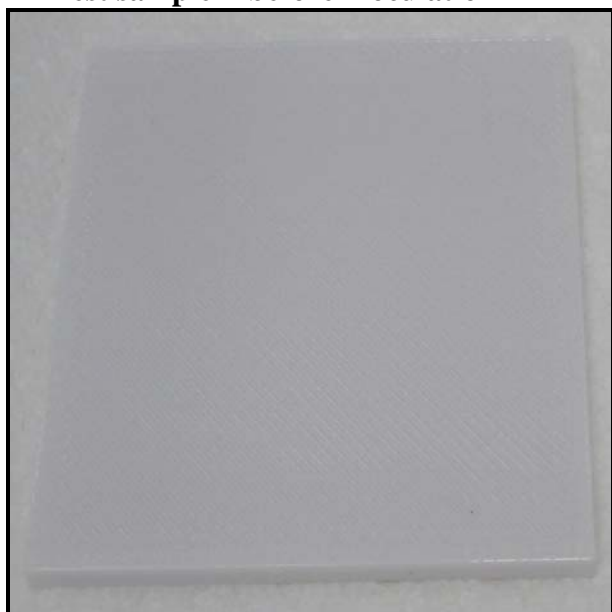
Test sample E before inoculation



Test sample E after 4 weeks incubation



Test sample F before inoculation



Test sample F after 4 weeks incubation





Test sample G before inoculation



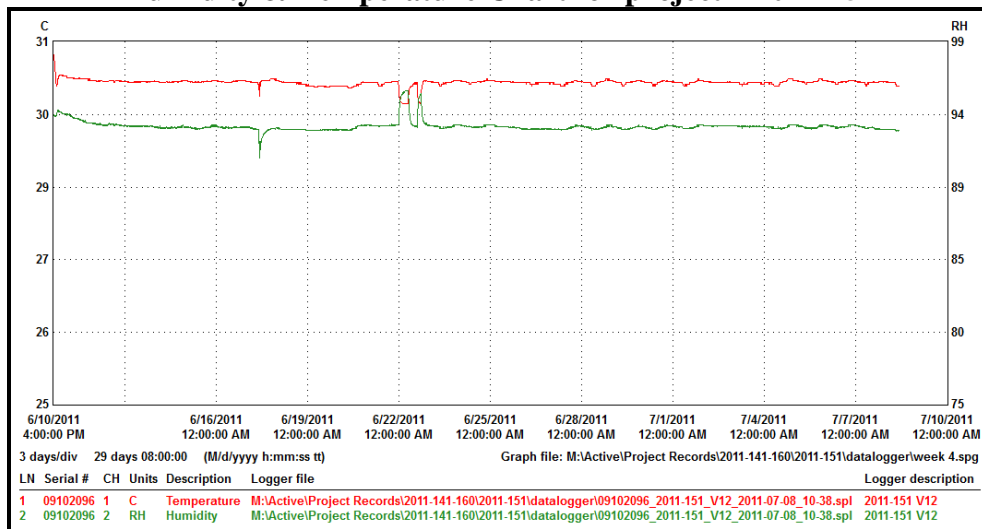
Test sample G after 4 weeks incubation



Conclusions

- The tested samples had no fungal growth present after 4 weeks incubation. No test organisms were recovered on the tested pieces after 28 days of incubation. These results are recorded in the Post-Test Documentation Section.
- When the control strips were checked for growth after 7 days, the test pieces were only inspected within the chamber with the unaided eye and no visible growth was noticed. Descriptions of the Day 28 growth are given in the Post-Test Documentation Section.
- No staining or deterioration of the surface was noted. Physical interference and detrimental effects on performance were not evaluated at this time. Health risks for persons with allergies to mold do not apply due to the lack of fungal growth.

Humidity & Temperature Chart for project # 2011-151



All fluctuations of temperature and humidity in the test chamber remained in the required ranges throughout the test period.

