SF-250A CYCLEDYN

TEST CELL REQUIREMENTS

Contents

NOTICE

It is imperative that you understand dynamometer testing can be hazardous. A properly designed and built test cell is a prerequisite to providing a safe environment for testing vehicles on a dynamometer.

While SuperFlow provides specific test equipment designed to test motorcycles and ATVs, we have no control over how you build your test cell. These room recommendations are generic and may not be suitable for your particular location or application.

A locally certified engineer or contractor *must* approve your designs and certify they conform to local building codes. Your local governing body regulations and insurance company policies will rule over any questions or uncertainties.

SuperFlow, its employees, or agents do not assume any responsibility or liability for suggestions, applications, or mechanical failure outside of the normal warranty or for issues where negligence, ignorance, or mis-applied technologies are present. Ultimately, you are responsible for ensuring your test cell is safe and conforms to all local codes and regulations.

Read this document in its entirety before beginning construction. Contact SuperFlow Sales or Customer Service if you have any questions or need assistance.

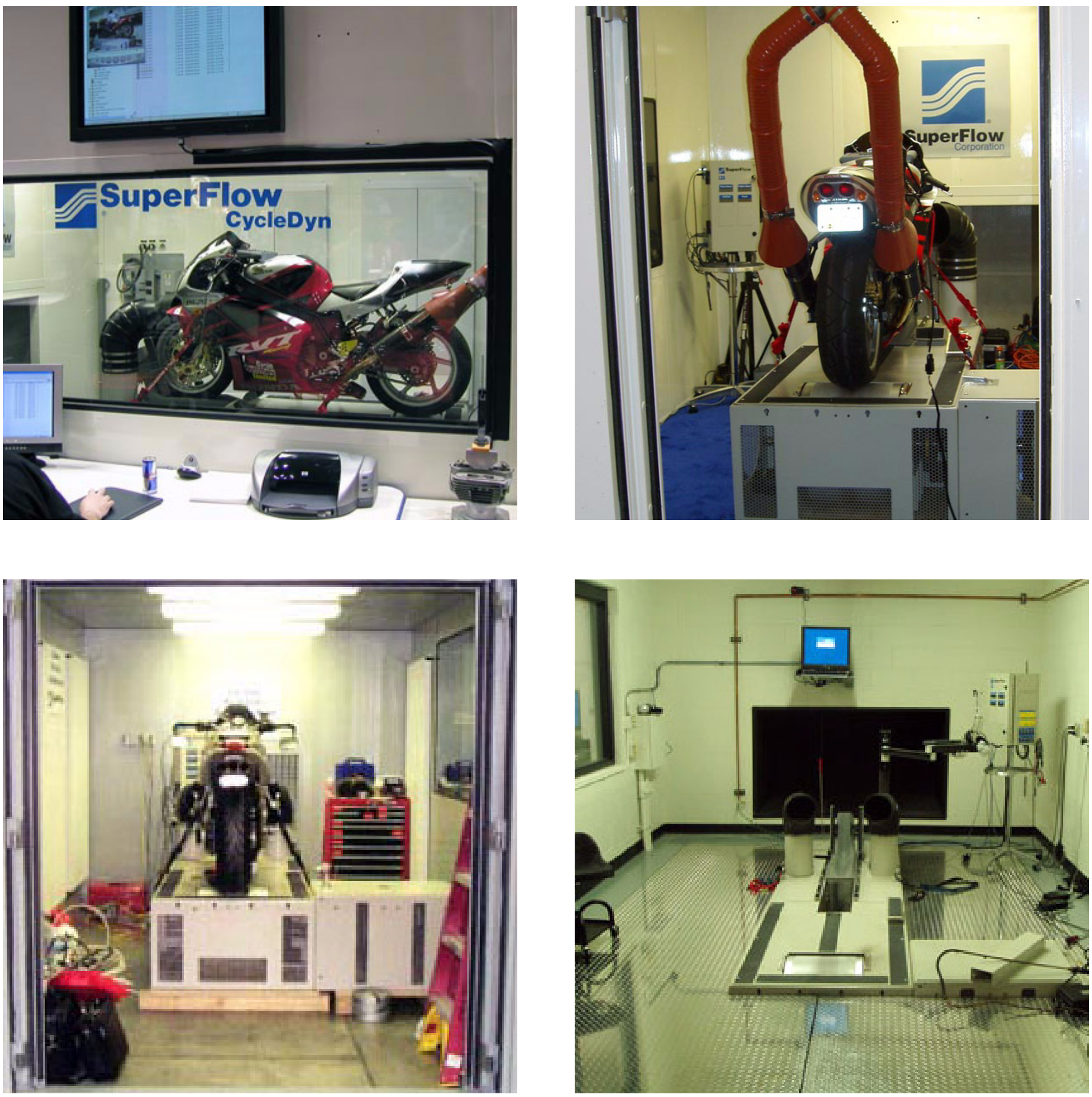
SAFETY

1. Follow all local construction codes.
2. Do not locate electric motors in close proximity where fuel is present.
3. Install a carbon monoxide (CO) detector in the test cell and the console area.
4. Provide fire extinguishers rated for gasoline and oils.
5. Provide adequate lighting in the test cell and at the operator's console.
6. Provide a switch outside the test cell to turn off the ventilation fans and high-voltage circuits.
7. Always use hearing and eye protection where applicable.
8. Regularly inspect the cell for fuel, oil, or liquid spills because flammable vapors can ignite.
9. Keep all personnel, flammable items, and sensitive objects away from any rotating or hot items.

OVERVIEW

The CycleDyn makes dynamometer testing affordable and practical for a broad range of users including those who have little or no experience. Although it is very easy to obtain test results with the CycleDyn, it takes some effort to ensure the accuracy of these results. A properly designed and built test cell can help ensure accurate and repeatable test results.

Although the CycleDyn dynamometer can be operated anywhere, it may be difficult to provide sound control or safety in open areas. An enclosed and well-ventilated test room with proper test procedures provides adequate protection against these hazards. Therefore, dynamometer testing should be confined to a restricted area where only the operator is allowed during testing.



CYCLEDYN TEST CELL EXAMPLES

A dynamometer should be installed in a facility with proper lighting and electrical outlets, good ventilation, exhaust extraction, and a fire detection and control system. Make the test cell large enough to easily install and remove the test vehicle. It should allow enough space to work on the vehicle while it is place on the dynamometer, yet small enough to take up minimal space in your building.

Proper airflow through the test cell is critical for engine cooling and room ventilation. Having a larger test cell than necessary makes it difficult to control airflow through the cell and increases the cost because of the need for larger air-handling equipment.

The plans of the following pages provide information on how to design your CycleDyn test cell to achieve the highest possible level of accuracy and safety.

TIP: *Prefabricated rooms are available as an option to building a room.*

Hazards of Dynamometer Testing

Dynamometer testing involves running internal combustion engines. Doing so exposes the operator to rotating parts, fluids under pressure, explosive fuels, high voltages, noise, heat, and exhaust gases. Chassis dynamometer testing has additional risks associated with rotating transmission parts, wheels, and chassis rolls.

