FIATALLIS®

FR10B

wheel loader

service manual set

Supplement #3
Form 73151988
FR10B WHEEL LOADER
SERVICE MANUAL

(10-91)

ATTENTION: **Insert this sheet in the front of publication as record or receipt.**
Replace or add pages in the publication according to instructions below.

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This is Supplement No. 3 for the subject manual. This supplement is written to add brake pressure procedure for units prior to S/N 61097.

PAGE 4-4A	**no chnage**
PAGE 4-4B	**added**
PAGE 4-5	**changed**
PAGE 4-6	**no change**

Supplement #2
Form 73151988
FR10B WHEEL LOADER
SERVICE MANUAL

(1-91)

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This is Supplement No. 2 for the subject manual. This supplement is written to clarify and describe modified systems. Follow the instructions carefully to insert this supplement into the manual.

REPLACE OR ADD:

Section 0 in its entirety

Section 1: Table of Contents and pages 1-41, 42 and 47 thru 54

Section 2: Pages 2-115 and 2-116

Section 3: Pages 3-21 and 3-22

Section 4: Pages 4-4A, 4-5, 4-6, 4-9, 4-10

Section 5: Pages 5-2A, 5-2B, 5-33, 5-34

Section 7: Pages 7-3, 7-4, 7-65, 7-66, 7-73, 7-74, 7-77, 7-78

and at the end of all text add - Rear Flysheet

FR10B
SERVICE MANUAL
73151988
Supplement #1

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This is supplement number 1 for the subject manual. This supplement is written to clarify and desc[illegible]modified systems. Follow the instructions carefully to insert [illegible]ement into the manual.

Replace:

Section 0 in its entirety

Section 1 in its entirety

Section 2 page 2-59/2-60

Section 3 page 61

Section 4 in its entirety

Section 5 in its entirety except schematics

Add:

Section 7

FR10B

wheel loader

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Form 73151988 English

WARNING

STUDY THE OPERATION AND MAINTENANCE INSTRUCTION MANUAL THROUGH BEFORE STARTING. OPERATING, MAINTAINING, FUELING OR SERVICING THIS MACHINE.

The Operation and Maintenance Instruction Manual provides the instructions and procedures for starting, operating, maintaining, fueling, shutdown and servicing that are necessary for properly conducting the procedures for overhaul of the related components outlined in this Service Manual.

This symbol is your safety alert sign. It MEANS ATTENTION! BECOME ALERT! YOUR SAFETY IS INVOLVED.

Read and heed all safety instructions carrying the signal words WARNING and DANGER.

Machine mounted safety signs have been color coded yellow with black borders and lettering for warning and red with white borders and lettering for danger points.

INDEX

SAFETY RULES

GENERAL

Study the Operation and Maintenance Instruction Manual before starting, operating, maintaining, fueling, or servicing machine.

Read and heed all machine-mounted safety signs before starting, operating, maintaining, fueling or servicing machine.

Machine-mounted safety signs have been color coded yellow with black border and lettering for ***WARNING*** and red with white border and lettering for ***DANGER*** points.

Never attempt to operate the machine or its tools from any position other than seated in the operator's seat. Keep head, body, limbs, hands and feet inside operator's compartment at all times to reduce exposure to hazards outside the operator's compartment.

Do not allow unauthorized personnel to operate service or maintain this machine.

Always check work area for dangerous features. The following are examples of dangerous work areas: slopes, over hangs, timber, demolitions, fire, high walls, drop off, back fills, rough terrain, ditches, ridges, excavations, heavy traffic, crowded parking, crowded maintenance and closed areas. Use extreme care when in areas such as these.

An operator must know the machine's capabilities. When working on slopes or near drop offs be alert to avoid loose or soft conditions that could cause sudden tipping or loss of control.

Do not jump on or off machine. Keep two hands and one foot, or two feet and one hand, in contact with steps grab rails and handles at all times.

Do not use controls or hoses as hand holds when climbing on or off machine. Hoses and controls are movable and do not provide a solid support. Controls also may be inadvertently moved causing accidental machine or equipment movement.

Keep operator's compartment, stepping points, grab-rails and handles clear of foreign objects, oil, grease, mud or snow accumulation to minimize the danger of slipping or stumbling. Clean mud or grease from shoes before attempting to mount or operate the machine.

Be careful of slippery conditions on stepping points, hand rails, and on the ground. Wear safety boots or shoes that have a high slip resistant sole material.

For your personal protection. Do not attempt to climb on or off machine while machine is in motion.

Never leave the machine unattended with the engine running.

Always lock up machine when leaving it unattended. Return keys to authorized security. Heed all shut down procedures of the Operation and Maintenance Instruction Manual. Always set the parking brake when leaving the machine for any reason.

Do not wear rings, wrist watches, jewelry, loose or hanging apparel, such as ties, torn clothing, scarves, unbuttoned or unzipped jackets that can catch on moving parts. Wear proper safety equipment as authorized for the job. Examples: hard hats, safety shoes, heavy gloves, ear protectors, safety glasses or goggles, reflector vests, or respirators. Consult your employer for specific safety equipment requirements.

Do not carry loose objects in pockets that might fall unnoticed into open compartments. Do not use machine to carry loose objects by means other than attachments for carrying such objects.

DO NOT CARRY RIDERS unless the machine is equipped for carrying people to reduce personal exposure to being thrown off.

Do not operate machinery in a condition of extreme fatigue or illness. Be especially careful towards the end of the shift.

Roll Over Protective Structures are required on wheel loaders, dozer tractors, track type loaders, graders and scrapers by local or national requirements. *DO NOT* operate this machine without a Roll Over Protective Structure.

Do not operate a machine without a falling object protective structure (FOPS).

Do not operate this machine without a rear canopy screen when machine is equipped with rear mounted towing winch.

Seat belts are required to be provided with roll over protective structures or roll protection cabs by local or national regulations. Keep the safety belt fastened around you during operation.

