

## Introduction

○ Facility A/C, commercial packaged air conditioner for facilities, has a wide variety of applications such as A/C for human comfort, A/C in a factory for goods and A/C for special users(for server rooms and clean rooms).Fig1

○ Main characteristics(1)

1. Although the Facility A/C does not have individual air conditioning system, some systems are larger than VRF system in capacity(refrigerant amount).
2. There is a case where multiple refrigerant systems are connected to the large capacity indoor unit.
3. There is a case where it is installed in a room with very high thermal load such as server room and a room for special use.
4. There are ignition sources (blast furnaces, drying furnaces, etc.) which are unique to Facility A/C.
5. There is a case where the ratio of refrigerant amount to a room volume (LFL ratio>1) is high ⇒ Even though it mainly has pair connection, the countermeasure which was extended from that of commercial A/C shall not be accepted.



Ratio of projects delivered with Facility A/C

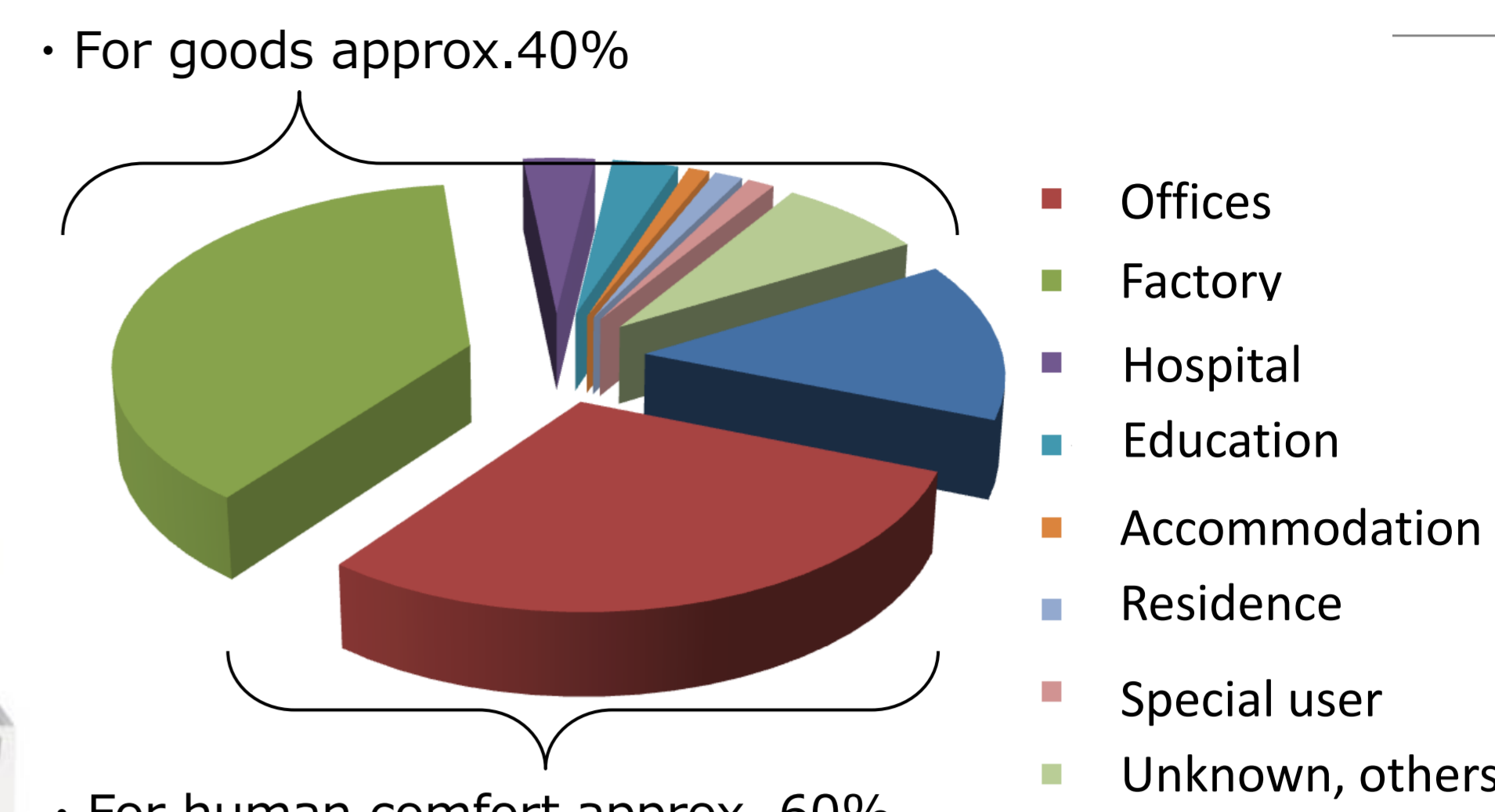


Fig.1

## System Comparison

○ System comparison per product type

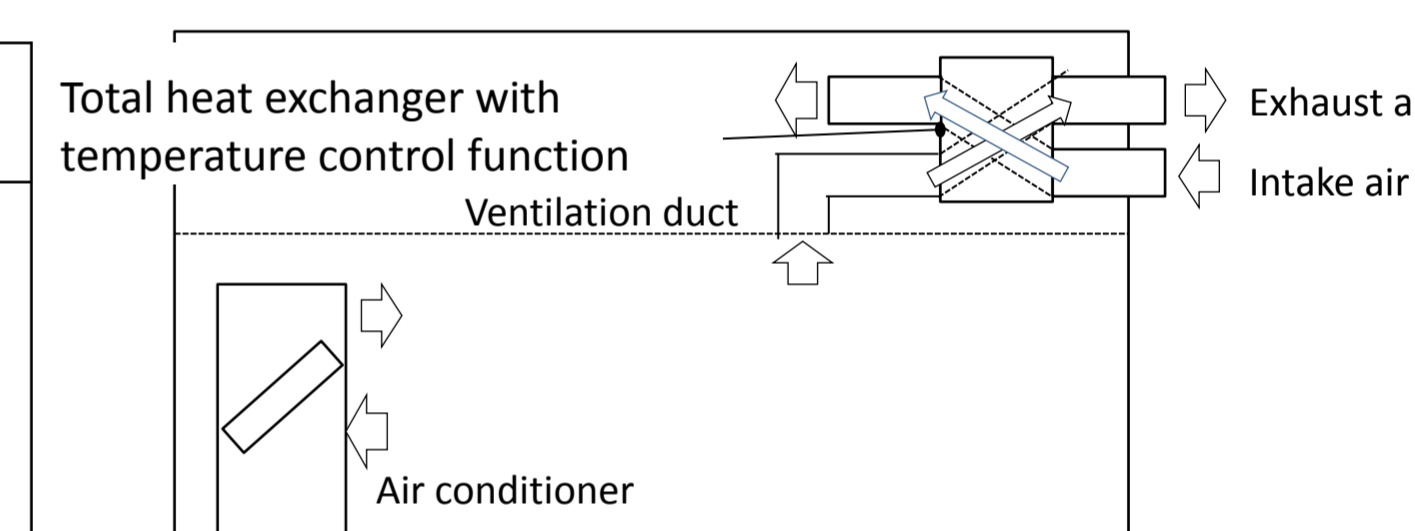
Types of products	Commercial A/C	VRF System	Facility A/C
Refrigeration capacity※	Less than 3 tons	3 tons or more - less than 20 tons	Less than 20 tons
Main installation system (Outdoor unit : Indoor unit)	1 unit : 1 to 4 units All indoor units are installed in the same space	1 to 3 units : 1 to 64 units Each indoor unit is installed in a separate space	1 to 3 units : 1 unit There are multiple refrigerant circuits per indoor unit. Multiple units are installed per room.