IMPORTANT

Safety equipment required to provide maximum protection for the operator must be readily available for dynamometer testing. Refer to Table 1 for a list of hazards and the recommended protection.

Table 1. Safety Hazards and Protection

Hazard	Protection
Exhaust Gas	Exhaust gas extraction
Fuel (vapors)	Adequate ventilation
Fuel (fire)	• No fuel containers in the test area • No-smoking policy • Fire blanket and fire extinguisher
Rotating Parts	Restricted access, no loose clothing, guards and covers on moving machinery
Projections	Guards, safety glasses
Hot Parts	Guards, protective equipment (gloves)
Noise	• Hearing protection for the operator • Sound insulation of the test area for other personnel

These risks are associated with the vehicle under test rather than the dynamometer. It is not possible for SuperFlow to protect the operator against all hazards by the design of the dynamometer. The dynamometer must be installed in an environment which is specifically designed for this type of testing and provides maximum protection for the operator.

Accuracy of Dynamometer Testing

Accurate measurement of the output of internal combustion engines is only possible under tightly controlled test conditions. The power output of the engine is directly affected by the quantity and quality of the combustion air, thermal conditions during the test, and atmospheric conditions.

As scientific practice teaches, measurement accuracy is largely determined by the level of control over test conditions during the test. While the system can compensate (to a certain extent) for atmospheric variations, it cannot account for every possible variable in the test environment.

While it is possible to correct the measured power to existing standards, these standards only apply to atmospheric conditions during the test (barometric pressure, air temperature, and vapor pressure). Some factors that the system cannot account for include:

- Exhaust back-pressure
- Oil, water, and fuel temperatures
- Tire pressure and temperature
- Air quality due to contaminates such as exhaust fumes

To keep as many variables as possible under control, the dynamometer needs to be installed in a proper environment. The test cell should have adequate ventilation and exhaust extraction systems, the data acquisition system should allow the operator to measure the various pressures and temperatures of the engine during the test, and the test procedures should be standardized and consistent. For the best results, the test cell should have provisions for maintaining some level of standard environmental conditions.

Installation Options

The CycleDyn was designed to provide a choice of above-ground or in-floor installation.

- Above-ground installations are the standard configuration and need no special requirements.
- For in-floor or pit installations:
  - You must fabricate a suitable pit or construct a platform to enclose the dynamometer.
  - When in a pit or enclosed under covers, the eddy current absorber requires ventilation to prevent it from overheating. Plus, the pit itself may require ventilation according to local codes.
  - You may need to remove the battery and battery charger electronics from the dynamometer and install them on a wall outside the pit. SuperFlow can provide an accessory kit for relocating the electronics.

Drawings detailing the typical configuration for both above-ground and pit installations are available from SuperFlow Sales or Customer Service. Table 2 lists the drawing and installation kit numbers for each possible CycleDyn configuration.Contact your Sales or Customer Service representative to obtain the drawings or for more information.

Table 2. CycleDyn Test Cell Documentation Reference

Configuration					Drawing Number: U.S.	Drawing Number: Metric	Installation Kit
Floor	Inertia	No Blower	No ATV Roll	No Drag Kit	5301-0201	5302-0201	N/A
				Drag Kit	5301-0203	5302-0203	N/A
			ATV Roll	No Drag Kit	5301-0202	5302-0202	N/A
				Drag Kit	5301-0204	5302-0204	N/A
		Blower	No ATV Roll	No Drag Kit	5301-0201	5302-0201	N/A
				Drag Kit	5301-0203	5302-0203	N/A
			ATV Roll	No Drag Kit	5301-0202	5302-0202	N/A
				Drag Kit	5301-0204	5302-0204	N/A
	E/C	No Blower	No ATV Roll	No Drag Kit	5301-0205	5302-0205	N/A
				Drag Kit	5301-0207	5302-0207	N/A
			ATV Roll	No Drag Kit	5301-0206	5302-0206	N/A
				Drag Kit	5301-0208	5302-0208	N/A
		Blower	No ATV Roll	No Drag Kit	5301-0205	5302-0205	N/A
				Drag Kit	5301-0207	5302-0207	N/A
			ATV Roll	No Drag Kit	5301-0206	5302-0206	N/A
				Drag Kit	5301-0208	5302-0208	N/A
Pit	Inertia	No Blower	No ATV Roll	No Drag Kit	5301-0209	5302-0209	1200A-0215
				Drag Kit	5301-0212	5302-0212	1200A-0215
			ATV Roll	No Drag Kit	5301-0211	5302-0211	1200A-0215
				Drag Kit	5301-0215	5302-0215	1200A-0215
		Blower	No ATV Roll	No Drag Kit	5301-0210	5302-0210	1200A-0215
				Drag Kit	5301-0214	5302-0214	1200A-0215
			ATV Roll	No Drag Kit	5301-0213	5302-0213	1200A-0215
				Drag Kit	5301-0216	5302-0216	1200A-0215
	E/C	No Blower	No ATV Roll	No Drag Kit	5301-0217	5302-0217	1200A-0215
				Drag Kit	5301-0219	5302-0219	1200-A0216
			ATV Roll	No Drag Kit	5301-0218	5302-0218	1200-A0216
				Drag Kit	5301-0220	5302-0220	1200-A0217
		Blower	No ATV Roll	No Drag Kit	5301-0217	5302-0217	1200-A0217
				Drag Kit	5301-0219	5302-0219	1200-A0216
			ATV Roll	No Drag Kit	5301-0218	5302-0218	1200-A0216
				Drag Kit	5301-0220	5302-0220	1200-A0217

GENERAL REQUIREMENTS

Many possible facility and room layouts exist for a motorcycle chassis dynamometer. Testing needs vary from basic power runs to extensive R&D with power levels ranging anywhere from 0 to 500+ hp. It is not possible to recommend a generic design that will fit every customer's needs and budget. These instructions point out issues to be aware of when designing and building your facility. The four general categories are:

- Safety/environmental issues
- Room construction
- Technical issues
- System requirements

In all cases, consult with your architect, contractor, mechanical and electrical engineers, and city planning and regional building offices. Your SuperFlow sales associate or Customer Service representatives are happy to assist you with general design advice; however, they cannot provide detailed engineering services for each facility.

If desired, your SuperFlow Sales representatives can help you obtain a prefabricated room designed to accommodate many of the items discussed below. You can contact them at sales@superflow.com or call 1-800-471-7701.

The test cell should provide a convenient space for the computer and printer and adequate storage space for the dynamometer accessories (such as sensors, cables, calibration equipment, tie-downs, etc.). The computer system may be located outside the test cell.

The test cell must provide optimum control over test conditions and address safety hazards. Table 3 is a quick reference on what a typical chassis dynamometer room should include.

