Proposal for the Design of Engine Overhaul workshop

Ahmed Tarek Mohamed Shawki
Military Technical College, Cairo, Egypt, at9175@gmail.com

Supervisor: Metwally Mohamed Elsayed Moussa, Associate Professor
Military Technical College, Cairo, Egypt, Metwallymoussa@mtc.edu.eg

Abstract– The objective of this project is to plane Proposal for the Design of Engine Overhaul workshop with better characteristics. The number of cars in Egypt is increasing year after years. This need the improvement of the level of car service, the engine is regarded as the most important part in the vehicle as it is responsible for providing power to the vehicle, so it must achieve the standard specifications. Therefore, the workshop should be well equipped with all necessary tools and machines, perfectly designed and planned, managed well and have highly qualified workers. in this project we will discuss the workshop site selection, the designing of the workshop, workshop safety, the cost and Also will show how to do the repairs and the major engine overhaul procedures in details which start from engine testing and diagnosis, engine removal, engine disassembly, engine inspection and measurement, engine service and ending with engine assembly and installation.

I. INTRODUCTION

The overhaul engine workshop regarded as one of the most important specified workshops in field of vehicles as it makes engines repairing, the engine is regarded as the most important part in the vehicle, so it must achieve the standard specifications. In this project we will show how to design an engine overhaul workshop. Also, will show how to do the repairs and the major rebuilding procedures. you will learn the basic repair procedures for the engine and when to rebuild and overhaul an engine.

This project consists of numbers of chapters, which are divided according to the major topics to be presented. Each chapter begins with a review of previous work dealing with the concerned problem. This is followed by a detailed discussion of the topic at hand.

II. Planning of the workshop

1) Site selection:

Since the site location has a large influence on the success of the garage, careful consideration must be given to the selection of site location. Moreover, since the publicity effect is large, site selection is something which contributes to the overall expansion of the company.

The site should of course, be large enough for future expansion. The future development of the surrounding area itself should also be considered, along with the following points.

- Is the site easily accessible to heavy-duty vehicles by way of existing roads?
- Is it easy to find, even by people who are unfamiliar with the neighborhood?
- Are there any problems with the electricity or water supply or sewer facilities?
- Will there be any problem of noise, exhaust or oil disposal regulations? Are there hospitals, schools, housing areas, etc., nearby which would be affected by loud noises? Are there plans for such construction in the near future? Of course, extreme care must be taken in constructing the garage not to cause any form of pollution.

2) Items for consideration in site selecting:

-It should face a main road (or be close to a main road)
- It should be on a level ground.
- It should be a location where there are no traffic delays, etc.
- It should be possible to secure an adequate surface area.
- It should be a location with room for expansion.
- It should be a location where public facility can be used.
- It should be a location without legal restrictions.
- The soil base should be suitably firm.

3) Shape of site:

After the site has been selected according to the above items, the shape of site to be bought becomes the next consideration. For the site shape, a rectangular shape is the best; a square is the next best. Curved and poly-angled shapes are undesirable. Some examples, both good and bad, are indicated below.

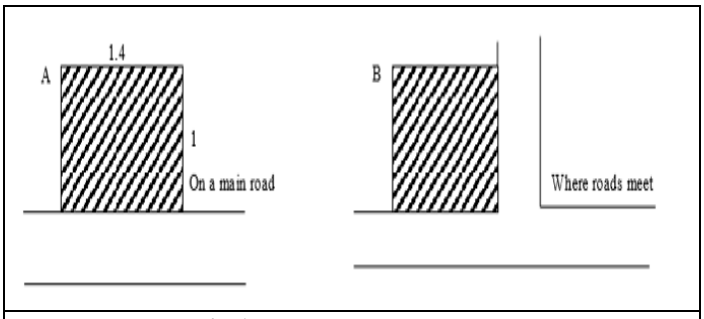

Fig 1: good example

3) List of various office, room, shops of garage:

