Thermal Evaluation Report

ELMA 8U Type 12 VME64x System

Revision History Form

Description	***Revision***	***Date***	***Engineer***
Document Creation	*1*	*6/16/2006*	*Steve Orsini*
Editorial Revisions	*2*	*9/28/2006*	*Steve Orsini*

INTRODUCTION

This report was prepared to document the results of the thermal and flow study performed for an ELMA 8U, 12-slot, Type 12 VME64x system. Simulation was performed using FloTherm 6.1 simulation software.

This simulation effort was undertaken with the primary goal of evaluating the airflow in the slots populated with the SBC, DSP and Interface Card to ensure that there is a minimum of 10cfm at all times, even with one fan failed. Of particular concern is that the cooling shall not be degraded below 10cfm if the number of circuit card assemblies in backplane slots 2 to 6 (inclusive) increases.

SIMULATION PARAMETERS

1. The ambient temperature was assumed to be 30° C.
2. Power on each circuit card was assumed to be as listed below, and distributed evenly over the surface of the circuit card.
    a. Slot 1 through 3 – Slot Air Blockers
    b. Slot 4 (Backplane Slot 1) – SBC (40 W)
    c. Slots 5 through 9 (Backplane Slots 2 through 6) – CCA's (30W each)
    d. Slot 10 (Backplane Slot 7) – Slot Air Blocker
    e. Slot 11 (Backplane Slot 8) – DSP (30 W)
    f. Slot 12 (Backplane Slot 9) – Slot Air Blocker
    g. Slot 13 (Backplane Slot 10) – Interface Card (20 W)
    h. Slots 14 & 15 (Backplane Slots 11 & 12) – Slot Air Blockers
    i. Slots 16 and 17 (Power Supply) – PSU at 80% efficiency (48W)
    j. Slots 18-21 – Slot Air Blockers
3. Each board was assumed to have an airflow restriction equivalent to a high-density signal processing card. A basic board model was created using a PCB, heat source and heat sink. The heat source was distributed evenly over the entire PCB.

4. The chassis contains four Delta FFB0912EHE-F00 fans mounted in separate, removable trays below the card cage. The suffix “-F00” indicates tachometer output option. The fans were modeled according to the manufacturer provided P-Q curves.

5. Figure 1 below shows the fan pressure and flow characteristics.

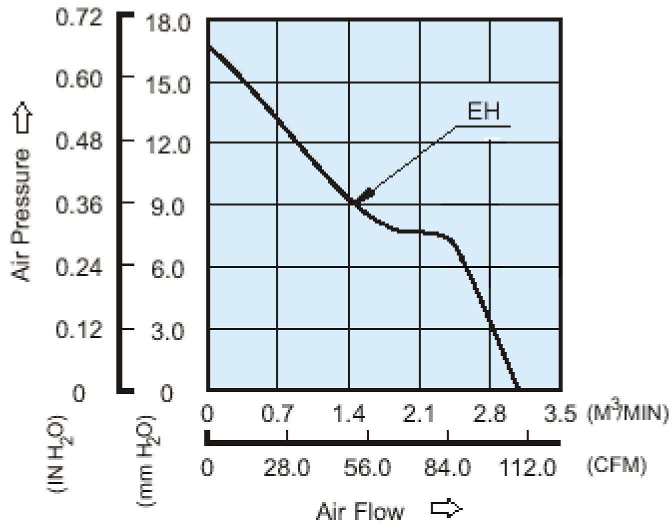


FIGURE 1 – Delta FFB0912EHE Performance Curve

6. Cooling air flow is bottom to top.

7. In total, 336 watts are being dissipated within the card cage. This includes the payload cards and power supply plus 12 watts for each fan (12V@1A).

8. An adjustable metering plate was modeled between the fan exhaust and the bottom of the card cage, allowing air flow to be regulated to each slot. The baffles for slots 4, 5, 6, 7, 8, 9, 11, 13, 16 and 17 were adjusted to maintain minimum air flow of 10cfm in each populated slot. All other baffles were modeled in the fully closed position. ***These baffles are factory preset and require no adjustment after final assembly***. Figure 2 below shows the location of the metering plate with respect to the fans.

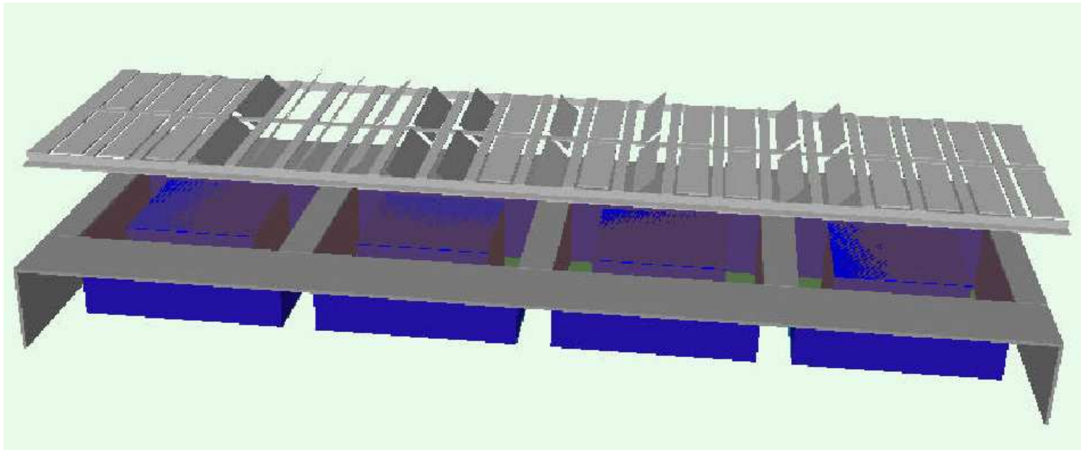


Figure 2 – Metering Plate Mounted Above Fans

9. Two temperature monitor points were located above each slot. A single monitor point was placed in the air intake for each fan. Monitor point locations are shown in Figures 3(a) and 3(b).

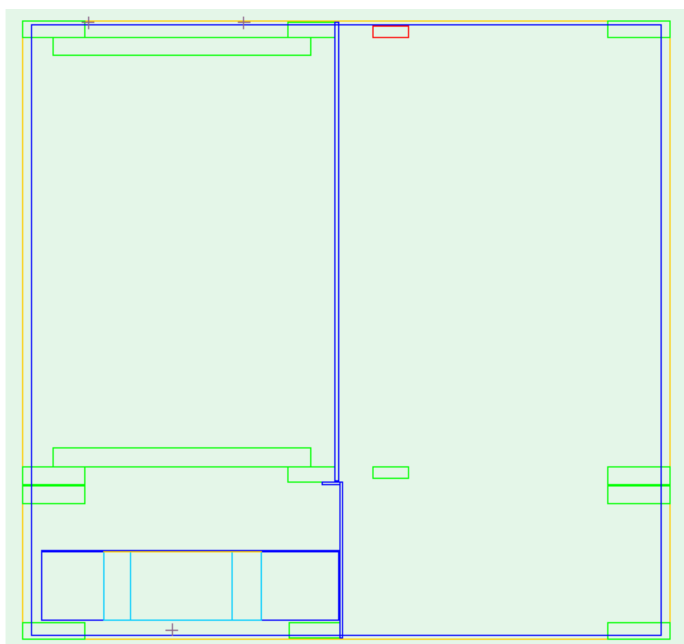


Figure 3(a) – Monitor Point Locations, Left Side View (+ = Monitor Point)

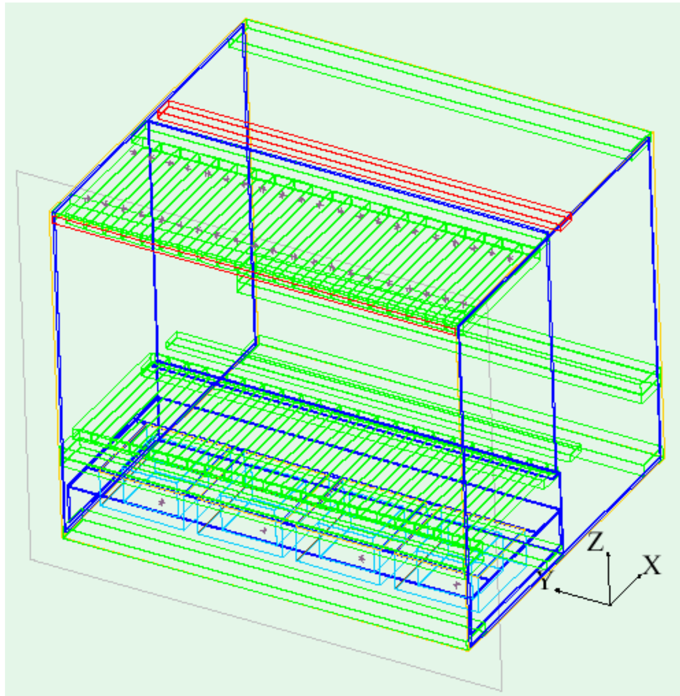


Figure 3(b) – Monitor Point Locations, Front Isometric View (+ = Monitor Point)

AIRFLOW

Figure 4 below shows the path of the cooling air flow through the system. Air intake is through the bottom of the chassis and the air exhaust is at the top of the chassis.

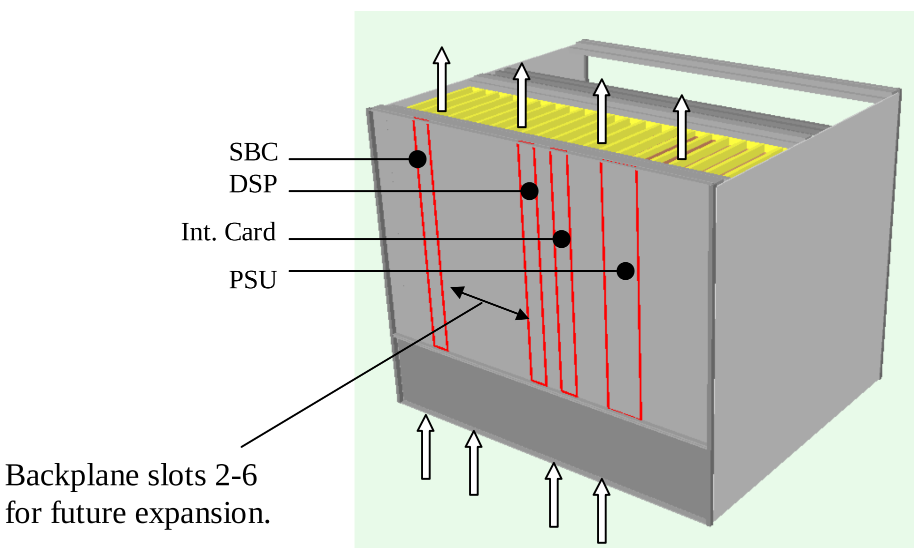


Figure 4

Summarized Results

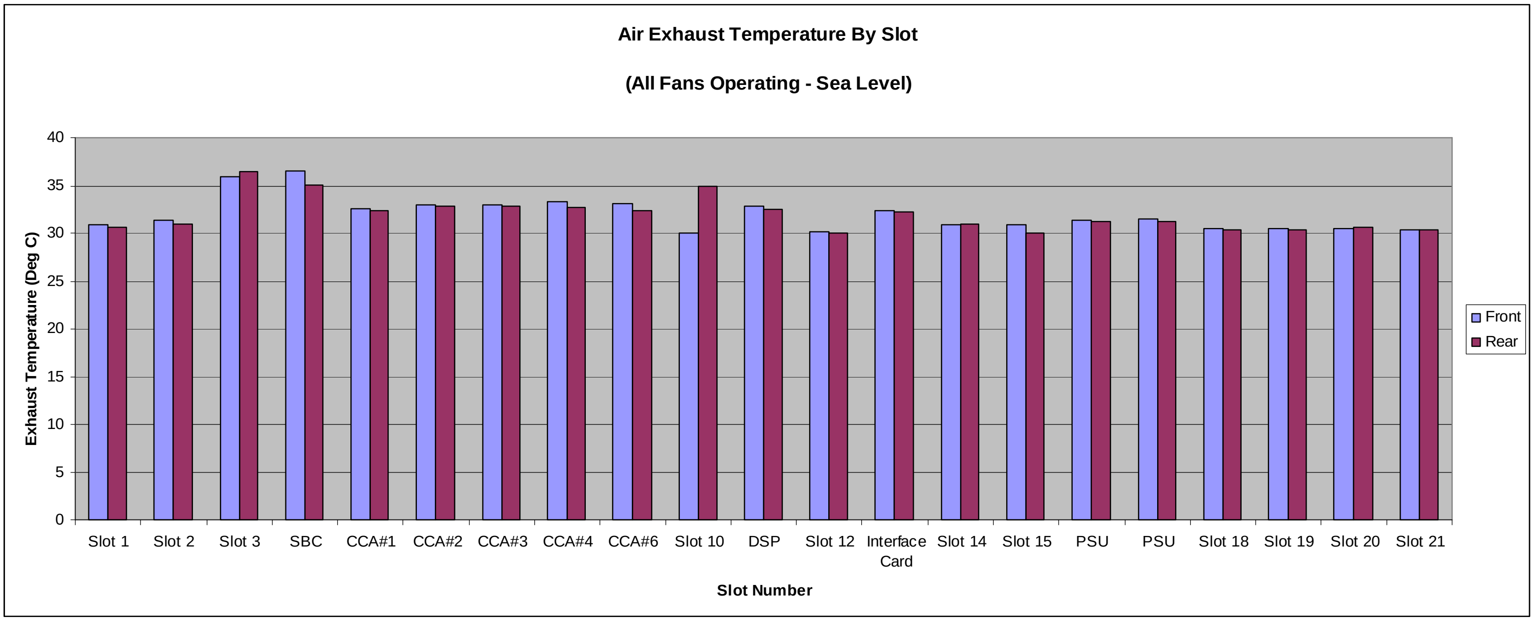
There are as many as thirty different simulation scenarios that might be realized if all possible fan operating conditions were simulated under all possible payload configurations. For this report, it was assumed that the worst case scenario would be a complete payload of cards, including an SBC, five “expansion” cards in slots 2-6, a DSP and an Interface Card. Because all of the “expansion” cards will be loaded between the SBC and the DSP on the left side of the chassis, the worst case scenarios include a failure of either the extreme left fan or the middle left fan. The results that follow show that 10 CFM per slot will be maintained at all times, even after a failure of either of these fans. It follows then that, if under the worst case conditions the minimum airflow is maintained, it could be correctly assumed that a failure of either the middle right or extreme right fans, which cool a less populated portion of the chassis, will not cause air flow to drop below 10 CFM per slot.

