BUSINESS CASE ANALYSIS

# Improving Data Center Reliability and Efficiency by Recovering Cooling Capacity with KoldLok® Raised Floor Grommets

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Subject: This business case examines the benefits and costs of improving data center cooling problems by sealing unmanaged cable openings with KoldLok Raised Floor Grommets.

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## Executive Summary

The trend toward higher heat densities in new IT and telecommunications equipment (and the presence of reduced cooling unit capacity and airflow) leads to hotspots, a debilitating data center issue. The higher ambient temperatures (typically measured at the top of server racks) can reduce IT equipment reliability and increase operating costs, negatively impacting business operations—particularly mission-critical applications that rely on "24 by forever" availability. Data center managers can reclaim the lost conditioned airflow by sealing unmanaged cable openings.

Developed with 10 years of field research, KoldLok Raised Floor Grommets are designed to improve precision cooling to specific heat loads by increasing the volume of conditioned airflow available to the areas most challenged by the increasing heat densities of new equipment. This design also improves the return-air conditions which can lead to recovery of lost cooling unit capacity due to latent cooling.

KoldLok products help data center personnel using multimillion-dollar computer equipment avoid the risks of heat-related damage, outages, and information blackouts. They also improve cooling effectiveness, reduce hotspots, assist with rebalancing airflow, and, as a result, offer a financial payback in just a few months.

## Background

Historically, conditioned air has been injected under the raised floor by computer room cooling units. Cool air moves under the raised floor and flows through openings as it returns to the intake of the cooling unit. Extensive measurements at targeted data center sites have shown that approximately 60 percent of the conditioned air flows through unmanaged openings rather than through the perforated floor tiles (see The Uptime Institute, Inc.® (*Institute*) white paper *Reducing Bypass Airflow Is Essential for Eliminating Computer Room Hotspots*, ©2004–2007 for more information). This condition is known as Bypass Airflow and it impacts computer room cooling in three significant ways:

- Hotspots: IT Equipment Intake Air Temperature Above Recommended Condition For Maximum Reliability. Hotspots are typically created by airflow escaping through cable cutouts and perimeter penetrations thereby reducing airflow through perforated tiles, which are intended to deliver conditioned air to the equipment. Hotspots are also created when the supply air emerging from the floor is hot. Hot supply air occurs when cooling units reduce their cooling capacity because return air has been cooled by conditioned air escaping through cable cutouts.
- Cooling Unit Incapacity: Sensible Cooling Unit Capacity Is Reduced. Conditioned airflow escaping through cable cutouts pre-cools the computer-heated exhaust air returning to the cooling unit. This reduces the return air temperature at the cooling unit and reduces the temperature difference (delta T) across the cooling unit coil. Reduced return-air temperature from pre-cooling (as little as 2°F) reduces the delivered or sensible capacity of a cooling unit by more than 10 percent, with no reduction in energy consumed. Reduced return air temperature also increases latent cooling, which wastes energy by removing moisture instead of reducing temperature.
- Latent Cooling Penalty: Moisture Removed Unnecessarily Must Be Replaced to Maintain a Reliable Computing Environment. Replacing lost moisture requires energy and the phenomenon is known as the latent cooling penalty. A 2°F reduction in return air temperature from bypass air requires the replacement of more than 1,300 gallons of water per month per cooling unit. This adds up to more than two vertical feet of water in a typical data center over a one-year period.

Many site managers respond to overheating problems by installing additional cooling units, believing erroneously that inadequate cooling capacity is the problem. Unfortunately, this strategy wastes capital and incurs unnecessary operating expenses. In too many cases, the real problem is a combination of wasted and/or poor delivery of existing conditioned air. Because the wrong root cause is addressed, additional capacity solutions often make no improvement and can even exacerbate existing cooling problems. The construction required to add capacity can also increase the risk of an unscheduled outage due to significant activity in an operating data center.

## Business Case Description

This analysis examines two data centers that are equivalent in size, computing equipment, heat load, and continuous uptime requirements. Case I illustrates a newly built data center, and Case II describes a retrofit of an existing data center. Common and specific assumptions are outlined below.