(a) Office and warehouse
- General manager office
- Service manager office
- Service office
- Customer waiting room
- Reception room
- Watchman room
- Sales manager office
- Sales office
- Showroom
- Parts manager office
- Parts office
- Parts warehouse

(b) Workshops and related areas
- General service bay(s)
- Inspection bay(s)
- Lubrication bay(s)
- Engine repair and overhaul shop
- Tool room
- Machine shop
- Air compressor room
- Service parking area
- Stock yard
- Grounds

4) Safety precautions:

Accidents in the workshop claim many victims and approximately 70% of these accidents are caused by negligence/carelessness on the part of the workman, consequently the need for care cannot be overstressed, the points set out here are intended to warn vehicle mechanics of some of the dangers he is likely to meet in the motor vehicle workshop. A tidy workshop can help to reduce the number of accidents. Tools and components should not be left where someone may fall over them. They must never be allowed to obstruct gang ways or passages; neither should they be laid carelessly upon a bench. A tidy bench reflects a tidy methodical, business-like mind, which is the basis of accident prevention. Oil or grease on the workshop floor is dangerous and should be covered with sand or sawdust to prevent accident. Appropriate Personal Protection Equipment (PPE) must be used when cleaning and maintaining equipment and also when using cleaning materials generally. Many of the substances used for cleaning are hazardous to the skin and eyes. Special care must be taken with solvents as they are flammable and some give off dangerous vapour. Some PPE and their uses are shown on the following screen.

Fig 2: PPE

Safety goggles – Use safety goggles when there is any risk of eye contamination, e.g. splashes from a cleaning material.

Rubber or plastic gloves – Make sure that these are free from holes. Gloves must always be worn when using degreasing equipment.

Rubber or plastic apron – Replace if it has holes. Aprons should be worn when using strong acids and solvents.

Safety boots and shoes – These should be worn when working with any heavy equipment. Other items of PPE that are used in the workshop include the following:

- Safety helmet
- Welding goggles or mask
- Ear defenders
- Face mask
- Leather gloves
- High visibility clothing

Note that: in engine overhauling Petrol is extremely flammable, so take extra precautions when disconnecting any part of the fuel system. Don't smoke, or allow naked flames or bare light bulbs in or near the work area, and don't work in a garage where a natural gas appliance (such as a clothes dryer or water heater) is installed. If you spill petrol on your skin, rinse it off immediately. Have a fire extinguisher rated for petrol fires handy, and know how to use it.

III. Engine testing and diagnosis

Testing an engine in order to diagnose its problems is the most important step in the repair of any engine. No matter how precisely and carefully you repair reassemble an engine if you haven`t fixed the problem you have wasted time and money. For instance, a mechanic can Diagnose a knocking sound in the engine as a bad rod or main bearing. he then pulls the engine, rebuilds and reinstalls it , only to discover the knock is still there because it was caused by a loose ring gear on the flex plate or flywheel.

1)General testing and diagnosis practices:

Most engine problems are discovered through the process of elimination. If the problem is a loss of power or a dead

cylinder, be sure that the fuel and ignition systems are working properly.
If a fluid leak is the problem, first identify the fluid. don't assume that the liquid dripping from the bottom of the engine is engine oil. It could be transmission fluid, brake fluid, or power steering fluid.
If you hear what you think is an engine noise, first check all the pulleys and belts to make sure they aren't hitting or rubbing against something and duplicating the sound of an engine noise. Once these possible problem sources have been eliminated, you can begin engine diagnosis.

2) Engine Pre-Teardown Tests

Otherwise we will do pre-teardown tests like:
-Compression Pressure Test.
-Wet Compression Pressure Test
-Cylinder Leakage Test
-Cylinder Power Balance Test.
-Vacuum Test.
-Oil Pressure Test
-Oil Analysis.
-Exhaust Analysis.

