



Report No. 12128  
Date: 6/23/04

# Fuel & Electricity Reduction Pilot Program

CONDUCTED AT

STARWOOD'S SHERATON HOTEL

LOCATED IN

Stamford, Ct.

TEST RESULTS  
FOR  
DOMESTIC HOT-WATER HEATER  
AND  
COMMERCIAL REFRIGERATION

A Confidential Report  
*Prepared by*  
Intellidyne LLC

## **EXECUTIVE SUMMARY**

### **Sheraton Stamford Hotel Pilot Study** **June 24, 2004**

The following is a summary of the Energy Saving Performance of the Intellidyne IntelliCon<sup>®</sup> economizer controls installed for a pilot test program. Performance testing ran from January 9, 2004 through March 2, 2004. Two (2) IntelliCon<sup>®</sup>-RU controls were installed on two different refrigeration systems including one walk-in refrigerator and one walk-in freezer and fourteen (14) IntelliCon<sup>®</sup>-HW controls were installed on three banks of multi-purpose HydroTherm<sup>®</sup> hot-water boilers responsible for the generation of the domestic hot-water for the facility. These systems operate on a 24 hours per day, 7 days per week basis at the Stamford Sheraton Hotel located in Stamford CT.

**During the testing period at this particular location, the IntelliCon-RU delivered an electric consumption reduction of 12.59% on the walk-in refrigerator and 11.20% on the walk-in freezer** with no degradation of the temperature maintenance. Also during the testing period at this particular location, **the IntelliCon<sup>®</sup>-HW units delivered a fuel consumption reduction of 10.78% on the domestic hot water boilers.** There was no noticeable difference in the water temperature maintenance as documented within this report as well as that being observed and confirmed by the facility staff. Also notable is the fact that the **IntelliCon<sup>®</sup> controller reduced on/off cycling by 58.1% on the domestic hot water boilers.**

Although the facility has experienced domestic hot water availability problems from time to time, the IntelliCon<sup>®</sup> controls did not contribute to this occurrence. Also attached to this report is a diary of observations made by Intellidyne during the problem-prone test period of the domestic hot-water boilers.

Testing of the refrigeration systems proceeded normally and was without incident.

The attached report further contains documentation supporting the summary results and further elucidates the testing process and procedures, as well as documenting the overall temperature performance and predictability of the temperature range of each unit after the IntelliCon<sup>®</sup> affect.

The analysis of the data collected concludes that the IntelliCon<sup>®</sup> controls have reduced energy consumption beyond the minimum 10% that is guaranteed while providing predictable temperature performance which is consistent with the temperatures that are maintained without the use of the IntelliCon<sup>®</sup> technology. These results further document the financial benefit resulting from the implementation of the IntelliCon<sup>®</sup> Energy Saving Controls.

In summary, Starwood can expect a pay-back on their investment (ROI) in less than 12 months when the IntelliCon<sup>®</sup> controls are applied to the heating, air conditioning and refrigeration systems.

- IntelliCon<sup>®</sup>-RU delivered an electric consumption reduction of 12.59% on the walk-in refrigerator.
- IntelliCon<sup>®</sup>-RU delivered an electric consumption reduction of 11.20% on the walk-in freezer.
- IntelliCon<sup>®</sup>-HW units delivered a fuel consumption reduction of 10.78% on the 14 HydroTherm<sup>®</sup> domestic hot-water boilers.

Benefits / Features of IntelliCon<sup>®</sup> Controls:

- Guaranteed Energy Consumption Reductions
- Reduces Wear and Tear from Excessive on/off Cycling
- Consistent Temperature Performance
- 15 Year Replacement Warranty
- Low Upfront costs and High ROI

Intellidyne is confident that you will agree that the application of IntelliCon<sup>®</sup> technology is an excellent business decision which can deliver real and meaningful operating cost reductions year-in and year-out.

**Starwood Hotels & Resorts Worldwide, Inc.**  
Sheraton Hotel, Stamford, CT.

**Domestic Hot-Water Boilers  
Pilot Test Observations**

**General Information:**

**BOILERS**

- The domestic hot-water system is comprised of three (3) banks of HydroTherm® boilers, tagged Bank “A”, Bank “B”, Bank “C”.
- Each Bank consists of five (5) boilers and a heat-exchanger for a total of fifteen (15) boilers and (three) 3 heat-exchangers. Bank “C” has one boiler out of service due to leaks and has been permanently disconnected from the boiler side piping.
- Bank “C”, In addition to supplying domestic hot-water, has two (2) heating zones connected to the boiler side of its heat-exchanger. These zones heat the Mechanical Equipment Room (“MER”) (where the boilers are located), an electrical room (adjacent to the MER) and the laundry room (also adjacent to the MER).
- The individual firing rate of each boiler is 300,000 BTU’s, which gives a total input for all banks (14 boilers) of 4,200,000 BTU’s.

**HEAT-EXCHANGERS (Domestic Hot-Water Generation)**

- Each bank has a shell and tube type heat-exchanger from which the domestic hot-water is produced. A circulator on the boiler side of the heat-exchanger constantly circulates water from the bank of boilers through the shell of its associated heat-exchanger.
- A separate circulator circulates the domestic hot-water from the domestic hot-water storage tank through the heat-exchanger coil. This is where the domestic hot-water is produced.
- Domestic hot-water is distributed throughout the building by circulation pumps that extract the hot-water from a storage tank with a capacity of 1500 gallons.
- There are two (2) 600 gallon storage tanks in the laundry room that are not being used. These tanks are complete with all piping and pumps, and if insulated, could be used for additional domestic hot-water storage.
- Make-up [cold] water is piped into the inlet (return) of the domestic hot-water side of the heat-exchanger on all 3 banks. This “tempers” the cold city water by allowing it to go through the coil of the heat-exchanger before it goes into the storage tank.

## TEMPERATURE CONTROL:

- Each bank of boilers has its own wall mounted temperature controller manufactured by HydroTherm.
- The controller is of the sequencing type and monitors the domestic hot-water temperature using a surface mount sensor mounted on the domestic hot-water return piping connected to the heat-exchanger of the bank it is controlling.
- Depending on the temperature of the water returning to the heat-exchanger from the storage tank, the controller will determine how many boilers to sequence “on” for domestic hot-water generation.

The controller stages are as follows:

Stage 1: Boiler Bank Draft Inducer

Stage 2: Boiler #1

Stage 3: Boiler #2

Stage 4: Boiler #3

Stage 5: Boiler #4

Stage 6: Boiler #5

- The controller set-point is 144° – 145° F. A 1° to 2° drop will bring on the 1<sup>st</sup> boiler in the bank (the draft inducers run constantly). The controller will sequence boilers on if the sensed temperature continues to decline due to hot-water demand.

## INTELLIDYNE

Intellidyne installed fourteen (14) IntelliCon “HW” Economizers on 3 banks of boilers with test equipment. The test of all installed units began on November 13, 2003.

Testing equipment consisted of:

- 14 day time clock to alternate the days the Economizers were in the control circuit
- “State” data loggers that time and date stamp the Burner’s “On” and “Off” times.
- Temperature data loggers that record the domestic hot-water supply temperature from the storage tank to the hotel and outdoor air temperature.
- Light Intensity data logger to monitor the suns influence on the building.
- Data was downloaded weekly until the test was completed.

## **PROBLEMS ENCOUNTERED DURING TESTING of BOILERS**

### **12/09/03**

- Facility management was reporting domestic hot-water supply problems. Analysis of the temperature data being gathered by Intellidyne determined that the shortages were not just occurring on days that the IntelliCon controller was in-circuit. Intellidyne recommended that Starwood secure the services of an outside consulting firm to diagnose the ongoing domestic hot-water problems. As a result, Intellidyne placed all IntelliCon controls in “Off/Bypass” to enable the consultant to troubleshoot and repair the domestic hot-water.