With all fans operating and a full complement of cards installed, the airflow is significantly more than adequate to remove the heat generated. It is interesting to note that at 10,000 feet, even though the heat removal capability of the less dense air is reduced, the overall air flow is greater than at sea level.

Detailed Results

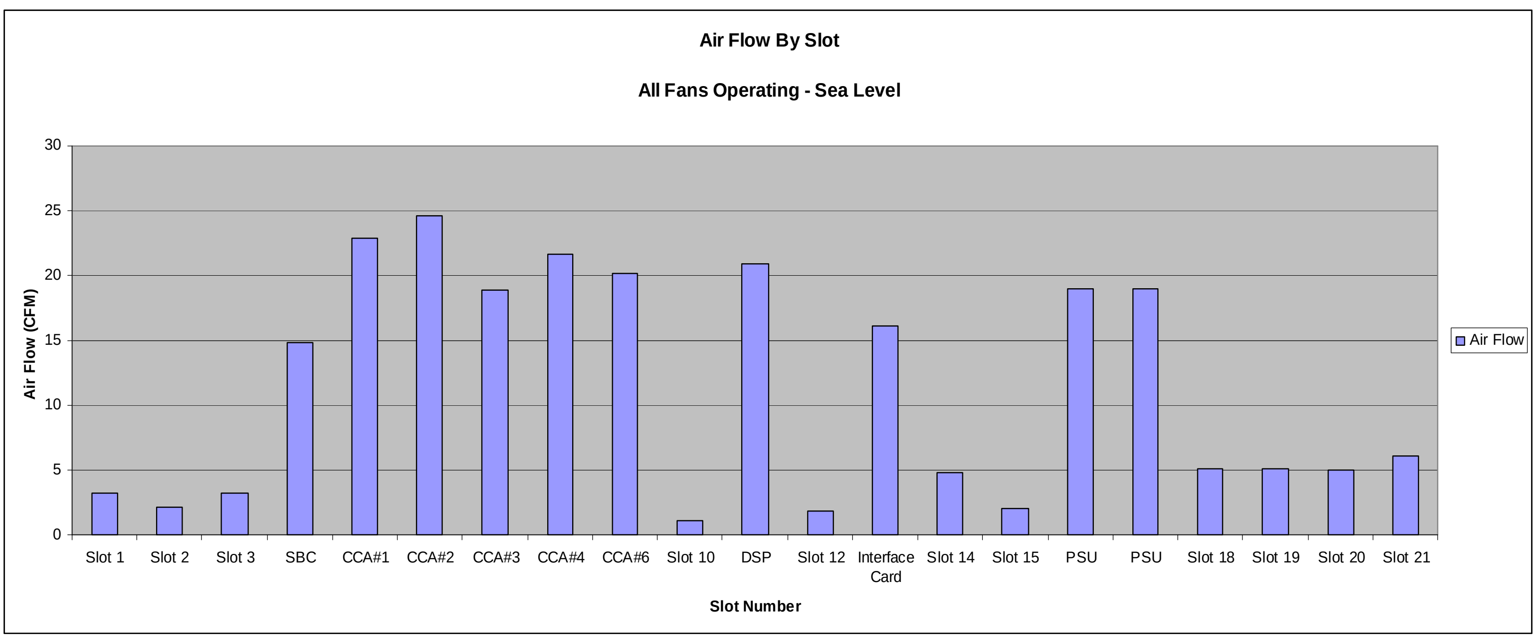
Simulation #1: All Fans Operating, 30°C Ambient, Sea Level

The graph below shows the per-slot temperature at each monitor point with all fans operating at sea level.



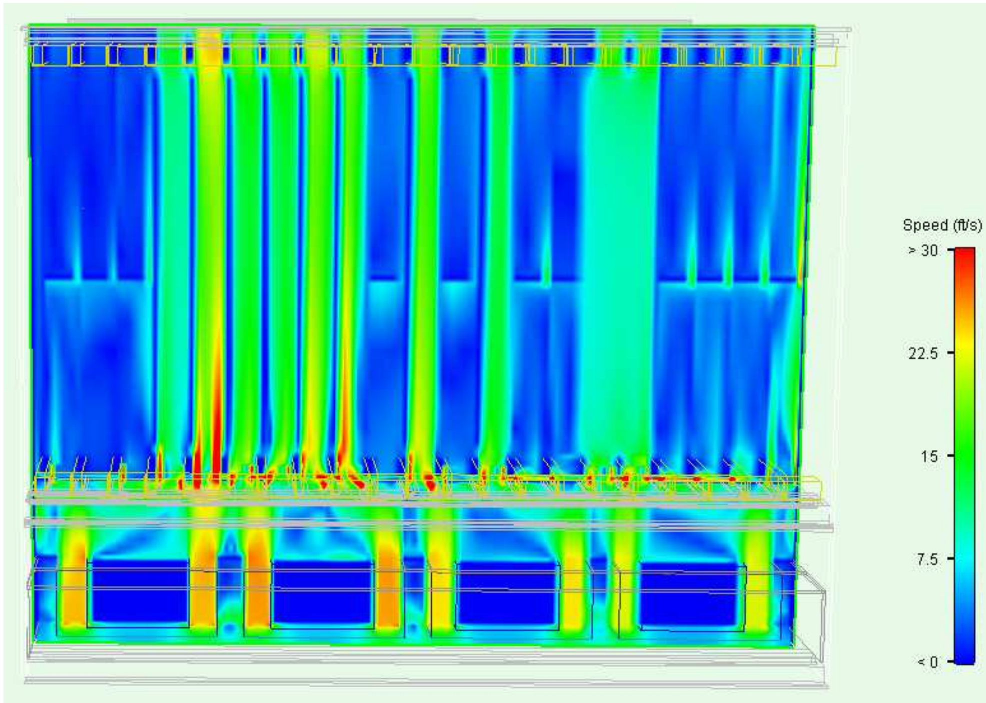
Air Exhaust Temperature by Slot, All Fans Operating, Sea Level

The graph below shows the air flow distribution per slot with all fans operating at sea level.



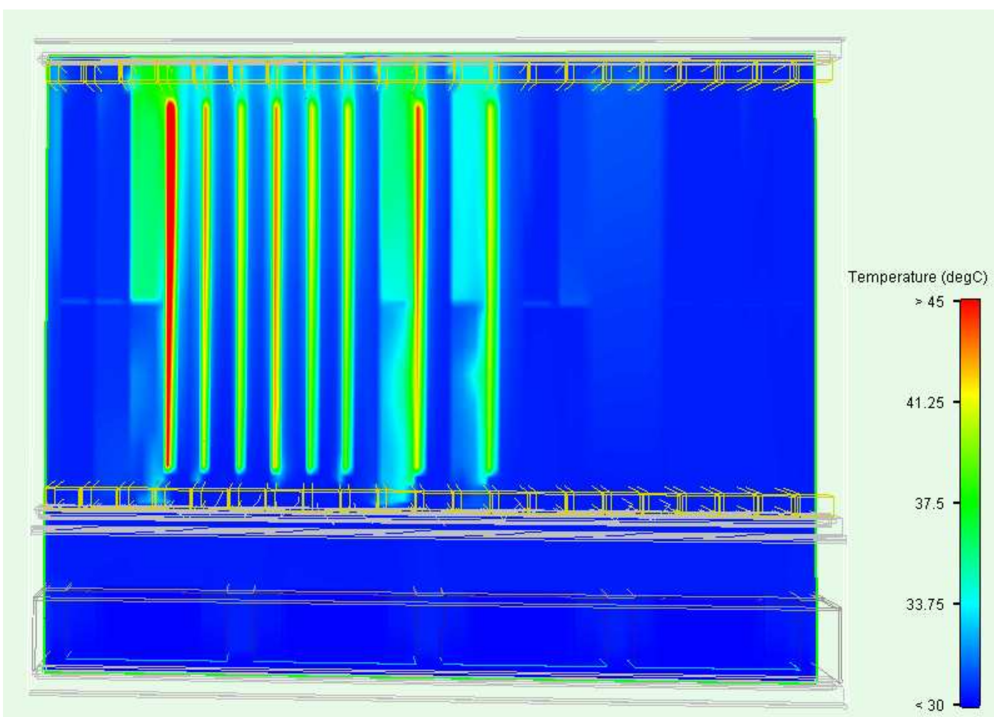
Air Flow by Slot, All Fans Operating, Sea Level

The results below show the air flow distribution per slot with all fans operating at sea level.



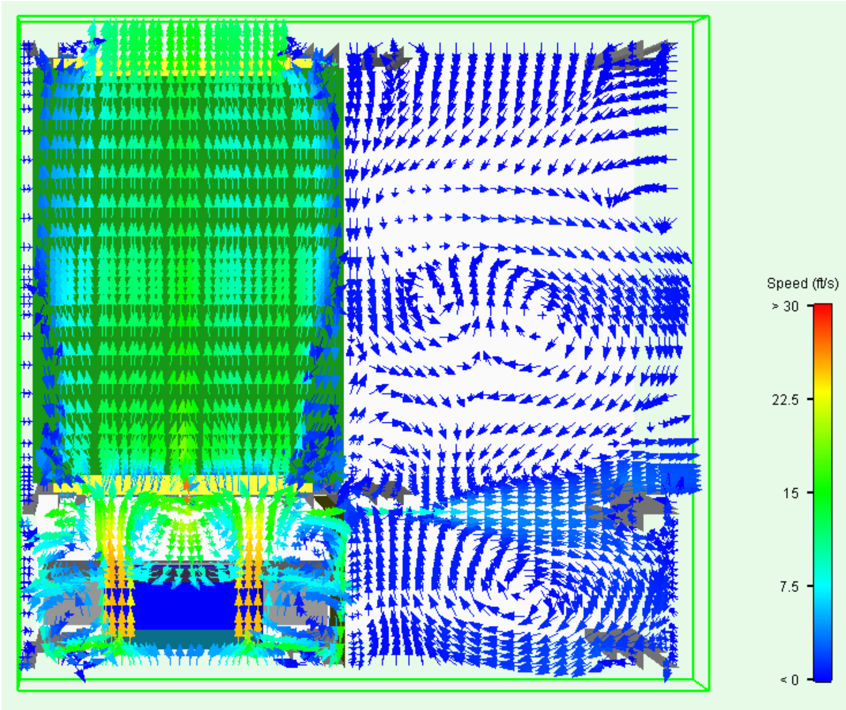
Air Flow Speed Profile

The results below show the temperature profile for each slot with all fans operating at sea level.

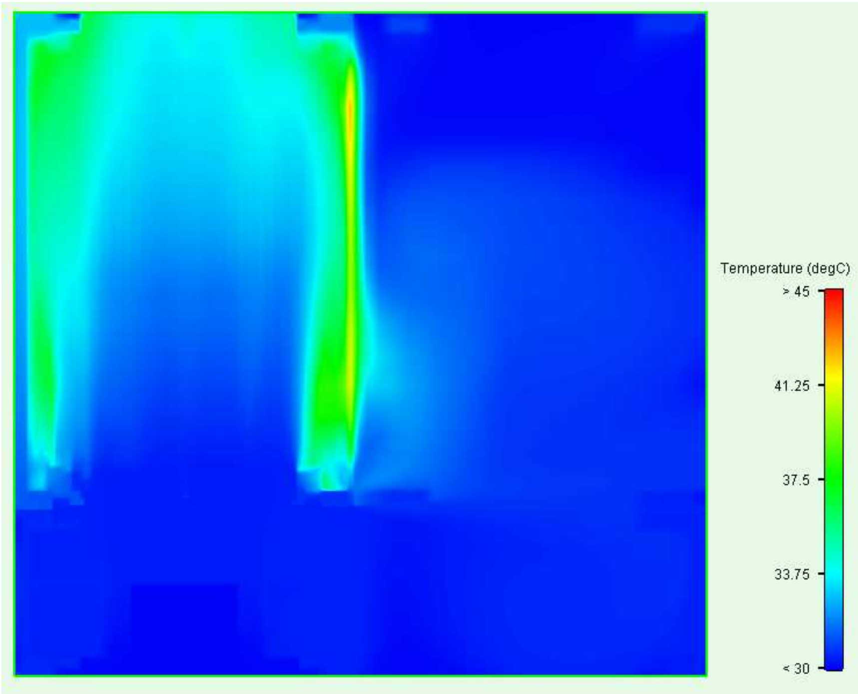


Temperature Profile

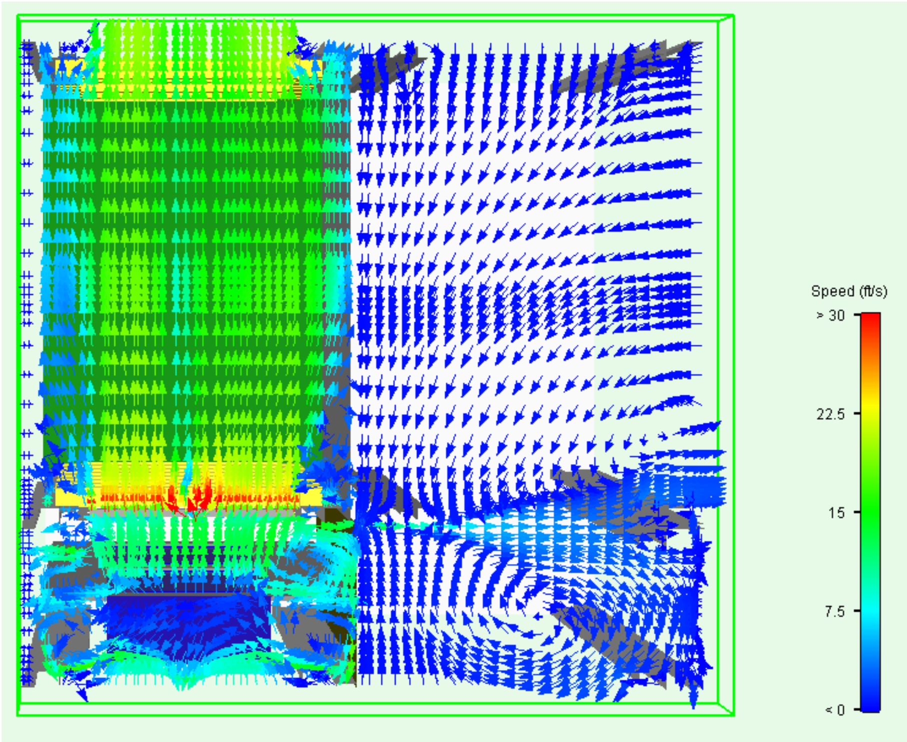
Speed and Temperature Profiles, All Fans Operating, Sea Level:



