Halton Company, Model KVE
Wall-Mounted Canopy Exhaust Hood
Performance Report

Application of ASTM Standard
Test Method F 1704-05

Food Service Technology Center
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Contents

Objectives and Scope

This report summarizes the results of performance testing a Halton Company, model KVE Exhaust Hood at the Commercial Kitchen Ventilation Laboratory within the scope of the PG&E Food Service Technology Center program. The objectives were to:

(1) Evaluate the capture and containment performance of this exhaust only, wall-mounted canopy hood when challenged with light-, medium-, heavy-, and mixed-duty appliances under the controlled conditions of the ASTM Standard Test Method F-1704 [Ref 1].

(2) Measure and report the pressure drop across the hood as a function of airflow.

(3) Measure and report the filter velocity profile across the length of the hood.

Equipment

Hood Specifications

The Halton model KVE is offered in two configurations, either with side panels or with Capture Jet™ technology on both sides. Both configurations incorporate the Capture Jet™ technology along the front, and both configurations are designated KVE with either side option specified. The canopy hood tested measured 10 feet wide by 4.5 feet deep by 2 feet high and was mounted to a transparent back wall. A 3-inch standoff behind the back panel was incorporated within the depth of the hood. The hood was equipped with six 19.5-inch by 13.0-inch stainless steel baffle-type grease filters (Halton KSA Multi-Cyclone™ grease extractors), and exhausted through an 18.0 inch by 10.0 inch exhaust collar. The front lower edge of the hood was located at 78.0 inches above the finished floor. The original hood setup over a heavy-duty broiler line is shown in Figure 1.

Figure 1. Halton KVE Wall-Mounted Canopy Hood Test Setup (Note Transparent Back Wall)

The hood was equipped with Capture Jets™ along the entire front edge, directed inward and downward. The Capture Jets™ were also along the entire lower edge of both sides of the hood, directed inward, downward and 45 degrees below horizontal. With either the front or the front and side Capture Jets™ operating, the flow rate through the jets was 7 cfm/ft and the plenum pressure was 0.10 inches of water. The purpose of the Capture Jet™ was to return the effluent plume towards the filter bank. The Capture Jet™ configurations are shown in Figure 2.

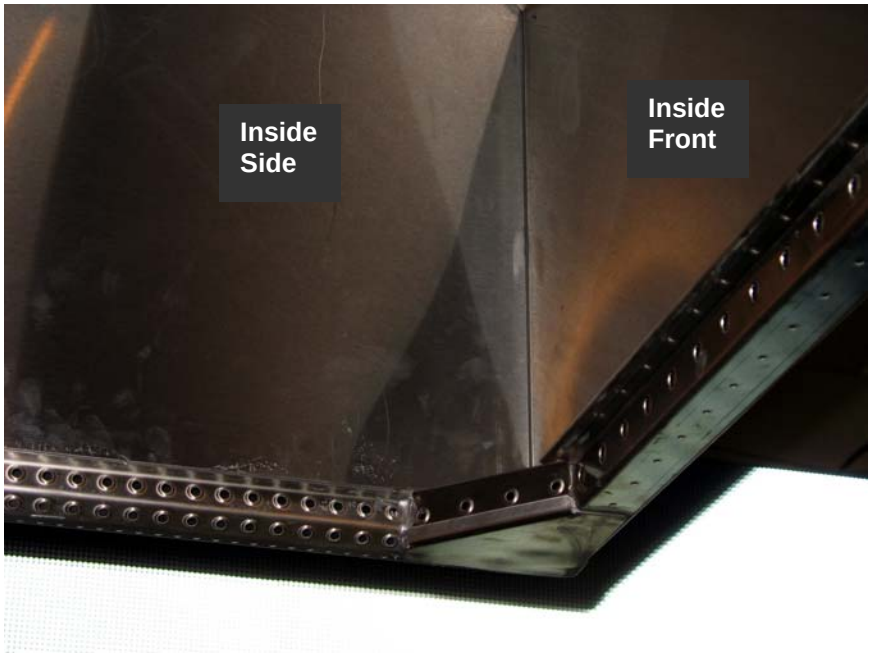


Figure 2 Capture Jet™ Configurations Along Side, Corner and Front Lower Edges of Hood.

Side Panel Configuration

Partial side panels were used in seven capture and containment evaluations. Three side panel options initially were evaluated to determine an optimum size. The side panels measured 50-inch by 50-inch by 45 degrees, 45-inch by 45-inch by 45 degrees, and 36-inch by 36-inch by 45 degrees. Sensitivity testing with the broiler line showed that the larger of the three panel options provided the greatest return on hood performance. Subsequently, all side-panel tests in the matrix were conducted using this preferred panel configuration. A photograph with and without the side panels installed on the three-broiler cook line, along with a dimensioned drawing, is shown in Figure 3.

