PRODUCT CERTIFICATION REPORT

KoldLok® Integral Raised Floor Grommet

Model 1010

Updated May 1, 2002

Prepared for

Upsite Technologies, Inc.
2904 Rodeo Park Drive East
Santa Fe, New Mexico 87505
505.982.7800

Team Leader

Robert F. Sullivan, Ph.D.
Uptime Institute, Inc.®
2904 Rodeo Park Drive East, Bldg. 100
Santa Fe, NM 87505
505.986.3900

Uptime Institute™

Product	KoldLok Integral Raised Floor Grommet
Product Number	Model 1010
Serial Number	
Date of Testing	April 14, 2002
Test Report Number	02-060
Test Location	Sempliner Industrial Design, Douglaston, NY
Test Conducted by	Dr. Robert F. Sullivan, The Uptime Institute
	Arthur Sempliner, Sempliner Industrial Design
	Kenneth G. Brill, Upsite Technologies

Disclosure

The Uptime Institute, Computersite Engineering, and Upsite Technologies are a family of companies under common control. Each functions as an independent entity with careful consideration being given to conflicts of interest. The testing regimen developed by the *Institute* for KoldLok products is rigorous and repeatable should a third party want to conduct their own tests using the procedures outlined in this Report.

Summary

The Uptime Institute supervised performance testing of the KoldLok Integral Raised Floor Grommet Model 1010. The testing program had three objectives: 1) What is the KoldLok grommet's sealing effectiveness in preventing the loss of cooling air? 2) How effective is the KoldLok grommet in conducting static charge into the raised floor? and 3) Is the 4" by 8" net usable opening size of the KoldLok grommet sufficiently large to accommodate the density of cable concentrations likely to occur at most sites?

1. The KoldLok Integral Grommet successfully sealed simulated cable penetrations. When compared to a KoldLok frame with no sealing filaments (a totally open 5" by 8" cutout), the unpenetrated KoldLok assembly had a 100% sealing effectiveness up through a static pressure of 0.10 inches of water, which is the maximum static pressure anticipated in a computer room with a fully-sealed under floor.

   With the worst-case simulation of cable penetrations tested (four rods offset from the centerline of the KoldLok assembly), the sealing efficiency was 100% at 0.01 inches of water and 92% at 0.10 inches of water.

2. The KoldLok Integral Grommet had a measured conductivity of one gigaohm, which is well within the accepted standards to assure safe dissipation of static charge for raised-floor applications.

3. The gross opening of the KoldLok Integral Grommet allows the easy pass through of a 100-ampere, 208 volt, three phase RussellStoll plug and receptacle without causing a permanent set to the filaments. This plug is the largest currently found in a raised-floor environment. Four small signal cables, fifty-six Z\x" SCSI cables, and two B\," power cables were passed through the KoldLok Integral Grommet.

Introduction and Background

The KoldLok Integral Raised Floor Grommet assembly consists of a plastic frame that is mounted to the floor tile with screws. The frame holds two sets of opposing filaments of different lengths meeting in the middle of the assembly. These layers of different length filaments on each side of the frame are installed to minimize the airflow through the assembly. The smaller diameter filaments in the top layer provide better compliance to cables penetrating the assembly. The stiffer, larger diameter lower filaments support the thinner fibers used in the top layer. The bottom layer is designed to assist the top in minimizing airflow by providing a second layer of sealing and by limiting the effect of "veeing" (veeing of the filaments occurs naturally when cables are pulled tightly against the sides of the frame causing the filaments to form the shape of a "V"). The stiffer bottom layer is also designed to direct cables to the center of the assembly, thereby minimizing the opening created by a cable penetration.

Photo 1. Integral KoldLok Grommet is installed in the raised floor tile providing NFPA required raw metal edge dressing, access to install and remove cables, and sealing around cables to prevent the escape of cooling air

A KoldLok product is intended to provide access for pulling cables and for cable passage through the raised floor while sealing the resulting openings to minimize air leakage. A KoldLok product is also designed to integrate into the static charge dissipation capability of the raised floor. The KoldLok frame and filaments are mildly conductive to bleed off any static charge buildup on the cables due to high velocity airflow under the raised floor. The objective of all *Institute* product testing is to create repeatable, engineering based, industry standard processes for performance testing. The processes are formulated such that a competent third party can replicate them. Testing needs to incorporate user inputs and needs on how the product will actually be installed and used in real world applications.