### **12/16/03**

- The outside consulting firm determined that the domestic hot-water supply problems were caused by insufficient heat transfer due to dirty coils with the heat-exchangers and that they needed to be cleaned.
- Sheraton directed the contractor to clean the Heat-exchanger coils which was completed on 12/12/03.
- Intellidyne placed all IntelliCon controls back to the “ON” position and re-initialized testing.
- Intellidyne observed that all of the boiler operating aquastat (thermostats that control the water temperature within the boiler) settings had been adjusted to 210° – 230° (prior to heat-exchanger cleaning they were set to 185°- 190°).
- Intellidyne observed that draft inducer fans now properly shut down when there were no boilers running in that bank.
- Intellidyne observed that the boiler and heat-exchanger pumps still ran continuously.
- Intellidyne observed that the HydroTherm panels appear to have been adjusted to a new set-point of 152° (prior to heat-exchanger cleaning they were set to 141°).
- Facility management reported hot-water supply problems on the fifth floor. After analysis, Intellidyne recommended that the “House” washing machine located on that floor be isolated from the water supply and to observe if that corrected the problem.

### **12/23/03**

- Intellidyne observed on arrival that the circulator pump on Bank “C” was replaced due to a leak (replaced on 12/19/03).
- Intellidyne observed on arrival that the HydroTherm panels were all indicating that the domestic hot-water temperatures were 141° even though the setpoint was 151°.
- Intellidyne was informed that our suggestion to take the washing machine on the 5<sup>th</sup> floor out of service, to solve the hot-water problem in that area, had been done and that it did indeed solve the problem.

**1/06/04**

- Intellidyne observed upon arrival that Bank "C" had been turned "off" due to a leak in the expansion tank.
- Intellidyne was informed that all of the boilers had been shut down on 12/29/03 to repair leaks throughout the entire domestic hot-water system.
- Intellidyne shut down all test equipment including time clocks and data loggers pending notification by Sheraton that the expansion tank for Bank "C" had been repaired and that all boilers had been placed back into service.

**1/08/04**

- Intellidyne reestablished testing of domestic hot-water system.

**1/22/04**

- Intellidyne downloaded data from all loggers.
- Intellidyne observed that Bank "C" had a leaking pump (boiler side of heat-exchanger). No determination was available as to when the repair/replacement would be completed.

**3/02/04**

- Intellidyne determined that sufficient data had been gathered to properly evaluate the performance of the IntelliCon controls that were installed. Intellidyne removed all test equipment from boilers and left all IntelliCon controls online.

**4/20/04**

- Engineering reported that the Hotel was full (Occupancy was at 107%) and that they were receiving domestic hot-water supply complaints.
- Engineering shut off all IntelliCon "HW" Economizers at 5:10pm to help diagnose the problem.
- Arrangements were made for Intellidyne personnel to visit the Sheraton test site on 4/22/04.

**4/22/04**

- Found that Bank "C" had been shut down due to "boiler side" pump leaking and that Bank "C" had been shut down on 4/20/04. This shut down reduced domestic hot-water generation by 1/3<sup>rd</sup> which is why the demand for domestic hot-water could not be met on 4/20/04.
- Intellidyne tested all IntelliCon controls and determined that all controls were working properly. One sensor (out of 14) had questionable accuracy and was replaced.
- Intellidyne was informed that the pump would be repaired on 4/23/04.

**4/24/04**

- Intellidyne was informed that Engineering turned off the IntelliCon "HW" Economizers at 5:45PM for Bank "B" & 3 to help diagnose the domestic hot-water problem due to guest complaints.

#### **4/25/04**

- Engineering turned the IntelliCon “HW” Economizers back on at 9:55PM.

#### **4/26/04**

- Intellidyne was informed by engineering that the hotel was at 100% occupancy over the weekend and that the occupancy went down on Sunday (4/25/04) night.
- Intellidyne scheduled site visit for Thursday, (4/29/04) and requested that engineering turn all IntelliCon “HW” Economizers to the off/bypass position until we arrived.
- Intellidyne conducted internal meeting to strategize a method to eliminate the possibility that the IntelliCon controls were contributing to the domestic hot-water supply problem. It was concluded that Intellidyne would install time-clocks to bypass control operation during the peak load periods and would monitor the domestic hot-water supply temperatures to determine if the problems were still occurring even when the controls were bypassed.

#### **4/29/04**

- Intellidyne provided and installed digital time clocks on each boiler bank.
  - Set “bypass” times as follows (for every day):
    - OFF: 5:30 am (bypassed)
    - ON: 8:30 am (normal)
  
    - OFF: 5:30 pm (bypassed)
    - ON: 8:30 pm (normal)
- Installed temperature data logger on domestic hot-water supply line leaving storage tank.

#### **6/01/04**

- Downloaded and removed temperature data logger from domestic hot-water storage tank.
- Found Bank “C” shut down again due to boiler circulator. Bank was shut down since (5/31/04). Circulator was only partially repaired on 5/31/04. As of (6/01/04), the circulator still had not been replaced.
- Found Boiler #2, Bank “C”, would not come on when called to do so by controls.

The data collected during the test demonstrated that the IntelliCon controls had no negative effect on the domestic hot-water supply problem. It was concluded that while persistent breakdowns of various heating system components are a significant factor, it appears that hot-water storage capacity/delivery stands out as the single largest chronic contributor to guest complaints related to domestic hot-water.



Intellidyne was provided with occupancy data by the hotel, which was used to compare occupancy levels to hot-water complaints. Analysis concluded that while there is a direct correlation of occupancy levels to usage, there was not a correlation to the complaints. Even on days when the water temperature did not drop below 125° there were complaints. This leads us to believe that there are other issues connected with the supply problems other than a lack of storage.



90 Pratt Oval  
Glen Cove, NY 11542  
Phone: 516-676-0777  
Fax: 516-676-2640

# Testing Methodology

## EQUIPMENT USED FOR TESTING PURPOSES

Specific timing and data logging devices are used to gather detailed information about the unit(s) being evaluated. Each device has been carefully selected for its reliability, capability and function. The individual devices INTELLIDYNE uses are explained below.

### 1. TIME CLOCK:

Manufacturer: Tork Model: 8007V-0

Is used to switch the IntelliCon® product in and out of the circuit. This is done on a 24 hour basis. The result is that the IntelliCon® product is in control ("in" the circuit) one day and not in control ("out" of circuit) the next day. A 14 day time clock was selected so that a complete alternation of days that IntelliCon® is in control would result.

### 2. CURRENT SWITCH:

Manufacturer: Veris Industries Model: Hawkeye 608/908

The current switch is used to monitor when current is being drawn by the cooling/refrigeration compressor or heating burner. When current is sensed it is "On" when no-current is sensed it is off "OFF". The current switch is used in conjunction with the "Change-of-State" data logger.

### 3. "CHANGE-OF-STATE" DATA LOGGER:

Manufacturer: Onset Computer Corp. Model: H06-001-02

This device monitors and logs the "change-of-states" (the on / off status) of the unit being tested. It is used in conjunction with the CURRENT SWITCH, above, and time and date-stamps (logs) each change of status. By processing the logged data, the durations for each cycle can be determined.

### 4. "LIGHT INTENSITY" DATA LOGGER

Manufacturer: Onset Computer Corp. Model: HLI

This data logger is used to monitor and log Light Intensity and is used to determine the solar-load influence on the facility.

### 5. "T/Rh" DATA LOGGER

Manufacturer: Onset Computer Corp. Model: H08-004-02

This data logger is used to monitor and log the temperature and relative humidity in the conditioned space.