Case I benefits from KoldLok Integral Raised Floor Grommets, installed during construction. The KoldLok Integral Raised Floor Grommet automatically seals data and power cable openings for new equipment applications. The penetrable grommet has multilayered, opposing filaments, and it requires no additional parts, tools, or management after installation. KoldLok grommets are the result of extensive field tests to develop a device that permanently minimizes underfloor air losses. Case II benefits from the delivery of Upsite's EnergyLok℠ remediation service, which involves sealing existing cable cutouts and perimeter penetrations without shutting down computer equipment. EnergyLok also provides a portfolio of packaged engineering services to optimize cooling efficiency as outlined in the Case II assumptions.

**Methods:** This analysis calculates the reduced number of cooling units Cases I and II need based on sealing unmanaged openings that waste cooled air.  Using the calculations, data centers can easily determine the financial impact to their business. This same calculation can also be used in data centers that operate with chilled water systems.

**Operational Metrics:** By sealing cable cutouts, data centers can reduce the number of cooling units in operation. This number can be determined using simple calculations involving bypass airflow and thermal cooling demand. Previously lost bypass air is recovered and forced to flow to the perforated floor tiles that should be located at the computer cabinet air intakes, thus delivering increased airflow where it is needed most.

**Financial Metrics:** The positive financial impact of installing KoldLok products is calculated using a five-year savings model. The financial models are simplified by:

- Including savings from electricity, maintenance, and capital due to a reduction in cooling units installed or operating
- Excluding the impact of business risks of strategic information outages
- Excluding the impact of cooling unit depreciation and property taxes

As a result, the financial models are limited to the incremental cost savings and do not fully capture significant additional benefits, such as:

- Reduction in risk of business losses due to information downtime
- Reduction in the risk that computer manufacturers will not honor maintenance warranties, but instead will charge on a time-and-materials basis for repairs to computer hardware. The probability of this grows as the frequency and cause of product failures at the top of racks becomes better understood
- Reduction in management time required to respond to heat-related soft errors and outages
- Potential for increased revenue from more rentable floor space made available by the reduction in cooling units
- Other contributions to business objectives

Using the cost savings, a variety of financial benchmark values can be calculated, including payback, discounted cash flow, and Internal Rate of Return (IRR).

Assumptions Common to Both Business Case I and Case II:

- Data center consists of 10,000 $ft^2$ of raised-floor space with an underfloor cooling plenum of 18" or higher for distributing cooled air.
- Data center has 400 equipment cabinets averaging 2' X 3' at the base and 6' high.
- Data center consumes 600 kilowatts (kW) of power for an average of 1.5 kW per rack and $60W/ft^2$. All power consumed by computer equipment within the racks is converted to heated air.
- Electrical energy, including demand charges, costs $0.06 per kilowatt hour (kWh).
- Liebert Model VH267W 20-ton cooling units are used to cool the data center. Each cooling unit uses a 5 horsepower (Hp) fan to deliver 10,000 cubic feet per minute (CFM) of airflow and consumes 3.73 kW for airflow demand and 16.7 kW for thermal demand (liebert.com).
- Field measurement of airflow in numerous data centers has determined that 50 to 80 percent of the CFM discharged from cooling units into the underfloor plenum escapes through unsealed openings. Lost air through cable openings can be verified by simple measurements of actual perforated tile and grate openings ($ft^2$) compared to measurements of cable cutouts and perimeter penetrations ($ft^2$). Air lost through floor, sidewall, or ceiling penetrations can also be verified by simple cross-sectional area measurements. If the air returns to the computer room, these penetrations can be treated the same as

cable cutout bypass air. If the air fails to return to the computer room, cooled air has been permanently lost and must be replaced, which increases the total thermal cooling demand.

