IN-DEPTH SURVEY REPORT:
EVALUATION OF VENTILATION AND FILTRATION SYSTEM FOR LMDS AND DPRC

at

United States Postal Service
Processing and Distribution Center
Cincinnati, Ohio

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REPORT DATE:
May 2005

REPORT NO:
279-21a

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SITE SURVEYED:	USPS Processing and Distribution Center, Cincinnati, Ohio
SIC CODE:	4311
SURVEY DATES:	March 21-22, 2005
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ABSTRACT

Researchers from the National Institute for Occupational Safety and Health (NIOSH) conducted an evaluation of the Ventilation/Filtration System (VFS) developed for the United States Postal Service (USPS) mail processing equipment – the Loose Mail distribution System (LMDS) and Dual Pass Rough Cull (DPRC). The VFS was developed and installed by a private contractor hired by the USPS to reduce the potential for employee exposure to harmful substances that could be contained in mail pieces processed by the equipment. NIOSH was asked to assist the USPS in evaluating controls for this and other mail processing equipment after the 2001 terrorist attacks that used the mail as a delivery system for anthrax.

Evaluations were based on a variety of tests including tracer gas (TG) experiments, air velocity measurements and smoke release observations. All three tests were made to evaluate contaminant capture efficiency of the VFS at the New Universal "Dump Into" Hamper Dumper Hoods for the DPRC and showed that the system meets or exceeds minimum USPS contaminant capture requirements in this area. However, only TG experiments and smoke release observations were made at the New Universal "Dump Into" Hamper Dumper Hood for the LMDS since the final configuration of the VFS hood was not in place. It is recommended that a full analysis including smoke release observations, TG experimentation and air velocity measurements be made at the New Universal "Dump Into" Hamper Dumper Hood for the LMDS when the final configuration is implemented.

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH) is located in the Centers for Disease Control and Prevention (CDC), within the Department of Health and Human Services. NIOSH was established in 1970 by the Occupational Safety and Health Act at the same time that the Occupational Safety and Health Administration (OSHA) was established in the Department of Labor (DOL). The OSHAct legislation mandated NIOSH to conduct research and education programs separate from the standard-setting and enforcement functions conducted by OSHA. An important area of NIOSH research deals with methods for controlling occupational exposure to potential chemical and physical hazards.

The Engineering and Physical Hazards Branch (EPHB) of the Division of Applied Research and Technology (DART) has been given the lead within NIOSH to study and develop engineering controls and assess their impact on reducing occupational illness. Since 1976, EPHB (and its forerunner, the Engineering Control and Technology Branch) has conducted a large number of studies to evaluate engineering control technology based on industry, process, or control techniques. The objective of each of these studies has been to evaluate and document control techniques and to determine the effectiveness of the control techniques in reducing potential health hazards in an industry or for a specific process.

Researchers from NIOSH were requested to assist the USPS in the evaluation of contaminant controls for various mail processing equipment. These new controls are being installed to significantly reduce operator exposure to any potentially hazardous contaminants emitted from mail pieces during normal mail processing. This effort is driven by the 2001 terrorist attacks which used the mail as a delivery system for anthrax. NIOSH researchers have subsequently made several trips to postal facilities in the Washington, DC area and in Ohio to observe mail processing equipment in operation and to study the effectiveness of the newly designed controls.

The control evaluated in this report is a production model ventilation/filtration system (VFS) for the New Universal "Dump Into" Hamper Dumper Hoods on the Loose Mail Distribution System (LMDS) and the Dual Pass Rough Cull (DPRC) units. This control was designed and installed by a USPS contractor to significantly reduce the potential for operator exposure to bacterial contaminants that could be contained in mail pieces processed by this equipment. This system was evaluated at the Cincinnati, Ohio Processing and Distribution Center (P&DC) during a field survey that took place on March 21 and 22, 2005.

DESCRIPTION OF EQUIPMENT

The USPS 010 Culling System is comprised of two conveyor systems that size the collection mail brought to the P&DC into letters, flats (magazine size), and parcels. The first system is called the Dual Pass Rough Cull and the second is the Loose Mail Distribution System. The hampers of raw mail are loaded into the DPRC and LMDS. Flats and parcels are separated from the letter mail and sent to the appropriate areas of the facility for processing. The output of the LMDS sends letter mail to the next stage in its processing which is the cancellation equipment.