### 6. "TEMPERATURE" DATA LOGGER

Manufacturer: Onset Computer Corp. Model: H08-001-02

This data logger is used to monitor and log the outdoor air temperature, and is used to determine the degree-day influence on the facility

## **WHAT DATA IS COLLECTED**

Linking all of the above together with the IntelliCon® product being “in” and “out” of the circuit, on alternating days, yields the following data:

- ? How many on/off cycles per day (if applicable).
- ? Total “on time” per cycle, per day.
- ? Total “off time” per cycle, per day.
- ? What the solar load of the facility was during the test period (if applicable).
- ? What the relative humidity in the conditioned space was during the test period (if applicable).
- ? What the temperature of the conditioned space was during the test period (if applicable).
- ? What the outdoor air temperature was during the test period (if applicable).

## **How The Data Is Analyzed**

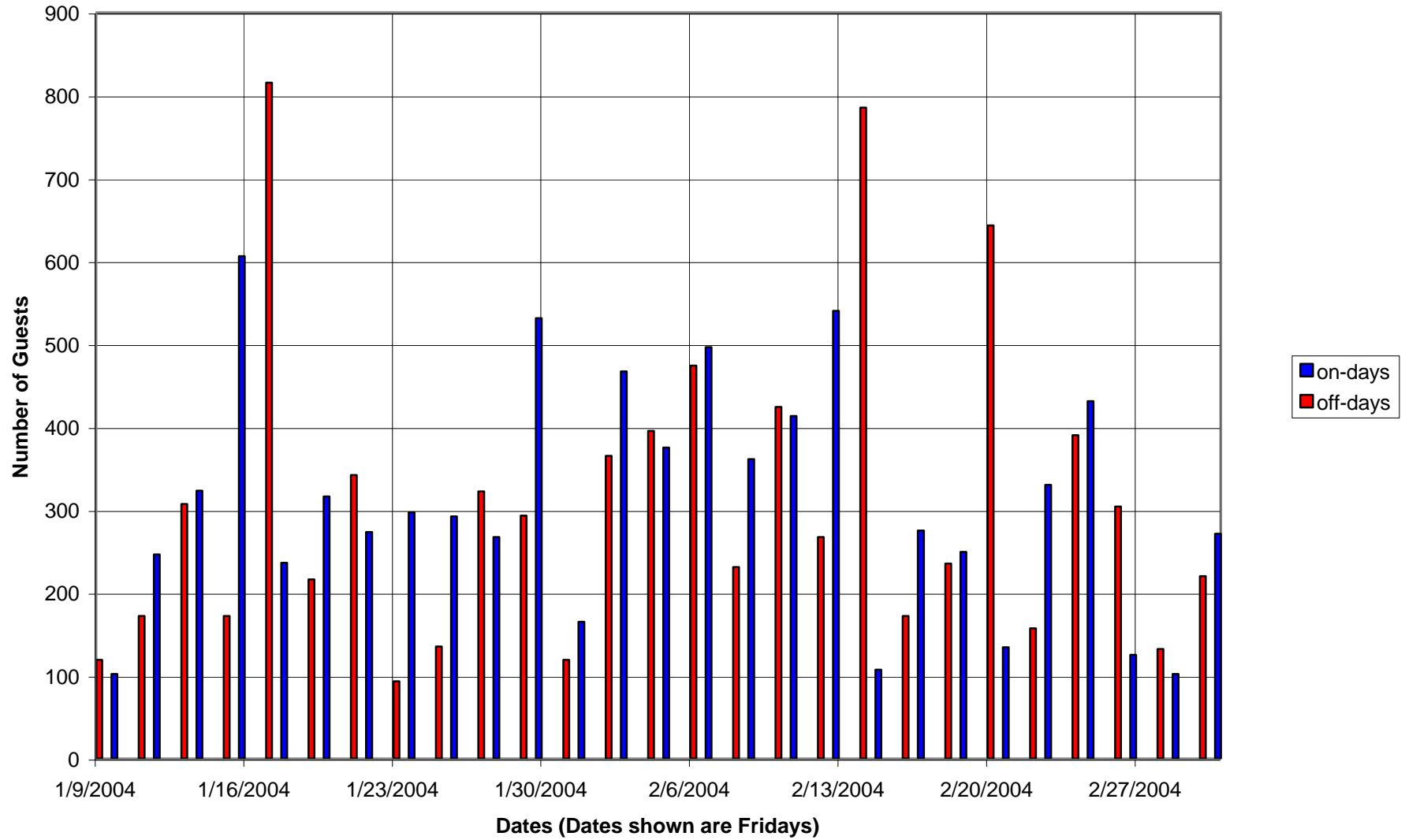
Upon completion of the test, all the data is evaluated to calculate the reduction of consumption (savings).

Short-term testing analysis can only be performed properly by the elimination and reduction of as many variables as possible and through the analysis of the data on a statistical basis. The alternating “in” circuit / “out” of circuit testing has the advantage of minimizing the variations due to time-sensitivity, day-of-week sensitivity, degree-day effects, etc.

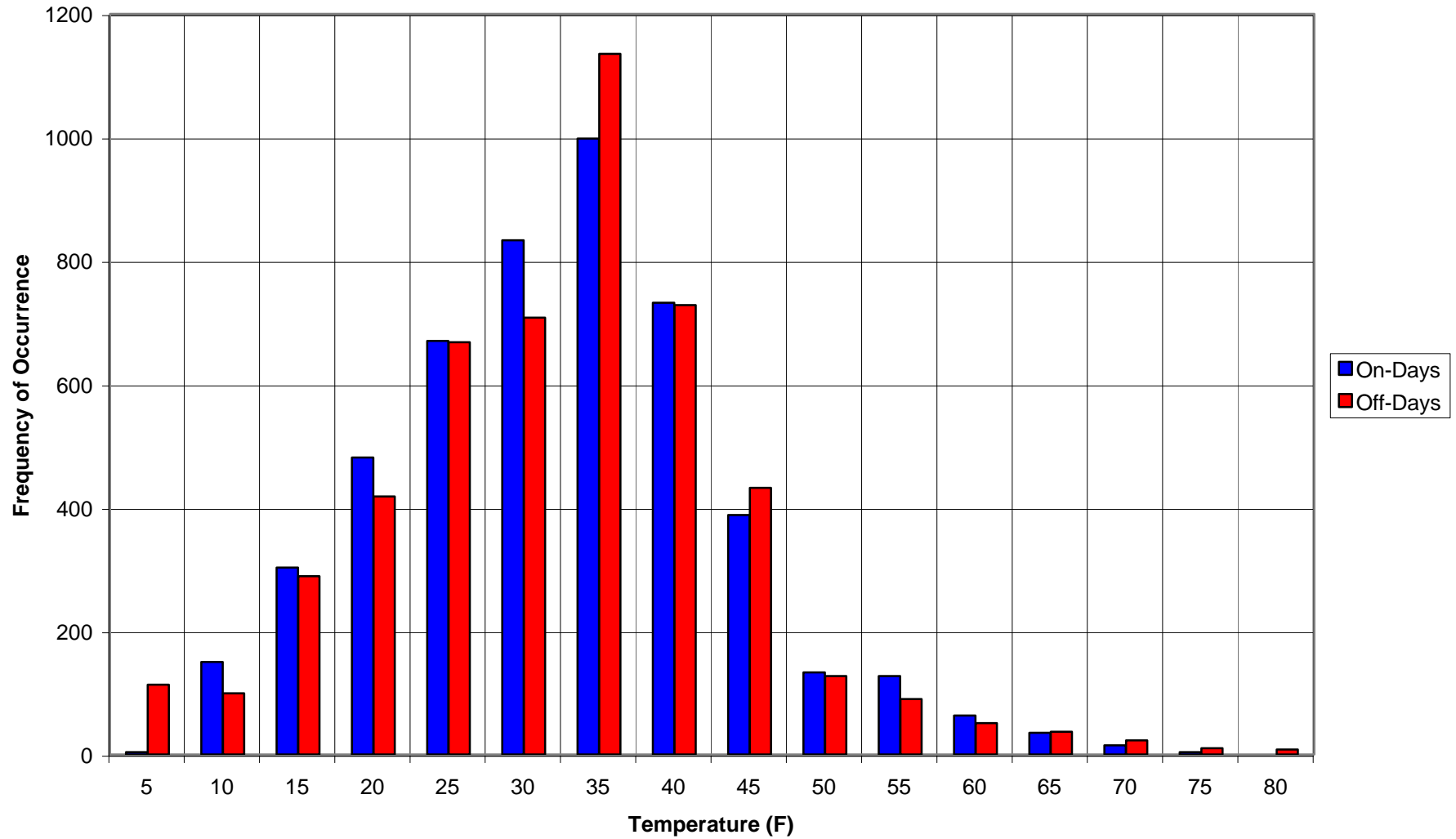
In order to properly evaluate the data, the following must be determined:

