ENERGY STAR® Laboratory Guidance Manual:

Building a Testing Facility and Performing the Solid State Test Method for ENERGY STAR Qualification of Ceiling Fans

Version 1.2
Rev. 05/11

Prepared by:
The U.S. Environmental Protection Agency

Contributing Laboratories:
Hunter Fan Company
Intertek
Underwriters Laboratory, Taiwan Branch

ENERGY STAR® Laboratory Guidance Manual: Building a Testing Facility and Performing the Solid State Test Method for ENERGY STAR Qualification of Ceiling Fans

Appendices

List of Figures

This test manual will be updated and augmented as necessary in response to changes in testing requirements and specifications under the ENERGY STAR Product Specification for Residential Ceiling Fans.

For questions related to ENERGY STAR contact:

Abigail Daken, EPA
Program Manager
ENERGY STAR for Residential Ceiling Fans
1200 Pennsylvania Avenue
Washington, DC 20460
Phone: (202) 343-9375
E-mail: daken.abigail@epa.gov

Rebecca Duff, ICF International
1725 Eye Street NW, Suite 1000
Washington, DC 20006
Phone: (202) 862-1266
E-mail: rduff@icfi.com

EPA would like to thank all those interested parties who contributed comments during the development of this document, especially Natural Resources Canada.

Additional comments or questions on this document should be directed to ceilingfans@energystar.gov.

CHAPTER 1
Introduction

1.1 Background

ENERGY STAR is a voluntary program that manufacturers can join to qualify and label their energy-efficient products. Where possible, ENERGY STAR adopts existing testing methods when developing product specifications and testing criteria. However, there was no standardized test method available to the ceiling fan industry at the time of specification development for this product.

In 2001, EPA partnered with Hunter Fan Company to develop the Solid State Test Method. The Solid State Test Method allows for the measurement of total cubic feet per minute (CFM) and CFM/watt readings for multiple fan speeds. This test method is designed to increase efficiency and improve accuracy. It provides an accurate representation of the air circulation created by the fan in the room. The method reduces the testing and validation time to a fraction of the time period required by other industry testing standards.

The Solid State Test Method was provided by Hunter Fan Company as non-proprietary and is subject to improvements as technologies change and standard operating procedures are re-evaluated.

1.2 Purpose

The purpose of this guidance manual is to provide ENERGY STAR partners and other interested parties, such as laboratories, the necessary information needed to build a ceiling fan testing chamber, or air delivery room, and perform adequate product testing for ENERGY STAR qualification. It is important to note that this manual provides the minimum requirements for building the test facility. Engineering designs may vary outside of these minimum requirements. The testing criteria and method, however, shall be followed closely in order to ensure consistent results across the board.

This following information is provided in this manual:

- List of equipment and reference vendor contacts
- Air delivery room construction and set-up
- Equipment set-up and CFM test method
- Laboratory reporting form(s)
- Blueprints for air-delivery room cylinder

1.3 Applicability

Any ceiling fan manufacturer, laboratory, or other interested party may build a ceiling fan test chamber. All testing facilities intending to test residential ceiling fans under ENERGY STAR requirements must follow the facility blueprints, additional building instructions, and test methods provided in this manual, and apply for and be granted EPA recognition to test ceiling fans pursuant to ENERGY STAR qualification, prior to carrying out such testing.

CHAPTER 2
List of Equipment and Vendors

The table below provides a list of the testing equipment needed to perform the Solid State Test Method. EPA does not endorse the products or vendors listed in the table below, but provides this information to offer examples of devices that meet the functional requirements of ceiling fan testing. Any precision control equipment that performs similar functions, but is sold under a different brand name, is acceptable. All instruments except velocity sensors shall have tolerances within ± 1%. Velocity sensors shall be rated for ± 5% accuracy and standard flow ranges of 0.15 to 10 m/s (approximately 30 - 1969 fpm). **Note:** All equipment used to measure fan performance shall be calibrated in a traceable manner at least once a year to compensate for variation over time.

Function	Suggested Equipment Name/Type	Serial/ Model Number of Suggested Equipment	Vendor Contact
Timer	Robic Stop Watch	56964 / SC-505	
Measure airflow and temperature at multiple locations simultaneously. Accuracy shall be within ± 5% or better. Standard flow range shall be from 0.15 to 10 m/s (approximately 30 - 1969 fpm).	Cambridge Accusense Air Velocity and Air Temperature Sensors Kit: ▪ ATM-24 instrument ▪ Accutrac Software (PC only) or Kermit (Mac only) ▪ 5V Universal Power Supply with AC power cord ▪ RS-232 cable ▪ Carrying case ▪ Plastic mounting clips for CAFS sensors ▪ CAFS sensors	0135-992832-001 / ATM24 CAFS F900 P5122	Degree C Tel: +1 (603) 672-8900 Toll-free: +1 (877) 334-7332 www.degreec.com rick.melloy@degreec.com See website for specific country telephone numbers and addresses.
Measure amps, watts, power factor, voltage	Extech True RMS Power Analyzer	NA / 380801	www.extech.com Tel: +1 (781) 890-7440 ext.220
	Magtrol Power Analyzer	6510E	www.magtrol.com See website for specific country telephone numbers and addresses.

Measure temperature, barometric pressure, and humidity within testing facility	Vaisala Combined Pressure, Humidity and Temperature Transmitter	PTU300	www.vaisala.com See website for specific country telephone numbers and addresses.
Infrared beam counter	Shimpo Digital Tachometer	10049812 / DT-5TG	Shimpo Instruments Division of NIDEC-Shimpo America Corporation Tel: +1 (630) 924-7138 Toll-free: +1 (800) 237-7079 www.shimpoinst.com
	Shimpo Retro-Reflective Beam Sensor	H9 / RS-220H	
	Omron Metal Body Sensor	E3S-CT61	www.omron.com
Raise and lower ceiling fan	Actuator Arm and Drive Mechanism	NA / KBPI-24OD(R)(8501)	KB Electronics, Inc. Toll-free: +1 (800) 221-6570 www.kbelectronics.com info@kbelectronics.com
Testing cylinder*	Testing cylinder	60” CFM Aluminum Chamber TD#8067*	Custom Projects Inc. 333 E. Brooks Rd. Memphis, TN 38109 Tel: +1 (901) 396-7398 Fax: +1 (396) 396-7399 Contact: Randy Jones customprojects@bellsouth.net
Rotate arm upon which sensors are mounted	Mechanical Arm Rotator (for example, an antenna rotator)	YAESU G-800S	Radiomart Tel: +1 (716) 632-1189 Fax: +1 (716) 632-6304 radiomart@buffalo.com www.radiomart.com
Sensor mount	Arm as shown in Figure 3.9	Custom-manufactured	Custom Projects Inc. 333 E. Brooks Rd. Memphis, TN 38109 Tel: +1 (901) 396-7398 Fax: +1 (396) 396-7399 Contact: Randy Jones customprojects@bellsouth.net

* Ordering of multiple sized cylinders should be considered to accommodate more than one fan size.

CHAPTER 3
Air Delivery Room Construction and Preparation

3.1 Air Delivery Room Requirements

The air delivery room cylinder shall be constructed per the blueprint provided in Appendix B. The room dimensions shall be 20 ± 0.75 ft. x 20 ± 0.75 ft. with an 11 ± 0.75 ft. high ceiling. **Note:** The control room shall be constructed external to the air delivery room.

