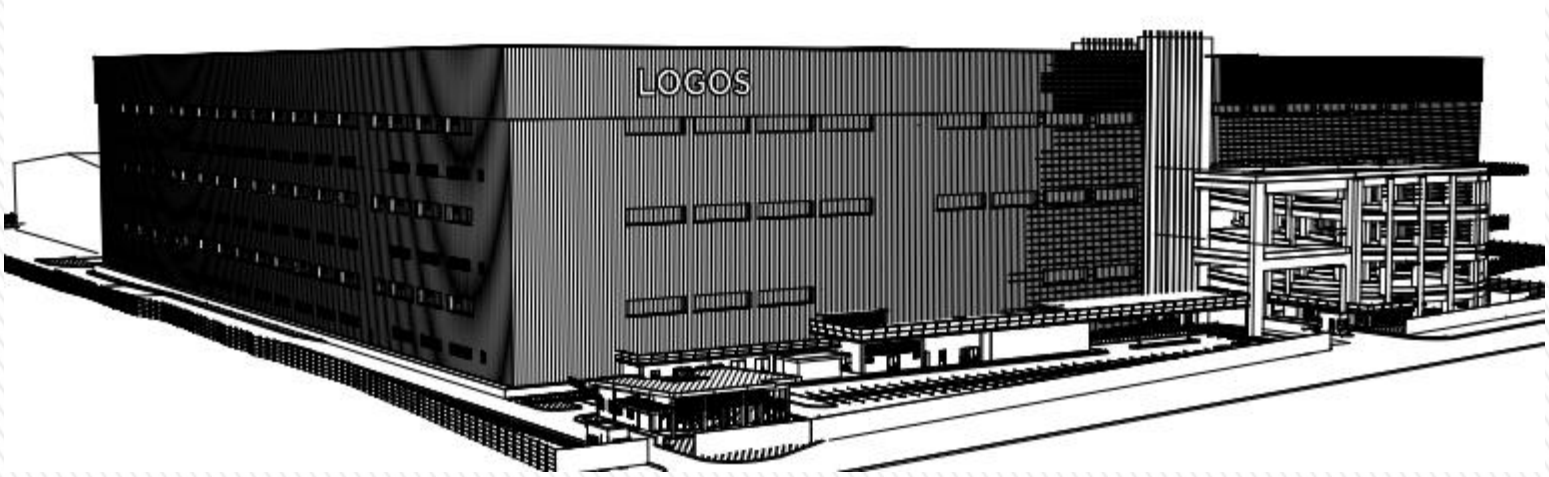
Progress Report

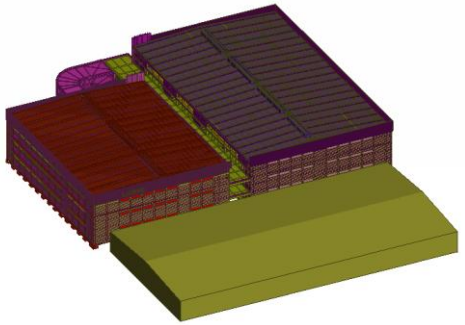
27 September 2021

To: Mr. Tony Elie – Director
Mr. Erwin Wong – Development Manager
LOGOS

By Dr. Dena Hendriana
Researcher at CCFD

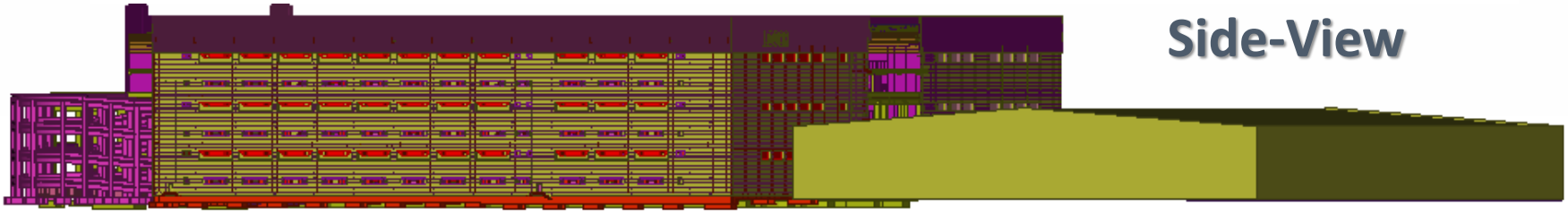


Building Design



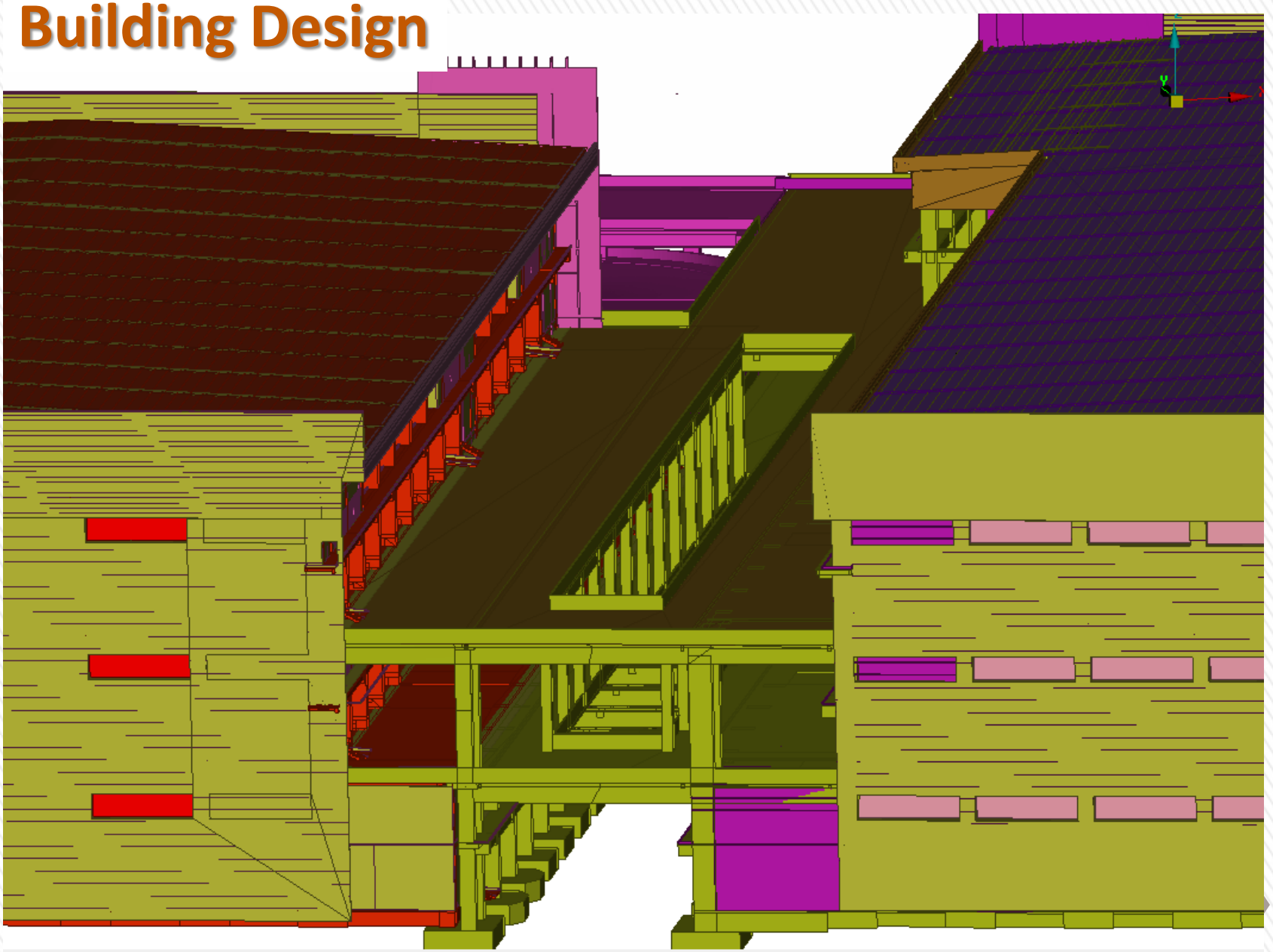
Old Design

Iso-View



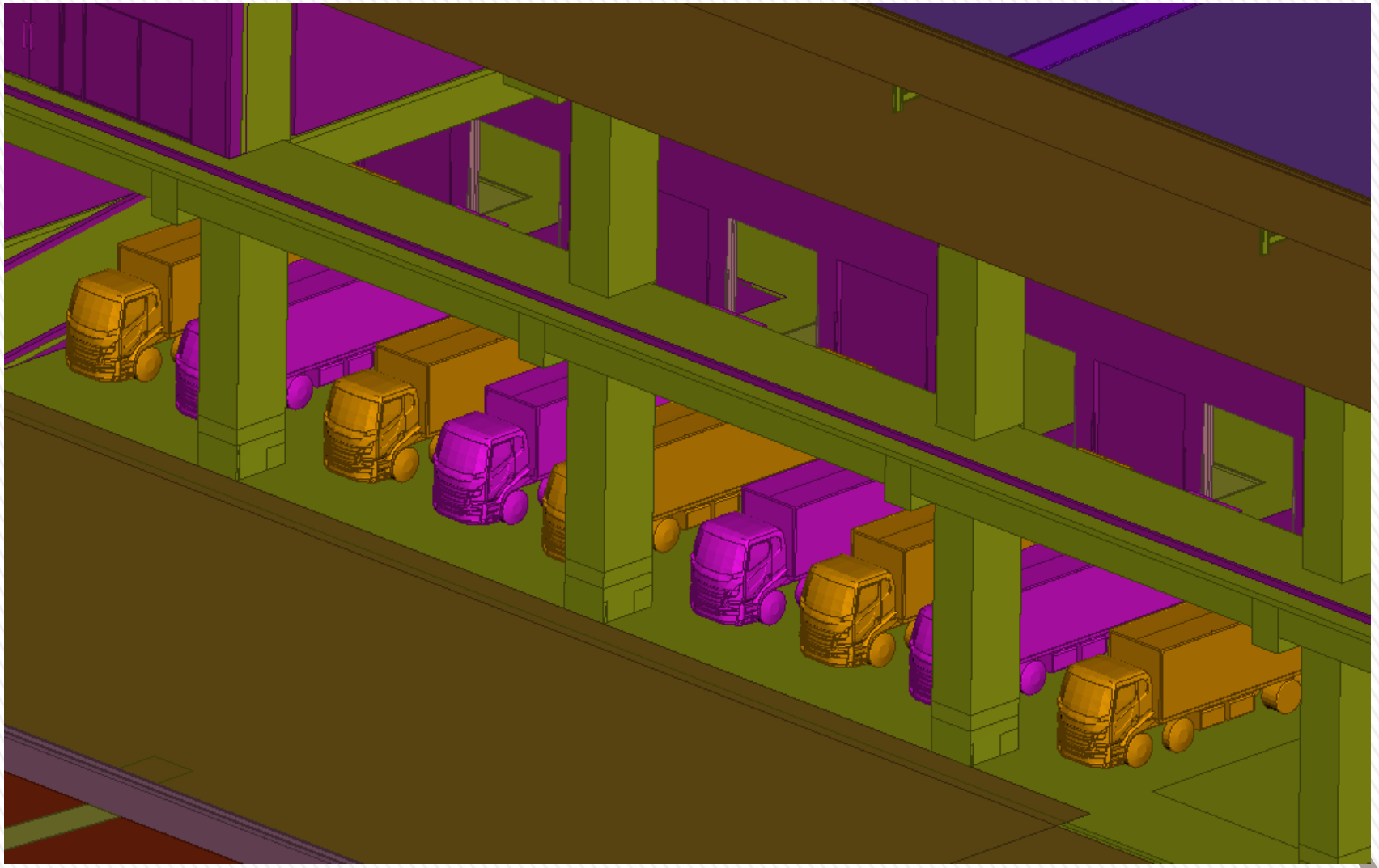
Side-View

Building Design



Driveway (1st, 2nd,3rd level)

Building Design



Full Truck Capacity in Loading Area

50% Truck On and 50% Loading Door Open

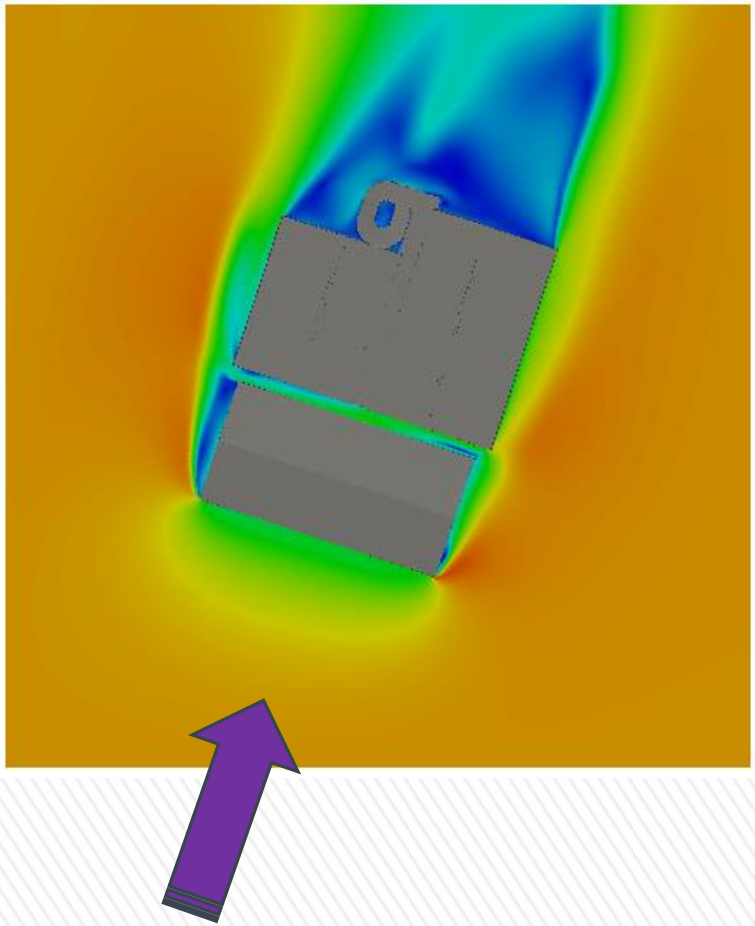
CFD Simulation Parameters

	Case	Wind from	Speed	Temp. u/n roof	Truck	WH Door	Ambient Temp.	Fan	Driveway Temp	WH Temp.	Priority
			km/h	Inside/Outside [C]	[%]	with Louvre	[C]				
Exisiting	1	S to N	0	40/55	75	All Closed	30	0			1
	2	S to N	25	40/55	100	All Closed	30	0			1
	3	S to N	0	40/55	75	All Closed	30		30	30	3
	4	S to N	25	40/55	100	All Closed	30		30	30	3
	5	S to N	0	40/55	75	50% Closed	30	0			5
	6	S to N	25	40/55	100	50% Closed	30	0			5
	7	S to N	0	40/55	75	50% Closed	30		30	30	7
	8	S to N	25	40/55	100	50% Closed	30		30	30	7
New	11	S to N	0	40/55	75	All Closed	30	0			2
	12	S to N	25	40/55	100	All Closed	30	0			2
	13	S to N	0	40/55	75	All Closed	30		30	30	4
	14	S to N	25	40/55	100	All Closed	30		30	30	4
	15	S to N	0	40/55	75	50% Closed	30	0			6
	16	S to N	25	40/55	100	50% Closed	30	0			6
	17	S to N	0	40/55	75	50% Closed	30		30	30	8
	18	S to N	25	40/55	100	50% Closed	30		30	30	8

Current simulation is Case 16

CFD Simulation Parameters

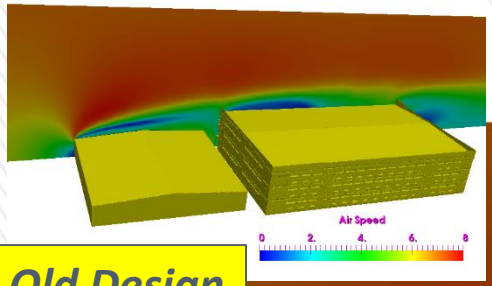
- Wind speed 25 kph (6.94 m/s)
- Direction of Wind: South - North
- Ambient Temperature 30C
- CeilingTemperature 40C
- Truck Capacity 100% full
- 50% truck loading doors closed
- 50% truck idling (T=45C)
- Driveway 3rd floor T=50C
- Initial Temperature 35C



Result outcome:

- Air velocity around the building
- Air velocity around driveway
- Air circulation inside warehouse A and B
- Air temperature around driveway
- Air temperature inside warehouse