Table 3. Test Room Recommendations

Equipment	Purpose	Requirements
Room	Provide a safe environment for dynamometer testing	• Adequate size for easy and safe access to equipment (see section , "General Requirements," on page 1-6) • Adequate lighting • Fire resistance and sound-reducing material used in construction • Doors open outward for emergency evacuation • Wide doors for easy access
Floor	Support dynamometer, vehicle, and operator	Adequate strength, easy maintenance, easy cleaning, anti-slip
Room Ventilation	Constant supply of air for combustion, engine cooling, eddy current absorber cooling, and to prevent accumulation of noxious fumes in the test cell	• Sufficient capacity for room size (see section , "Room Ventilation," on page 1-12) • Maintain a slight negative pressure in the cell, typically 1" (2.5 cm) of H2O.
Exhaust Gas Extraction	Evacuate exhaust gas to prevent contamination of engine inlet air and to protect the operator	• Sufficient capacity for maximum expected engine power (see Appendix D, "Exhaust Extraction") • Hoses must be rated for exhaust temperature with vehicle under load, typically 800–1000°F • CO detectors in the test cell
Fire Equipment	First response to a developing fire	• Fire extinguisher suitable for gasoline and electric fires • Fire blanket • Smoke detectors

Testing vehicles on a dynamometer is hazardous. The room construction, layout, and the proper safety equipment should provide optimal protection to the vehicle operator and to bystanders.

Safety

The first rule for safety is to prevent room access to personnel other than the operator during testing. Install warning lights and signs to this effect. Make sure the room has overall good visibility including sufficient lighting and wide-field mirrors installed so the operator can see all areas of the cell from the driver's seat of the test vehicle. Because projections from the tires could cause damage or a hazard, you should install adequate shields. Install barriers or guards around the vehicle test area to prevent contact with rotating tires or dynamometer rolls. Avoid placing windows directly behind the rotating tires.

Personnel doors should be escape doors, opening outward from the cell. Proper fire-fighting equipment must be available (fire blanket, extinguishers, etc.). Install battery-backup safety lights in case of power failures.

Install a Carbon Monoxide (CO) detector in the test cell in plain view from all operator positions. Use detectors with a visual and audible alarm.

All electrical wiring must conform to local codes and regulations. Use Ground Fault Circuit Interrupter (GFCI) breakers where required.

WARNING

If your dynamometer is installed in a pit, be aware that poisonous CO gas tends to accumulate in low areas. PROVIDE FORCED AIR VENTILATION IN THE PIT.

Environmental Concerns

The installation of a dynamometer test cell normally requires permits. You must contact local zoning, building, and environmental authorities. Expect to comply with regulations for noise control, pollution (exhaust gas), fire hazards, and employee safety.

Pit drains and floor drains should be routed to a separator because they can contain contaminated fluids.

Coat the floor of the room with a sealant for easy spill cleaning. Epoxy paint mixed with an abrasive material is commonly used.

A chassis dynamometer room can quickly accumulate dirt, oil, and other contaminates from the test vehicles. Consider floor maintenance in the room layout. An appropriate floor drain routed to an oil separator can make cleanups easier.

For pit installations, a drain or sump pump is essential to prevent flooding.

ROOM CONSTRUCTION

A motorcycle chassis dynamometer can represent a significant investment. Unless secrecy of your development program is an important issue, it is to your advantage to create a highly visible location for the dynamometer. Position your dyno within view of customers in the reception area of your facility or most visible location from the street to optimize your exposure.

The dynamometer test cell room should be at least 20’ (6 m) long, 12’ (3.6 m) wide, and 10’ (3 m) high. The larger the room, the more expensive the construction, and the more difficult it is to achieve proper ventilation. Your room should only be large enough to comfortably accommodate your motorcycles and conduct your tests.

IMPORTANT

Safety equipment required to provide maximum protection for the operator must be readily available for dynamometer testing. Refer to Table 1 for a list of hazards and the recommended protection.

In all cases, it is essential to provide easy vehicle and operator access to the dynamometer area. Many high-performance or racing vehicles have limited ground clearance and turning radius. Short ramps or tight turns cause problems.

The dynamometer area should be well insulated from the rest of the facility to avoid noise issues. Positioning the dynamometer next to an exterior wall could reduce the cost of air- and exhaust-handling system installations.

Wherever possible, position the dynamometer to direct exhaust extraction systems away from other nearby buildings to minimize exhaust gas and noise impact on your neighbors. You can install industrial exhaust silencers to further minimize noise impact as required.

The floor must be able to support the dynamometer, motorcycle or ATV, and a rider. The dynamometer with an eddy current absorber and an auxiliary roll will weigh approximately 3,500 pounds [1,600 kg]. A 4” to 6” (10 to 15 cm) reinforced concrete slab of 4,000 psi (280 kg/cm2) is generally adequate. In some cases, you may need to reinforce the floor for proper support.

Pit installations require specific design considerations prior to construction or modification to an existing floor. Pit designs must encompass the requirements for the dynamometer and all purchased options such as an eddy current module, auxiliary roll, AC motor module, extended wheelbase, and any other option that will require space in the pit.

The primary door to the test cell should be large enough to accommodate the size of the vehicle and open outwardly for safety. Ideally, the door should be centered on the dynamometer to make it easy to move the vehicle on and off the rolls.

There must be provisions for room ventilation, vehicle cooling blower(s), and exhaust extraction.

Cabinets may be a good idea to store dynamometer accessories and ancillary equipment.