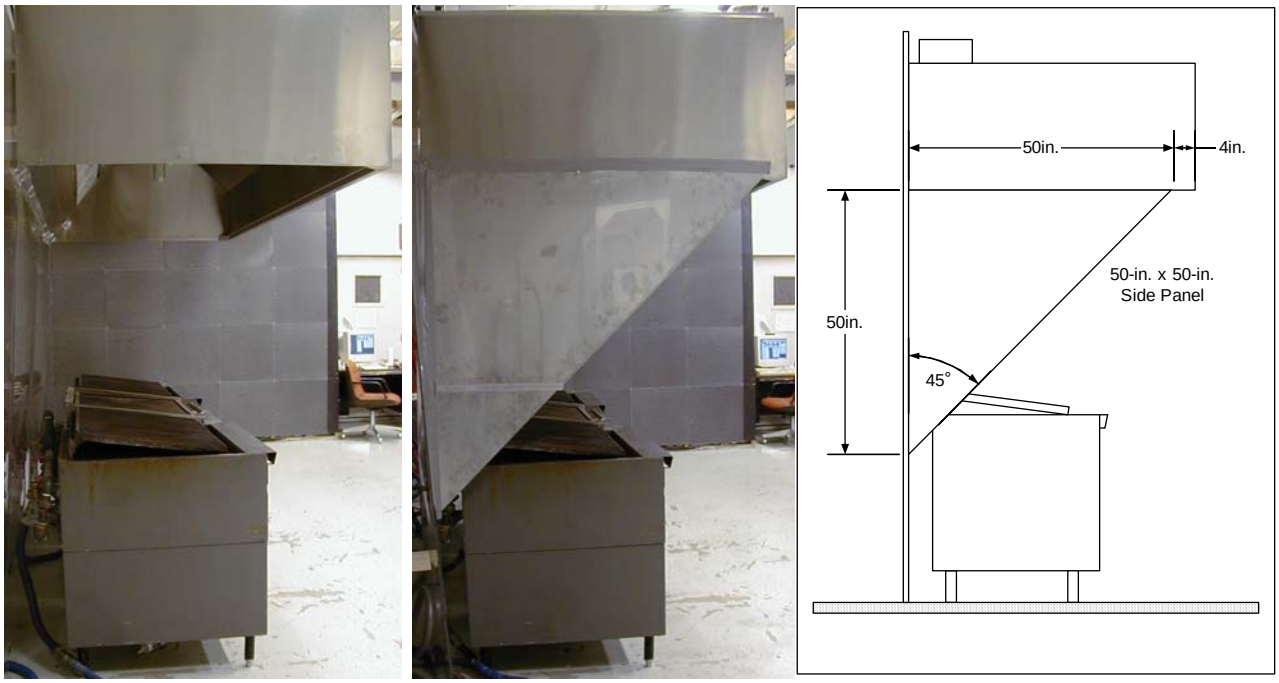


Figure 3. Side View with and without 50-inch x 50-inch Side Panel

Cooking Appliances

The appliances used to challenge this wall-mounted canopy hood were full-size electric ovens (light-duty category), 2-vat high-efficiency gas fryers, a three-foot griddle (medium-duty) and 3-foot underfired gas broilers (heavy-duty). For each setup, the appliances were operated under simulated heavy-load cooking conditions established by a recent ASHRAE research project [Ref 2]] based on the heavy load testing per the ASTM Standard Test Methods for appliances [Ref 5,6,7,8]. The cooking appliance specifications are listed in Table 1.

Table 1 Cooking Appliance Specifications

	3-Ft. Gas Broiler	Full-Size Electric Convection Oven	2-Vat Gas Fryer	3-Ft. Gas Griddle
Rated Input	96,000 Btu/h	12.1 kW	160,000 Btu/h	90,000 Btu/h
Capacity	719 sq. in.	8.6 cu. ft	Two 50 lb. vats	1026 sq. in.
Height	37.0 in.	57.3 in.	45.3 in.	37.0 in.
Width	34.0 in.	40.0 in.	31.3 in.	36.0 in.
Depth	31 in.	41/38/42 in.	28 in.	37 in.

Hood/Appliance Overhang Relationship

The appliance lines were positioned in a "pushed back" condition with a minimum distance between the back wall and the rear of the appliance (i.e., rear gap), while allowing enough space for utility connections. Figure 4 illustrates the relationship between front overhang and rear gap. Table 2 shows the actual dimensions of front overhang and rear gap in the "pushed back" condition. Ovens remained in the 12-inch overhang position for all tests, as this was also the position of maximum "push back" and minimum rear gap.

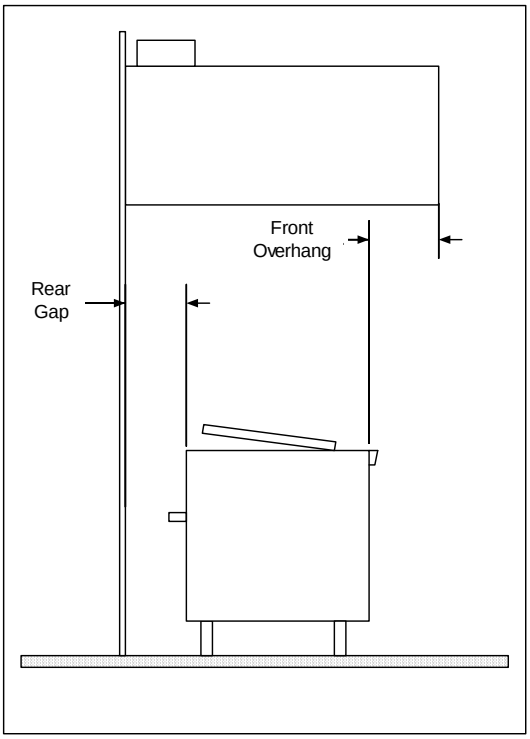


Figure 4. Relationship between Front Overhang and Rear Gap

Table 2 Hood/Appliance Overhang Relationships

	3-Ft. Gas Broiler	Full-Size Electric Convection Oven	2-Vat Gas Fryer	3-Ft Gas Griddle
Front Overhang to Appliance [in.]	18	12	22	12
Rear of Appliance to Backwall [in.]	5	1	4	5

Test Protocol

Capture & Containment Testing

"Hood capture and containment" is defined in ASTM F1704-05, *Capture and containment performance of commercial kitchen exhaust ventilation systems*, as "the ability of the hood to capture and contain grease laden cooking vapors, convective heat and other products of cooking processes." Hood capture refers to the products getting into the hood reservoir, while containment refers to these products staying in the hood reservoir and not spilling out into the space. "Minimum capture and containment" is defined as "the conditions of hood operation at which the exhaust flow rate is just sufficient to capture and contain the products generated by the appliance in idle and heavy load cooking conditions, or at any intermediate prescribed load condition."

For each capture and containment (C&C) evaluation, the exhaust rate was reduced until spillage of the plume was observed (using the airflow visualization techniques described below) at any point along the perimeter of the hood. The exhaust rate was then increased in fine increments until C&C was achieved. For most cases, single-test determinations were used to establish the reported threshold of C&C. This threshold C&C rate was used for direct comparisons across scenarios. In all evaluations, the replacement air was supplied from low velocity, floor-mounted diffusers along the opposite wall (Figure 8). The introduction of replacement air from such sources has been found to be optimum (i.e., the least disruptive) for the laboratory test setup [Ref 3].

A walk-by protocol was introduced to simulate operator movement in the restaurant in the vicinity of the hood during the cooking process. The procedure was used in the lab to emulate the effect of operator disturbance on capture and containment. For this assessment, a researcher walked a line 18 inches in front of the appliances with a 12 inch front overhang (i.e., 6 inches forward of the front panel of the hood) at a rate of 100 steps per minute. The exhaust rate was then increased to achieve capture and containment of the thermal plume under this dynamic challenge.

