GTG™

Car Park Jet Fan

Content

ABOUT GTG

GTG™ has been an innovative player in the air-conditioning and mechanical ventilation (ACMV) industry for the past 20 years. It is owned by leading industrialists who have in-depth experience in managing worldwide operation of large conglomerate in ACMV field. With management's vast exposure in international market, leading technologies & R&D, GTG has been providing innovative solutions & components to local industries for a long time. GTG is also the OEM manufacturer for some of the world renowned brands. The most recent development in GTG is the jet fan system. After spending years in research with institution of higher learning and consultation with experts who have international experience, GTG has developed and is ready to offer a better solution to conventional car park ventilation system.

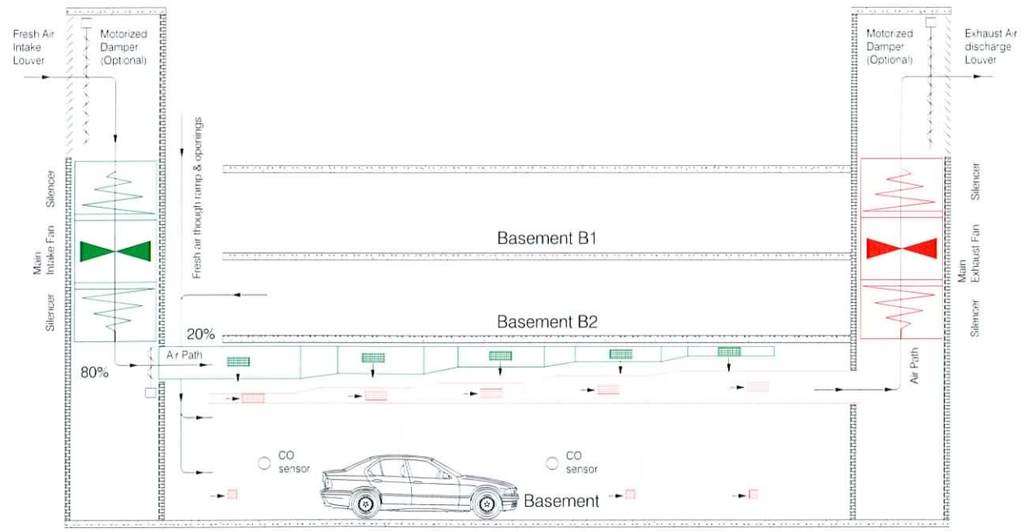
INTRODUCTION

The general use of the car park is to cater to the ever increasing traffic and it is mandatory for every new building now to provide adequate car park space. With the diminishing land area in cities, aboveground car parks are more of a luxury. Since most city car parks are underground, effective ventilation with exhaust system becomes very critical and essential.

For a car park to be fully naturally ventilated, permanent openings for ventilation should be provided. The openings should have an aggregate equivalent area of at least 5% of the floor area of each car park storey. At least half of this should be equally arranged between two opposing walls. Normally, underground car park will not meet the criteria and mechanical ventilation is necessary.

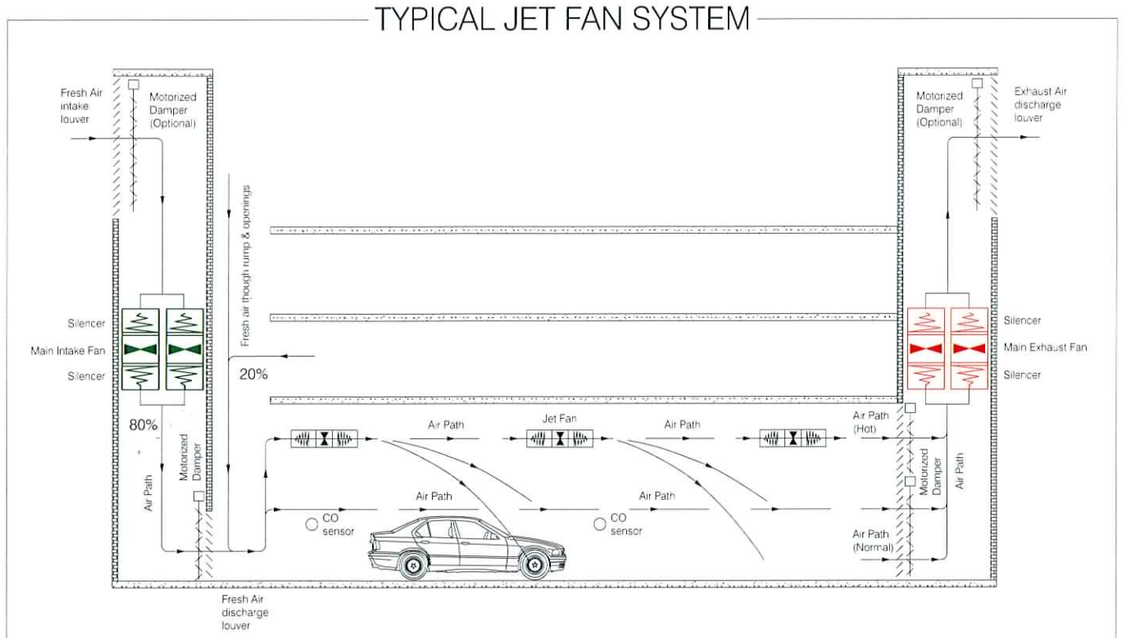
Nevertheless, adequate ventilation for aboveground car park premises is essential as well for large floor areas or when openings at walls are not sufficient to provide natural ventilation. While a car park is an important feature of a building, the appreciation of costs on building materials also forces the architects to reduce the unnecessary headroom in the car park in order to save costs and space. Conventional method of ducted system ventilation that requires high headroom will not meet this trend and it always fails to provide a neat and efficient ventilation and exhaust solution.

TYPICAL DUCTED SYSTEM



Over the years, conventional ducted ventilation system has established its standards and functionalities. Firstly, it has to effectively remove or dilute toxic gases from emission of vehicles and make sure that there are no pockets of stagnant air. Secondly, in the event of a fire, it has to clear heat and smoke generated by fire as soon as possible for fire-fighting to be carried out after that. Other criteria that are desirable, though harder to be attained, are to create a smoke-free clear path for Fire Service personnel to enter for fighting the fire as well as protection for the public to escape. To achieve better result, conventional ducted system always demands a larger space for ducting installation but this is difficult under constraint of a normally limited space in car park. Therefore, in previous years, jet fan (or impulse / induction) ventilation system has emerged as the most significant new solution available for car park design of the building industry. The benefits of the system can be reaped not only by the car park owners, but also the users and designers. Jet fan system has evolved from the longitudinal tunnel ventilation system that is mostly used in road tunnel system and has long been proven in safeguarding vehicular movement in confined spaces. Designed for effective environmental and smoke control, the jet fan system has been tried and tested in many car parks throughout Europe and Middle East.