Room Layout

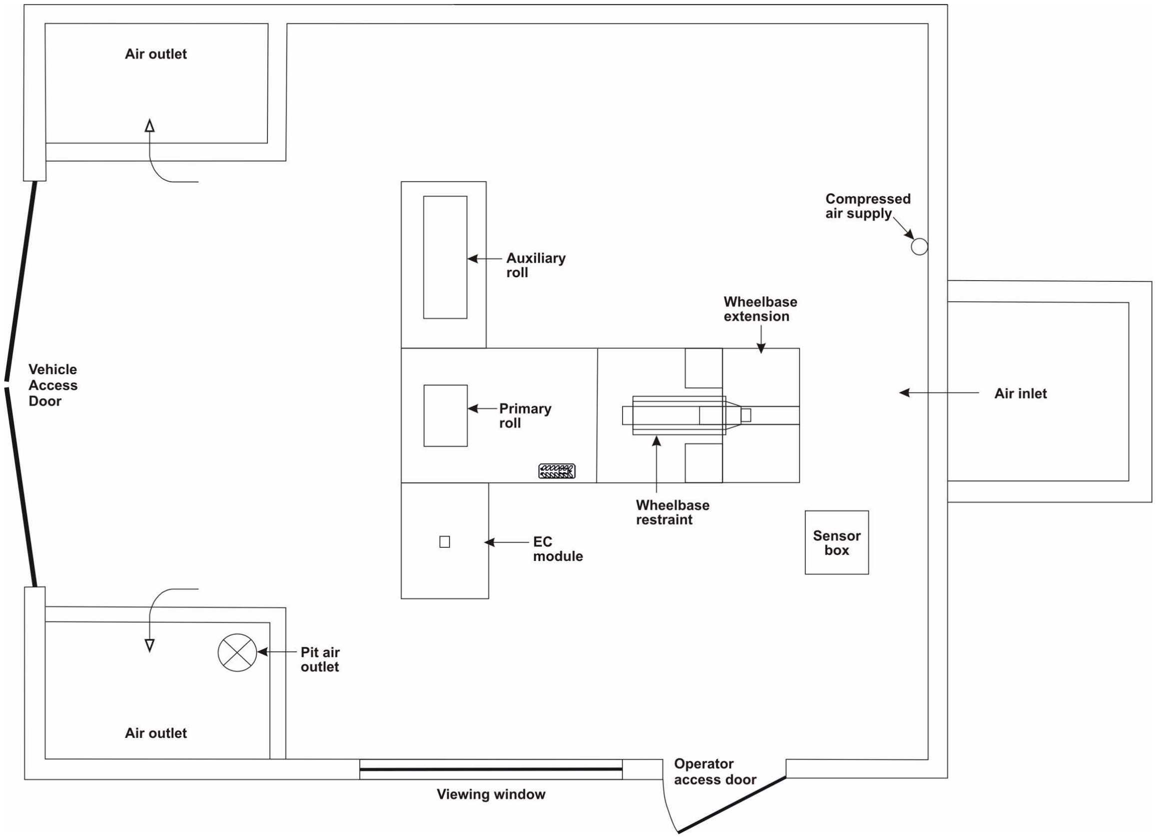


Figure 2. CycleDyn Room Layout

The CycleDyn is a modular-design dynamometer. The position of the dynamometer in the room depends on the requirement to test standard motorcycles, ATVs, go-karts, Legend cars, electric cars, or dwarf cars. If using an auxiliary roll, the room should accommodate a wider entry door and floor space.

Above-ground installations also require a ramp to load the vehicle onto the dynamometer. These are typically 4 to 6 feet [1 to 2 meters] but can be longer for low-clearance vehicles. The ramps can be removed and reinstalled after each loading/unloading to save space.

The wheelbase extension kit requires more room in front of the dynamometer.

Vehicle Tie-Downs

When positioning the dynamometer in the room, you must take tie-down requirements into consideration as well. The CycleDyn has provisions for strap anchor points along the sides of the base enclosure.

Figure 3. Tie Down Straps

However, when the dyno is installed below ground, the anchor points are not available. In these situations, tie-down hooks must be installed in the floor next to the dynamometer. Make sure the anchors are positioned to provide tie-down points forward and rearward of the motorcycle on both sides.

Cored or poured anchors are typically suitable for securing the vehicle. All anchors should be rated for over 5,000 lbs. as a minimum. Discuss with the anchor manufacturer what is available for high-horsepower applications.

Figure 3. Tie Down Straps

Control Room

A separate control room or dedicated viewing area overlooking the dynamometer should be part of the test cell design. This room may be used to house the computer and printer, thus providing a convenient viewing area during testing. For better exposure, enlarge this space or tie it into a showroom. However, avoid positioning the control room where an object thrown from the vehicle may create a hazard. The recommended size of the room is 8x6 feet [2.5x2m].

The control room must allow easy access into the dynamometer room and optimum viewing of the vehicle and operator. A separate outward-opening personnel door directly from the control room to the test cell can be convenient. A large viewing window should be between the control room and the dynamometer area.

DANGER

The potential exists for projectiles to be thrown from the vehicle during testing. Such projectiles typically fly toward the rear and side walls of the test cell. If a projectile impacts a non-reinforced glass window, it could shatter the glass and injure someone.

The viewing window should be installed so a standing person can see all of the vehicle. At a minimum, the window should be 36 inches wide by 30 inches high (101 x 76 cm). The sound isolation provided by the window is much less than the dynamometer test cell walls, so if the window is overly large, it may rattle or transmit excessive noise into the control room.

It is best to use at least two panes of glass in the window with the pane on the dynamometer side wire reinforced. The multiple panes help with sound insulation, and the wire reinforcement helps prevent the glass from shattering. Both panes should be 1/2 to 1/4 inch thick [6 to 13 mm]. If a third pane is added, it is best to center the pane at an angle so it is not parallel to the other two panes. The angle helps reduce transmitted sound vibrations. The area directly behind the operator should be a dark or unlit area so the operator cannot see strong reflections in the windows when viewing the vehicle.

TIP: *Prefabricated sound-deadening windows can be purchased from a reputable sound enclosure or window manufacturer.*

The two major problems faced in a motorcycle chassis dynamometer test cell are heat evacuation and exhaust gas extraction.

- Power generated by the engine is converted to heat. The engine combustion, cooling system(s), transmission, and exhaust system all generate heat. The dynamometer itself also radiates heat.
- Internal-combustion engines generate carbon monoxide gas (CO) that must be extracted, or the test cell literally becomes a poisonous gas chamber.

ROOM VENTILATION

DANGER

Poisonous carbon monoxide gas is produced as a result of engine operation and may collect inside the building if proper ventilation is not utilized. Always exhaust the air from dynamometer test cells outside and away from other buildings. Always place CO detectors in various locations throughout the building.

Test cell ventilation is one of the most overlooked aspects of a dynamometer test cell room design. Chassis dynamometer testing produces a significant amount of heat that is released into the test room air. Ventilation is required to evacuate this heat from the room. If the room temperature increases during the test or exhaust gas recirculates into the engine inlet, your test results will vary in an unpredictable manner. Both the quantity and direction of airflow are critical for repeatable test results.

Proper room ventilation makes a considerable difference when assessing engine power.

Fundamentally, air is a critical property of the combustion process. Without clean air it is difficult to create power. Figure 5 is a graph from a 493.9-hp alcohol circle track motor on an engine dynamometer. Combustion air was taken from inside the test cell, and the exhaust was ventilated outside the building. The first test (MIKE3835) was done with the room fans turned off. Notice the 25.6 hp and 14.63 lb•ft gain that occurred in the second test (MIKE3836) after providing adequate airflow through the room.

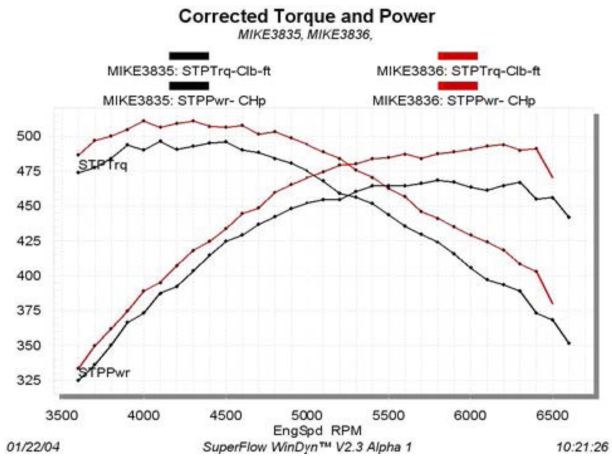


Figure 5. The Effects of Air Ventilation

Some racing vehicles require air speed through the radiator or ram air at near road speed. Achieving high flows at high speeds requires tremendous airflow which explains why many highperformance chassis dynamometer rooms resemble wind tunnels with high-volume fans rated at several hundred horsepower.

Proper airflow in a dynamometer test cell is also important for safety. An engine builder almost lost his life because of the excess exhaust fumes he encountered when entering the un-ventilated test cell after only one run. Understandably, ventilation systems can be expensive, but the alternative is inaccurate testing and the risk of injury or death.