IV. Engine removal

That you can use to remove all engines. engines removal procedures vary with make, model, year, options, and accessories. Describing the exact removal and replacement procedures for every engine is not possible in this volume, nor is it necessary. There are certain procedures common to remove all engines. Before removing anything from the vehicle, it is important to determine exactly what you will be doing so you will know what to include in the engine removal. for example, if you are going to be working on the transmission, it may be easier to remove the engine and transmission together instead of separating them in the engine compartment. In some case, it is easier to remove the engine and transmission together because you will not have to remove nearly as many items. it could also make the installation easier because after separating the transmission and engine outside of the car to perform any needed service, it is easier to align them before putting them back in the engine compartment.

There are two types of engine removal:
1-Remove under the vehicle
2-Top side removal

Lifting the engine

There are basic types of hoists used for engine removal. a stationary hoist is mounted to the roof of the shop or building, and is operated manually or by an electric motor. the portable hoist is operated hydraulically. It consists of a boom that reaches over the engine compartment, and two legs on wheels that roll under the vehicle. The specific procedure to use when removing the engine is determined by the type of hoist being used.

Fig 3: engine removal

V. Measuring and inspection of engine

Measuring the components of an engine is necessary to determine the specific condition and serviceability of each part. For machined parts, measuring tools are used to determine when the proper size or clearance has been achieved. Automotive measuring tools include the standard measuring tools used in the machining industry, such as the scale, inside and outside micrometers, the dial indicator, the Vernier caliper, and telescoping gauges. There are also highly specialized measuring tools developed for the automotive industry to make measuring certain engine parts easier, faster and more accurate. In this chapter we will cover the measurement and inspection of some major automotive engine parts using standard as well as special measuring tools when appropriate. You can use these techniques to measure any part not specifically mentioned in this chapter. Additional details on measuring and inspection can be found in the chapters of this book which cover the individual parts.

VI. Repairing cracks and threads

Repairing damaged threads

There are as many as 300 fasteners in an engine and all are susceptible to thread damage. Bolts and nuts that are tightened to a specific torque, such as head bolts and bearing cap nuts, as well as tapped holes, must have threads that are in perfect condition. Otherwise the torque reading will be inaccurate and the bolt, stud, or nut will not hold the part securely. The easiest and most common way of repairing threads damaged by dirt or mild corrosion is to run a tap, or die. down the threads. This will clean each thread and will repair any slight damage. On an engine which is highly susceptible to corrosion, perform this operation on every threaded hole or stud that will take a torqued fastener. You can also use a thread-restoring fie, to clean up minor damage on external threads. This file is made with a different pitch of teeth on each side for use on a wide range of threads.

If threads are stripped or damaged beyond repair, they'll have to be replaced. On threads where the size of the bolt is not critical, the hole can be drilled and tapped to the next larger thread size and a larger fastener installed. However, this only works in certain areas of the engine because sometimes enlarging a hole will interfere with a water jacket or some other passage or part. To keep the original fastener size, damaged threads can be replaced with a threaded insert kit.

Crack detection and repairing

Engine blocks and heads are susceptible to cracks, because they are constantly changing temperature. These wide temperature changes cause the castings to expand as they heat and shrink as they cool. Cracks often occur in areas which get too hot. This can result if the cooling system doesn't cool the area because of a particular engine design problem or because of a malfunctioning cooling system. You should learn to recognize problems that occur in certain engines so you will know where to look for cracks.

There are three types of crack detection methods: pressure testing, magnetic particle inspection, and dye penetrant.

Welding cracks

Aluminum castings that are cracked can often be welded with an arc welder. The casting has to be preheated to 200 to 300 F (93 to 149 C) so that the welding operation won't cause further cracking. After the bead is welded it is then ground down or resurfaced, depending on the location of the crack. On air-cooled Engine cases, heat distortion from welds performed in the area of bearing journals usually makes it necessary to remachine these areas. Welding can also be used to restore corroded water passage holes, and to restore damaged combustion chambers. Until recently it was not possible to do a good job welding cast iron because of the many impurities in the iron as a result of sand casting. Pinholes in the weld would still allow the part to leak. However, a recent welding technique called "metal spray" works very well. The casting is heated and a special welder is used to spray a fine iron powder on the crack. As the metal is sprayed the welder melts it, causing it to fuse to the crack.