CFD Simulation Result



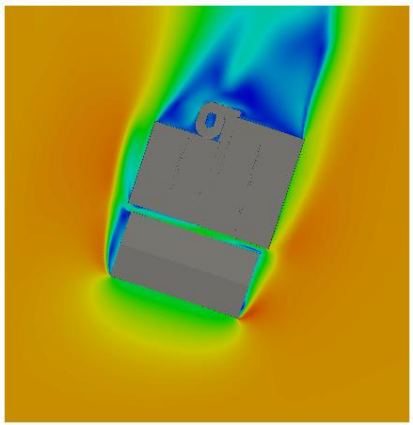
Old Design

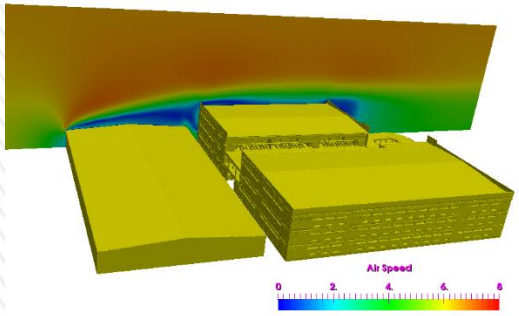
Wake flow

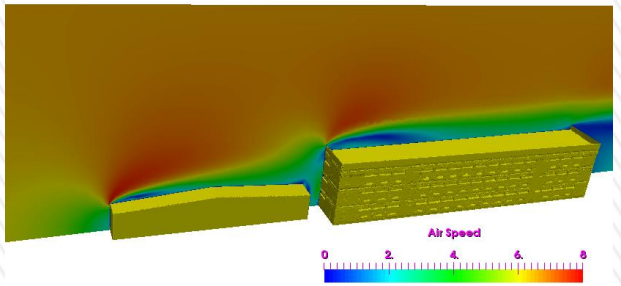
Stagnant area

Air Speed

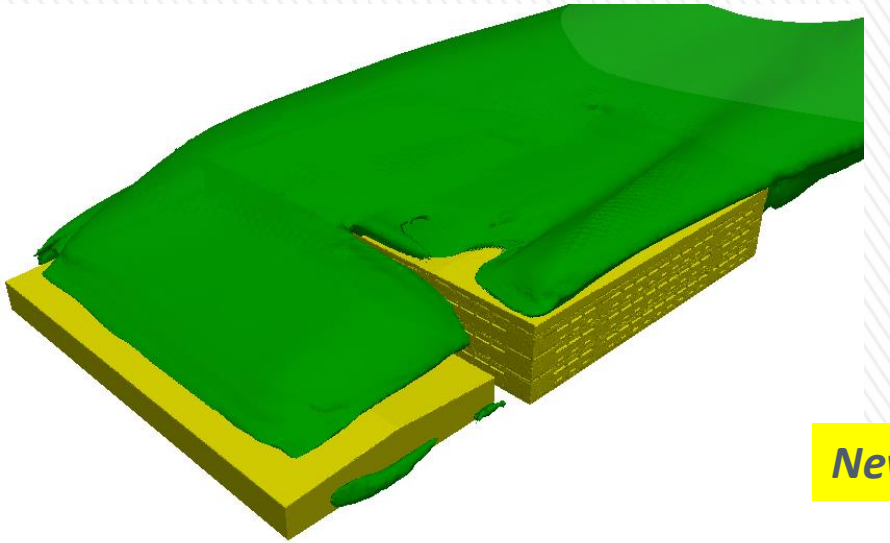
0 2. 4. 6. 8





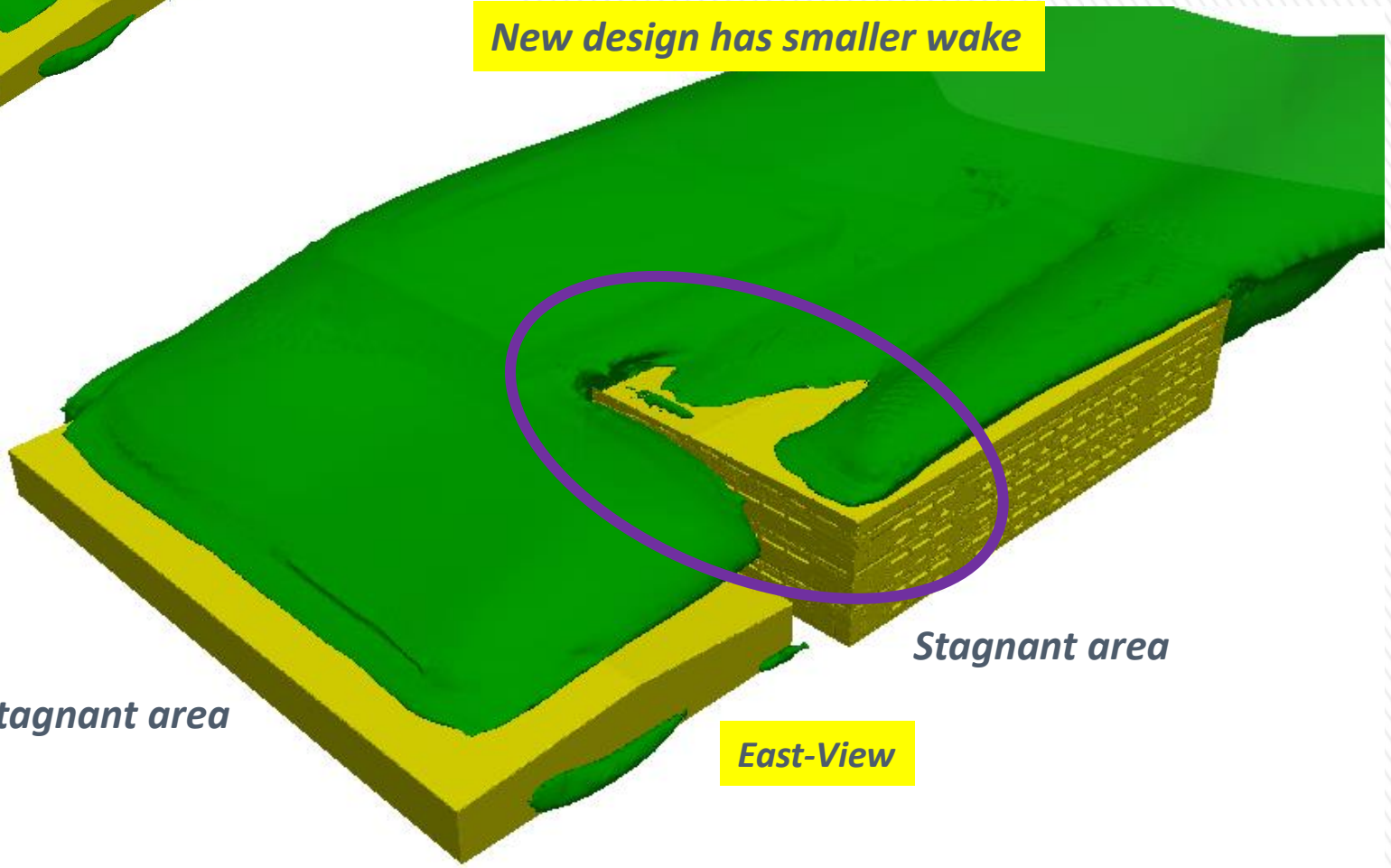


CFD Simulation Result
Wake Regions



Old Design

New design has smaller wake

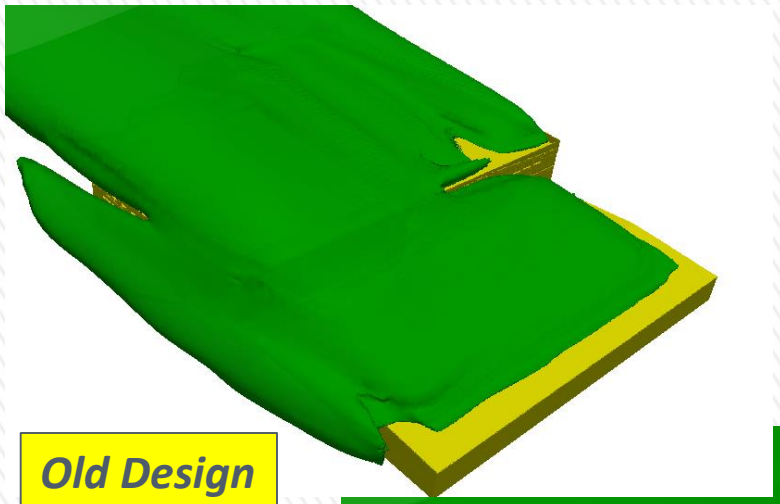


Stagnant area

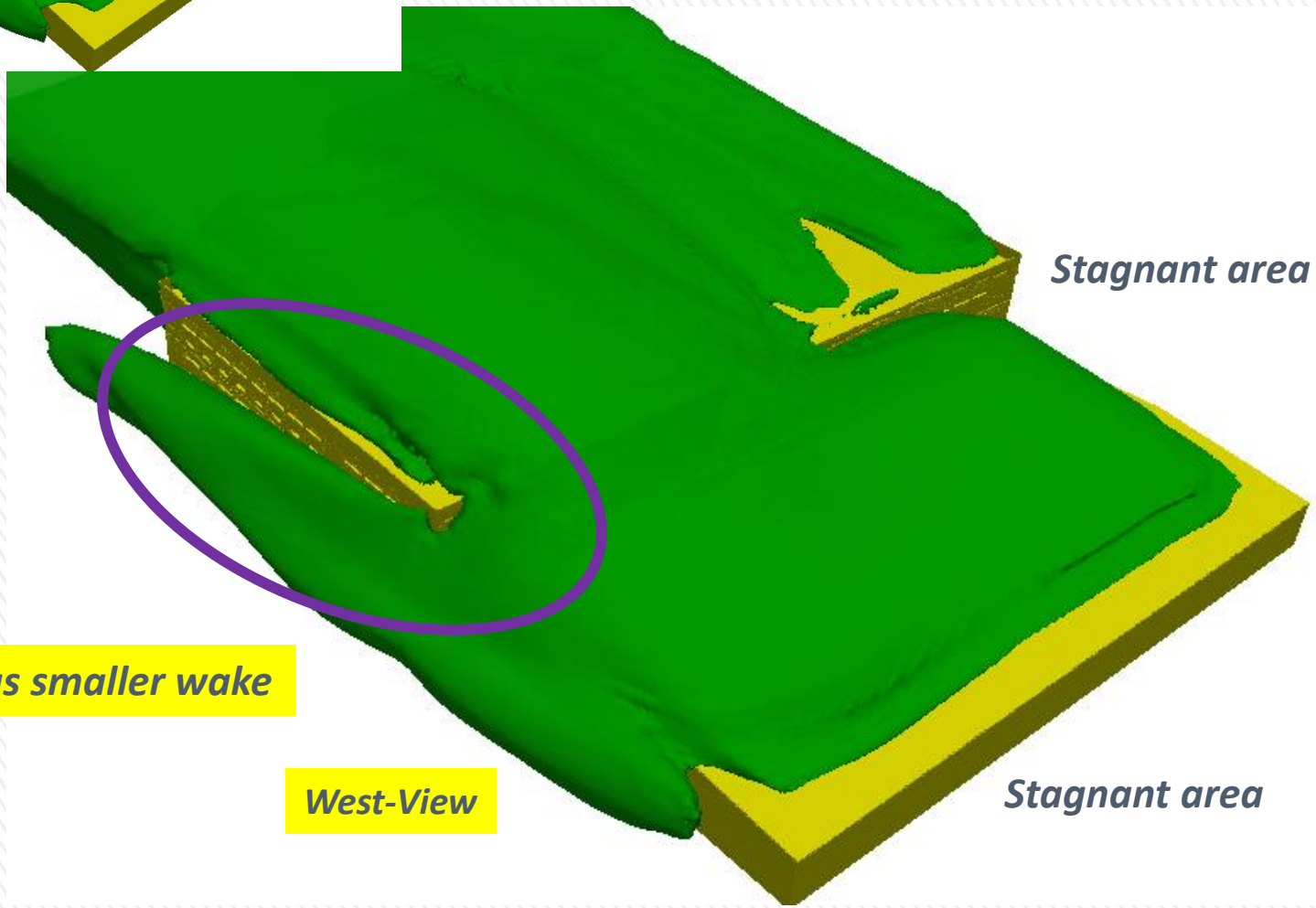
Stagnant area

East-View

CFD Simulation Result
Wake Regions



Old Design



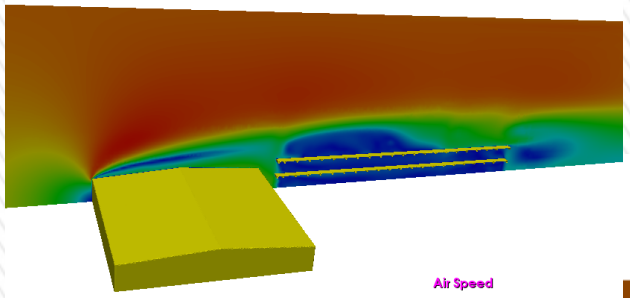
Stagnant area

New design has smaller wake

West-View

Stagnant area

CFD Simulation Result



Old Design

New design has similar air flow around the building

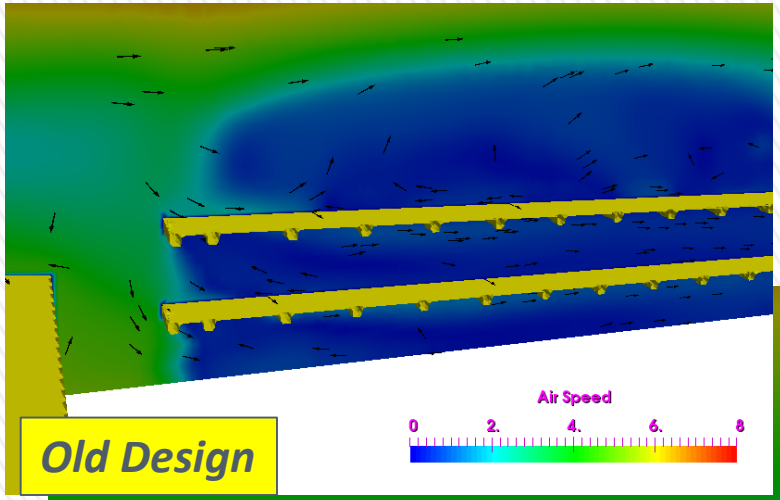
Wake flow

Stagnant area

Driveway area
1st, 2nd, 3rd Levels
Low air velocity in these areas

Air Speed
0 2. 4. 6. 8

CFD Simulation Result



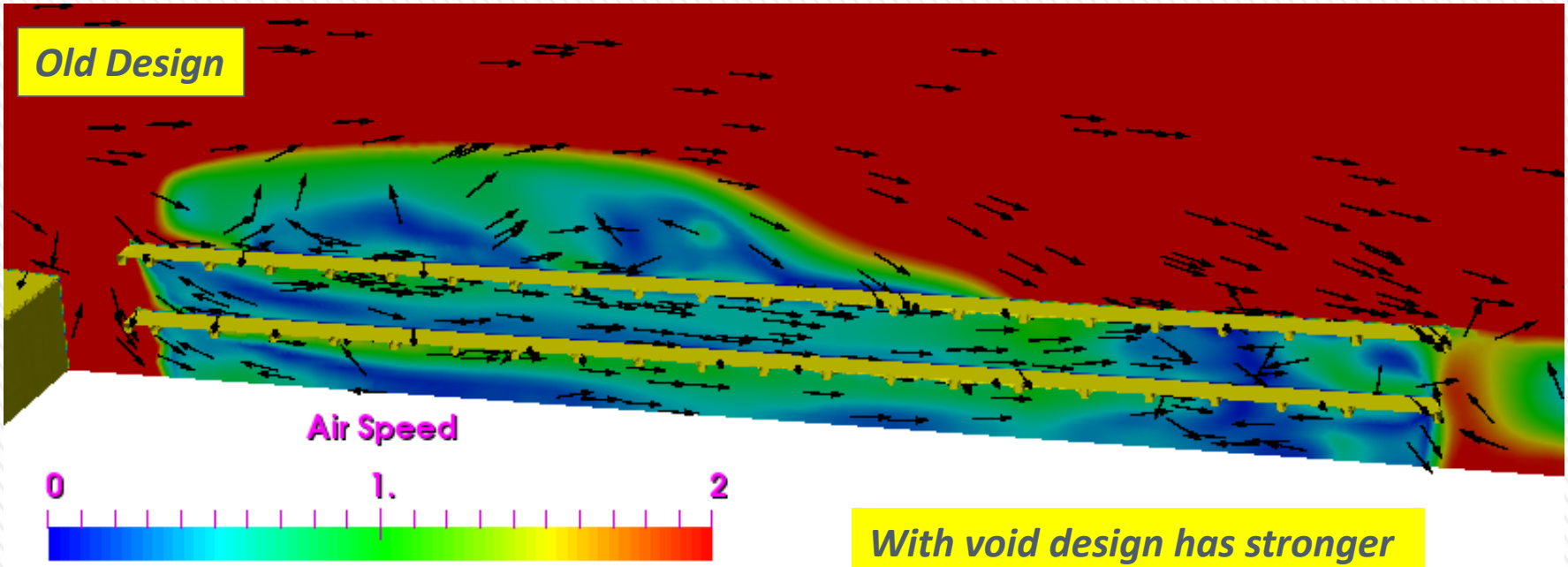
Old Design

New design has stronger air flow in Level 3 driveway.

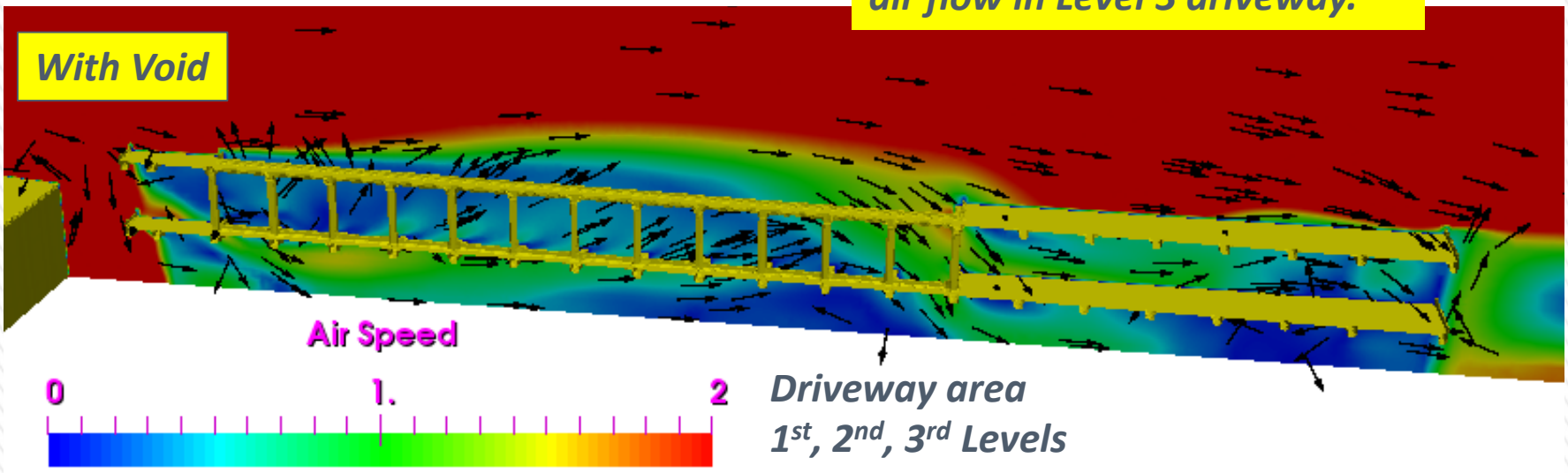
Driveway area
1st, 2nd, 3rd Levels
Low air velocity in these areas

Air Speed
0 2. 4. 6. 8

CFD Simulation Result

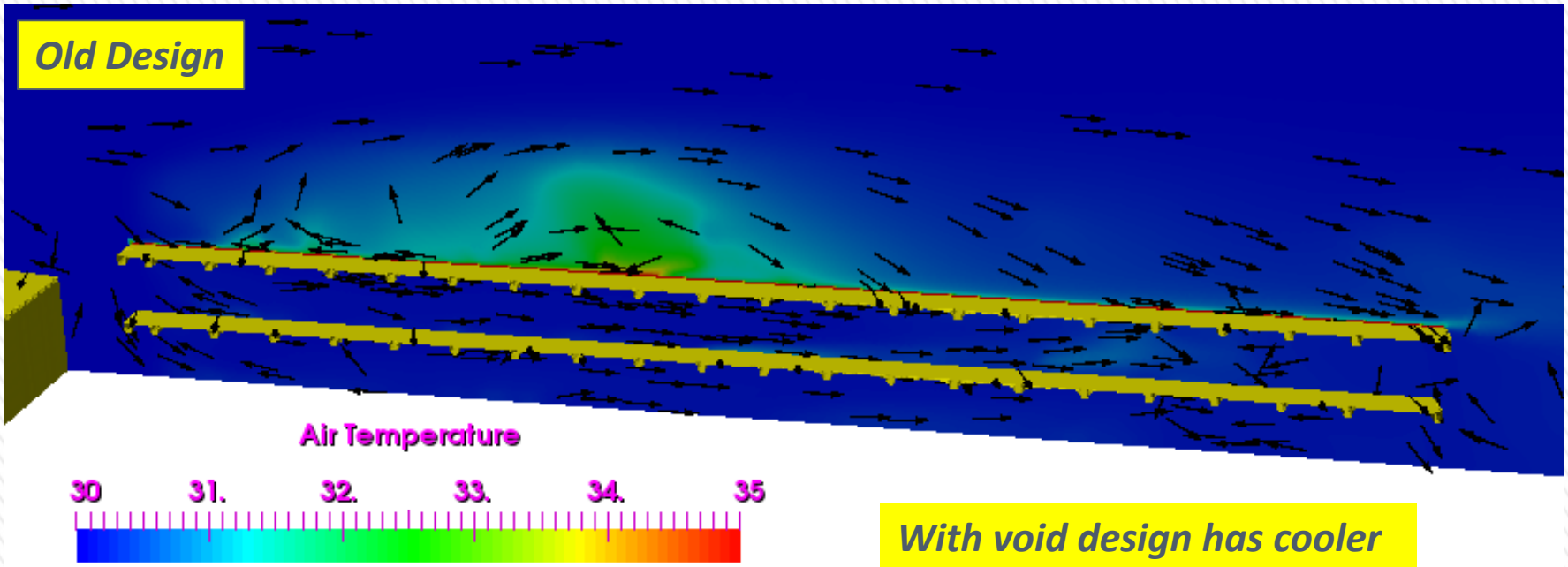


With void design has stronger air flow in Level 3 driveway.

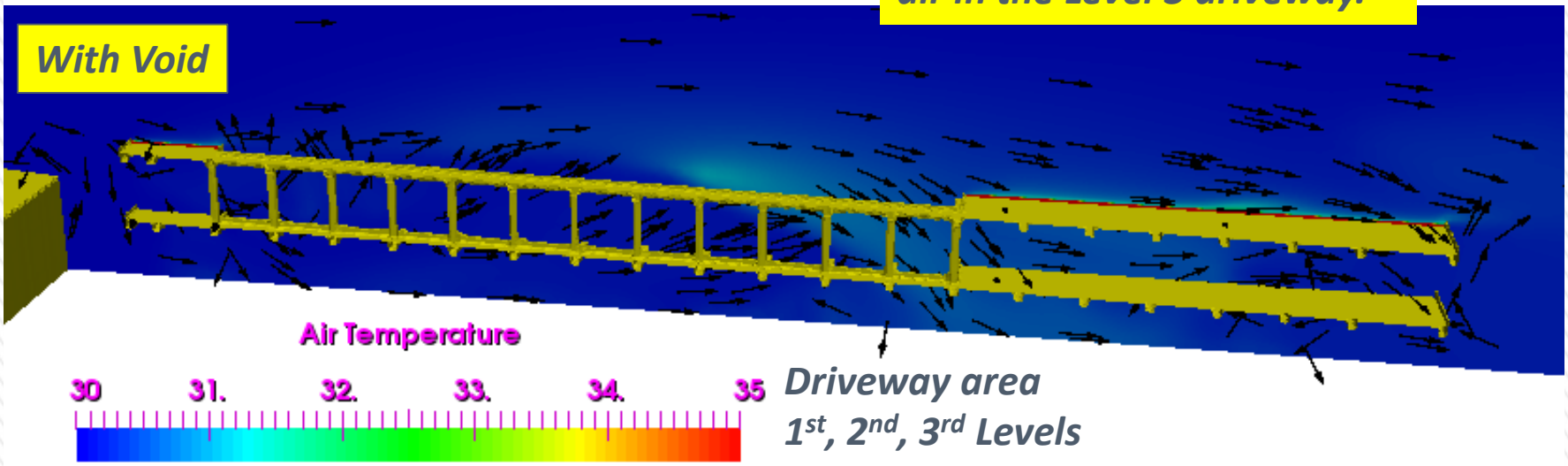


Driveway area
1st, 2nd, 3rd Levels
Low air velocity in these areas

CFD Simulation Result

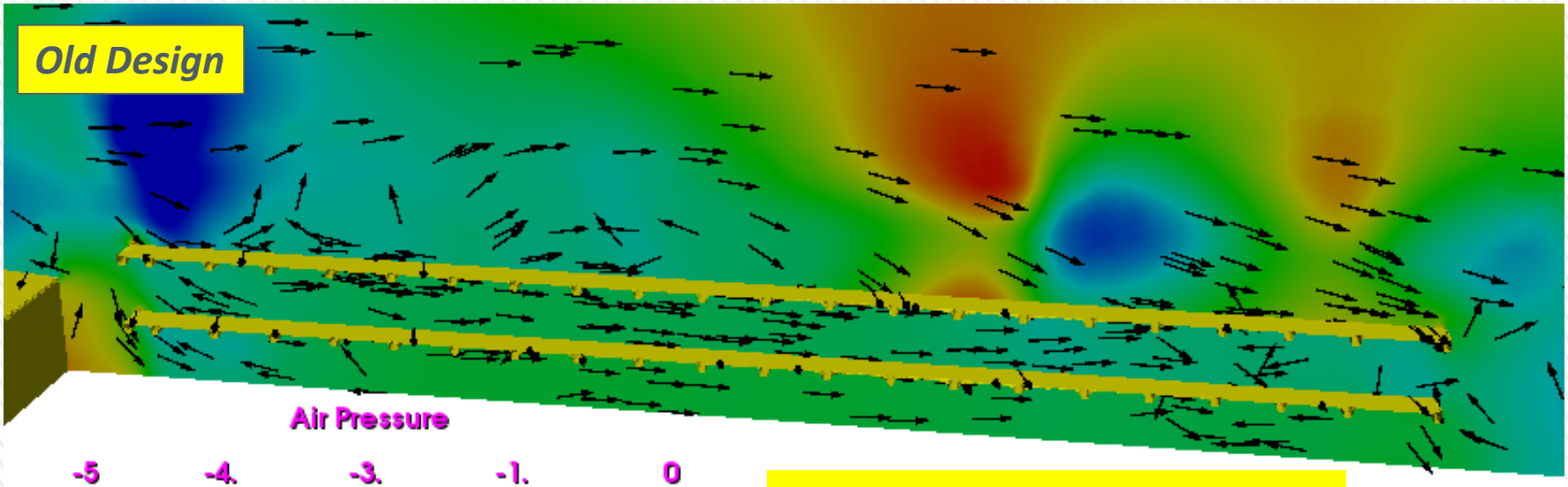


With void design has cooler air in the Level 3 driveway.

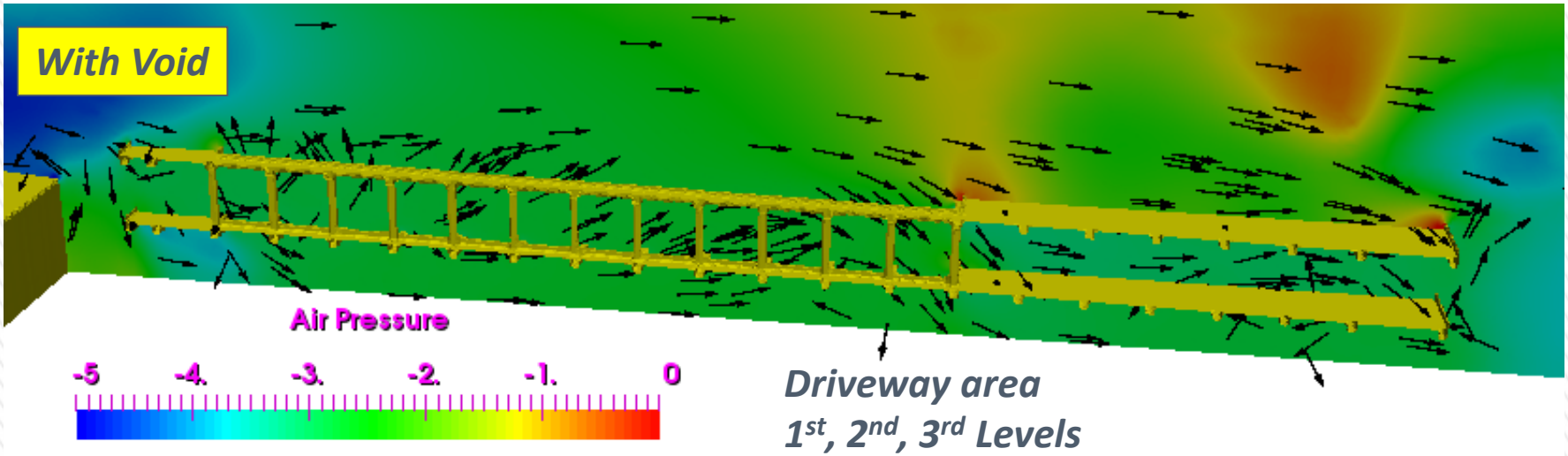


Driveway area
1st, 2nd, 3rd Levels
Low air velocity in these areas

CFD Simulation Result

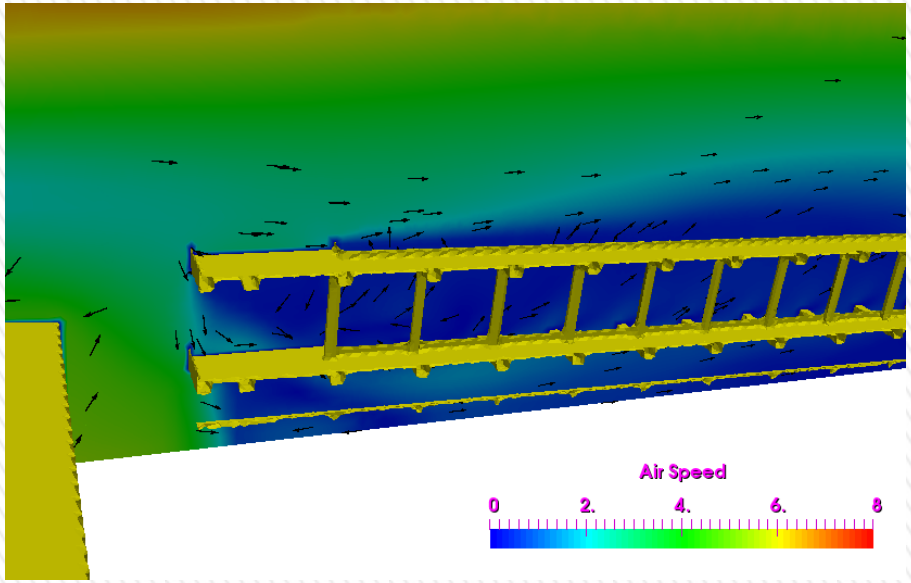


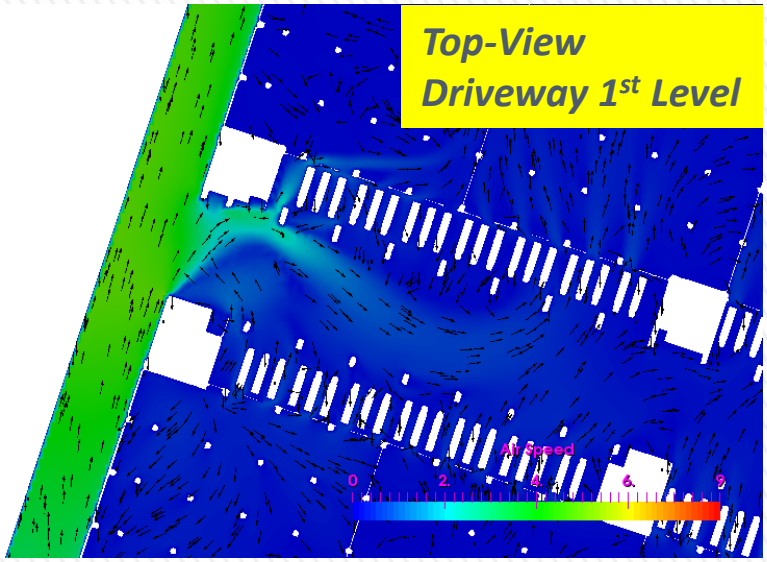
North end of Level 2 driveway has lower pressure.

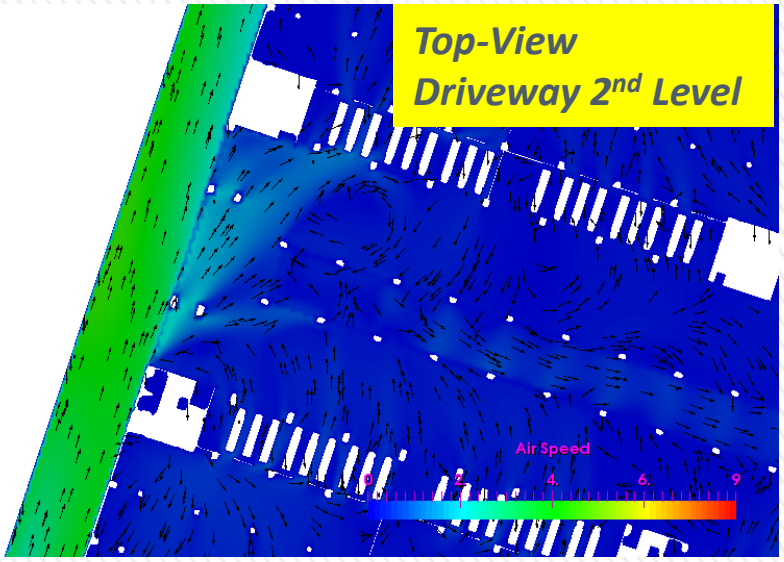


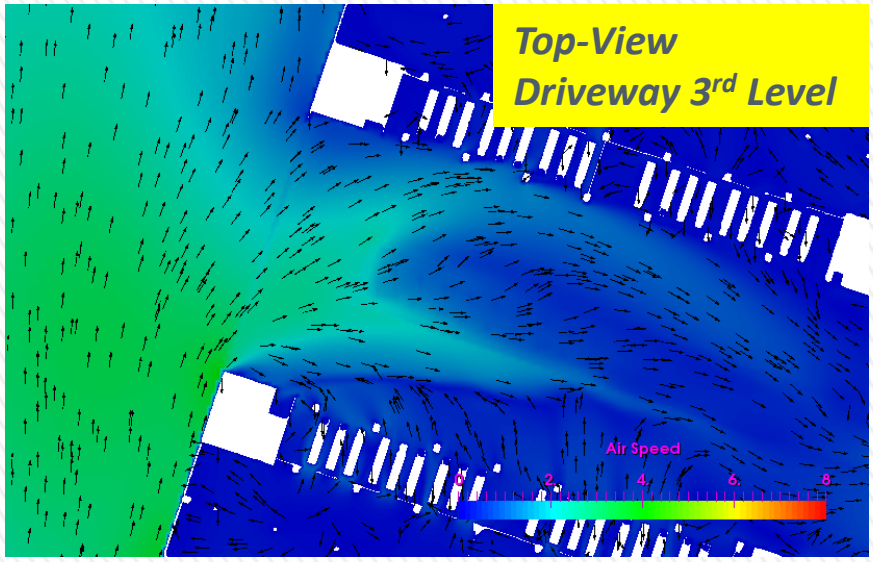
Driveway area
1st, 2nd, 3rd Levels
Low air velocity in these areas

CFD Simulation Result

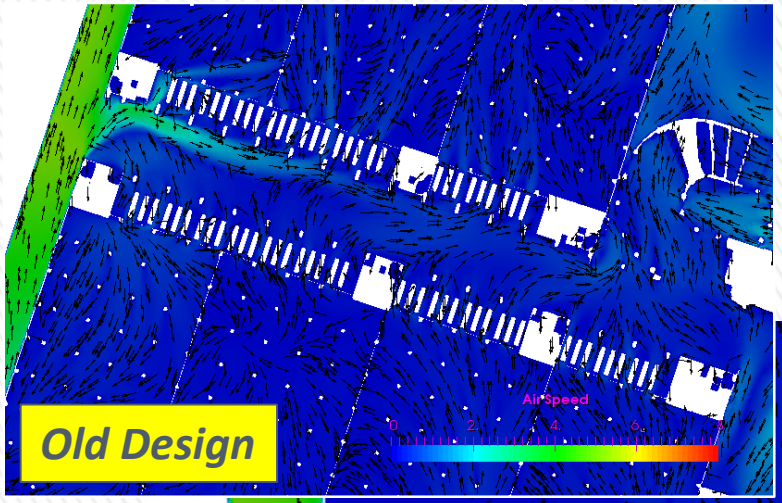








CFD Simulation Result

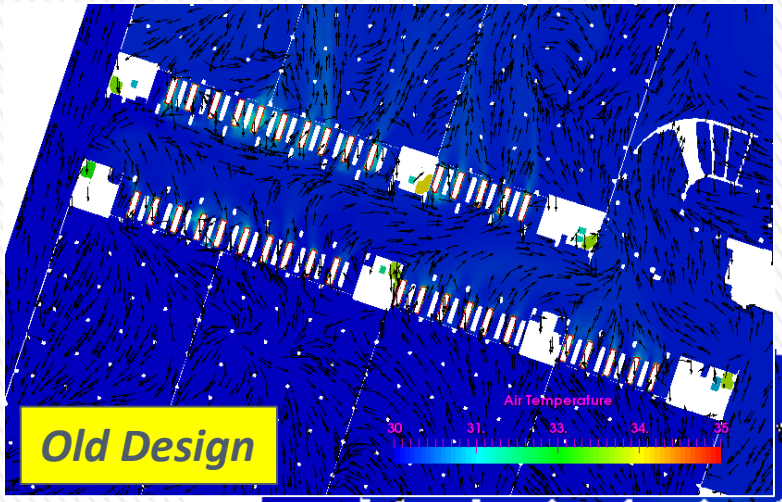


Old Design

Top-View
Driveway 1st Level
Plane 2 meter above floor
Low air velocity in this area

