Cell Design

Designing an engine dyno cell or chassis bay is a lot like laying out a new shop, there are no hard and fast rules! It is possible to spend just a little, or a small fortune, on both good and bad designs. Dimensioned pit drawings (for in-ground roller dynamometers only) and generic test cell (or chassis bay) plans are included with complete DYNOmite systems. They should be referred to, along with the information in this manual, when planning new installations.

The least expensive alternative is to just test outdoors – where most engines ultimately are run. Many DYNOmite units are designed to simplify this option. For example, engine stands can be outfitted with wheels, a self-contained fuel system, power supply, and even a portable water pump. The wheels allow rolling everything back into the shop for modifications. When testing outdoors, even a light breeze (with proper orientation of the dyno) handles ventilation well. Noise control can be handled with a decent muffler system (with the design dictated by your neighbors' tolerance). However, once you move inside, things get much more complicated.

Ventilation is typically the biggest issue with an indoor test cell. Matching the effectiveness of even a mild outdoor breeze requires huge fans! Most first time cell designers grossly undersize their cell's air handling system! It is not enough to just have high, localized, velocity immediately in front of the fan. Very high-volume flow rates are required too, in order to get the required number of cell air changes per minute.

Assume a thermal efficiency of about 50% for internal combustion engines. So, a test engine delivering 100 flywheel Hp to the absorber (254,000 BTU/hr) radiates up to 127,000 additional BTUs per hour into the cell from its exhaust, cooling radiator, and block surfaces! Even at idle, when zero crankshaft Hp is available, significant heat energy must be dealt with – as the engine is still burning fuel in overcoming its internal friction.

For installations where the engine's exhaust will be routed out of the cell (in stainless steel flexible exhaust tubing, for example) plan on at least 2,000 CFM per 100 Hp. This is the preferred configuration, and quick disconnect flanges and locking clamps are available to speed engine changes. High temperature flexible silicone exhaust hoses and thru-wall (or overhead door) fittings are available for chassis dynamometer bays.

> *Tip: Use double wall exhaust piping to reduce heat load into the cell. This also protects against burns, melted wires, etc.*

If the engines will be dumping their exhaust directly into the cell or there is an air-cooled eddy current absorber is in the room, then as much as five times more CFM per 100 Hp may be required. Also, in such cases, the orientation of the engine's air intake and exhaust pipes in relation to the cells fresh air and exhaust ducts are crucial to successfully keeping all exhaust gases out of the engine's fresh air supply.

> *Tip: Keep in mind that even a small volume of exhaust fumes, breathed into the engine, will ruin its power output.*

WARNING: BESIDES "KILLING" ENGINE PERFORMANCE, CARBON MONOXIDE EXHAUST IS DEADLY TO HUMANS!

For near free-air (non-ducted) applications, axial fans provide the most CFM for the money. If your cell is on an outside wall (into which you may cut a large opening), then a 48" diameter 1-Hp axial exhaust fan (e.g. Grainger #CF31) can provide over 18,000 CFM. This will require installation of a similarly large size (4'x4') air intake, with motorized louvers tied into the fan's switch. Size the actual fan, up or down, to suit your unique testing requirements (contact a local HVAC supplier for assistance).

Chassis dyno test bays require that you also provide enough airflow to keep items like the engine compartment, radiator, exhaust systems, underbody, etc. from getting too hot. This may require (multiple) portable high power ducted fans, aimed at those various hot spots. Remember, the longer the tests and the higher the duty cycle, the more significant these cooling requirements become.

WARNING: FAILURE TO PROVIDE ADEQUATE EXHAUST SYSTEM COOLING TO THE UNDERSIDE OF THE VEHICLE DURING EXTENDED CHASSIS DYNO TESTING CAN LEAD TO A VEHICLE FIRE!

Depending on your test environment, noise control can be either a large or small issue. At the least, good hearing protector "ear muffs" are required within the actual cell. Hearing protection may also be required in control room and surrounding area, if the cell's construction provides inadequate sound damping. Check with your insurance carrier for the latest noise exposure guidelines.

Relatively inexpensive noise control walls can be built using a "super-insulated" construction design. This is accomplished by building a pair of (parallel) 2"x3" studded and insulated walls – to create a single 6" thick finished wall. These 2" x 3" walls are each built 24" on center, but the studs of the adjacent wall pairs are offset by 12" from one another. Also, try to minimize any noise conducting mechanical connection between the wall pairs. For insulation, use horizontally lain fiberglass batts, woven between the individual 2" x 3" wall studs. Double 5/8 " gypsum wallboard makes a cost effective sheathing for both the exterior and interior of the cell.

Although it is expensive, special acoustical sheathing, applied to the inner walls of the dyno cell, can significantly reduce reflected noise. This will be especially appreciated when you are

working next to a running engine. In fact, for cells with concrete walls, acoustical sheathing may be a necessity to deaden the echo from the hard wall surface.
We suggest that the wall paint be a high gloss enamel (or epoxy) paint to ease cleaning chores. Bright white or a very light gray color makes the best of the available light.

Floor drains are frowned upon, from an environmental and safety standpoint, because of the inevitable fuel spillage. If you decide to install them, they should drain into some sort of explosion protected catch tank. Contact your building inspector for local requirements and regulations regarding such floor drains.