## Business Case I for a Newly Built Data Center

Assumptions for Case I

- Common Case I and II assumptions as listed above.
- KoldLok Integral Raised Floor Grommets are mounted into raised-floor tiles to seal cable cutouts as the floor tiles are installed. All 400 cabinet cable cutouts are sealed.
- Alternating hot-aisle and cold-aisle equipment configurations are implemented.
- Twenty-five percent open perforated floor tiles are installed one per every two racks at the rack air intake for a total of 200 perforated floor tiles.
- All perimeter penetrations in the subfloor, walls, and ceiling are sealed.
- The supply temperature is 57˚F, exhaust temperature is 74˚F, and the temperature increase of the air as it passes through the computer equipment is an average of 17˚F.
- Without sealing the cable cutouts, 30 percent of available cold air bypasses the perforated floor tiles through cable cutouts averaging 5” x 6” in size (use of larger openings increases bypass air and its negative environmental effects). Thirty percent bypass air results in a return air temperature of 70˚F/48 percent relative humidity (Rh). At this condition, each cooling unit provides 219,700 British Thermal Units per hour (BTU/h) of total cooling, of which 93 percent or 203,400 BTU/h (59.7 kW) is sensible cooling. This yields 16,300 BTU/h (4.8 kW) of latent cooling (capacity data provided by Liebert).
- By sealing the cable cutouts, only 10 percent of available cold air bypasses the perforated floor tile openings resulting in a return air temperature increase to 72˚F/45 percent Rh. For this return air condition, each cooling unit provides 229,900 BTU/h of total cooling, of which 100 percent or 229,900 BTU/h (67.0 kW) is sensible thermal cooling (capacity data provided by Liebert). There is no latent cooling.
- Humidification is via electric canister type humidifiers. The energy consumed by these canisters to vaporize the necessary replacement water is assumed to be the same as the latent energy required to remove the moisture (4.8 kW from above). This assumes 100 percent efficiency. In reality, actual efficiency is significantly less than 100 percent and the energy consumption will be greater than assumed.

### Operational Metrics for Case I

Without KoldLok products installed, 16 operating cooling units are needed to meet the airflow demand, but only 10.1 cooling units are required to meet the thermal cooling demand. Calculations are determined by the following:

- Heat load per perforated tile: 600kW x 200 perforated tiles = 3kW / perforated tile
- Airflow per perforated tile: 550 CFM (550 CFM is the airflow required to cool 3kW at a delta T of 15˚F)
- Total perforated tile airflow: 550 CFM x 200 perforated tiles = 110,000 CFM
- Total airflow required: 110,000 x 70% = 157,143 CFM (accounts for 30 percent bypass air)

Cooling Units Required to Meet Airflow and Thermal Demands Without KoldLok Installed:

- Airflow demand: 157,143 CFM x 10,000/cooling units = 15.7 or 16 cooling units (since the fan can only be on or off)
- Thermal demand: 600 kW x 59.7 kW/cooling units = 10.1 cooling units

With KoldLok products installed, 13 cooling units are needed to meet the airflow demand and 8.9 cooling units are required to meet the thermal cooling demand. Calculations are determined by the following:

- Heat load per perforated tile: 600kW x 200 perforated tiles = 3kW / perforated tile
- Airflow per perforated tile: 550 CFM (550 CFM is airflow required to cool 3kW)
- Total perforated tile airflow: 550CFM x 200 perforated tiles = 110,000 CFM
- Total airflow required: 110,000 x 90 percent = 122,222 CFM (accounts for 10 percent bypass air)

Cooling Units Required to Meet Airflow and Thermal Demands With KoldLok Installed:

- Airflow demand: 122,222 CFM x 10,000/cooling units = 12.2 or 13 cooling units

- Thermal demand: 600 kW x 67.0 kW/cooling units = 8.9 cooling units

Since there are no perimeter penetrations, there is no cold air escaping the data center envelope.

In both examples above, the number of cooling units required to be operating is dictated by the airflow demand, not the thermal demand. In the non-KoldLok product case, one additional cooling unit is required to compensate for the reduction to 88 percent sensible cooling (203,400 x 229,900) caused by the premixing of the return air.