Air Speed
0 2 4 6 8

CFD Simulation Result

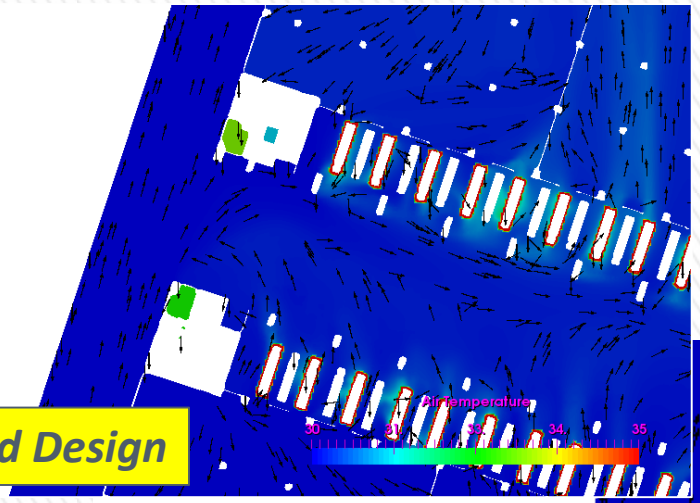


Old Design

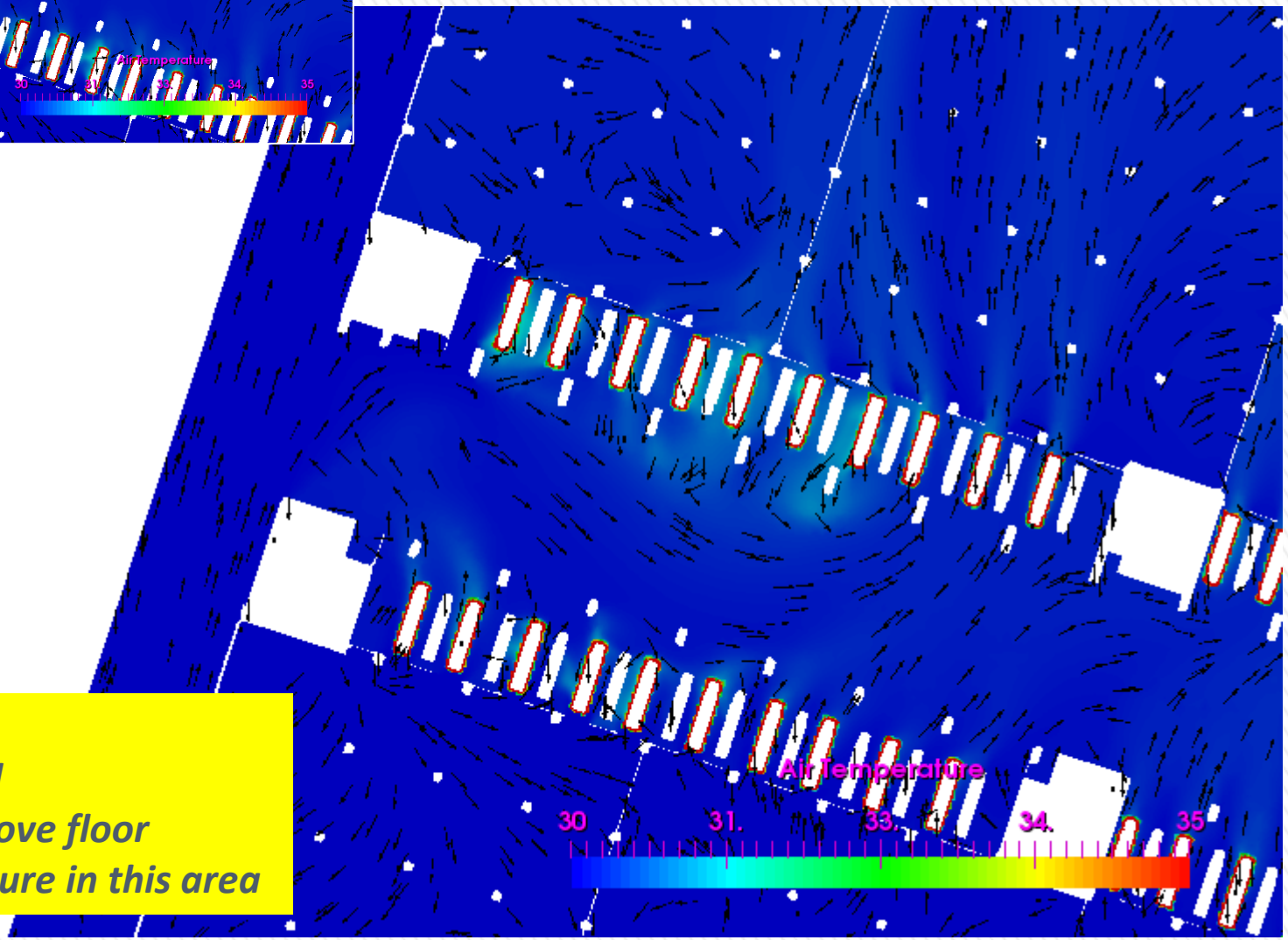
Top-View
Driveway 1st Level
Plane 2 meter above floor
Low air temperature in this area

Air Temperature
30 31. 32. 33. 34. 35

CFD Simulation Result

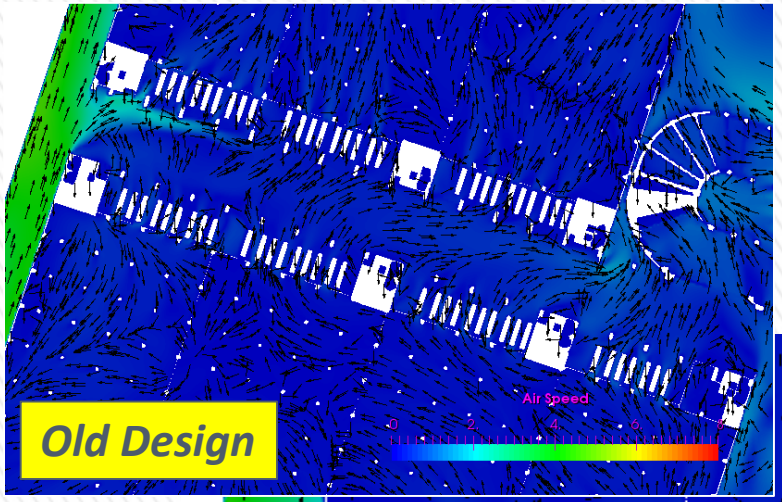


Old Design



Top-View
Driveway 1st Level
Plane 2 meter above floor
Low air temperature in this area

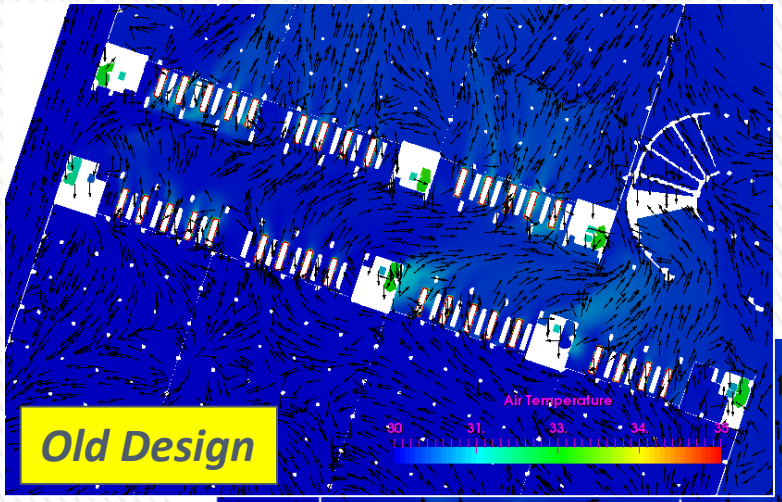
CFD Simulation Result



Old Design

Top-View
Driveway 2nd Level
Plane 2 meter above floor
Low air velocity in this area

CFD Simulation Result

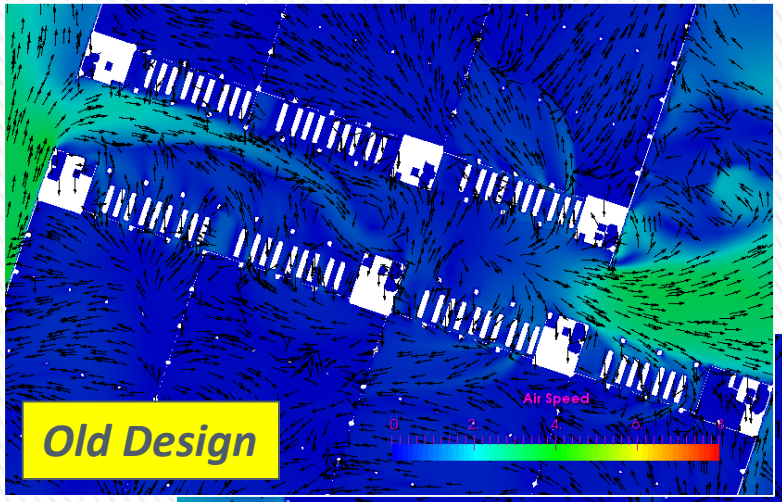


Old Design

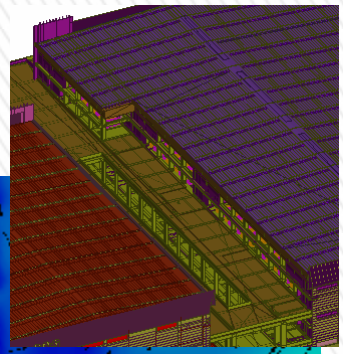
Top-View
Driveway 2nd Level
Plane 2 meter above floor
Low air temperature in this area

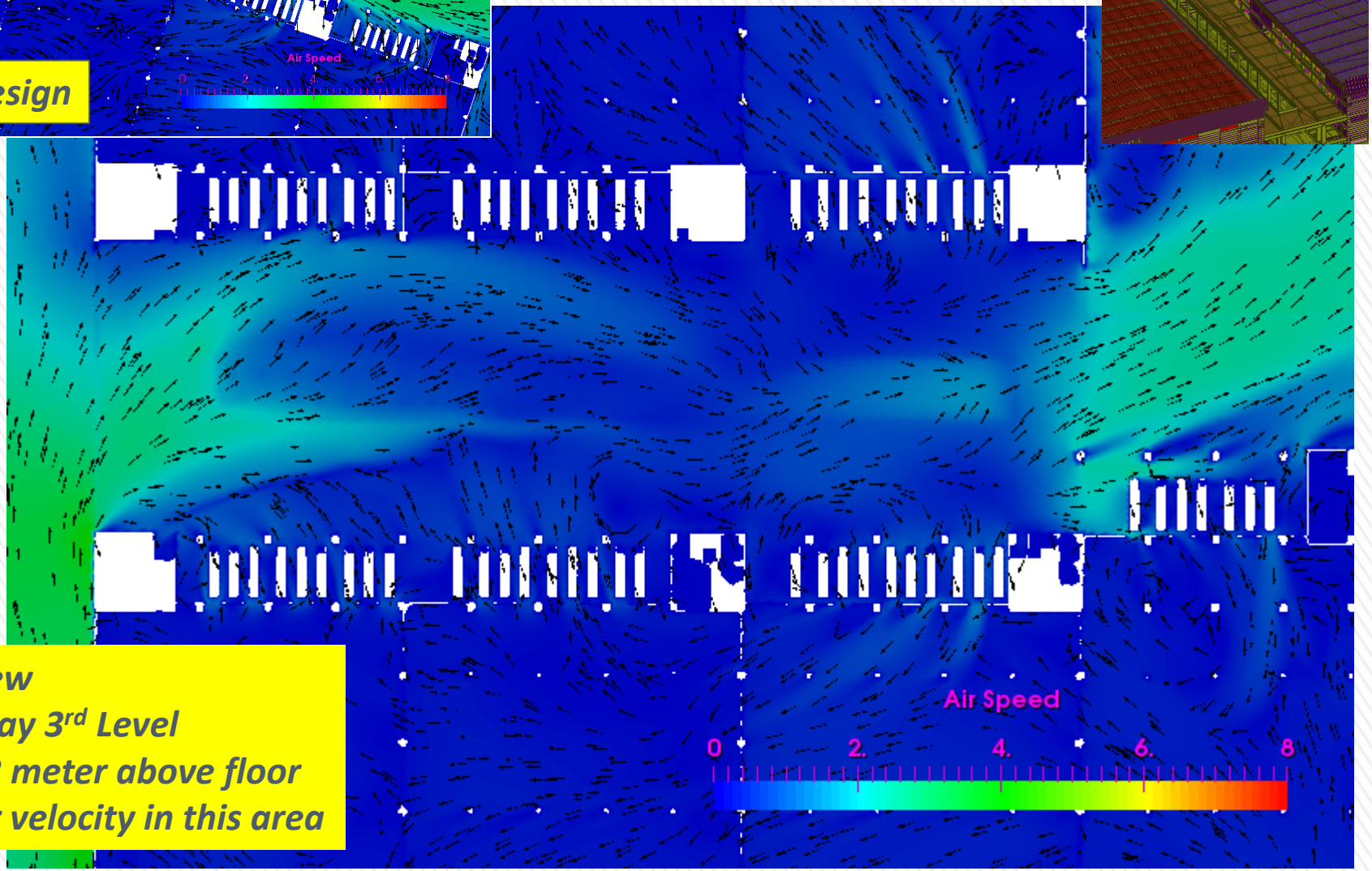
Air Temperature
30 31. 32. 33. 34. 35

CFD Simulation Result



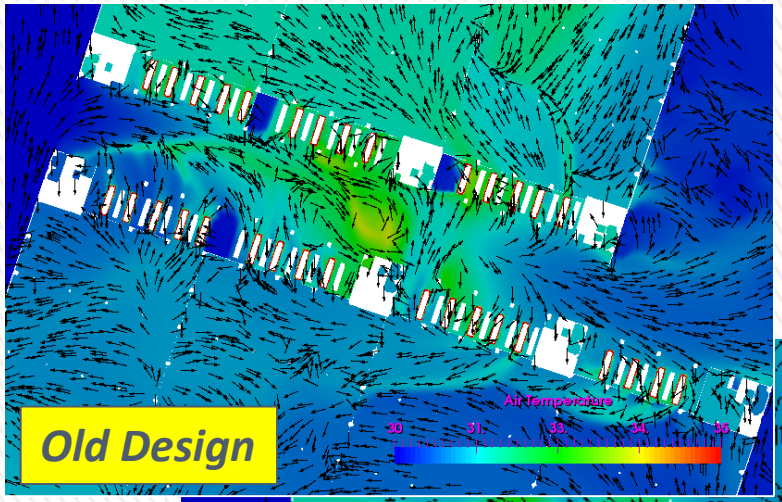
Old Design



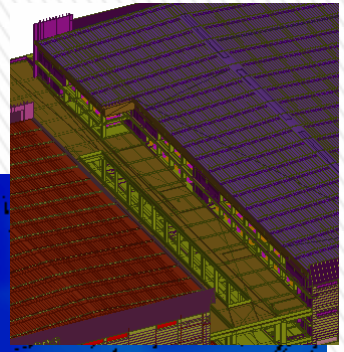


Top-View
Driveway 3rd Level
Plane 2 meter above floor
Low air velocity in this area

CFD Simulation Result

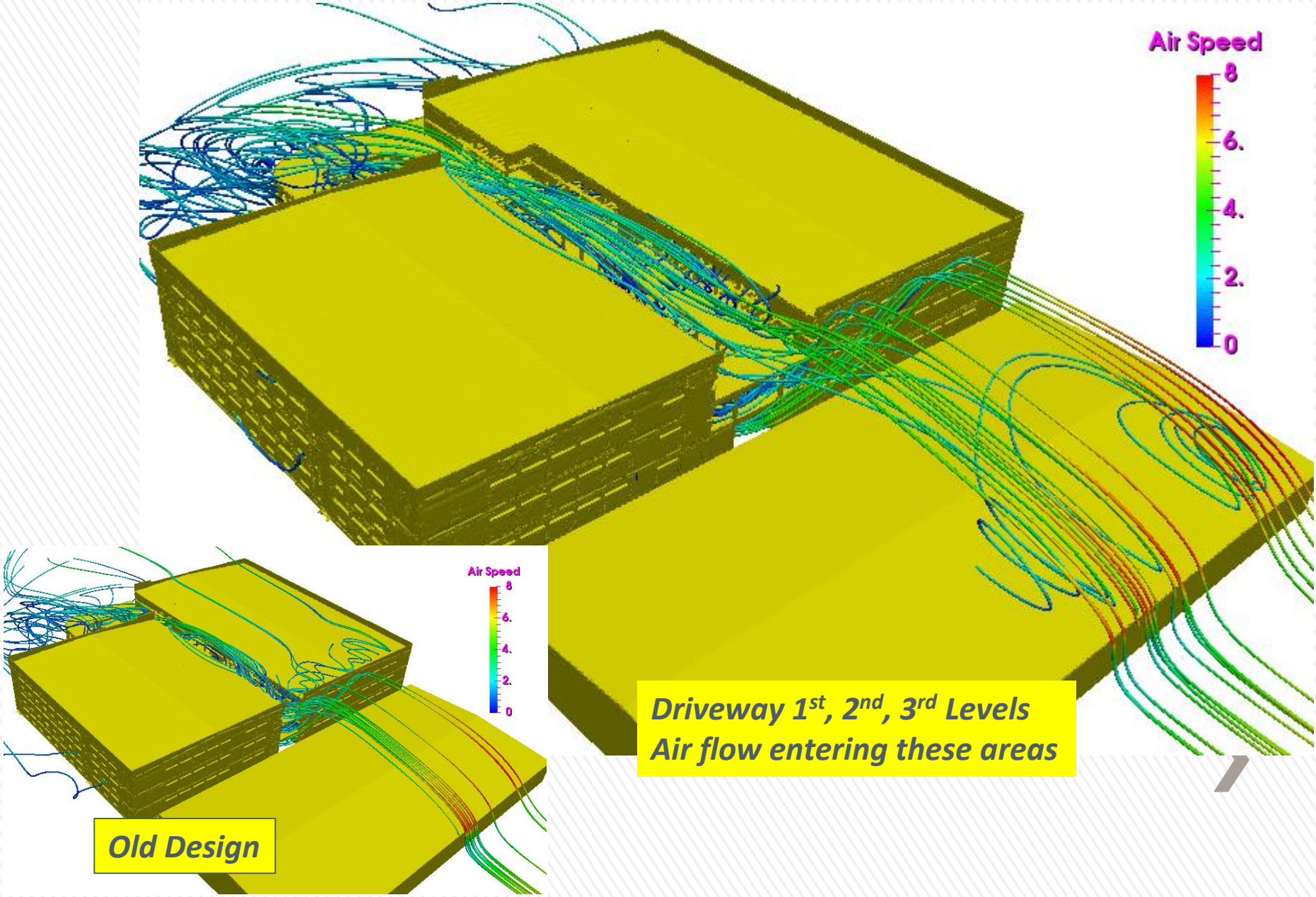


Old Design



Top-View
Driveway 3rd Level
Plane 2 meter above floor
Local high air temperature in this area, 33C

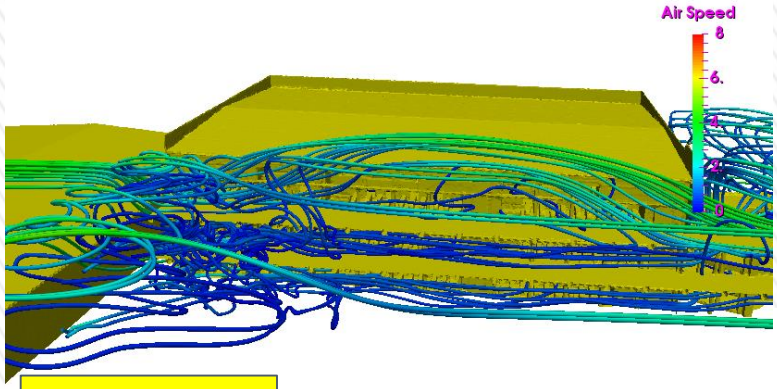
CFD Simulation Result



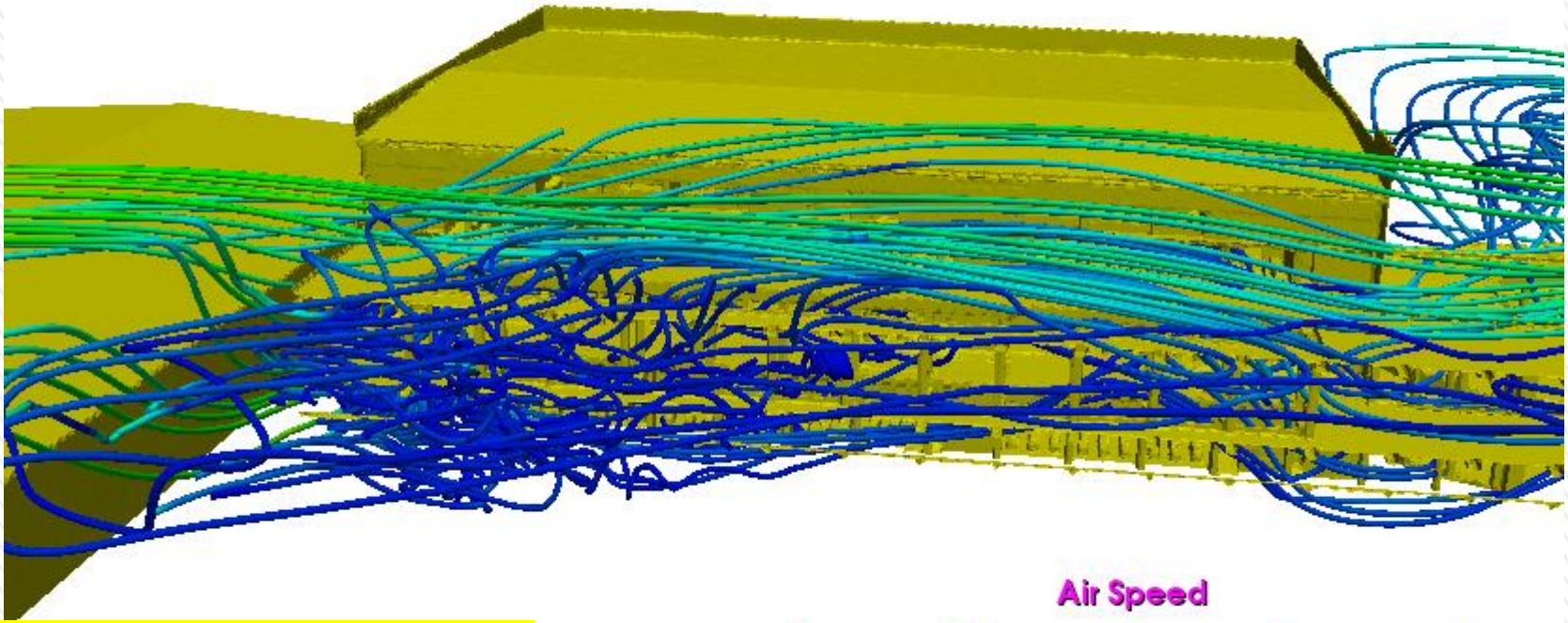
Driveway 1st, 2nd, 3rd Levels
Air flow entering these areas

Old Design

CFD Simulation Result

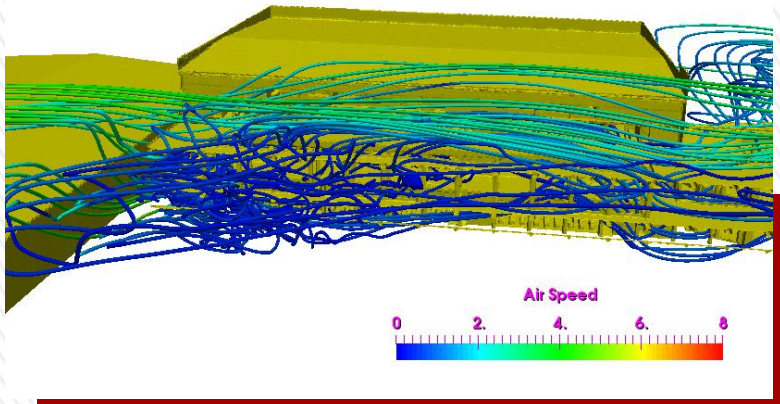


Old Design

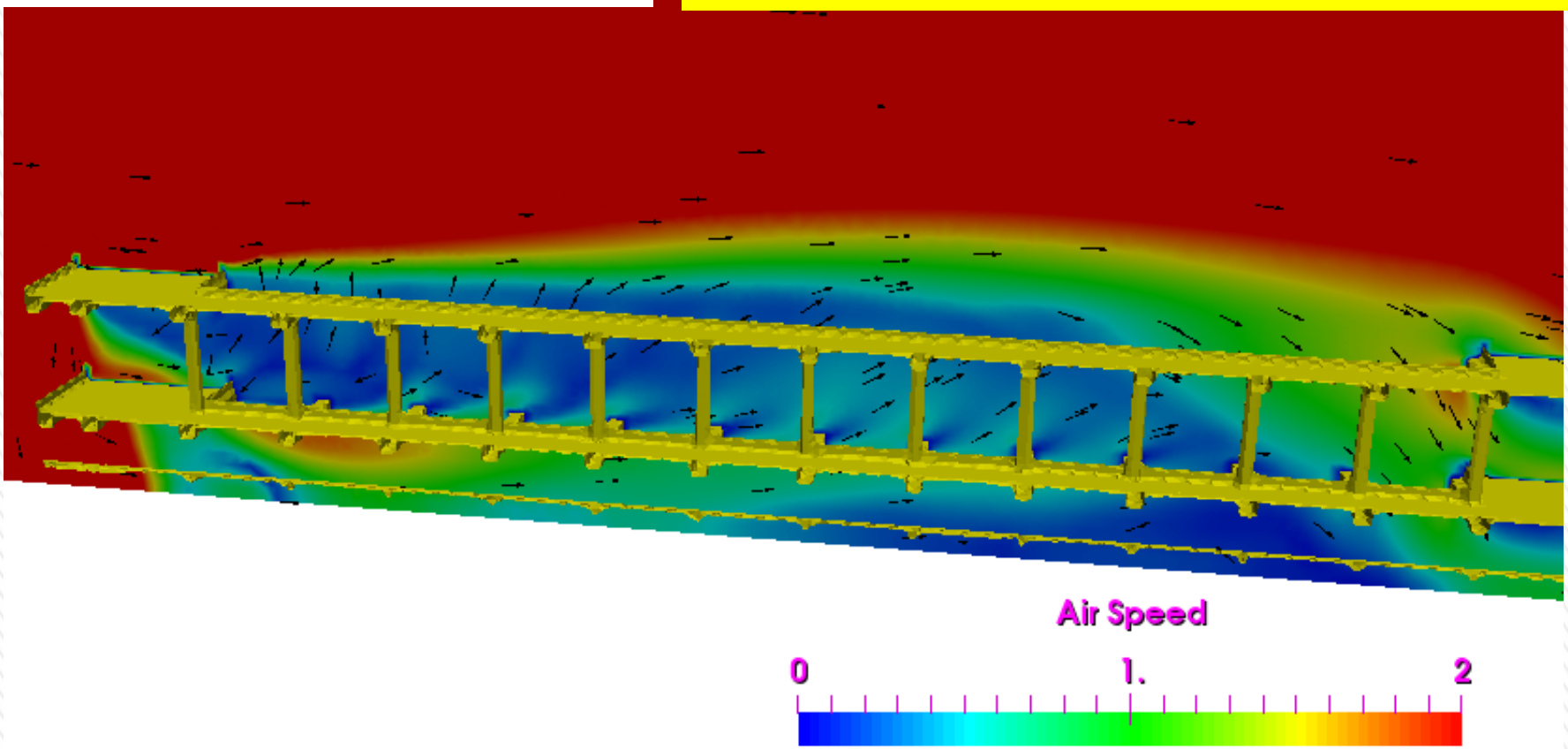


Driveway 1st, 2nd, 3rd Levels
Air flow entering these areas
Bottle neck at the front opening