Test Objectives

The objectives of this project were to:

1. Test KoldLok airflow sealing performance,
2. Test KoldLok conductivity to assure slow dissipation of static charge, and
3. Test the gross and usable Grommet opening area to be sure a single size Grommet will fit 98% of cable opening requirements.

Escape Airflow Measurement Testing

The initial airflow test chamber proved to be inadequate for producing consistent measurements and had to be completely rebuilt before certified testing could be completed. Engineering problems overcome by the final test chamber included 1) Adding sufficient fan capacity to generate high volumes of airflow through a totally open test fixture at high static pressures, 2) Stabilizing static pressure to allow consistent and accurate measurements of escaping airflow, 3) Developing a method for making consistent and accurate static pressure measurements, 4) Reducing escape air turbulence in the discharge section to allow consistent and accurate airflow measurements, and 5) Developing a consistent and accurate means for measuring very low rates of escaping airflow.

The custom made apparatus for testing KoldLok sealing effectiveness consisted of four major sequential sections: A) a static pressure generation chamber, B) a cable simulation test fixture that held penetrations in a fixed location, C) a test fixture for accurately holding the KoldLok Integral Grommet in a fixed location, and D) an escaping airflow measurement section.

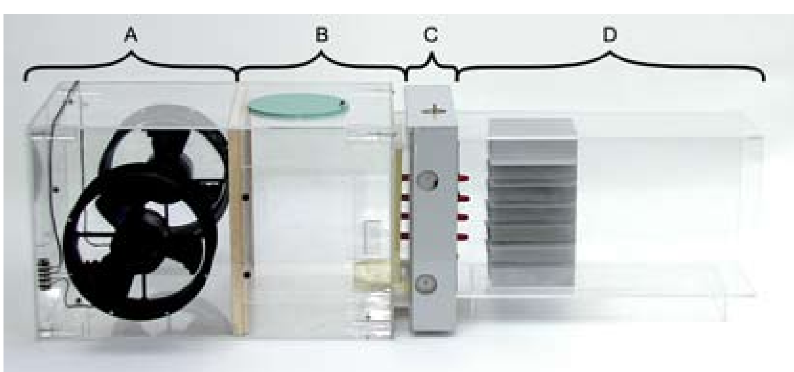


Photo 2. Apparatus used for testing KoldLok sealing effectiveness. The apparatus has four major sections. From left to right: A. Static pressure generation chamber, B. Cable penetration test station, C. KoldLok test station, and D. Escape airflow measurement section

A. The static pressure generation chamber consists of a Plexiglas box 15” H x 15” W x 24.5” L, with two 12VDC fans mounted opposed to each other and orthogonal to the airflow direction. Fan speed was controlled from a DC power supply. This chamber was capable of generating a stable static pressure from 0.005 inches of water to 0.250 inches of water into a KoldLok frame having no filaments. A Z\,” mesh screen was placed between the fans and the KoldLok test fixture to provide an airflow baffle to stabilize the static pressure.

B. The penetration test station allowed accurate placement of penetrator assemblies that were inserted into the KoldLok frame. The standardized penetrator assemblies used to simulate cables and cable bundles passing through the KoldLok blocked openings were:

Penetrator 0	KoldLok frame containing no filaments simulating an open cutout of 5” by 8”
Penetrator 1	Four Z\x” diameter wooden rods located on the vertical KoldLok centerline
Penetrator 2	One 2” diameter wood rod on the vertical KoldLok centerline One B\,” diameter wood rod located C\v” to the right of the vertical KoldLok centerline
Penetrator 3	One M\,” diameter wood rod on the vertical KoldLok centerline One Z\x” diameter wooden rod offset C\,” to the left and two Z|x” diameter rods offset B\,” to the right of the vertical KoldLok centerline

C. The KoldLok test fixture section allowed accurate mounting of the KoldLok Integral assembly in a fixed location. Static pressure was measured in the immediate underside of the grommet assembly.