Cell floors are generally concrete – sealed and painted. Epoxy paint holds up best, but even a good gloss floor enamel cleans up better than bare concrete (and its inexpensive to renew). If your budget allows it, tile makes cleanup easier – and it can be laid in the popular "racing" checkerboard pattern for aesthetics.

Like the walls, the cell's ceiling can also be done in double 5/8" gypsum wallboard. Again, a bright white paint makes the best use of the available light.

Lighting is typically fluorescent, and more is better! Use plenty of tubes to keep things bright, but take care to place them where they will not interfere with any air ducts, fire extinguisher nozzles, overhead plumbing or wiring booms, or beams for an overhead hoist. Most OEM factory cells use explosion proof fixtures, again consult your electrical inspector for local requirements.

> *Tip: Use 3-way switches on the cell's lights and fans so you can operate them inside or outside the cell. Shutting off the lights helps you catch sparkplug arching.*

WARNING: IN THE EVENT OF A CELL FIRE, YOU NEED IMMEDIATE ACCESS TO THE VENTILATION FAN'S SHUT-OFF SWITCH! A BIG RED BUTTON THAT IS ALSO INTERLOCKED WITH THE ENGINE'S IGNITION AND FUEL PUMP RELAYS IS RECOMMENDED!

Engine dyno test cells need a door wide enough to easily wheel the engine stand (or hoist) through. A single wide steel door works best. For best noise control this door should be insulated and have a magnetic seal. Avoid double doors as they are less soundproof.

Chassis dyno test bays will require an overhead door at one (or both) ends of the room. The heavier the door's construction, the better it will be as a sound insulator. If your installation requires a lift, make sure the door are installed so that opening the door will not hit the raised lift (or the vehicle on it)! Verify that the selected location for the dyno's roller assembly provides adequate clearance for the longest vehicle to be tested (check both front and rear wheel drive orientation). Remember to allow room for fans, other test equipment, and servicing the vehicle. Carefully planning is especially important if you must excavate for an in-ground chassis dyno installation, underground plumbing, or drain sump-pumps – be sure to consider the possibility of encountering sub-surface water or ledge during excavation.

All poured concrete pit walls and floors should be sealed (to limit dust) and painted a light color to aid visibility. Epoxy paint holds up best but a quality gloss floor enamel is less expensive.

WARNING: EXPLOSIVE GASOLINE FUMES SETTLE INTO BELOW GROUND PITS! CONTACT YOUR BUILDING INSPECTOR FOR LOCAL PIT VENTILATION REQUIREMENTS AND REGULATIONS!

Any window into the cell should either be Lexan or wired safety glass. Use double (or triple) panes with silicone sealing for noise suppression. Size and locate the window cutout so that you can see all important areas of the cell (from the console) while running the engine. Mirrors (or a video camera) placed in the cell can be used to help you see what's going on in any "hidden" zones.

> *Tip: DYNO-MAX "Pro" supports both viewing and capturing of test cell video and audio streams during testing!*

Besides access to light and ventilation switches, the control area should have power for computers, printers etc. Make sure that there is a phone by the console and that it has a long enough cord to reach into the test cell (or install a phone jack in the cell). Any PC used for testing should also have access to an Ethernet (or modem) hookup. Bells and whistles like quick disconnect hose fittings, overhead hoists, electrically operated Halon or CO2 cell fire extinguisher systems, electrically switched (and software controlled) alternate fuel sources, etc. make it nicer to dyno too. Just don't blow the whole testing budget on the room (it's happened)!

Plumbing, wiring, control cables, air lines, etc. (required for the test cell or control console) area can be run in almost any combination of overhead, on-ground, or underground conduit to best suit the installation. As you plan how to run them, consider each item's access and service requirements, as well as how their layout might interfere with the safety of personnel or operation of the engine.

To minimize problems with electro magnetic interference (EMI or RFI from ignition systems) bothering data acquisition or PC performance, ground your equipment properly. Plan to run all ground leads to either the engine's battery (or block if no battery is used) or to a clean common junction connected by a heavy-duty ground cable to the engine's battery. Ideally this battery's negative terminal and/or dynamometer's frame itself should be connected directly to a quality earth ground (e.g. buried copper rod) via a large gauge wire (for a very low resistance connection). Avoid multiple ground points as this often creates a "ground loop" (where RFI can get onto the circuit).

If you run any supply or drain plumbing, wiring, control cables, airline, etc. to the test stand or control console room underground, it is a must to have everything on hand before you start digging! Remember, water brakes must gravity drain, so don't forget to plan for any required sump-pump reservoir. For in-ground chassis dyno roller systems (where professional excavation and concrete from work will be required), this is even more important. Otherwise, some oversights in the layout will invariably become apparent only after the parts are ready to be hooked up. It is zero fun breaking out concrete you just paid to have poured – to the wrong dimensions!

> *Tip: Allow room for any engine hoists, overhead lifts, door swings, other maintenance and diagnostic test equipment, etc. when laying out walls, excavations, and equipment mounting. However, resist the temptation to start construction prior to delivery of your Dynamometer!*