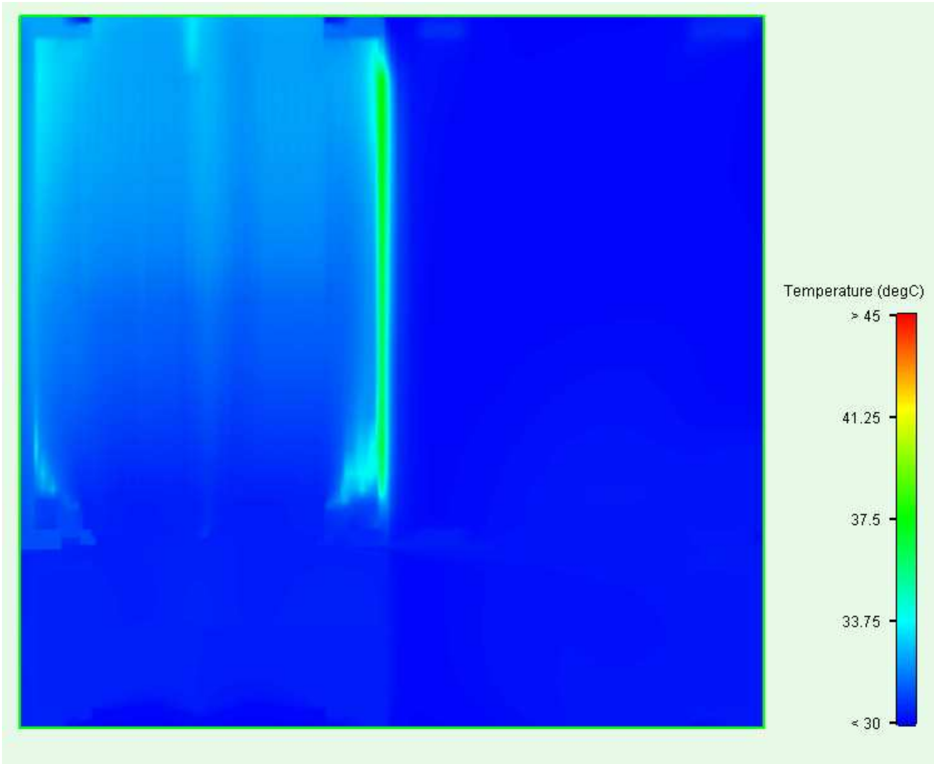
Speed Profile, SBC Slot, All Fans, Sea Level



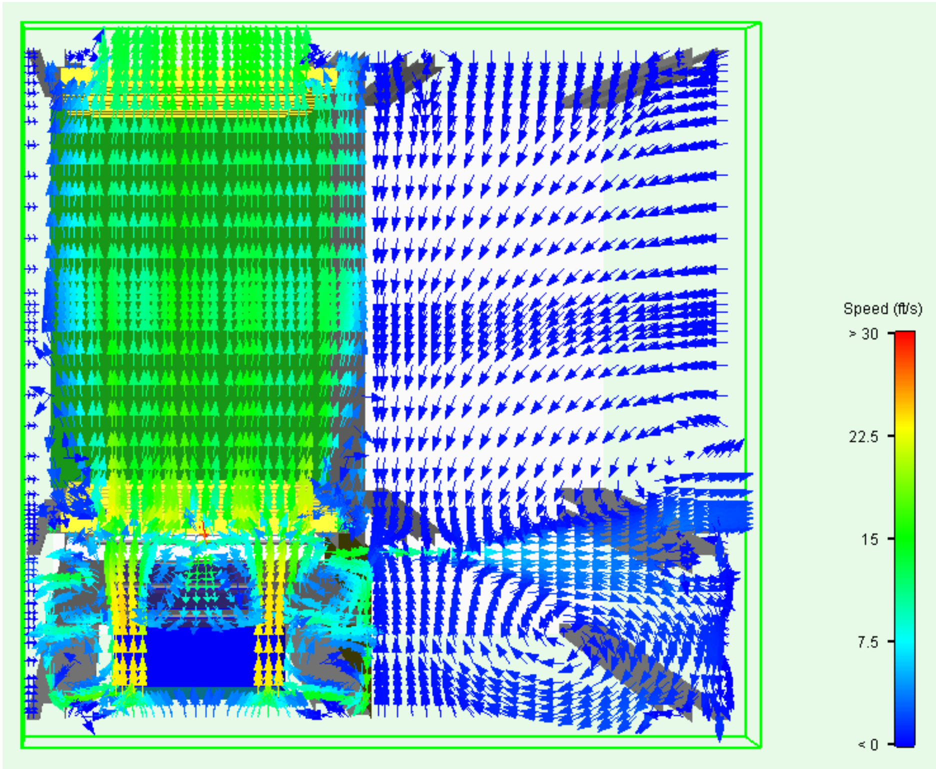
Profile, SBC Slot, All Fans, Sea Level



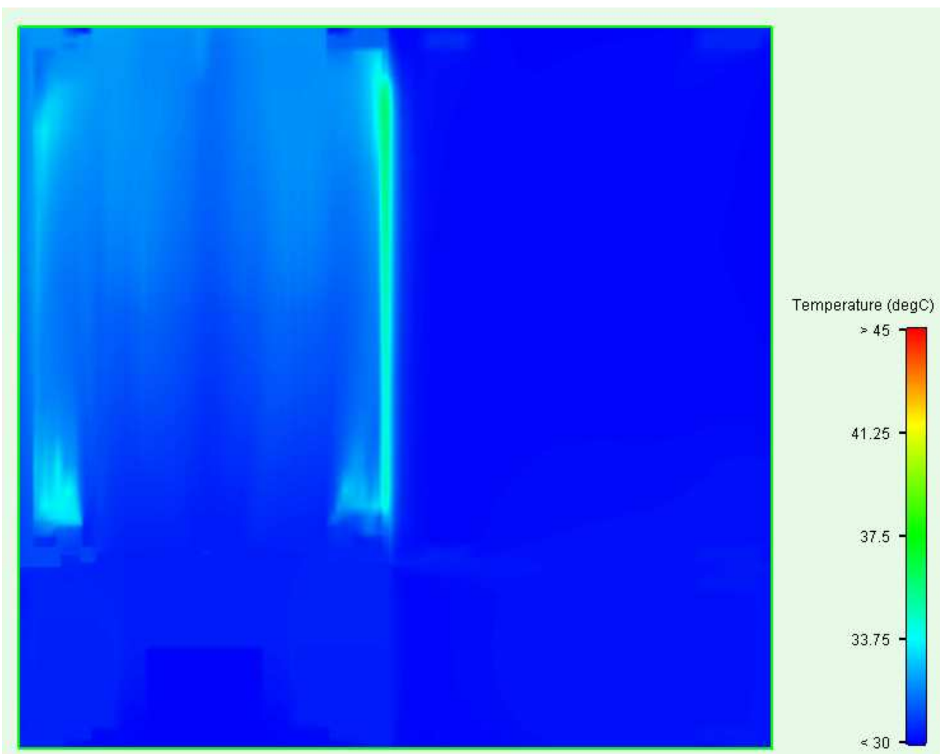
Speed Profile, DSP Slot, All Fans, Sea Level



Temperature Profile, DSP Slot, All Fans, Sea Level



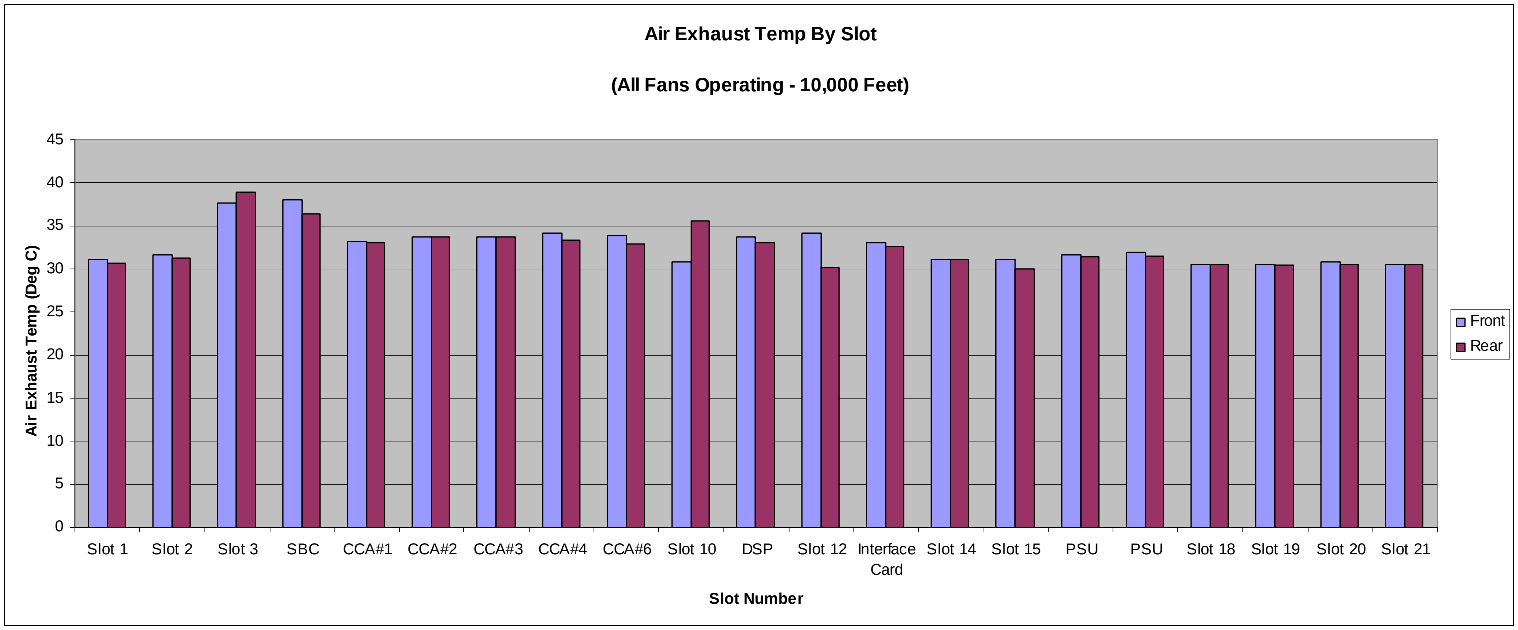
Speed Profile, Interface Card Slot, All Fans, Sea Level



Temperature Profile, Interface Card Slot, All Fans, Sea Level

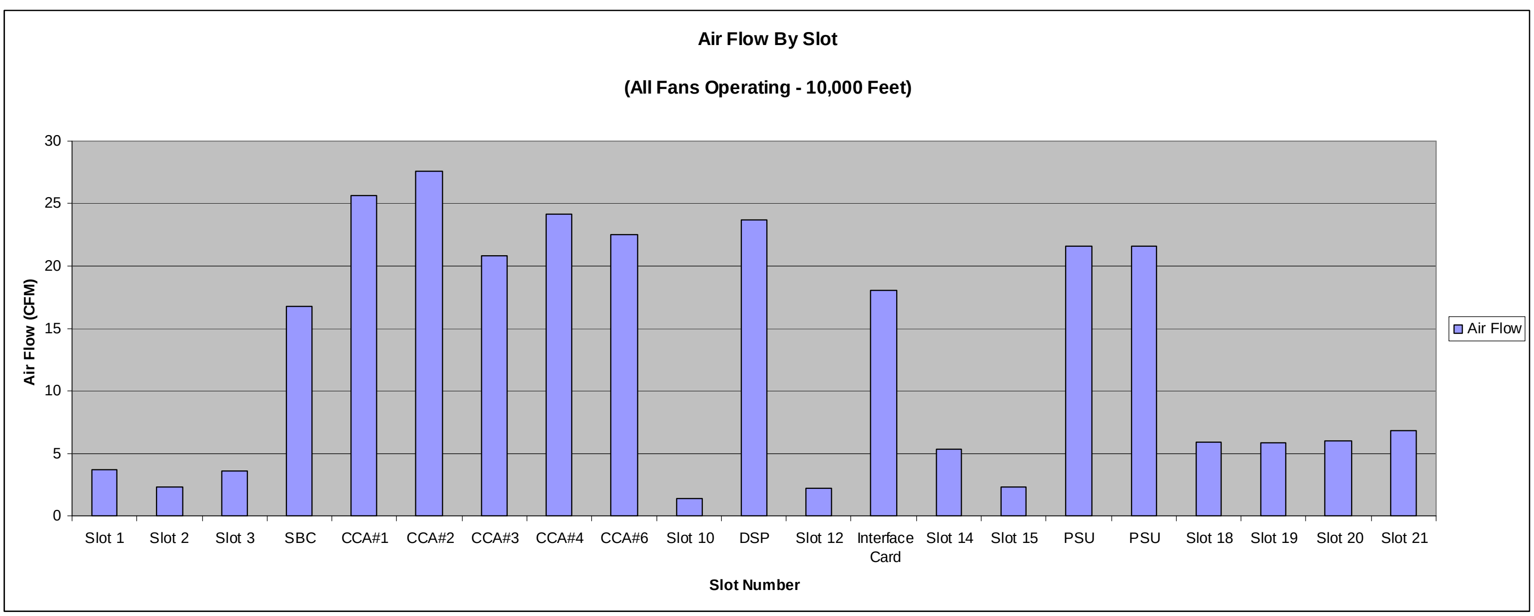
Simulation #2: All Fans Operating, 30°C Ambient, 10,000 feet

The graph below shows the per-slot temperature at each monitor point with all fans operating at 10,000 feet.