A sketch of jet fan system is as follow:



GTG JET FAN

JF250

JF315 / JF400

WHAT IS JET FAN VENTILATION SYSTEM ?

A jet fan or impulse ventilation system is an alternative to the conventional ducted system and it improves and overcomes the shortcomings of ducted system. A jet fan comprises a high velocity axial fan with both inlet and outlet attenuators as well as the flow distribution control device. The velocity and volume of the impulse jet fan airflow are the decisive parameters which are represented by its thrust at discharge. The thrust of the jet fan is also a determining criteria to the number of impulse jet fans required in this ventilation system.

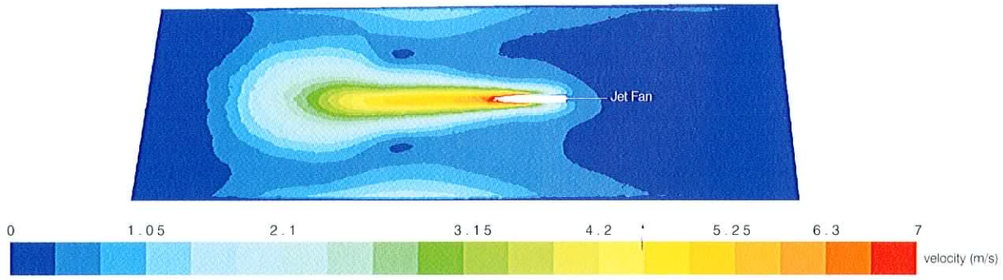


Figure A : Top view of velocity profile of jet fan

As we can see the amount of air movement induced by the thrust of the jet fan is many times the airflow through the jet fan. This property enables the jet fan to replace conventional ducting in car park ventilation though the main exhaust/ fresh air fans remain.

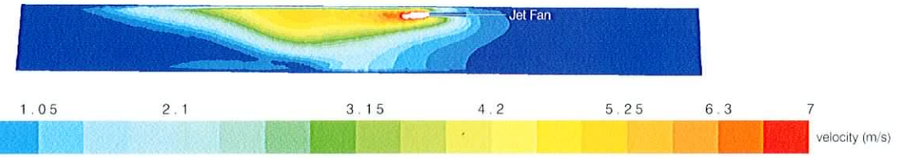
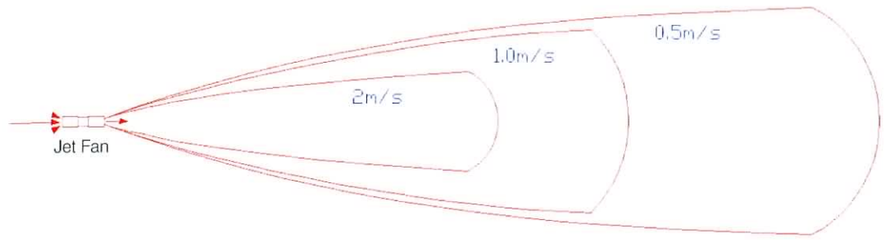


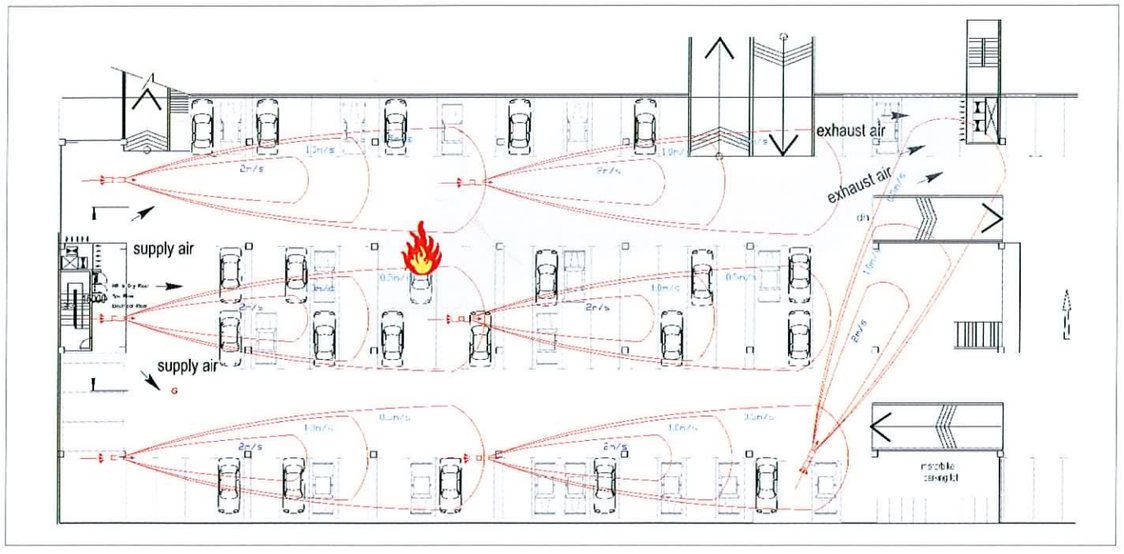
Figure B : Side view of velocity profile of jet fan

The velocity profile of a jet fan can be numerically determined through Computational Fluid Dynamic (CFD) analysis with the boundary conditions (proximity to floor slab, beam obstruction, etc) as stated. The velocity profile of the most common 400mm diameter axial type of jet fan, operating at high speed under a ceiling slab is as follow:



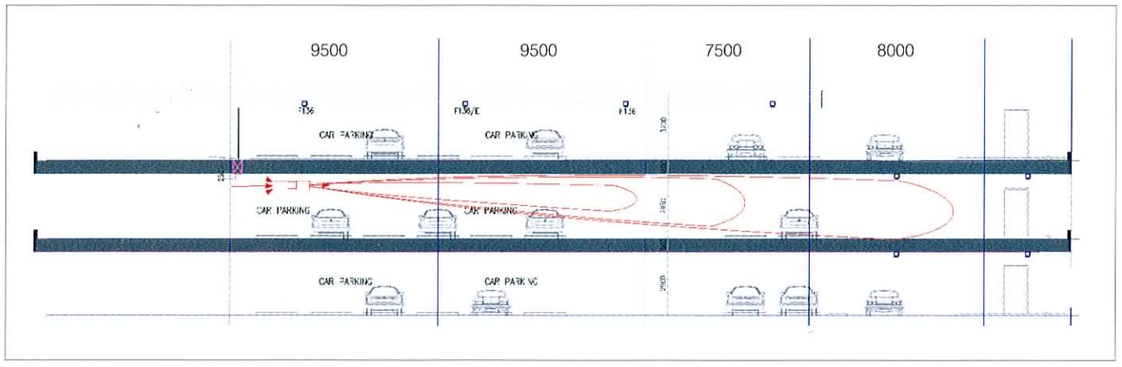
This jet fan typically produces a thrust force of 50 N (Newtons) at high speed. Some modification to impeller blade or its pitch angle can result in higher thrust force but at the expense of higher noise level and power consumption. The higher the thrust force, the further and wider the air throw of jet fan can reach and thus covering a larger floor area. Larger fan has higher thrust but designer of car park ventilation system has to consider the size of fan as well as the head room requirement by relevant authorities. It is also favorable to keep minimum number of fans in a system as life safety feature in emergency mode.