Stop-drilling cracks

Many cracks, if caught in time, have no bearing on engine performance and do not cause any leakage the crack can be stopped from increasing in length by drilling a hole at the ends of the crack. Each hole forms a radius at the end of the crack which halts it.

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Pinning cracks

drilling a hole into which a threaded taper pin can be inserted, threaded taper pins, can be screwed into cracks in cast iron to seal them and prevent them from cracking further.

VII. Servicing cylinder heads and manifolds

Head disassembly, inspection and cleaning:

To disassemble a head, first take off the rocker arm and pivot, then remove the keepers, springs, seals, and valves. Use a valve spring compressor to compress the valve spring. Then remove the keepers from the top of the valve stem. Release the compressor, and take off the spring retainer and spring. Remove the valve guide seal, and push the valve through the head if possible. If you cannot do this, it indicates that the top of the valve stem is mushroomed from the rocker arm hitting the stem. You can remove the valve by driving it through the guide with a punch, but you should do this only as a last resort because it will most likely damage the valve and the guide.

If the stem is not too badly mushroomed, remove the edges with a file. If varnish buildup on the valve stem is preventing the valve from coming out, remove it with a solvent such as lacquer thinner or acetone.

After removing the valves, discard any that are not serviceable. Inspect the heads for cracks or other damage. Then clear the cylinder head casting in a hot tank or spray cleaner.

After the head is clean, bead-blast the ports, combustion chamber, and valves. Do not bead-blast the valve stems or they will stick in the valve guides.

Valve guide repair:

There are many different methods of restoring valve guides to their original clearance specifications. When choosing the right method for the vehicle you are working on remember that the best (longest lasting) methods are the most expensive. Also consider how many of the guides in the engine need repair and how excessive the clearance is. If you cannot repair it you can repair it.

VIII. Servicing Camshafts, Lifters, Pushrods, and rocker arms.

There are two types of camshaft lobes. One type is designed to rotate the part it contacts. This lobe has a slight taper across its face of 005-002" (.01-.05 mm).

The camshaft lobe usually rotates a valve lifter. The lifter has a slight crown on the bottom and is mounted a little off center in relation to the cam lobe. When the cam lobe rotates across the bottom of the lifter it causes the lifter to rotate in its bore. This rotation distributes wear evenly across the entire face of the lifter and prevents a concentrated wear pattern from developing on the lifter.

The other type of cam lobe does not rotate a lifter, but there are valve stem caps that rotate, Fig 8-1. The camshaft has no taper. The valve stem cap is placed off center and since it is wider than the lifter, it causes the cap to rotate. If the cam operates directly on the rocker arm, there is nothing to rotate and the lobe is not tapered.

PUSHRODS AND ROCKER ARMS

Always mark pushrods when removing them unless you intend to replace them with new pushrods, reinstall them in their original location when putting them back in the engine. Clean hollow pushrods by running rod through them Roll each Pushrod on a flat surface to check for straightness. Discard bent pushrods. Check the ends the pushrods for wear and damage and cu those that exhibit either.

IX.Servicing blocks:

Block service consists of restoring fits and clearances in three general areas. The cylinders are resized to restore the proper piston-to-cylinder wall clearances and to provide the proper surface finish for the rings to seat properly. The crankshaft main bearing bores are honed or bored to allow the crankshaft to run straight and true and to restore proper oil clearances. And the head gasket surface is refinished to provide a good sealing surface. You can make cylinder service by cylinder glazing, cylinder boring, cylinder sleeving, cylinder honning and block resurfacing.

X.Servicing crankshaft, flywheels, pistons and rods:

Crankshaft service:

Crankshaft grinding is a very complicated process that requires a high degree of skill, as well as a thorough knowledge of the machinery used. In this chapter we will not show a step-by-step crankshaft grinding process, but will discuss general crank grinding procedures as well as what to look for in a properly ground crankshaft.