Airflow Visualization

The primary tools used for airflow visualization were schlieren and shadowgraph systems, which visualize the refraction of light due to air density changes. Since the heat and effluent generated by the cooking process change the air density above the equipment, the sensitive flow visualization systems provide a graphic image of the thermal activity along the perimeter of the hood. The front and left lower edges of the hood were monitored by schlieren systems located at a height that was centered between the typical 36-inch appliance height and the 78-inch hood height. The right lower edge of the hood was monitored using a shadowgraph system, located at the same height as the hood edge. Other flow visualization tools used to seed the thermal plume included smoke sticks and theater fog. Figure 5 shows a plan view of the laboratory with the relative position of the hood and flow visualization tools.

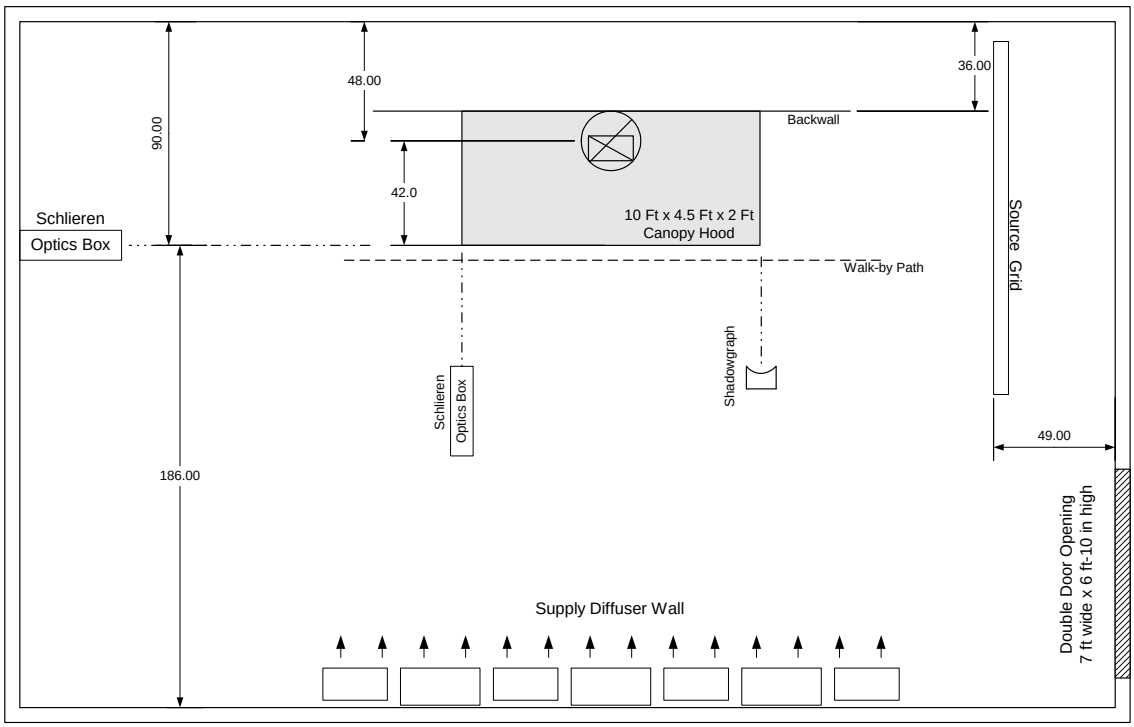


Figure 5. Plan View of Lab During Hood Evaluation

The airflow measurements in the laboratory comply with the AMCA 210/ASHRAE 51 Standard [Ref 4]. The error on the airflow rate measurement is less than 2%. The repeatability of capture and containment determinations is typically within 5%.

Static Pressure Differential

The static pressure difference was measured between the laboratory and the exhaust collar of the hood. The pressure was taken at the exhaust collar with a 4-inch by 2-inch right-angle static pressure probe inserted at the center of the 18-inch side of the collar. The static pressure taps were located approximately 4-inches inside the exhaust collar wall and 1-inch above the top of the hood. The pressures were taken for five exhaust flow rates (1500, 2000, 2500, 3000, and 3300 cfm).

Filter Face Velocity Profile

The filter face velocity was measured with a 4-inch diameter, rotating vane anemometer (RVA) flush against the filter. One-minute average readings were recorded for each filter traverse. The profiles were taken for two exhaust airflow rates, 2000 and 3000 cfm.

Appliance and Hood Configuration Test Matrix

The performance of the Halton KVE hood was evaluated for 12 test conditions. Generally, each appliance line configuration was evaluated in a best practice "pushed back" condition. The evaluation of the hood performance was done either with side panels and the front Capture Jets™ on and at a flow rate of 7 cfm/ft with a plenum pressure of 0.10 inches of water, or without side panels and with the front and side Capture Jets™ on at the same flow rate of 7 cfm/ft with a plenum pressure of 0.10 inches of water. In addition, one test with the broiler challenge included a seal between the rear of the appliances and the wall. Another additional test was performed on the mixed appliance line to evaluate hood performance under a dynamic walk-by challenge. In this case, the exhaust rate was increased to achieve capture and containment under the disruption caused by operator movement. The following test matrices present the details of the test setups for the respective appliance lines. Each test condition is sequentially numbered for reference to the reported data.

Underfired Gas Broiler (Heavy-Duty) Test Matrix

The heavy-duty challenge was comprised of three 3-foot, underfired gas broilers. The front overhang was 18 inches in the pushed back condition and resulted in a rear gap of 5 inches. The hood performance was tested with either side panels (SP) or side Capture Jets™ (CJ). They were tested in a static (no operator movement) condition. With the broilers in the pushed-back configuration and the side panels installed, an additional evaluation was done with the 5-inch rear gap sealed between the broilers and the back wall at the height of the top of the appliance cabinet (Test 3). The test matrix for the heavy-duty broilers is shown in Table 3 and the setup illustrated in Figure 6.

Table 3. Underfired Gas Broiler (Heavy-Duty) Test Matrix

Test #	LH Appliance	LH Appliance Effective Front Overhang[1] [in.]	LH Appliance Effective Rear Gap [in.]	CTR Appliance	CTR Appliance Effective Front Overhang[1] [in.]	CTR Appliance Effective Rear Gap [in.]	RH Appliance	RH Appliance Effective Front Overhang[1] [in.]	RH Appliance Effective Rear Gap [in.]	Side Panels or Side Capture Jets[2]	Side Overhang [in.]
1	Broiler	18	5	Broiler	18	5	Broiler	18	5	CJ	6
2	Broiler	18	5	Broiler	18	5	Broiler	18	5	SP	6
3	Broiler	18	5	Broiler	18	5	Broiler	18	5	SP & Rear Seal	6

[1]Front overhang measured from front of hood to front of appliance
[2]All tests conducted with front Capture Jet on

Figure 6. Heavy-Duty Underfired Gas Broiler Line

Gas Fryer (Medium-Duty) Test Matrix

The medium-duty test matrix consisted of three 2-vat gas fryers (6 vats total). The front overhang was 22 inches and resulted in a rear gap of 4 inches. The hood performance was tested with either side panels (SP) or side Capture Jets™ (CJ). They were tested in a static (no operator movement) condition. The test matrix for the medium-duty fryers is shown in Table 4 and the setup illustrated in Figure 7.