## Cooling Unit Summary

| | Cooling Units Required to Meet Airflow Demand | Cooling Units Required to Meet Thermal Demand |
|---|---|---|
| Without KoldLok Products | 16 | 10.1 |
| With KoldLok Products | 13 | 8.9 |
| Cooling Unit Savings | 3 | 1.2 |

## Financial Metrics for Case I

The financial impact of saving 20-ton cooling units can be calculated as detailed below:

- $30,000.00 is the capital investment per each incremental cooling unit.
- $1,960 is the annual energy cost per cooling unit required for airflow demand (fans only): $1,960 = 5 Hp fan x .746 kW/Hp x 24 hr/day x 365 day/yr x $0.06 /kWh.
- $8,778 is the annual energy cost per cooling unit required for thermal demand (refrigeration only). $8,778 = 16.7 kW x 24 hr/day x 365 day/yr x $0.06 /kWh
- $2,523 is annual cost per cooling unit for the latent cooling penalty. The latent cooling (dehumidification) occurring without KoldLok products installed will require rehumidification to counter the moisture lost to maintain the computer room's relative humidity above the minimum level required for reliable computing. (The only humidification costs included here are for electricity. Additional humidification costs not included are canister replacement and the risks of having active water sources under the raised floor.): $2,523 = 4.8 kW x 24 hr/day x 365 day/yr x $0.06/kWh.
- $3,000 is the annual maintenance cost per cooling unit: $3,000 = $250 per month x 12 months.

## Case I Summary

Financial savings for the Case I comprise the following, which are used in the cash flow analysis:

- Capital cost savings from installing three fewer cooling units ($90,000)
- Electrical energy savings due to running three fewer cooling units for airflow ($5,880 annually)
- Electrical energy savings due to running of 1.2 fewer cooling units for thermal demand ($10,534 annually)
- Electrical energy savings due to avoiding the latent cooling penalty on 10.1 cooling units ($25,482 annually)
- Maintenance savings due to running three fewer cooling units ($9,000 annually)

## Summary of Financial Savings for Case I

### Cash Flow Analysis for Installing KoldLok Integral in a 10,000 ft² New Data Center

| Item | Initial | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Total |
|---|---|---|---|---|---|---|---|
| Reduction of Cooling Units for Airflow Demand | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| Reduction of Cooling Units for Thermal Demand | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 |
| KoldLok with Installation ($82.50 each) | ($33,000) | | | | | | ($33,000) |
| Cooling Unit Acquisition Cost Saved | | $90,000 | | | | | $90,000 |
| Airflow Demand Energy Saved | | $5,880 | $5,880 | $5,880 | $5,880 | $5,880 | $29,400 |
| Thermal Demand Energy Saved | | $10,534 | $10,534 | $10,534 | $10,534 | $10,534 | $52,668 |
| Latent Cooling Penalty Saved | | $25,482 | $25,482 | $25,482 | $25,482 | $25,482 | $127,412 |
| Maintenance Saved | | $9,000 | $9,000 | $9,000 | $9,000 | $9,000 | $45,000 |
| Net Cash Flow | ($33,000) | $140,896 | $50,896 | $50,896 | $50,896 | $50,896 | $311,480 |
| Cumulative Cash Flow | ($33,000) | $107,896 | $158,792 | $209,688 | $260,584 | $311,480 | $311,480 |

| **Energy Cost (kWh + Demand)** | **$0.06** | **$0.10** |
|---|---|---|
| Payback in Months | 3 | 2 |
| Return on Investment (5-year) | 944% | |
| Internal Rate of Return | 369% | |
| Discounted Cash Flow @ 15% | $187,715 | |
| Discounted Cash Flow @ 10% | $219,776 | |