Flywheel service

Flywheels are reground to restore the surface finish against which the clutch friction disc presses. After long service the flywheel will develop hard spots, heat checking, or possibly cracking, Fig 10-12. If the flywheel isn't resurfaced and installed with a new clutch disc, it will grab and chatter when the clutch is engaged.

This is because the surface is not smooth and even, and the new disc has a hard time seating properly on this surface.

The starter motor ring gear is frequently overlooked on flywheels. In many cases the ring gear is worn or missing teeth because of wear from the starter motor. The ring gear can be replaced on many flywheels. This is done by heating the old gear and removing it from the flywheel. The new gear is then heated and slipped into place. As it cools it shrinks and holds tightly to the flywheel. If a flywheel doesn't have any hard spots, it is possible to turn it in a regular lathe. However, the flywheel grinder is most commonly used. The flywheel grinder, has a table that rotates the flywheel and a cup-shaped grinding stone: which grinds a smooth surface on the flywheel face as it rotates.

Rod service:

There are three basic connecting rod services:

-Fitting piston pins.

-Honing crankpin journals.

-Aligning the piston pin and crankpin bores.

Piston pin fitting is done many times to engines that are being overhauled because the pins were making noise. Pin fitting is also done to new pistons or rods. Honing the crankpin end of the rod is done to restore the correct oil clearance and to make the bore perfectly round (see Chapter 5). With use, the rod bores become misaligned which causes premature bearing wear. To correct this the bores are realigned in a press.

Knurling pistons:

Piston knurling increases the diameter of the piston. This reduces the piston-to-cylinder wall clearance in an engine that is being overhauled. The piston knurler has two bits that displace metal on each skirt of the piston, Fig 10-37. This metal displacement causes the skirt to expand. The metal displacement can be controlled to give the amount of piston-to-cylinder wall clearance desired.

Measuring pistons:

Piston diameter is usually measured with an outside micrometer, Fig 10-38. In most cases the measurement should be taken at the top of the piston skirt at right angles to the pin bore. Some manufacturers specify exactly where to

measure their pistons. The measurement should not exceed the manufacturer's specifications.

Measure the gap between the piston ring land and the ring with a feeler gauge. This should not exceed 2006" (.15 mm) on the compression rings.

XXX. Engine balancing:

Balancing an engine consists of balancing the reciprocating components of the engine and also balancing the rotating components. Balancing reciprocating parts such as pistons, piston pins, piston rings, and the piston pin side of the rods involves weighing each part and comparing that weight to the weight of the other parts. The smaller the difference in weight between parts, the better balanced the engine.

Balancing the rotating parts of an engine involves balancing the crankshaft, flywheei. clutch, and harmonic balancer. This is done by spinning them in a balancing machine. The machine has a strobe light that indicates the location of the extra weight so t can be removed.

The flywheel, clutch, and harmonic balancer are balanced for static weight only. That is, the parts are checked to see that their mass is equally distributed around their centers.

Since the crankshaft is long and suspended at points along its length, it must also be dynamically balanced. Dynamic balance keeps the Crankshaft from wobbling from end to end. Wobble occurs because even though the static weight is balanced, the static weight may be located at opposite ends of the crankshaft. Even though that weight is evenly distributed around the center of the part, if it is at opposite ends it will cause the crankshaft to wobble.

Dynamic balance exists when the weight distributed evenly around the center of the part is also distributed evenly from one end of the shaft to the other. If a shaft is not dynamically balanced, it will wobble as it rotates. The wobbling will increase as the speed increases. This is because as the speed increases the centrifugal force of the imbalance increases. Since the other rotating parts of the engine such as the flywheel and harmonic balancer are very short in length, unlike a shaft, they need only be statically balanced.

XL. Lubrication system service

There are two types of oil pumps in common use, the rotor type and the gear type. If wear is not excessive it is possible to restore either type to serviceable limits by replacing internal parts and removing minor scoring on the end housing.

L. Engine assembly:

The most important aspects of engine as are the rechecking of measurements and keeping internal engine parts clean. Because engine machine work is done at a machine shop, when you reassemble the engine vey must double-check all fits and clearance self. You must verify that the machinist performed all machining operations correctly and accurately.