Main indoor unit type	Ceiling cassette type, Ceiling suspended type, Wall mounted type, Built-in duct type, Floor mounted type(slim type)	Ceiling cassette type, Ceiling suspended type, Wall mounted type, Built-in duct type, Floor mounted type (for perimeter)	Floor mounted type, <b>Floor mounted type (built-in compressor)</b> <b>For computer room(ceiling suspended),</b> <b>For computer room(floor mounted air outlet)</b> <b>For clean room</b>
Main outdoor unit type	Air cooled type horizontal flow, Ice thermal storage type (air cooled) horizontal flow	Air cooled type Vertical flow, Ice thermal storage type (air cooled) Vertical flow, Water cooled type (in a machinery room)	Same as on the left (common with VRF system) Condensing unit (without compressor)
Main indoor installation location	Office, Kitchen,/Dining hall, Factory(general), Karaoke room (highly sealed space)	Office, Kitchen,/Dining hall, Factory(general), Karaoke room (highly sealed space)	<b>Factory(foundry, etc.), Computer room (floor mounted air outlet)Clean room, Dining hall</b>
Main installation location of outdoor unit	Above the ground(rooftop), Install on every floor, Semi-underground, Small and narrow space (alley, gap)	Above the ground(rooftop), Install on every floor, Semi-underground, Indoor installation (machinery room)	Same as on the left (same as VRF system)