The figure below shows a car park space of around 2,600m^2 that is ventilated by jet fan system. It illustrates only the fire mode operation of the system:

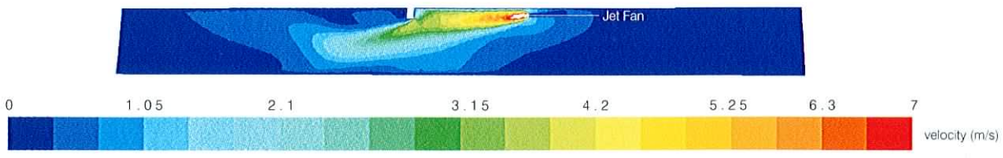


The jet fans are operating at high speed (fire mode) and a car in the middle is on fire. The main exhaust fans are at the top right hand corner while the main supply air fans are at the left hand side. The bulk airflow created by the main fans as well as the airflow induced by the jet fans will direct the smoke towards the exhaust point of the system. The induced airflow also effectively helps to dilute the smoke & heat produced by the fire to keep toxicity and temperature from reaching dangerous level.

The cross-sectional view of jet fan installation shows its great range of air throw at fire mode if no or minimal obstruction to airflow by beam or other M&E services exists:



However, we sometimes need to analyze the effect of obstruction to airflow by deep beam. Optional air deflector can be installed to direct air jet for optimum flow after analysis:

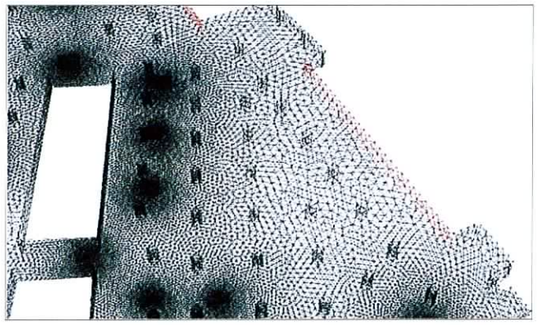


The range of jet fan can be reduced after consideration of the deep beam effect. The clearance between floor slabs may affect the range of jet fan as well. Therefore, the quantity of jet fans & their locations varies from project to project even if for similar floor areas, depending on the building geometry & structure. Design of jet fan system thus needs a more scientific approach as mentioned below.

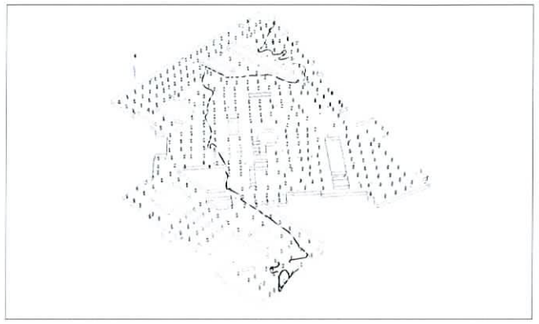
THE DESIGN APPROACH

The design criteria for a car park impulse jet fan system must take into consideration the parameters such as,

- Air change rate at normal ventilation mode and emergency exhaust mode;
- Total supply and exhaust air volume for normal and emergency mode;
- Direction of airflow with regards to architectural design;
- The shape of the car park;
- Location of ramps, wall openings, fresh air and exhaust air vent shafts;
- Depth of beam, size and location of columns;
- Size and location of internal core (lobbies, etc.) that obstruct air passage;
- Number and position of impulse jet fans;
- Computer Fluid Dynamic (CFD) analysis with impulse jet fans in designated positions. It can be used to analyze both normal ventilation (pollution control) & fire mode operation.



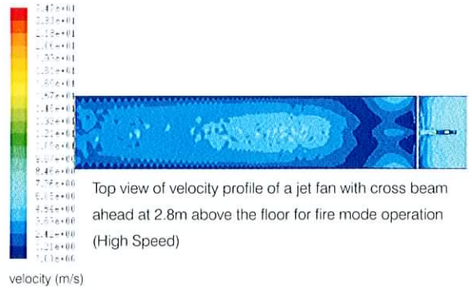
Hybrid meshing technique in car park



Smoke path tracing in a car park

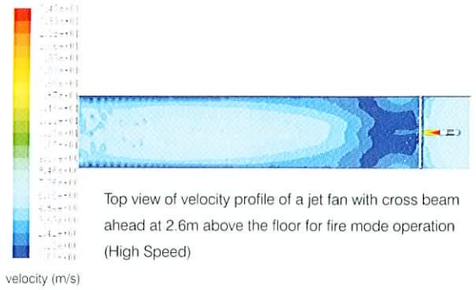
WHAT IS CFD SIMULATION?

Building schemes and designs are getting more and more complex in the internal geometries and architectural features and many of these buildings may not follow the conventional design. Standard and simple calculation techniques may not provide adequate levels of detail to describe the flow patterns in these designed environments as it can be too tedious a task. These calculations are now possible and feasible with the advancements in computer hardware & software, thus allowing detailed and accurate calculations at each location.

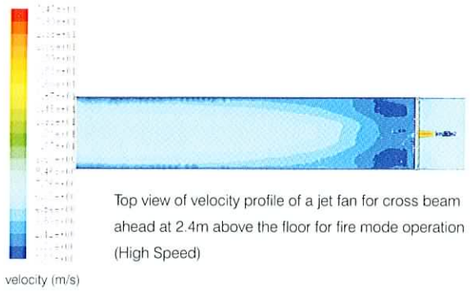


Top view of velocity profile of a jet fan with cross beam ahead at 2.8m above the floor for fire mode operation (High Speed)

Computer Fluid Dynamics (CFD), is an accurate, real time analysis of interacting physical properties. It works by allowing an object, structure or domain of interest to be split into a computational mesh containing hundreds of thousands of small volumes or cells (computational mesh). Well validated equations are then applied to describe the transfer of quantities such as heat, airflow, density, mass or momentum. This will build up a real time 3D model of the specific system.