Where noise exposure exceeds 90 dBA for 8 hours, wear authorized ear protective equipment per local or national requirements that apply.

Keep clutches and brakes on machine and attachments such as power control units, winches and master clutches adjusted according to Operation and Maintenance Instruction Manuals of the manufacturers at all times. *DO NOT* adjust machine with engine running except as specified.

Do not operate a machine with brakes out of adjustment. See the Operation and Maintenance Instruction Manual.

Move carefully when under, in or near machine or implements. Wear required protective equipment, such as hard hat, safety glasses, safety shoes, ear protectors.

To move a disabled machine, use a trailer or low boy truck if available. If towing is necessary, provide warning signals as required by local rules and regulations and follow Operation and Maintenance Instruction Manual recommendations. Load and unload on a level area that gives full support to the trailer wheels. Use ramps of adequate strength, low angle and proper height. Keep trailer bed clean of clay, oil and all materials that become slippery. Tie machine down securely to truck or trailer bed and block tracks (or wheels) as required by the carrier.

SAFETY RULES

To prevent entrapment in cabs or mounted enclosures, observe and know the mechanics of alternate exit routes.

On machines equipped with suction radiator fans, be sure to periodically check all engine exhaust parts for leaks as exhaust gases are dangerous to the operator. Keep a vent open to outside air at all times when operating within a closed cab.

STARTING FLUID IS FLAMMABLE. Follow the recommendations as outlined in the Operation and Maintenance Instruction Manual and as marked on the containers. Store containers in cool, well-ventilated place secure from unauthorized personnel. *DO NOT PUNCTURE OR BURN CONTAINERS.*

Follow the recommendations of the manufacturer for storage and disposal.

Wire rope develops steel slivers. Use authorized protective equipment such as heavy gloves, safety glasses when handling.

OPERATION

Before starting machine, check, adjust and lock the operator's seat for maximum comfort and control of the machine.

DO NOT START OR OPERATE AN UNSAFE MACHINE. Before working the machine, be sure that any unsafe condition has been satisfactorily remedied. Check brakes, steering and attachment controls before moving. Advise the proper maintenance authority of any malfunctioning part or system. Be sure all protective guards or panels are in place, and all safety devices provided are in place and in good operating condition.

Check instruments at start-up and frequently during operation.

Do not run the engine of this machine in closed areas without proper ventilation to remove deadly exhaust gases.

Be sure exposed personnel in the area of operation are clear of the machine before moving the machine or its attachments. *WALK COMPLETELY AROUND* the machine before mounting. Sound horn. Obey flag man, safety signals and signs.

Know the principles of cross steering of crawler tractors. Read section in Operation and Maintenance Instruction Manual on cross steering.

Keep engine exhaust system and exhaust manifolds clear of combustible material. Equip machine with screens and guards when working under conditions of flying combustible material.

If engine has a tendency to stall for any reason under load or idle, report this for adjustment to a proper maintenance authority immediately. Do not continue to operate machine until condition has been corrected.

Never use bucket as a man-lift.

Use recommended bucket for machine and material load ability and heaping characteristics of material, terrain, and other pertinent job conditions.

Avoid abrupt starts and stops when transporting a loaded bucket.

Inspect your seat belt webbing and hardware at least twice a year for signs of fraying, wear or other weakness that could lead to failure.

Use only designated towing or pulling attachment points. Use care in making attachment. Be sure pins and locks as provided are secure before pulling. Stay clear of draw bars, cables or chains under load.

When pulling or towing through a cable or chain, do not start suddenly at full throttle. Take up slack carefully. Guard against kinking chains or cables. Inspect carefully for flaws before using. Do not pull through a kinked chain or cable due to the high stresses and possibility of failure of the kinked area. Always wear heavy gloves when handling chain or cable.

Be sure cables are anchored and the anchor point is strong enough to handle the expected load. Keep exposed personnel clear of anchor point and cable or chain. *DO NOT PULL OR TOW UNLESS OPERATOR'S COMPARTMENT OF MACHINES INVOLVED ARE PROPERLY GUARDED AGAINST POTENTIAL CABLE OR CHAIN BACKLASH.*

During operation always carry ripper in full raised position when not in use and lowered to ground when parked.

When counterweights have been provided, do not work machine if they have been removed unless their equivalent weight has been replaced. See the Operation and Maintenance Instruction Manual.

When operating a machine know what clearances will be encountered, overhead doors, wires, pipes, aisles, roadways; also the weight limitations of ground, floor, and ramps.

Know bridge and culvert load limits and do not exceed them. Know machine's height, width, and weight. Use a signal person when clearance is close.

Be sure that the exact location of gas lines, utility lines, sewers, overhead and buried power lines, and other obstructions or hazards are known. Such locations should be precisely marked by the proper authorities to reduce the risk of accidents. Obtain shut-down or relocation of any such facilities before starting work, if necessary.

Be certain to comply with all local, state, and federal regulations regarding working in the vicinity of power lines.

When roading find out what conditions are likely to be met - clearances, congestion, type of surface, etc. Be aware of fog, smoke or dust element that obscure visibility.

When backing, always look to where the machine is to be moved. Be alert to the position of exposed personnel. *DO NOT OPERATE* if exposed personnel enter the immediate work area.

SAFETY RULES

Never travel a machine on a job site, in a congested area, or around people without a signal person to guide the operator.

In darkness, check area of operation carefully before moving in with machine. Use all lights provided. Do not move into area of restricted visibility.

Maintain clear vision of all areas of travel or work. Keep cab windows clean and repaired. Carry blade low for maximum visibility while traveling. Obtain and use fan blast deflectors where tractors are used a pusher tractors in tandem.

Transport a loaded bucket with the bucket as far tipped back and in as low a position as possible for maximum visibility, stability, and safest transport of the machine. Carry it at a proper speed for the load and ground conditions.

Carry the bucket low when traveling with a load.

Maintain a safe distance from other machines. Provide sufficient clearance for ground and visibility conditions. Yield right-of-way to loaded machines.