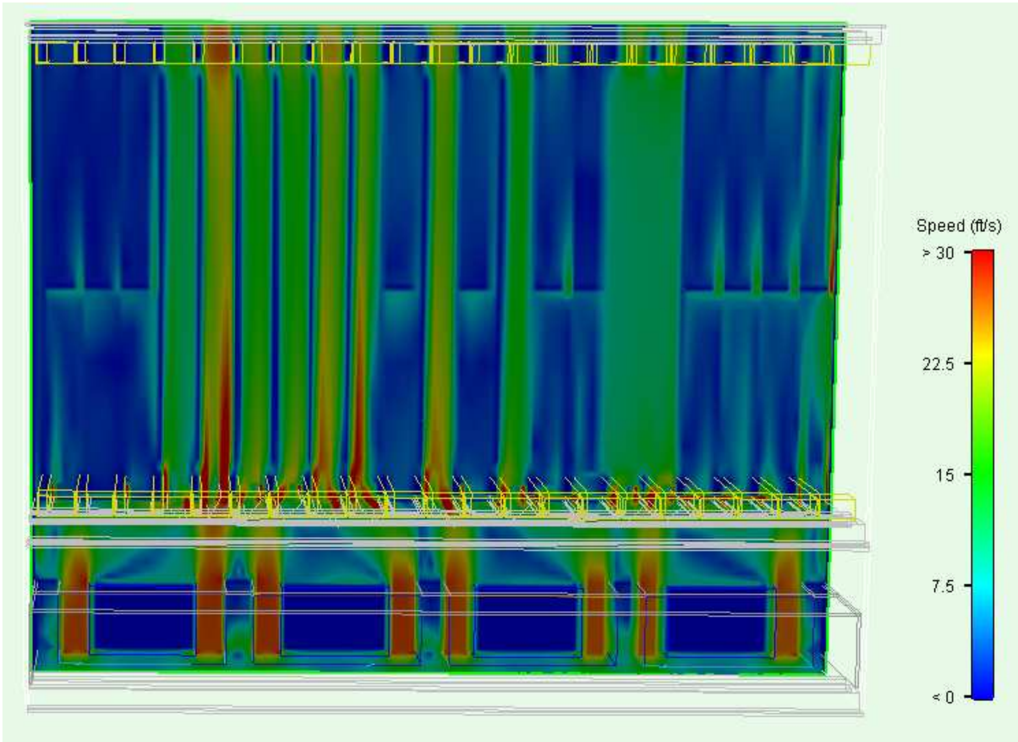
Air Exhaust Temp by Slot, All Fans Operating, 10,000 Feet

The graph below shows the air flow distribution per slot with all fans operating at 10,000 feet.



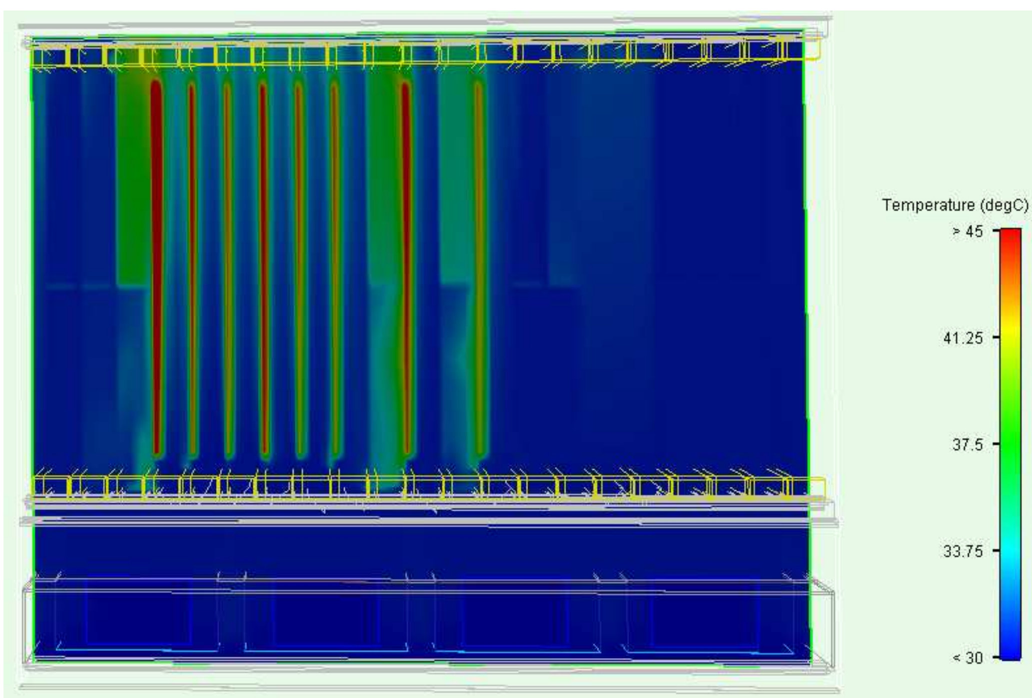
Air Flow Distribution by Slot, All Fans Operating, 10,000 Feet

The results below show the air flow distribution per slot with all fans operating at 10,000 feet.



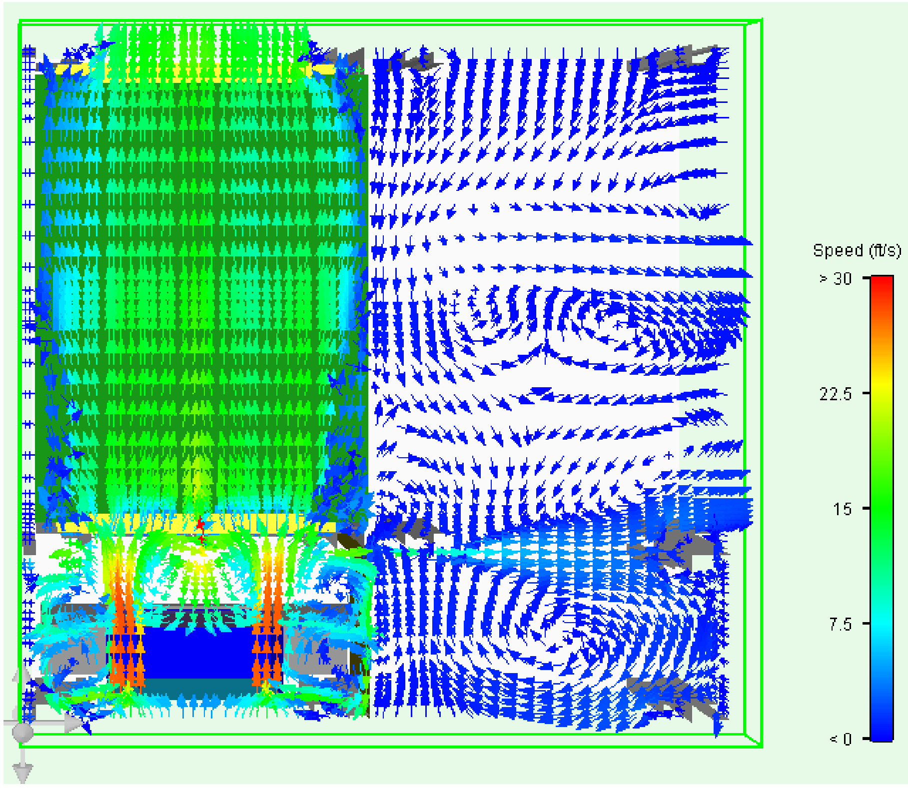
Air Flow Speed Profile, All Fans, 10,000 Feet

The results below show the temperature profile for each slot with all fans operating at sea level

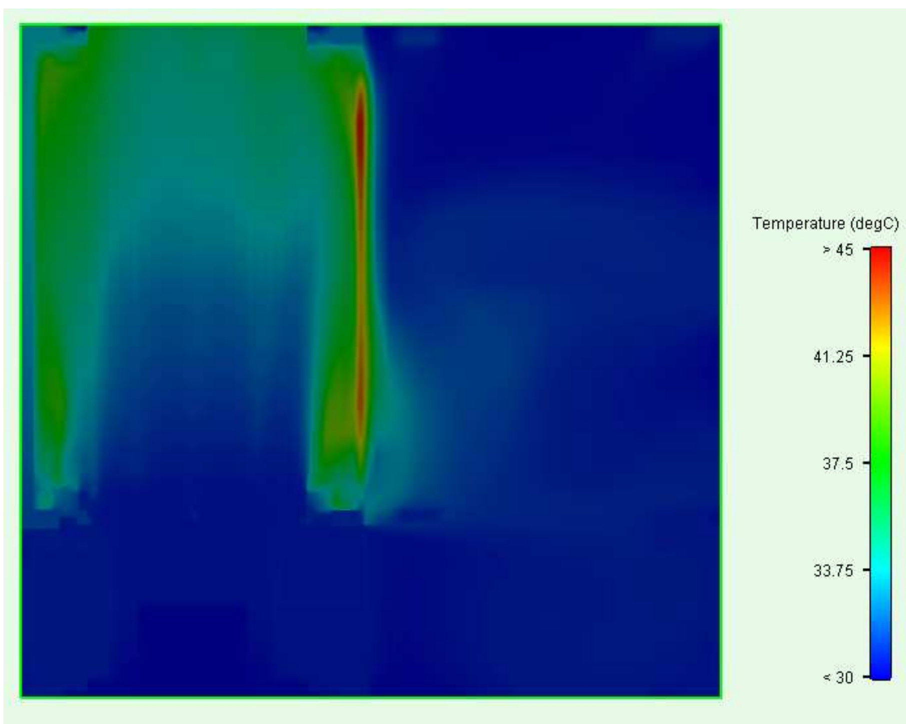


Temperature Profile, All Fans, 10,000 Feet

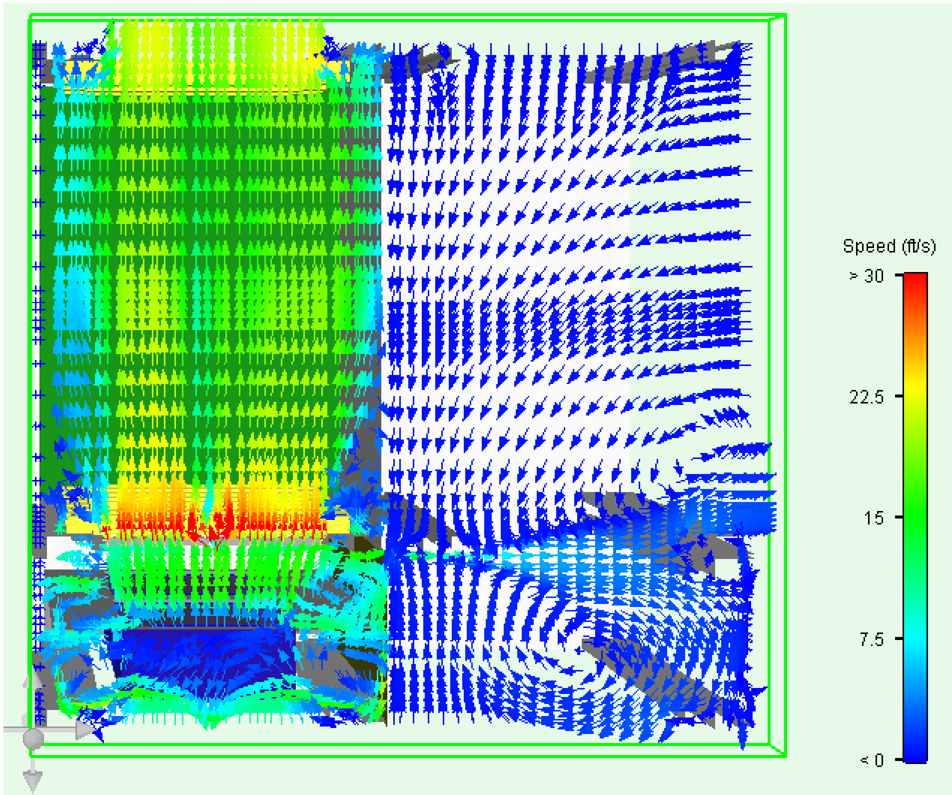
Speed and Temperature Profiles, All Fans Operating, 10,000 Feet:



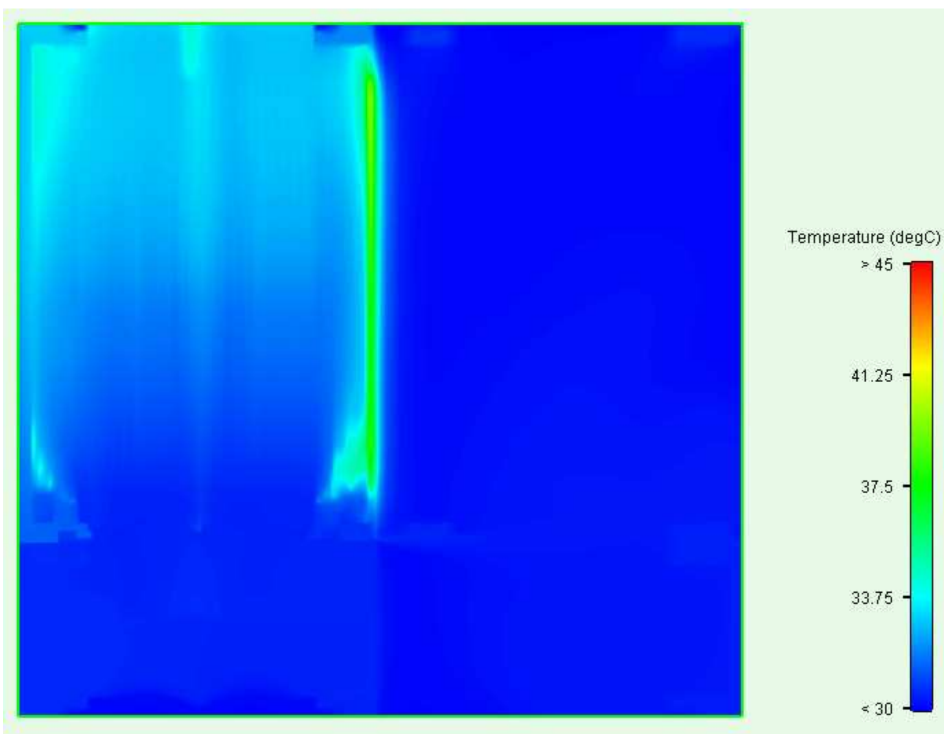
Speed Profile, SBC Slot, All Fans, 10,000 Feet



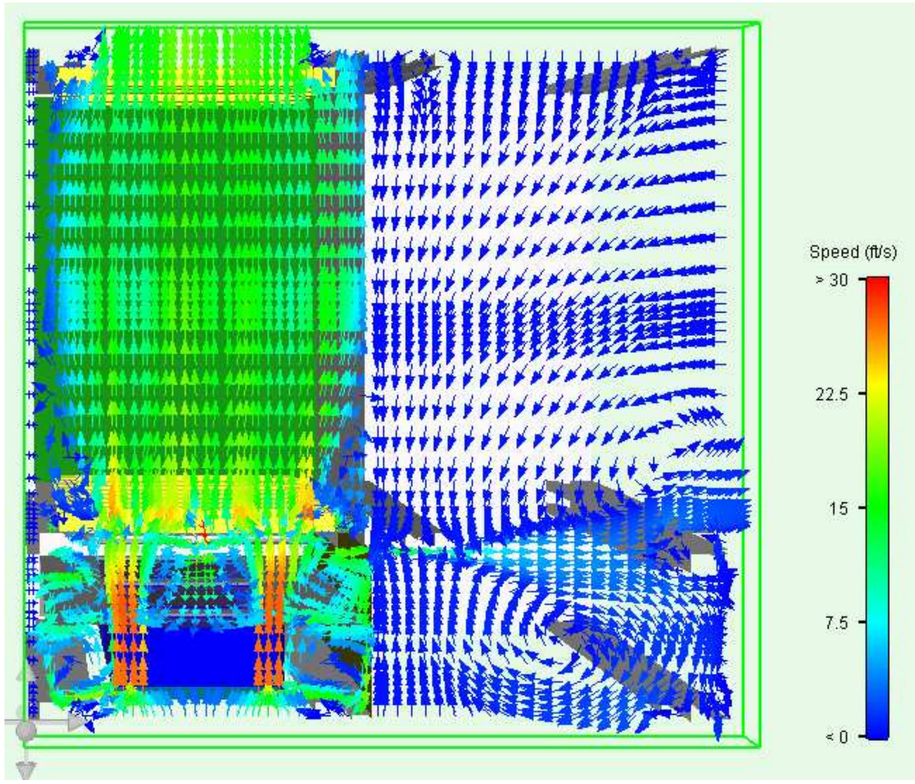
Temperature Profile, SBC Slot, All Fans, 10,000 Feet



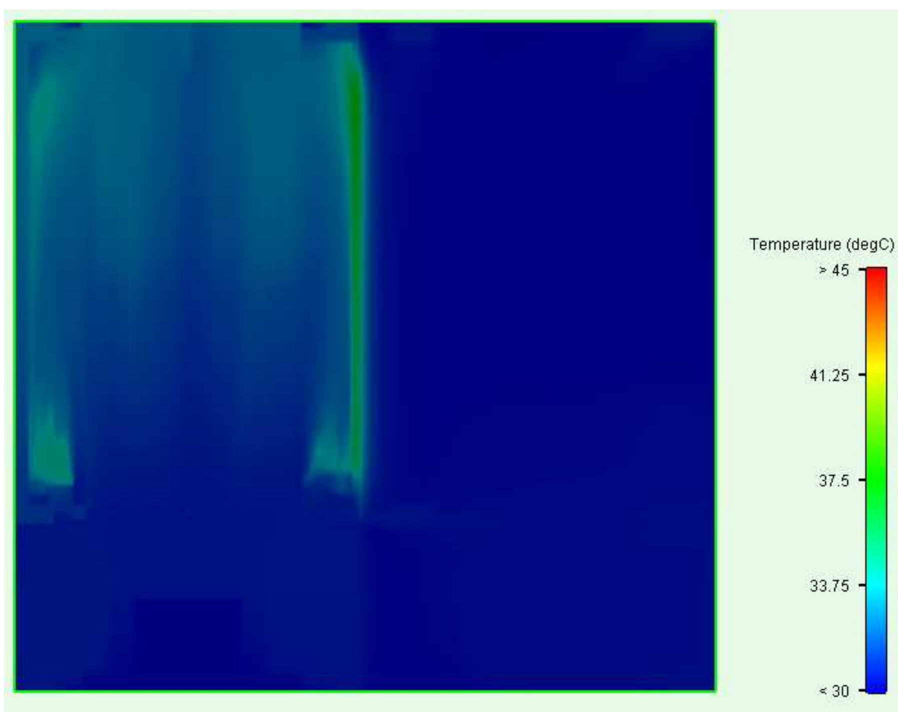
Speed Profile, DSP Slot, All Fans, 10,000 Feet



Temperature Profile, DSP Slot, All Fans, 10,000 Feet



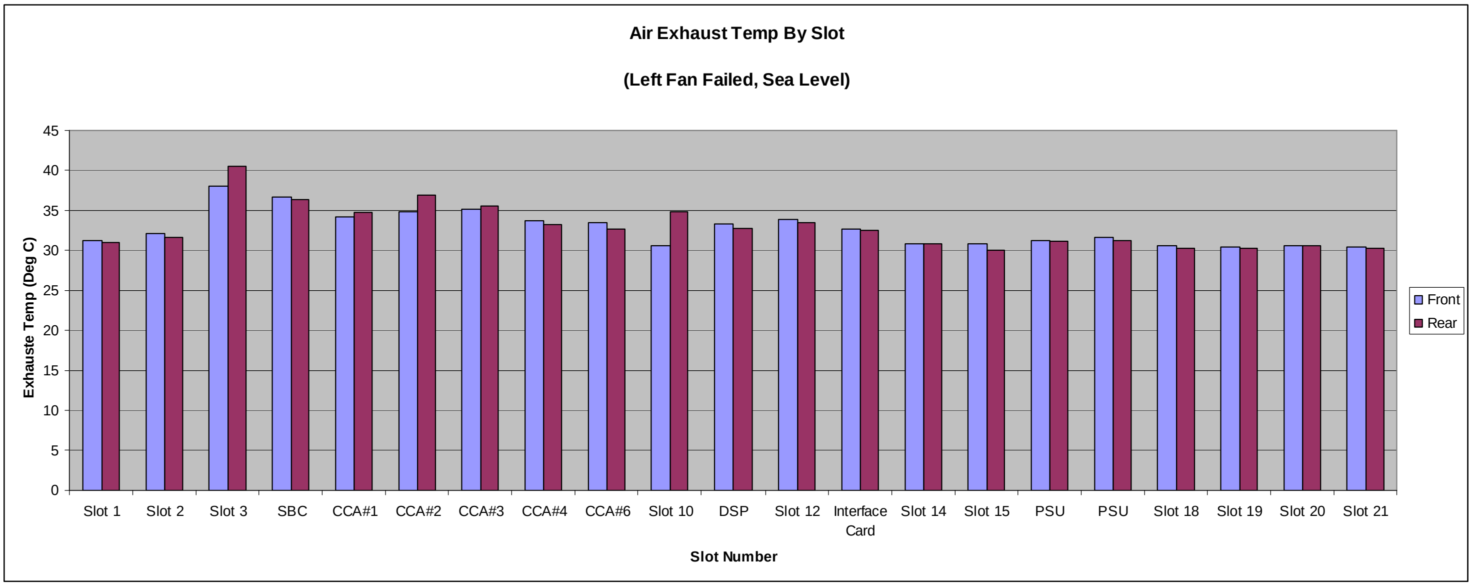
Speed Profile, Interface Card Slot, All Fans, 10,000 Feet



Temperature Profile, Interface Card Slot, All Fans, 10,000 Feet

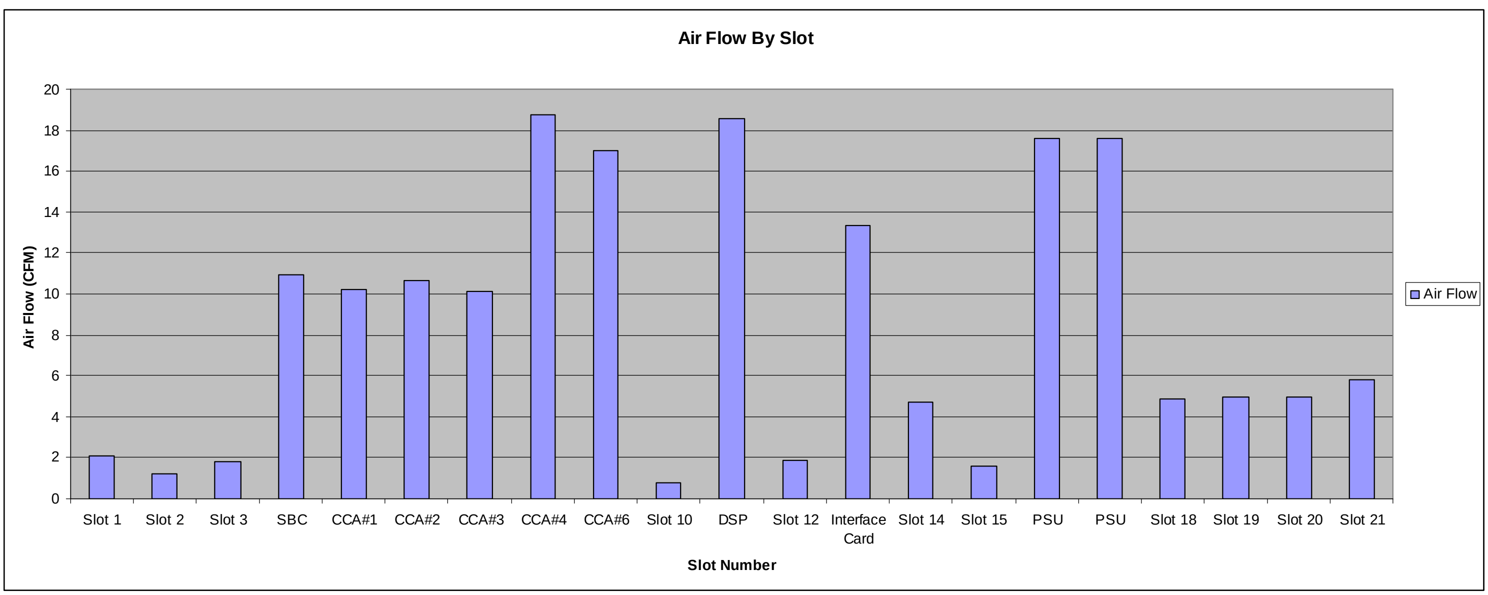
Simulation #3: Left Fan Failed, 30°C Ambient, Sea Level

The graph below shows the per-slot temperature at each monitor point with the left fan failed at sea level.



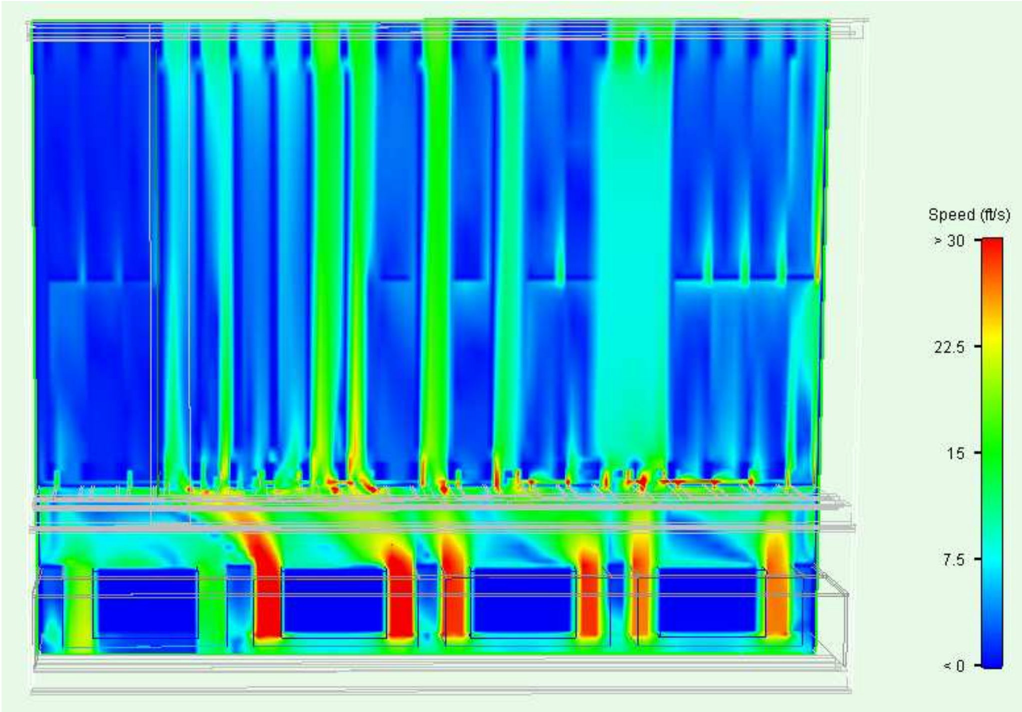
Air Exhaust Temp by Slot, Left Fan Failed, Sea Level

The graph below shows the air flow distribution per slot with the left fan failed at sea level.