Room Design

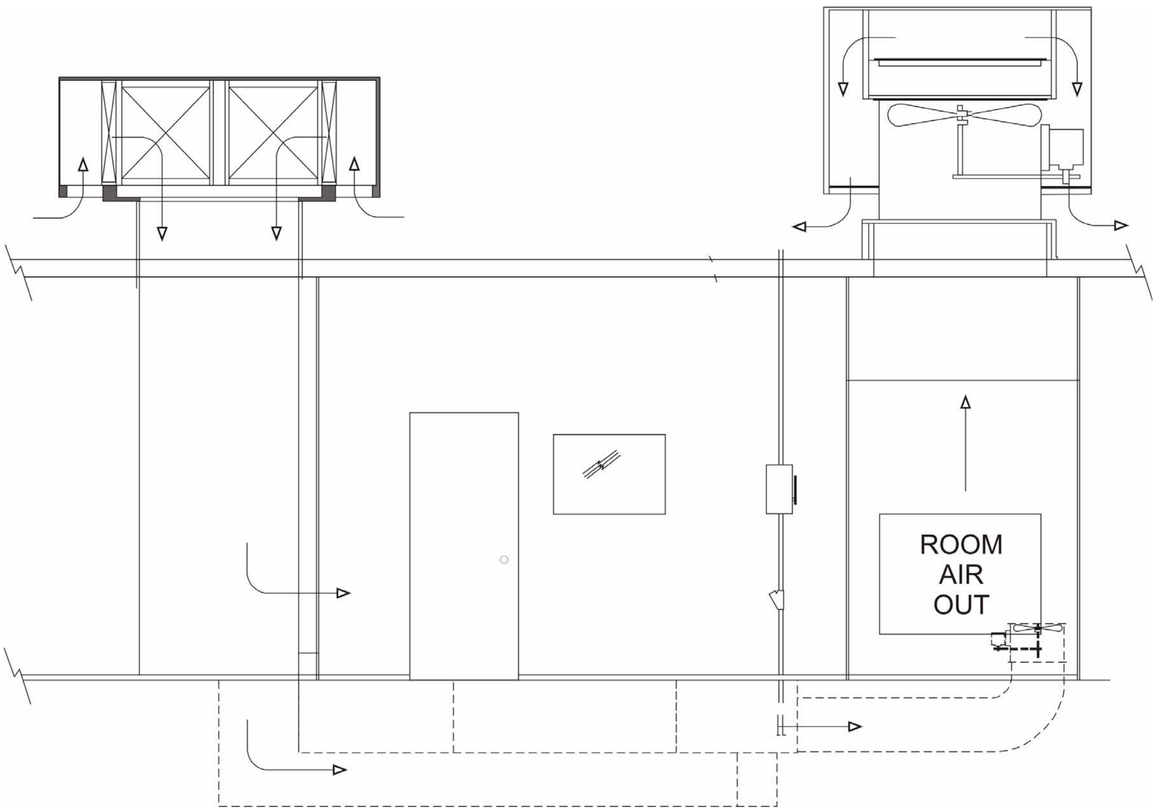


Figure 6. CycleDyn Room Ventilation

SuperFlow recommends a cross-flow design for the ventilation system. Position the air inlet duct in the test cell directly in front of the dynamometer with the outlet in the back of the room. The ventilation system should draw fresh air from outside the building and exhaust the air outside the building well away from the inlet to prevent air recycling.

TIP: *Using outside air to ventilate the test cell will reduce building heating and cooling expenses by not wasting conditioned air.*

The large fans required to provide the necessary airflow are noisy. They should be installed in a location where the noise causes minimal disturbance to your employees and neighbors. You may need to take additional protective measures such as enclosing the fans and ducts in sounddampening material.

The inlet air duct can be fairly large. Place the outlet ducts behind the dynamometer. It is best to have two outlet ducts, one on both sides of the vehicle access door (see Figure 2).

The ventilation system must be able to generate the necessary airflow at the pressure drop caused by your inlet and outlet ducting. Minimizing the length and complexity of ducting greatly reduces the pressure drop and required fan power. The size of the room is critical when choosing the equipment used in the ventilation system. Larger rooms require higher capacity fans. In larger cells it is typically harder to maintain proper airflow while avoiding turbulence and eddy currents. You must consider a cost analysis when airflow requirements escalate.

The vehicle itself plays a part in the room ventilation design. When an engine runs, it radiates heat from all its external surfaces and from its exhaust pipes. The larger the engine, the greater the heat load on the room.

Both the airflow direction and quantity are critical for repeatable test results. Air should enter at the front of the cell and flow across the engine to the rear of the cell. The engine exhaust pipes should be directly in the airflow to propel any leaking exhaust gases out with the main stream of air and prevent it from recirculating to the engine intake.

The room fans should be positioned to extract air from the room even if the access door is open. If the fan is on the inlet side, it will blow the smoke out into the operator area when the door is open and through any natural leaks. Fans should also be placed at the end of the exhaust duct to prevent contaminated air from escaping through leaks or auxiliary ducts into other parts of the building.

Equipment

Realistically, most Heating, Ventilation, and Air Conditioning (HVAC) system designers or contractors do not understand how much air a dynamometer test cell needs and will probably underestimate the amount of airflow required.

SuperFlow recommends an air exchange rate of at least 8 to 10 exchanges per minute. To determine the fan size, multiply the total cubic area of the room by 10. Obtain a fan that will deliver the resultant airflow.

Example:	For a 20 x 12 x 10 foot room, the recommended airflow is 24,000 cfm 20 x 12 x 10 = 2400 cubic feet 2400 x 10 = 24,000 cfm

That might seem like a lot of airflow, but think of a motorcycle going down the road at 80 mph.

TIP: *The airflow through the room should exert enough suction force to make an outward opening door to the test cell difficult to open when the exhaust fans are on.*

Axial fans are most effective for high airflow at low-pressure drops. The fan(s) are best installed on the outlet side. This maintains a negative pressure (about 0.5 to 1 inH2O or 100 to 200 kPa) in the test room. Most squirrel-cage type blowers of comparable size do not provide an adequate amount of airflow.

TIP: *Variable-speed controls can be installed to provide adjustable airflow that allows for slow speeds while an operator is working in the test cell and fast speeds while running an engine test. The SuperFlow control system is capable of interfacing with the Variable Speed Drive (VFD) to allow the airflow to coincide with the vehicle road speed.*

Properly connect and ground all electrical items used in the ventilation systems (motors, switches, speed controllers). Explosion-proof motors provide the best safety. Mount the control switch for the fan where it is convenient for the operator. Where applicable, you must use GFCI breakers/outlets.

Shutters

Shutters can be installed on the intake and exhaust to seal of the room and maintain comfortable working conditions when not running a dyno test.

TIP: *Electrically operated shutters with automatic controls can aid in fire-suppression systems and enhance security for your building*

Screens or grating on the ducts help keep trash and animals out. Grating should have a minimum spacing of 1 inch (2.5 cm) between the bars. If using mesh screening, increase the size of the opening by at least 50% to accommodate the added airflow restriction. Install rain hoods when applicable.

