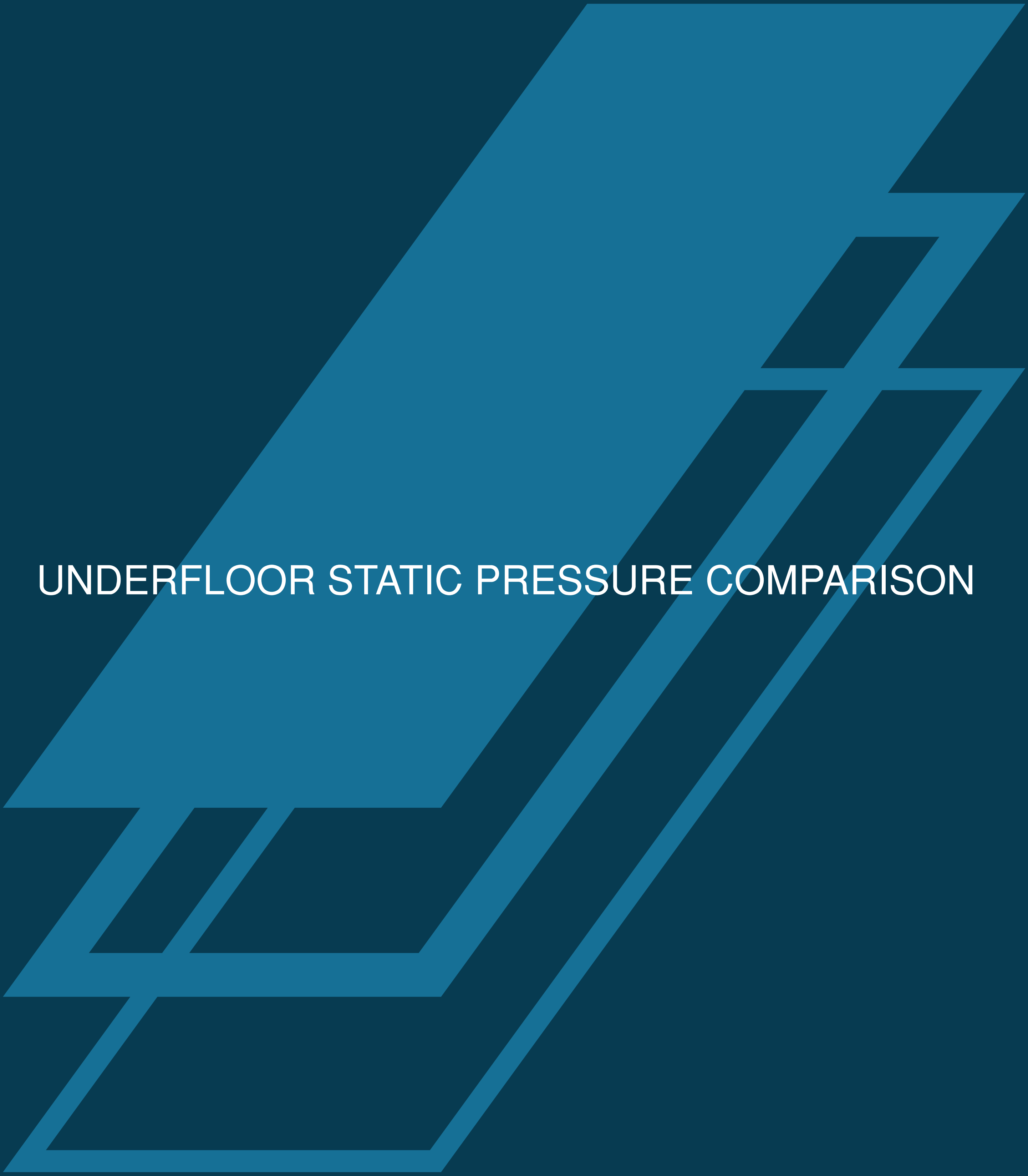

UNDERFLOOR STATIC PRESSURE COMPARISON

INTERSTITIAL
SYSTEMS

A COMPARATIVE ANALYSIS OF UNDERFLOOR STATIC PRESSURE:
INTERSTITIAL
AN ELECTRO-MECHANICAL DISTRIBUTION SYSTEM
VS.
A CONVENTIONAL RAISED FLOOR

Effective Underfloor Air Distribution Requires Maintaining Sufficient and Consistent Static Pressure…

It's virtually impossible to achieve this under a single level floor, but with Interstitial it's easy.