※High Pressure Gas Safety Act, Refrigeration Safety Regulation

○ Characteristics per life stage

Life stage	Transportation	Storage	Installation	Repair/service	Disposal	Usage
Facility A/C	(Same as VRF system)	(Same as VRF system)	<ul style="list-style-type: none"> <li>• In important facilities, normal ventilation shall not be carried out since a large change in temperature is not allowed. Therefore 100% outside air processing is required.</li> <li>• There are indoor units with built-in compressor.</li> <li>• Back-up units operate continuously even at the time of maintenance and disposal in important facilities.</li> </ul>			

○ Example of 100% outside air processing



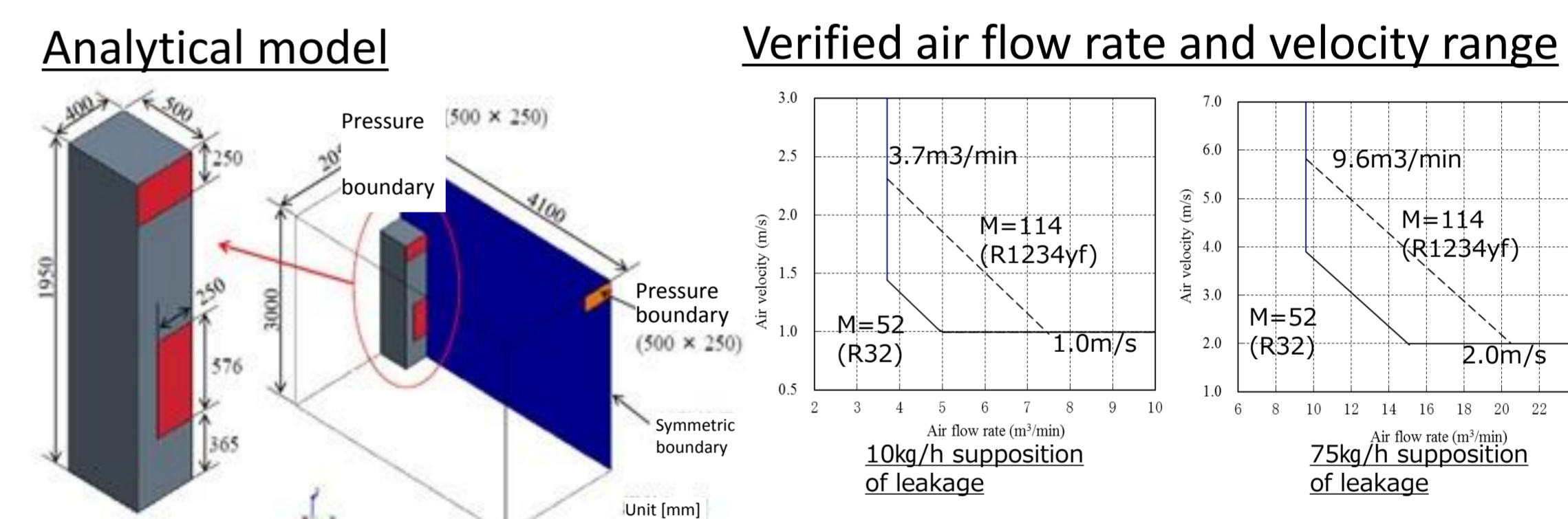
## Conclusion

- 1) A large portion of them are used for goods(not for human comfort), and their uses vary widely. Some are used in spaces where ignition sources are present that cannot be removed. Others are used in applications where immediate restoration of operation is required after such problem as refrigerant leakage.
- 2) Multiple air conditioners are often installed in a single space, where some air conditioners are installed or repaired, or disposed while other air conditioners are in operation.
- 3) Most of the indoor units are floor mounted type, which are at a risk of creating flammable regions near the floor in case of a refrigerant leak.