At the time of evaluation, the VFS for the 010 Culling System consisted of two separate air-handling/filtration units that provided exhaust for various locations of possible contaminant release. Air-handling Unit # 1 processed about 18,176 cubic feet per minute (cfm) which represented dirty filter conditions for the VFS. Air-Handling Unit # 2 processed about the same flow rate and serviced the primary areas of the DPRC. Each of these air-handling units was fitted with three stages of filtration composed of a pre-filter, a MERV 14 filter and a High Efficiency Particulate Air (HEPA) filter.

METHODS

In general, experimentation was performed with 2 different airflows through the air handling units:

1) Under "dirty filter" conditions (approx. 18,176 cfm). This airflow was set by the VFS manufacturer to simulate typical performance of the VFS when the filters are dirty.

2) Airflows further reduced by about 25% (approx. 13,632 cfm). This airflow was set by the VFS manufacturer to determine if the VFS airflow could be further reduced and still provide adequate worker protection from possible contaminants.

TRACER GAS

Apparatus

To quantitatively evaluate the capture efficiency of the ventilation system, a tracer gas method was used. The gas, CP sulfur hexafluoride (SF_6), was released at a constant rate at points in and near the sorter to determine the capture efficiency of the VFS at these release points. The gas was supplied through a mass flow controller (Model 1359C-10000SV, MKS Baratron® & Control Products, Six Shattuck Road, Andover, Massachusetts, 01810) set to produce about 2 to 4 parts per million (ppm) in the exhaust outlet of the system. The exhaust from the ventilation system was filtered and then returned to the workroom near the ceiling. The concentration of the SF_6 was measured in the exhaust duct, just upstream of the filters. In order to sample this air stream uniformly, the exhaust air was drawn through a 1/4 in. diameter copper tube having six 3/32 in. diameter holes spread uniformly across the duct diameter, inserted into and perpendicular to the exhaust duct. After exiting the copper tube, the air was first filtered (HEPA Capsule Filter, Model # 12127, Gelman Sciences, Incorporated, Ann Arbor, Michigan, 48106) to remove dust, and then pulled through a MIRAN® SapphIRe Specific Vapor Analyzer (Thermo Environmental Instruments, 8 West Forge Parkway, Franklin, MA 02038), using an AirCon® high volume air sampler (Gilian Instrument Corporation, W. Caldwell, New Jersey) set for approximately 30 liters per minute, and using Tygon® tubing throughout the sampling system. After exiting the pump, the sampled air was released into the workroom. The analogue output signal from the MIRAN® was routed to a PCMCIA 12-bit analog card (Quatech Model # DAQP-12, Akron, OH) which allowed data storage and display at one-second intervals in real-time on a portable computer.

Procedures
For these measurements, the output signal from the MIRAN® was recorded at 1 second intervals. Each measurement of capture efficiency was recorded for a 2 to 4 minute interval. The MIRAN® concentration corresponding to 100% capture was measured by releasing the SF_6 directly into a duct supplying the exhaust intake in that part of the system. This measurement was made immediately before the capture efficiency measurements as well as between a number of the efficiency measurements, to detect and correct for drift in the 100% level. All of the tracer gas measurements were made with the ventilation system blower turned on. A list of the sampling sites is given in Table 1.

SMOKE RELEASE

Apparatus
A smoke machine (Mini Fogger, Model F-800, Chauvet USA, 3000 North 29th Court, Hollywood, Florida, 33020) was used to visualize air movement in and around these systems.

Procedures
By releasing smoke at points in and around the sorter with the VFS operating, the path of the smoke, and thus any airborne material released at that point, could be determined. If the smoke was captured quickly and directly by the VFS, it was a good indication of acceptable control design and performance. If the smoke was slow to be captured when released at a certain point, or took a circuitous route to the air intake for the exhaust, the VFS design was considered marginal at that point. A list of the sampling sites is given in Table 2.