Avoid going over obstacles such as rough terrain, rocks, logs, curbs, ditches ridges, and railroad tracks whenever possible. When obstructions must be crossed, do so with extreme care at an angle if possible. Reduce speed - down-shift. Ease up to the break over point - pass the balance point slowly on the obstruction and ease down on the other side.

Cross gullies or ditches at an angle with reduced speed after insuring ground conditions will permit a safe traverse.

Be alert to soft ground conditions close to newly constructed walls. The fill material and weight of machine may cause the wall to collapse under the machine.

Operate at speeds slow enough to insure complete control at all times. Travel slowly over rough ground, on slopes or near drop offs, in congested areas or on ice or slippery surfaces.

Be alert to avoid changes in traction conditions that could cause loss of control. *DO NOT* drive on ice or frozen ground conditions when working the machine on steep slopes or near drop offs.

Keep the machine well back from the edge of an excavation.

Be especially careful when traveling up or down slopes. Position the bucket in such a way as to provide a possible anchorage on the ground in case of a slide.

When proceeding across a hill side proceed slowly. Never turn sharply up hill or down hill.

Avoid side hill travel whenever possible. Drive up and down the slope. Should the machine start slipping sideways on a grade, turn it immediately downhill.

In steep down hill operation, do not allow engine to over speed. Select proper gear before starting down grade.

There is no substitute for good judgement when working on slopes.

The grade of slope you should attempt will be limited by such factors as condition of the ground, load being handled, the type of machine, speed of machine and visibility.

NEVER COAST the machine down grades and slopes with the transmission in neutral on power shift machines, or clutch disengaged on manually shifted machines.

To reduce the danger of uncontrolled machine, choose a gear speed before proceeding down grade that will hold machine to proper speeds for conditions.

Operating in virgin rough terrain that includes previously mentioned hazards is called pioneering. Be sure you know how this is done. Danger from falling branches and upturning roots is acute in these areas.

When pushing over trees, the machine must be equipped with proper over head guarding. Never allow a machine to climb up on the root structure particularly while the tree is being felled. Use extreme care when pushing over any tree with dead branches.

Avoid brush piles, logs or rocks. *DO NOT DRIVE THE MACHINE ONTO BRUSH PILES, LOGS, LARGE ROCKS* or other surface irregularities that break traction with the ground especially when on slopes or near drop offs.

Avoid operating equipment too close to an over hang or high wall either above or below the machine. Be on the look out for caving edges, falling objects and slides. Beware of concealment by brush and under growth of these dangers.

Park in a non-operating and non-traffic area or as instructed. Park on firm level ground if possible. Where not possible, position machine at a right angle to the slope, making sure there is no danger of uncontrolled sliding movement. Set the parking brake.

Never park on an incline without carefully blocking the machine to prevent movement.

If parking in traffic lanes cannot be avoided, provide appropriate flags, barriers, flares and warning signals as required. Also provide advance warning signals in the traffic lane of approaching traffic.

Move the machine away from pits, trenches, overhangs and over head power lines before shutting down for the day.

When stopping operation of the machine for any reason, always return the transmission or hydrostatic drive control to neutral and engage the control lock to secure the machine for a safe start up. Set parking brake, if so equipped.

Never lower attachments or tools from any position other than seated in operator's seat. Sound the horn. Make sure the area near the attachment is clear. Lower the attachment slowly. *DO NOT USE* float position to lower hydraulic equipment.

SAFETY RULES

Always before leaving the operator's seat and after making certain all people are clear of the machine, slowly lower the attachments or tools flat to the ground in a positive ground support position. Move any multi purpose tool to positive closed position. Return the controls to hold. Place transmission control in neutral and move engine controls to off position. Engage all control locks, set parking brake, and open and lock the master (key, if so equipped) switch. Consult Operation and Maintenance Instruction Manual.

Always follow the shut down instructions as outlined in the Operation and Maintenance Instruction Manual.

MAINTENANCE

Do not perform any work on equipment that is not authorized. Follow the Maintenance or Service Manual procedures.

Machine should not be serviced with anyone in the operator's seat unless they are qualified to operate the machine and are assisting in the servicing.

Shut off engine and disengage the Power Take Off lever if so equipped before attempting adjustments or service.

Always turn the master switch (key switch if so equipped) to the *OFF* position before cleaning, repairing, or servicing and when parking machine to forestall unintended or unauthorized starting.

Disconnect batteries and *TAG* all controls according to local or national requirements to warn that work is in progress. Block the machine and all attachments that must be raised per local or national requirements.

Never lubricate, service or adjust a machine with the engine running, except as called for in the Operation and Maintenance Instruction Manual. Do not wear loose clothing or jewelry near moving parts.

Do not run engine when refueling and use care if engine is hot due to the increased possibility of a fire if fuel is spilled.

Do not smoke or permit any open flame or spark near when refueling, or handling highly flammable materials.

Always place the fuel nozzle against the side of the filler opening before starting and during fuel flow. To reduce the chance of a static electricity spark, keep contact until after fuel flow is shut off.

Do not adjust engine fuel pump when the machine is in motion.

Never attempt to check or adjust fan belts when engine is running.

When making equipment checks that require running of the engine, have an operator in the operator's seat at all times with the mechanic in sight. Place the transmission in neutral and set the brakes and lock. *KEEP HANDS AND CLOTHING AWAY FROM MOVING PARTS.*

Avoid running engine with open unprotected air inlets. If such running is unavoidable for service reasons, place protective screens over all inlet openings before servicing engine.

Do not place head, body, limbs, feet, fingers, or hands near rotating fan or belts. Be especially alert around a pusher fan.

Keep head, body, limbs, feet, fingers, or hands away from bucket, blade or ripper when in raised position.

If movement of an attachment by means of machine's hydraulic system or winches is required for service or maintenance, do not raise or lower attachments from any position other than when seated in the operator's seat. Before starting machine or moving attachments or tools, set brakes, sound horn and call for an all clear. Raise attachments slowly.