Table 4. Fryer (Medium-Duty Appliance) Test Matrix

Test #	LH Appliance	LH Appliance Effective Front Overhang[1] [in.]	LH Appliance Effective Rear Gap [in.]	CTR Appliance	CTR Appliance Effective Front Overhang[1] [in.]	CTR Appliance Effective Rear Gap [in.]	RH Appliance	RH Appliance Effective Front Overhang[1] [in.]	RH Appliance Effective Rear Gap [in.]	Side Panels or Side Capture Jets[2]	Side Overhang [in.]
4	2-Vat Fryer	22	4	2-Vat Fryer	22	4	2-Vat Fryer	22	4	CJ	6
5	2-Vat Fryer	22	4	2-Vat Fryer	22	4	2-Vat Fryer	22	4	SP	6

[1]Front overhang measured from front of hood to front of appliance
[2]All tests conducted with front Capture Jet on

Figure 7. Medium-Duty Gas Fryer Line

Full-Size Convection Oven (Light-Duty) Test Matrix

The light-duty test matrix consisted of one full-size electric convection oven and two full size gas convection ovens. As the electric oven idled, the gas ovens maintained the same operating temperature, and then the burners were turned off during the capture and containment evaluation [Ref 2]. The front overhang was 12.0 inches. In this configuration, the left oven had 4.0 inches between the convection motor and the back wall, the center oven had 1.0 inch between the motor and the back wall, and the right oven was flush against the back wall. The rear gap was measured from the rear of the convection fan motor to the back wall, except for the right oven that had its motor shrouded. The hood performance was tested with either side panels (SP) or side Capture Jets™ (CJ). They were tested in a static (no operator movement) condition. The test matrix for the full-size ovens is shown in Table 5 and the setup illustrated in Figure 8.

Table 5. Full-Size Convection Oven (Light-Duty) Test Matrix

Test #	LH Appliance	LH Appliance Effective Front Overhang[1] [in.]	LH Appliance Effective Rear Gap [in.]	CTR Appliance	CTR Appliance Effective Front Overhang [in.][1]	CTR Appliance Effective Rear Gap [in.]	RH Appliance	RH Appliance Effective Front Overhang[1] [in.]	RH Appliance Effective Rear Gap [in.]	Side Panels or Side Capture Jets[2]	Side Overhang [in.]
6	Oven	12	4	Oven	12	1	Oven	12	0	CJ	0
7	Oven	12	4	Oven	12	1	Oven	12	0	SP	0

[1]Front overhang measured from front of hood to front of appliance
[2]All tests conducted with front Capture Jet on

Figure 8. Light-Duty Full Size Convection Oven Line

2-Vat Fryer/Broiler or Griddle/Convection Oven (Combination-Duty) Test Matrix

The combination duty test matrix consisted of the 2-vat fryer in the left position, the 3-foot underfired broiler in the center position and the full size convection oven in the right position. The hood performance was tested with either side panels (SP) or side Capture Jets™ (CJ). They were tested in a static (no operator movement) condition, except for Test 10. For this test, hood performance was evaluated using a walk-by protocol. In Test 11 and 12, the broiler was replaced with a griddle. The test matrix for the combination-duty appliance line is shown in Table 6 and the setup illustrated in Figure 9.

Table 6. Fryer/Broiler/Convection Oven (Combination Duty) Test Matrix

Test #	LH Appliance	LH Appliance Effective Front Overhang[1] [in.]	LH Appliance Effective Rear Gap [in.]	CTR Appliance	CTR Appliance Effective Front Overhang[1] [in.]	CTR Appliance Effective Rear Gap [in.]	RH Appliance	RH Appliance Effective Front Overhang[1] [in.]	RH Appliance Effective Rear Gap [in.]	Side Panels or Side Capture Jets[2]	Side Overhang [in.]
8	2-Vat Fryer	22	4	Broiler	18	5	Oven	12	1	CJ	6
9	2-Vat Fryer	22	4	Broiler	18	5	Oven	12	1	SP	6
10[2]	2-Vat Fryer	22	4	Broiler	18	5	Oven	12	1	SP	6
11[3]	2-Vat Fryer	22	4	Griddle	12	5	Oven	12	1	CJ	6
12	2-Vat Fryer	22	4	Griddle	12	5	Oven	12	1	SP	6

[1]Front overhang measured from front of hood to front of appliance
[2]All tests conducted with front Capture Jet on
[3]Test condition was conducted with "walk-by" protocol.

Figure 9. Fryer/Broiler/Convection Oven Appliance Line

Results and Discussion

The capture and containment (C&C) results are presented below for the different appliance-line configurations.

Broiler (Heavy-Duty) Testing

The results of the broiler-line capture and containment testing are presented in Table 7. It was found that the exhaust rate required to capture and contain the thermal challenge from three broilers was 2500 cfm when utilizing the canopy hood that incorporated the Capture Jet™ technology along both sides (in addition to the front edge). When the hood was used with side panels (without Capture Jet™ technology along both sides), the threshold airflow rate for C&C reduced to 2200 cfm. When the rear gap between the broiler cabinet and backwall was sealed, the C&C exhaust rate was reduced even further to 1900 cfm (190 cfm/ft).

Table 7. Capture and Containment Results for Broilers

Test #	LH Appliance	LH Appliance Effective Front Overhang[1] [in.]	CTR Appliance	CTR Appliance Effective Front Overhang[1] [in.]	RH Appliance	RH Appliance Effective Front Overhang[1] [in.]	Side Panels or Side Capture Jets[2]	Side Overhang [in.]	C&C Exhaust Rate [acfm]	C&C Exhaust Rate [acfm/ft]
1	Broiler	18	Broiler	18	Broiler	18	CJ	6	2500	250
2	Broiler	18	Broiler	18	Broiler	18	SP	6	2200	220
3	Broiler	18	Broiler	18	Broiler	18	SP& Rear Seal	6	1900	190

[1]Front overhang measured from front of hood to front of appliance
[2]All tests conducted with front Capture Jet on

Fryer (Medium-Duty) Testing

The results of the fryer capture and containment testing are presented in Table 8. It was found that the exhaust rate required to capture and contain the three 2-vat fryers (6-vats total) was 1900 cfm, when utilizing the hood that incorporated the Capture Jet™ technology along both sides. The hood's ability to capture and contain was challenged by the strong thermal plume from the fryers' flues jetting up along the rear wall and then sideways along the rear of the hood, escaping at the rear corners. When the hood was used with side panels (without Capture Jet™ technology along both sides), the exhaust rate dropped to 1400 cfm (140 cfm/ft).