1. A baseline must be established. Baseline consumption data is the “use” or consumption information that is unaffected by the IntelliCon economizer (“out” of circuit). This may be derived during the test (which is what is done here) or from historical records. The advantage of deriving the base-line during the test is that site specific degree-day and solar data may be determined as opposed to weather-service data that may or may not be indicative of the test site.
2. It is necessary to determine what effects or influences are caused by solar- load and degree-day variations. This is done by performing a statistical analysis on the solar and degree-day data collected during the base-line phase.
3. In order to properly compare the two consumption cases (IntelliCon “in” and “out” of circuit), and determine the savings, it is necessary to adjust (or “normalize”) the data collected during the “in-circuit” phase. The consumption data collected when the IntelliCon economizer was “in-circuit”, is “normalized” by compensating for the effects of the solar and degree-day influences that occurred during the same phase of the test. This is accomplished by applying the statistical analysis results of the solar and degree-day influences (collected during the base-line phase) as a means to compensate for the solar and degree-day variations that occurred during the “in” circuit phase of the test.
4. The normalized consumption data acquired during the “in” circuit phase is compared to the base-line data and the savings determined.

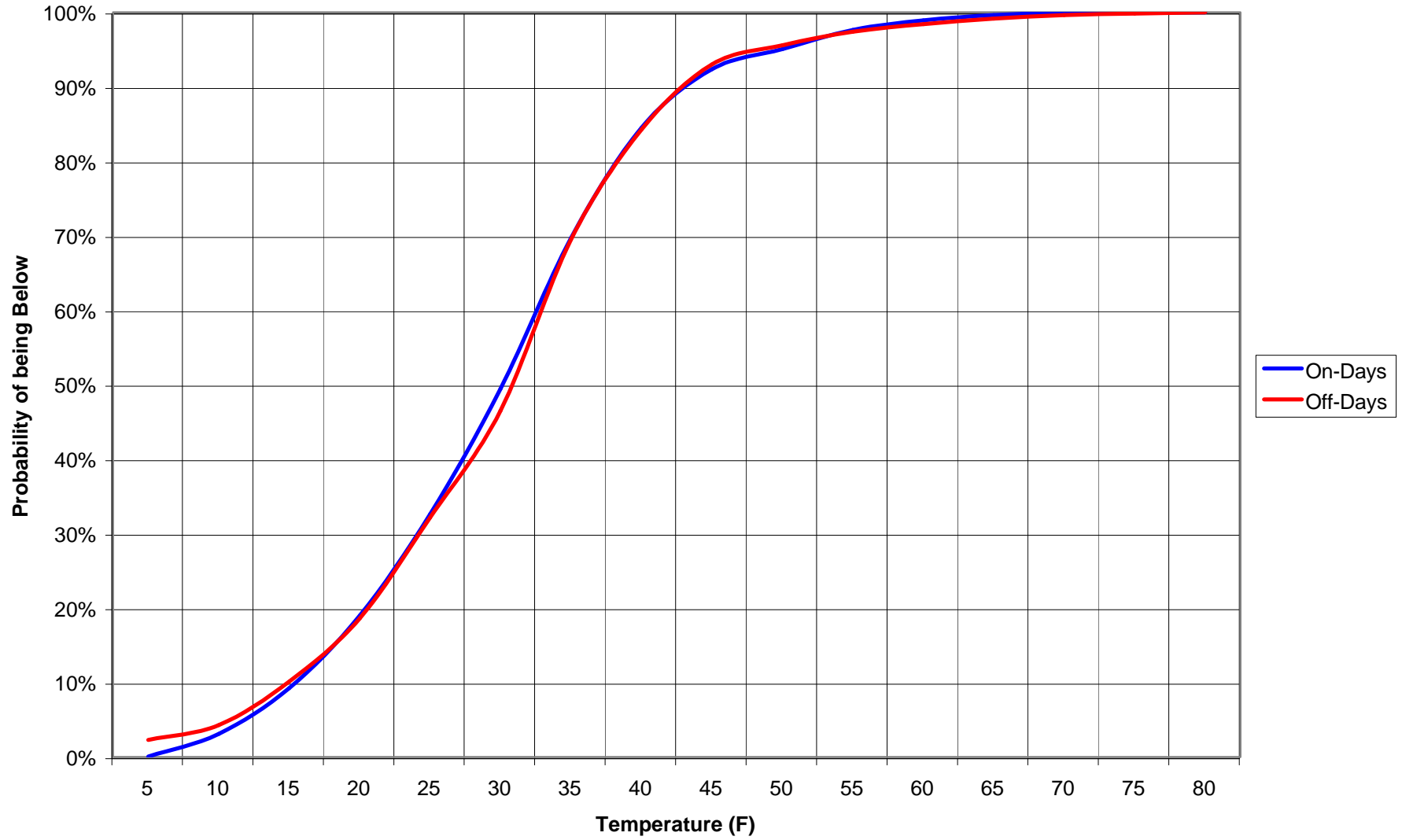