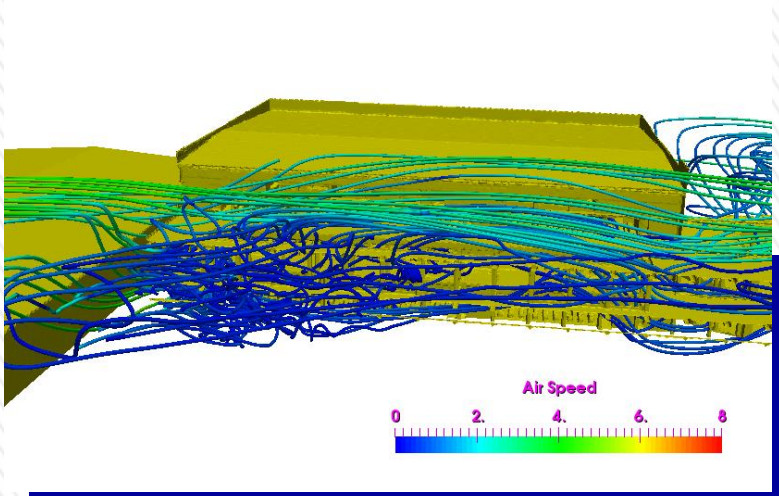
CFD Simulation Result



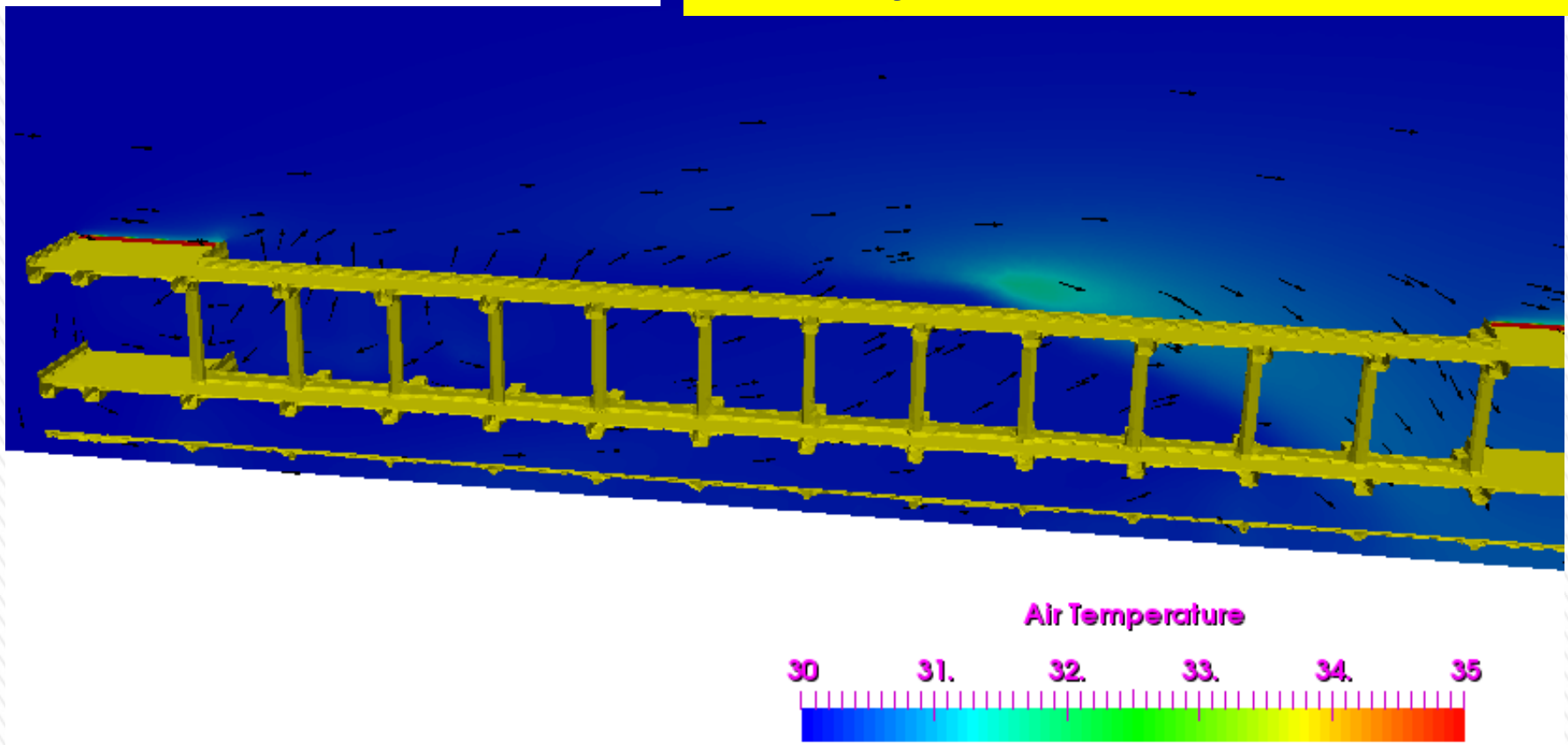
Void at the driveways
Air flow going from Level 1 to Level 3 at left area and from level 3 down to level 1 and 2 at right area.
Air speed of 1.5 m/s or less



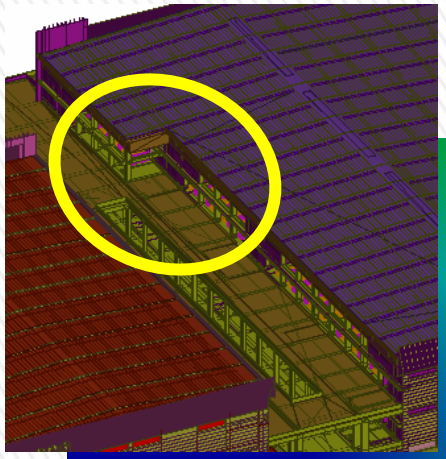
CFD Simulation Result



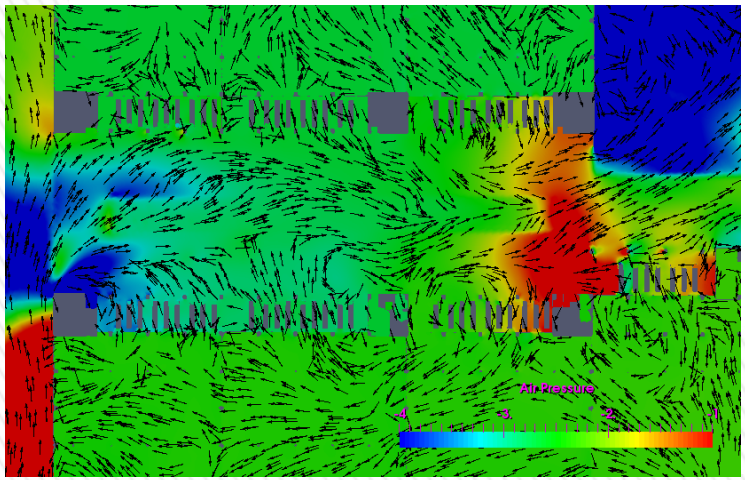
Void at the driveways
Air flow going from Level 1 to Level 3 at left area and from level 3 down to level 1 and 2 at right area.
Heated Air from level 3 to level 1 and 2.



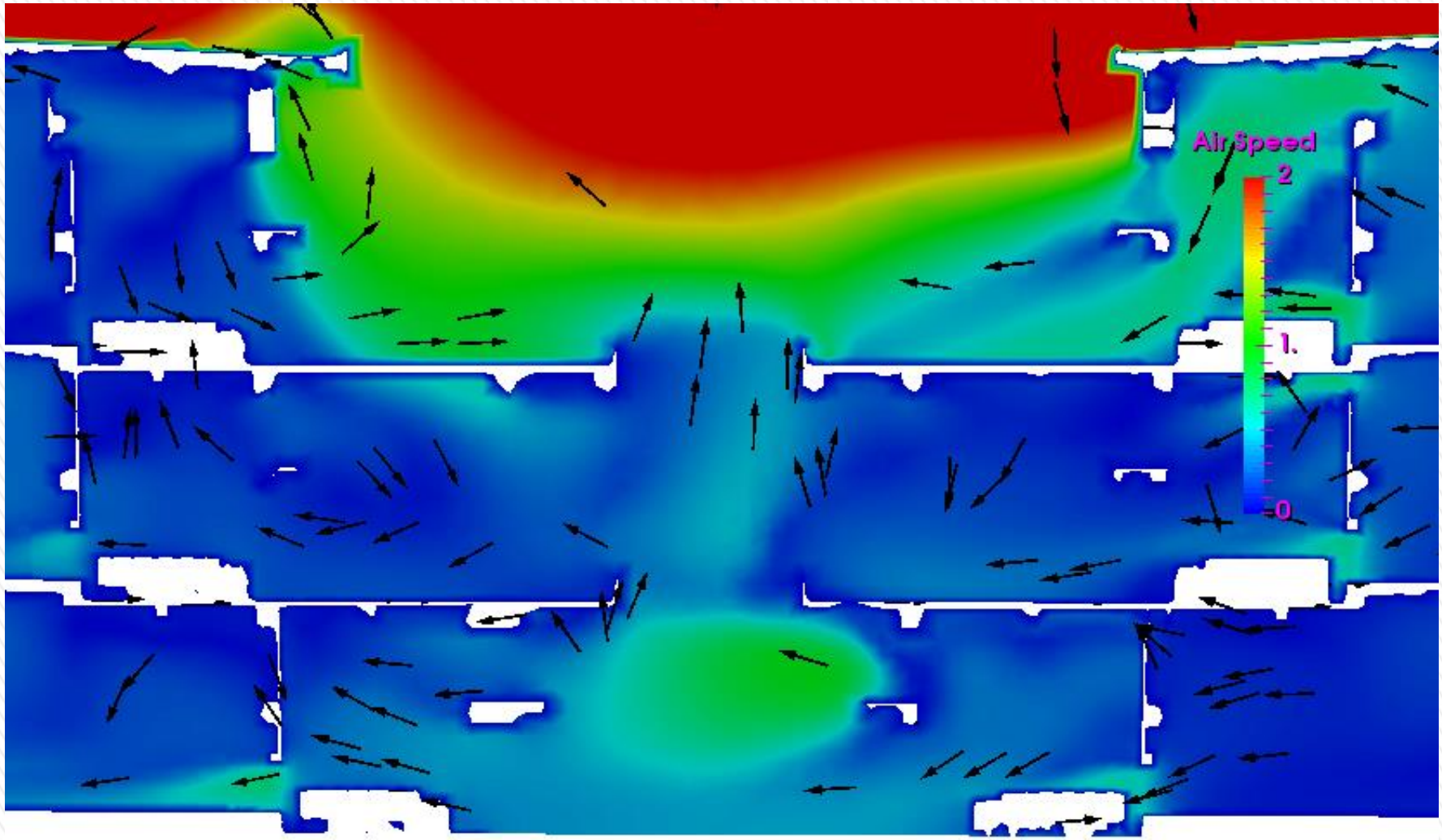
CFD Simulation Result



Void at the driveways
Relatively high pressure at right area due to flow impingement to Warehouse A.

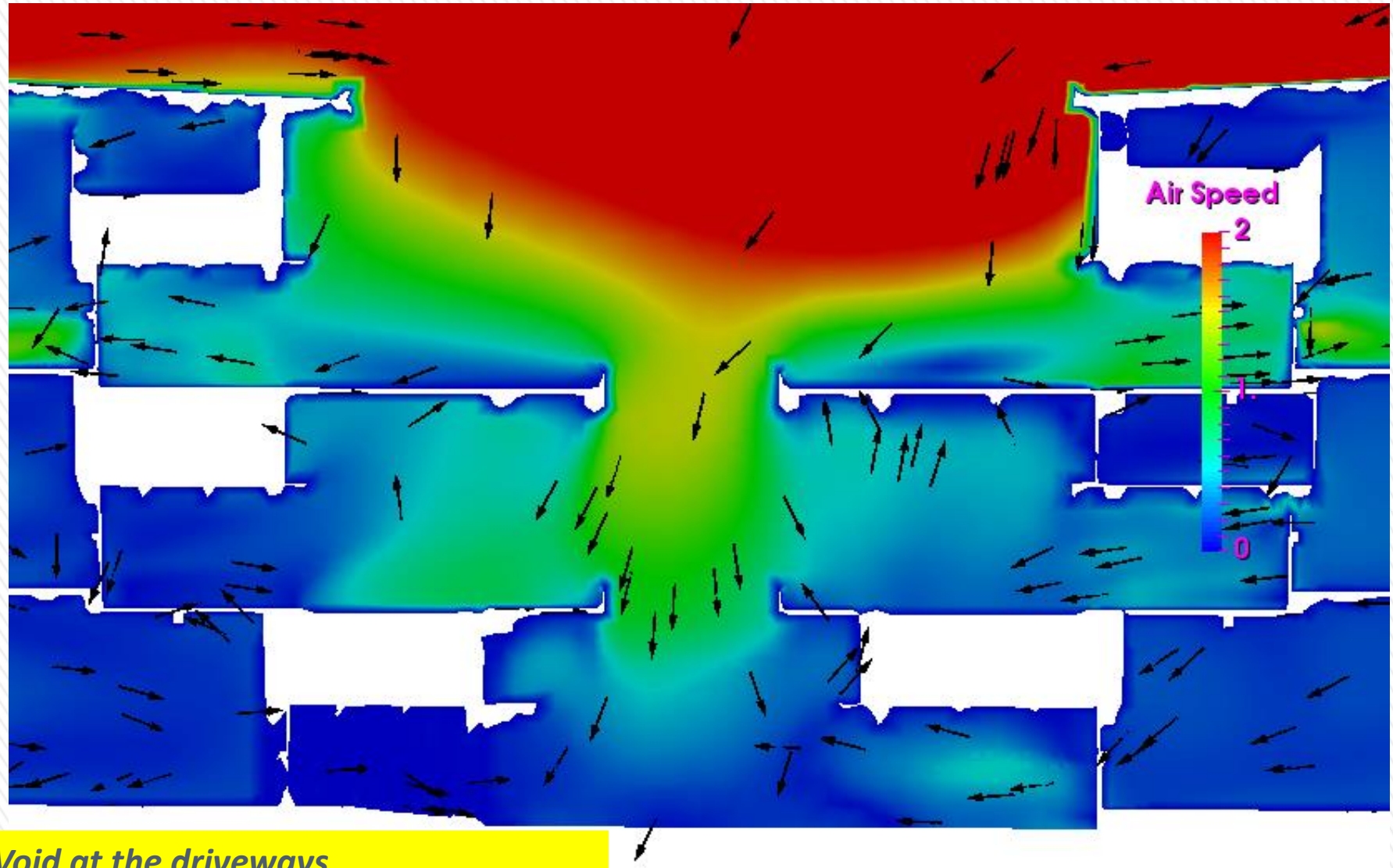


CFD Simulation Result



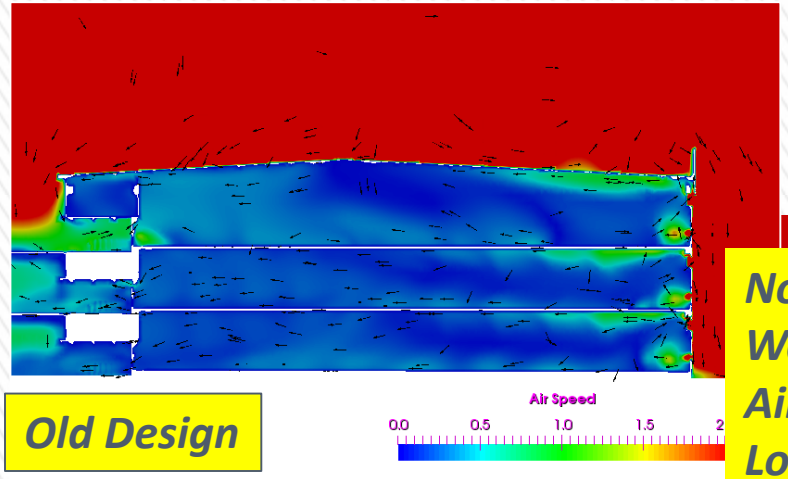
Void at the driveways
Middle - Cut
Air flow going from Level 1 to Level 3.

CFD Simulation Result



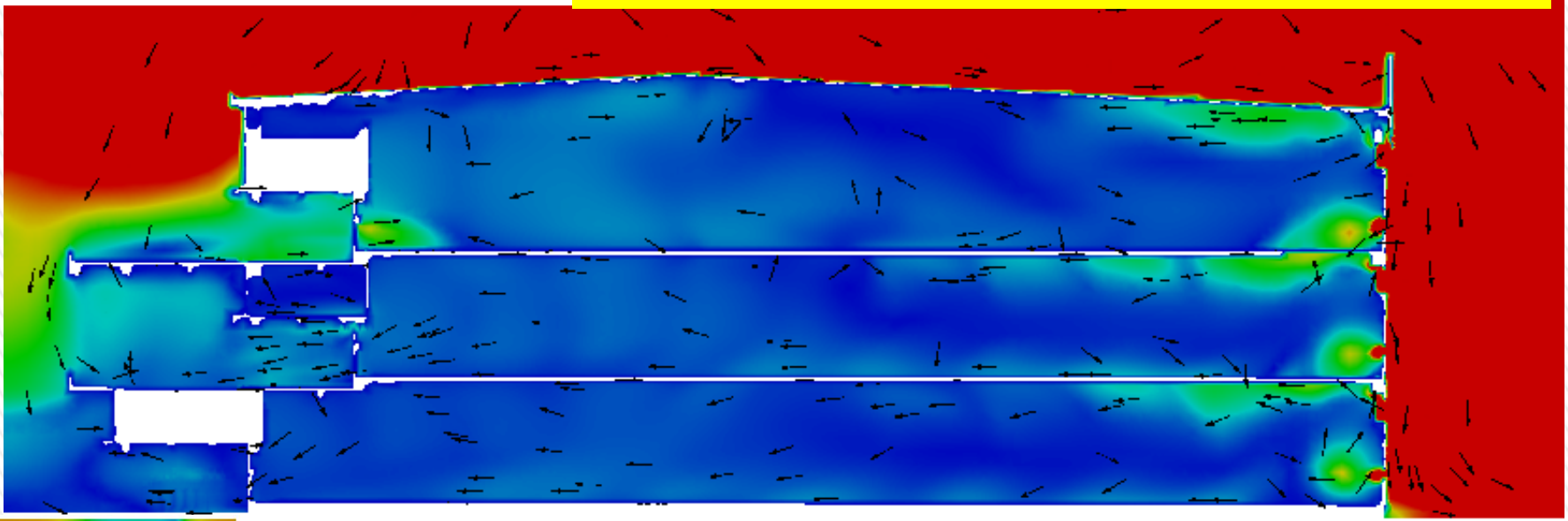
Void at the driveways
North end - Cut
Air flow going from Level 13to Level 1.

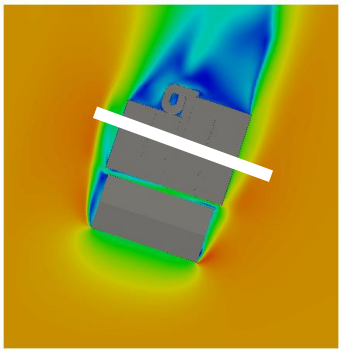
CFD Simulation Result

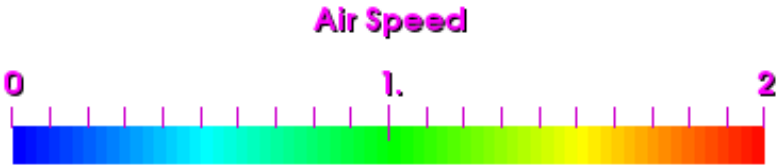


Old Design

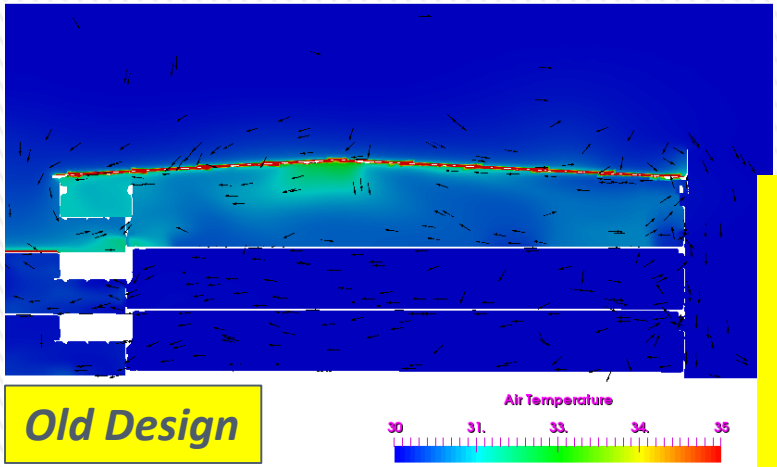
North-View
Warehouse A – Close to rear end
Air flow mainly going from right to left in the picture.
Low air speed inside the building, 1.5 m/s or less.





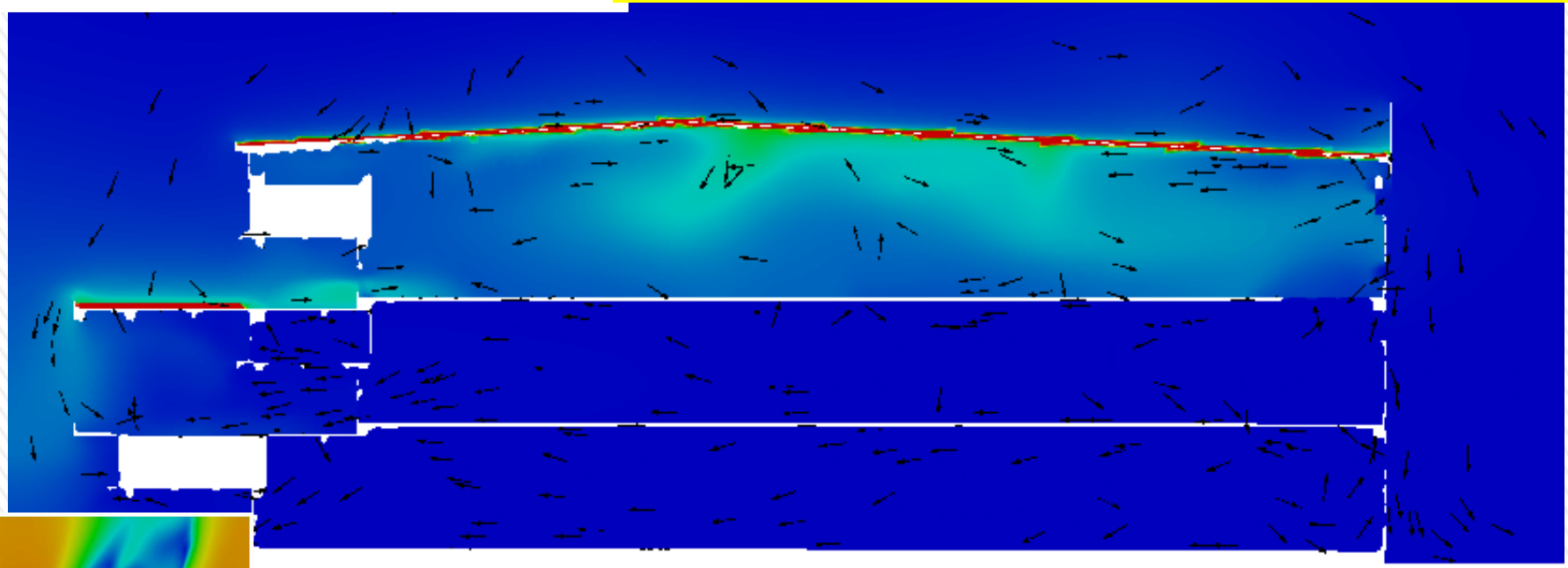


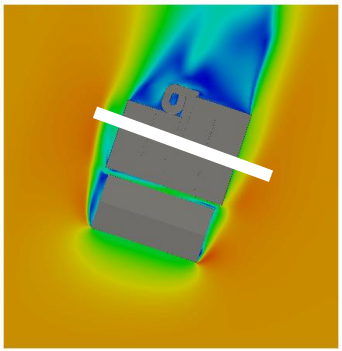
CFD Simulation Result

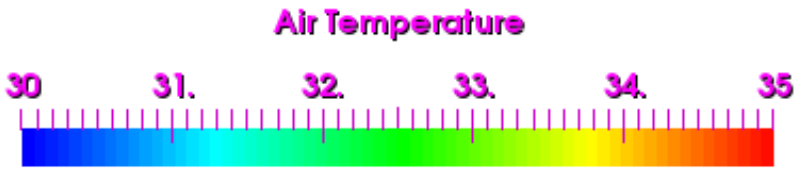


Old Design

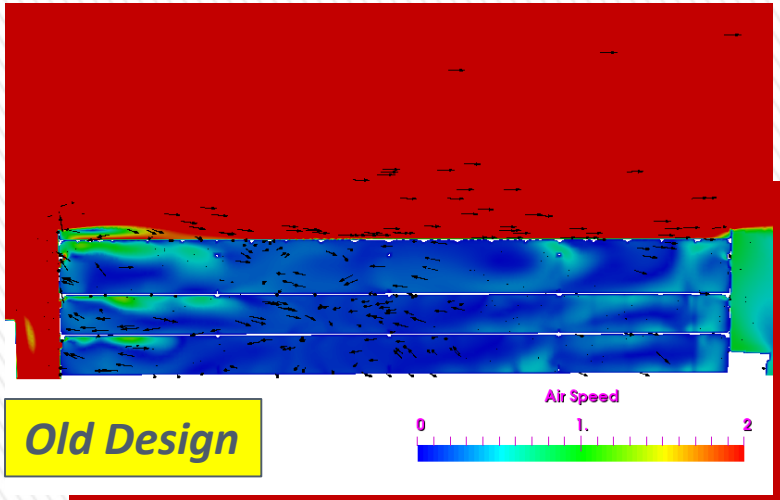
North-View
Warehouse A – Close to rear end
Heated air from ceiling is dissipated well inside the building
Low air temperature inside the building, 31C or less.