CAPTURE VELOCITY

Apparatus
A hot wire anemometer was used to measure air speeds at the New Universal "Dump Into" Hamper Dumper Hood on the DPRC (Velocicalc® Plus Anemometer, Model 8388, TSI Incorporated, P.O. Box 64394, St. Paul, Minnesota, 55164). The LMDS was not assessed using this technique due to incomplete hood installment and working conditions at the time of the survey.

Procedures
To measure the velocities achieved by the control at critical points, the anemometer was held perpendicular to the flow direction at those points. Velocities were recorded at the New Universal "Dump Into" Hamper Dumper Hood locations for the DPRC system, taking measurements in the front opening of the hood and the side opening where a worker would be positioned. A list of the sampling sites is given on figures 2 and 3.

RESULTS

Tracer gas

The mass flow controller was set to produce a 2 to 4 ppm concentration of SF_6 in the ventilation system exhaust when 100% of the gas was being captured. The relative concentration in the exhaust as a result of tracer dosing at any point, which is equivalent to the capture efficiency at that point, is given in Table 1. Tracer Gas experimentation revealed that the capture efficiency of the VFS at the New Universal "Dump Into" Hamper Dumper Hoods of the DPRC and the LMDS met expected USPS standards (above 98% capture) at the two assessed locations under "dirty filter" conditions. Additionally, capture efficiency continued to meet expected standards near the location of the operator at the DPRC and LMDS after reducing the air flow (about 25% reduction) in the vicinity of the dumping location.

Smoke

Smoke release experiments were conducted under "dirty filter" conditions to visually determine how effective the VFS is at various points around the mail distribution system. Smoke testing with the New Universal "Dump Into" Hamper Dumper Hood in the up-position showed smoke escape when smoke was released against the flow. However, when evaluated with test mail, no smoke escaped with the New Universal "Dump Into" Hamper Dumper Hood in the up-position. Smoke was well controlled in most areas and was found to be effectively captured by the exhaust system (see Table 2).

Air Velocity

Air velocity measurements were taken at various locations. Most measurements met or exceeded the USPS minimum standard of 150 feet per minute (see Tables 3 through 8). Air velocity measurements are consistent with the smoke test performed for the New Universal "Dump Into" Hamper Dumper Hood on the DPRC system.

DISCUSSION

The ventilation and filtration system met or exceeded overall expectations for TG experimentation (above 98% capture efficiency) and for smoke release observations (excellent capture at all points). These good results can be explained by the large air mass that is being moved into the VFS in this area. At the DPRC system some smoke did escape when released against the flow on the conveyor belt. However, when sampled with test mail, the smoke was pulled into the VFS with no noticeable complications. The air velocity measurements were consistently above 150 fpm (goal for UPSP capture velocity) at all points, even when tested with a 25% flow reduction of regular flow characteristics.

RECOMMENDATIONS

Although VFS performance met or exceeded USPS requirements at tested locations, the final configuration of the VFS hoods at the LMDS New Universal "Dump Into" Hamper Dumper Hood was not in place at the time of the survey. Subsequently, only TG experiments and smoke release observations were made at that location. It is therefore recommended that a full analysis including smoke release observations, TG experimentation and air velocity measurements be made at the New Universal "Dump Into" Hamper Dumper Hood for the LMDS when the final configuration is implemented. In this way, the

USPS can make more certain that the final hood design meets standards designed to protect workers from airborne contamination emitted from mailpieces.