# Occupancy



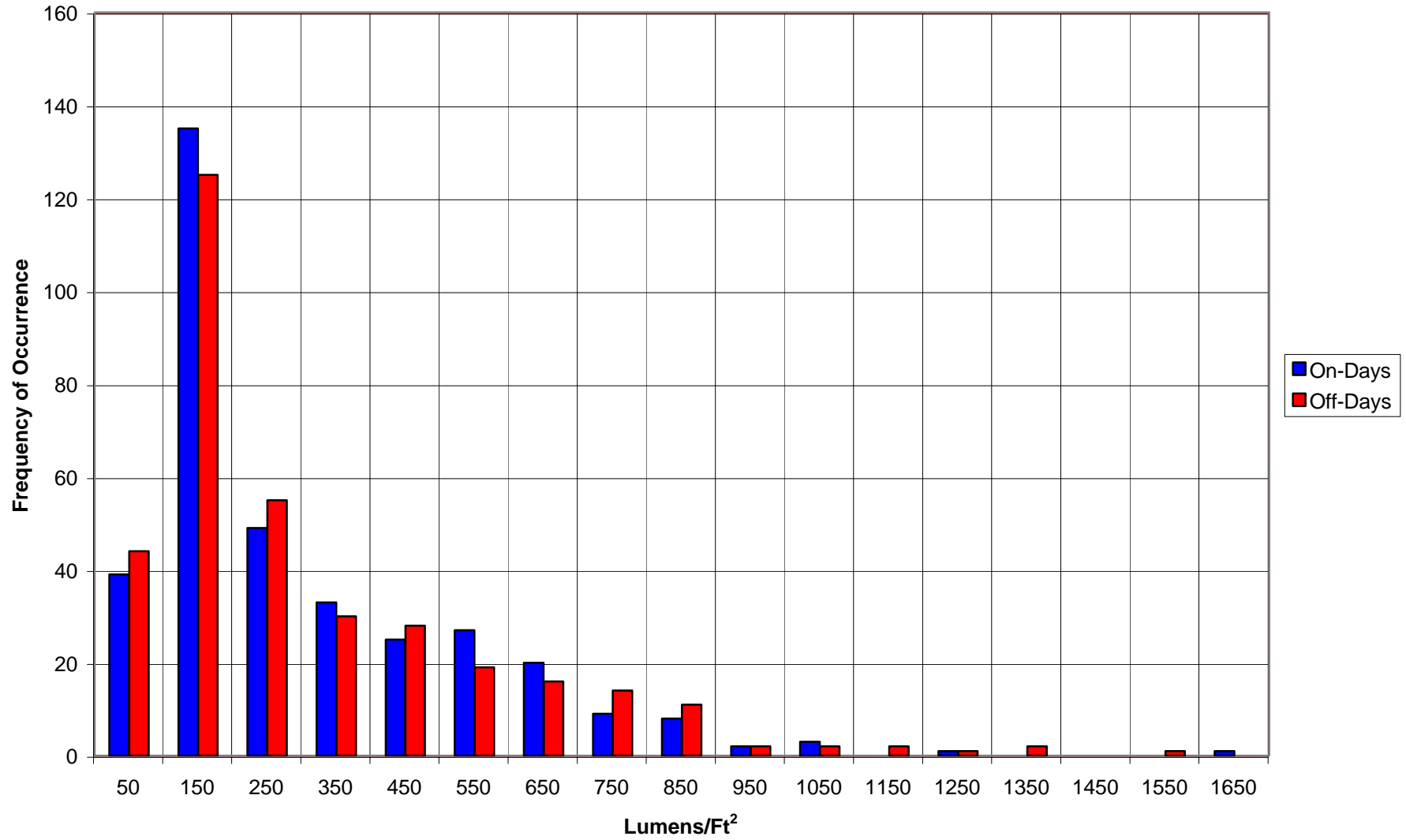
**Outside Air Temperature Histogram  
(1/9/04 - 3/3/04)**



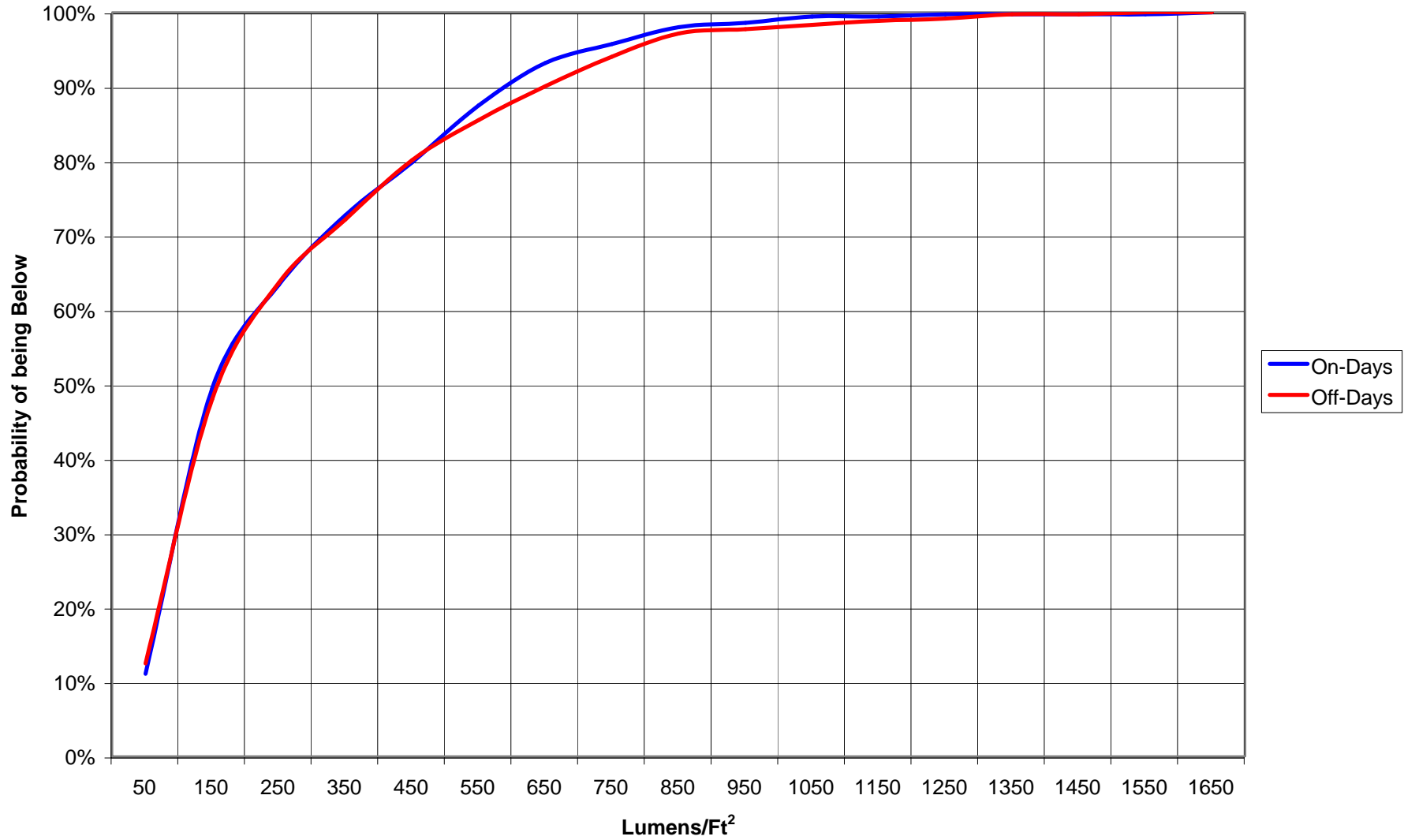
### Outside Air Temperature Probability Curves



### Solar Load Histogram



### Solar Load Probability Curves







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# Test Report

Report No. 12128-1

Date: 06/23/04

**Customer:**

Starwood Hotels & Resorts Worldwide, Inc.  
 111 Westchester Avenue  
 White Plains, NY 10604  
  
 Attn: Gus Newbury, VP Engineering

**Test Site Location:**

Sheraton Hotel  
 Stamford, CT.

Test Type:  HEATING     AIR CONDITIONING     REFRIGERATION     OTHER: \_\_\_\_\_  
 Product Tested:  HW     LCH     LCS     CHW     CHS     AC     CAC     RU     OTHER: \_\_\_\_\_

**Type of Equipment:**

Service: DOMESTIC HOT WATER and Partial HEATING  
 Configuration: 2 Banks of 5 Boilers, 1 Bank of 4 Boilers  
 Manuf.: HydroTherm  
 BTU Input: 300,000 btu/hr each boiler, Total = 4.2MMBTU  
  
 All 3 Banks provided heat for the Domestic Hot-Water Bank C, also provided heat to the Mechanical Equip. Rm, the Electric Rm. And the old Laundry Office.

Test Start Date: 01/09/04  
 Test End Date: 03/02/04  
 No. of Days in Test: 54

**BURNER RUN-TIME:**

in HRS.     in MIN.

IntelliCon ON-DAYS: 2262:44:25

IntelliCon OFF-DAYS: 2506:35:56

The Boilers Ran **10.78%**  
 More on the Off-Days

**BURNER USAGE FACTOR:**

IntelliCon On-Days: **25%**

IntelliCon Off-Days: **28%**

**HEATING DEGREE-DAYS (FOR TEST PERIOD)**

IntelliCon ON-DAYS: 173362

It was **2.7%** Colder on the On-Days.