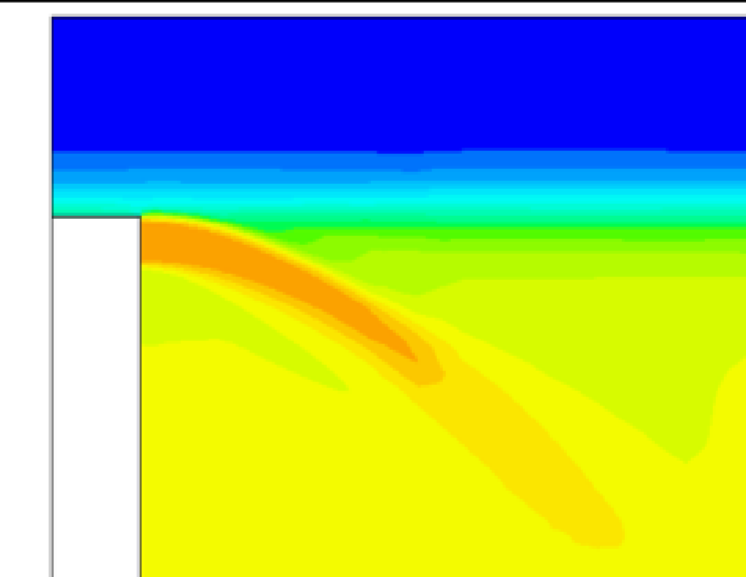
- a) Refrigerant detectors and alarms shall be installed regardless of the estimated maximum refrigerant concentration of leaked refrigerant.
- b) Floor mounted indoor units shall have an air circulation function that goes into operation when a refrigerant leak detector is triggered.
- c) If the maximum refrigerant concentration of leaked refrigerant exceeds one-quarter of the LFL, additional safety measures (such as a shut-off valve or ventilation) are required.
- d) Where an unremovable ignition source is present, refrigerant leak detectors shall be installed closer to the area where refrigerant leak is likely than to the ignition sources.

## Safety Measure Effect Verification (1)

○ It shall be verified whether the air can be circulated at the minimum airflow rate and air velocity with a floor-mounted type.