## Business Case II for EnergyLok Service Package of an Existing 10,000 ft² Data Center

Assumptions for Case II

- Common Case I and II assumptions as listed above.
- Twenty-five percent open perforated floor tiles are installed one per every rack at the air intake for a total of 400 perforated floor tiles.
- Data center has one raised-floor cable cutout for each rack or cabinet—most of which are located at the rear of the cabinet—and none are effectively sealed.
- Data center has unsealed perimeter penetrations that are also leaking cooled air.
- Supply temperature is 57°F, exhaust temperature is 74°F, and the temperature increase of the air as it passes through the computer equipment is an average of 17°F.
- Humidification is via electric canister type humidifiers.
- Before sealing cable cutouts and perimeter penetrations, 60 percent of available cold air bypasses the perforated floor tiles, 50 percent of which is through unmanaged raised-floor cable openings, and 10 percent is permanently lost to the computer room through unsealed perimeter penetrations. This results in a return air temperature of 70°F/48 percent Rh. At this condition, each cooling unit provides 219,700 BTU/h of total cooling, of which 203,400 BTU/h (59.7 kW) is sensible cooling. This yields 16,300 BTU/h (4.8 kW) of latent cooling penalty (capacity data provided by Liebert).
- Engineered remediation services are performed by Upsite engineers and Upsite certified installation professionals and include the following:
  - EnergyLok Services:
    - Diagnosis of existing cooling problems
    - Creation of fluid dynamics airflow models predicting improvement
    - Solution engineering
    - Creation of sequence plan.
    - Project management
  - Sealing 400 cable cutouts with KoldLok Surface Mount Raised Floor Grommets
  - Sealing perimeter penetrations in subfloor, walls, and ceiling
  - Adjusting the number and placement of perforated tiles to assure properly cooled airflow is delivered to the equipment.
  - Documentation of changes and provisional one-year certification for future capacity if the Institute Hot aisle/Cold aisle configurations and other recommendations are followed.

After completion of EnergyLok, all perimeter penetrations and raised-floor cable cutouts have been sealed. Only 10 percent of available cold air bypasses the perforated floor tiles, resulting in a return air temperature increase to 72°F/45 percent Rh. At this condition, each cooling unit provides 229,900 BTU/h of total cooling, of which 229,900 BTU/h (67.0 kW) is sensible thermal cooling (capacity data provided by Liebert). There is no latent cooling.

### Operational Metrics for Case II

Before EnergyLok remediation, 28 cooling units are required to meet the airflow demand and 11.2 cooling units are needed to meet the thermal demand. Calculations are determined by the following:

- Heat load per perforated tile: 600kW x 400 perforated tiles = 1.5kW / perforated tile
- Airflow per perforated tile: 275 CFM (275 CFM is airflow required to cool 1.5kW)
- Total perforated tile airflow: 275 CFM x 400 perforated tiles = 110,000 CFM
- Total airflow: 110,000 x 40 percent = 275,000 CFM (accounts for 60 percent bypass air)

Cooling Units Required to Meet Airflow and Thermal Demands Without KoldLok Installed:

- Airflow demand: 275,000 CFM x 10,000/cooling units = 28 cooling units
- Thermal demand: 600 kW x 90 percent x 59.7 kW/cooling units = 11.2 cooling units (Dividing by 90 percent accounts for 10 percent of cooling capacity lost through perimeter penetrations).

After EnergyLok remediation, 13 operating cooling units are required to meet the airflow demand and 8.9 cooling units are needed to meet the cooling demand. Calculations are determined by the following:

- Heat load per perforated tile: 600kW x 400 perforated tiles = 1.5kW / perforated tile
- Airflow per perforated tile: 275 CFM (275 CFM is airflow required to cool 1.5kW)
- Total perforated tile airflow: 275 CFM x 400 perforated tiles = 110,000 CFM
- Total airflow: 110,000 x 90 percent = 122,222 CFM (accounts for 10% bypass air)

Cooling Units Required to Meet Airflow and Thermal Demands With KoldLok Installed:

- Airflow demand: 122,222 CFM x 10,000/cooling units = 12.2 or 13 cooling units
- Thermal demand: 600 kW x 67.0 kW/cooling units = 8.9 cooling units

In both examples, the number of cooling units required is dictated by the airflow demand, not the thermal demand.