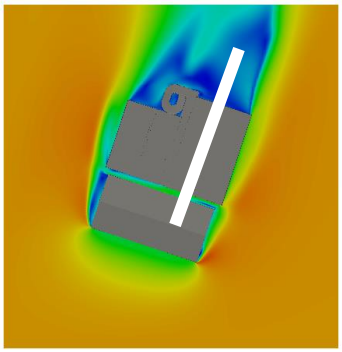


CFD Simulation Result

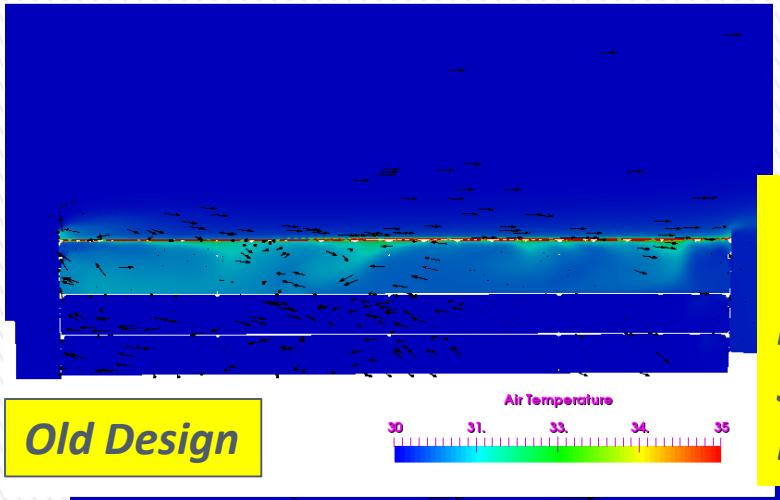


Old Design

West-View
Warehouse A – Center plane
Air flow recirculation inside the building
Low air velocity inside the building

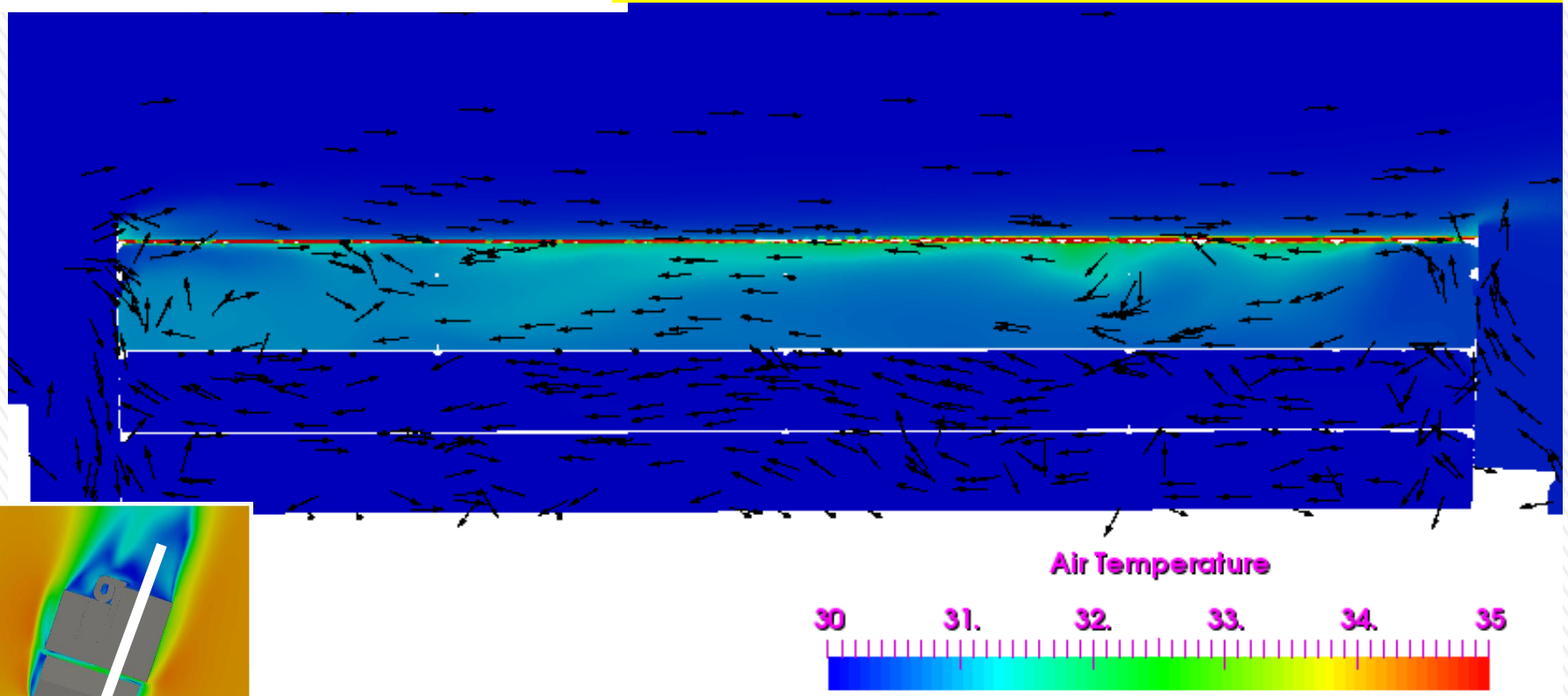


CFD Simulation Result

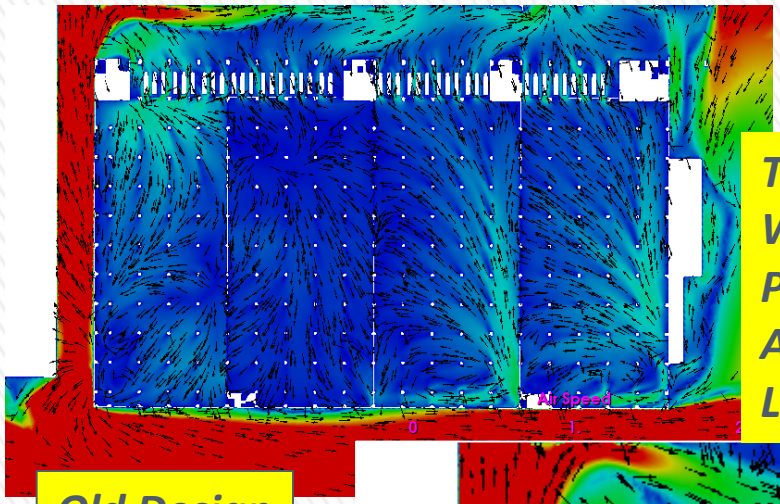


Old Design

West-View
Warehouse A – Center plane
Local high air temperature inside 3rd level building, 31C or less
Low air temperature in 1st and 2nd Levels

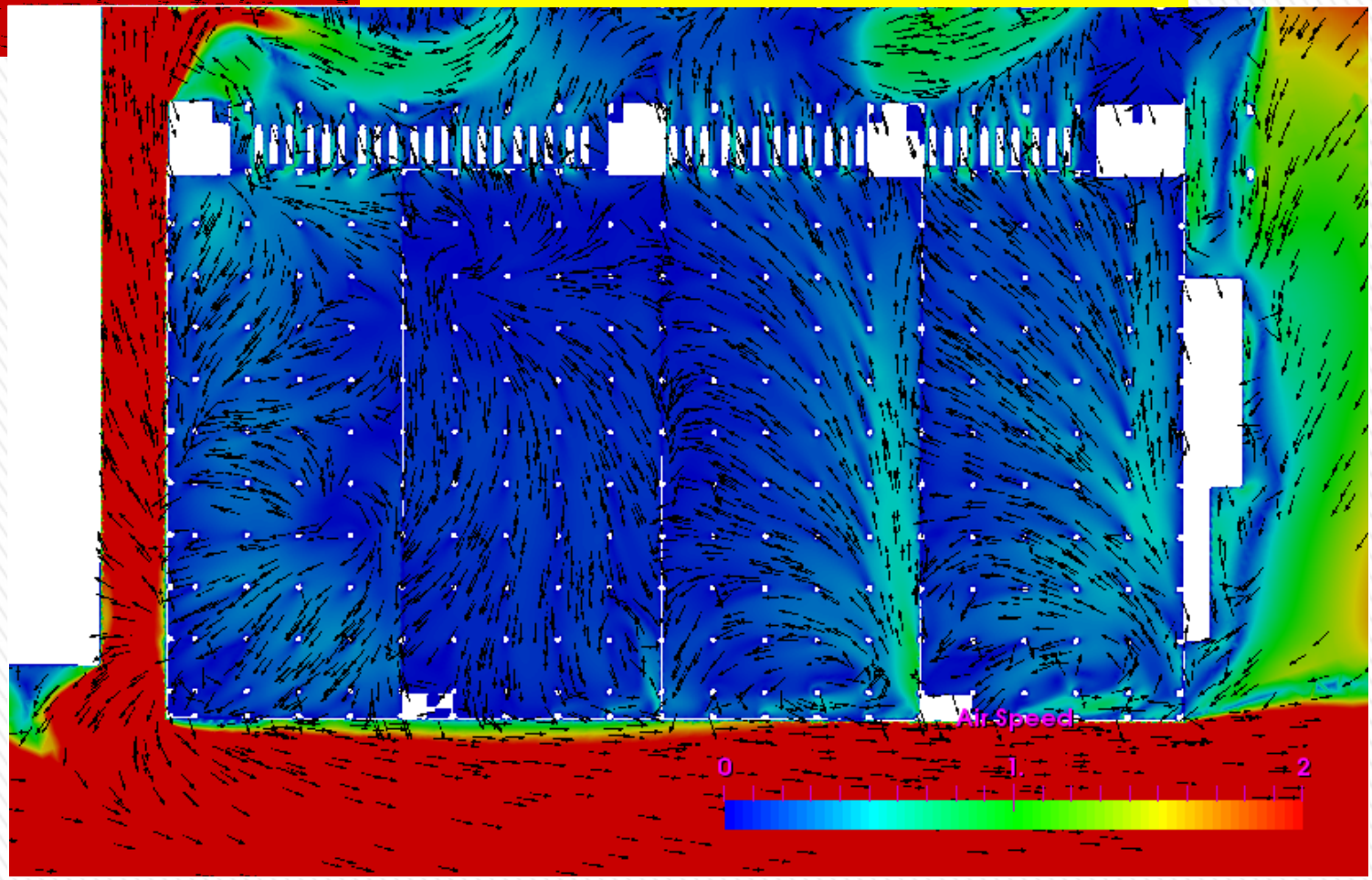


CFD Simulation Result

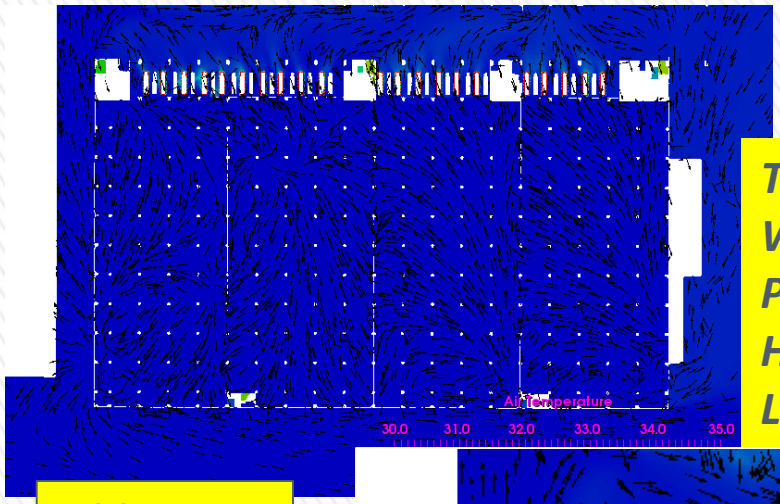


Old Design

Top-View
Warehouse A - 1st Level
Plane 2 meter above the driveway floor.
Air flow mainly toward the driveway.
Low air speed inside 1st Level, 1 m/s or less.

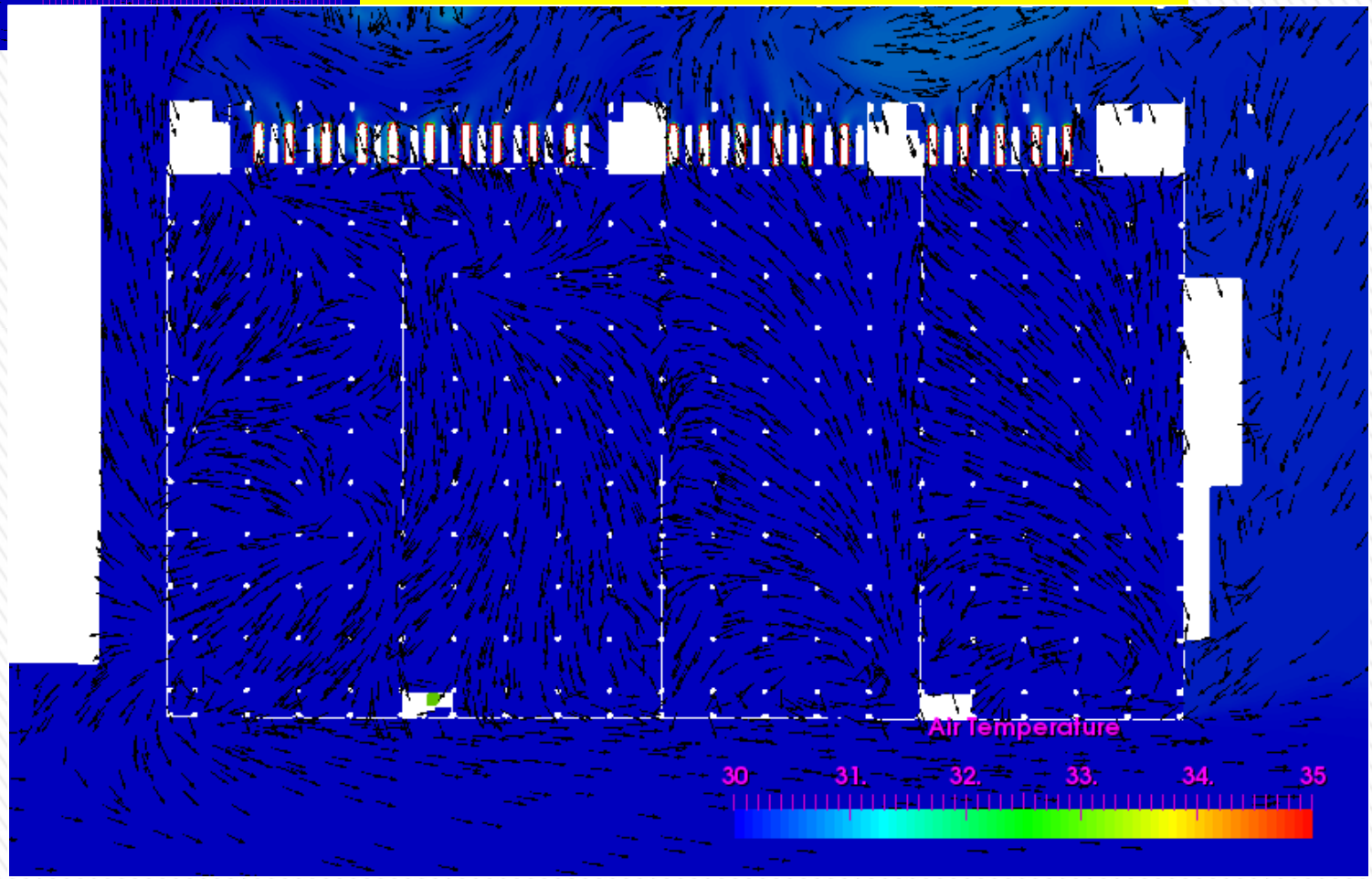


CFD Simulation Result

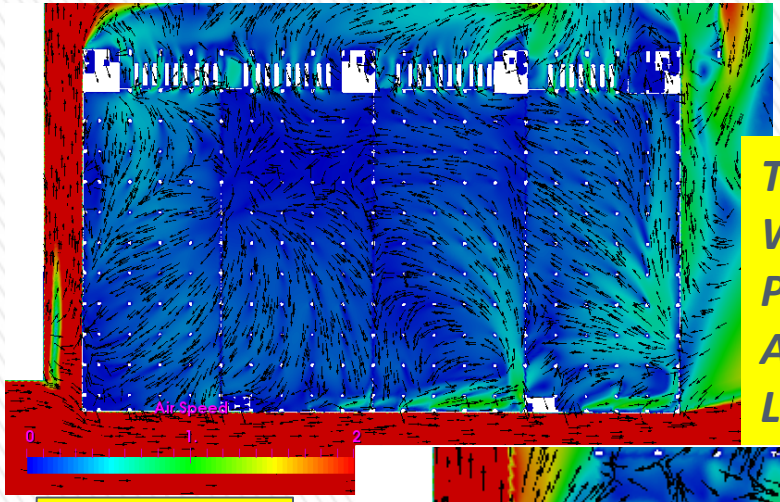


Old Design

Top-View
Warehouse A - 1st Level
Plane 2 meter above the driveway floor.
Heat source only from running trucks, 45C.
Low air temperature inside 1st Level.

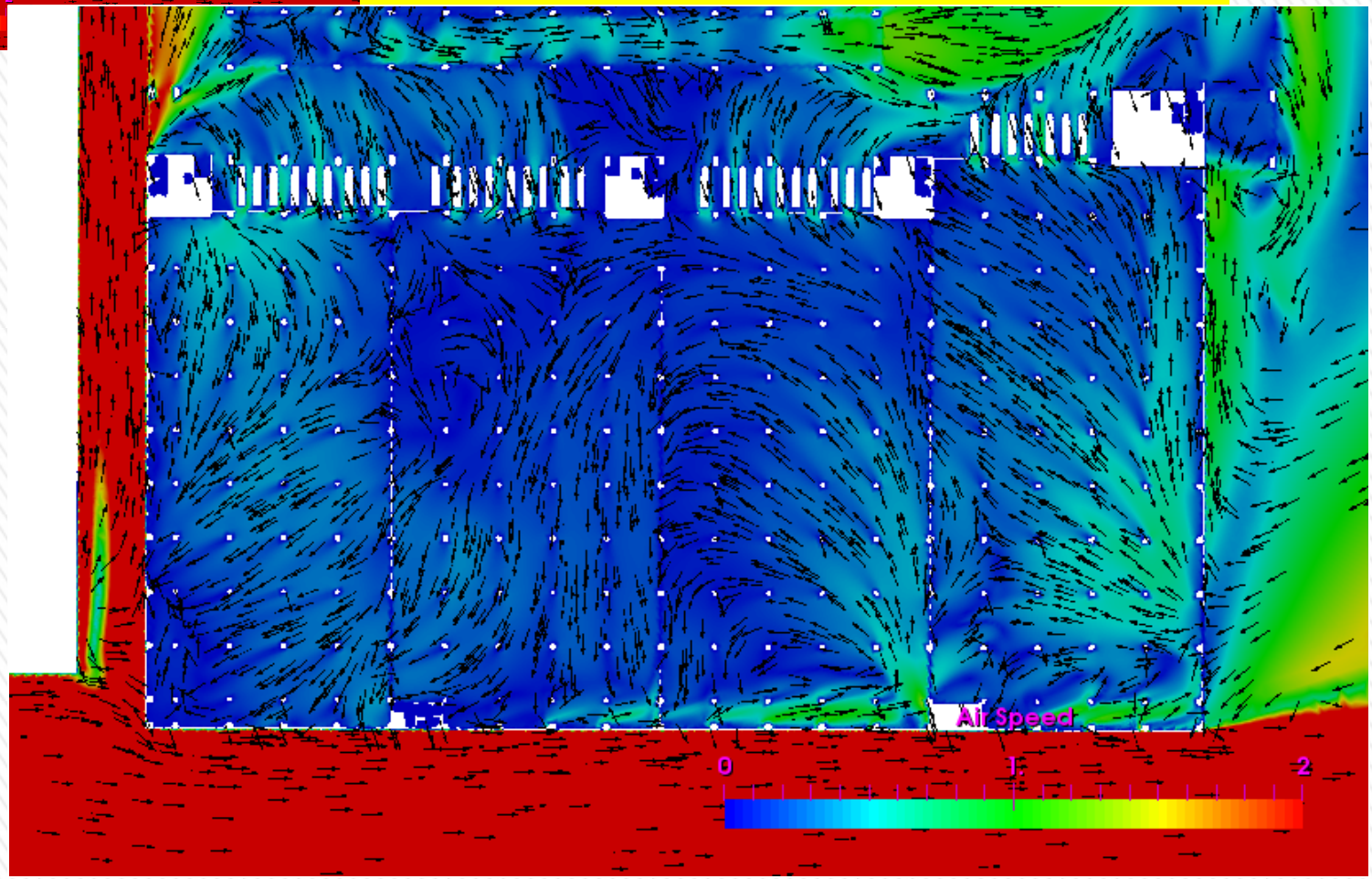


CFD Simulation Result

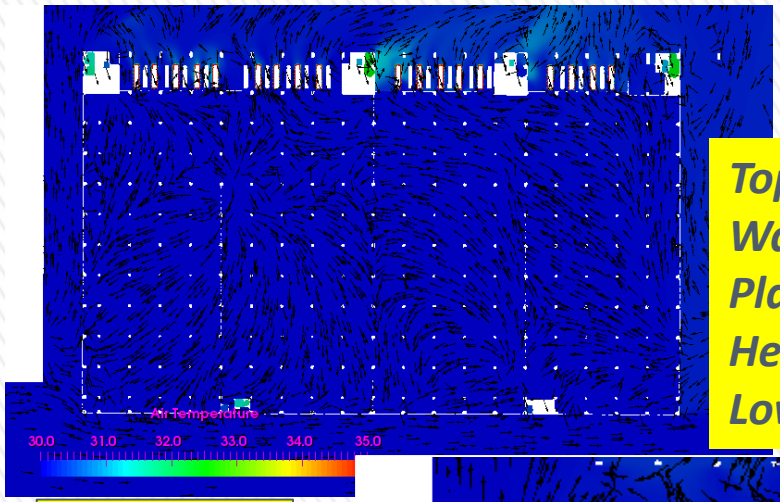


Old Design

Top-View
Warehouse A – 2nd Level
Plane 2 meter above the driveway floor.
Air flow mainly toward the driveway.
Low air speed inside 2nd Level, 1 m/s or less.

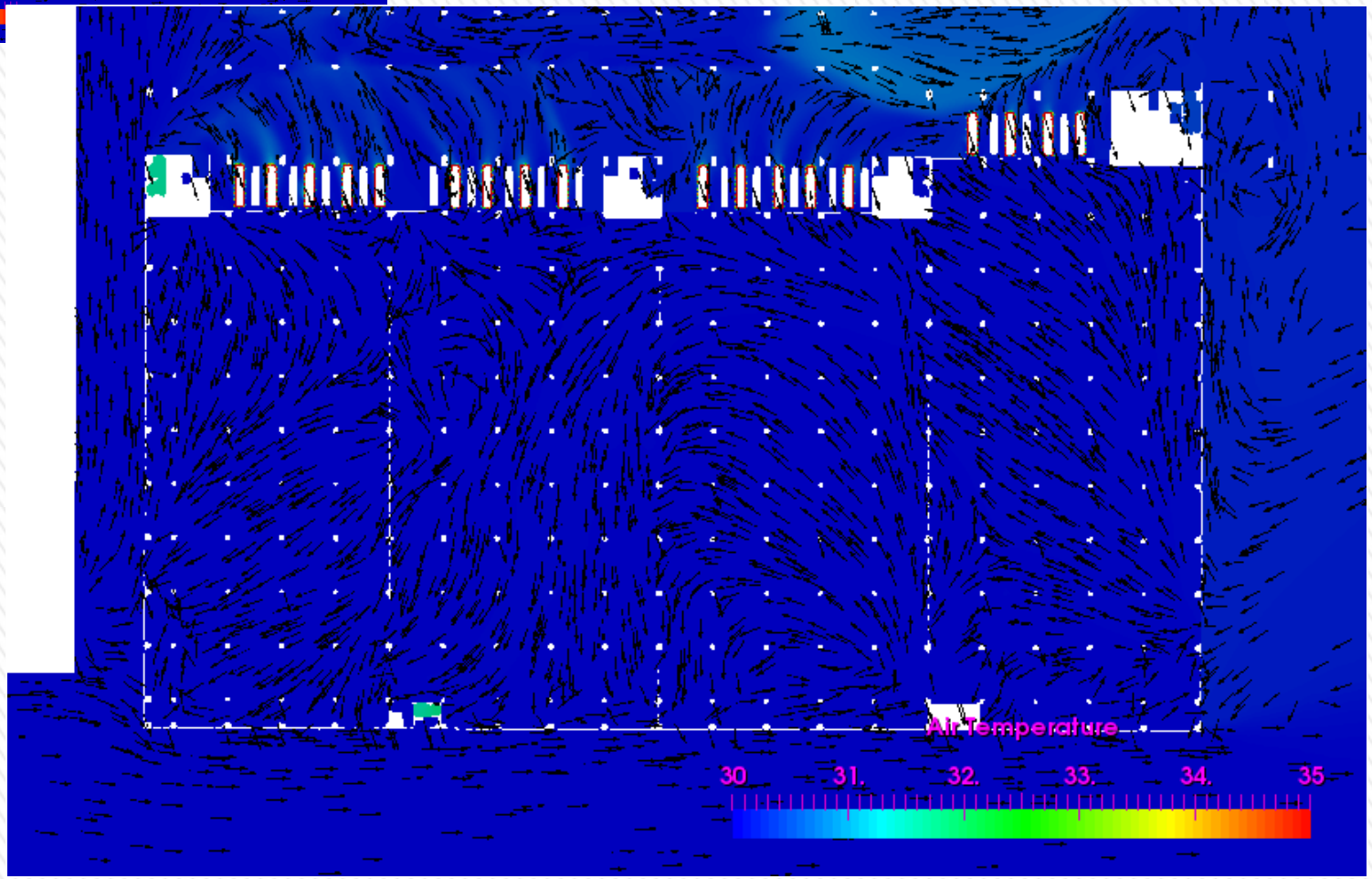


CFD Simulation Result

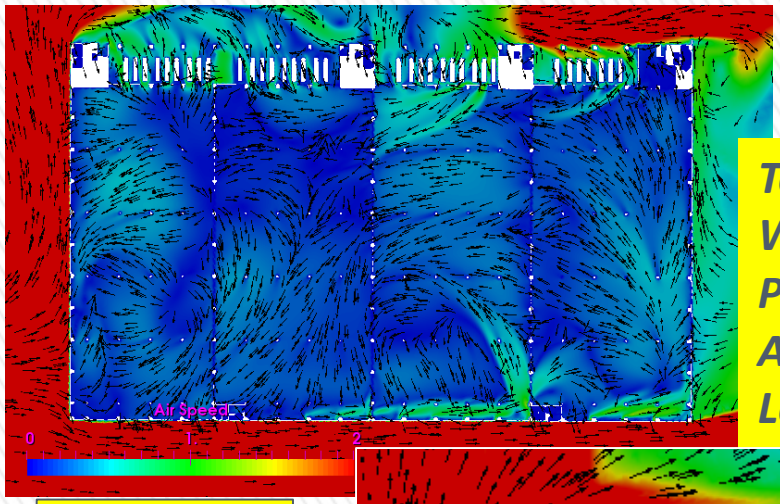


Old Design

Top-View
Warehouse A – 2nd Level
Plane 2 meter above the driveway floor.
Heat source only from running trucks, 45C.
Low air temperature inside 2nd Level.