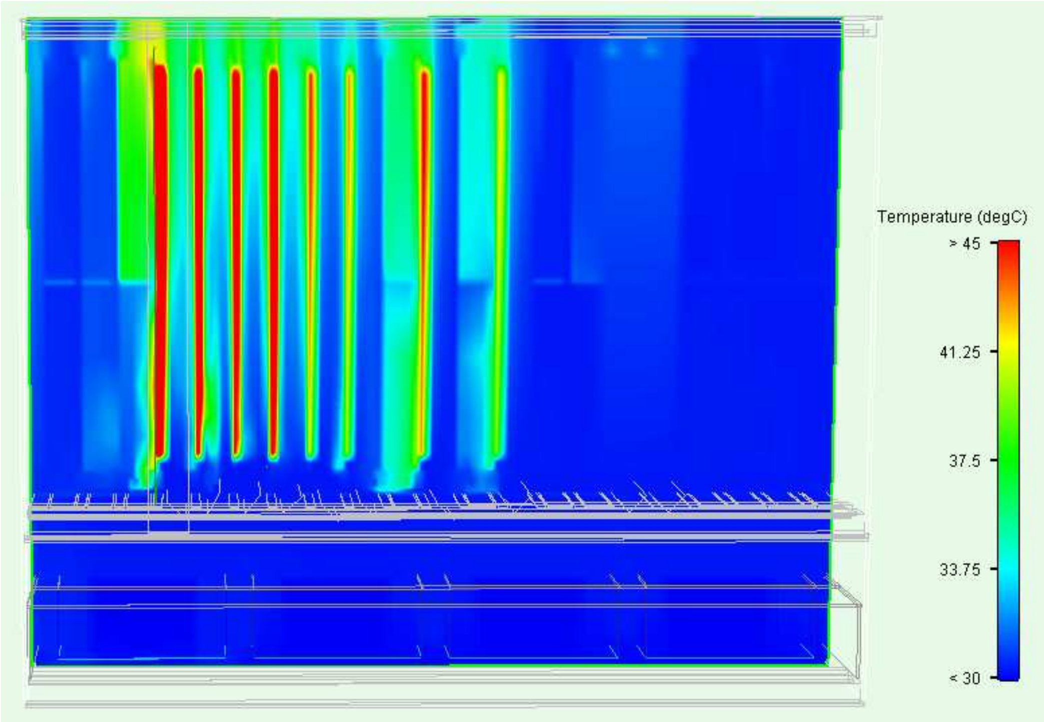
Air Flow Distribution by Slot, Left Fan Failed, Sea Level

The results below show the air flow distribution per slot with the left fan failed at sea level.



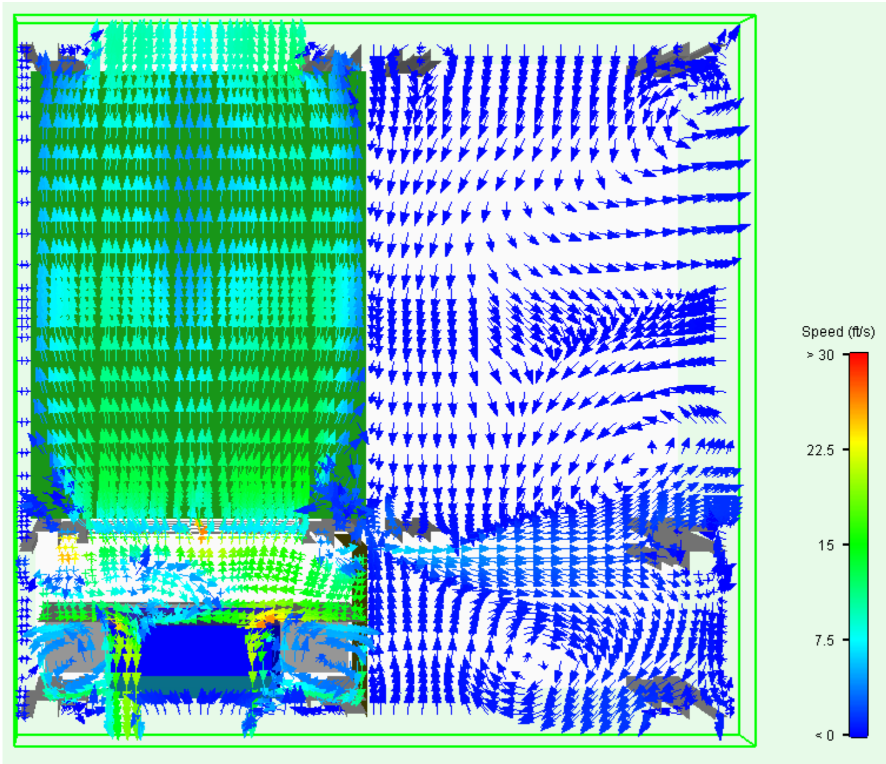
Air Flow Speed Profile, Left Fan Failed, Sea Level

The results below show the temperature profile for each slot with the left fan failed at sea level.

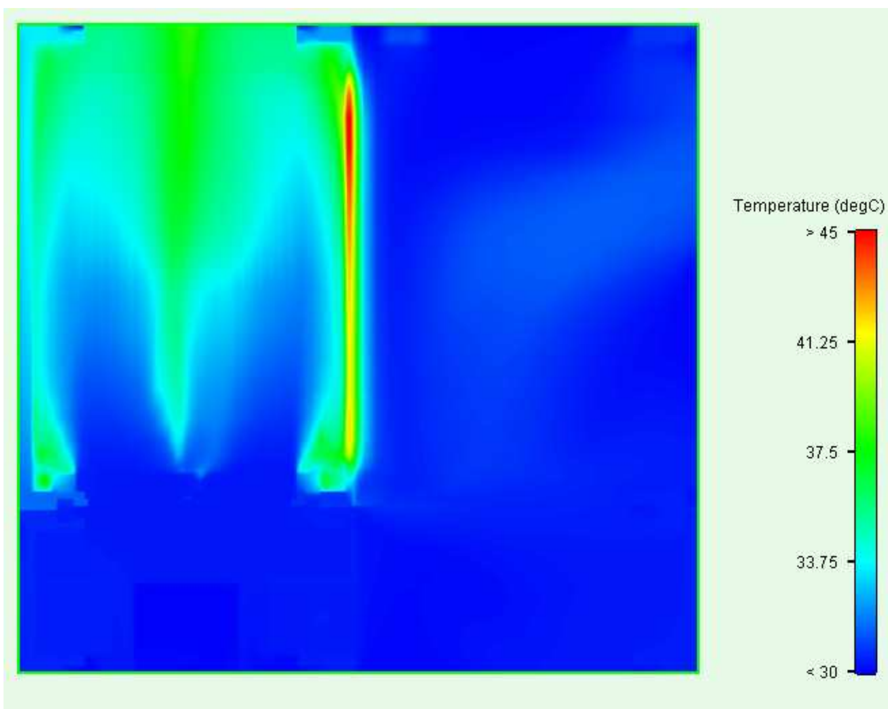


Temperature Profile, Left Fan Failed, Sea Level

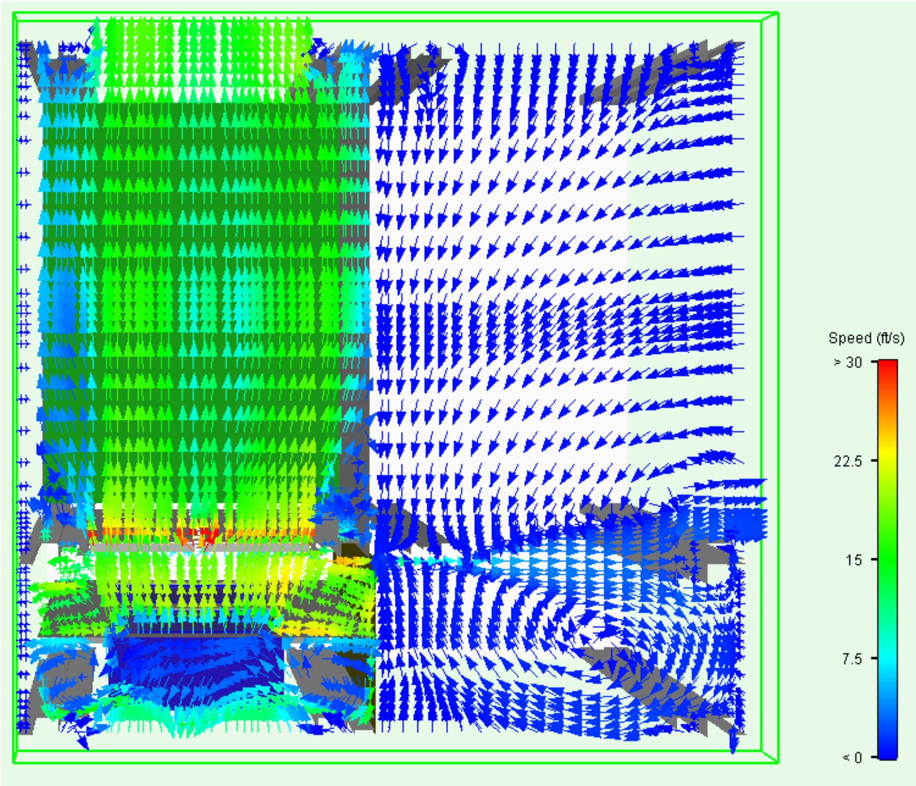
Speed and Temperature Profiles, Left Fan Failed, Sea Level:



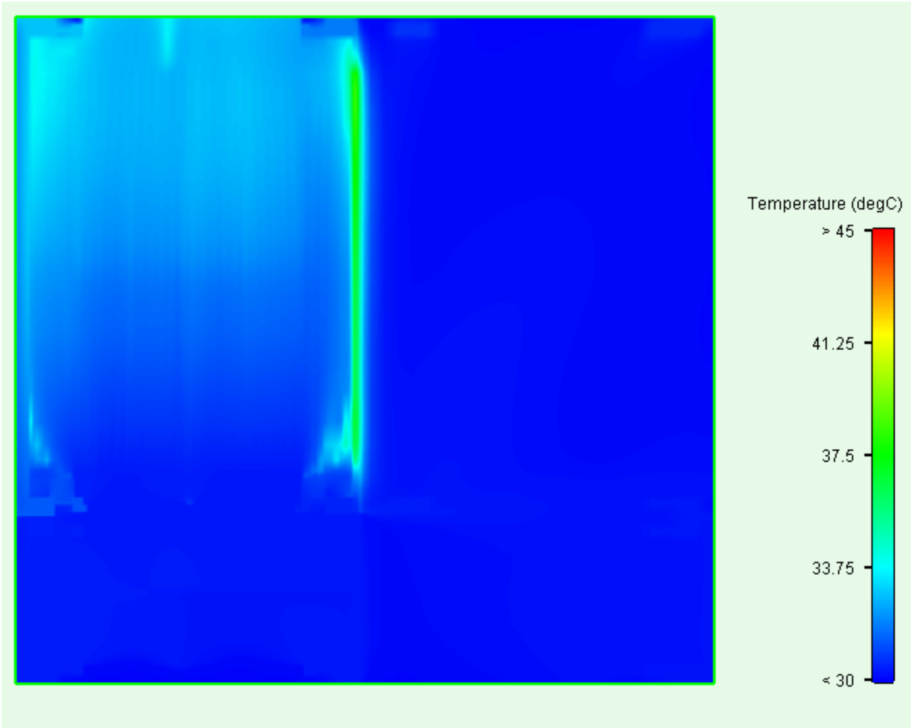
Air Flow Speed Profile, SBC Slot, Left Fan Failed, Sea Level



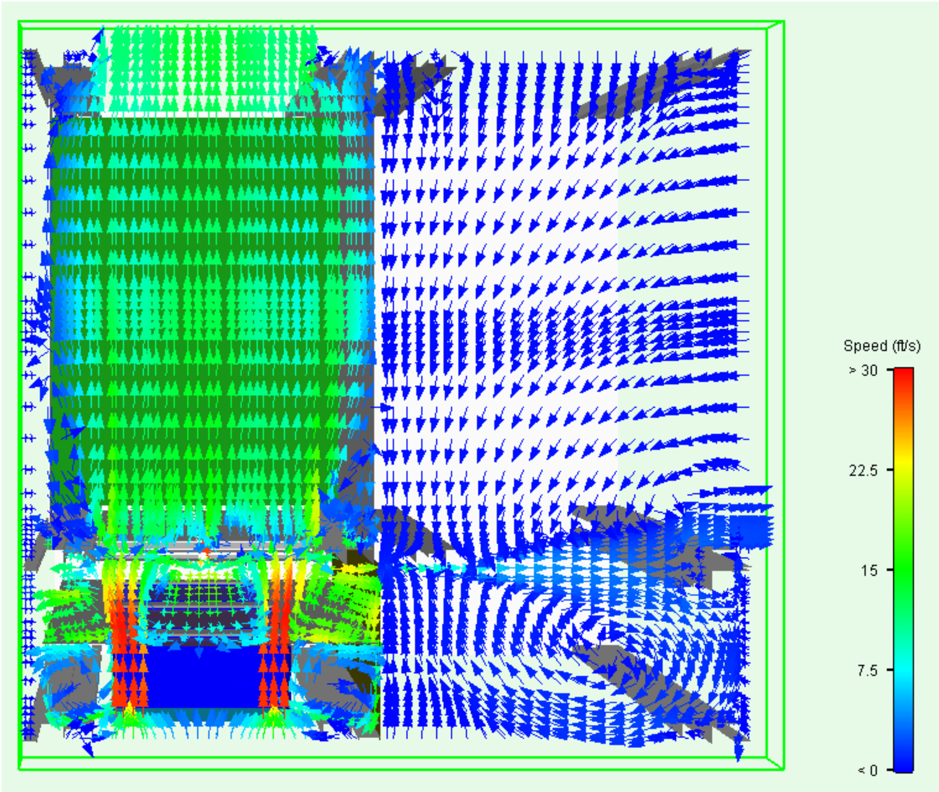
Temperature Profile, SBC Slot, Left Fan Failed, Sea Level