Dust and dirt particles in a rebuilt engine do a great deal of damage. Bearing manufacturers have discovered that over 42 percent of all bearing failures result from dirt or other foreign material in the engine. For this reason, take extreme care to keep all dirt and foreign particles out of the engine you are assembling The engine assembly area must be clean and free of dust. Try to keep yourself clean when assembling an engine, and be sure all engine parts are clean before beginning assembly.

LX. Engine installation, preoiling and break-in:

After you have assembled all the basic, components, paint the engine. Although painting the engine will not extend its service improve its performance, to the average customer a painted engine is the only visible evidence of where his money has gone. Taking a little extra time to make the engine look good will go a long way toward making the custom happy, and will show that you have pride in your work.

Engine paint is special heat-resistant enamel that will withstand the high engine operating temperatures. It is available in spray cans in all colors originally used by the manufacturers.

Before you start painting, cover or mask off all openings which should not get paint in them. Remove any oil on the outside of the engine with lacquer thinner or some other solvent. Start painting from the top and work toward the bottom. Take care to avoid runs when painting sheet metal surfaces since these will show up clearly. Be sure to get paint in all the corners and crevices.

Many production machine shops paint all their engines one color. They buy paint in bulk quantities and use a spray gun to apply it. Using only one color reduces their expenses and allows them to identify engines they have rebuilt before. However, it is usually best to paint the engine the factory color so that it will look original.

Engine preoiling:

Before attempting to start a new or rebuilt engine you should preoil it. This procedure pressurizes the entire oil system and floods engine bearings with oil.

Engine installation

you were told to clean the engine and engine compartment before removing the engine.

Now that the engine is removed, clean the rest of the engine compartment and inspect any parts that the engine was covering such as the steering box and suspension components. Look around the engine compartment and make mental notes of brake lines, air conditioning hoses, and any other things that could be damaged when the engine is installed. The engine is very heavy, and during installation it can easily flatten a brake line or damage a bracket without your knowing it.

Cycling the engine (breaking-in the engine):

Cycling or breaking in the engine is done by alternately accelerating and decelerating the vehicle. Do this as follow:

1 With the vehicle in third gear (manual transmission) or second gear (automatic transmission) accelerate from 20 to 50 miles per hour at full throttle.

2. When 50 miles per hour is attained, release the throttle and let the vehicle slow to 20 miles per hour using engine braking.

3. Repeat this procedure until no oil smoke comes from the tailpipe.

When the vehicle is accelerated, the load on the engine causes the rings to press against the cylinder walls which makes them seat rapidly. When coasting, or decelerating, the high vacuum in the engine draws oil up around the rings which cools them and washes away any metal particles that may be present.

Do not rev the engine higher than necessary because when engine bearings are new they are very soft so they can conform to the shape of the crankshaft. Also, foreign particles can embed themselves in the bearings without doing any harm. After a few hundred miles the bearings work harden and can withstand higher engine speeds. For this reason, instruct your customers to avoid sustained speeds over 50 miles per hour for the first few hundred miles,

After the engine has been cycled, it should be returned to the shop so that you can adjust the timing, the idle speeds, and the belt tension. Before turning the vehicle over to the customer, double check hose routings, check again for fluid leaks, and look for any tools that may have been left under the hood. Make any minor adjustments as necessary, and clean off dirt marks that may be on the body or interior. You should also have the customer return the vehicle at 500 miles so you can retorque the cylinder head bolts and change the oil and filter. If the engine has solid valve lifters, adjust them at this time also, because the valves will have recessed slightly in their seats, reducing the valve clearance. Check the engine for leaks that may have developed and for any other signs of trouble.

LXX. Cost summary:

Land cost	375,000
Administration construction	750,000 L.E
Office furnishing	16,000
Computers and networks	105,000
Air conditioning	50,000
Engine testing and diagnosis equipments	10060
Overhaul equipments	800,000
safety	114,700
Spare parts	500,000
Total cost	2,720,760

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