In general, the ceiling shall be constructed of sheet rock or stainless plate. However, a drop ceiling with full coverage from wall to wall is also acceptable. The walls shall be of adequate thickness to maintain temperature and humidity during the test. It is important that the type of paint used on the walls, as well as the wall material, not absorb humidity while keeping the temperature of the room consistent at the time of testing. Oil based paint, which prevents absorption of humidity in the room, is preferred although other means of controlling humidity and temperature are acceptable.

Room Ventilation
The room shall have no ventilation other than the air conditioning and return. The air conditioning is used to control the temperature and humidity of the room (see Chapter 4 for requirements). At the time of construction of the room, means shall be provided to close the air conditioning vents inside the room to ensure consistent air circulation patterns within the room.

Closing all vents during testing increases the accuracy of air flow and the reading of the air velocity sensors. Therefore, air conditioning vents shall be closed during testing. **Note:** It is preferred to have electronically operated damper doors for the vents that can be controlled from a switch outside of the testing room.

3.2 Equipment Set-Up

Supportive Ceiling Rails

The ceiling rail tracks, used to support and move the testing cylinder, shall be installed as shown in Figures 3.1 – 3.3.

Figure 3.1 – Rail Track in Ceiling

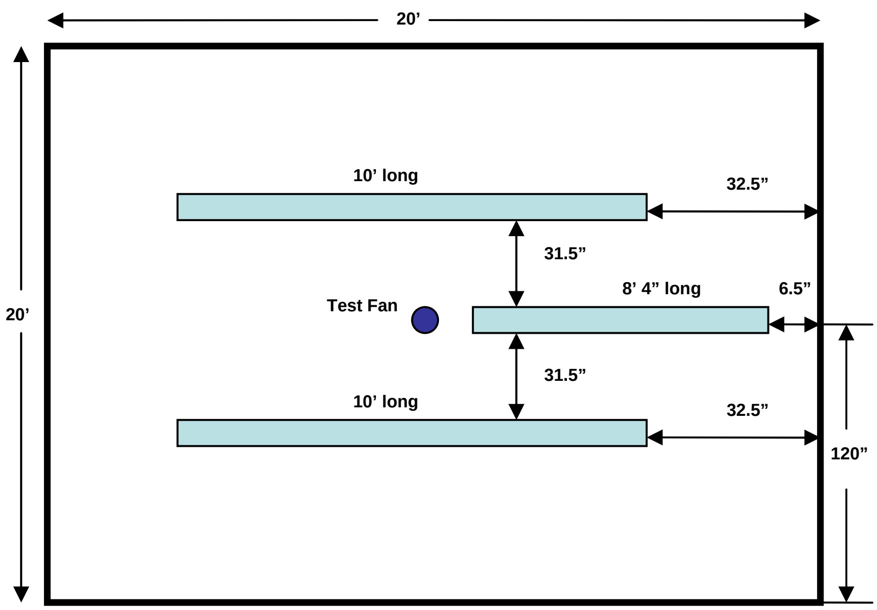


Figure 3.2 – Rail Measurements and Details

Figure 3.3 – Test Cylinder and Rail Track Support

Wiring
The amount of exposed wiring shall be minimized. All sensor lead wires should be stored under the floor, if possible (Figure 3.4, below).

Sensors and Sensor Rotating Arm
The sensors shall be placed at exactly 4-inch intervals. Sensor placement is shown in Figure 3.5, below. **Note:** It is extremely critical that the actual sensor not be touched prior to testing. Enough sensors shall be used to record air delivery to the end of the testing cylinder as shown in Figure 3.6.

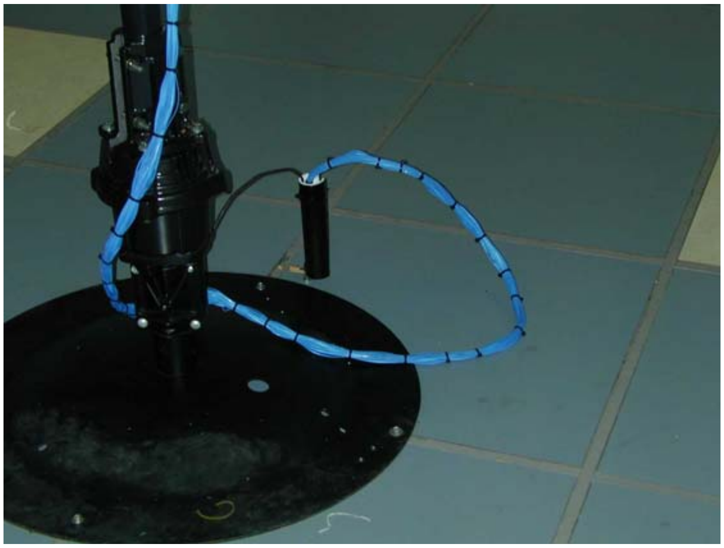


Figure 3.4 – Arm Rotator with Sensor Wires Covered (if using single rotating arm instead of four fixed arms)

Figure 3.5 – Sensors Mounted in Testing Position

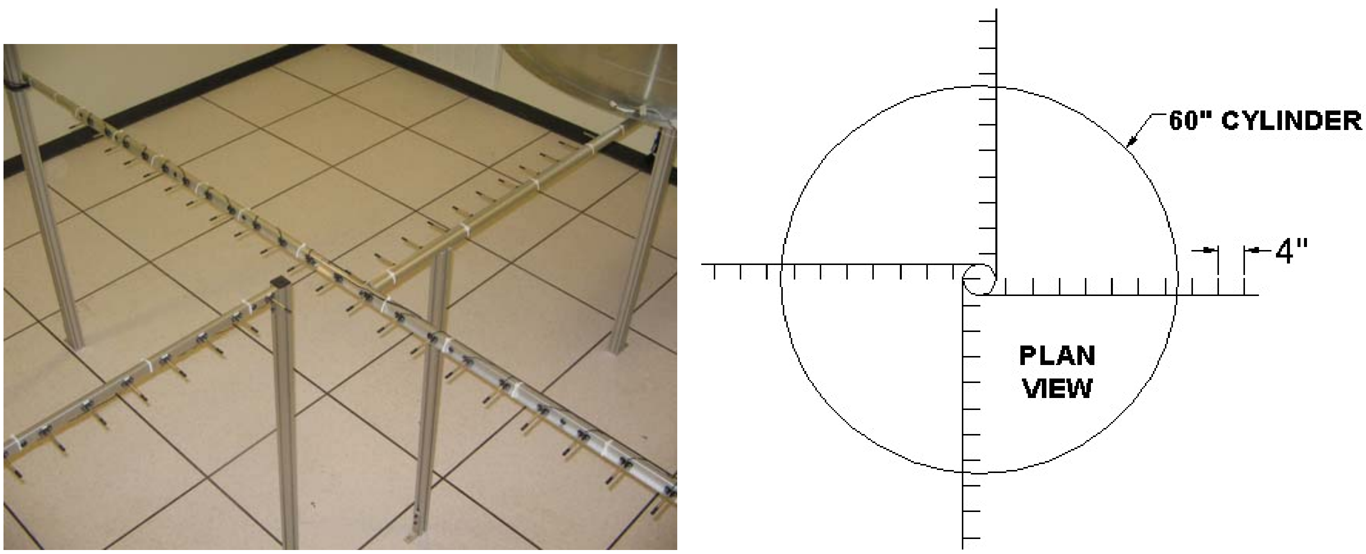


Figure 3.6 – Sensors and Sensor Arms (if using four fixed arms instead of single rotating arm)

Test Cylinders

The test cylinder hangs from the ceiling rails as shown in Figure 3.3. Test cylinders shall be eight inches (diameter) larger than the fan model being tested. For example, a 52-inch fan shall be tested within a 60-inch cylinder. Also, no inside seam of the test cylinder shall be directly aligned with the velocity sensors when measuring airflow. Proper cylinder set-up is shown in Figures 3.7 – 3.9, below. Table 3.1, below, shows the appropriate cylinder size and number of sensors to use for each fan size.