D. The escape airflow measurement section consisted of a Plexiglas chamber 8Z\v” W x 11” H x 21” L. Within the escape chamber is a 6” long, 35-cell (seven high by five wide), baffle and turbulence straightening assembly allowing more accurate exhaust air measurements, especially at low escape velocities.

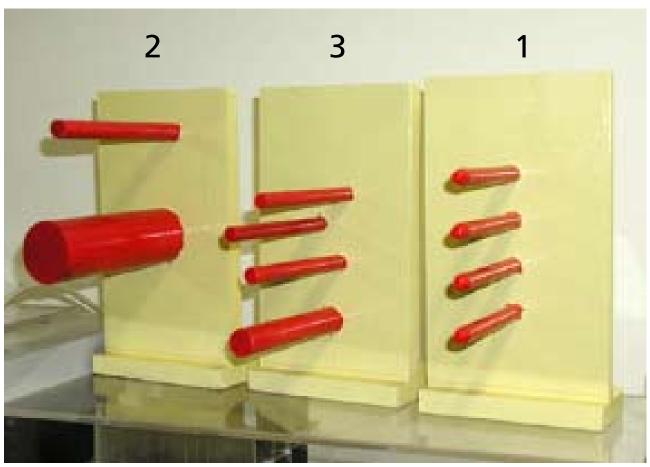


Photo 3. These penetrator assemblies were used to simulate cables and cable bundles passing through a floor opening. Not shown is Penetrator 0 which was an Integral KoldLok frame with no filaments simulating an unmanaged cable cutout opening.

Measurement Instruments

A. Static Pressure. Static pressure was measured with two different instruments, a Dwyer 0 to 0.25 inches of water Magnahelic gauge (Catalog number 2000-00) and a Dwyer 0 to .6 inches of water Inclined Manometer (Catalog number 1227)

B. Escape Airflow. Escaping airflow velocity was measured using a Shortridge Instruments Airdata Multimeter (Catalog ADM860 with a Velocity Grid Pressure Sensor—the pressure sensing points of the Velocity Grid Pressure Sensor outside the escape airflow cross section were sealed to increase measurement accuracy). Escaping airflow was triple checked using an Extech Thermo-Anemometer (Model 45112) and a Dwyer Thermo-Anemometer (Model UT120).

Test Procedure

KoldLok sealing performance was conducted using a specially fabricated test chamber allowing high volumes of airflow at static pressures of up to 0.250 inches of water, accurate measurement of the static pressure, a consistent means of mounting a KoldLok Grommet into the airflow, a consistent means of penetrating the KoldLok assembly with a variety of wooden rods to simulate standardized sets of cables and cable bundles passing through the KoldLok sealing filaments, and a means for measuring the volume of air escaping through the KoldLok assembly.

The first test was to measure the airflow through an open KoldLok Integral frame (one without filaments installed). This frame had a 5” x 8” open area. A fully assembled KoldLok grommet was next tested without any cable penetrations. Finally a series of three different penetration assemblies were inserted through the filament sealing assembly to simulate cables passing through the KoldLok assembly. These penetrations were wooden rods ranging in diameter from Z\x” to 2 inches. Some of the rods were installed on the filament centerline, while others were as far as C\v” off the brush centerline, simulating cables being pulled to the side of the assembly.

Each test was run with a series of static pressures ranging from 0.01 inches of water (the pressure typically found in many computer rooms) to 0.10 inches of water (the pressure estimated to be the maximum possible in a fully sealed computer room). Data collected included the test setup configuration, the static pressure, and escaping airflow velocity. Escape air volume in cubic feet per minute (CFM) was calculated using the measured airflow velocity and multiplying it by the cross section of the discharge area.

Photo 4. Dr. Bob Sullivan testing KoldLok sealing effectiveness

Data and Analysis

The open KoldLok frame (no filaments installed) had an airflow that ranged from 148 CFM at 0.01 inches of water to 483 CFM at 0.10 inches of water. When the KoldLok assembly without any penetrations (Penetrator 0) was installed, the airflow through the assembly was reduced to 0 CFM from 0.01 inches of water to 0.10 inches of water. This is a sealing efficiency of 100% throughout the static pressure range expected in most computer rooms.