Air Conditioning & Heating

For sophisticated systems, it is possible to heat or cool the incoming air to maintain a constant temperature and humidity in the test cell during tests. For high-powered engines, the flow rates and energy required are very high; therefore, the equipment cost can be much greater than the cost of the rest of the test cell. For most cells, this is not a cost-effective solution.

Airflow Test

After completing the room, check the airflow by attaching a piece of cloth or tissue to a long stick and exploring the airflow direction through the room. The engine intake should be in the area of high flow. Check for swirls to make sure the air behind the vehicle is not recirculating into the engine intake after it passes over the exhaust pipes.

PIT VENTILATION

Pit-installed CycleDyn systems require ventilation to remove heat and fumes from the pit. For eddy current packages, proper pit air flow is critical for extracting heat the absorbers create. A dedicated fan for the pit ventilation will ensure proper air flow through the pit. Relying solely on the room ventilation fan will result in a minimal amount of air flow in the pit. Airflow should be directed across the absorbers.

For CycleDyns equipped with an eddy current absorber or AC motor option, proper airflow through the pit is crucial for extracting heat. Provide a 16” (41 cm) or larger duct with a suitable blower for adequate absorber cooling air supply.

A 6” (15 cm) duct with a small 4” blower suffices for inertia-only systems. If you plan to add an eddy current or AC motor module at a later date, install the a larger fan recommended below. The best design draws pit air separately from the room air although it is acceptable to route pit air from the room air inlet duct and out the room air outlet. This can be done below surface through a built-in raceway or duct in the floor. Because fuel vapors can potentially settle in the pit, SuperFlow recommends using an explosionpro of fan or blower for the pit ventilation.

See Figure 2 on page 10 and refer to the pit design drawing available from SuperFlow Sales or Customer Service. Suggested fans are shown in “Ventilation Tube Axial Fans” on page 24.

Exhaust Extraction

IMPORTANT

Consult the local authorities before designing an exhaust system to ensurecompliance with environmental restrictions concerning emissions.

A proper exhaust extraction system is critical for the safety of your employees and customers inside and outside the test room. In addition to noxious gases, a significant amount of heat releases through the exhaust system. The exhaust extraction system must be able to handle the flow and the exhaust gas temperature.

The two methods to handle exhaust extraction are:

- **Room Ventilation:** If the room ventilation system is designed properly, it can provide exhaust extraction as well. In this design, exhaust gas is diluted with ambient air and removed by the room ventilation fans. However, this rarely works. Most ventilation ducts and fans only handle temperatures up to 250°F (110°C), so the air flow volume has to be even higher than normal to achieve total exhaust extraction without damaging the duct or fan. For best results, the dilution ratio of clean air to exhaust should be about 4:1. Therefore, the room ventilation system would need to provide an air exchange rate of 10 to 12 times per minute with special provisions for higher temperatures.
- **Spot Extraction:** The best way to extract exhaust gases is by using temperature-resistant ducting to capture the exhaust gas close to the vehicle tailpipe. Do not seal the duct to the tailpipe. This allows dilution of the exhaust gas with ambient air and reduces any possible influence on engine performance by exhaust back pressure. The open duct on the tailpipe should provide enough free area to achieve the desired dilution ratio.

Install a high-speed, centrifugal-type fan at the outlet end of the exhaust duct to ensure the maximum efficiency of the system. The exhaust duct or hose must be able to withstand exhaust temperatures when the dynamometer is at full load, typically greater than 800°F [425°C] at the tailpipe.

To determine the recommended fan size, multiply the maximum potential engine horsepower by 1.4 (cfm per hp), then multiply that by 10 to get the total cfm flow requirement.

Example:	For a motorcycle rated at 100 engine hp: 100 x 1.4 x 10 = 1400 cfm required airflow

A sharp bend in the exhaust ducting will reduce the overall flow in the duct. Take proper care to minimize the number of 90° bends. A gradual arc works much better for maximizing airflow efficiency.

TIP: *Routing an exhaust duct from the tailpipe under a door or through a wall without an extraction fan generally does not work well for dynamometer testing unless you install a very good room ventilation system to back it up.*

Table 4 shows the recommended minimum hose diameters for the power level of the engine. However, for maximum efficiency the test cell exhaust system hose should be at least twice the diameter of the engine exhaust pipes. For larger high-powered engines, it is generally best to use two exhaust pipes.

Table 4. Exhaust Pipe Diameters

KW/Exhaust	Hose Diameter	HP/Exhaust	Hose Diameter
7.5	7 cm	10	3”
75	10 cm	200	4”
150	13 cm	300	5”
250	16 cm	450	6”
350	20 cm	800	8”
500	23 cm	1000	9”

NOTE: A good exhaust system with a properly designed room ventilation system will ensure removal of all exhaust gases from the test cell and the building.

All dynamometer systems are unique in some way, but they all essentially require the same facility services and provisions.

ELECTRONICS & COMPUTERS

The SuperFlow chassis dynamometer electronics typically consist of a sensor box and a computer system. Some systems may have additional components such as an electric throttle controller or a relay control box. The sensor box, throttle controller box, and the relay box are all located in the test cell while the computer is usually outside.

Sensor Box

The sensor box houses the Central Processing Unit (CPU) for data acquisition and control along with all the sensor input connections. For chassis dynamometers the sensor is usually mounted on a roll-around pedestal but can be mounted on a wall or support structure.

The data acquisition system has one 35-ft. shielded Category 5 (Cat-5) Local Area Network (LAN) cable that connects the sensor box to the computer. If the computer is outside the test cell, you must route the cable through the test cell wall in a manner that protects them. SuperFlow suggests using 1½- or 2-inch conduit or wireway for this pass-through.

Handheld Controller

The SF-1853 wired or wireless remote handheld controller is used when conducting a test on a SuperFlow chassis dynamometer. The wired handheld connects to the sensor box with a 22-ft. cable (6.7 meters). The wireless handheld uses Bluetooth® technology and has a range of about 30 feet (9 meters) radius. Both units should be protected from damage when the system is not in use.

Figure 7. SF1853 Wired Handheld Controller

Computer Systems

A computer with WinDyn™ software installed enhances SuperFlow dynamometer operation. Provide table or console space for the computer and printer. Place the monitor, computer keyboard, and mouse in a location convenient for the operator.

If desired, you can attach a custom support stand for the monitor, keyboard, mouse, handheld controller, and test cell controls to the dynamometer frame or nearby wall. This makes it easy for an operator to conduct a test and review the results without dismounting the motorcyle.

Another option is to install a second monitor for the computer and position it near the dynamometer which allows the operator to view the real-time display on the second monitor but review the test results at a table workstation.