Figure 1: Schematic representation of the Ventilation and Filtration System

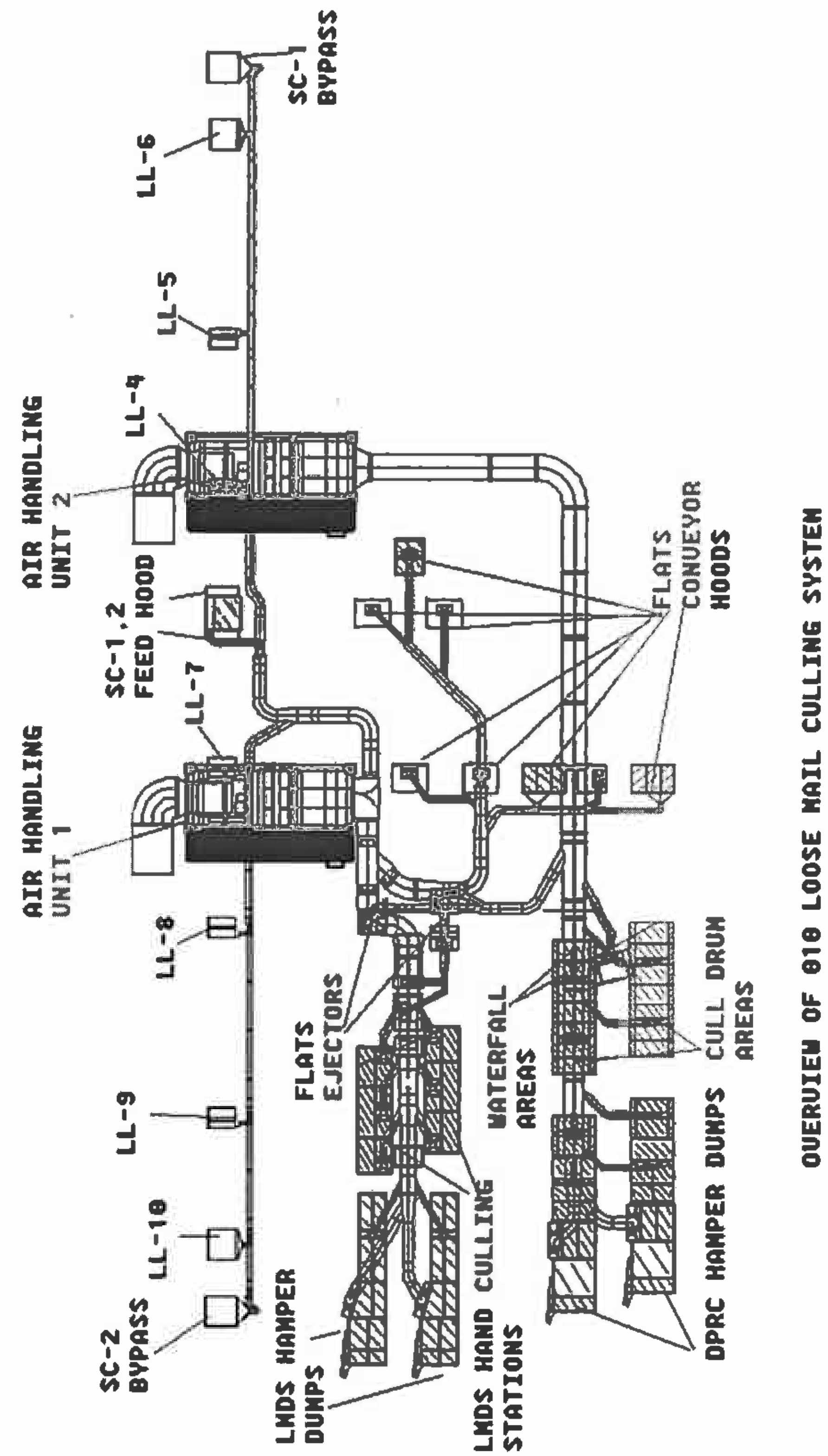

Figure 2: Sampled locations at front of the hood on the DPRC

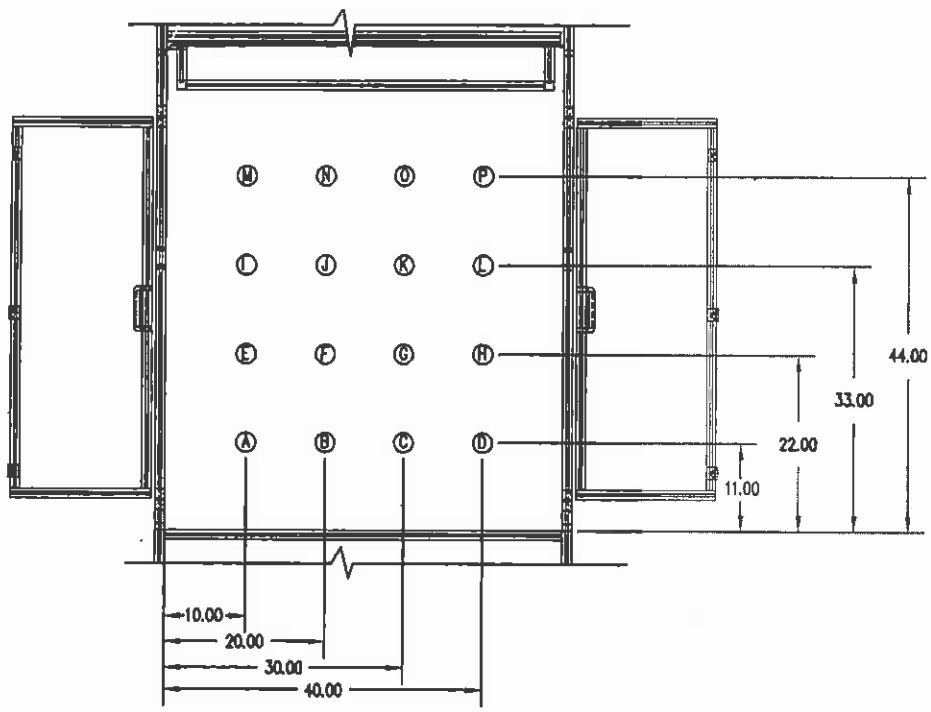

Figure 3: Sampled locations at right side of the hood on the DPRC

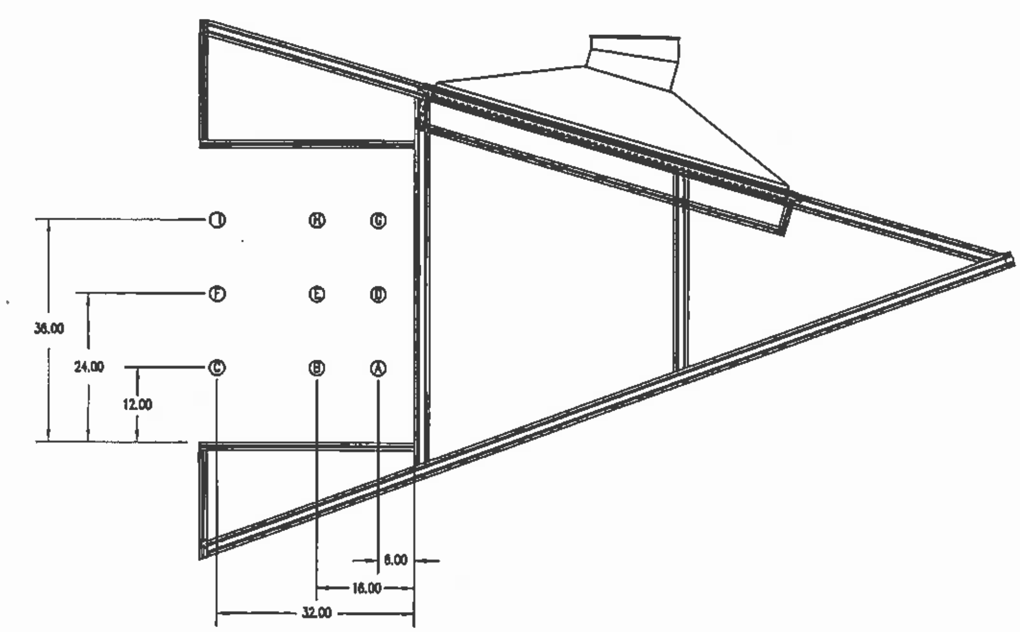

Table 1. Positions for Tracer Gas Release and Measured Efficiencies.

Description of Measurement Location	Efficiency
DPRC	
Front of the New Universal "Dump Into" Hamper Dumper Hood	>99%
Operator Side (right side of hood)	98%
LMDS	
Front of Hood	>99%
Operator Side (right side of hood) (25% airflow reduction)	>99%

Table 2. Positions for Smoke Release Observations and Comments.