## Cooling Unit Summary

| | Cooling Units Required to Meet Airflow Demand | Cooling Units Required to Meet Thermal Demand |
|---|---|---|
| Without EnergyLo | 28 | 11.2 |
| With EnergyLok | 13 | 8.9 |
| Cooling Unit Savings | 15 | 2.3 |

## Financial Metrics for Case II

The financial impact of reducing the number of 20-ton cooling units can be calculated as detailed below:

- $0 capital saving is assumed for reducing the number of cooling units required because the cooling equipment has already been installed. This equipment would be available for relocation or removal and sale.
- $1,960 is the annual energy cost per cooling unit required for airflow (fans only running): $1,960 = 5 hp fan x .746 kW/Hp x 24 hr/day x 365 day/yr x $0.06 /kWh.
- $8,778 is the annual energy cost per cooling unit required for thermal demand (refrigeration only): $8,778 = 16.7 kW x 24 hr/day x 365 day/yr x $0.06 /kWh.
- $2,523 is annual cost per cooling unit for the latent cooling penalty. The latent cooling (dehumidification) occurring in the before EnergyLok will require rehumidification to add back the moisture lost to maintain the computer room's relative humidity above the minimum level required for reliable computing. The only humidification costs included here are for electricity. Additional humidification costs not included are canister replacement and the risks of having active water sources under the raised floor: $2,523 = 4.8 kW x 24 hr/day x 365 day/yr x $0.06/kWh.
- $3,000 is the annual maintenance cost per cooling unit: $3,000 = $250 per month X 12 months.

Financial operational savings for the retrofit remediation of the data center consist of:

- Capital cost savings from installing fewer cooling units ($0).
- Electrical energy savings due to running 15 fewer cooling units for airflow ($29,400 annually).
- Electrical energy savings due to running 2.3 fewer cooling units for thermal demand ($20,189 annually).
- Electrical energy savings due to avoiding the latent cooling penalty on 11.2 cooling units ($28,258 annually).
- Maintenance savings due to running 15 fewer cooling units ($45,000 annually).

## Summary of Financial Savings for Case II

### Cash Flow Analysis from **EnergyLok** Remediation in a 10,000 $ft^2$ Existing Data Center.

| Item | Initial | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Total |
|---|---|---|---|---|---|---|---|
| Reduction of Cooling Units for Airflow Demand | 15 | 15 | 15 | 15 | 15 | 15 | 15 |
| Reduction of Cooling Units for Thermal Demand | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 |
| EnergyLok Remediation Service | ($175,000) | | | | | | ($175,000) |
| Cooling Unit Acquisition Cost Saved | | | | | | | $0 |
| Airflow Demand Energy Saved | | $29,400 | $29,400 | $29,400 | $29,400 | $29,400 | $147,000 |
| Thermal Demand Energy Saved | | $20,189 | $20,189 | $20,189 | $20,189 | $20,189 | $100,947 |
| Latent Cooling Penalty Saved | | $28,258 | $28,258 | $28,258 | $28,258 | $28,258 | $141,288 |
| Maintenance Saved | | $45,000 | $45,000 | $45,000 | $45,000 | $45,000 | $225,000 |
| Net Cash Flow | ($175,000) | $122,847 | $122,847 | $122,847 | $122,847 | $122,847 | $439,235 |
| Cumulative Cash Flow | ($175,000) | ($52,153) | $70,694 | $193,541 | $316,388 | $439,235 | $439,235 |

| Energy Cost (kWh + Demand) | $0.06 | $0.10 |
|---|---|---|
| Payback in Months | 17 | 12 |
| ROI (5-year) | 251% | |
| Internal Rate of Return | 64% | |
| Discounted Cash Flow @ 15% | $205,915 | |
| Discounted Cash Flow @ 10% | $264,261 | |

## Summary of Financial Results

A review of the financial models for both the newly built and existing data centers indicates a highly favorable investment opportunity. Moreover, the added revenue from increased usable floor space due to increased cooling efficiencies can have a substantial impact.