Figure 3.7 – Testing Cylinder, Sensors, and Sensor Arms (if using four fixed arms instead of single rotating arm)

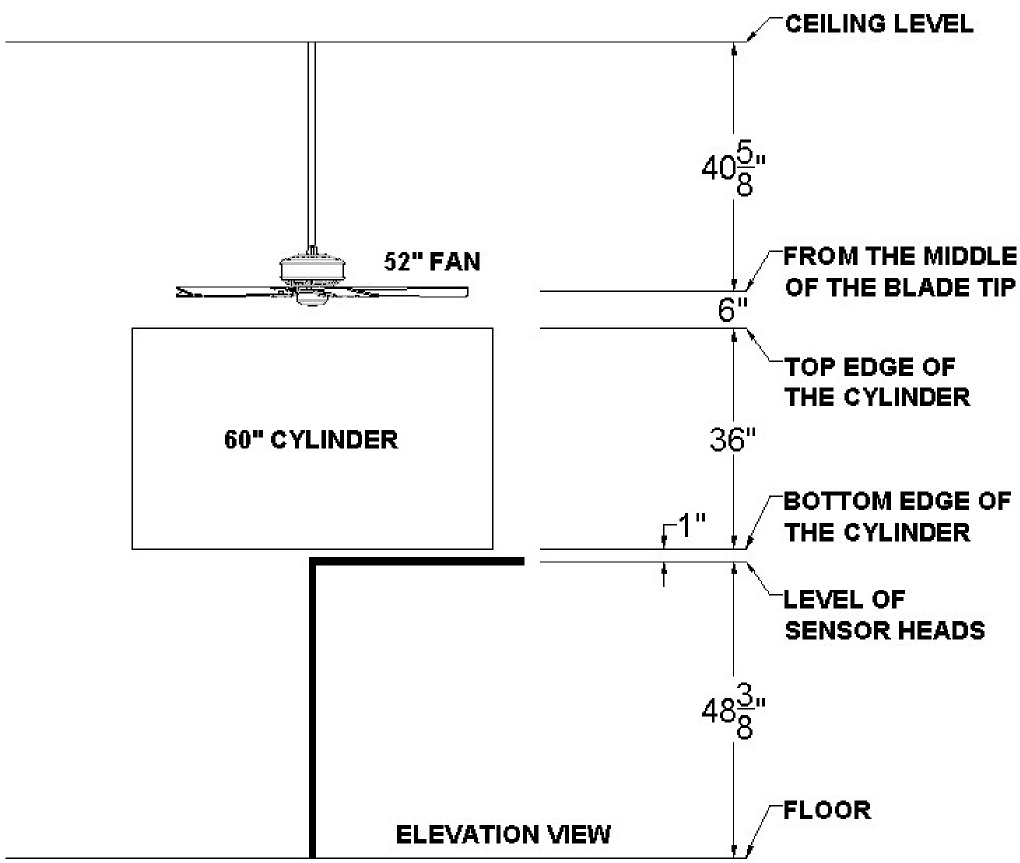


Figure 3.8 – Air Delivery Room Set-Up with 60" Cylinder

Figure 3.9 – Testing Cylinder and Chamber (if using single rotating arm instead of four fixed arms)

Fan Size (in.)	Cylinder Diameter (in.)	Number of Sensors	Comments	Circle area factor of last sensor
36	44	6		
42	50	7	The effective area of last sensor will have circle width of 3"	3.0761
44	52	7		
48	56	7	The effective area of last sensor will have circle width of 6”	6.5449
52	60	8		
56	64	8	The effective area of last sensor will have circle width of 6”	7.5922
60	68	9		

Table 3.1 – Cylinder and Sensor Selection Guide

CHAPTER 4
Equipment Set-Up and Test Method

This chapter provides general instructions on setting up the equipment and performing the ceiling fan test. Lab personnel shall refer to equipment manuals for specific instructions.

4.1 General Instructions

Listed below are some important things to remember when testing. These points are described in further detail in Section 4.3.

- The temperature and humidity setting shall be 70 ±5 degrees F, and 50 ±5% relative humidity – these shall be held constant during entire test process (Figure 4.1)
- Allow the sensors to be turned on and the fan to run for 30 minutes at its first and lowest speed setting, and 15 minutes at each subsequent fan speed/setting before taking readings.
- If present, light fixture shall be turned off during testing.

Figure 4.1 – Temperature and Humidity Sensors in Testing Room

Figure 4.2 – Tachometer Set-Up

4.2 Tachometer Set-Up

The installation of the RPM meter, or tachometer, is shown in Figure 4.2, above.

4.3 Fan Set-Up and Testing Method

Step 1: Make sure the transformer power is off. Hang fan at the actuator hanging system and connect black and white wires from ceiling to fan. Ignore other wires, until further notice. **Note:** Fan will need to be assembled prior to the test; it is important that lab personnel follow the instructions provided by the fan manufacturer. If during set-up it is discovered that not all of the blades meet the 6" height above the cylinder requirement, an average shall then be taken of all of the blade heights, which then must meet the 6" requirement. While determining the average height, the maximum variation in height of each individual blade from the edge of the cylinder should be limited to 0.5". If this is exceeded, the manufacturer shall then be required to send another fan for testing.

Step 2: Slide the metal cylinder to the center such that the fan is hanging above and exactly in the center of the cylinder. As mentioned in Chapter 3, test cylinders shall be a total of eight inches larger than the fan model being tested.

Step 3: Adjust the actuator such that the middle of the blade tip is 6 inches above the top edge, or lip, of the metal cylinder (see note on p. 10). If necessary, use the Penta-Drive hoist's toggle switch and adjust height. **Note:** If not all the blades are the same distance from the cylinder, adjust them until there is no fan wobble when the fan is in operation.

Step 4: Set the first sensor arm (if using four fixed arms) or single sensor arm (if using a single rotating arm) to the 0 degree Position (Axis A). Axes B, C and D are at 90, 180 and 270 degree positions relative to the arm. If necessary, use black tape marking as reference. To adjust beam alignment use antenna rotator by pressing the **LEFT** and **RIGHT** rocker switch. **Note:** Axes A – D can be designated either by using the four walls or four corners of the room. It is important that all axis points are equidistant from one another. See Figure 4.3, below.