Top view of velocity profile of a jet fan with cross beam ahead at 2.6m above the floor for fire mode operation (High Speed)

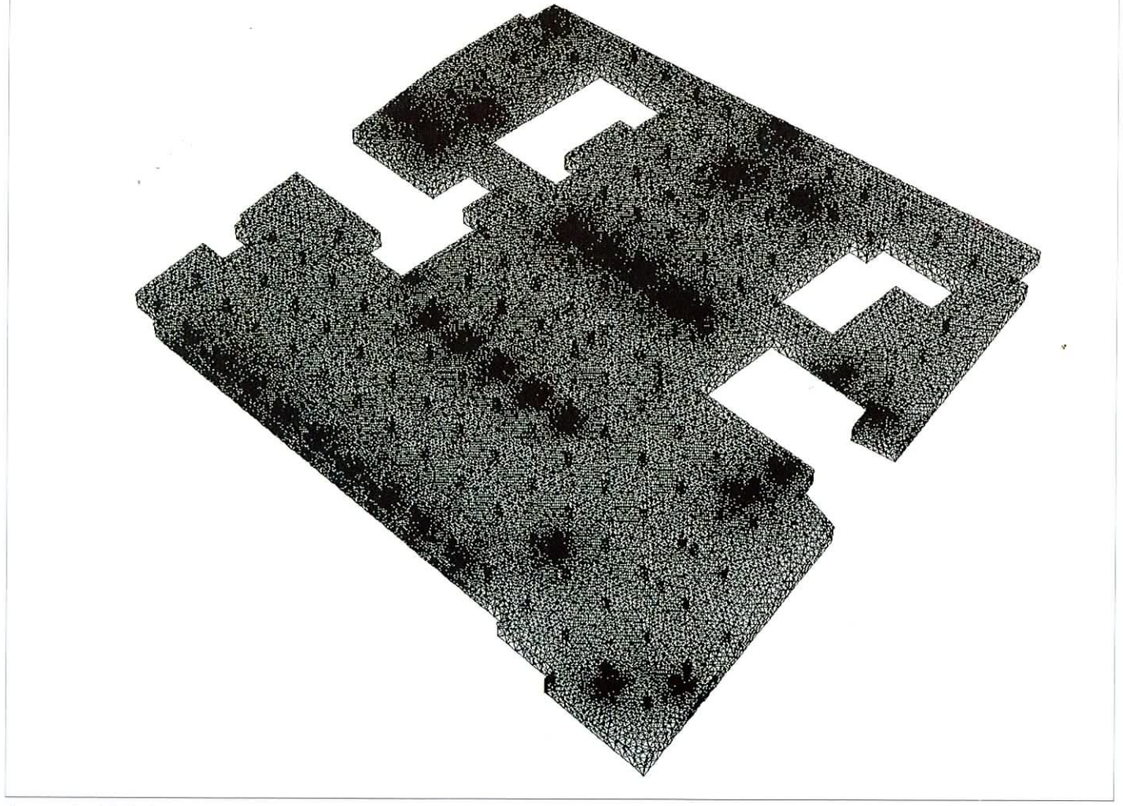


Top view of velocity profile of a jet fan for cross beam ahead at 2.4m above the floor for fire mode operation (High Speed)

For CFD to be applied to car park ventilation and smoke extraction system, the designer needs to make many decisions and assumptions. These decisions include what mesh size is appropriate and which CFD software package to use. These decisions will affect the validity and accuracy of the output. The heat source, beams, columns, location of ramps, internal cores must all be represented in the CFD analysis as it will inevitably affect the flow.

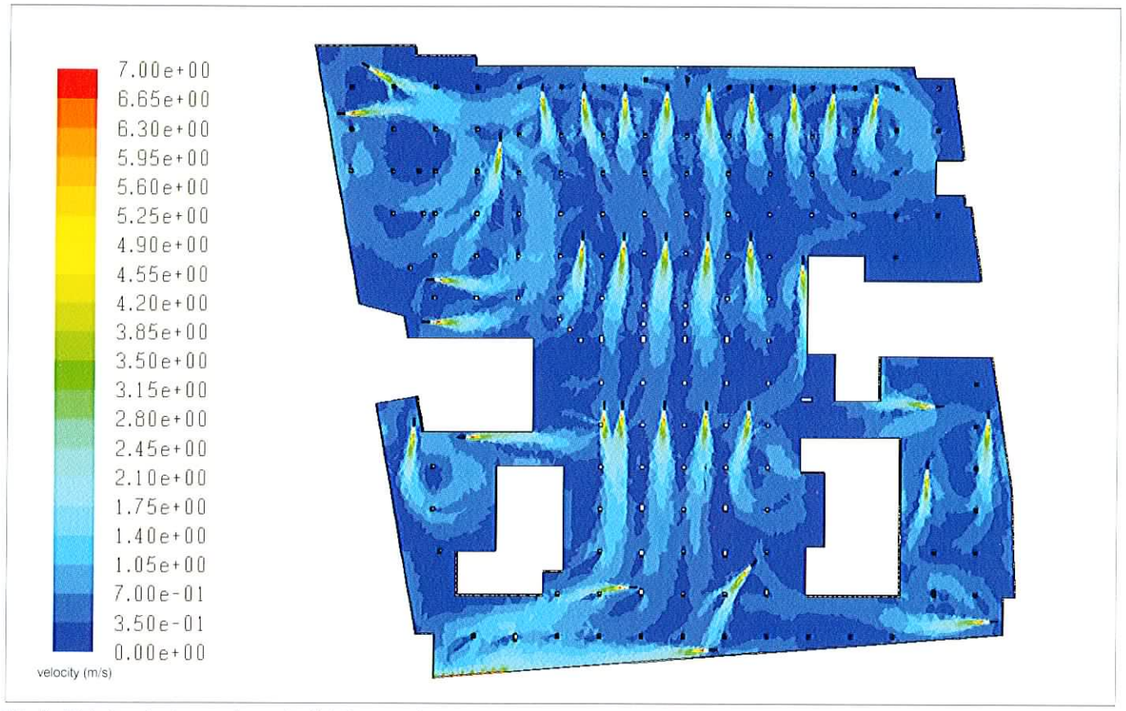
Computational mesh should be designed to suit the application and complied with the requirements. These requirements include,

- The geometric details are represented appropriately;
- The flow phenomena that driving smoke movement are resolved adequately where a fire is being modeled;
- Fire - should use several mesh cells to represent the plan dimensions;
- Thermal plume - sufficient detail is needed to capture the rise of the hot gases;
- Mechanically induced / assisted flows are represented appropriately.