IntelliCon OFF-DAYS: 168863

Total: 342225

**BURNER CYCLING REDUCTION:**

IntelliCon ON-DAYS: 8547

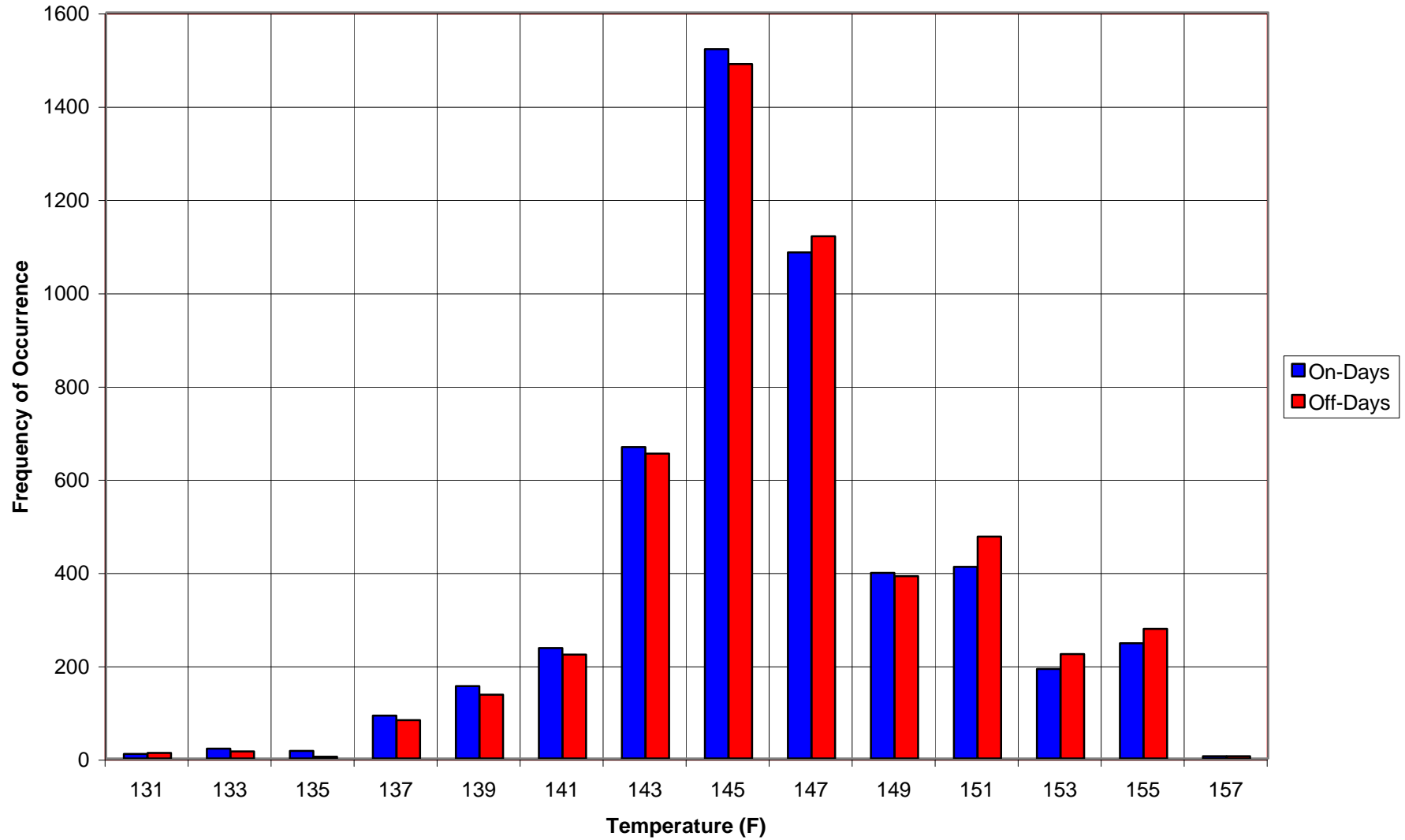
IntelliCon OFF-DAYS: 20390

Cycling was reduced by: **58.1%**

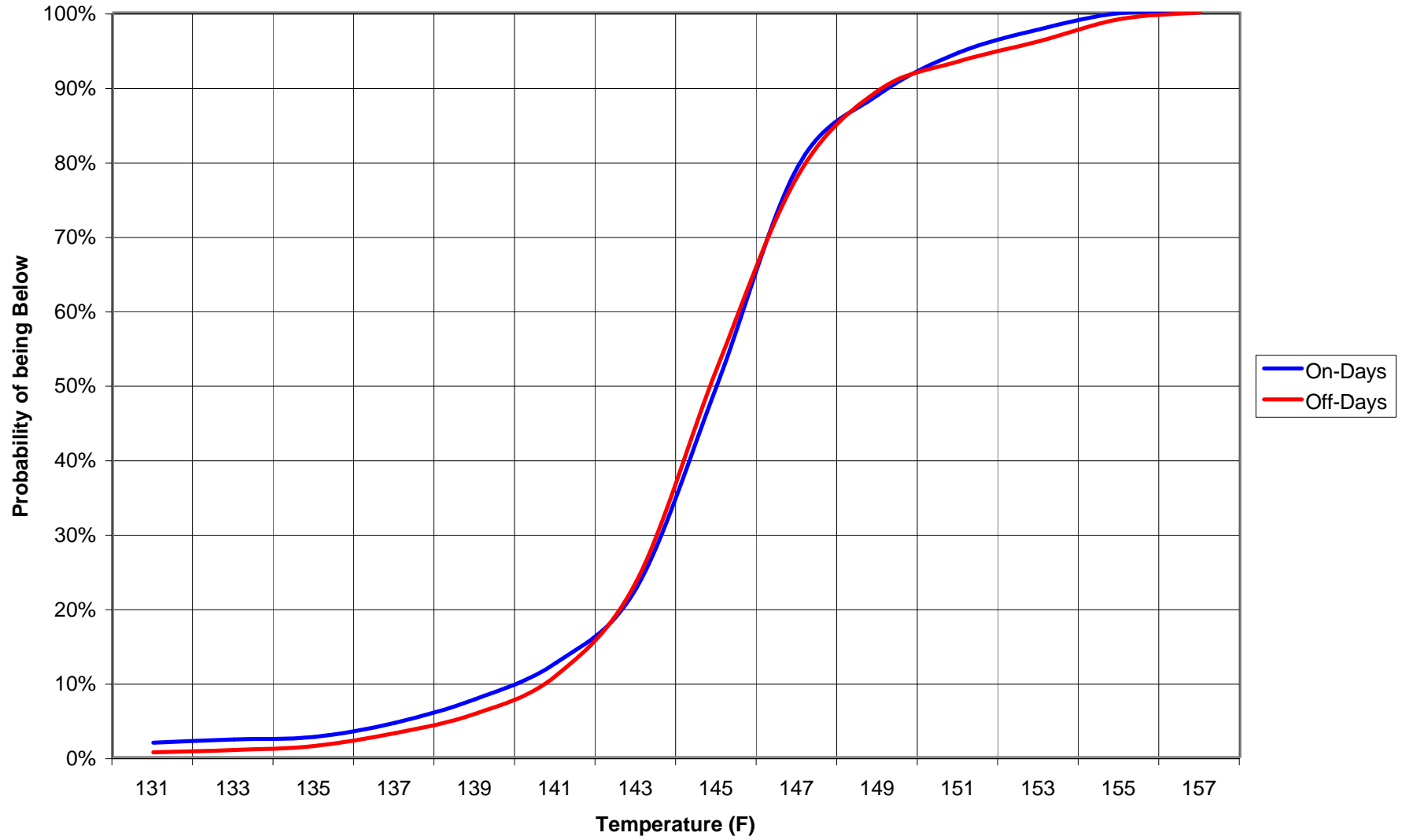
**Savings = 10.78%**

COMMENTS: The effects of Heating Degree-Days was insignificant, thus no adjustment was made to normalize the data. The number of guests during the test period varied by less than 1% when comparing the IntelliCon "On" and "Off" days. Thus no adjustment was made to normalize the data due to the number of guests. While there was a definite correlation of the number of guests versus hot-water usage (and thus fuel), there was very little correlation to the water shortage problems that were reported. Water shortages occurred both on days when the IntelliCon was "in" and "out" of the circuit.