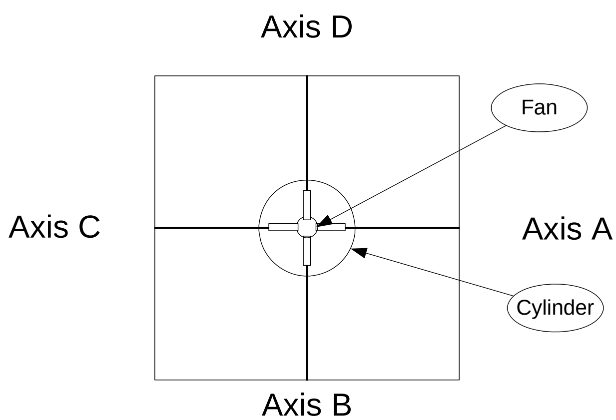


Figure 4.3 – Testing Room and All Four Axes

4.4 Accutract Software Instructions: Reading the Sensors

- Connect sensors as instructed in the Cambridge Airflow Temperature Monitor instruction manual
- The setting of the software shall be as follows (appropriate COM port of computer):

  - Statistics: Avg., Min., Max.
  - Probe: Gen'd
  - Prob Grid: (0X0)
  - Reading Interval: 1 second
  - Option Menu: (Altitude compensation: enter altitude, time unit second, airflow units FPM)

Figure 4.4 – Ceiling Fan Testing Set-Up

4.5 CFM and Power Consumption Testing Method

Listed below are the basic steps of the ceiling fan test. Figure 4.4, above, shows a ceiling fan during an air delivery test. Measurements shall be recorded at the resolution of the test instrumentation.

Step 1: If using a single rotating arm, rotate the sensor arm to Axis A.

Step 2: Load Accutrac Software. **Note:** The software shall be set up for 1 sec reading and for air velocity only, not for temperature. Insert current barometric pressure.

Step 3: Allow test fan to run 30 minutes at rated voltage and lowest frequency (speed), close all doors and turn off all environmental conditioning equipment entering the chamber (e.g., air conditioning), and wait an additional 3 minutes prior to starting test session. **Note:** Efforts shall be made to ensure that temperature and humidity readings are held within the required tolerances (see Chapter 4, section 4.1) for the duration of the test (all speeds). For example, it may be helpful to turn on environmental conditioning equipment between test sessions to ready the room for the following speed test.

Step 4: Start the session and begin recording readings. Take 100 readings (100 seconds run-time) and save the file to Data A. **Note:** When the session has started recording, make sure that only FPM are recorded; there is no need to record temperature readings.

Step 5: Similarly take the readings in Axis B, C, and D; these files will be saved as Data B, Data C, and Data D, respectively.

Step 6: Take the average value of each sensor and fill in the appropriate calculation spreadsheet shown in Appendix A.

Step 7: Repeat steps 1 through 6 above for the remaining fan speeds. However, instead of allowing the fan to run for 30 minutes, allow it to run for 15 minutes prior to taking measurements.

To measure ceiling fan power consumption during the CFM test, position an RMS sensor capable of measuring power with an accuracy of 1% at a point that includes all power consuming components of the ceiling fan (with any attached light kit powered off). After continuously measuring power at the rated voltage that represents normal operation over the duration of the airflow test, record the average power consumption in watts, and round to the nearest whole number as follows:

(i) A fractional number at or above the midpoint between two consecutive whole numbers shall be rounded up to the higher of the two whole numbers.

(ii) A fractional number below the midpoint between two consecutive whole numbers shall be rounded down to the lower of the two whole numbers.

After rounding, use the resultant figure with the corresponding CFM measurement to calculate the airflow efficiency in CFM/W.

4.6 Reporting Test Results and Additional Test Conditions

Test results shall be recorded and presented using the Laboratory Reporting Forms presented in Appendix A of this manual.

In addition, there are a number of important requirements that lab personnel should be aware of and communicate to the manufacturer. These are listed below.

- Lighting Requirements

Under the ENERGY STAR specification, a ceiling fan model that will be sold with an attached or integral light kit shall be tested with the light source mounted in its' intended position and switched off. If a ceiling fan model is sold both with and without a light kit, two separate tests shall be performed. Lab personnel shall indicate on the Laboratory Reporting Form whether or not the fan tested includes lighting.

- Other Testing Considerations and Recommendations

This test method is intended to provide fan performance results for the complete ceiling fan model and shall not be used as a means to test individual components. Laboratory personnel shall not accept new components from a customer for means of a re-test.

CHAPTER 5
Definitions and Acronyms

5.1 Definitions

Actuator: Mechanism that puts something into automatic action; motor driven. For purposes of this test method, the actuator holds and controls the height of the fan above the test cylinder.

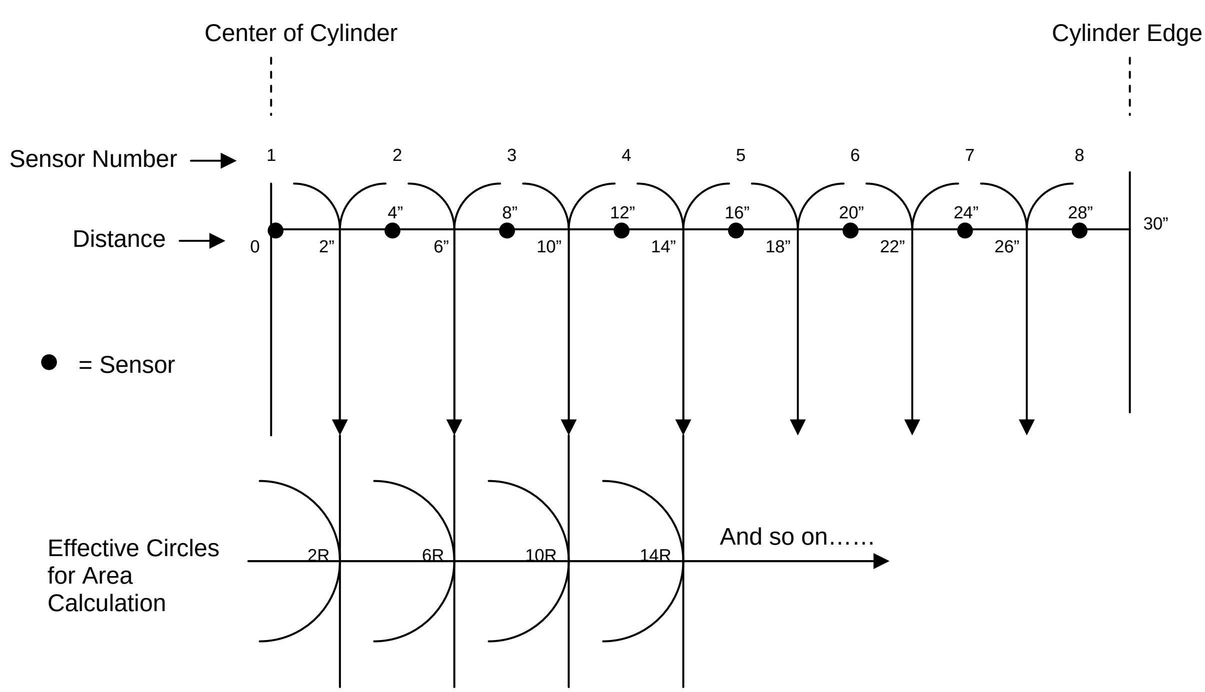
Airflow: The rate of air movement at a specific fan speed setting expressed in cubic feet per minute (CFM).

Airflow Efficiency: The ratio of airflow divided by power at a specific ceiling fan speed setting expressed in CFM per watt (CFM/watt).

Attachable Light Kit: Equipment that is used to provide light from the ceiling fan, and is not physically attached to the fan at the time of sale.

Blade Pitch: The angle between the fan's blades and the horizon.