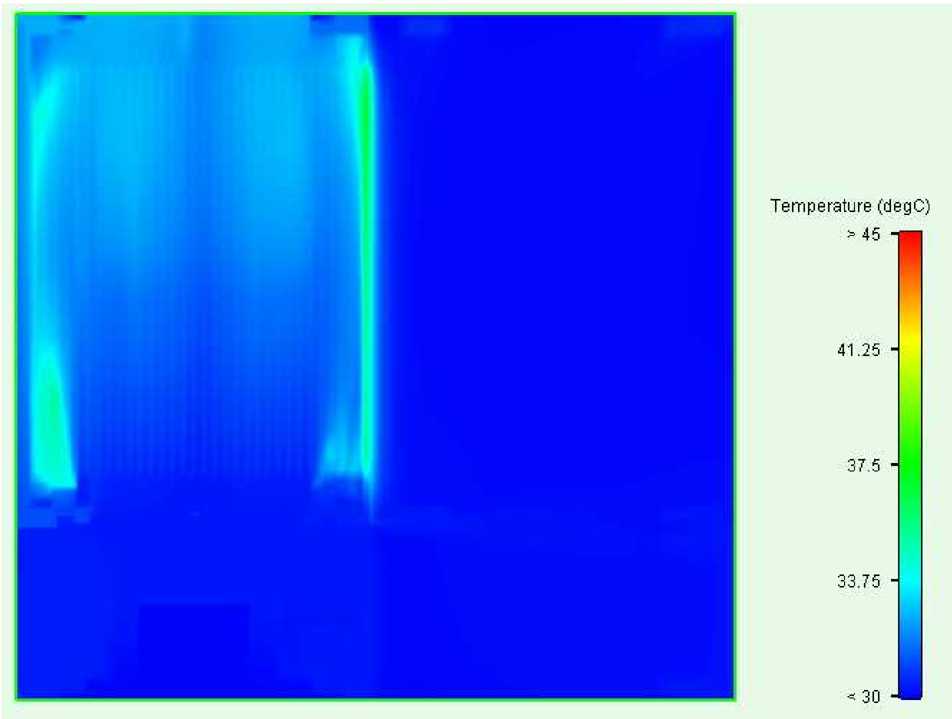
Air Flow Speed Profile, DSP Slot, Left Fan Failed, Sea Level



Temperature Profile, DSP Slot, Left Fan Failed, Sea Level



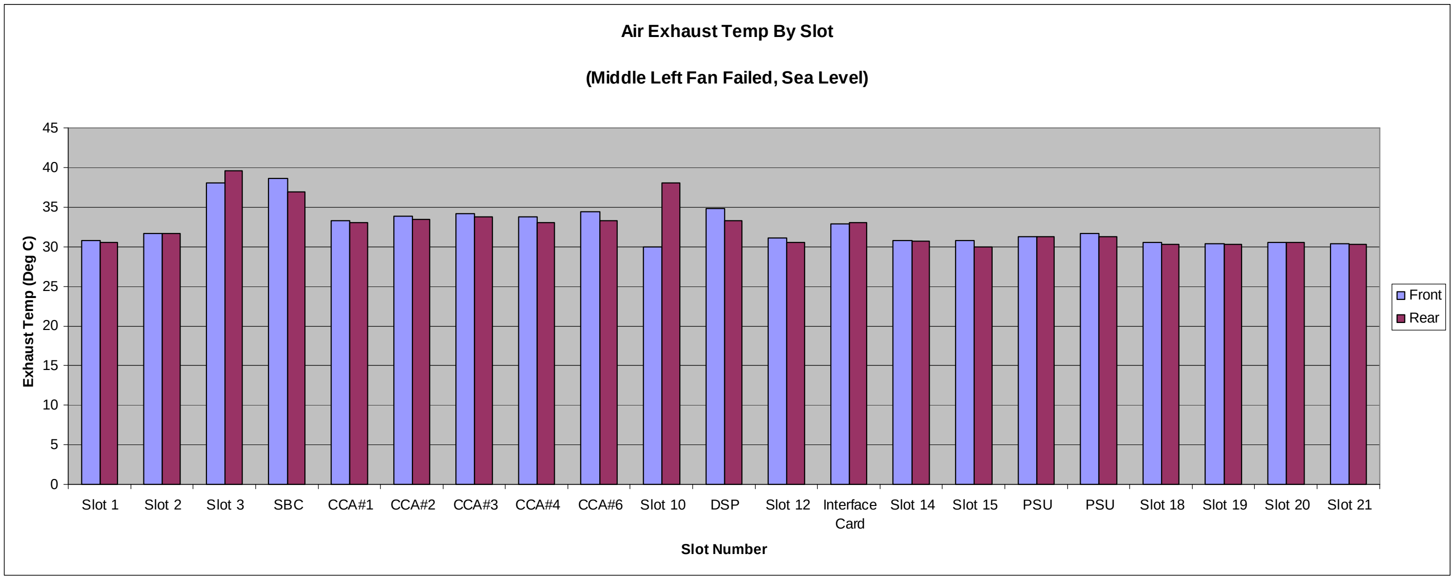
Air Flow Speed Profile, Interface Card Slot, Left Fan Failed, Sea Level



Temperature Profile, Interface Card Slot, Left Fan Failed, Sea Level

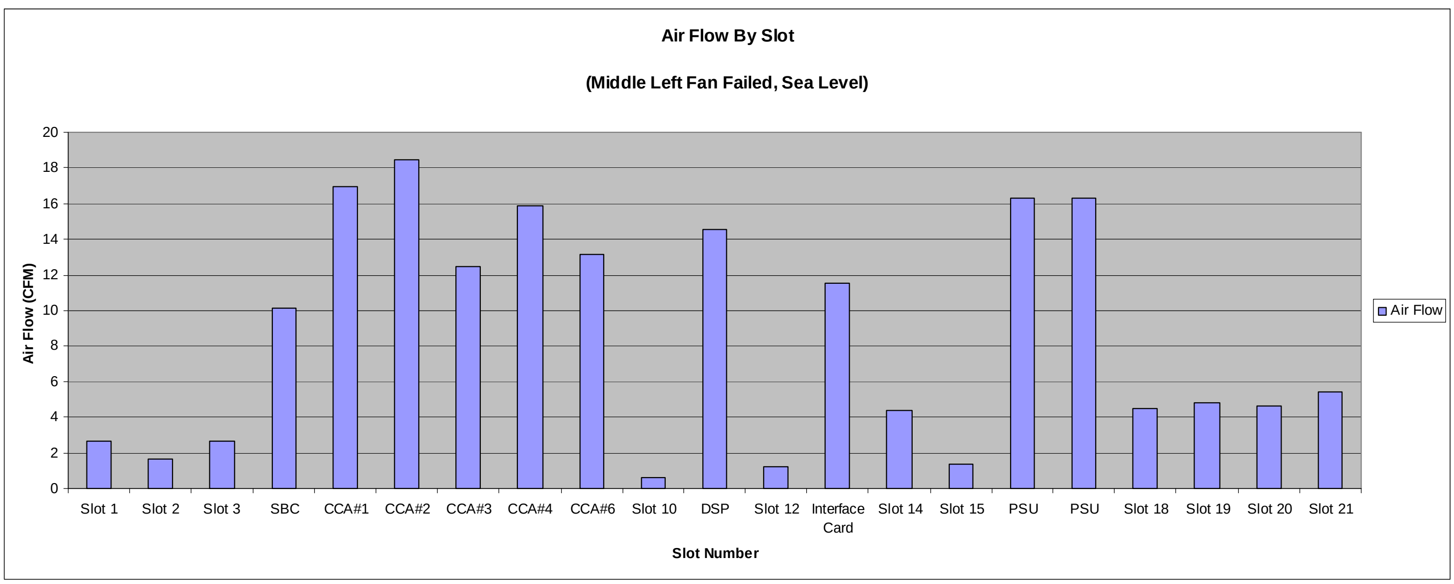
Simulation #4: Middle Left Fan Failed, 30°C Ambient, Sea Level

The graph below shows the per-slot temperature at each monitor point with the Middle Left fan failed at sea level.



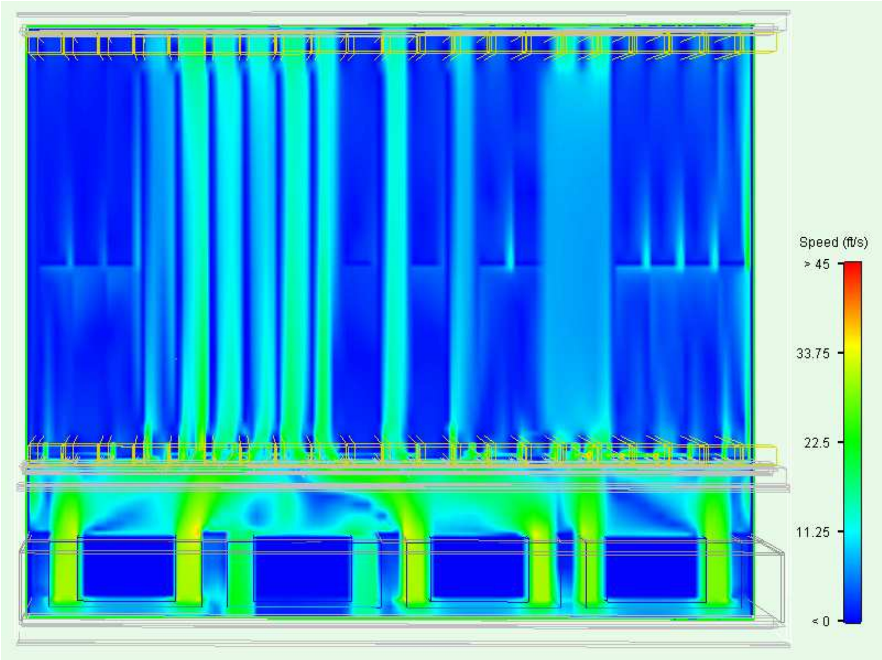
Air Exhaust Temp by Slot, Middle Left Fan Failed, Sea Level

The graph below shows the air flow distribution per slot with the Middle Left fan failed at sea level.



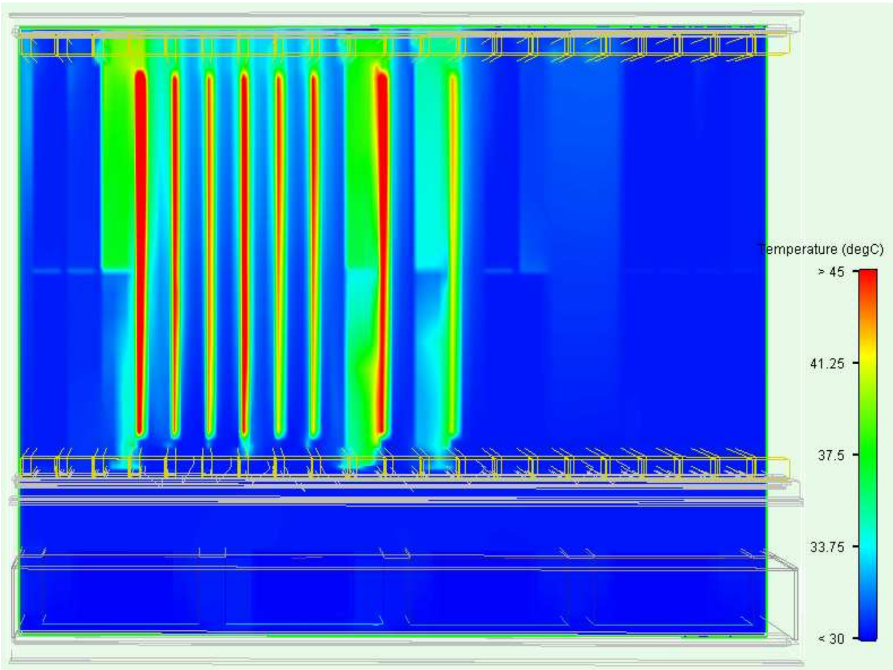
Air Flow Distribution by Slot, Left Fan Failed, Sea Level

The results below show the air flow distribution per slot with the middle left fan failed at sea level.