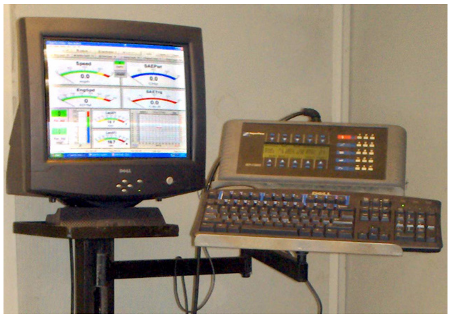


Figure 8. Handheld/Keyboard Stand

ELECTRICAL POWER

Do not underestimate the total amount of electrical power required to supply the test room services. Electrical power is required for:

- Data acquisition electronics and computer system
  - 115/230VAC, 15/8 amps, single phase, 50/60 hz
- The eddy current power absorber (when installed)
  - 208–240VAC, 20 amps, single phase, 50/60 hz (per absorber)
- Lights and accessory outlets for wideband 02, gas analyzer, etc.
- AC Motoring module (when installed)
- Cell ventilation fan(s)
- Exhaust extraction fan(s)
- Spot cooling blower(s); power dependent upon model
- Space heaters and air conditioning units (when needed)

NOTE: Power requirements for the AC Motor module and test cell ancillary devices is dependent upon the selected models.

SuperFlow recommends using a separate circuit with surge protection for the computer system and data acquisition electronics. For better protection, use an Uninterruptible Power Supply (UPS).

Remember to install plenty of wall outlets in the room for battery chargers, power tools, and other equipment. A GFCI circuit should protect all electrical outlets in the dynamometer room.

When installing eddy current or AC motor modules, install a dedicated power source for the AC power. Welders and other high-current equipment in use may corrupt non-isolated circuits.

IMPORTANT

Contact your electrician for detailed installation advice.

COMPRESSED AIR SUPPLY

Compressed air actuates the dynamometer front wheel restraint clamp. An air supply pressure of 70–90 psi [483–620 kPa] is required. Flow is not a factor because it is static pressure.

The optional exhaust tailpipe probe for O2 sensors is also air driven and uses approximately 25 psi [206 kPa]. It requires a continuous flow of air while in use.

Keep the air lines clean and dry. Install a filter and water separator on the supply line to the dynamometer. SuperFlow recommends a safety shutoff valve for the air supply and an automatic water purging system accompanied by a quality water separator.

TIP: Power requirements for the AC Motor module and test cell ancillary devices is dependent upon the selected models.

COMPRESSED AIR SUPPLY

Provide controls for ventilation and exhaust systems, safety shutoff valves, fire warning and protection systems, and basic cell services such as room lights, warning lights, and door controls. Centralize controls on a control panel in or near the test cell. If the controls are inside the test cell, install a main disconnect or emergency stop switch outside the room in case of emergency.

Install a carbon monoxide (CO) detector in the test cell in plain view from all operator positions. Use detectors with a visual and audible alarm.

VEHICLE COOLING

The main room ventilation system should evacuate the heat produced by the vehicle cooling system, engine block, transmission, and exhaust. But in many cases, the airflow patterns resulting from the room ventilation system do not provide adequate cooling of certain vehicle components.

The vehicle cooling system, engine compartment, and exhaust system are usually the most troublesome areas. The CycleDyn offers optional integrated blowers, but you may also use spotcooling fans to handle this deficiency. These fans do not increase the overall airflow through the room. They basically modify the local patterns and speeds of the airflow to accomplish specific cooling goals.

Figure 9. Spot Cooling Fan

Some racing vehicles require air through the radiator or ram air at near road speed velocities. Achieving these high-speed flows requires tremendous power. This explains why many high performance dynamometer rooms resemble wind tunnels.

WATER DRAINS

Water and other liquids may collect in the pit. Locate a drain or sump pump in the pit to keep it clear of liquids.

SOUND CONTROL

For most test cell installations, sound control is extremely important if running tests frequently. A properly designed test cell can reduce the sound level by 40 to 50 decibels (dB) between the inside of the cell and outside. The guidelines below are general and applicable to any facility installation.

TIP: Prefabricated sound-deadening enclosures can be purchased from a reputable sound enclosure manufacturer. Check for local code requirements before installing prefabricated rooms.

If the walls of the room are constructed properly, the room should provide good sound reduction. However, most of the sound will exit the room through the door, the window, and any leaks through the walls. Caulk all around the window panes during installation and make sure all joints are filled in the gypsum board surrounding the room. Be sure all electrical boxes are caulked all the way around their penetration through the wall, and even caulk all of the small screw holes in the electrical box. Caulk around any wires where they enter the conduit. Sound travels very well down long tubes.

Use special sound-control insulation on the door and a lowering threshold at the bottom of the door. These devices push down against the floor when the door is closed and are available from building suppliers (one manufacturer is Sonitrol). Plug any cable pass-through holes in the walls with blocks of compressible foam. Caulk all around the external switch plates and holes in the test cell wall.

Most rooms are finished with semi-gloss painted walls so they are easy to clean and reflective for better lighting. It is possible to further reduce the sound level in the room by placing absorptive pads on the walls. These are typically one to two inches [2 to 5 cm] thick and covered with perforated metal. They are available from various sound-control companies. It is not necessary to cover all the walls to substantially deaden the room. Sound-absorptive pads on 25% of the total surface area will make a significant difference.

Line the inlet and outlet ventilation ducts with a minimum of one-inch thick [2.5 cm] duct liner to prevent sound transmission through the ducts. Also line the inside of roof covers. The sound will bounce back and forth across duct liner through several direction changes before exiting at the roof of the building. Make sure the liner is well-adhered to the wall of the duct so the high-velocity air does not blow it loose. Never use duct liner in an area exposed to exhaust gases. The duct liner will collect oil or unburned fuel and become a fire hazard.

FIRE SUPPRESSION

Engines, fuel, oil, fans, electrical devices, motors, pumps, and all other items inside and outside the test cell can catch fire at any time. When designing your test cell, pay special attention to local fire codes and insurance requirements. This can include sprinkler heads installed inside the test cell (use high-temperature pop-offs due to normal engine heat). Fire extinguishers should conform to local fire codes and be conveniently accessed. If using an automatic fire suppression system, make sure it has safeguards against human contact. Other safeguards such as fire dampers can also be used if allowed in your area.

NOTE: SuperFlow does not make any specific recommendations related to fire protection or insurance.

CONVENIENCE ISSUES

Based on our experience, SuperFlow suggests the following enhancements to your facility:

- Wireless two-way communication link between the driver and system operator.
- Intercom between the test room and control room.
- Digital camera to take pictures of the vehicle while tested. You can download the pictures to the test system computer to display and store with the test data files. Pictures provide a quick method to record the vehicle configuration and the cooling blower arrangement for the test, improving test repeatability.
- Closed-circuit video with monitor in the control room (and/or in the customer viewing area).
- Microphone in the test room, driving speakers in the control room. Due to the test room noise insulation, it may be difficult to hear abnormal engine or driveline sounds from the control room.
- Telephone for communication purposes. A cordless telephone or cell phone is convenient when talking with someone while moving to different areas of the test cell.
- Additional test system computer monitor in the customer viewing area if separate from the control room (e.g., your facility lobby).
- Battery-powered emergency lighting in the test room and control room.
- Space heater and air conditioning, depending upon your climate.
- A secure storage space in the control room for software, manuals, backup disks, and test results. A closed storage space in the test room for sensors, cables, calibration equipment, and personal protective equipment (such as earmuffs and safety glasses).