Never place head, body, limbs, feet, fingers, or hands into an exposed portion between uncontrolled or unguarded scissor points of machine without first providing secure blocking.

Never align holes with fingers or hands - Use the proper aligning tool.

Disconnect batteries before working on electrical system or repair work of any kind.

Check for fuel or battery electrolyte leaks before starting service or maintenance work. Eliminate leaks before proceeding.

BATTERY GAS IS HIGHLY FLAMMABLE. Leave battery box open to improve ventilation when charging batteries. Never check charge by placing metal objects across the posts. Keep sparks or open flame away from batteries. Do not smoke near battery to guard against the possibility of an accidental explosion.

Do not charge batteries in a closed area. Provide proper ventilation to guard against an accidental explosion from an accumulation of explosive gases given off in the charging process.

Be sure to connect the booster cables to the proper terminals (+ to +) and (- to -) at both ends. Avoid shorting clamps. Follow the Operation and Maintenance Instruction Manual procedure.

Due to the presence of flammable fluid, never check or fill fuel tanks, storage batteries or use starter fluid near lighted smoking materials or open flame or sparks.

Rust inhibitors are volatile and flammable. Prepare parts in well ventilated place. Keep open flame away - *DO NOT SMOKE.* Store containers in a cool well ventilated place secured against unauthorized personnel.

Do not use an open flame as a light source to look for leaks or for inspection anywhere on the machine.

DO NOT pile oily or greasy rags - they are a fire hazard. Store in a closed metal container.

SAFETY RULES

Never use gasoline or solvent or other flammable fluid to clean parts. Use authorized commercial, non-flammable, non-toxic solvents.

Never place gasoline or diesel fuel in an open pan.

Shut off engine and be sure all pressure in system has been relieved before removing panels, housings, covers, and caps. See Operation and Maintenance Instruction Manual.

Do not remove hoses or check valves in the hydraulic system without first removing load and relieving pressure on the supporting cylinders. Turn radiator cap slowly to relieve pressure before removing. Add coolant only with engine stopped or idling if hot. See Operation and Maintenance Instruction Manual.

Fluid escaping under pressure from a very small hole can almost be invisible and can have sufficient force to penetrate the skin. Use a piece of card board or wood to search for suspected pressure leaks. *DO NOT USE HANDS.* If injured by escaping fluid, see a doctor at once. Serious infection or reaction can develop if proper medical treatment is not administered immediately.

Never use any gas other than dry nitrogen to charge accumulators. See Operation and Maintenance Instruction Manual.

When making pressure checks use the correct gauge for expected pressure. See the Operation and Maintenance Instruction Manual or Service Manual for guidance.

For field service, move machine to level ground if possible and block machine. If work is absolutely necessary on an incline, block machine and its attachments securely. Move the machine to level ground as soon as possible.

Brakes are inoperative when manually released for servicing. Provision must be made to maintain control of the machine by blocking or other means.

Block all wheels before bleeding or disconnecting any brake system lines and cylinders.

Never use make shift jacks when adjusting track tension. Follow the Undercarriage Service Manual.

Know your jacking equipment and its capacity. Be sure the jacking point used on the machine is appropriate for the load to be applied. Be sure the support of the jack at the machine and under the jack is appropriate and stable. Any equipment up on a jack is dangerous. Transfer load to appropriate blocking as a safety measure before proceeding with service or maintenance work according to local or national requirements.

Always block with external support any linkage or part on machine that requires work under the raised linkage, parts, or machine per local or national requirements. Never allow anyone to walk under or be near unblocked raised equipment. Avoid working or walking under raised blocked equipment unless you are assured of your safety.

When servicing or maintenance requires access to areas that cannot be reached from the ground, use a ladder or step platform that meets local or national requirements to reach the service point. If such ladders or platforms are not available, use the machine hand holds and steps as provided. Perform all service or maintenance carefully.

Shop or field service platforms and ladders used to maintain or service machinery should be constructed and maintained according to local or national requirements.

Lift and handle all heavy parts with a lifting device of proper capacity. Be sure parts are supported by proper slings and hooks. Use lifting eyes if provided. Watch out for people in the vicinity.

In lifting and handling heavy parts, slings must be of adequate strength for the purpose intended and must be in good condition.

Handle all parts with extreme care. Keep hands and fingers from between parts. Wear authorized protective equipment such as safety glasses, heavy gloves, safety shoes.

When using compressed air for cleaning parts use safety glasses with side shields or goggles. Limit the pressure to 207 kPa (30 psi) according to local or national requirements.

Wear welders protective equipment such as dark safety glasses, helmets, protective clothing, gloves and safety shoes when welding or burning. Wear dark safety glasses near welding. *DO NOT LOOK AT ARC WITHOUT PROPER EYE PROTECTION.*

Replace seat belts every two years on open canopy units and every three years on machines with cabs or at change of ownership.

Wear proper protective equipment such as safety goggles or safety glasses with side shields, hard hat, safety shoes, heavy gloves when metal or other particles are apt to fly or fall.

Use only grounded auxiliary power source for heaters, chargers, pumps and similar equipment to reduce the hazards of electrical shock.

Keep maintenance area *CLEAN* and *DRY*. Remove water or oil slicks immediately.

Remove sharp edges and burrs from reworked parts.

Be sure all mechanics tools are in good condition. *DO NOT* use tools with mushroomed heads. Always wear safety glasses with side shields.

Do not strike hardened steel parts with anything other than a soft iron or non-ferrous hammer.

Do not rush. Walk, do not run.

Know and use the hand signals used on particular jobs and know who has the responsibility for signaling.

SAFETY RULES

Face the access system when climbing up and down.

Apply the parking device and place the transmission in neutral before starting the machine.

Do not bypass the starter safety switch. Repair the starter safety controls if they malfunction.

Fasten seat belt before operating.