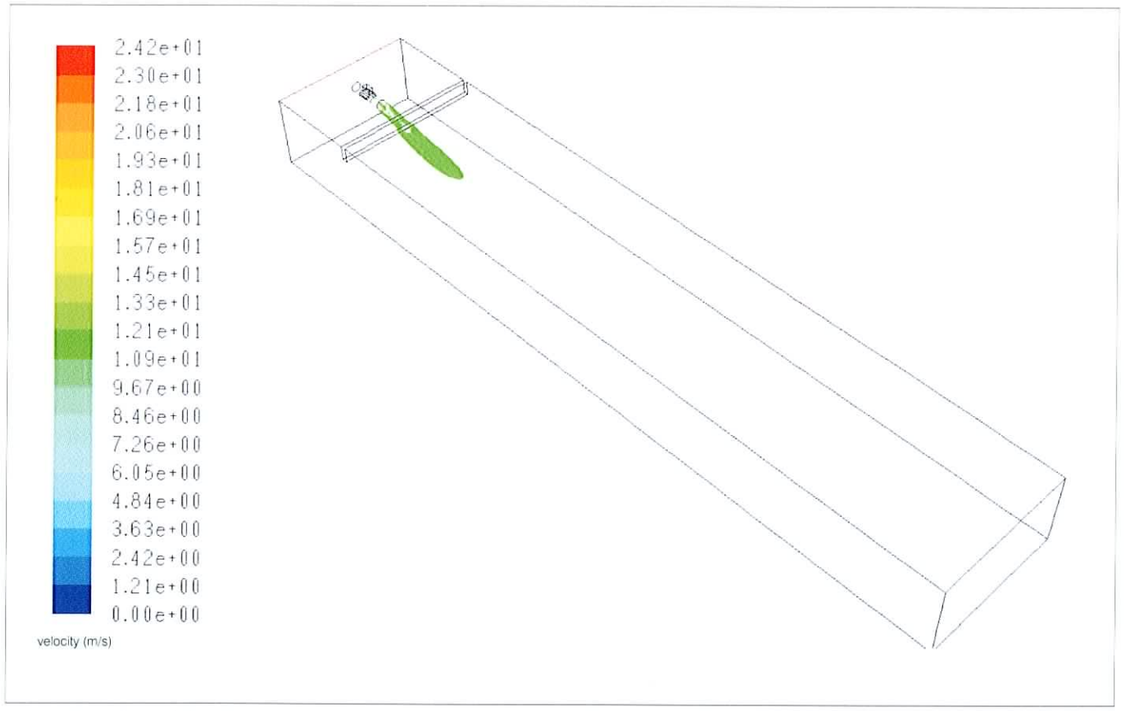
Computational Grid of a car park

Simulation result can be shown in colored figures for easy visualization of airflow:



Velocity distribution of underground car park with jet fan operation

GTG has an on on-going CFD research program with a renowned local university specializing in fluid dynamic. Contribution from GTG towards this institution of higher learning is both a social commitment and commercial development of local technologies. The company believes that the research group has the best personnel and hardware in complex engineering analysis and the most impartial conclusion of result.



Iso-plane of 0.4m/s velocity tracing

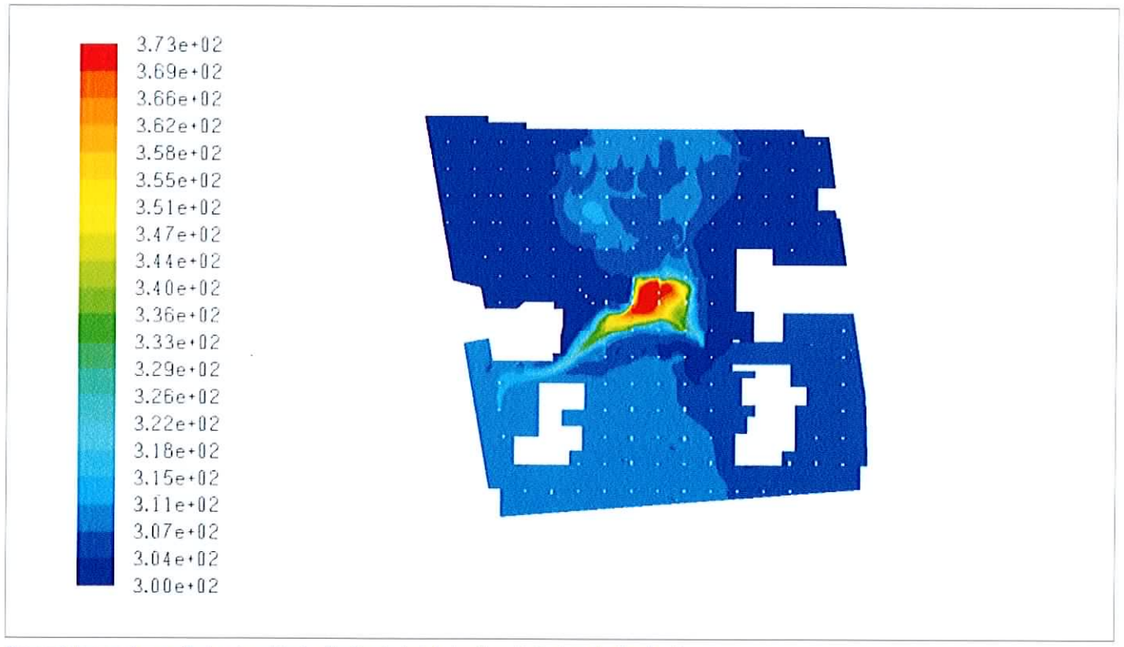
ADVANTAGES OF IMPULSE JET FAN SYSTEMS

1) Easier and quicker installation with higher available headroom

- Elimination of conventional ducts;
- increased headroom with minimal required fan size;
- Easier site management with proper design of impulse jet fan positioning

2) Smoke controllability in the event of fire

- The direction of the smoke can be designed to be contained in the affected area; or even keeps the escape area or path free of smoke with more sophisticated design;
- A series of impulse jet fans will move the smoke to a pre-designated extraction fans more efficiently & effectively
- The Computer Fluid Dynamic (CFD) simulation actually shows that the jet fan system can effectively cool the affected area and control the smoke to a designated extract point.