Table 8. Capture and Containment Results for Fryers

Test #	LH Appliance	LH Appliance Effective Front Overhang[1] [in.]	CTR Appliance	CTR Appliance Effective Front Overhang[1] [in.]	RH Appliance	RH Appliance Effective Front Overhang[1] [in.]	Side Panels or Side Capture Jets[2]	Side Overhang [in.]	C&C Exhaust Rate [acfm]	C&C Exhaust Rate [acfm/ft]
4	2-Vat Fryer	22	2-Vat Fryer	22	2-Vat Fryer	22	CJ	6	1900	190
5	2-Vat Fryer	22	2-Vat Fryer	22	2-Vat Fryer	22	SP	6	1400	140

[1]Front overhang measured from front of hood to front of appliance
[2]All tests conducted with front Capture Jet on

Full-Size Convection Oven (Light Duty) Testing

The results of the full-size convection oven testing are presented in Table 9. It was found that the exhaust rate required to capture and contain three full-size convection ovens without side panels was 1000 cfm when utilizing the hood that incorporated the Capture Jet™ technology along both sides. When the hood was used with side panels (without Capture Jet™ technology along both sides), the C&C exhaust rate was 1100 cfm (110 cfm/ft).

Table 9. Capture and Containment Results Full-Size Convection Ovens

Test #	LH Appliance	LH Appliance Effective Front Overhang[1] [in.]	CTR Appliance	CTR Appliance Effective Front Overhang [in.]	RH Appliance	RH Appliance Effective Front Overhang[1] [in.]	Side Panels or Side Capture Jets2	Side Overhang [in.]	C&C Exhaust Rate [acfm]	C&C Exhaust Rate [acfm/ft]
6	Oven	12	Oven	12	Oven	12	CJ	0	1000	100
7	Oven	12	Oven	12	Oven	12	SP	0	1100	110

[1]Front overhang measured from front of hood to front of appliance
[2]All tests conducted with front Capture Jet on

Fryer/Broiler or Griddle/Convection Oven (Combination-Duty) Testing

The results for the 2-vat fryer/3-foot broiler/full-size convection oven capture and containment tests are presented in Table 10. All evaluations were conducted at a static condition except for test 10 that incorporated a walk-by protocol. Test 11 and 12 were conducted with a griddle in place of the broiler.

The exhaust rate required to capture and contain a 2-vat fryer/3-foot broiler/full-size convection oven cook line was 1800 cfm when utilizing the hood that incorporated the Capture Jet™ technology along both sides (in addition to the front edge). The hood's capture and containment performance was challenged by the aggressive plume from the fryers' flues that would escape at the left rear corner of the hood. When the hood was used with side panels (without Capture Jet™ technology along both sides) the exhaust rate was 1600 cfm (160 cfm/ft).

Table 10. Capture and Containment Results for 2-Vat Fryer / Broiler or Griddle/ Full-Size Convection Oven Appliance Line

Test #	LH Appliance	LH Appliance Effective Front Overhang[1] [in.]	CTR Appliance	CTR Appliance Effective Front Overhang [in.]	RH Appliance	RH Appliance Effective Front Overhang[1] [in.]	Side Panels or Side Capture Jets[2]	Side Overhang [in.]	C&C Exhaust Rate [acfm]	C&C Exhaust Rate [acfm/ft]
8	2-Vat Fryer	22	Broiler	18	Oven	12	CJ	6	1800	180
9	2-Vat Fryer	22	Broiler	18	Oven	12	SP	6	1600	160
10[3]	2-Vat Fryer	22	Broiler	18	Oven	12	SP	6	2200	220
11	2-Vat Fryer	22	Griddle	12	Oven	12	CJ	6	1400	140
12	2-Vat Fryer	22	Griddle	12	Oven	12	SP	6	1400	140

[1]Front overhang measured from front of hood to front of appliance
[2]All tests conducted with front Capture Jet on
[3]Test condition was conducted with "walk-by" protocol.

A walk-by evaluation was conducted for the combination duty line with side panels. The increase in exhaust flow rate required to capture and contain the dynamically disturbed thermal plume was 2200 cfm (600 cfm higher than the static condition).

The combination-duty appliance line was also evaluated with a griddle replacing the broiler in the center position. When utilizing the Capture Jet™ technology along both sides (in addition to the front edge), the measured C&C exhaust rate was 1400 cfm. With side panels, the C&C exhaust rate was the same at 1400 cfm (140 cfm/ft).

Static Pressure Differential Measured at Exhaust Collar

The static pressure drop between the laboratory and the exhaust collar was measured for five exhaust flow rates. The pressure drop across the hood ranged from 0.30 in. of water at 1500 cfm to 1.50 in. of water at 3300 cfm. At 2500 cfm the pressure drop was 0.87 in. of water. The results are presented in Table 11.

Table 11. Hood Static Pressure Readings at Exhaust Collar

Exhaust Flow Rate [acfm]	Hood Static Pressure at Exhaust Collar [inches of water]
1500	0.30
2000	0.54
2500	0.87
3000	1.24
3300	1.50

Figure 10 presents the static pressure versus airflow curve. The data were a very good fit, reflecting a typical pressure versus airflow relationship.