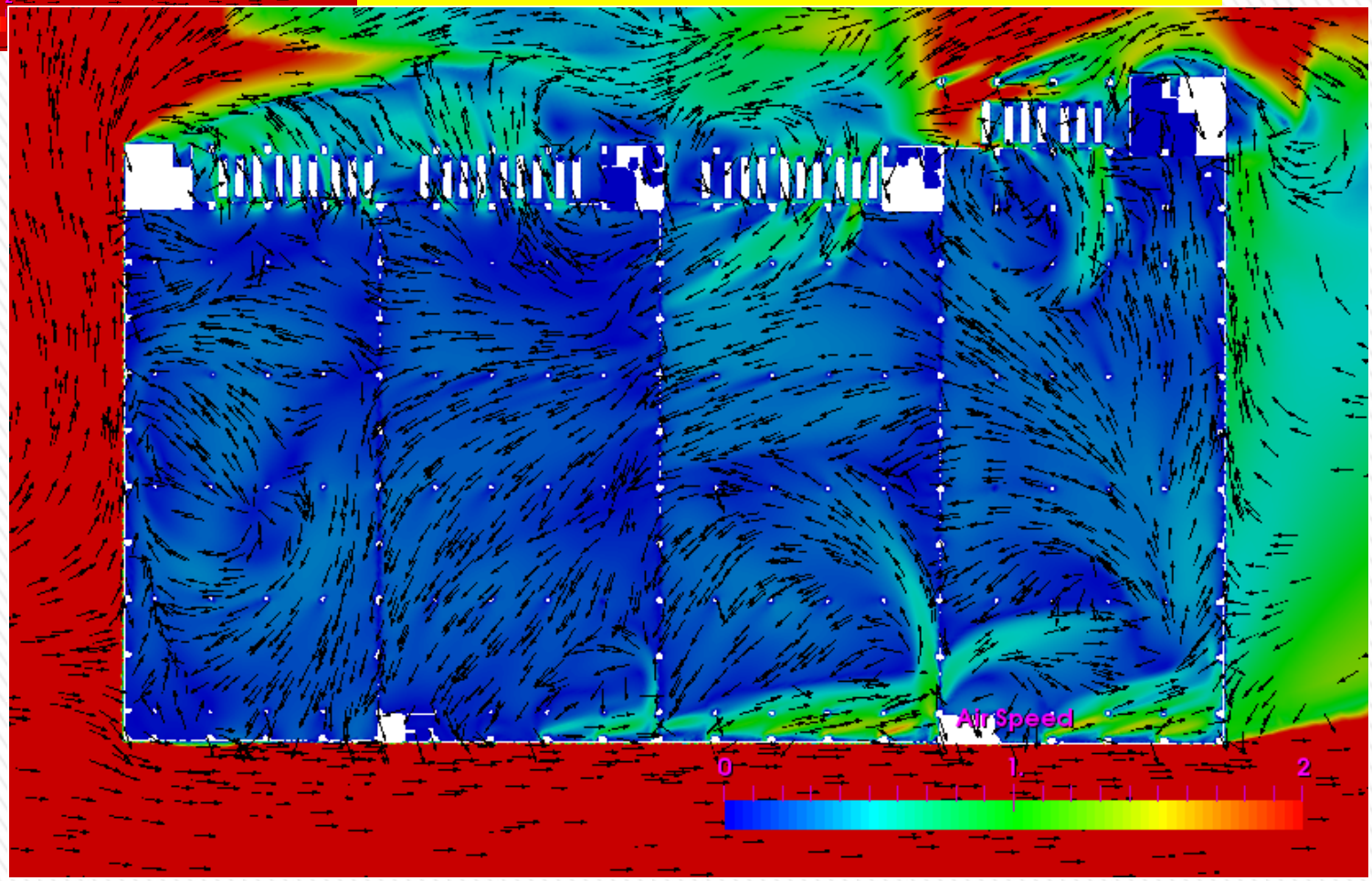


CFD Simulation Result

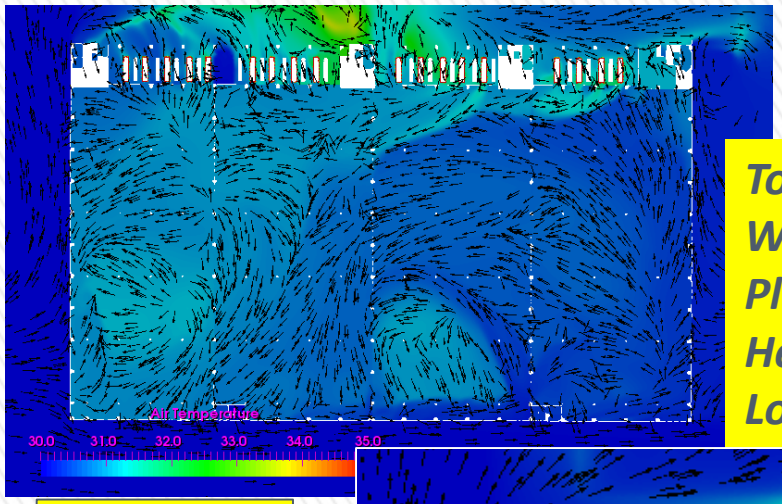


Old Design

Top-View
Warehouse A – 3rd Level
Plane 2 meter above the driveway floor.
Air flow coming out and in to the driveway.
Low air speed inside 3rd Level, 1 m/s or less.

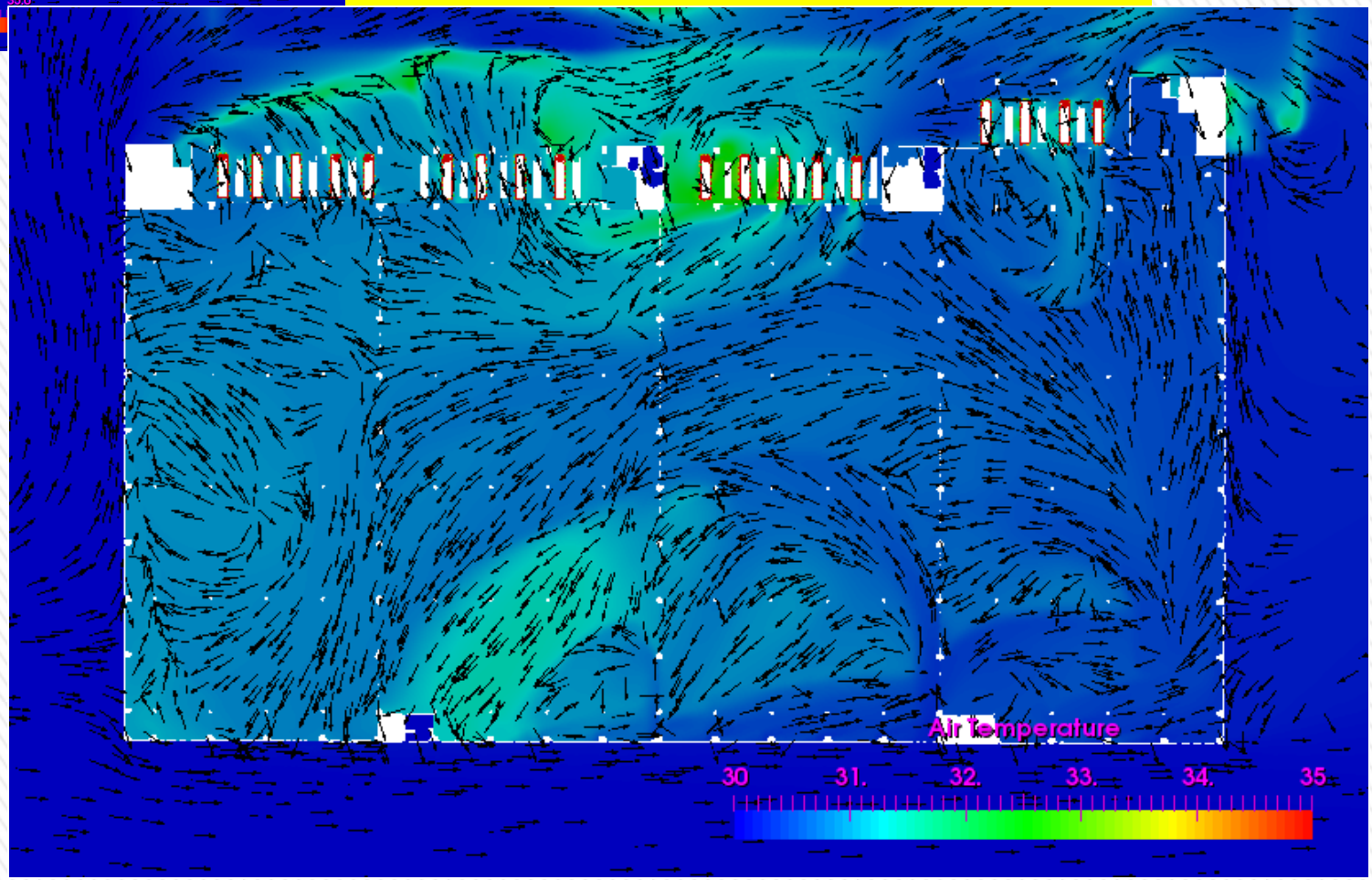


CFD Simulation Result

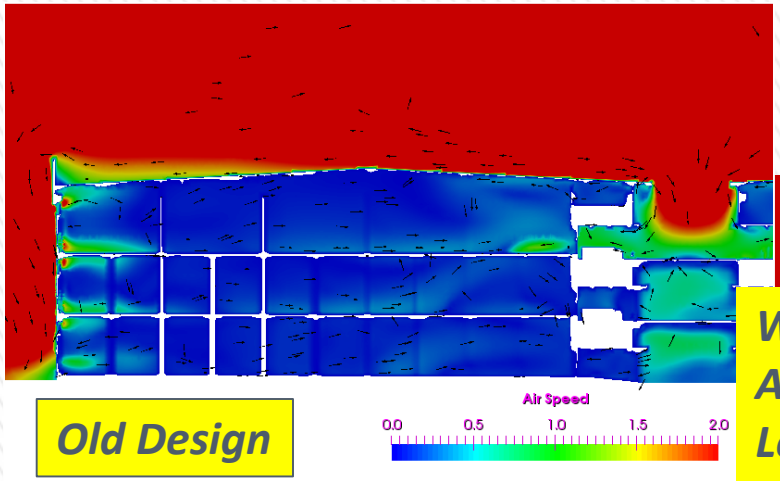


Old Design

Top-View
Warehouse A – 3rd Level
Plane 2 meter above the driveway floor.
Heat source running trucks and ceiling.
Low air temp inside 3rd Level, 32C or less.

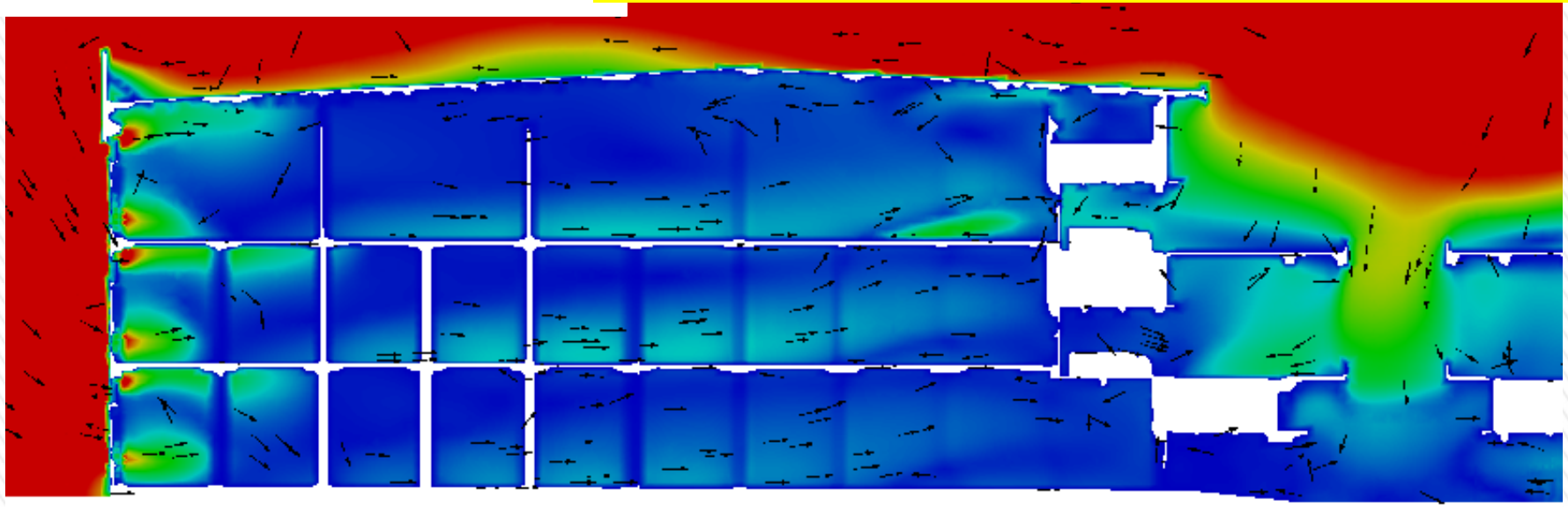


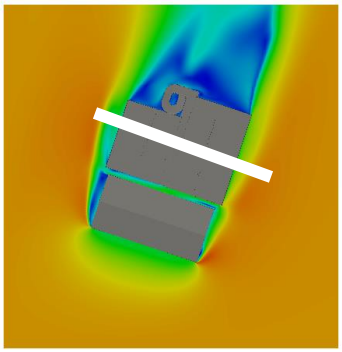
CFD Simulation Result

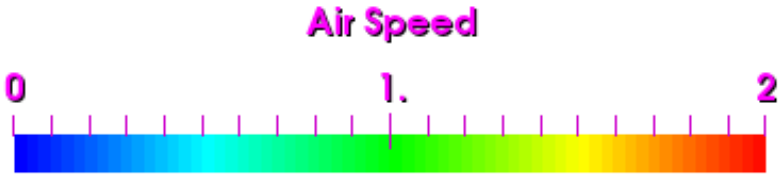


Old Design

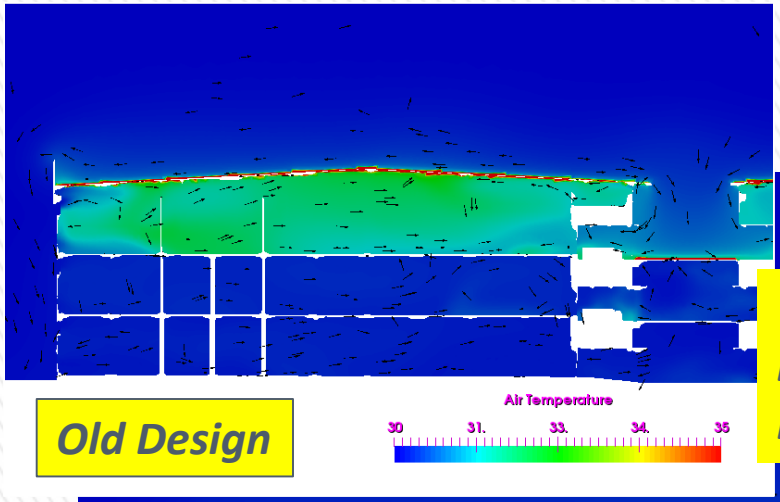
Warehouse B – Close to rear end
Air flow mainly going from left to right in the picture.
Low air speed at the middle area.





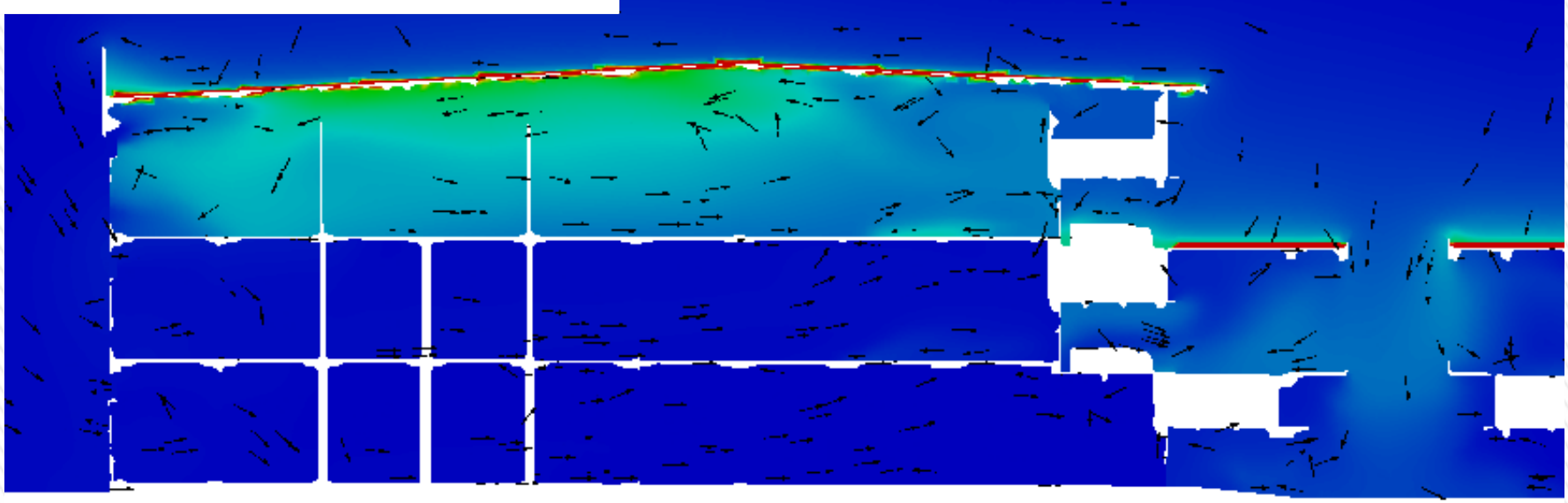


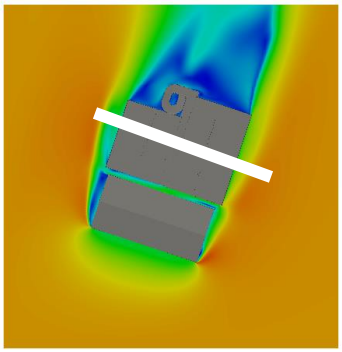
CFD Simulation Result



Old Design

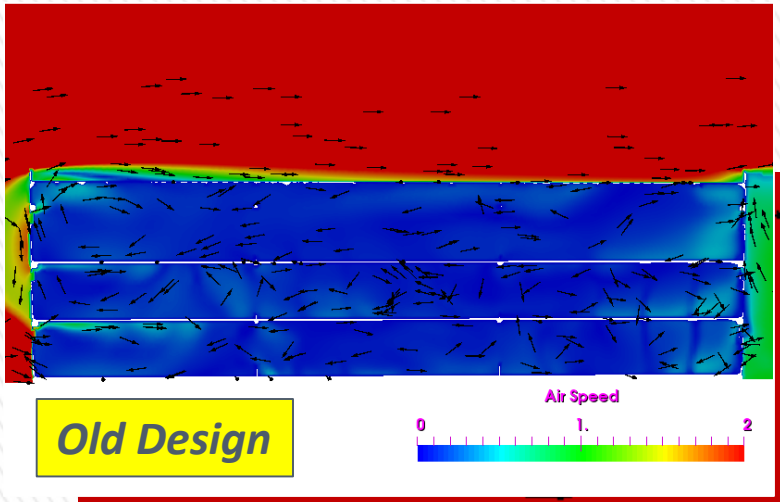
Warehouse B – Close to rear end
Local high air temperature at 3rd Level, 31C or less.
Low air temperature in 1st and 2nd Levels.





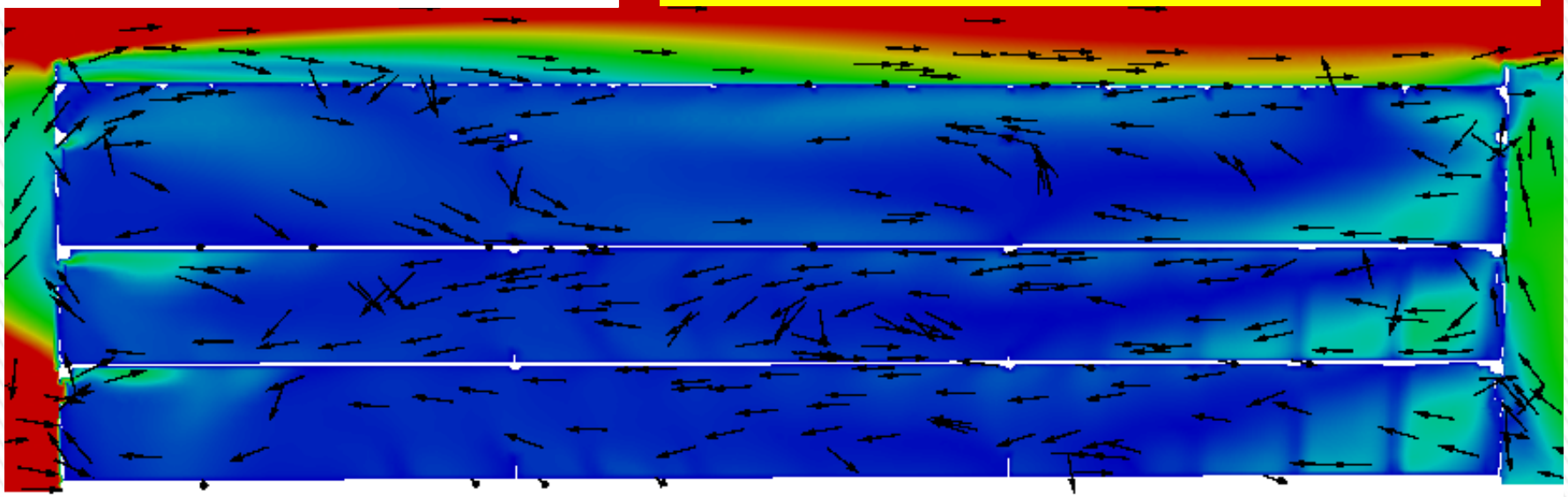
Air Temperature
30 31. 32. 33. 34. 35

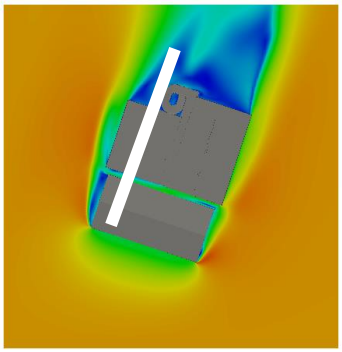
CFD Simulation Result

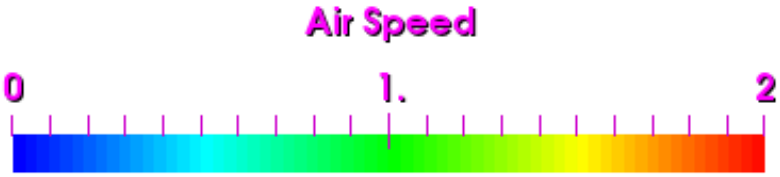


Old Design

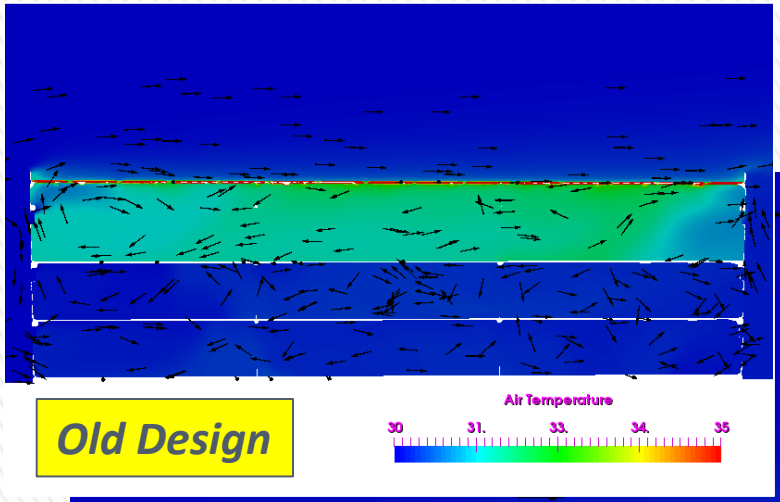
West-View
Warehouse B – Center plane
Air flow recirculation inside the building.
Very low air velocity inside the building, 0.5m/s or less.