INTRODUCTION

The comparison discussed in this report was developed using Computational Fluid Dynamics (CFD). The plots use a range of colors to show various static pressures within the underfloor environments at the mid-height of the supply air plenum. In the case of Interstitial that means the system's dedicated, obstruction-free, and substantially leak proof air distribution level. In the case of the single-level conventional raised floor, that means the volume between the building slab and the bottom of the walking floor panels. For illustration purposes, the study is based on a room filled with 10 kW cabinets, but of course the results are not affected by the room's heat load.

The space under a conventional single-level floor is cluttered with pipes, wires, and cabling, which collectively create an underfloor "dam" that blocks airflow and creates turbulence (not taken into consideration with the CFD). This impedes the delivery of air -- a problem that is all-too well known. In addition, leaks through gaps between floor panels, removed panels, and cutouts make adequate static pressure impossible to achieve, much less maintain. In contrast, Interstitial optimizes air delivery, and consequently energy efficiency, by confining airflow to the system's sealed and uncluttered air plenum, isolated from its upper plenum, which is dedicated to wires and cables.

Data center managers should be able to easily adjust and direct airflow from under the floor through the floor grates to wherever it is needed whenever it is needed in the white space. But with the impeded airflow and insufficient static pressure universally encountered when using single-level floors, rooms are plagued with "hotspots" and "cold spots." These unwanted conditions often require the installation of additional expensive equipment and thwart all attempts to provide the dependable airflow so critically needed. Interstitial eliminates all of these problems throughout the life of the facility.

An independent mechanical engineering firm specializing in CFD simulation has provided the comprehensive results comparing the two designs using design assumptions shown below. The analysis proves that Interstitial provides far more effective air distribution than a conventional raised floor, which translates directly into using fewer, larger, and more energy efficient cooling units.

TWO ROOM LAYOUTS—INCLUDING CABINETS, PDUS, AND A/C EQUIPMENT INSTALLED ON A 36" HIGH FLOOR
BOTH DESIGNS ARE BASED ON USING 375–24" X 48" CABINETS AT 10 KW EACH, AN EQUIPMENT LOAD OF 3,750 KW
THE PDUS ARE WITHIN THE ROOM, MAKING A TOTAL ROOM LOAD OF 4,050 KW, HOWEVER, THE COOLING OF THAT EQUIPMENT IS NOT TAKEN INTO CONSIDERATION IN THIS REPORT.