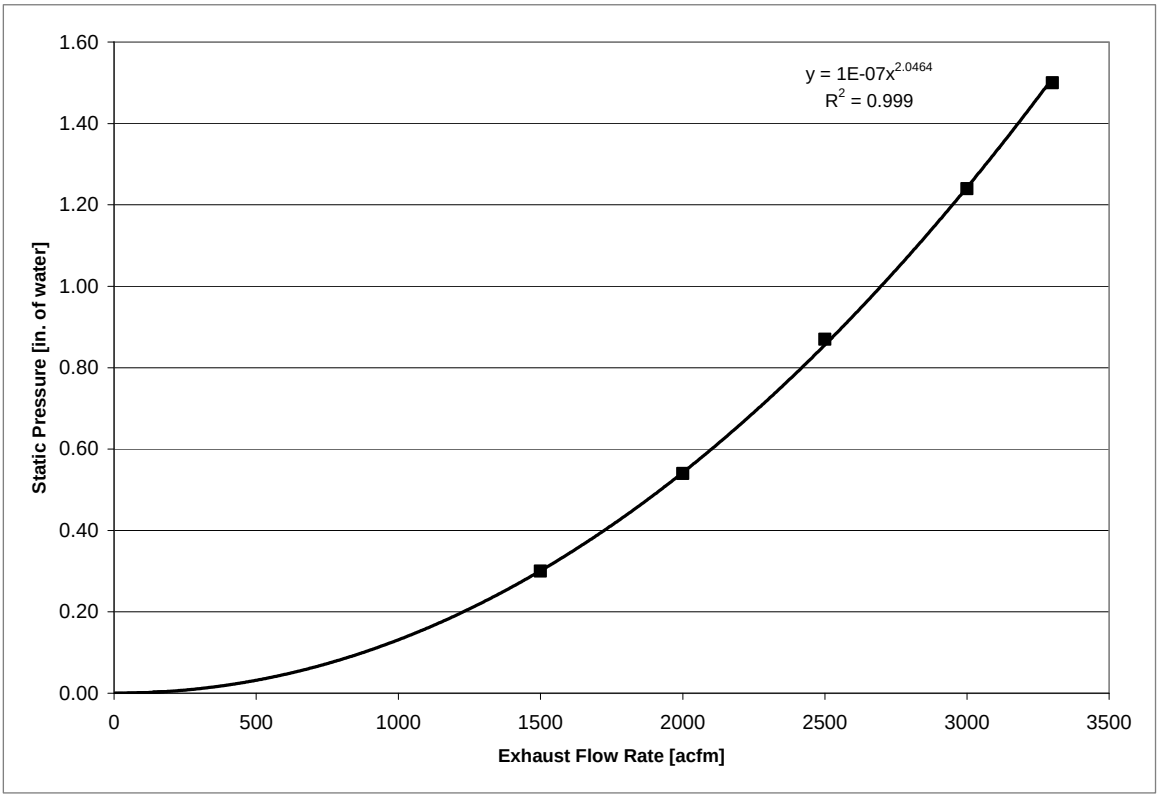


Figure 10. Static Pressure Differential Measured at the Exhaust Collar

Filter Face Velocity Testing

Filter face velocity readings were taken for each of the six filters at two exhaust flow rates. For the 2000 cfm exhaust rate, the filter velocities ranged from 168 to 199. For the 3000 cfm exhaust rate, the filter velocities ranged from 230 to 276 fpm. The data are presented in Table 12 and a velocity profile is shown in Figure 11.

Table 12. Filter Face Velocity Readings

Exhaust Flow Rate [acfm]	Left Filter #1 Velocity [fpm]	Filter #2 Velocity [fpm]	Filter #3 Velocity [fpm]	Filter #4 Velocity [fpm]	Filter #5 Velocity [fpm]	Right Filter #6 Velocity [fpm]	Avg. Filter Velocity [fpm]	Standard Deviation [fpm]	Standard Deviation [%]
2000	187	193	199	199	191	168	190	12	6
3000	256	258	274	276	253	230	258	17	6

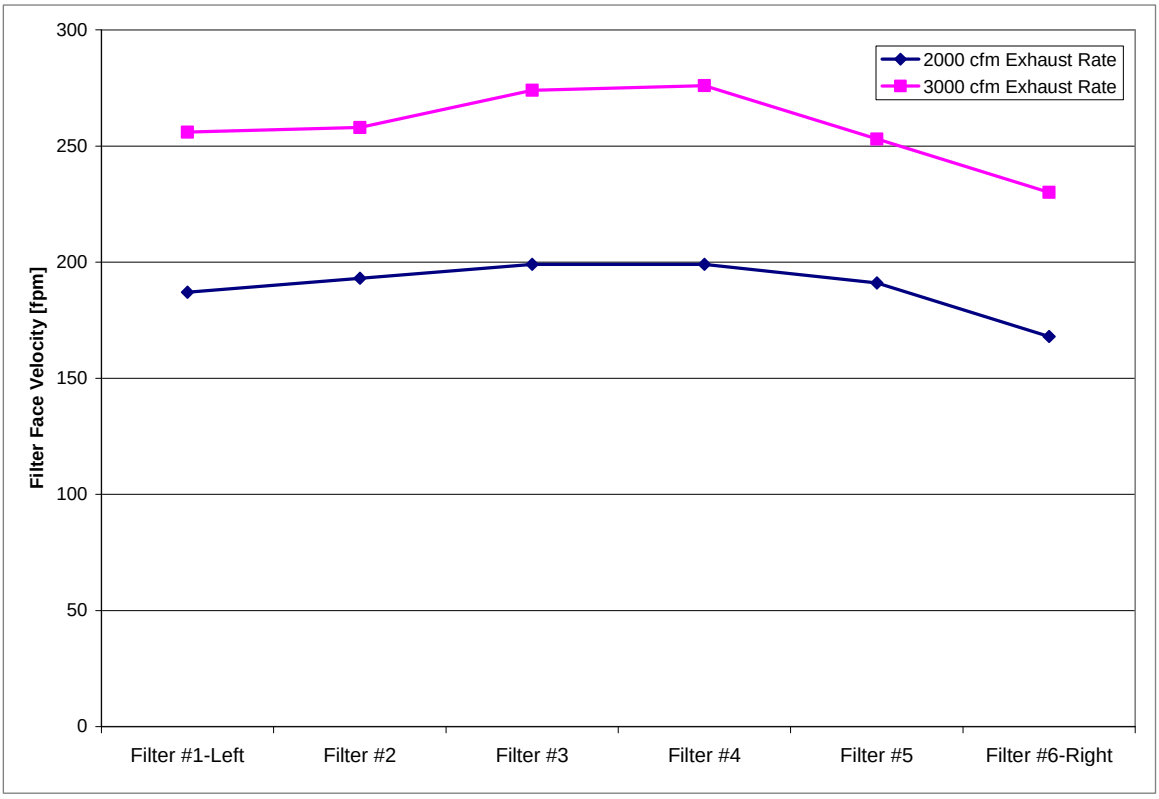


Figure 11. Filter Face Velocity Profiles

For both exhaust rates, the profiles show that the velocity was at a maximum in the center of the hood (below the exhaust collar) and a minimum towards the ends. For the 2000 cfm exhaust rate, the average filter velocity was 190 fpm. The velocity increased to 199 fpm near the exhaust collar and dropped to 168 fpm at the right end filter. For the 3000 cfm rate, the average filter velocity was 258 fpm, with a center velocity of 276 fpm and an end velocity of 230 fpm.