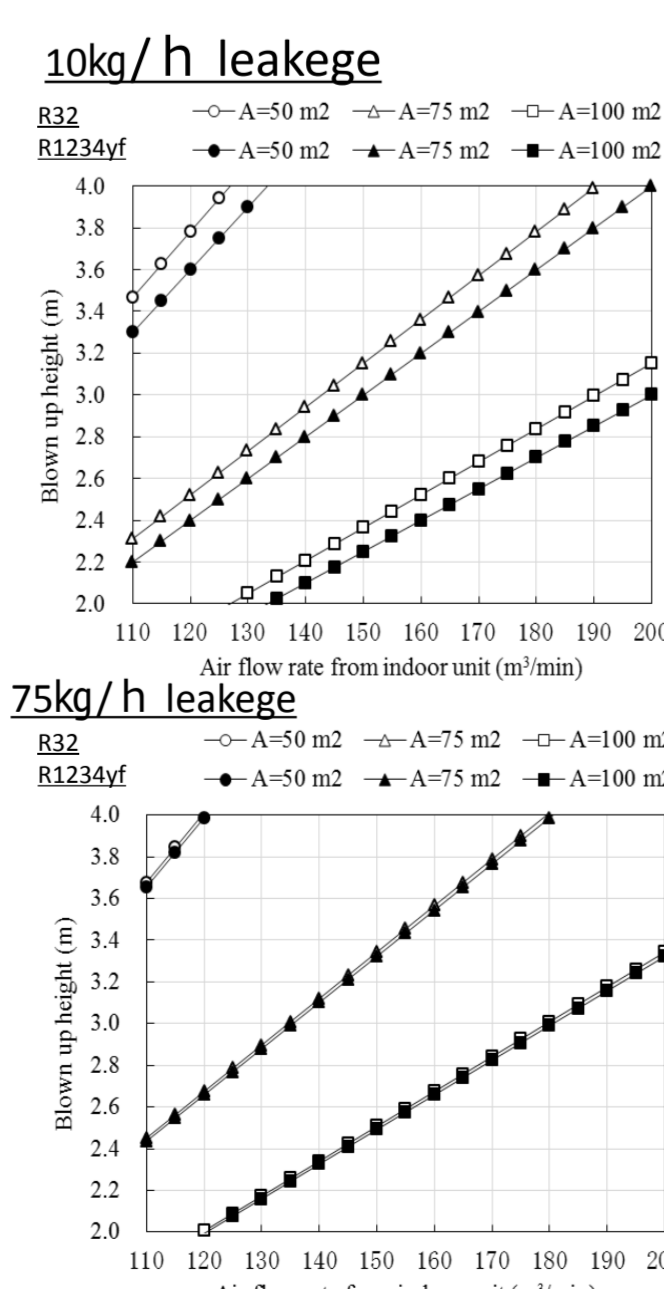
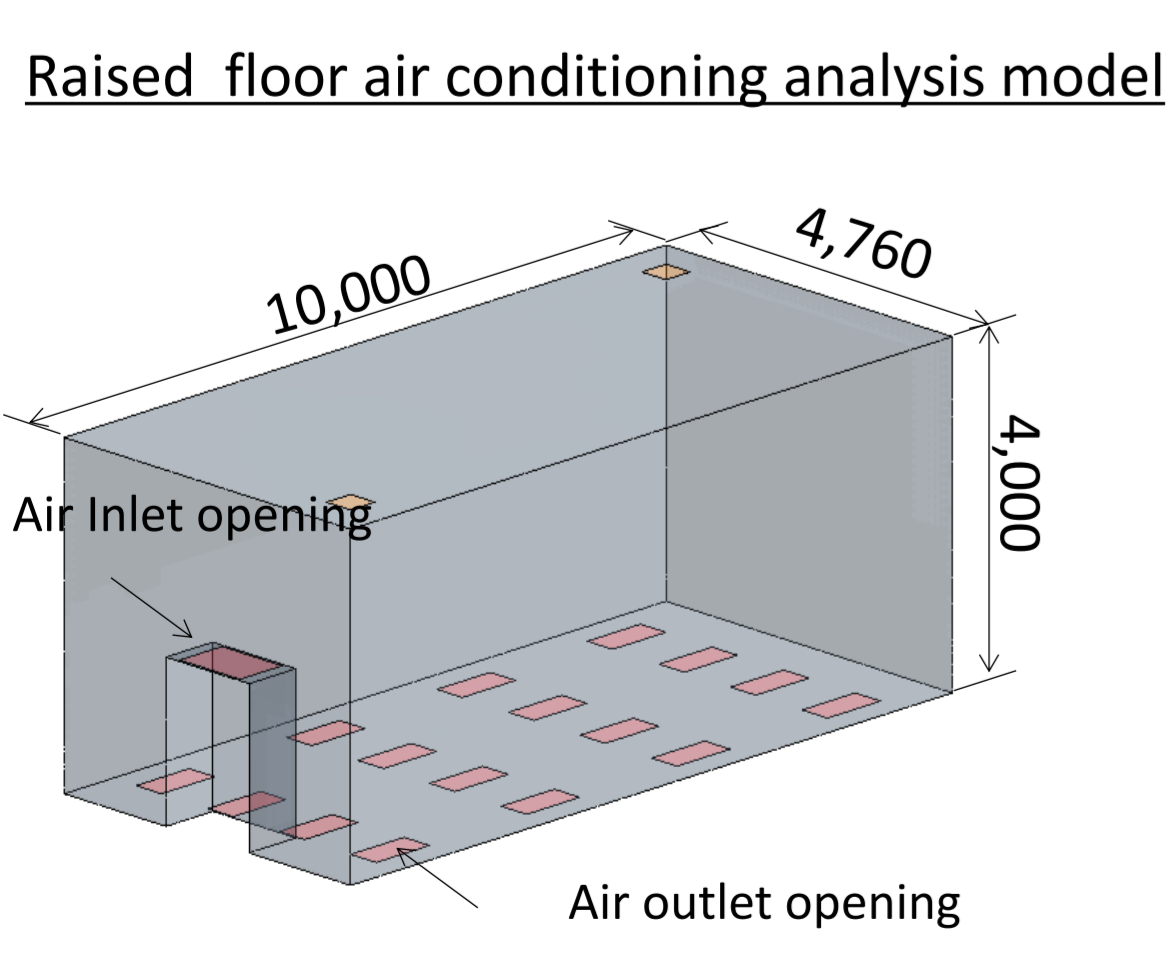
Result of the air circulation by horizontal flow of direct flow type