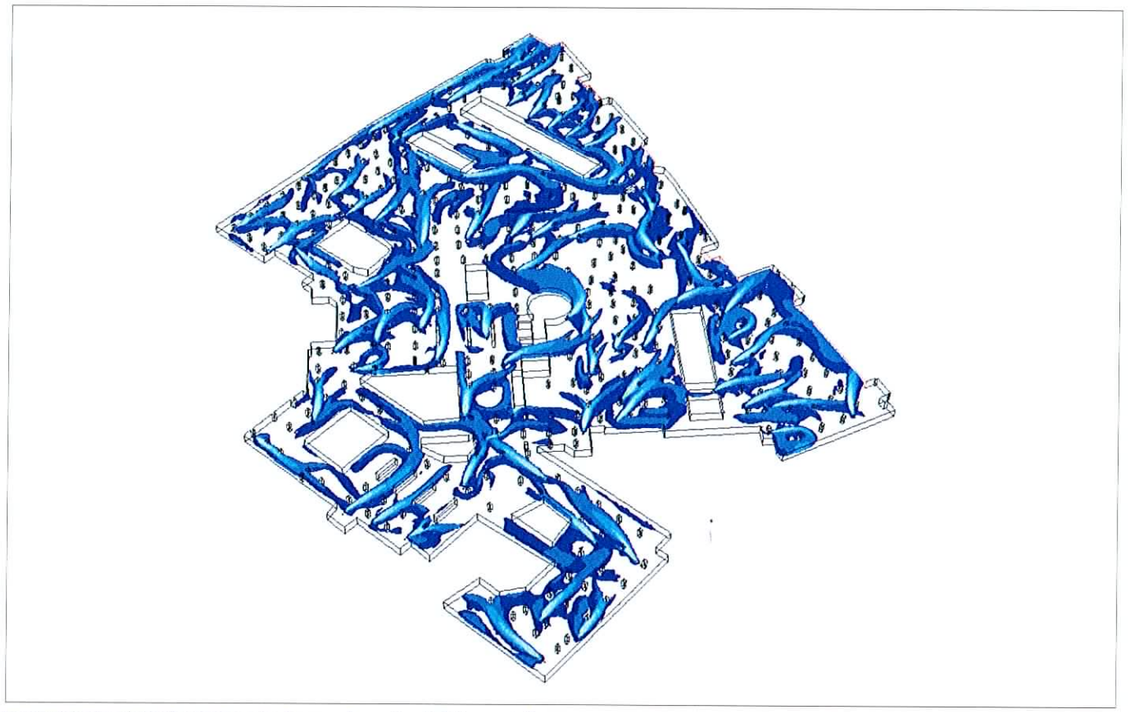
Fire mode temperature profile top view at 2 min after fire started at elevation of 1.5m from the floor level.

3) Lower operation power consumption; lower maintenance and lower emergency power supply provision.

- The conventional ducted systems require the ventilation fans to operate against the limited duct size due to the limited space. High pressure losses will translate into higher power in order for the ventilation fan to perform its functions;
- The impulse jet fans replace the duct and act as an "invisible" duct, hence reduces the pressure losses in the duct and power consumption;
- Requires minimal ductwork and dampers maintenance.

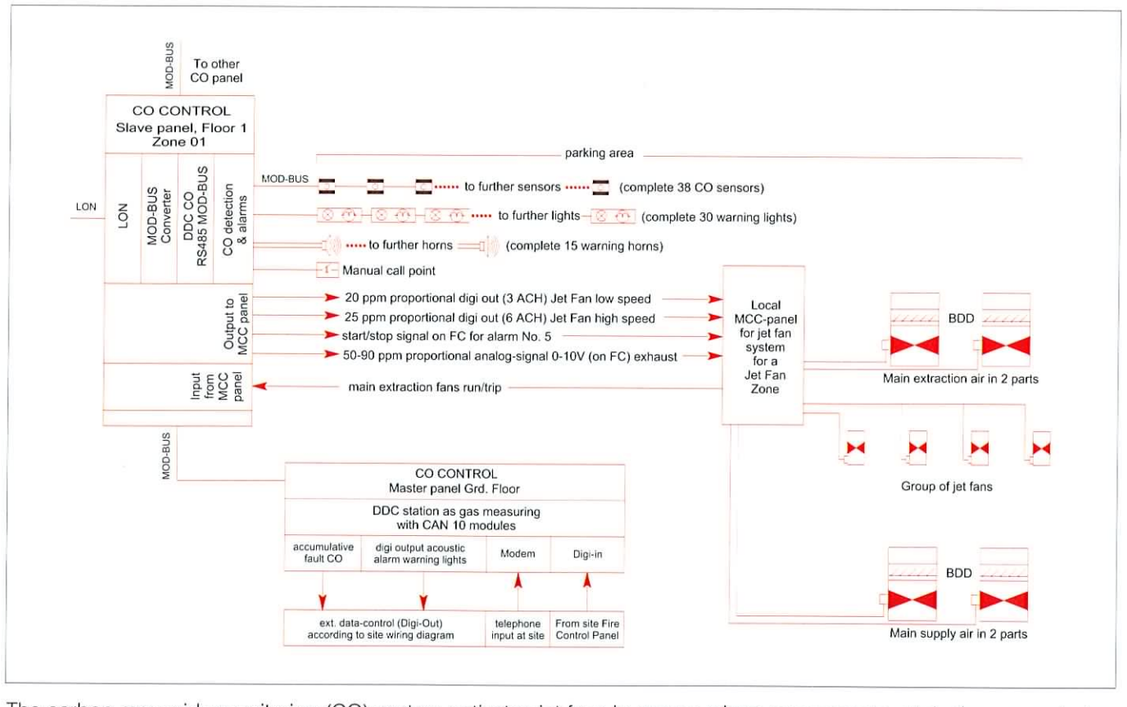
4) Improved air quality throughout the entire car park

- In CFD analysis, better normal (pollution control) ventilation is shown by clear visualization of air movement with jet fan installation.
- The constant operation of the impulse jet system will induce substantial airflow that reduces the risk of CO accumulation effectively.