AREA OF RELEASE	COMMENTS
DPRC	
Front of the New Universal "Dump Into" Hamper Dumper Hood	VERY GOOD EVACUATION OF SMOKE
Operator Side (right side of hood)	VERY GOOD EVACUATION OF SMOKE
Against flow on conveyor belt	VERY GOOD EVACUATION OF SMOKE
Outside the physical boundaries of the VFS	VERY GOOD EVACUATION OF SMOKE
LMDS	
Front of Hood	VERY GOOD EVACUATION OF SMOKE
Operator Side (right side of hood)	VERY GOOD EVACUATION OF SMOKE
Against flow on conveyor belt	VERY GOOD EVACUATION OF SMOKE
Outside the physical boundaries of the VFS	VERY GOOD EVACUATION OF SMOKE

Table 3: Air Velocity Measurements and Recorded Values for DPRC with Hamper Down and dirty filter conditions (Front of Hood)

Front Face				
Hamper dumper down & dirty filter condition				
PT.	# 1	# 2	# 3	AVG.
A	248	212	208	223
B	226	230	191	216
C	207	195	215	206
D	209	194	179	194
E	249	212	220	227
F	224	213	247	228
G	164	196	180	180
H	143	136	123	134
I	254	221	230	235
J	220	160	183	188
K	124	155	237	172
L	159	129	171	153
M	210	251	276	246
N	124	201	210	178
O	222	207	260	230
P	108	79	136	108
Average across the face =				195 fpm

Table 4: Air Velocity Measurements and Recorded Values for DPRC with Hamper Down and dirty filter conditions (Right side of Hood)

Right side face with door open				
Hamper dumper down & dirty filter condition				
PT.	# 1	# 2	# 3	AVG.
A	294	298	297	296
B	167	201	161	176
C	145	80	102	109
D	360	340	302	334
E	226	232	210	223
F	74	64	127	88
G	304	315	316	312
H	256	265	253	258
I	240	244	240	241
Average across the face =				226 fpm

Table 5: Air Velocity Measurements and Recorded Values for DPRC with Hamper Up and dirty filter conditions (Front of Hood)

Front Face				
Hamper dumper up & dirty filter condition				
PT.	# 1	# 2	# 3	AVG.
A	235	269	228	244
B	300	298	270	289
C	176	189	185	183
D	190	269	176	212
E	173	290	314	259
F	277	330	317	308
G	260	247	236	248
H	82	105	43	77
I	110	55	158	108
J	247	271	259	259
K	226	149	227	201
L	121	88	132	114
M	268	229	233	243
N	302	302	272	292
O	218	211	219	216
P	96	81	106	94
Average across the face =				209 fpm

Table 6: Air Velocity Measurements and Recorded Values for DPRC with Hamper Up and dirty filter conditions (Right side of Hood)

Right side face with door open				
Hamper dumper up & dirty filter condition				
PT.	# 1	# 2	# 3	AVG.
A	348	330	334	337
B	253	224	238	238
C	152	74	145	124
D	330	313	328	324
E	232	219	219	223
F	111	83	102	99
G	333	332	331	332
H	260	256	256	257
I	238	229	238	235
Average across the face =				241 fpm

Table 7: Air Velocity Measurements and Recorded Values for DPRC with Hamper Up and Damper changed to meet 150 fpm face velocity (Front of Hood)

Front Face				
Hamper dumper up (decreased face velocities by 25%)				
PT.	# 1	# 2	# 3	AVG.
A	165	192	209	189
B	208	161	217	195
C	166	152	124	147
D	120	120	224	155
E	123	102	106	110
F	215	208	173	199
G	106	98	113	106
H	109	103	88	100
I	114	166	70	117
J	177	163	174	171
K	127	116	111	118
L	103	112	106	107
M	210	217	208	212
N	229	212	253	231
O	207	123	123	151
P	161	82	157	133
Average across the face =				153 fpm

Table 8: Air Velocity Measurements and Recorded Values for DPRC with Hamper Up and Damper changed to meet 150 fpm face velocity (Right Side of Hood)

Right side face with door open				
Hamper dumper up (decreased face velocities by 25%)				
PT.	# 1	# 2	# 3	AVG.
A	251	209	226	229
B	148	172	187	169
C	133	107	115	118
D	246	267	240	251
E	192	180	190	187
F	128	137	67	111
G	261	257	247	255
H	196	200	189	195
I	181	177	174	177
Average across the face =				188 fpm