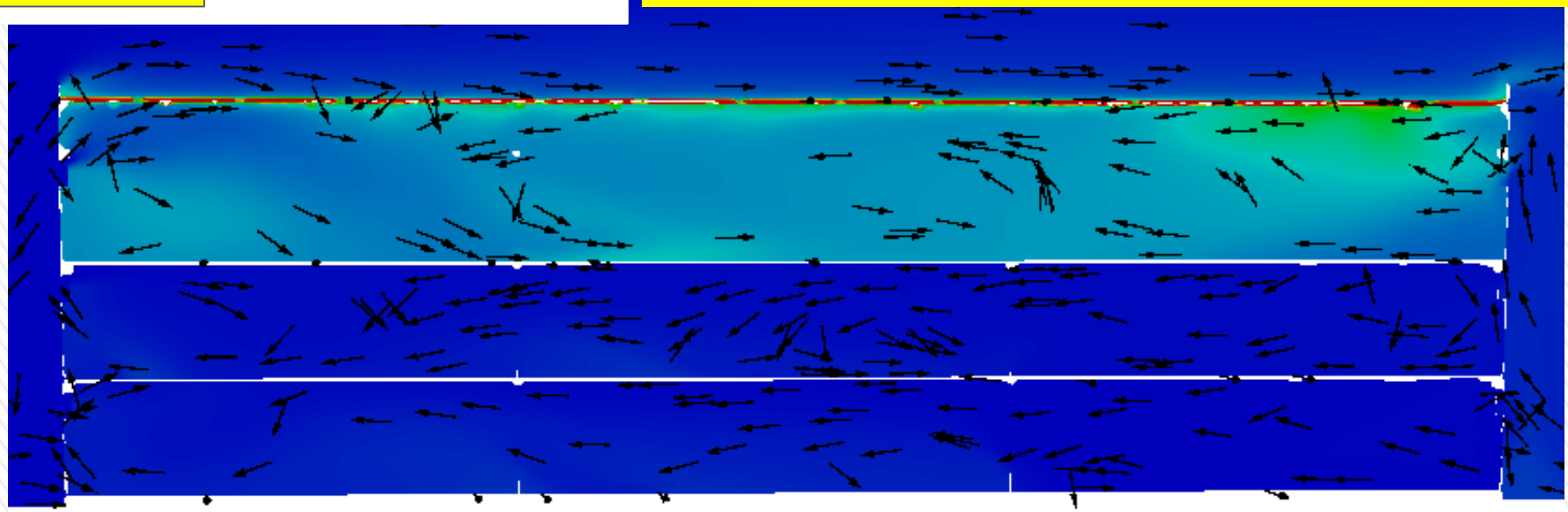


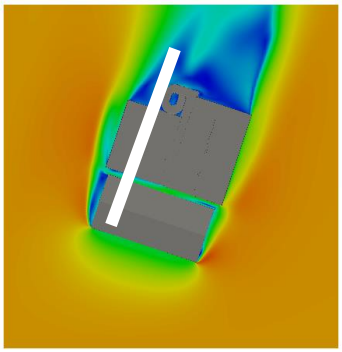
CFD Simulation Result



Old Design

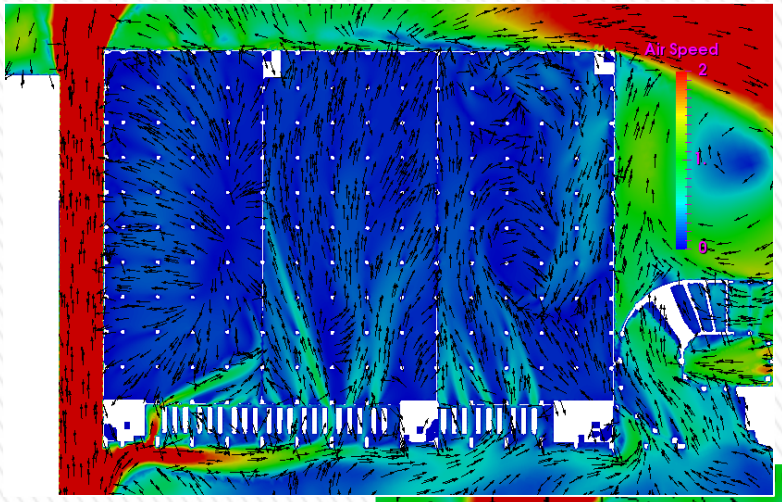
West-View
Warehouse B – Center plane
High air temperature inside 3rd Level, 33C and less.
Low air temperature inside 1st and 2nd Levels.





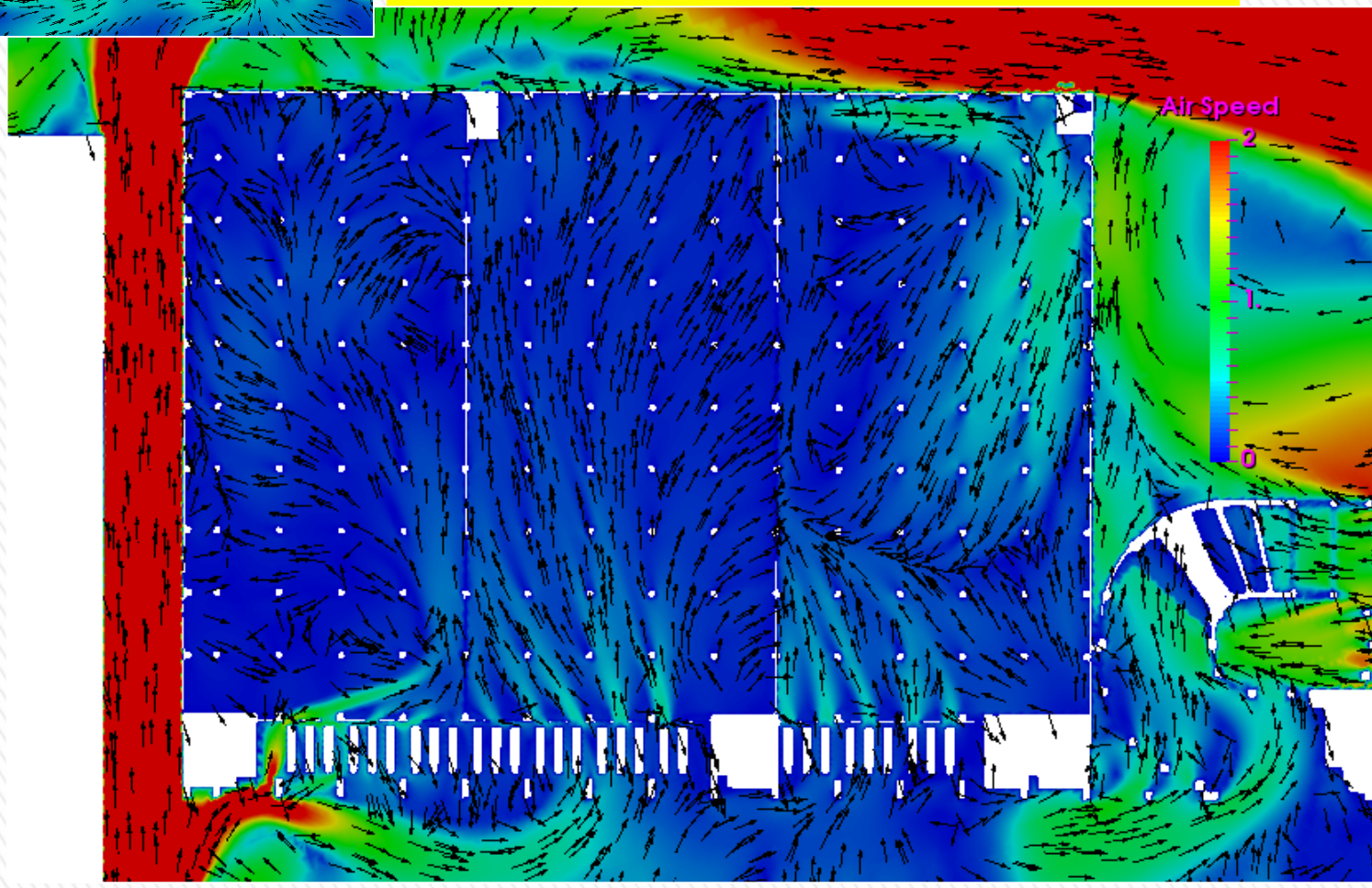
Air Temperature
30 31. 32. 33. 34. 35

CFD Simulation Result

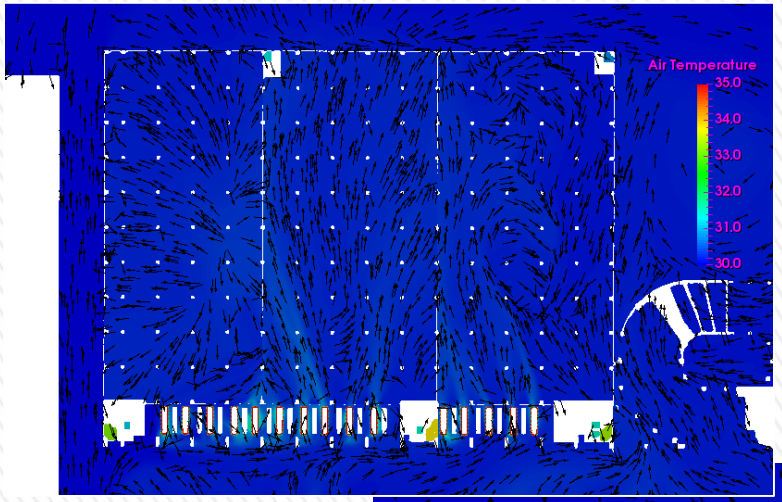


Old Design

Top-View
Warehouse B - 1st Level
Plane 2 meter above the driveway floor.
Air flow mainly entering from the driveway.
Low air speed inside 1st Level, 1 m/s or less.

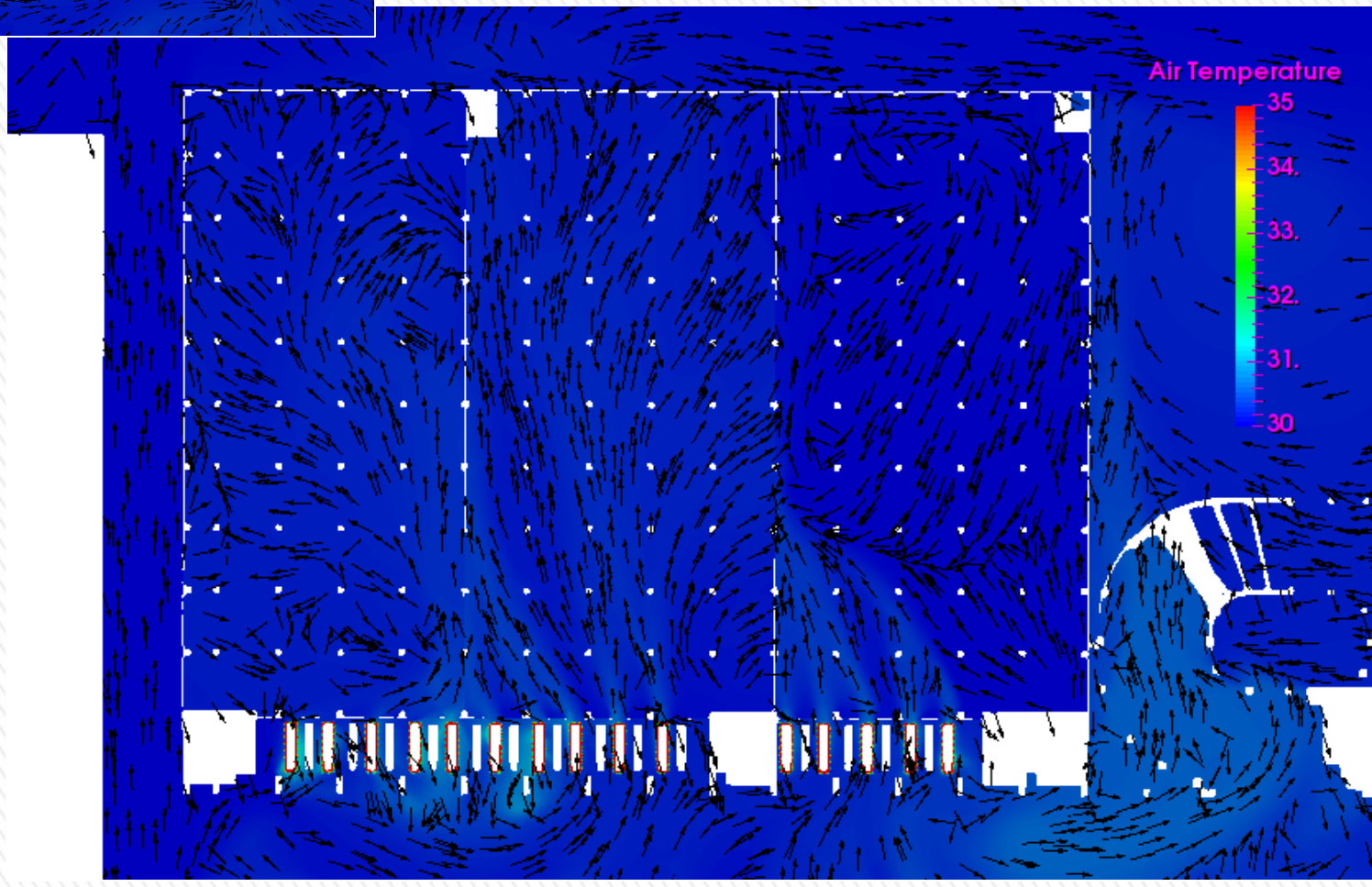


CFD Simulation Result

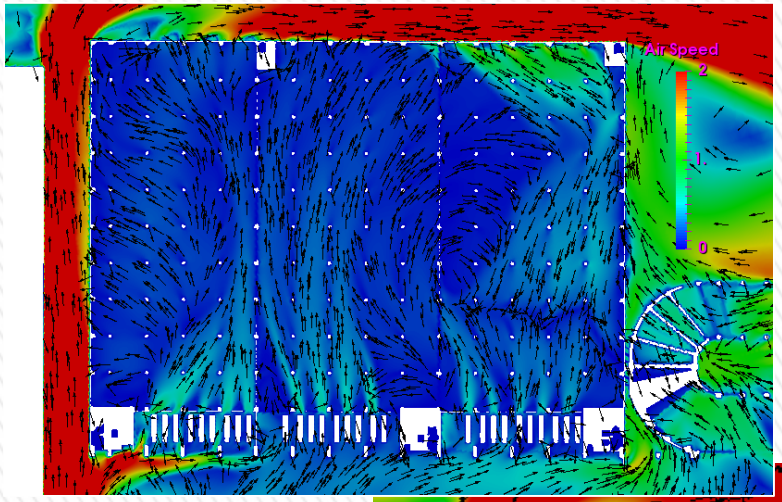


Top-View
Warehouse B - 1st Level
Plane 2 meter above the driveway floor.
Heat source only from running trucks, 45C.
Low air temperature inside 1st Level, 31C or less.

Old Design

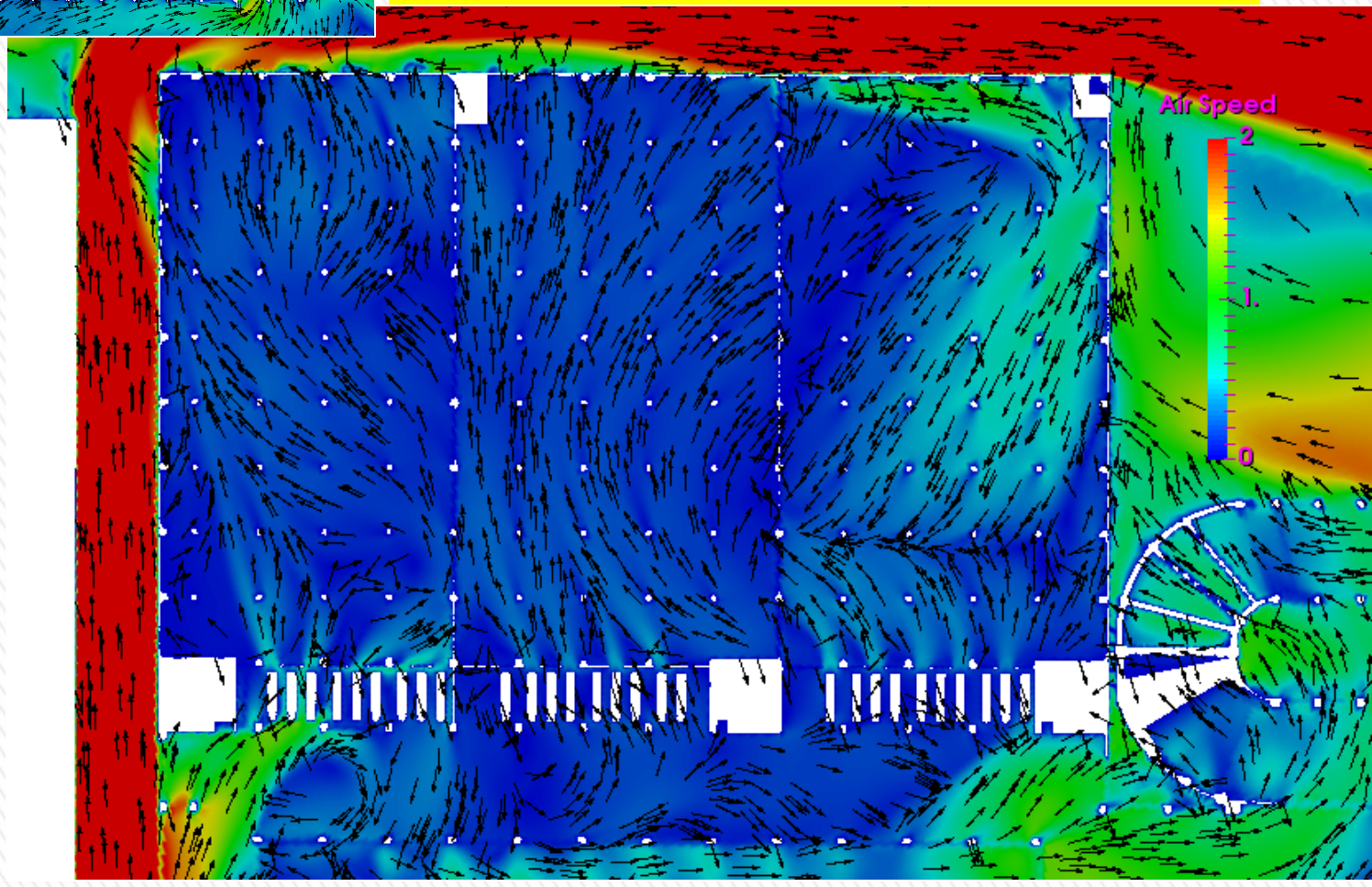


CFD Simulation Result

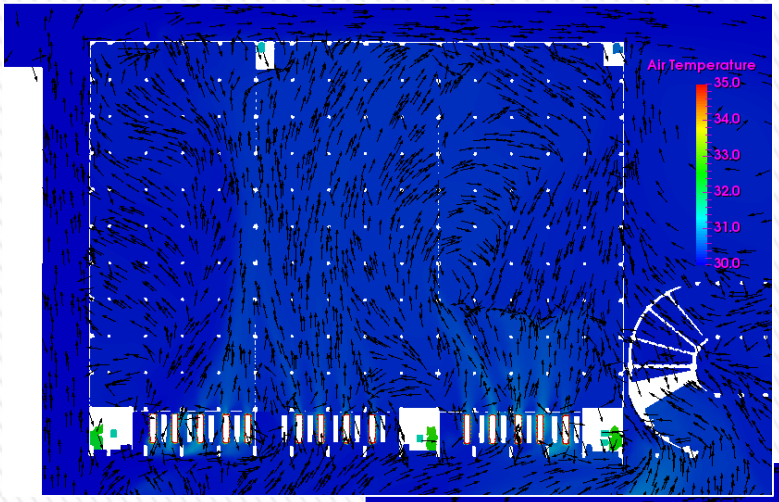


Old Design

Top-View
Warehouse B – 2nd Level
Plane 2 meter above the driveway floor.
Air flow mainly coming from the driveway.
Low air speed inside 2nd Level, 1 m/s or less.

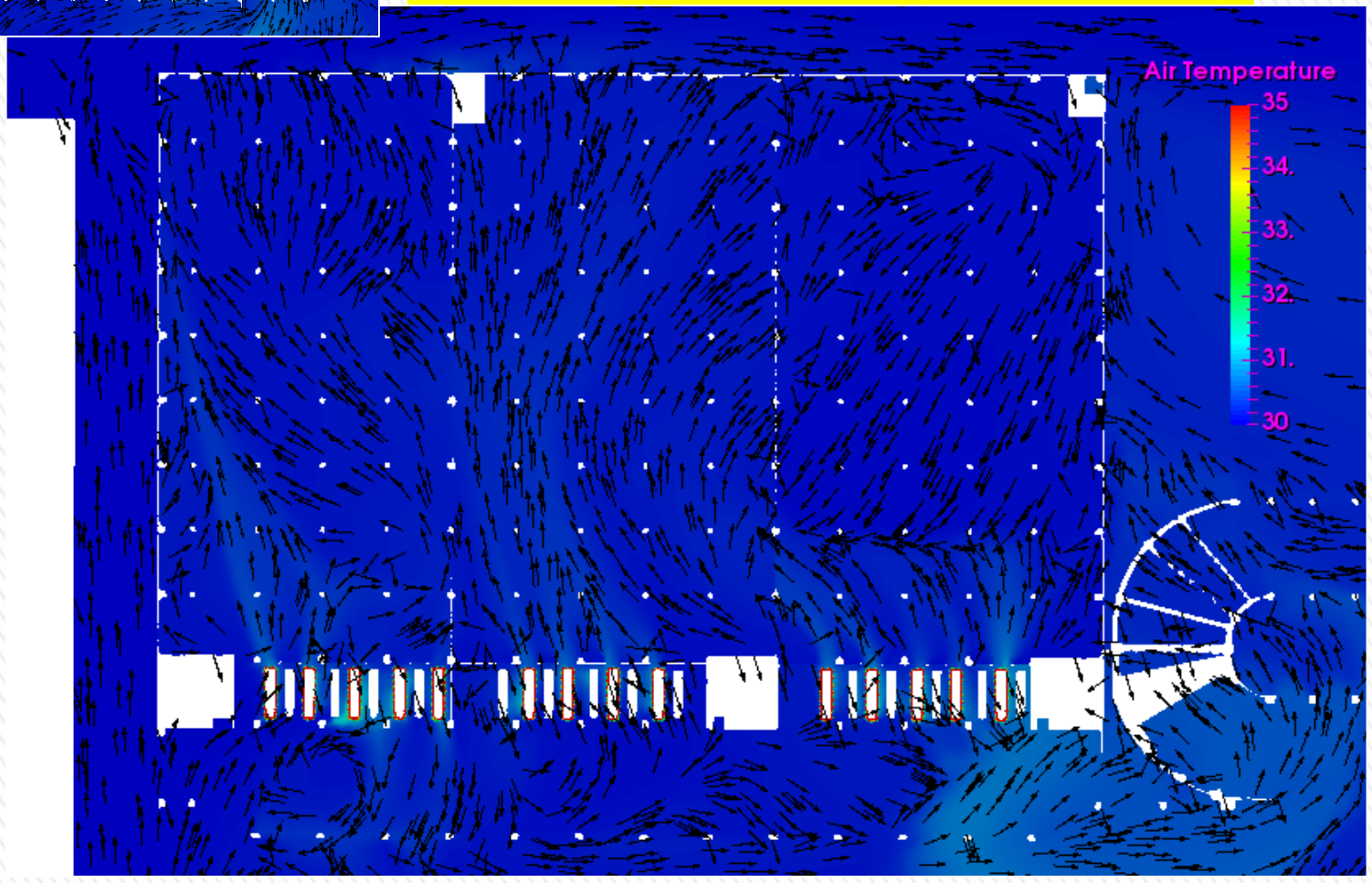


CFD Simulation Result

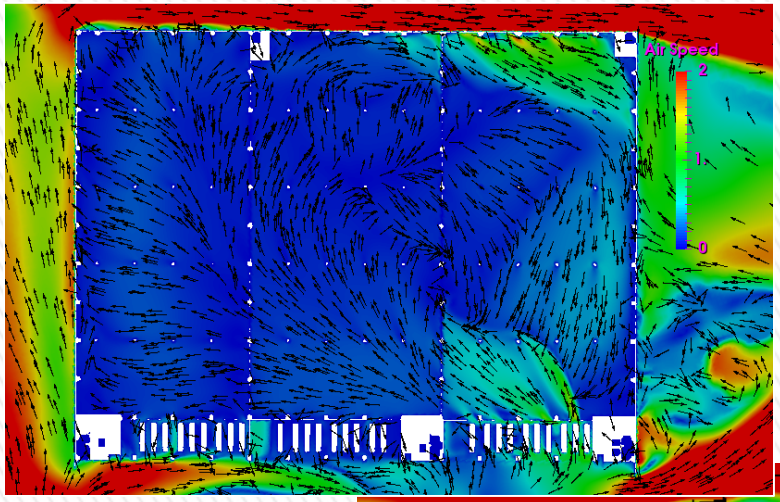


Old Design

Top-View
Warehouse B – 2nd Level
Plane 2 meter above the driveway floor.
Heat source only from running trucks, 45C.
Low air temp inside 2nd Level, 30.5C or less.

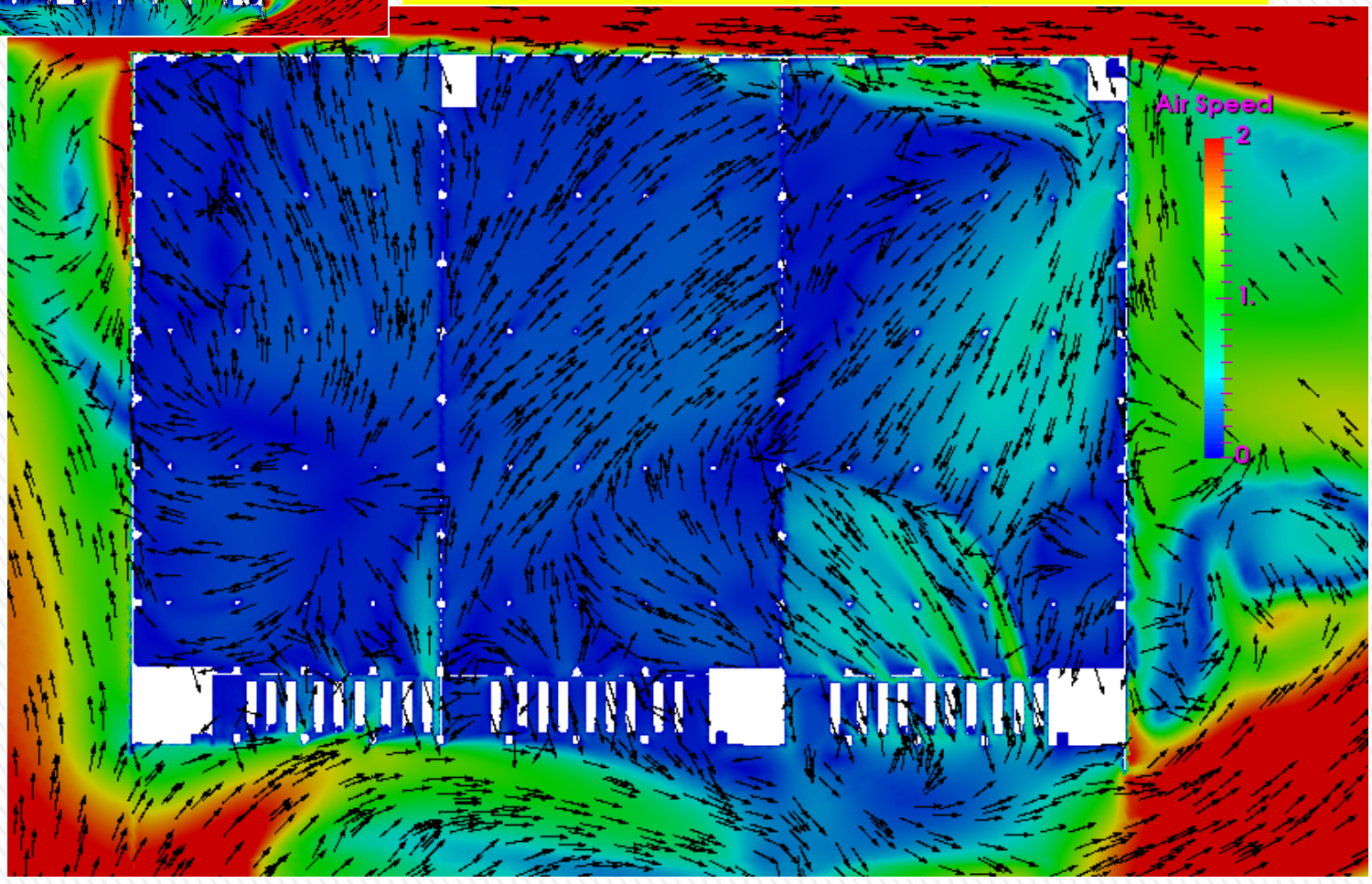


CFD Simulation Result

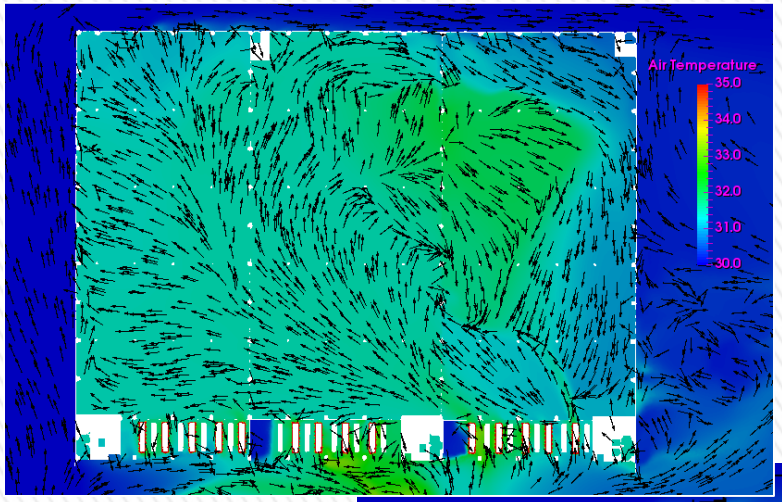


Top-View
Warehouse B – 3rd Level
Plane 2 meter above the driveway floor.
Air flow coming in from the driveway.
Low air speed inside 3rd Level, 1 m/s or less.