Domestic HW Supply Temperature Histogram



**Domestic HW Supply Temperature Probability Curves**





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# Test Report

Report No. 12128-2

Date: 06/23/04

**Customer:**

Starwood Hotels & Resorts Worldwide, Inc.  
 111 Westchester Avenue  
 White Plains, NY 10604  
  
 Attn: Gus Newbury, VP Engineering

**Test Site Location:**

Sheraton Hotel  
 Stamford, CT.

Test Type:  HEATING  AIR CONDITIONING  REFRIGERATION  OTHER: \_\_\_\_\_  
 Product Tested:  HW  LCH  LCS  CHW  CHS  AC  CAC  RU  OTHER: \_\_\_\_\_

**Type of Equipment:**

Manu.: Copeland water cooled  
 Model: N/A  
 Service, SetPt: Produce / Fresh Meat, 34°F  
 Tons, Btu, Hp: 1HP  
 Act. V,Amps, Ph: 200vac, 2.2 amps, 3ø

Test Start Date: 11/20/03  
 Test End Date: 12/21/03  
 No. of Days in Test: 32

**COMPRESSOR RUN-TIME:**  in HRS.  in MIN.  
*IntelliCon ON-DAYS:* 47:09:25  
*IntelliCon OFF-DAYS:* 53:05:30  
 The Compressor Ran **12.59%**  
 More on the Off-Days

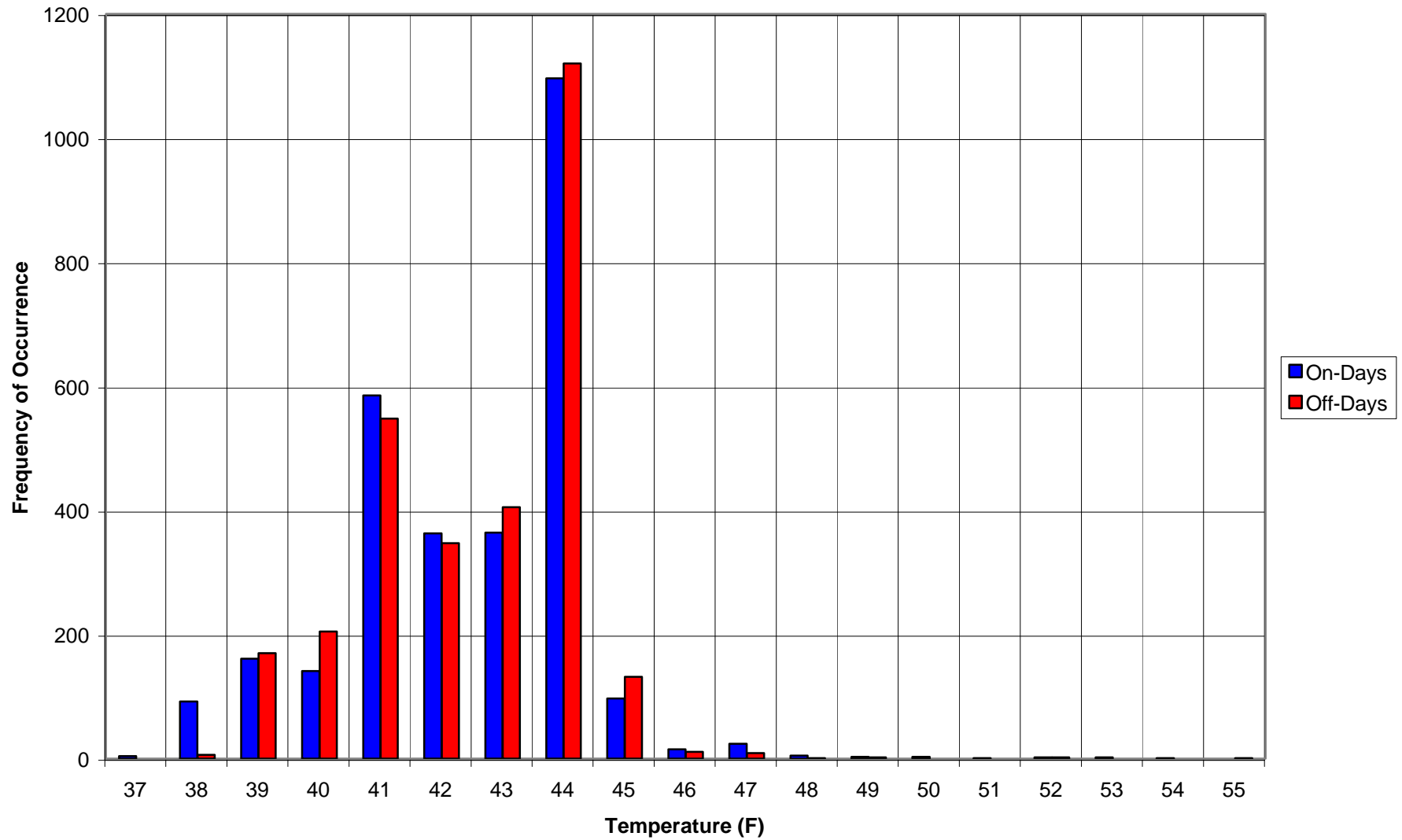
**COMPRESSOR USAGE FACTOR:**  
*IntelliCon On-Days:* 12%  
*IntelliCon Off-Days:* 14%

**COMPRESSOR CYCLING REDUCTION:**  
*IntelliCon ON-DAYS:* 533  
*IntelliCon OFF-DAYS:* 592  
 Cycling was reduced by: **10.0%**