Plan A—Uses a Conventional Single Level Raised

Plan B—Uses the Interstitial Electro-Mechanical Distribution System

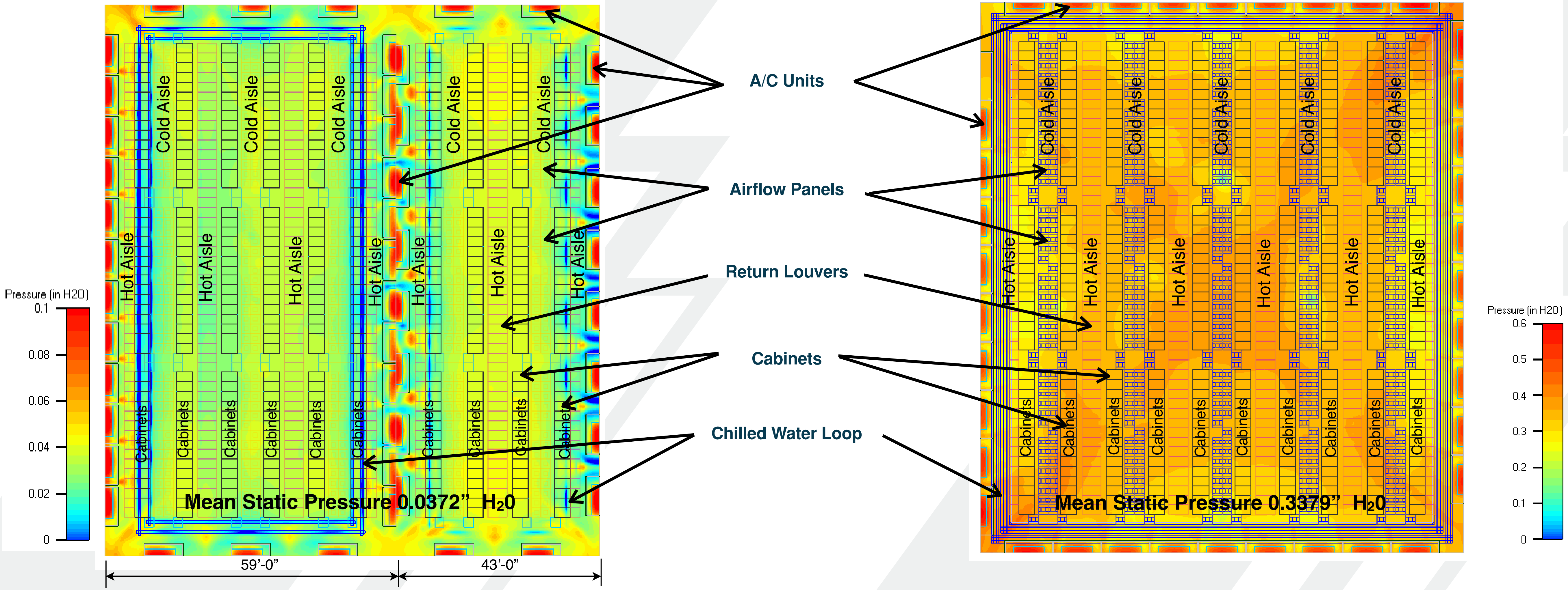

Fig 1—This is a CFD plot showing the underfloor pressure 17" below the underside of the floor panel, which is the mid-height of the air plenum.

Fig.2—This CFD plot shows the underfloor static pressure 10.5" above the concrete floor, which is the mid-height of Interstitial's dedicated pressurized plenum.

This plan using a single-level floor requires 50 Liebert 529C AHUs units, some positioned at the perimeter of the room and, because of the 102' X 114' overall dimension, some units also had to be installed in the middle of the room. This creates two underfloor piping loops, breaks up the cabinet continuity, and affects the overall flexibility of the space.

This configuration is dictated by the fact that when AHUs are used with a conventional raised floor the lack of adequate static pressure means that maximum air distribution, under ideal conditions, is limited to the area reached by the throw distance of a unit's fan. This maximum is 30 feet in a crescent shaped pattern. Especially when floor heights are increased beyond 18" this is a pretty accurate theoretical figure. But the maximum distribution performance, which is really not that impressive to begin with, will almost always be drastically reduced under practical conditions when airflow encounters the obstructions and leaks identified above.

The mean static pressure across the space is 0.0372" $H_2$0, which is nowhere near the pressure needed to force enough air through the grates to reach the top of the cabinets. At some panels the air pressure is actually negative. Fig. 5, Table 3, shows that at this low static pressure each air grate only delivers about 800 CFM (highlighted in Yellow), when a total of 1,263 CFM is required (Fig. 6, Table 4, highlighted in Yellow). That is a significant and unacceptable deficit.

Design Parameters		
Conventional Floor		Interstitial
50 Liebert 529C	Cooling Units	37 Liebert 740C
12,400 ea.	CFM per Unit	16,500 ea.
620,000	Total CFM	610,500
1,179	Total Sensible Cooling	1,174
None	Redundancy	N+1
3,750 kW	Total Equip Load (excl. UPS & PDU)	3,750 kW
36"	Finished Floor Height	36"
102' X 114'	Room Dimensions	100' X 114'
11,628	Square Footage	11,400
16'	Ceiling Height	16'
348	Watts/sf	355
199/hour	Air Change Rate	201/hour

This plan requires 37 Liebert 740C AHUs, which are larger capacity units than the 529C's used in Plan A. They can be positioned along the outer perimeter of the room, and in contrast to the other plan there is no need to divide the space into two sections. This is because Interstitial's integrated electro-mechanical distribution system provides a pressurized air distribution plenum that allows conditioned air to be moved in excess of 150 feet, a far greater distance than is possible under a single-level floor even under ideal conditions.