Summary of Results and Conclusions

Figure 12 and Table 13 summarize the results for the capture and containment testing. The test numbers in Figure 12 refer to the first column of Table 13 and associated test condition. Overall, the capture and containment airflow rates ranged from a low of 1000 cfm (100 cfm/ft) to a high of 2500 cfm (250 cfm/ft).

The benefit of side panels was demonstrated for all appliance combinations tested except the oven line and combination line with griddle. With the 50-inch x 50-inch x 45-degree panel installed on both ends of the 10-foot, wall mounted Halton KVE hood, the capture and containment flow rate was 2200 cfm (220 cfm/ft) for the three broilers. When a rear shield was installed between the rear of the appliance and the back wall, the capture and containment flow rate dropped to 1900 cfm (190 cfm/ft). Based on testing experience of the CKV research team and data from the ASHRAE study [Ref 2], this is considered to be a very low threshold of C&C for a heavy-duty appliance challenge.

The multi-duty line was incorporated with the test matrix to reflect a cooking equipment challenge in a real-world, casual dining kitchen. In this case, the capture and containment rate was 1800 cfm for a hood utilizing the Capture Jet™ technology on both sides (in addition to the front edge). When the side panels were installed on a hood without the Capture Jet™ technology on both sides, the exhaust flow rate dropped to 1600 cfm (160 cfm/ft). When the griddle was substituted for the broiler under static test conditions, a capture and containment rate of 1400 cfm (140 cfm/ft) was recorded. Under the dynamic walk-by condition for the multi-duty line with the broiler, the capture and containment exhaust rate for the original hood with side panels increased to 2200 cfm (220 cfm/ft). Based on the experience of the CKV/FSTC research team, this exhaust rate is believed to be the representative design rate for a multi-duty appliance line.

The static pressure differential measured at the exhaust collar, varied from 0.30 to 1.24 in. of water between 1500 to 3000 cfm of exhaust airflow. At 2500 cfm (250 cfm/ft) the measured static pressure difference was 0.87 in. of water.

The measured filter velocities across the length of the exhaust hood showed a 6% standard deviation from the average measured velocity.

Table 13. Summary of Capture and Containment Results

Test #	LH Appliance	LH Appliance Effective Front Overhang[1] [in.]	LH Appliance Effective Rear Gap [in.]	CTR Appliance	CTR Appliance Effective Front Overhang[1] [in.]	CTR Appliance Effective Rear Gap [in.]	RH Appliance	RH Appliance Effective Front Overhang[1] [in.]	RH Appliance Effective Rear Gap [in.]	Side Panels or Side Capture Jets[2]	Side Overhang [in.]	C&C Exhaust Rate [cfm]
1	Broiler	18	5	Broiler	18	5	Broiler	18	5	CJ	6	2500
2	Broiler	18	5	Broiler	18	5	Broiler	18	5	SP	6	2200
3	Broiler	18	5	Broiler	18	5	Broiler	18	5	SP & Rear Seal	6	1900
4	2-Vat Fryer	22	4	2-Vat Fryer	22	4	2-Vat Fryer	22	4	CJ	6	1900
5	2-Vat Fryer	22	4	2-Vat Fryer	22	4	2-Vat Fryer	22	4	SP	6	1400
6	Oven	12	4	Oven	12	1	Oven	12	0	CJ	0	1000
7	Oven	12	4	Oven	12	1	Oven	12	0	SP	0	1100
8	2-Vat Fryer	22	4	Broiler	18	5	Oven	12	1	CJ	6	1800
9	2-Vat Fryer	22	4	Broiler	18	5	Oven	12	1	SP	6	1600
10[3]	2-Vat Fryer	22	4	Broiler	18	5	Oven	12	1	SP	6	2200
11	2-Vat Fryer	22	4	Griddle	12	5	Oven	12	1	CJ	6	1400
12	2-Vat Fryer	22	4	Griddle	12	5	Oven	12	1	SP	6	1400

[1]Front overhang measured from front of hood to front of appliance
[2]All tests conducted with front Capture Jet on and with side panels or side Capture Jet on
[3]Test condition was conducted with "walk-by" protocol.