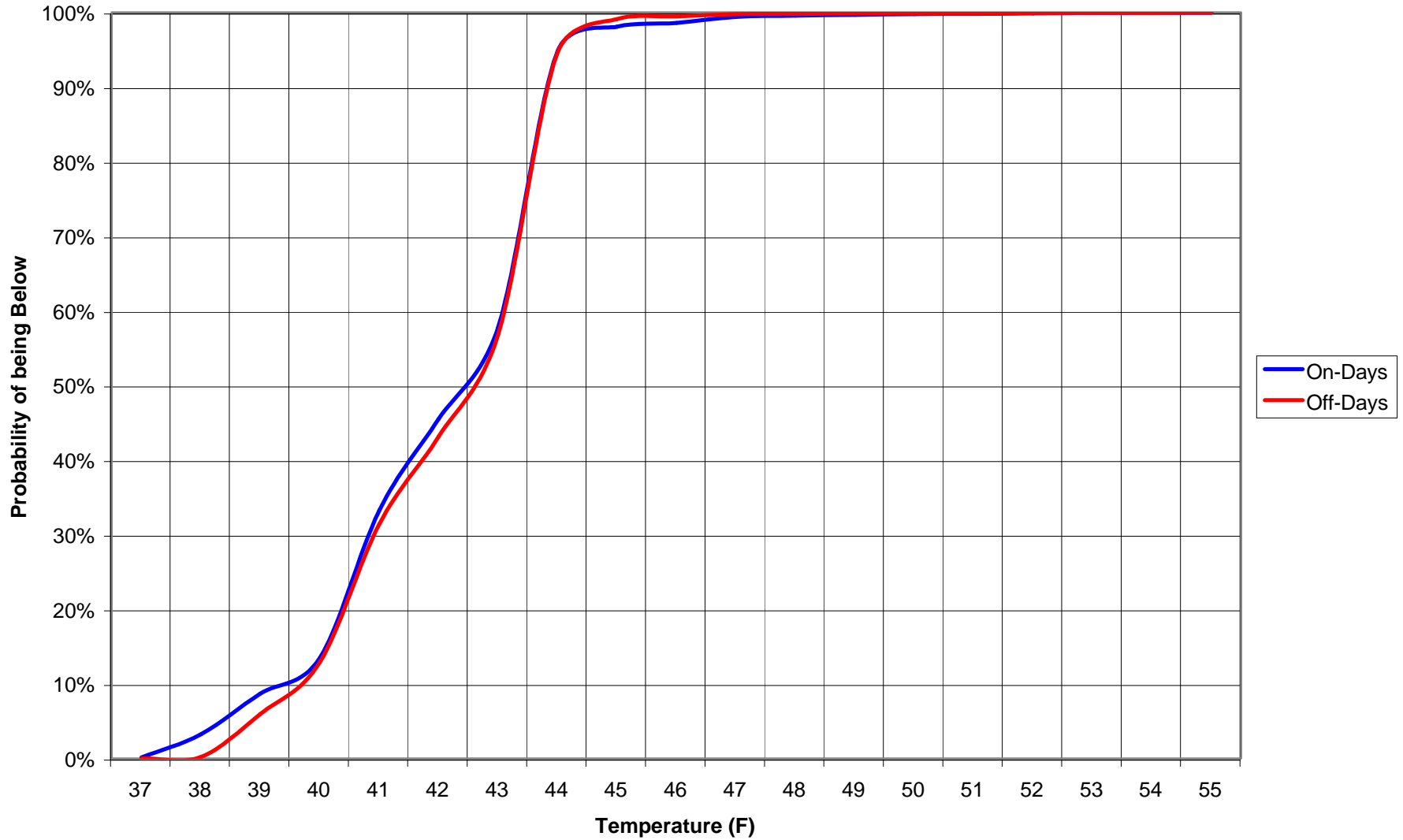
**Savings = 12.59%**

COMMENTS:

### Walk-In Refrigerator Temperature Histogram



### Walk-In Refrigerator Temperature Probability Curves





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 Fax: 516-676-2640

# Test Report

Report No. 12128-3

Date: 06/23/04

**Customer:**

Starwood Hotels & Resorts Worldwide, Inc.  
 111 Westchester Avenue  
 White Plains, NY 10604  
  
 Attn: Gus Newbury, VP Engineering

**Test Site Location:**

Sheraton Hotel  
 Stamford, CT.

Test Type:  HEATING  AIR CONDITIONING  REFRIGERATION  OTHER: \_\_\_\_\_  
 Product Tested:  HW  LCH  LCS  CHW  CHS  AC  CAC  RU  OTHER: \_\_\_\_\_

**Type of Equipment:**

Manu.: Copeland water cooled  
 Model: N/A  
 Service, SetPt: Frozen Foods, -10°F  
 Tons, Btu, Hp: 3HP  
 Act. V,Amps, Ph: 200vac, 10.2 amps, 3ø

Test Start Date: 11/20/03  
 Test End Date: 12/21/03  
 No. of Days in Test: 32

**COMPRESSOR RUN-TIME:**  in HRS.  in MIN.  
*IntelliCon ON-DAYS:* 182:46:55  
*IntelliCon OFF-DAYS:* 203:15:33  
 The Compressor Ran **11.20%** More on the Off-Days

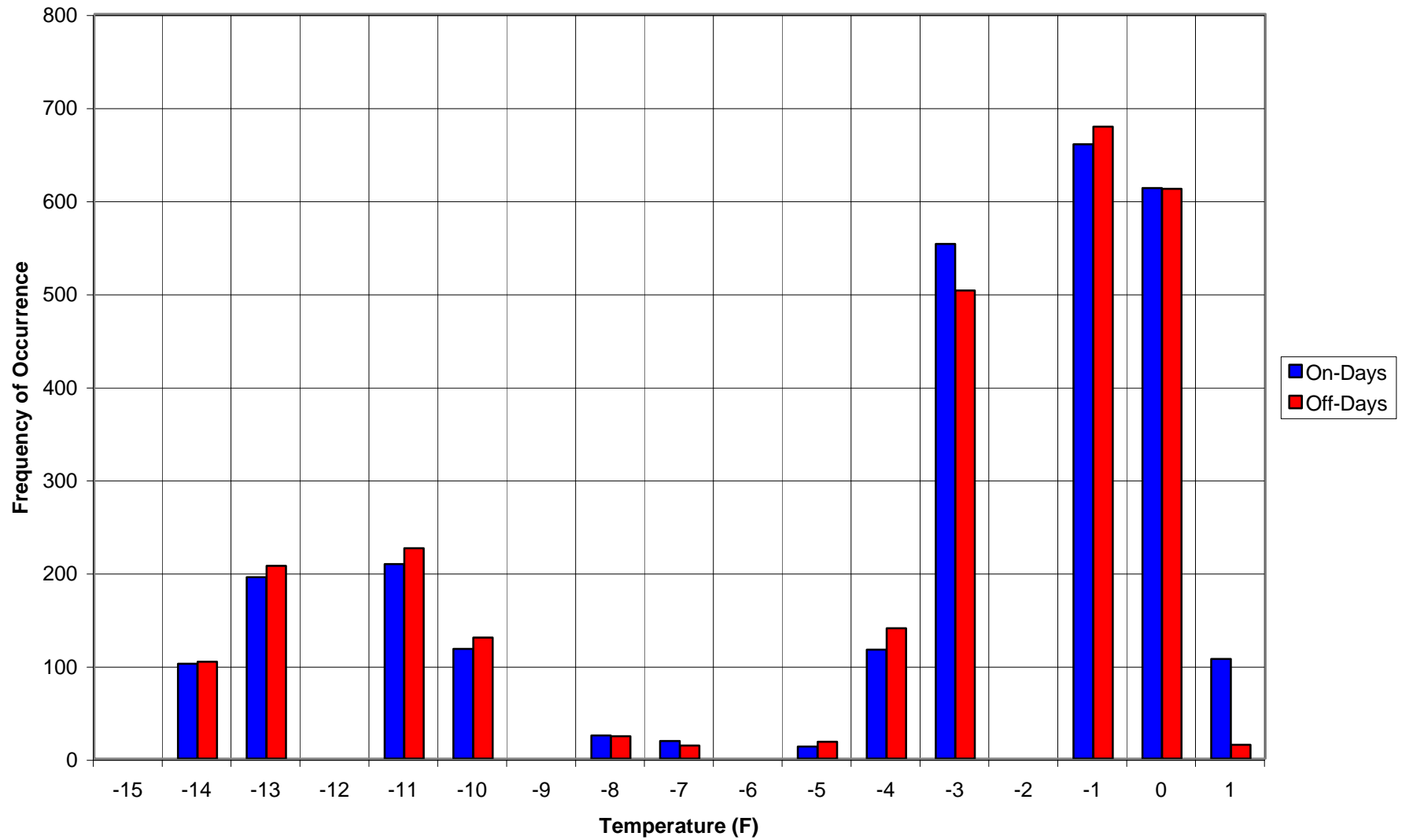
**COMPRESSOR USAGE FACTOR:**  
*IntelliCon On-Days:* **48%**  
*IntelliCon Off-Days:* **53%**

**COMPRESSOR CYCLING REDUCTION:**  
*IntelliCon ON-DAYS:* 1751  
*IntelliCon OFF-DAYS:* 1778  
 Cycling was reduced by: **1.5%**

**Savings = 11.20%**

COMMENTS:

### Walk-In Freezer Temperature Histogram





### Walk-In Freezer Temperature Probability Curves