The mean static pressure in this design is 0.3379" H^2O, almost ten times that of Plan A. For this plan the engineer was compelled to use a different scale for the colors ranging from 0 to 0.6" $H_2$0 compared to 0 to 0.10" $H^2$0 in Plan A. Even with the significantly greater pressure achieved with the Interstitial design there is no additional use of energy as compared to the plan using a conventional single-level floor.

Fig., 5, Table 3, shows that at 0.3379" $H^2$0 static pressure an airflow panel can deliver up to 2,675 CFM, and according to Fig. 6, Table 4, the10 kW cabinet heat load only requires 1,263 CFM. This means that the dampers on the airflow panels could be closed to almost 50%. Or, as an alternative, it would be possible to install half the number of airflow panels by alternating them in the cold aisle with solid panels.

CFMs Through Airflow Panels

		Single Level Floor		TIER E/A	
	CFM	Quantity	%	Quantity	%
	>1563	24	6.4%	0	0.0%
	1463-1563	48	12.8%	62	16.5%
Baseline	1363-1463	62	16.5%	180	48.0%
(+/- 100 CFM	1163-1363	55	14.7%	129	34.4%
	1063-1163	24	6.4%	2	0.5%
	963-1063	39	10.4%	1	0.3%
	863-963	13	3.5%	1	0.3%
	763-863	19	5.1%	0	0.0%
	0-763	72	19.2%	0	0.0%
	<0	19	5.1%	0	0.0%
Total Panels		**375**		**375**	
Percentage Baseline and Above			**50.4%**		**98.9%**

Fig.4—Table 2, Shows a comparison of the CFM flow through the airflow panels in both designs. Note the single-level floor has 19 panels with negative airflow.

Table 2 to the Left shows the number of airflow panels within a variety of CFM ranges for each plan. The telling difference between the plans is revealed when measuring the CFM through the airflow grate. The Base Line (Yellow) is the ideal air required for each panel in a room of 10 kW cabinets. There are significant performance and precision delivery improvements when using Interstitial. A remarkable 98.9% of the airflow panels deliver the Base Line or more air to cool the cabinets, compared to only 50.4% with the single-level floor

Airflow Through Grate

Static Pressure Inches H_2O	Opposed Blade Damper 100% Open	Opposed Blade Damper 75% Open	Opposed Blade Damper 50% Open
0.01	460	334	212
0.02	651	473	300
0.03	**797**	**579**	**368**
0.04	920	668	425
0.05	1,029	747	475
0.1	1,455	1,057	671
0.15	1,782	1,294	822
0.2	2,057	1,494	949
0.25	2,300	1,671	1,061
0.3	2,533	1,840	1,147
0.31	2,580	1,874	1,168
0.32	2,628	1,908	1,191
0.33	**2,675**	**1,943**	**1,212**
0.34	2,719	1,975	1,234
0.35	2,763	2,006	1,255

Fig.5—Table 3, Shows the CFM flow through the airflow panel used in this comparative analysis.

CFM Required per Cabinet at Different kW

Heat Load		Temperature Differential 25°F		
kW	Ton per Cabinet	ΔT °F	CFM per Ton	Total CFM Req'd.
2.5	0.71	25	444	316
5	1.42	25	444	631
7.5	2.13	25	444	947
10	**2.84**	**25**	**444**	**1,263**
12.5	3.55	25	444	1,579
15	4.26	25	444	1,894
17.5	4.97	25	444	2,210
20	5.68	25	444	2,526
22.5	6.39	25	444	2,842
25	7.10	25	444	3,157
27.5	7.81	25	444	3,473
30	8.53	25	444	3,789

Fig.6—Table 4, Shows the CFM required to cool cabinets at different kW loads. In this instance a common 25ºF ΔT is used. That could vary, however, and thus change the required CFM.

Interstitial delivers the performance and reliability that is essential in today's critical environments and does so while providing both upfront and ongoing cost efficiencies

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