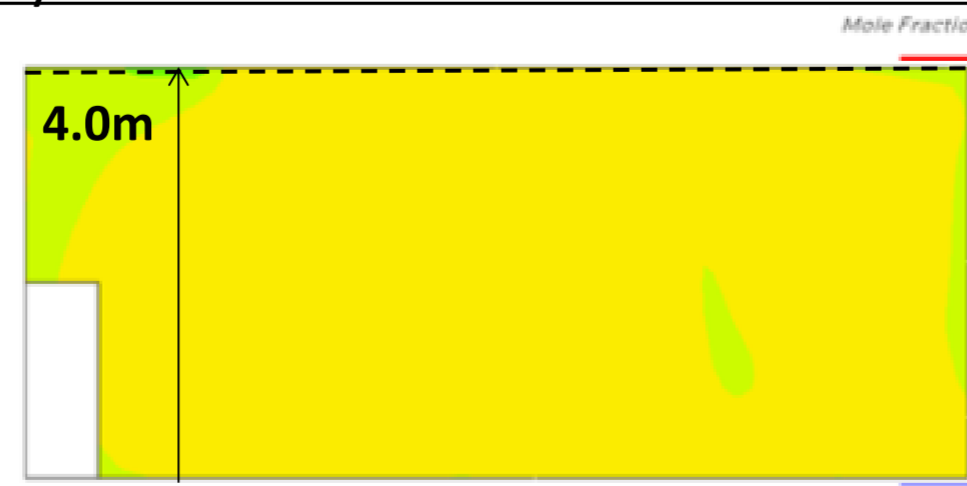
In the rapid leakage with refrigerant amount LFL/4, flammable region is not formed since the air is circulated up to the upper end of an indoor unit.

## Safety Measure Effect Verification (2)

○ It shall be verified whether the air can be circulated at the minimum airflow rate and air velocity in a raised floor air conditioning system. Relationship between the air flow rate and velocity of air circulation from analysis.