Iso-plane tracing of 0.5m/s velocity region for normal operation (Pollution control)

GTG jet fan system can be integrated with standard carbon monoxide monitoring system to achieve substantial energy saving and improved indoor air quality. An example of control schematic diagram is as follow:

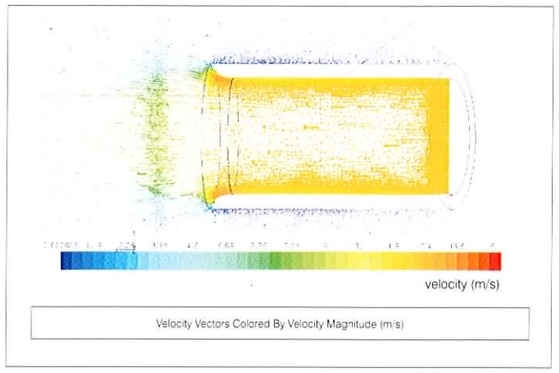


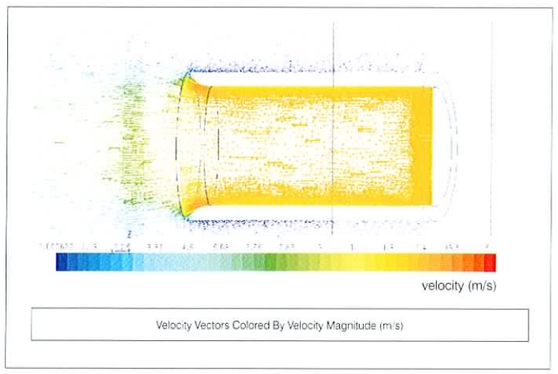
The carbon monoxide monitoring (CO) system activates jet fans in groups where necessary to attain the proper indoor air quality. It is linked with the fire alarm system which will override operation of CO system and put the whole system to fire mode (fans run at high speed) until emergency signal is reset.

GTG IMPULSE JET FANS

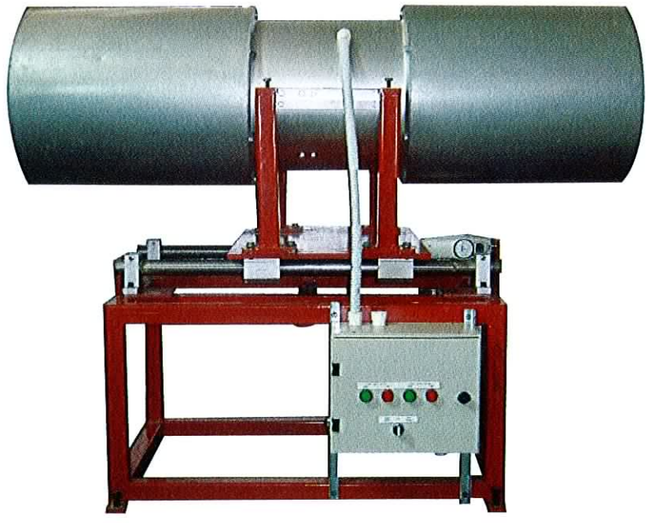
GTG impulse jet fans are tested in accordance to BS EN 12101-3 and certified rating of 300°C for 2 hours to ensure its compliance of performance even during operation at elevated temperatures. Each unit of fans is fitted with a dual speed high temperature motor to cater to the needs for normal and emergency mode operation. The low speed (1440 RPM) operation is ideally designed to meet the normal ventilation mode which helps to remove CO and eliminate stagnant air. This will ensure that there is effective air-change rate of at least 6 per hour. The high speed (2880 RPM) will ensure a quick and sound exhaust of smoke during the emergency; or creates a clear path for fire fighters to enter; and for public to escape.

After a long survey in the market, it is noted that impulse jet fan (axial type) with 400mm nominal diameter is most favorable size for the industry. This size of fan has enough thrust to induce large air movement (minimal no. of fan required), yet small enough for low headroom situation. In contrast with other induction jet fans that have high thrust (and therefore use less no. of fans), impulse jet fan has better flow control and zoning flexibility with more no. of fans. On the other hand, induction jet fan (centrifugal type) can be designed to have higher thrust but it is less efficient and less flexible in installation for complex building geometry. Impulse jet fan makes use of bell mouth at discharge for maximum airflow efficiency. The bell mouth was designed by CFD in order to achieve the optimum performance as shown below:





GTG jet fans are tested for its performance according to the testing procedures of ANSI/AMCA 250-05 or IS0-13350. Both testing standards are near identical. A special test rig has been constructed with the help of research institution to perform this test.



Special Test Rig constructed in accordance with ANSI/AMCA 250-05

TECHNICAL DATA

Fan Impellers

The impellers are pitch-adjustable blades and are made of die-cast aluminium. The pitch angle is pre-set to perform the pre-determined duty. Performance is tested in accordance to AMCA standard 250-05 to verify the thrust.

Fan Casing

Standard mild steel housing with screwed fixation struts for the centric installation of the drive motor. All welding seams are continuous. The standard finish is epoxy powder coated for corrosion resistance and aesthetic purpose. Hot-dipped galvanizing can be provided upon request. Solid steel terminal box with a rating of IP55 is fitted on the external part of the fan housing.

Motor

Motors fitted inside jet fans come with protection class of IP55 and Class H insulation which are capable of withstanding up to 250°C for 2 hours or 300°C for 2 hours upon request in accordance to BS EN 12101-3. The motors are manufactured in accordance to specific standards that include,

- Good internal clearance in bearings lubricated with extra high temperature grease
- Double insulated terminal leads;
- Double varnish system for winding crown etc.

Silencers (attenuators)

The inlet & outlet silencer are designed with an aerodynamically shaped inlet cone (bell mouth), which is welded to the outer housing of the silencer. Perforated galvanized iron sheet is fitted in the inner side of housing and non-flammable rock wool or fiberglass is inserted beneath for sound attenuation purpose. Theoretically, any desirable sound level can be achieved with the proper length of the silencer but site constraints may limit the choice. The option to include a deflector louver at the outlet of fan silencer can be necessary to divert the air stream from jet fan should the obstruction to airflow by beams or other M&E services is considered significant. An option to include inlet guards for preventing ingress of foreign objects and personnel protection is also available.

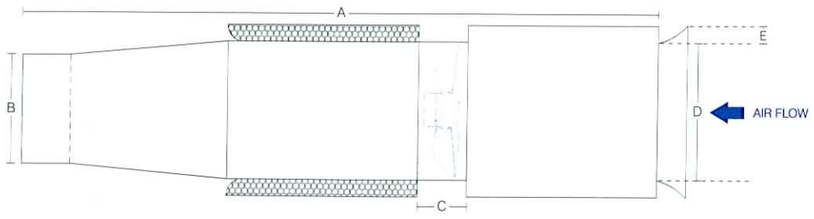
Suspension & mounting brackets

The jet fan has to be mounted onto the ceiling slab with proper anchor bolts, hanger (rod or strap) system to mounting steel brackets rigidly fixed to fan casing. The mounting brackets are finished with epoxy powder coating. Hot-dipped galvanizing finish is available upon request. To avoid transmission of vibration from fan to ceiling slab, neoprene pad or spring isolator is recommended to be installed in the hanger system.