Circle Area: Circular area over which the sensor can detect and record air delivery from a testing cylinder. For purposes of this test method, the following calculation was performed to determine circle area (see picture below):



Sensor #1 at 0” $\prod\ (2/12)^2 = 0.0873\ ft^2$

Sensor #2 at 4” $\prod\ [(6/12)^2 – (2/12)^2] = 0.6981\ ft^2$

Sensor #3 at 8” $\prod\ [(10/12)^2 – (6/12)^2] = 1.3963\ ft^2$

COM Port: Of a device or network, a point of access where signals may be inserted or extracted, or where the device or network variables may be observed or measured; ability to communicate with external devices.

Damper: A device that decreases the amplitude of electronic, mechanical, acoustical, or aerodynamic oscillations. For purposes of this test method it is an airtight door that prevents external airflow into the testing room.

Fan Housing: The decorative body of the fan which encloses the motor.

Fan Motor: Device that turns the ceiling fan blades in order to move air.

Fan Size: Total diameter (circumference) of blade span; measured in inches at the blade tips.

Integral Light Kit: Equipment that is used to provide light from the ceiling fan, and is connected to the fan at the time of purchase. For purposes of this test method, the integral light kit must be attached at the time of testing.

Infrared Beam: Beam of light situated outside the visible spectrum at its red end, having a wavelength between about 700 nanometers and 1 millimeter; longer than visible light but shorter than radio waves. Infrared beam is used within the Tachometer to count the revolutions per minute (RPM).

Representative Fan Model: Prototype or fan model that is tested to qualify a line of products under the same model name and number. Those fans represented by this model must be the same in every aspect but finish.

Sensor: An electronic device used to measure a physical quantity such as temperature, pressure, loudness, or airflow and convert it into an electronic signal of some kind. Sensors are normally components of some larger electronic system such as a computer control and/or measurement system.

Solid State Test Method: Test method that specifies the apparatus and testing protocol for measuring a residential ceiling fan’s airflow and power consumption. The method, developed by Hunter Fans, utilizes a thermister based hot-wire anemometer and requires a temperature controlled room and computer for recording test data.

Tachometer: Device that measures rotational motion; a speed indicator. Measurement is usually in revolutions per minute (RPM).

5.2 Acronyms

CFM	Cubic feet per minute
FPM	Feet per minute
RMS	Root Mean Square
RPM	Revolutions per minute

APPENDIX A

Laboratory Reporting Form(s)

Air Delivery Test
36" Fan

Test #	
Date of Test	
Test Conducted By:	

Model #	
Name	
Size	
Blade Description	
Light Kit (yes/no)	
Model #	

Relative Humidity (%)	
Room Temp (F)	
Barometric Pres. (PSI)	

Volts / Hz	
Watt	
Amp	
RPM @start	
Speed	

Sensor #	Sensor Dist. From Center (inch)	Velocity in FPM - Axis #				Average Vel. (FPM)=A	Circle area (sq. Ft.) = B	Air Delivery (CFM)=A*B
		A	B	C	D			
1	0						0.0873	
2	4						0.6981	
3	8						1.3963	
4	12						2.0944	
5	16						2.7925	
6	20						3.4907	
							Total Air Delivery (CFM)	
							CFM/W	

Air Delivery Test
42" Fan

Test #	
Date of Test	
Test Conducted By:	

Model #	
Name	
Size	
Blade Description	
Light Kit (yes/no)	
Model #	

Relative Humidity (%)	
Room Temp (F)	
Barometric Pres. (PSI)	

Volts / Hz	
Watt	
Amp	
RPM @start	
Speed	

Sensor #	**Sensor Dist. From Center (inch)**	**Velocity in FPM - Axis #**				**Average Vel. (FPM)=A**	**Circle area (sq. Ft.) = B**	**Air Delivery (CFM)=A*B**
		A	**B**	**C**	**D**			
1	0						0.0873	
2	4						0.6981	
3	8						1.3963	
4	12						2.0944	
5	16						2.7925	
6	20						3.4907	
7	24						3.0761	
							Total Air Delivery (CFM)	
							CFM/W	

Air Delivery Test
44" Fan

Test #	
Date of Test	
Test Conducted By:	

Model #	
Name	
Size	
Blade Description	
Light Kit (yes/no)	
Model #	

Relative Humidity (%)	
Room Temp (F)	
Barometric Pres. (PSI)	

Volts / Hz	
Watt	
Amp	
RPM @start	
Speed	

Sensor #	Sensor Dist. From Center (inch)	Velocity in FPM - Axis #				Average Vel. (FPM)=A	Circle area (sq. Ft.) = B	Air Delivery (CFM)=A*B
		A	B	C	D			
1	0						0.0873	
2	4						0.6981	
3	8						1.3963	
4	12						2.0944	
5	16						2.7925	
6	20						3.4907	
7	24						4.1888	
							Total Air Delivery (CFM)	
							CFM/W	

Air Delivery Test
48" Fan

Test #	
Date of Test	
Test Conducted By:	

Model #	
Name	
Size	
Blade Description	
Light Kit (yes/no)	
Model #	

Relative Humidity (%)	
Room Temp (F)	
Barometric Pres. (PSI)	

Volts / Hz	
Watt	
Amp	
RPM @start	
Speed	

Sensor #	**Sensor Dist. From Center (inch)**	**Velocity in FPM - Axis #**				**Average Vel. (FPM)=A**	**Circle area (sq. Ft.) = B**	**Air Delivery (CFM)=A*B**
		A	**B**	**C**	**D**			
1	0						0.0873	
2	4						0.6981	
3	8						1.3963	
4	12						2.0944	
5	16						2.7925	
6	20						3.4907	
7	24						6.5449	
							Total Air Delivery (CFM)	
							CFM/W	

Air Delivery Test
52" Fan

Test #	
Date of Test	
Test Conducted By:	

Model #	
Name	
Size	
Blade Description	
Light Kit (yes/no)	
Model #	

Relative Humidity (%)	
Room Temp (F)	
Barometric Pres. (PSI)	

Volts / Hz	
Watt	
Amp	
RPM @start	
Speed	

Sensor #	**Sensor Dist. From Center (inch)**	**Velocity in FPM - Axis #**				**Average Vel. (FPM)=A**	**Circle area (sq. Ft.) = B**	**Air Delivery (CFM)=A*B**
		A	**B**	**C**	**D**			
1	0						0.0873	
2	4						0.6981	
3	8						1.3963	
4	12						2.0944	
5	16						2.7925	
6	20						3.4907	
7	24						4.1888	
8	28						4.8869	
							Total Air Delivery (CFM)	
							CFM/W	

Air Delivery Test
56" Fan

Test #	
Date of Test	
Test Conducted By:	

Model #	
Name	
Size	
Blade Description	
Light Kit (yes/no)	
Model #	

Relative Humidity (%)	
Room Temp (F)	
Barometric Pres. (PSI)	

Volts / Hz	
Watt	
Amp	
RPM @start	
Speed	

Sensor #	Sensor Dist. From Center (inch)	Velocity in FPM - Axis #				Average Vel. (FPM)=A	Circle area (sq. Ft.) = B	Air Delivery (CFM)=A*B
		A	B	C	D			
1	0						0.0873	
2	4						0.6981	
3	8						1.3963	
4	12						2.0944	
5	16						2.7925	
6	20						3.4907	
7	24						4.1888	
8	28						7.5922	
							Total Air Delivery (CFM)	
							CFM/W	

Air Delivery Test
60" Fan

Test #	
Date of Test	
Test Conducted By:	