Steering should be checked to both right and left. Brakes should be tested against engine power. Clutch and transmission controls should be moved through or to neutral positions to assure disengagement. Operate all controls to insure proper operation. If any malfunctions are found, park machine, shut off engine, report and repair before using machine.

If the power steering or the engine ceases operating, stop the machine motion as quickly as possible. Lower equipment, set parking device and keep machine securely parked until the malfunction is corrected or the machine can be safety towed. Never lift loads in excess of capacity.

Should the machine become stuck or frozen to the ground, back out to avoid roll over.

Know and understand the job site traffic flow patterns.

Keep the machine in the same gear going down hill as used for going up hill.

When roading a machine, know and use the signaling devices required on the machine. Provide an escort for roading where required.

Always use the recommended transport devices when roading the machine.

Do not attempt repairs unless proper training has been provided.

Use extreme caution when removing radiator caps, drain plugs, grease fittings or pressure taps. Park the machine and let it cool down before opening a pressurized compartment.

Release all pressure before working on systems which have an accumulator.

When necessary to tow the machine, do not exceed the recommended towing speed, be sure the towing machine has sufficient braking capacity to stop the towed load. If the towed machine cannot be braked, a tow bar must be used or two towing machines must be used - one in front pulling and one in the rear to retard. Avoid towing over long distances.

Observe proper maintenance and repair of all pivot pins, hydraulic cylinders, hoses, snap rings and main attaching bolts.

Always keep the brakes and steering systems in good operating condition.

Replace all missing, illegible or damaged safety signs. Keep all safety signs clean.

Do not fill the fuel tank to capacity. Allow room for expansion.

Wipe up spilled fuel immediately.

Always tighten the fuel tank cap securely. Should the fuel cap be lost, replace it only with the original manufacturers approved cap. Use of a non-approved cap may result in overpressurization of the tank.

Never drive the machine near open fires.

Use the correct fuel grade for the operating season.

MACHINE THEFT AND VANDALISM

ACTIONS TO DISCOURAGE THEFT AND VANDALISM

Immediately upon receipt of a new machine, record the serial numbers of the machine and of all major components and attachments. Keep this list up-to-date as components are replaced or exchanged on the machine. File these numbers in a safe location for fast retrieval.

Report all model, machine and component serial numbers to the insurance company at the time of purchase. If the numbers are noted on the insurance policy, make certain that the numbers are correct.

Remove keys from unattended machines.

Attach, secure, and lock all anti-vandalism and anti-theft devices on the machine.

Lock doors of cabs when not in use.

Immobilize machine by lowering the blade, bucket, or boom to the ground, removing the battery or removing a critical electrical or starting system component.

Discourage the thief! Inspect the gates and fences of the machinery storage yard or construction site. If possible, keep machines in well-lighted areas. Ask the law enforcement agency having local jurisdiction to make frequent checks around the storage or work sites, especially at night, during weekends or on holidays.

Establish liaison with neighbors and ask them to watch equipment left at job sites and report suspicious activities to the applicable law enforcement agency.

Make frequent inventories of machines to promptly detect losses and vandalism.

ACTIONS TO AID IN RECOVERY OF STOLEN MACHINES

Take photographs of the machine for identification purposes.

In the event of theft, immediately notify the law enforcement agency having jurisdiction. Provide the investigating officer with brand name, type of equipment, and serial numbers of the machine and of major attachments and components. It is helpful to show the investigating officer an Operator's Manual, photographs, and advertising to familiarize him with the appearance of the machine.

Report the theft to the insurance company. Provide the model and all serial numbers.

Report the model and serial numbers of the stolen machine to a dealer handling the respective line of equipment. Request that the dealer forward this same information to the equipment manufacturer.

Ask the dealer to post a description of the stolen machine, including serial numbers, and to inform his sales and service personnel.

FOREWORD

Always furnish serial number if making an inquiry to dealer or factory about this machine.

Many equipment owners employ the Dealer Service Department for all work other than routine lubrication and minor service. This practice is encouraged, as our Dealers are well informed and equipped to render efficient service by factory trained mechanics.

Illustrations show standard and optional items.

IMPORTANT

The information in this manual was current at the time of publication. It is our policy to constantly improve our product and to make available additional items. These changes may affect procedures outlined in this manual. If variances are observed, verify the information through your Dealer.

Fiatallis is not responsible for any liability arising from any damage resulting from defects caused by parts and/or components not approved by Fiatallis for use in maintaining and/or repairing products manufactured or merchandized by Fiatallis.

In any case, no warranty of any kind is made or shall be imposed with respect to products manufactured or merchandized by Fiatallis when failures are caused by the use of parts and/or components not approved by Fiatallis.

1.16 STANDARD PART CLASSIFICATION TO DETERMINE TORQUE DATA

IMPORTANT: When a specific torque is not given the FIAT STANDARD TORQUE CHART should be used after fully indentifying the part.

Part may only be fully identified by the eight-digit code number, as follows:

l / a b c d e / f g

l - Standard part code
Always represented by figure 1. Such a number indicates that the part can be produced in various versions which differ in material and coating.

a-b-c-d-e-Standard part basic number

It always consists in five figures to identify the part in its dimensional characteristics.

f - Material code number
This number represents the material provided for a specific part. Its meaning is indicated in the table below.

g - Coating code number
This number represents the coating provided for a specific part.

1.17 FIAT STANDARD TORQUE CHARTS

When a specific fastener torque is not given, the following charts may be used:

IMPORTANT
- Fasteners with nominal diameter up to 24 mm to be lubricated with engine oil, major diameter fasteners with tallow.

- Torques for cadmium plated fasteners are valid also for not coated parts.