Once rods penetrated the filament assembly, the results varied by the severity of the penetrations. With the Penetrator 1 the sealing remained at 100% for 0.01 inches of water. At 0.10 inches of water the flow was measured at 22 CFM for a 95% sealing efficiency. With the Penetrator 2 the sealing again remained at 100% at 0.01 inches of water. At 0.10 inches of water the flow was measured at 37 CFM for a 92% sealing efficiency. With the Penetrator 3 the sealing was still 100% at 0.01 inches of water. At 0.10 inches of water the measured airflow was 38 CFM for a 92% sealing efficiency.

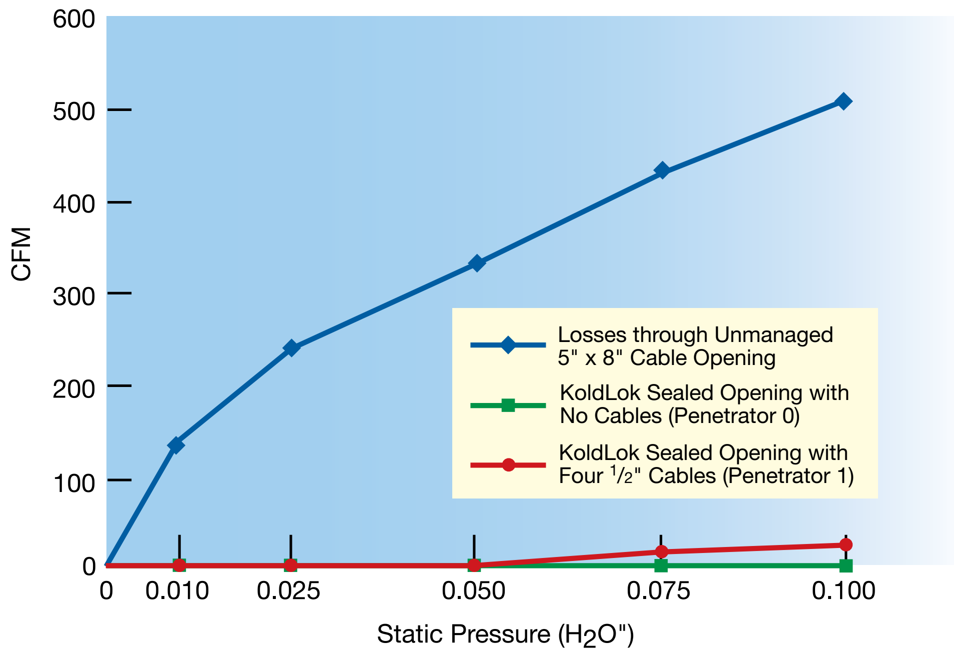
The entire set of test results are presented in Table 1.

Table 1. Lost Airflow (CFM) and Equivalent Lost Cooling (Watts)* under different test conditions