Old Design

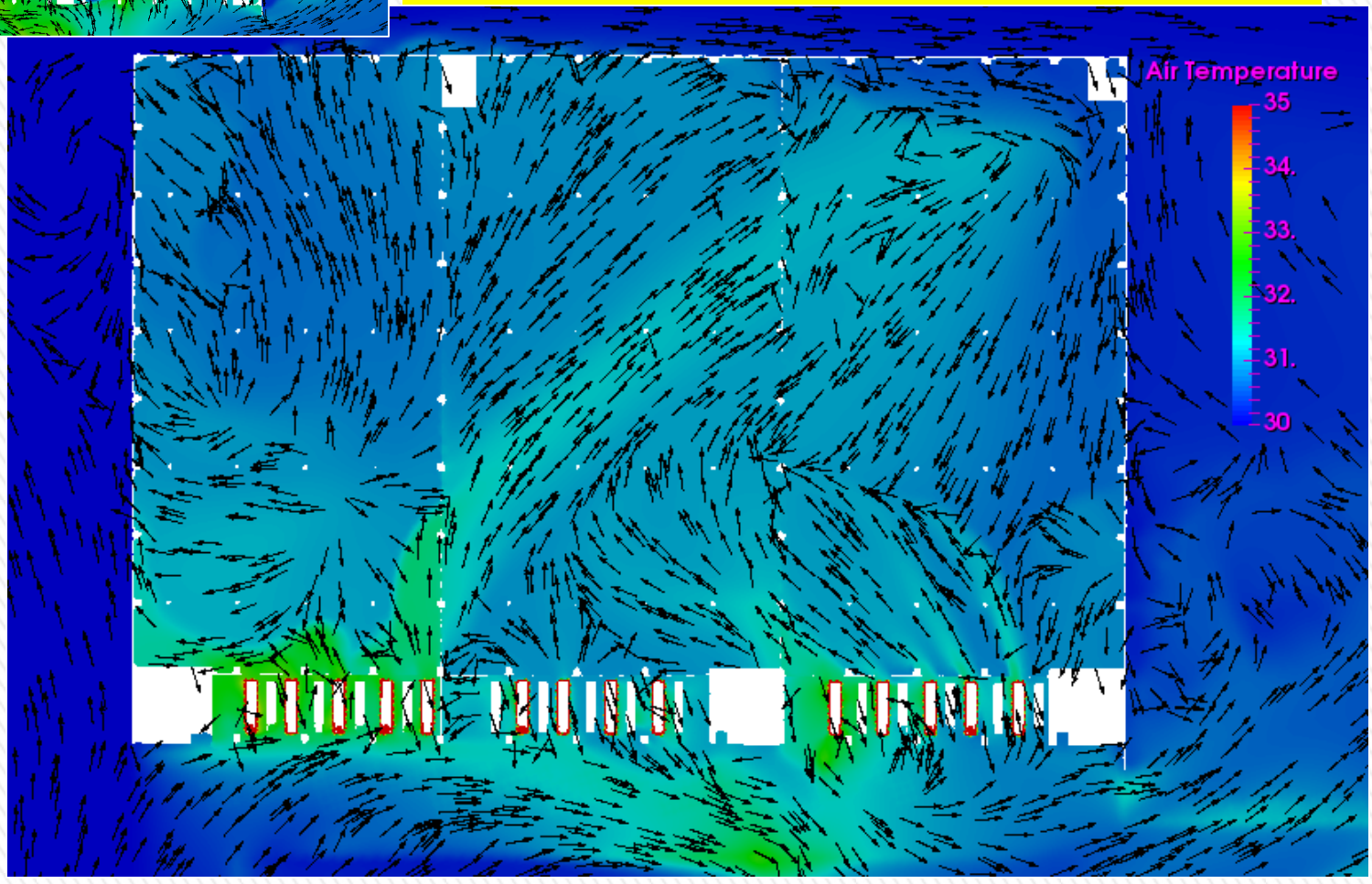


CFD Simulation Result



Old Design

Top-View
Warehouse B – 3rd Level
Plane 2 meter above the driveway floor.
Heat source: running trucks and ceiling.
Local high air temp inside 3rd Level, 33C or less.



Conclusions

- New design with void in the driveway has smaller building wake.
- Some areas of the void is having air flow from Level 1 to Level 3 and some other areas having air flow in the opposite direction.
- Air temperature in level 3 driveway is slightly lower in the new design due to stronger air flow.
- Driveway void does not change air flow inside the warehouse A and B significantly, but slightly cools the warehouse B Level 3.
- Local high air temperature on the driveway is 33C at the 3rd Level (which is lower than old design) due to heat load on driveway 3rd floor of 50C
- Local high air temperature in warehouse A is around 31C in the 3rd Level due to heat load on the ceiling of 40C.
- Local high air temperature in warehouse B is around 33C in the 3rd Level.
- In this case, wind speed of 25 kph is enough to stabilize the temperature inside the building and the driveway.

Next Step / Recommendation

- Run the simulation with low wind speed (3.6 kph or 1m/s) to see heat accumulation inside the building and in the driveway area.
  - Case No. 1
  - Case No. 5
  - Case No. 15
- Fans might be needed when considering low wind speed.

	Case	Wind from	Speed	Temp. u/n roof	Truck	WH Door	Ambient Temp.	Fan	Driveway Temp	WH Temp.	Priority
			km/h	Inside/Outside [C]	[%]	with Louvre	[C]				
Exisiting	1	S to N	0	40/55	75	All Closed	30	0			1
	2	S to N	25	40/55	100	All Closed	30	0			1
	3	S to N	0	40/55	75	All Closed	30		30	30	3
	4	S to N	25	40/55	100	All Closed	30		30	30	3
	5	S to N	0	40/55	75	50% Closed	30	0			5
	6	S to N	25	40/55	100	50% Closed	30	0			5
	7	S to N	0	40/55	75	50% Closed	30		30	30	7
	8	S to N	25	40/55	100	50% Closed	30		30	30	7
New	11	S to N	0	40/55	75	All Closed	30	0			2
	12	S to N	25	40/55	100	All Closed	30	0			2
	13	S to N	0	40/55	75	All Closed	30		30	30	4
	14	S to N	25	40/55	100	All Closed	30		30	30	4
	15	S to N	0	40/55	75	50% Closed	30	0			6
	16	S to N	25	40/55	100	50% Closed	30	0			6
	17	S to N	0	40/55	75	50% Closed	30		30	30	8
	18	S to N	25	40/55	100	50% Closed	30		30	30	8

Assignment Letter/*Surat Tugas*

No. AL/ARCS/1855/II/2021
Date February 1st, 2021
Page 1 of 1
Doc. Type Main Document/*Dokumen Utama*

Dena Hendriana, BSc., S.M., Sc.D,

Activity Assignment	***Penugasan Kegiatan***
Director of Academic Research and Community Services	*Direktur Lembaga Penelitian Akademik dan Pengabdian kepada Masyarakat*
In consideration of: His appointment as Director of Academic Research and Community Services of Swiss German University under Decree nr. SK/020/HR/XI/19, dated November 18th, 2019	***Mengingat:*** *Pengangkatannya sebagai Direktur Lembaga Penelitian Akademik dan Pengabdian kepada Masyarakat dengan SK pengangkatan no. SK/020/HR/XI/19, tertanggal 18 November 2019*
Herewith gives the task to: Name : **Dena Hendriana, BSc., S.M., Sc.D,** Position : **Head of Master of Mechanical Engineering Study Program** Employee ID : **11211528**	***Dengan ini menugaskan kepada:*** *Name* : ***Dena Hendriana, BSc., S.M., Sc.D,*** *Position* : ***Kepala Program Studi Master Teknik Mesin*** *NIK* : ***11211528***
To follow the activity below:	*Untuk berpartisipasi pada kegiatan berikut ini:*

Nr.	Activity/*Kegiatan*	Organizer/ *Penyelenggara*	Day & Date/ *Hari & Tanggal*	Venue/ *Tempat*
1.	Penelitian simulasi sirkulasi udara di dalam warehouse yang sangat besar bekerja sama dengan PT. LOGOS	Swiss German University	Februari – September 2021	Swiss German University The Prominance Office Tower

The appointed shall accomplish the task in responsible ways in line with the related guidelines and other regulations given by SGU.

Pihak yang bersangkutan harus melaksanakan tugas dan tanggung jawab sebaik-baiknya, sesuai dengan petunjuk dan peraturan dari SGU.

Assignor/*Pemberi Tugas:*

Kholis Abdurachim Audah , M.Sc, Ph.D
Director of Academic Research and Community Services
Direktur Lembaga Penelitian dan Pengabdian kepada Masyarakat

Swiss German University
The Prominence Tower Alam Sutera
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SWISS GERMAN UNIVERSITY

LAPORAN

PENELITIAN SIMULASI SIRKULASI UDARA DI DALAM
WAREHOUSE YANG SANGAT BESAR
BEKERJA SAMA DENGAN PT. LOGOS

Dena Hendriana, B.Sc., S.M., Sc.D – Team Leader
Erwin Wong (PT. LOGOS) – Team Member

MASTER OF MECHANICAL ENGINEERING

2021

Swiss German University
The Prominence Tower Alam Sutera
Jalan Jalur Sutera Barat No 15, Tangerang 15143
INDONESIA

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Fax. +62 21 2977 9598
info@sgu.ac.id
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Judul Penelitian	: Penelitian Simulasi Sirkulasi Udara di Dalam Warehouse yang Sangat Besar Bekerja Sama dengan PT. LOGOS
Nama Team Leader	: Dena Hendriana, B.Sc., S.M., Sc.D
Research Center/Dept.	: Master of Mechanical Engineering
E-mail	: dena.hendriana@sgu.ac.id
Mobile phone	: 081213715844
Masa program	: Februari – September 2021 (7 bulan)
Keterangan Aktifitas	: PT. LOGOS mengembangkan desain warehouse yang sedang dibangun. Mereka memerlukan informasi tentang estimasi sirkulasi udara didalam ruang warehouse, terutama ketika suhu udara panas. Thermal load datang juga dari truk yang diparkir dan dalam keadaan idle. Simulasi sirkulasi udara dilakukan dengan menggunakan software CFD OpenFOAM yang merupakan software OpenSource. Simulasi telah dilakukan untuk memprediksi suhu udara dalam ruang warehouse. Juga telah dilakukan simulasi udara untuk desain alternative konstruksi jalan akses ke tingkat 3 warehouse. Hasil simulasi memberikan konfiden kepada developer untuk meneruskan proses pembangunan warehouse. Kegiatan ini merupakan kegiatan pengabdian masyarakat dari Swiss German University yang memanfaatkan keilmuan akademik dari Komputasi Fluida untuk kebutuhan masyarakat yang disini adalah dari pihak Industri yaitu PT. LOGOS. Hasil dari penelitian ini tidak dipublikasikan dikarenakan kerahasiaan dari produk PT. LOGOS.

Alam Sutera, Tangerang
Date: September 2021

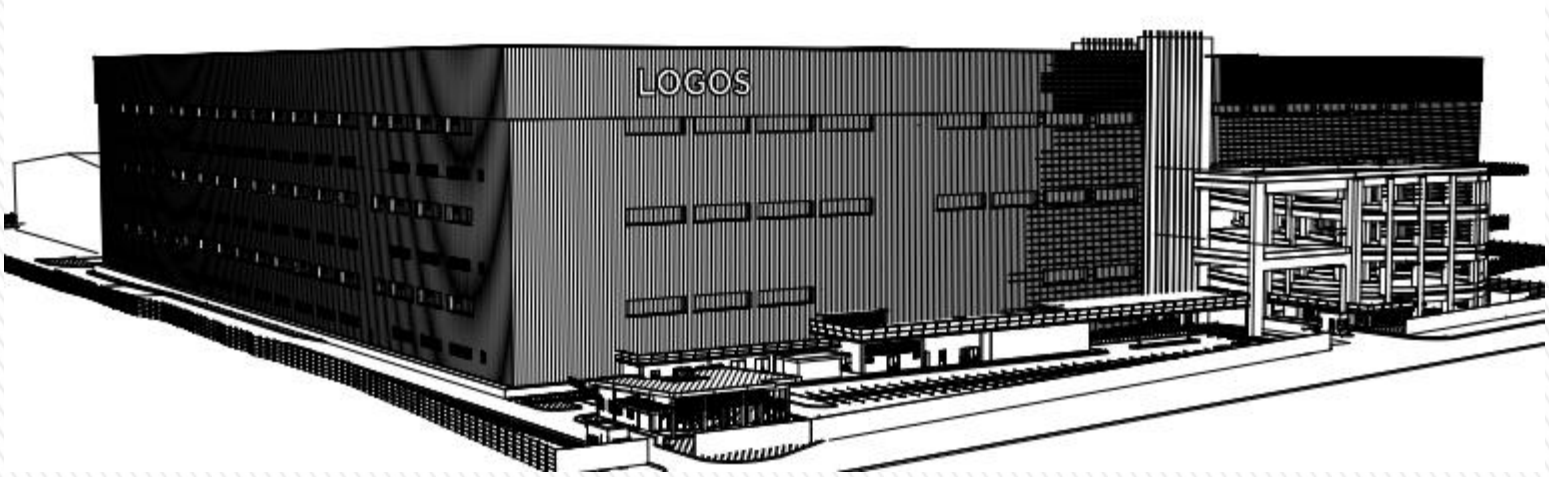
Dena Hendriana, B.Sc., S.M., Sc.D
NIK: 11211528

Progress Report

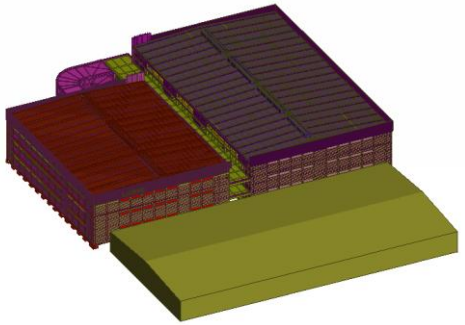
27 September 2021

To: Mr. Tony Elie – Director
Mr. Erwin Wong – Development Manager
LOGOS

By Dr. Dena Hendriana
Researcher at CCFD

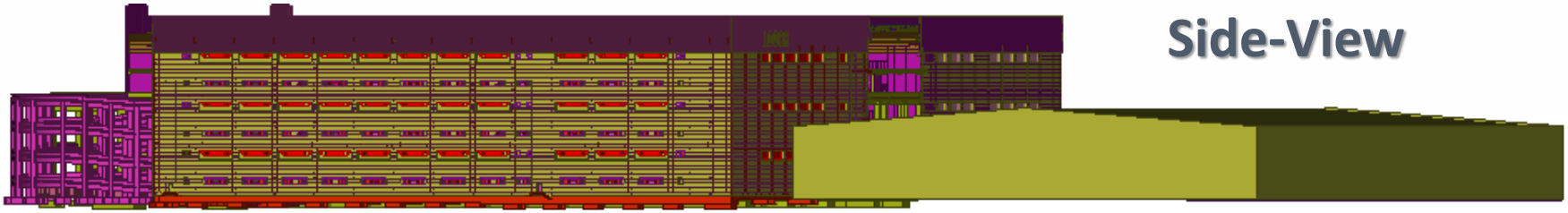


Building Design



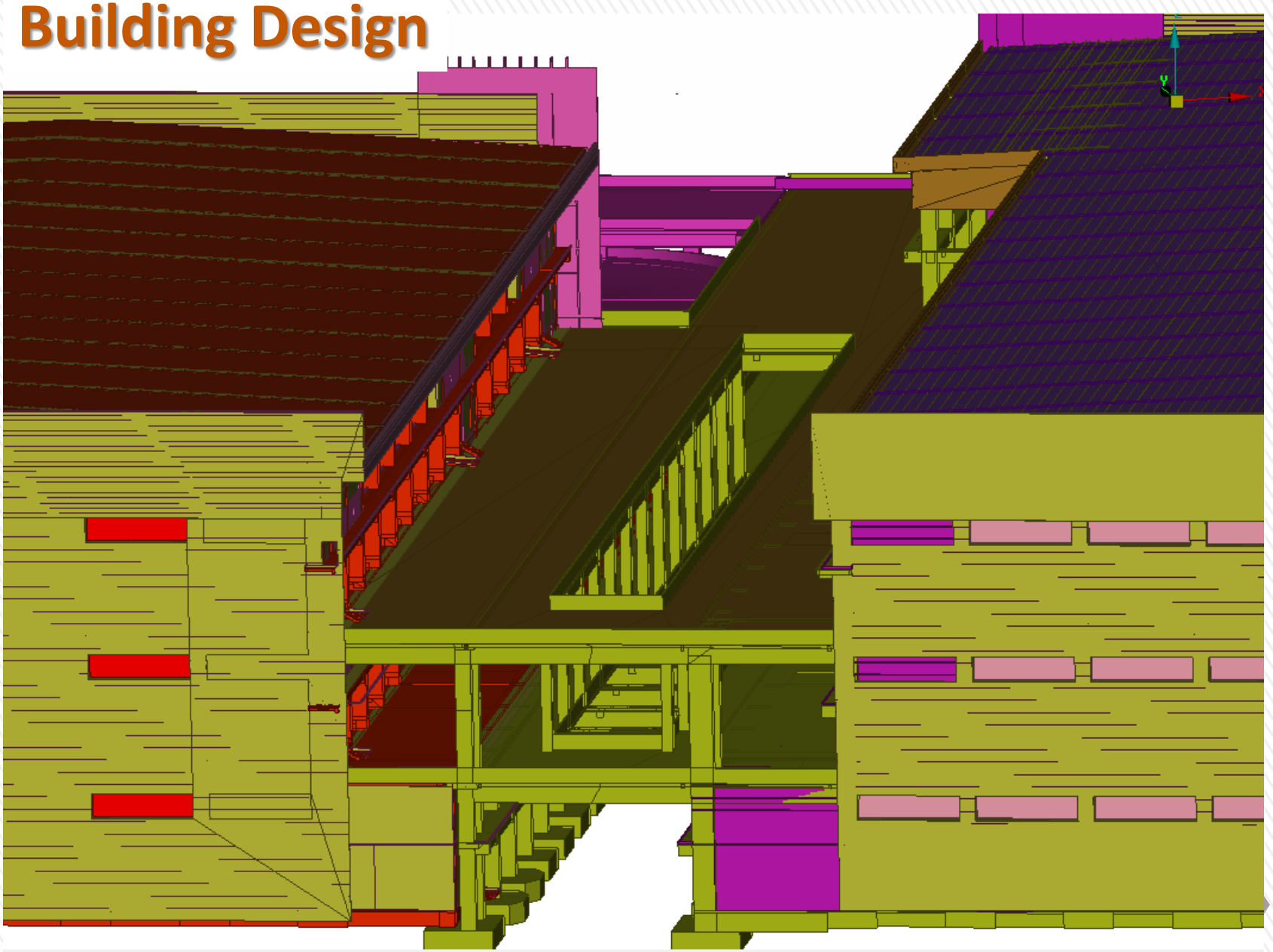
Old Design

Iso-View



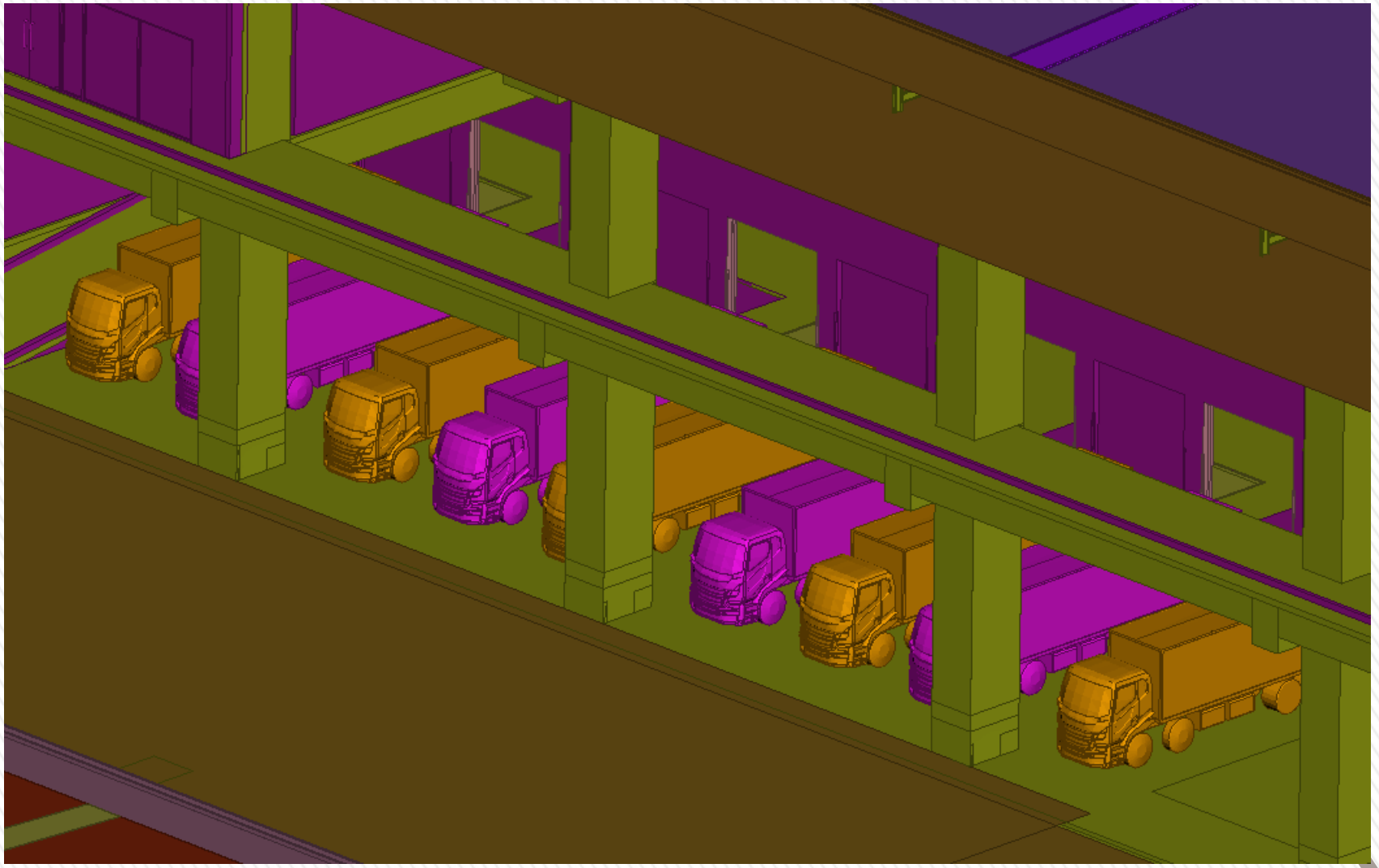
Side-View

Building Design



Driveway (1st, 2nd,3rd level)

Building Design



Full Truck Capacity in Loading Area

50% Truck On and 50% Loading Door Open

Conclusions

- New design with void in the driveway has smaller building wake.
- Some areas of the void is having air flow from Level 1 to Level 3 and some other areas having air flow in the opposite direction.
- Air temperature in level 3 driveway is slightly lower in the new design due to stronger air flow.
- Driveway void does not change air flow inside the warehouse A and B significantly, but slightly cools the warehouse B Level 3.
- Local high air temperature on the driveway is 33C at the 3rd Level (which is lower than old design) due to heat load on driveway 3rd floor of 50C
- Local high air temperature in warehouse A is around 31C in the 3rd Level due to heat load on the ceiling of 40C.
- Local high air temperature in warehouse B is around 33C in the 3rd Level.
- In this case, wind speed of 25 kph is enough to stabilize the temperature inside the building and the driveway.

Next Step / Recommendation

- Run the simulation with low wind speed (3.6 kph or 1m/s) to see heat accumulation inside the building and in the driveway area.
  - Case No. 1
  - Case No. 5
  - Case No. 15
- Fans might be needed when considering low wind speed.

	Case	Wind from	Speed	Temp. u/n roof	Truck	WH Door	Ambient Temp.	Fan	Driveway Temp	WH Temp.	Priority
			km/h	Inside/Outside [C]	[%]	with Louvre	[C]				
Exisiting	1	S to N	0	40/55	75	All Closed	30	0			1
	2	S to N	25	40/55	100	All Closed	30	0			1
	3	S to N	0	40/55	75	All Closed	30		30	30	3
	4	S to N	25	40/55	100	All Closed	30		30	30	3
	5	S to N	0	40/55	75	50% Closed	30	0			5
	6	S to N	25	40/55	100	50% Closed	30	0			5
	7	S to N	0	40/55	75	50% Closed	30		30	30	7
	8	S to N	25	40/55	100	50% Closed	30		30	30	7
New	11	S to N	0	40/55	75	All Closed	30	0			2
	12	S to N	25	40/55	100	All Closed	30	0			2
	13	S to N	0	40/55	75	All Closed	30		30	30	4
	14	S to N	25	40/55	100	All Closed	30		30	30	4
	15	S to N	0	40/55	75	50% Closed	30	0			6
	16	S to N	25	40/55	100	50% Closed	30	0			6
	17	S to N	0	40/55	75	50% Closed	30		30	30	8
	18	S to N	25	40/55	100	50% Closed	30		30	30	8