SuperFlow recommends keeping the test room clean at all times. Dirt from test vehicles tends to accumulate; the powerful room ventilation systems will sweep up and blow around any dirt, rags, papers, etc. Protect your engine, vehicle, and fans by avoiding loose objects. Clean test vehicles before installing them on the dynamometer. Provide a source of water and a garden hose to periodically wash down your test room.

EQUIPMENT SOURCES

Below are listed some of the common equipment sources for items used in a engine test cell. These are all U.S. companies, but equivalent sources may be available in other parts of the world.

W. W. Grainger
Pumps, fans, ventilation, valves
1-800-473-3473
www.grainger.com

Monoxivent Source Capture Systems
Exhaust pipe components
1-877-608-4383
www.monoxivent.com

American Fan
Room ventilation equipment
1-513-874-2400

Nelson Products
Mufflers, exhaust pipe components
1-800-223-4483
www.nelsondiv.com

Mechtronics E/M Products
Mufflers, exhaust pipe components
1-952-440-9200
www.mechtronics.net/catalog

Air Pro
Exhaust collection hoses/systems
1-800-967-0288
www.airpro.com

Riker Products
Exhaust pipe components
1-800-292-9744
www.rikerprod.com

Macurco
Gas detectors and controllers
1-303-781-4062
www.macurco.com

GTE Industries
Mufflers, exhaust pipe components
1-800-775-2466
www.gtexhaust.com

Car-Mon Products, Inc.
Exhaust Extraction Systems
1-847-695-9000
www.car-mon.com

MER Equipment
Exhaust components
www.merequipment.com

Plymovent
Exhaust Extraction Systems
1-609-395-3500
www.plymovent.com

Soundmaster
Prefabricated test cell enclosures
1-800-472-5952
www.dynotestcells.com

Intelligent Solutions
Portable CO Monitors
1-503-644-8723
www.ueitest.com

Stowe Enterprises — DynoAir
Climate-controlled airflow systems
1-800-315-6751
www.stoweenterprises.com

EQUIPMENT RECOMMENDATIONS

The equipment listed in the following sections are from the W.W. Graingers online catalog. They are suggestions only. Other brands and models may be suitable for the applications as long as the minimum specifications are met.

Call SuperFlow Sales or Customer Service for suggestions and alternatives.

Fan motors may require special controllers or relays. Consult a local certified electrician to determine the proper equipment for your area.

TIE DOWN STRAPS

SuperFlow recommends ratchet-type straps rather than cam buckle locks. You need at least four. You will also need several slings or axle straps for attaching the tie-downs to the vehicle.

Part Number	Size	Rating Capacity	Details
3LLF3	10 ft. x 1 in.		Ratchet strap
1DKX3	27 ft. x 2 in.	3,300 lbs.	Ratchet strap, U-hook
1DMU4	3 ft. x 1 in.	2,000 lbs.	Web sling, eye & eye
2RU88	3 ft. x 2 in.	3,200 lbs.	Web sling, eye & eye
3LLT9	36 in.		Axle strap w/ wear pad

VENTILATION TUBE AXIAL FANS

An air exchange rate of 8 to 10 times per minute (minimum) through the test cell (and pit if applicable) is recommended. The flow required depends on the room size (see "Room Ventilation" on page 12).

NOTE: These fan motors are not listed as explosion-proof and therefore should not be located inside the test cell or where fuel or fuel vapors are present. For better protection, request explosion-proof fan motors. Installation must comply with all local and national safety codes.

Consult SuperFlow Sales, Customer Service, or a qualified air handler contractor for assistance in selecting the proper size.

Room Ventilation

SuperFlow recommends ratchet-type straps rather than cam buckle locks. You need at least four. You will also need several slings or axle straps for attaching the tie-downs to the vehicle.

Part Number	cfm @ 1"H20 Static Pressure	Size	Motor *Single-phase motors also avialable*
7F843	13,190	30" diameter fan Belt drive: 47H x 34W x 24D	5 hp, 208–230/460 VAC 15–13/7 amps, 3 ph, 60 Hz
7F853	14,445	34" diameter fan Belt drive: 50H x 38W x 29D	5 hp, 208–230/460 VAC 15–13/7 amps, 3 ph, 60 Hz
7F862	14,825	36" diameter fan Belt drive: 52H x 40W x 29D	5 hp, 208–230/460 VAC 15–13/7 amps, 3 ph, 60 Hz
7F872	21,775	42" diameter fan Belt drive: 58H x 46W x 32D	7.5 hp, 208–230/460 VAC 20–18/9 amps, 3 ph, 60 Hz
7F883	28,550	48" diameter fan Belt drive: 65H x 52W x 36D	10 hp, 208–230/460 VAC 27–25/12 amps, 3 ph, 60 Hz

Pit Ventilation

Pit fans should not be physically located in the pit unless it is rated for hazardous locations.

Part Number	cfm @ 0.5"H20 Static Pressure	Size	Motor
7F930	2126	12" diameter fan Belt drive: 20H x 15W x 12D	3/4 hp, 115/230 VAC 12/6 amps, 1 ph, 60 Hz
7F942	3238	16" diameter fan Belt drive: 29H x 19W x 17D	1 hp, 115/230 VAC 14/7 amps, 1 ph, 60 Hz

Ventilation Air Shutters

When using motorized shutters, SuperFlow highly recommends using a micro switch for fan delay. This ensures the shutters are open before the fan engages.

Part Number			
Inlet Shutter	**Exhaust Shutter**	**Motorized Shutter**	**Inlet Size**
3C242	**3C311**	**3C235**	42" X 42"
3C243	**3C312**	**3C132**	48" X 48"

Ventilation Air Filters

Eight or more ventilation air filters are required.

Part Number	Size	Rating Capacity	Details
2W237	20"x25"x4"	92%	1740 cfm @ 0.22" H2O
2W239	24"x24"x4"	92%	2000 cfm @ 0.22" H2O

Sump Pumps

A sump pump is required if a drain is not available in a pit installation.

Equipment	Part Number	Flow Rating	Size	Details
Sump pump (submersible)	2P547	34 gpm @ 10 ft. of head	10" H 10" diameter	1/3 hp, 115VAC, 9.6A, 1 ph Vertical switch 1½ NPT outlet
Check valve	2P843	4 psi @ 130°F		1¼ or 1½ FNPT
Sump kit	2P778			3/10 hp pump, 4.8-gallon tank, check valve, 1 NPT outlet

Compressed Air

Compressed air is required for the wheel clamp and O2 exhaust tailpipe probe.

Equipment	Part Number	Max Pressure	Size	Details
Filter/regulator	6D756	250 psi	10H x 2.5W	1/4" NPT, 5-micron filter
Auto drain	6B251	250 psi	250 psi	Use with above filter/regulator
Pressure gauge	5WZ41	0–160 psi	2" diameter	1/4" NPT

Further Reading

Excellent books on the design of test facilities and dynamometer testing are:

Engine Testing – Theory and Practice
by Michael Plint and Anthony Martyr, Butterworth-Heinemann, Oxford, UK, 1995.
ISBN 0 7506 1668 7

Dyno Testing and Tuning
by H. Bettes and B. Hancock, Cartech Inc., 2008.
ISBN 978-1-932494-49-5