Model #	
Name	
Size	
Blade Description	
Light Kit (yes/no)	
Model #	

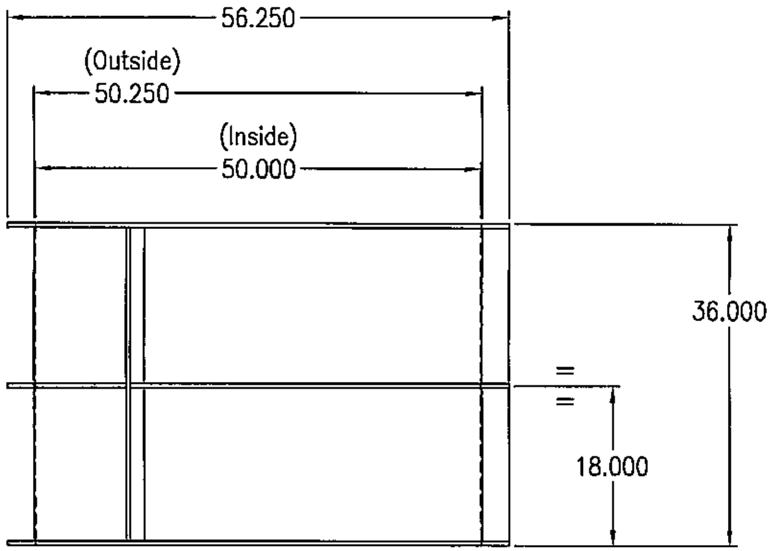
Relative Humidity (%)	
Room Temp (F)	
Barometric Pres. (PSI)	

Volts / Hz	
Watt	
Amp	
RPM @start	
Speed	

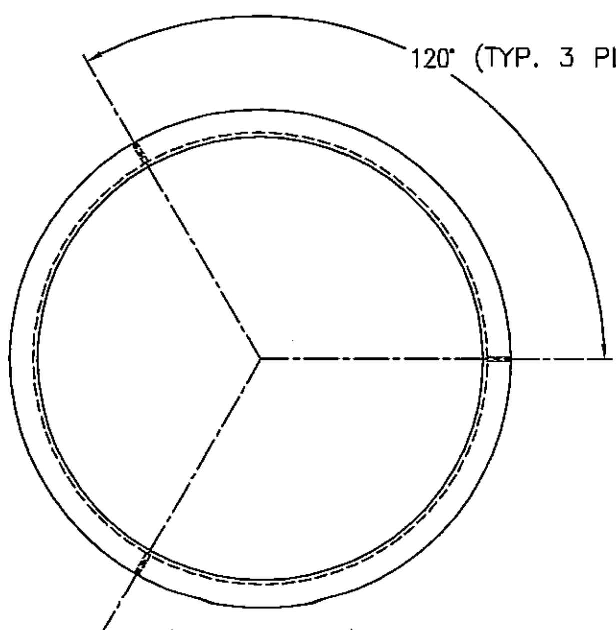
Sensor #	Sensor Dist. From Center (inch)	Velocity in FPM - Axis #				Average Vel. (FPM)=A	Circle area (sq. Ft.) = B	Air Delivery (CFM)=A*B
		A	B	C	D			
1	0						0.0873	
2	4						0.6981	
3	8						1.3963	
4	12						2.0944	
5	16						2.7925	
6	20						3.4907	
7	24						4.1888	
8	28						4.8869	
9	32						5.5851	
							Total Air Delivery (CFM)	
							CFM/W	

APPENDIX B

Engineering Blueprints for Air Delivery Room Cylinder



TOLERANCE FOR ALL DIMENSIONS = +/- 0.25 INCH



50" CHAMBER TO BE USED WITH 42" CEILING FANS ONLY!.

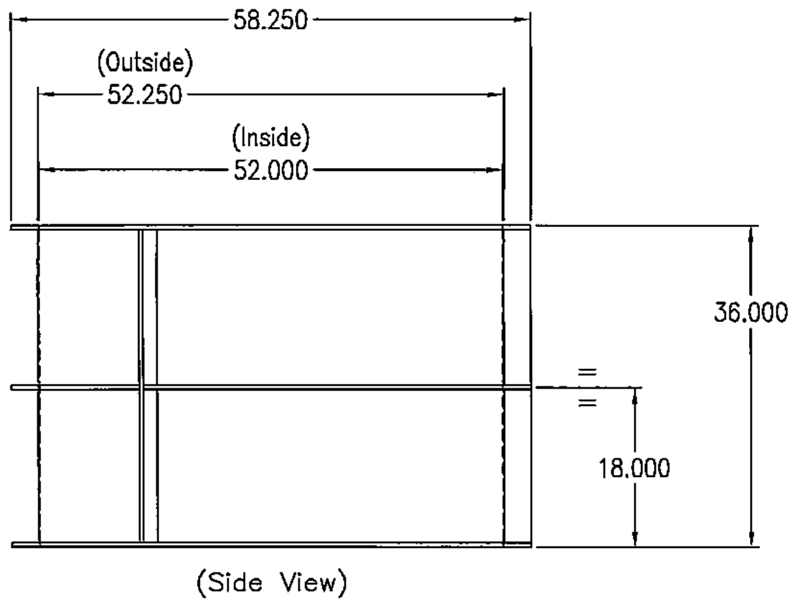
NOTES: GENERAL

1) MATERIAL: 0.125" ALUMINUM – T6 #6061.
2) MATERIAL THICKNESS (BOTTOM VIEW) EXAGERATED IN DRAWING FOR CLARITY.
3) REFERENCE #SK6-2150 FOR ASSEMBLED B.O.M.
4) ALL DIM TO BE INCHES UNLESS NOTED. DIM TEXT = AS NOTED.

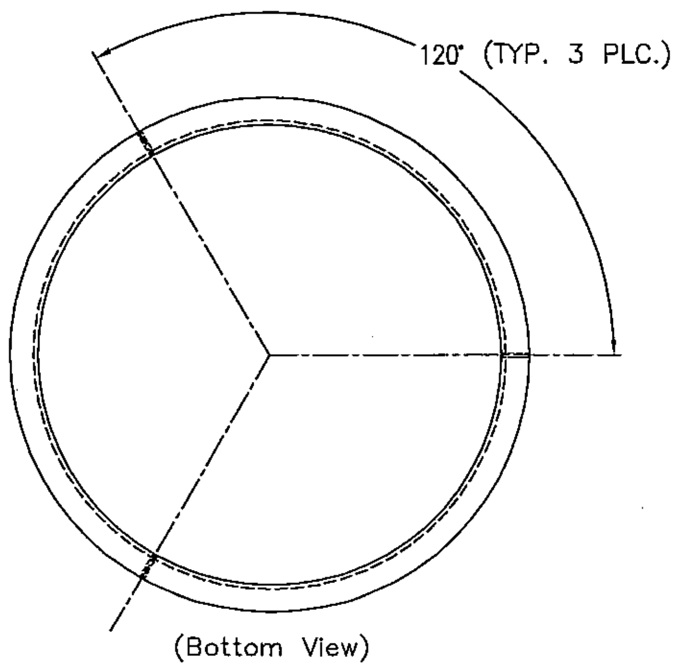
HUNTER SINCE 1886

HUNTER FAN COMPANY
2500 FRISCO AVE., MEMPHIS, TENN. 38114

TOLERANCES: (UNLESS OTHERWISE SPECIFIED) DECIMAL:	DATE: 02-14-00	DRAWN BY: RGPenton
.XX = ± .01	SCALE: 1=20	CHECKED BY: MBrown
.XXX = ± .005	FIRST USE: SK6-2150	ENG. APPVL.: MBrown
FRACTIONAL: ± 1/16	REFERENCE: SK6-2151	COPY DATE:
ANGULAR: ± .5°	PART NAME: 50" CFM Chamber Ref.	PART NO. SK6-2151



TOLERANCE FOR ALL DIMENSIONS = +/- 0.25 INCH



52" CHAMBER TO BE USED WITH 44" CEILING FANS ONLY!.