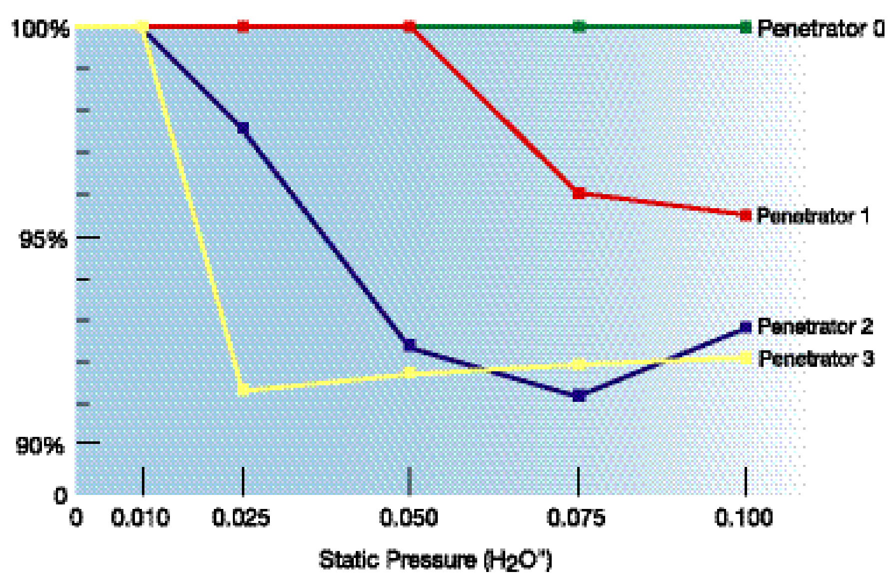
KoldLok Test Results	Static Pressure (Inches of H_2O)				
	0.010	0.025	0.050	0.075	0.100
Open KoldLok Frame (simulating a 5″ x 8″ unmanaged cable opening)					
Lost Airflow (CFM)	148	239	325	407	483
Equivalent Lost Cooling (Watts)	703	1,134	1,543	1,932	2,292
KoldLok + Penetrator 0 (simulating no cable penetrations)					
Lost Airflow (CFM)	0	0	0	0	0
Percent Sealing (%)	100	100	100	100	100
Equivalent Lost Cooling (Watts)	0	0	0	0	0
KoldLok + Penetrator 1 (simulating four ½″ cables on centerline)					
Lost Airflow (CFM)	0	0	0	0	0
Percent Sealing (%)	100	100	100	96.0	95.5
Equivalent Lost Cooling (Watts)	0	0	0	81	104
KoldLok + Penetrator 2 (simulating one large power cable pulled to one side and one cable on centerline)					
Lost Airflow (CFM)	0	6	25	32	37
Percent Sealing (%)	100	97.5	92.3	91.2	92.4
Equivalent Lost Cooling (Watts)	0	28	119	152	176
KoldLok + Penetrator 3 (simulating four offset cables)					
Lost Airflow (CFM)	0	21	27	33	38
Percent Sealing (%)	100	91.3	91.7	91.9	92.2
Equivalent Lost Cooling (Watts)	0	100	128	157	180

* Watts = 3,516 watts/ton x [measured airflow in CFM x Delta T across cooling coil in °F (15°F difference assumed) x 1.08] ÷ 12,000 Btu/ton
= 4.7466 x measured CFM

Graph 1. Integral KoldLok Grommet Escape Airflow with Different Simulations of Cable Penetration



Graph 2. Integral KoldLok Grommet Sealing Effectiveness with Different Simulations of Cable Penetration



A graphical presentation is included in Graph 1 and Graph 2.

Discussion of Results

Absolute accuracy of the lowest velocity airflow measurements are not guaranteed, but all tests were run consistently using the same instrumentation and with the same readings on the static pressure gauges. KoldLok sealing effectiveness was calculated as the relative difference in escape airflow using different penetrators under the same test conditions thereby eliminating the need for absolute measurement accuracy.

Static Charge Dissipation Testing

The conductivity of a KoldLok Integral Grommet was tested using an AEMC 100 Megohmmeter. One weight was positioned on the underside of the filaments and the other contacting the top surface of the raised floor.

Data and Analysis

At an excitation of 500 volts, the KoldLok Integral Grommet conductivity measured 1 gigaohm. This is well within the accepted industry standard for raised floor conductivity of greater than 150,000 ohms and less than 20 gigaohms.

Overall Conclusions

The KoldLok Integral Raised Floor Grommet's sealing effectiveness is virtually 100% (provided cables are not under tension and pulled against the sides of the KoldLok frame) under the static pressures typically seen in many computer rooms today. Under the highest static pressure expected in a well-sealed computer room and with the worst-case simulated cable penetrations, a sealing efficiency of 92% was achieved.

The static dissipation capability of the KoldLok Integral Grommet meets the accepted industry standard for raised floor applications.

Recommendations for Additional Testing

Best cable installation practice is to have some slack in the cables. If cables are under tension and are pulled against the edge of the KoldLok frame, veeing of the filaments will occur which will reduce sealing effectiveness. Over time, the filaments may take on the shape of a "V" and it could take some time for the filaments to return to their original fully sealed position after the cables are removed.

This problem was observed while the test chamber was being reconstructed during which time the Penetrator 2 was left installed for a period of several months. When the penetrator was removed, the filaments took several weeks to partially resume their original position. A more rigorous resiliency testing process is now being designed.

The static dissipation capability of an KoldLok Integral Grommet must be measured again when the grommet and tile are installed in an actual raised-floor environment.