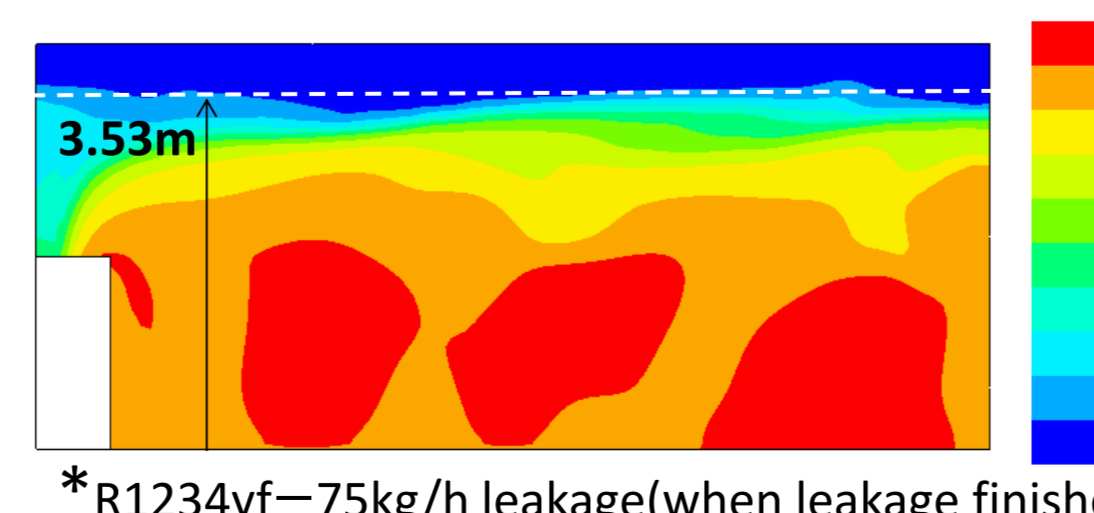


Analysis of Air circulation effect in raised floor 1



\*R1234yf-10kg/h leakage(when leakage finished)

Analysis of Air circulation effect in raised floor 2

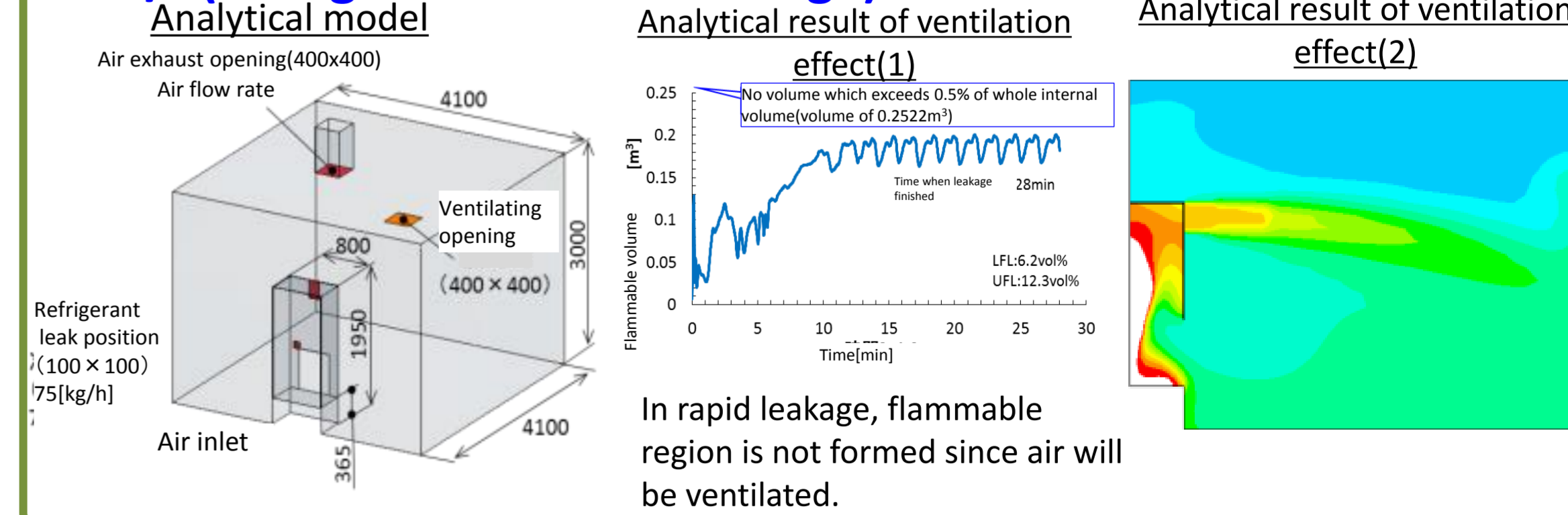


\*R1234yf-75kg/h leakage(when leakage finished)

In the rapid leakage with refrigerant amount LFL/4, flammable region is not formed since air is circulated up to the upper end of an indoor unit.

## Safety Measure Effect Verification (3)

○ Ventilation effect for the additional measures when exceeding LFL/4(Refrigerant amount is large)



## Summary

- Facility A/C is able to operate safely by taking safety measures mentioned above.
- In the future, it is required to perform risk assessment for the models excluded from this investigation such as integrated type.

## Document

- Guideline of design construction for ensuring safety against refrigerant leakage from commercial packaged air conditioner for facilities using lower flammability (A2L) refrigerants JRA GL-19:2016
- Requirements of ensuring safety against refrigerant leakage from Facility A/C using lower flammability (A2L) refrigerants JRA 4073:2016