Summary of Non-Financial Results

The qualitative benefits of KoldLok products and services can be widespread. The most obvious benefits can include:

- Increased reliability and life of computing equipment
- Reduced risk from unscheduled, heat-related computer outages
- Elimination of business losses due to heat-related outages
- Elimination of management time lost responding to heat-related outages
- Data center hardening
- Competitive advantages
- Improved industry reputation
- Increased employee morale when best practices are implemented
- Achievement of business objectives
- Reduction in subfloor debris due to sealed holes

## Summary Recommendation

Given the potential for (1) quick financial return, (2) reduction in business risk, and (3) data center hardening, Upsite's family of KoldLok products and services is recommended for data center facilities experiencing or expecting heat-density problems.

## Data Sources and Validation

Additional information regarding the effects of increasing heat densities is presented in Institute's white paper, Heat Density Trends in Data Processing, Computer Systems, and Telecommunications Equipment. Other related articles are referenced in the Additional Information section of this document. All referenced papers are available on the Institute's website at: uptimeinstitute.org

## Sensitivity and Risk Analysis

Airflow through a 25 percent open perforated floor tile will increase from the typical 200 CFM to 600 CFM or more as unmanaged openings are sealed. The primary element of risk addressed in this case analysis is the risk of being unable to increase underfloor static pressure and airflow. Achieving an airflow higher or lower than that assumed in this Business Case Analysis will result in a direct increase or decrease in the financial benefits, respectively.

Disclaimer

This analysis provides approximations of important financial consequences that should be considered in decisions involving the purchase and installation of KoldLok products and/or the delivery of EnergyLok services in data centers. This analysis is based on information believed by Upsite Technologies, Inc. to be accurate. Increases in airflow and underfloor static pressure are estimates and dependent on factors beyond Upsite's control. Price information is subject to change. Potential customers should use this analysis as an aid only to develop their own cost and benefit analyses.

## About the Author

Daniel L. Gollahon, CDP is Business Development Manager for Upsite Technologies, Inc. He has a BSEE from Southern Illinois University, 20 years experience in the computer industry, in which he has held a variety of technical, marketing, and management positions with Hewlett-Packard and Digital Equipment, and 10 years experience in the telecommunications industry, in which he has held a variety of marketing and management positions with TV Guide and Williams Communications.

## About Upsite

Upsite Technologies, Inc.™ develops energy-efficient, high-availability solutions specifically designed to optimize your data center's critical physical infrastructure and ensure site uptime, reliability, and flexibility.

As the innovator of engineered sealing solutions, Upsite continues to research and develop products and services to complement and enhance the already extensive lines of patented KoldLok® products and EnergyLok℠ services. Our inventions optimize thermal load capacity, target hotspot remediation, reduce intermittent equipment failures, improve equipment reliability, minimize bypass airflow, and diminish capital costs associated with installing additional cooling equipment.

Upsite's well-engineered solutions are employed by data centers worldwide to help reduce their carbon footprint and minimize energy and operating costs. Upsite's products and services currently optimize more than 6 million $ft^2$ of data center space.

## Additional Information

From Upsite Technologies, Inc.

- KoldLok Product Documentation (Product Data Sheets and Installation Guides)
- EnergyLok Service Data Sheet

- The Uptime Institute's White Paper: *Reducing Bypass Airflow is Essential for Eliminating Computer Room Room Hotspots*, Robert F. Sullivan, Ph.D., with Lars Strong, P.E., and Kenneth G. Brill
- The Uptime Institute: *Product Performance Testing: Certified Testing Report, KoldLok Integral Raised Floor Grommet, Model 1010*, by Robert F. Sullivan, Ph.D.

From The Uptime Institute, Inc. (uptimeinstitute.org)