- Nominal torque tolerance is ±5%

- R80, R100, R120 strength classes are to be considered as follows:

10.9 replaces R100
12.9 replaces R120 bolts & screws

10 replaces R80
12 replaces R100 nuts

- Coating abreviation meaning:

CDT = Cadmium plated
FOSF = Phosphatized
ZNT = Zinc plated

Material code (f)	FIAT	Strength class and type of material				
		UNI	DIN	SAE	BSI	BNA
0	R40	4D - 4S - 4A		1	A	42
1	R50	5S - 6S		3	P	56
2	R80	8G		5	T	80
3	R100	100	10K	8	V	100
4	Ottone	Ottone	Messing	Brass	Brass	Laiton
5	Alluminio	Alluminio	Aluminium	Aluminium	Aluminium	Aluminium
6	Rame	Rame	Kupfer	Copper	Copper	Cuivre
7	open to other metallic material					

BOLT AND SCREW TORQUE CHART

Diameter and width of thread mm	Strength class: 10.9				Strength class: 12.9	
	standard ZNT daNm (*/**) lbs ft (°/°°)	self locking ZNT daNm (*/**) lbs ft (°/°°)	standard CDT daNm (*/**) lbs ft(°/°°)	self locking CDT daNm (*/**) lbs ft (°/°°)	standard FOSF daNm (*/**) lbs ft (°/°°)	self locking FOSF daNm (*/**) lbs ft (°/°°)
M6 x 1	1.3 (9.5/6.5) 9.6 (0.37/0.25)	-	-	-	1.4 (12/8) 10 (0.47/0.31)	-
M8 x 1.25	3.2 (12.5/9) 23 (0.5/0.35)	3.5 (12/8) 26 (0.47/0.31)	-	3 (13.5/9.5) 22(0.53/.037)	3.5 (16.5/11) 26 (0.65/0.43)	3.8 (16.5/11) 28 (0.65/0.43)
M10 x 1.25	-	7.9 (18/12.5) 58 (0.70/0.50)	-	6.5 (18/12.5) 48 (0.70/0.50)	-	-
M10 x 1.5	6.5 (16/11) 48 (0.63/0.43)	7 (15.5/10.5) 52 (0.61/0.41)	-	6 (17/11.5) 44 (0.66/0.45)	7 (21/14) 52 (0.82/0.55)	7.8 (21/14.5) 57 (0.82/0.57)
M12 X 1.25	-	13.9 (23/15.5) 102 (0.90/0.61)	-	11.4 (23/15.5) 84 (0.90/0.61)	-	-
M12 X 1.75	11 (19.5/13.5) 81 (0.76/0.53)	12 (18.5/12.5) 88 (0.73/0.50)	-	10.1 (20.5/14) 74 (0.80/0.55)	12 (26/17.5) 88 (1.02/0.68)	13 (26/17.5) 96 (1.02/0.68)
M14 X 1.5	-	22 (26.25/18) 162 (1.04/0.70)	-	18 (26.5/18) 132 (1.04/0.70)	-	-
M14 X 2	18 (23/16) 133 (0.90/0.62)	19 (22/15) 140 (0.86/0.59)	-	16.2 (24/16.5) 119 (0.94/0.65)	19 (30/20) 140 (1.18/0.78)	21 (30/20) 155 (1.18/0.78)
M16 X 1.5	30 (30/20) 221(1.18/0.78)	33 (29/19.5) 243 (1.14/0.76)	25 (31/21) 184 (1.22/0.82)	27 (31/21) 199 (1.22/0.82)	33 (40/26.5) 243 (1.57/1.04)	36 (40/26.5) 265 (1.57/1.04)
M16 X 2	-	-	23 (28.5/19.5) 170 (1.12/0.76)	24.8 (28/19.5) 183 (1.10/0.76)	-	-
M18 X 1.5	45 (34/23) 332 (1.34/0.91)	48 (33.5/22) 354 (1.21/0.86)	36 (35.5/24) 265 (1.39/0.76)	39 (35.5/24) 288 (1.39/0.94)	48 (46/30.5) 354 (1.81/1.20)	52 (46.5/30.5) 383 (1.83/1.20)
M18 X 2.5	-	-	31 (30.5/21) 229 (1.20/0.82)	33.5 (30.5/21) 247 (1.20/0.82)	-	-
M20 X 1.5	60 (38/25.5) 412 (1.50/1.00)	65 (38/25) 479 (1.50/0.98)	50 (39.5/26.5) 369 (1.55/1.04)	-	65 (52.5/34.5) 479 (2.06/1.35)	70 (53/35) 516 (2.08/1.37)
M20 X 2.5	-	-	44 (35/44) 324 (1.37/1.73)	-	-	-
M22 X 1.5	80 (42/28) 590 (1.65/1.10)	90 (42.5/28) 664 (1.67/1.10)	66 (44/29.5) 487 (1.73/1.16)	-	90 (59/38.5) 664 (2.32/1.51)	95 (59.5/39) 700 (2.34/2.32)
M22 X 2.5	-	-	59 (39/26.5) 435 (1.53/1.04)	-	-	-
M24 X 2	100 (44/29.5) 737 (1.73/1.16)	110 (44.5/29.5) 811 (1.75/1.16)	83 (45.5/31) 612 (1.79/1.22)	-	110 (62/40.5) 811 (2.44/1.59)	120 (62/41) 885 (2.44/1.61)
M24 X 3	-	-	74 (41/28) 545 (1.61/1.10)	-	-	-
M27 X 2	100 (54/36) 737 (2.12/1.41)	-	-	-	100 (75/50) 811 (2.95/1.96)	-
M30 X 2	140 (61/40.5) 1032 (2.40/1.60	-	-	-	150 (85/56) 1106 (3.34/2.20)	-
M33 X 2	190 (68/45) 1401 (2.67/1.77	-	-	-	200 (95/63) 1475 (3.74/2.48)	-
M36 X 3	240 (71/47) 1770 (2.80/1.85	-	-	-	250 (97/65) 1844 (3.81/2.55)	-

(*/-) Minimum thread length in mm, specified for cast iron with 255 N/mm^2 tensile strength- (/**)Minimum thread length in mm, specificed for steel with 510 N/^{2} tensile strength - (°/)Minimum tread length in inches, specified for cast iron with 37,000 psi tensile strength- (/°^{8})Minimum tread length in inches, specified for steel with 74,000 psi tensile strength.