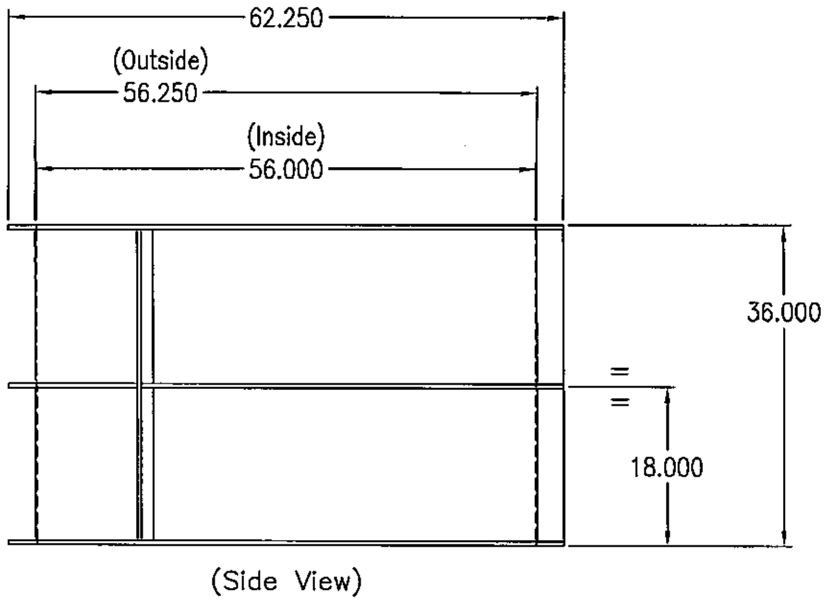
NOTES: GENERAL

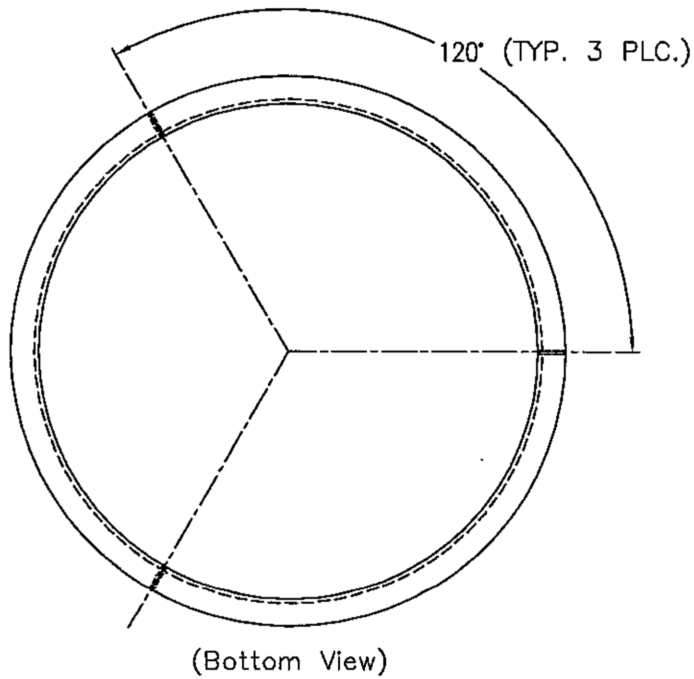
1) MATERIAL: 0.125" ALUMINUM – T6 #6061.
2) MATERIAL THICKNESS (BOTTOM VIEW) EXAGERATED IN DRAWING FOR CLARITY.
3) REFERENCE #SK6-2141 FOR ASSEMBLED B.O.M.
4) ALL DIM TO BE INCHES UNLESS NOTED. DIM TEXT = AS NOTED.

HUNTER SINCE 1886

HUNTER FAN COMPANY
2500 FRISCO AVE., MEMPHIS, TENN. 38114

TOLERANCES: (UNLESS OTHERWISE SPECIFIED) DECIMAL:	DATE: 02-14-00	DRAWN BY: RGPenton
.XX = ±.01	SCALE: 1=20	CHECKED BY: MBrown
.XXX = ±.005	FIRST USE: SK6-2141	ENG. APPVL.: MBrown
FRACTIONAL: ±1/16	REFERENCE: SK6-2142	COPY DATE:
ANGULAR: ±.5°	PART NAME 52" CFM Chamber Ref.	PART NO. SK6-2142





TOLERANCE FOR ALL DIMENSIONS = +/- 0.25 INCH

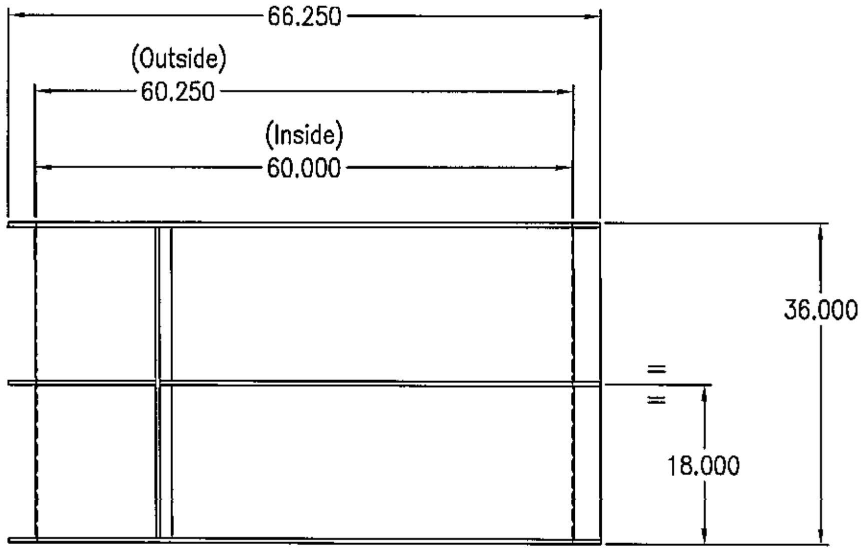
56" CHAMBER TO BE USED WITH 48" CEILING FANS ONLY!.