- *2005 - 2010 Heat Density Trends in Data Processing, Computer Systems, and Tele-communications Equipment*, by Kenneth G. Brill
- *Alternating Cold and Hot Aisles Provides More Reliable Cooling for Server Farms*, by Robert F. Sullivan, Ph.D.
- *Changing Cooling Requirements Leaves Many Data Centers at Risk*, by Robert F. Sullivan, Ph.D. with Lars Strong, P.E. and Kenneth G. Brill
- *Tier Classifications Define Site Infrastructure Performance* by Pitt W. Turner IV, John H. Seader, and Kenneth G. Brill
- *Cooling Techniques That Meet "24 by Forever" Demands of Your Data Center*, by Robert F. Sullivan, Ph.D. with Lars Strong, P.E. and Kenneth G. Brill
- *Continuous Cooling Is Required for Continuous Availability: Data Center Managers Need to Match Their Availability Expectations to the Appropriate Class of Continuous Cooling*, by Rob Menuet, P.E. and Pitt W. Turner IV, P.E.
- *Reducing Bypass Airflow Is Essential for Eliminating Computer Room Hotspots*, by Robert F. Sullivan, Ph.D. with Lars Strong, P.E. and Kenneth G. Brill

## Appendix A

Increasing Cooling Capacity by Redirecting Conditioned Airflow

Appendix A converts the savings in energy reduction from KoldLok products and EnergyLok services to increased number of heat-dense racks that will be properly cooled as a result of sealing unmanaged openings to regain lost bypass airflow.

Case I—Newly Built Data Center: Starting with the Case I KoldLok Savings Summary Table, the number of units reduced is below. Also listed is the calculated cooling regain in equivalent kW for both airflow demand and thermal demand. The calculations for the last 2 lines in the table are detailed below the table.

| | **Cooling Units Required to Meet Airflow Demand** | **Cooling Units Required to Meet Thermal Demand** |
|---|---|---|
| Without KoldLok | 16 | 10.1 |
| With KoldLok | 13 | 8.9 |
| Cooling Unit Savings | 3 | 1.2 |
| kW Capacity Regain | 147kW | 80kW |
| No. of Additional 10kW Racks Properly cooled with EnergyLok | 13 | 8 |

- Airflow demand: with KoldLok products, 3 cooling units are regained for a total of 27,000 CFM and 1.2 cooling units are regained for a total of 80 kW.

Cooling Units Regain:

- Airflow regain: 3 cooling units x 10,000 CFM x 90% = 27,000 CFM
- Airflow CFM to kW 27,000 CFM x (3kW x 550 CFM) = 147 kW
- Thermal regain: 1.2 cooling units x 67.0 kW = 80 kW

Assuming the use of heat dense computer cabinets (racks) generate 10 kW of heat, the following number of racks are regained as a result of sealing cable cutouts in a new data center:

- # 10 kW racks of cooling regained:
- Airflow regain: 147 kW x 10 kW/rack = 14 racks
- Thermal regain: 80 kW x 10 kW/rack = 8 racks

Case II—Existing Data Center: Starting with the Case II KoldLok Savings Summary Table, the number of units reduced is below. Also listed is the calculated cooling regain in equivalent kW for both airflow demand and thermal demand. The calculations for the last 2 lines in the table are detailed below the table.

| | **Cooling Units Required to Meet Airflow Demand** | **Cooling Units Required to Meet Thermal Demand** |
|---|---|---|
| Without KoldLok | 28 | 11.2 |
| With KoldLok | 13 | 8.9 |
| Cooling Unit Savings | 15 | 2.3 |
| kW Capacity Regain | 736kW | 154kW |
| No. of Additional 10kW Racks Properly cooled with EnergyLok | 73 | 15 |

- Airflow Demand: with KoldLok products, 9 cooling units are regained for a total of 81,000 CFM and 2.3 cooling units are regained for a total of 154 kW.

Cooling Units Regain:

- Airflow regain: 15 cooling units x 10,000 CFM x 90 percent = 135,000 CFM
- Airflow CFM to kW 135,000 CFM x (3kW x 550 CFM) = 736 kW
- Thermal regain: 2.3 cooling units x 67.0 kW = 154 kW

Assuming the use of heat-dense computer cabinets (racks) that generate 10 kW of heat, the following number of racks are regained as a result of performing an EnergyLok service to seal cable cutouts and tune the cooling system to match the heat loads on the data center floor:

- # 10 kW Racks of Cooling Regained:
- Airflow regain: 736 kW x 10 kW/rack = 73 racks
- Thermal regain: 154 kW x 10 kW/rack = 15 racks