Surface protection :

- Fan and mounting brackets: powder coated RAL 9006 (standard); galvanized (optional)
- Silencer/Attenuators: galvanized or powder coated RAL 9006
- Wire guard: galvanized steel.

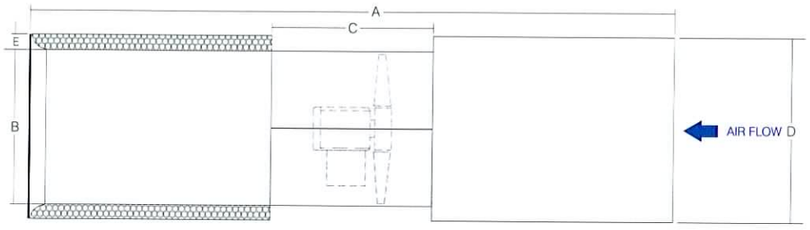
JF250



	JF250
A	1240
B	234
C	96
D	275
E	30

Dimension (mm)

JF315 / JF400



	JF315	JF400
A	1260	1600
B	315	400
C	315	400
D	415	500
E	50	50

Dimension (mm)

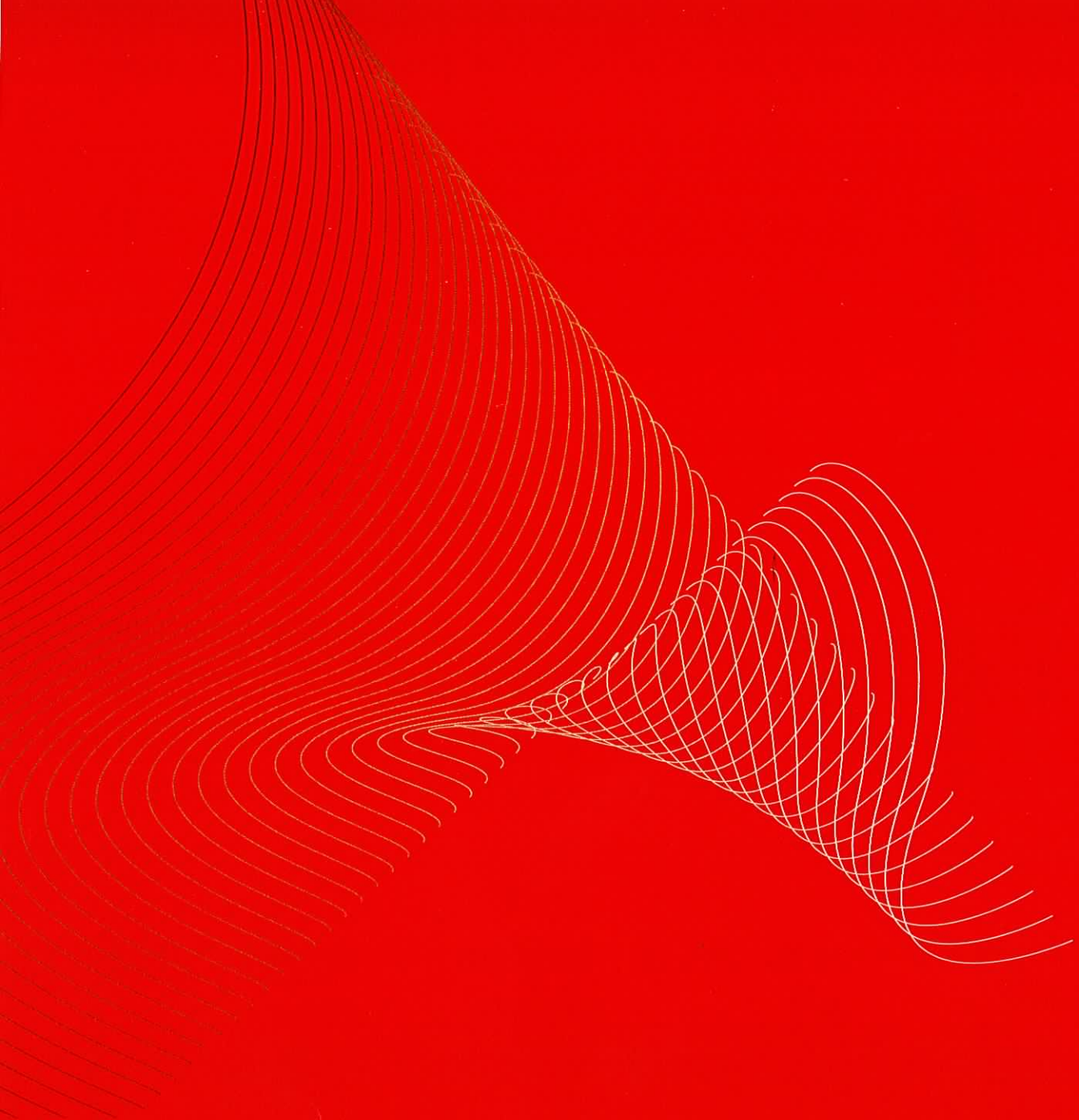
SPECIFICATIONS

	MODEL	JF250	JF315	JF400
Motor	Type	External Rotor	Induction Motor	
	Volt / Phase / Hz	240 / 1 / 50	415 / 3 / 50	
	Rated Current (A)	0.82	0.48 / 1.92	0.63 / 2.69
	Rated Output Power (KW)	0.18	0.16 / 0.80	0.24 / 1.20
	Insulation Class	F	H	
	Protection Class (IP)	44	55	
Fan	Thrust (N) *	12	6 / 23	13 / 50
	Material	G.I.	Aluminium	
	Air Volume (m^3/s)	1.18	0.62 / 1.97	1.17 / 2.29
	Air Velocity (m/s)	15.1	8.0 / 15.7	9.3 / 18.2
	RPM	2600	1440 / 2880	
	Sound Level [dB(A)] **	60	55 / 66	58 / 68
	Weight (KG)	30	60	80
	Open Ventilation Mode	< 65°C ambient	40°C ambient	
	Fire Mode	N/A	Min 250°C / 2 hours or 300°C / 2 hours	

*Tested according to AMCA 250-05 / ISO 13350

**Measurement at 1m/45° in free field

Specifications subject to changes without prior notice



GTG™

Sole Distributor:
GT-Gulf (M) Sdn Bhd (306488-x)
Lot 9, Jalan 13/6, Petaling Jaya, 46200 Selangor, Malaysia
Tel: +603-7957 0212, 7957 0223 Fax: +603-7957 0398 Email: inquiry@gtgulf.com