NOTES: GENERAL

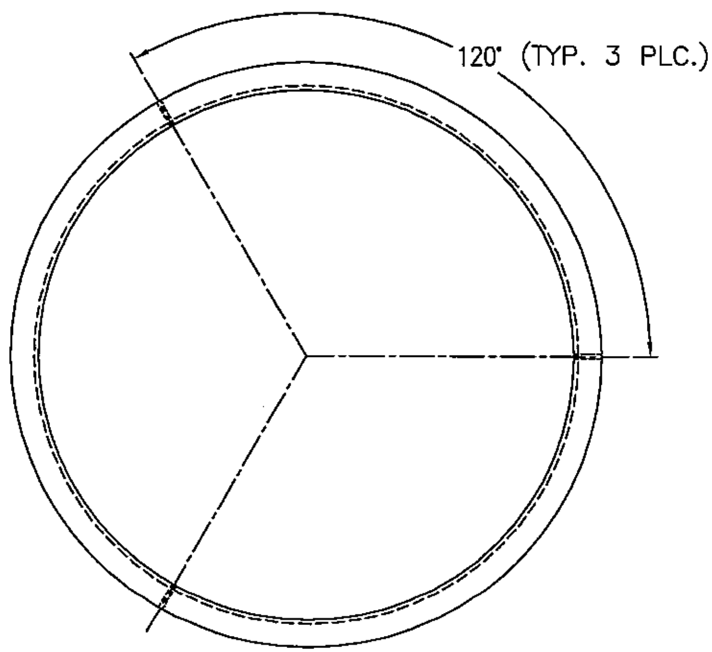
1) MATERIAL: 0.125" ALUMINUM – T6 #6061.
2) MATERIAL THICKNESS (BOTTOM VIEW) EXAGERATED IN DRAWING FOR CLARITY.
3) REFERENCE #SK6-2132 FOR ASSEMBLED B.O.M.
4) ALL DIM TO BE INCHES UNLESS NOTED. DIM TEXT = AS NOTED.

HUNTER FAN COMPANY
2500 FRISCO AVE., MEMPHIS, TENN. 38114

TOLERANCES: (UNLESS OTHERWISE SPECIFIED) DECIMAL:	DATE: 02-14-00	DRAWN BY: RGPenton
.XX = ±.01	SCALE: 1=20	CHECKED BY: MBrown
.XXX = ±.005	FIRST USE: SK6-2132	ENG. APPVL.: MBrown
FRACTIONAL: ±1/16	REFERENCE: SK6-2133	COPY DATE:
ANGULAR: ±.5°	PART NAME: 56" CFM Chamber Ref.	PART NO.: SK6-2133



(Side View)



(Bottom View)

TOLERANCE FOR ALL DIMENSIONS = +/- 0.25 INCH

60" CHAMBER TO BE USED WITH 52" CEILING FANS <u>ONLY!</u>.

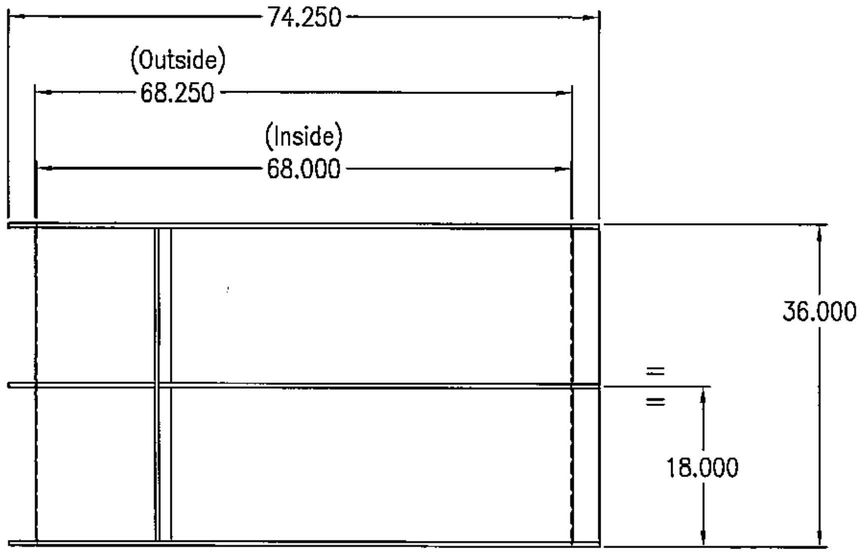
NOTES: GENERAL

1) MATERIAL: 0.125" ALUMINUM – T6 #6061.
2) MATERIAL THICKNESS (BOTTOM VIEW) EXAGERATED FOR CLARITY.
3) REFERENCE #SK6-2123 FOR ASSEMBLED B.O.M.
4) ALL DIM TO BE INCHES UNLESS NOTED. DIM TEXT = AS NOTED.

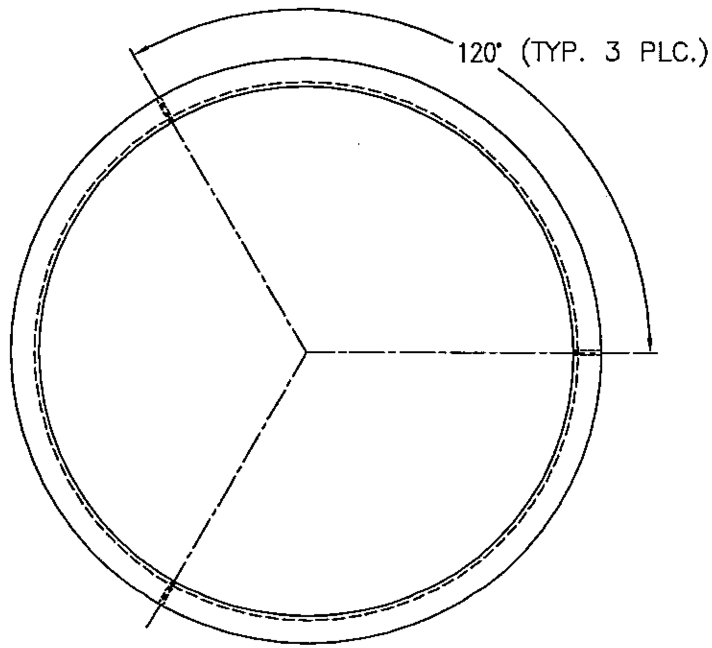
HUNTER SINCE 1886

HUNTER FAN COMPANY
2500 FRISCO AVE., MEMPHIS, TENN. 38114

TOLERANCES: (UNLESS OTHERWISE SPECIFIED)	DATE: 02-14-00	DRAWN BY: RGPenton
DECIMAL:	SCALE: 1=20	CHECKED BY: MBrown
.XX = ± .01	FIRST USE: SK6-2123	ENG. APPVL.: MBrown
.XXX = ± .005	REFERENCE: SK6-2124	COPY DATE:
FRACTIONAL: ± 1/16	PART NAME 60" CFM Chamber Ref.	PART NO. SK6-2124
ANGULAR: ± .5°		



(Side View)



(Bottom View)

TOLERANCE FOR ALL DIMENSIONS = +/- 0.25 INCH

68" CHAMBER TO BE USED WITH 60" CEILING FANS <u>ONLY!</u>.

NOTES: GENERAL

1) MATERIAL: 0.125" ALUMINUM – T6 #6061.
2) MATERIAL THICKNESS (BOTTOM VIEW) EXAGERATED FOR CLARITY.
3) REFERENCE #SK6-2159 FOR ASSEMBLED B.O.M.
4) ALL DIM TO BE INCHES UNLESS NOTED. DIM TEXT = AS NOTED.

HUNTER SINCE 1886

HUNTER FAN COMPANY
2500 FRISCO AVE., MEMPHIS, TENN. 38114

TOLERANCES: (UNLESS OTHERWISE SPECIFIED)		
DECIMAL:	DATE: 09-19-01	DRAWN BY: RGPenton
.XX = ± .01	SCALE: N.T.S.	CHECKED BY: VMehta
.XXX = ± .005	FIRST USE: SK6-2159	ENG. APPVL.: VMehta
FRACTIONAL: ± 1/16	REFERENCE: SK6-2160	COPY DATE:
ANGULAR: ± .5°	PART NAME: 68" CFM Chamber Ref.	PART NO. SK6-2160