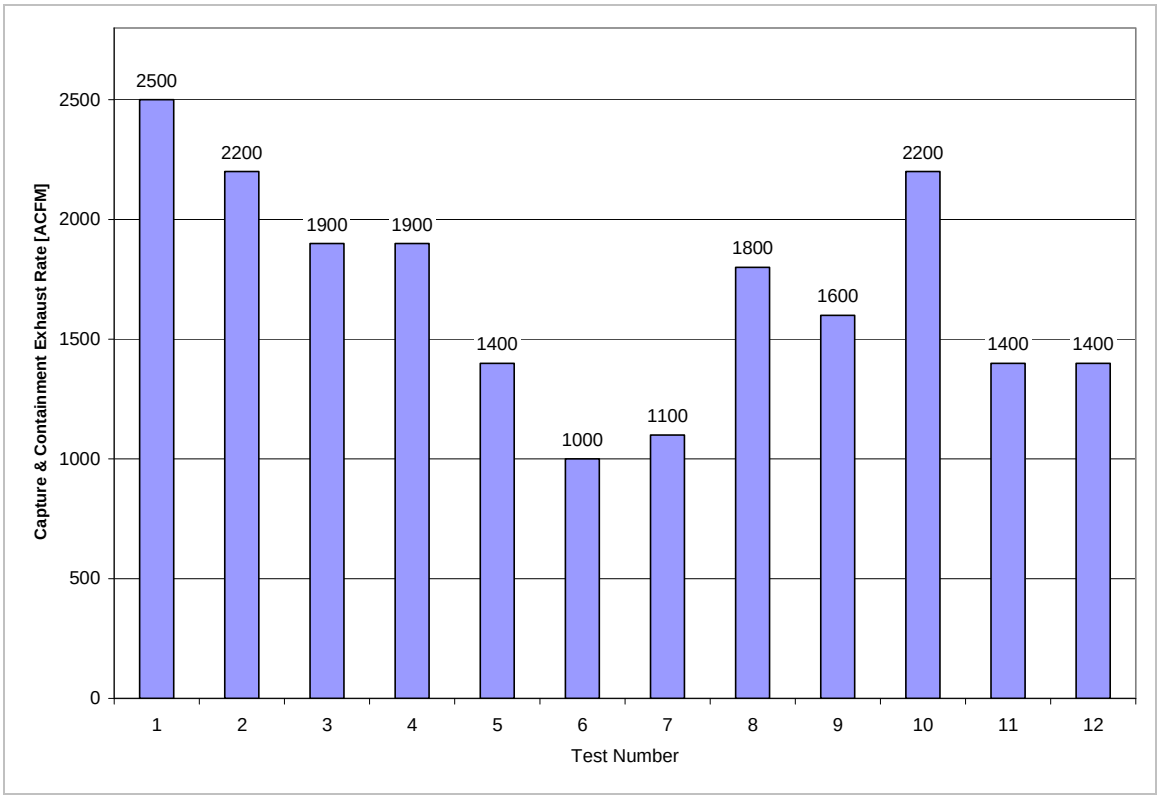


Figure 12. Summary of Capture and Containment Results

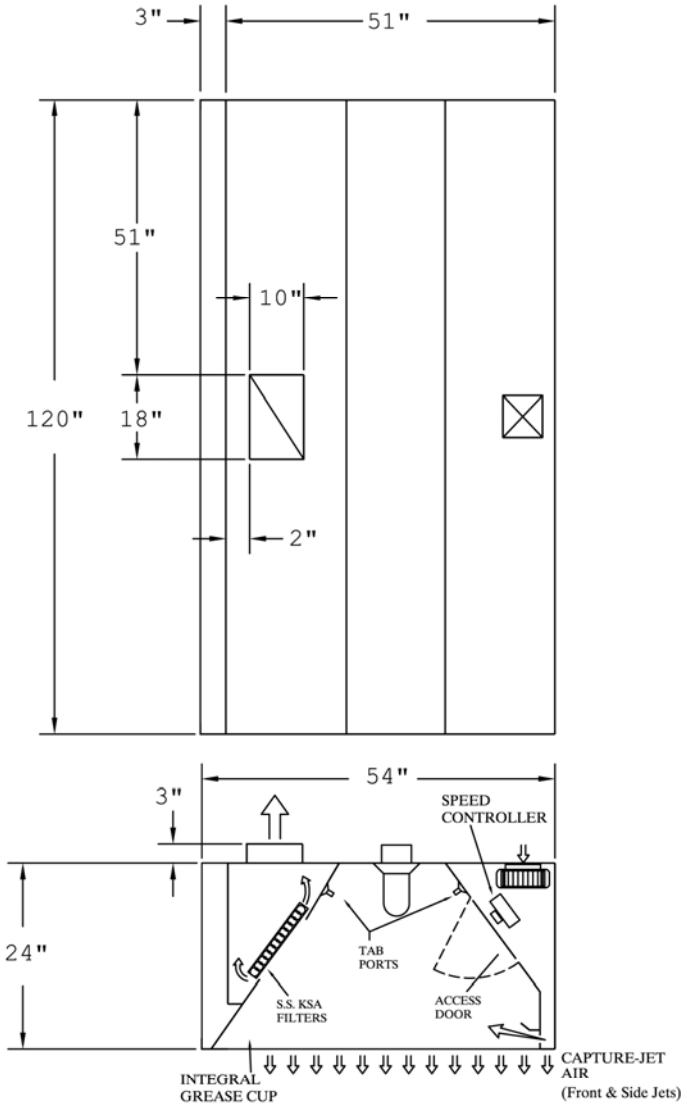
References

1. ASTM 2005. ASTM Designation F1704-05, *Capture and containment performance of commercial kitchen exhaust ventilation systems.* West Conshohocken, PA.
2. Swierczyna, R.T., P.A. Sobiski, D. Fisher. 2005. *1202-RP Effect of appliance diversity and position on commercial kitchen hood performance.* ASHRAE, Atlanta, GA.
3. Brohard, G., D.R. Fisher PE, V.A. Smith PE, R.T. Swierczyna, P.A. Sobiski. 2003. *Makeup air effects on kitchen exhaust hood performance.* California Energy Commission, Sacramento, CA.
4. Air Movement and Control Association, Inc. and American Society of Heating, Refrigeration, and Air Conditioning Engineers, Inc. *Laboratory methods of testing fans for rating.* AMCA Standard 210/ASHRAE Standard 51, Arlington Heights, IL and Atlanta, GA.
5. ASTM 2005. ASTM Designation F1496, *Standard test method for performance of convection ovens*. West Conshohocken, PA.
6. ASTM 2005. ASTM Designation F1361, *Standard test method for performance of open deep fat fryers*. West Conshohocken, PA.
7. ASTM 2003. ASTM Designation F1275, *Standard test method for performance of griddles*. West Conshohocken, PA.
8. ASTM 2003. ASTM Designation F1695, *Standard test method for performance of underfired broilers*. West Conshohocken, PA.

Appendix A: Halton KVE Hood Schematic

MODEL: KVE

* FACTORY MUST BE ADVISED OF ANY SPECIAL REQUIREMENTS OF THE "AUTHORITY HAVING JURISDICTION" AT TIME OF QUOTE



DATE	DWG. NO.	ITEM NO.	EXHAUST AIR INFORMATION*		
10/24/05			CFM	T.A.B.	DP
PROJECT:					
LOCATION:			CAPTURE AIR INFORMATION		
			CFM	T.A.B.	
SUBMITTED BY: HALTON CO.					

4114

STANDARD FEATURES	
S.S. FILTERS (KSA)	6
INCANDESCENT LIGHTS	4
Capture-Jets (front/sides)	*
STAND-OFF	*

OPTIONS	
FLUORESCENT LIGHTS	
SWITCH PANEL	
FIRE PROTECTION	
LISTED W/O EXHAUST DAMPER	*
SIDE SKIRTS	
CEILING CLOSURE	
STD. BACKSPLASH	
INSULATED BACKSPLASH	
STAND-OFF	
APPLIANCE INTERLOCK	

MATERIAL	
EXPOSED SURFACES 18 GA. 304 S.S.	*
ALL 18 GA. 304 S.S.	

COMMENTS:

ETL LISTED US — COMPLIES WITH LATEST NFPA-96 — NSF

Halton
CARE FOR INDOOR AIR