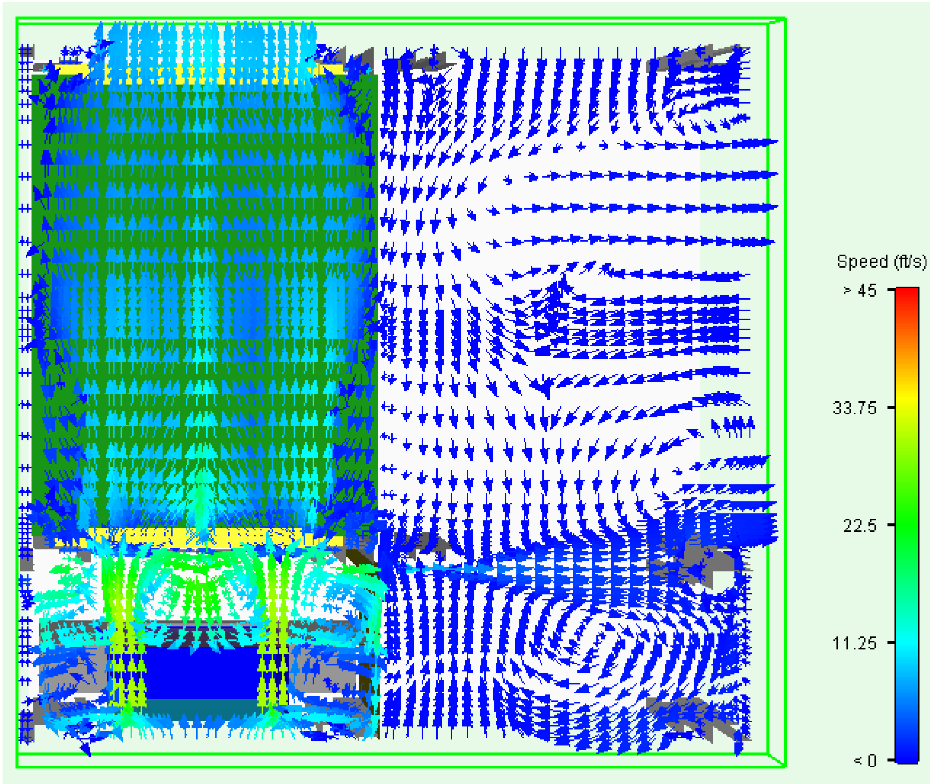
Air Flow Speed Profile, Middle Left Fan Failed, Sea Level

The results below show the temperature profile for each slot with the middle left fan failed at sea level.

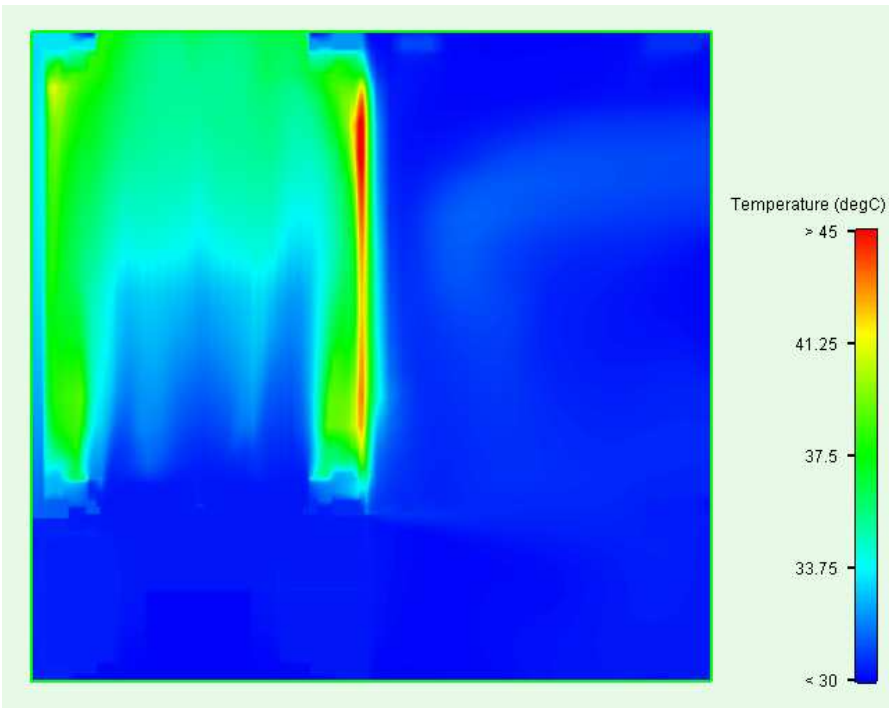


Temperature Profile, Middle Left Fan Failed, Sea Level

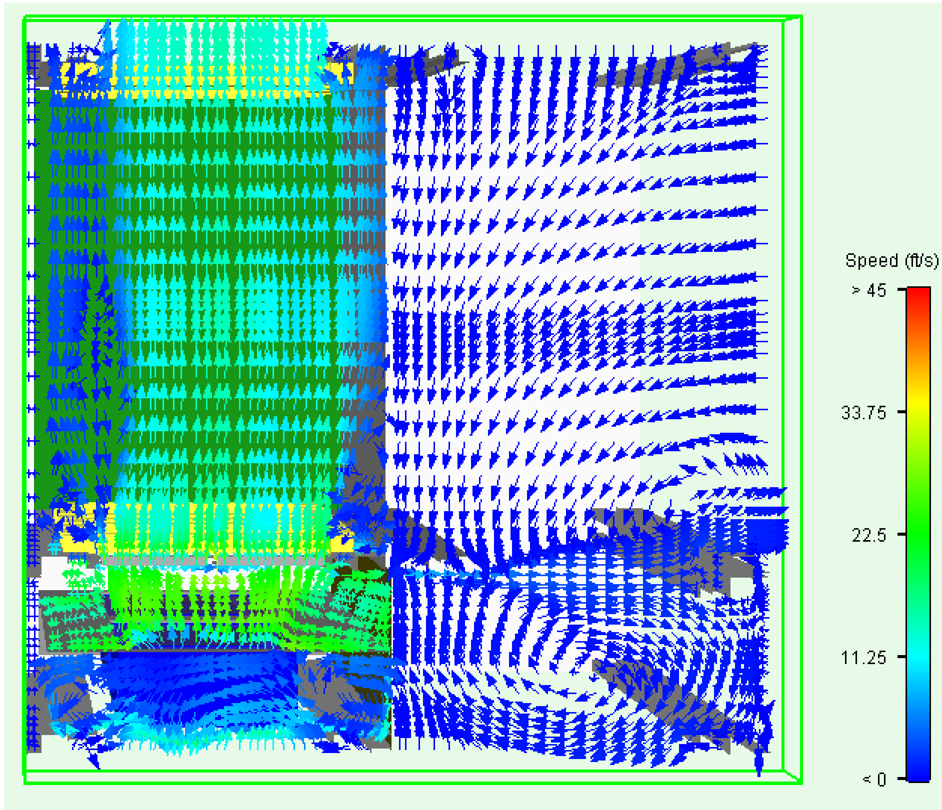
Speed and Temperature Profiles, Middle Left Fan Failed, Sea Level:



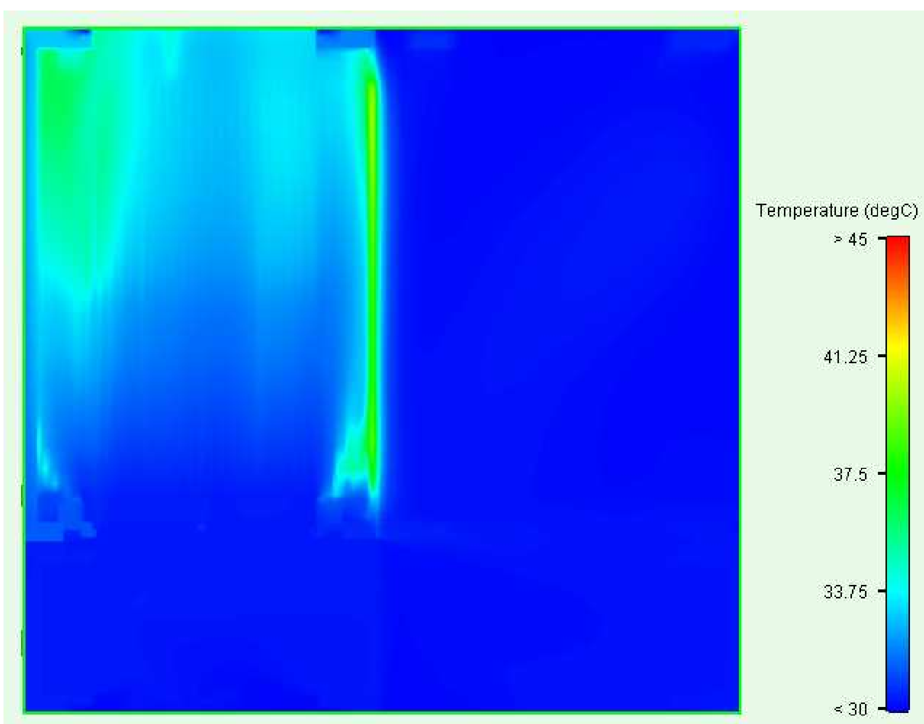
Air Flow Speed Profile, SBC Slot, Middle Left Fan Failed, Sea Level



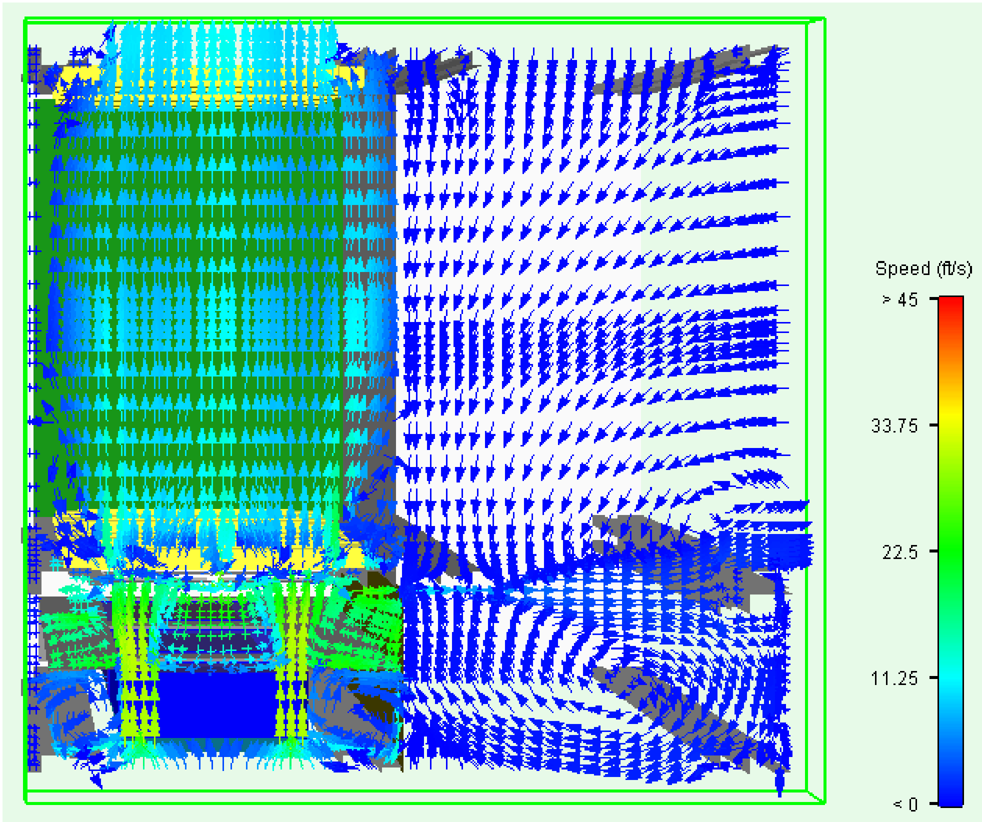
Temperature Profile, SBC Slot, Middle Left Fan Failed, Sea Level



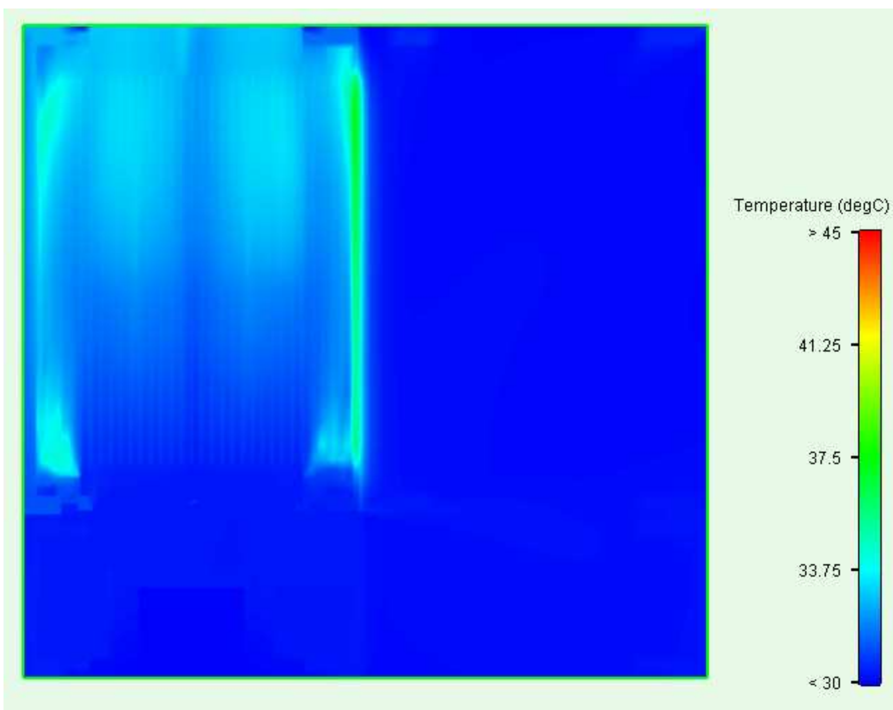
Air Flow Speed Profile, DSP Slot, Middle Left Fan Failed, Sea Level



Temperature Profile, DSP Slot, Middle Left Fan Failed, Sea Level



Air Flow Speed Profile, Interface Card Slot, Middle Left Fan Failed, Sea Level



Temperature Profile, Interface Card Slot, Middle Left Fan Failed, Sea Level

Acoustical Noise

The basic equation for an acoustic noise estimate is:

$$L = 10\log\left[10^{L1/10} + 10^{L2/10} + \ldots + 10^{Ln/10}\right]$$

Where:

L = total fan noise in dB
Ln = individual fan noise in dB

Therefore, for four Delta FFB0912EHE-F00 fans rated at 55 dB-A (running at full speed):

$$L = 10\log\,(4 \times 10^{5.5}) = \mathbf{61.02\ dB}$$

Conclusion

From the information presented in this report, Elma's 8U Type 12 VME64x System will provide cooling air in the approximate range of 10 to 25 CFM of air per slot. This is only an estimate given that the pressure drop for the payload cards was not provided for analysis. The information contained in this report is limited to the assumptions listed under the simulation parameters.