NUTS TORQUE CHART - Unit of measure daNm (lbs ft)

Diameter and width of thread	Strength class: 10 (RBO)					Strength class 12 (R100)
				with polyamide ring		
mm	standard ZNT	standard CDT	jam type	standard	jam type	standard FOSF
M6 x 1	1.3 (96)	-	-	-	-	1.4 (10)
M8 x 1.25	3.2 (23)	-	*2.6 (19)	*3.9 (19)	*3.2 (23)	3.5 (26)
M10 x 1.25	-	-	*5.2 (38)	*8.2 (60)	*6.2 (48)	-
M10 x 1.5	6.5 (48)	7.2 (53)	*5 (37)	*7.7 (57)	*6 (44)	7 (52)
M12 X 1.25	-	13 (96)	*8.7 (64)	*14.5 (107)	*10.2 (75)	-
M12 X 1.75	11 (81)	-	*8.1 (60)	*12.9 (95)	*9.6 (71)	12 (88)
M14 X 1.5	-	19.5 (144)	*13 (96)	*21.6 (159)	*15 (110)	-
M14 X 2	18 (133)	-	*12.5 (92)	*20 (147)	*14.6 (107)	19 (140)
M16 X 1.5	30 (221)	23.5 (173)	°13 (96)	°26.8 (198)	°16 (118)	30 (221)
M16 X 2	-	23 (170)	°12.5 (92)	°26.5 (195)	°16 (118)	-
M18 X 1.5	45 (332)	34.5 (254)	°19 (140)	°39 (236)	°23.5 (173)	45 (332)
M18 X 2.5	-	32 (236)	°17.5 (129)	°36.5 (269)	°22 (162)	-
M20 X 1.5	60 (442)	46 (339)	°23.5 (173)	°51.7 (381)	°29 (214)	60 (442)
M20 X 2.5	-	44.5 (328)	°21.5 (158)	°50 (369)	°27 (199)	-
M22 X 1.5	80(590)	62 (457)	°32 (236)	-	-	80 (590)
M22 X 2.5	-	61 (450)	°29.5 (217)	-	-	-
M24 X 2	100 (737)	78 (575)	°37 (273)	°85.8 (633)	°45 (332)	100 (737)
M24 X 3	-	76 (560)	°33 (243)	°84 (619)	°41 (302)	-
M27 X 2	95 (700)	-	-	-	-	95 (700)
M30 X 2	130 (959)	-	-	-	-	130 (959)
M33 X 2	170 (1254)	-	-	-	-	160 (1180)
M36 X 3	220 (1622)	-	-	-	-	220 (1622)

*ZNT (Zinc plated) °CDT(Cadmium plated)

CAPSCREW AND TORQUE VALUES

Capscrew Head Markings	SAE Grade Number	Capscrew Size									
Manufacturer's marks may vary		1/4	5/16	3/8	7/16	1/2	9/16	5/8	3/4	7/8	1
		Threads per inch									
		20	18	16	14	13	12	11	10	9	8
		28	24	24	20	20	18	18	16	14	14
	1 or 2	Torque Ft-Lb									
		5	11	18	28	39	51	83	105	160	235
		6	13	20	30	41	55	95	115	175	250
	5	8	17	31	49	75	110	150	270	395	590
		10	19	35	55	85	120	170	295	435	660
	6 or 7	10	19	34	55	85	120	167	280	440	660
		12	21	38	61	95	130	187	300	480	730
 	8	12	24	44	70	105	155	210	375	605	910
		14	27	49	78	120	170	240	420	675	990

Notes:

1. Always use the torque values listed above when specific torque values are not available.
2. Do not use above values in place of those specified in other sections of this manual; special attention should be observed.
3. The above is based on use of clean, dry threads.
4. Reduce torque by 10% when engine oil is used as a lubricant.
5. Reduce torque by 20% if new plated capscrews are used.
6. Capscrews threaded into aluminum may require reductions in torque of 30% of more of Grade 5 capscrews torque and must attain two capscrew diameters of thread engagement.

CAUTION:
If replacement capscrews are of a higher grade than originally supplied, adhere to torque specifications for that replacement.

SECTION 1
ENGINE RELATED COMPONENTS

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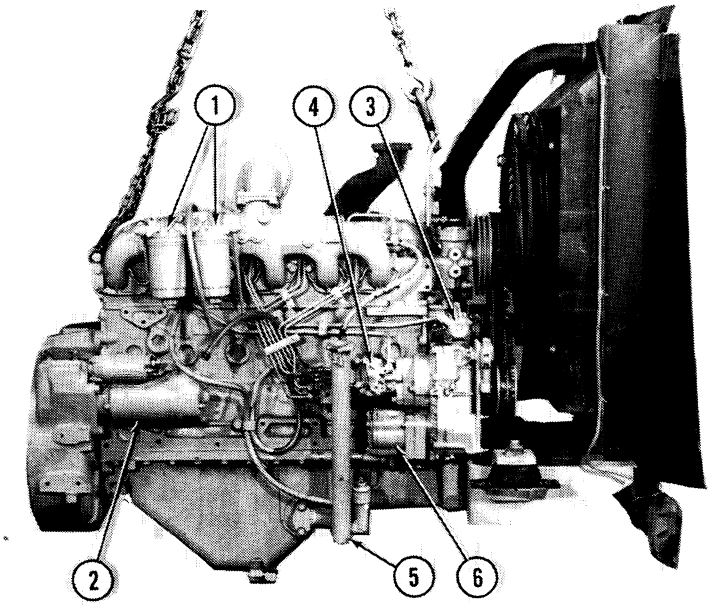
Revised January 1991

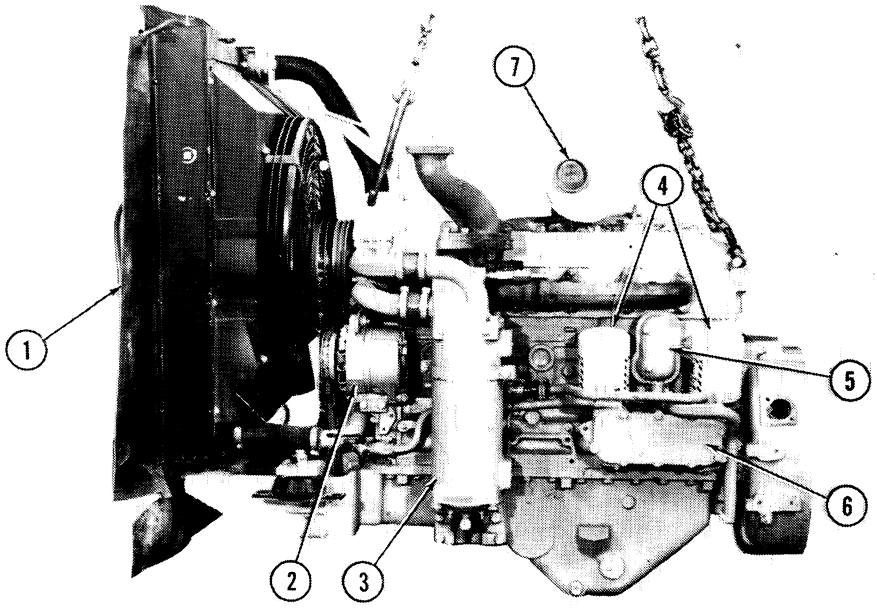
GENERAL DESCRIPTION

The FR10B is powered by a Fiat 8065.05.290 direct injected, four stroke, six cylinder diesel engine. The naturally aspirated engine drives the torque converter as well as the implement, steering and transmission pumps off the rear of the torque converter housing. The brake pump is driven from a pad beneath the fuel pump.



ENGINE LEFT SIDE T-89069

1. *Fuel filters*
2. *Starter*
3. *Fuel transfer pump*
4. *Fuel pump*
5. *Oil filler tube*
6. *Brake pump*



ENGINE RIGHT SIDE T-89068

1. *Radiator*
2. *Alternator*
3. *Transmission oil heat exchanger*
4. *Engine oil filters*
5. *Engine breather*
6. *Engine oil heat exchanger*
7. *Air intake silencer*

SYMPTOM	PROBABLE CAUSE	TOOLS REQUIRED	TEST	SOLUTION
Overheating of lubricating oil	Insufficient oil in crankcase		Check dipstick	Fill crankcase to proper level
	Improper lubricant	Operator's manual	Compare oil specifications in the manual with those of oil supplier	Fill crankcase with specified lubricant
	Engine oil cooler clogged	Engine diagnostic kit	Install the low temperature probes on the engine oil heat exchanger inlet and outlet. Run engine Performance test. Check temperature drop across exchanger	Check or replace the oil cooler
Excessive oil consumption	External oil leakage (gaskets, etc)		Visual	Correct all external leaks
	Engine oil seals worn or damaged		Teardown	Replace oil seals
	Lubricating oil too light	Operator's manual	Compare specifications to those of the oil	Fill crankcase with specified lubricant
	Pistons, rings, and/or cylinder sleeves worn	Engine diagnostic kit	Run engine performance test. Observe blue smoke	Replace affected parts
	Oil control rings stuck in piston ring grooves	Engine diagnostic kit	Run engine performance test. Observe blue smoke	Clean ring grooves and replace rings
	Valve guides worn	Engine diagnostic kit	Run engine performance test. Observe blue smoke	Replace valve guides. Check related parts
Excessive oil consumption during first 250 hours of operation and no improvement	Rings not sealed properly	Operator's manual	Compare specifications and break-in procedure	Allow more time for *"break in"*. Make certain specified lube oil is used and engine is operating at proper temperature
	Engine oil viscosity too light	Operator's manual	Compare specifications	Use recommended viscosity
Rapid wear on engine parts	Lubricating oil contaminated		Oil analysis	Fill system with clean engine oil. Replace engine oil filters
	Improper engine lubricating oil	Operator's manual	Compare specifications	Fill system with specified engine lubricating oil

SYMPTOM	PROBABLE CAUSE	TOOLS REQUIRED	TEST	SOLUTION
LUBRICATING SYSTEM				
No lubricating oil pressure	Insufficient oil in crankcase		Pull dipstick	Fill crankcase to proper level
	Oil pressure gauge inoperative	Second pressure gauge	Install second gauge in place of original. Note if operating pressure is OK	Replace gauge
	Lubricating oil pump screen clogged		Visual with engine sump removed	Remove and clean the screen
	Lubricating oil pump inoperative		Visual with engine sump removed	Repair or replace oil pump
	Oil line loose or broken inside crankcase		Visual with engine sump removed	Repair or replace affected parts
Low lubricating oil pressure with proper oil level in crankcase	Oil pressure gauge inaccurate	Second pressure gauge	Install second gauge in place of original. Note if operating pressure is OK	Replace if necessary
	Oil pressure relief valve or regulator valve stuck in the open position		Observation after teardown of valve	Clean, repair, or replace affected parts
	Oil line in crankcase loose or broken		Visual with engine sump removed	Repair or replace affected parts
	Improper lubricant	Operator's manual	Compare oil specifications with factory specifications	Fill crankcase with specified lubricant
	Main and/or connecting rod bearings worn	Micrometer	Engine teardown and measurement	Replace bearings
	Camshaft bearings worn	Micrometer	Engine teardown and measurement	Replace bearings
	Lubricating oil pump worn		Visual with engine sump and pump removed	Repair or replace oil pump
Excessive lubricating oil pressure	Pressure gauge inaccurate	Pressure gauge	Install second gauge and run engine test	Replace if necessary
	Oil pressure regulating valve improperly adjusted	Pressure gauge	Install second gauge and run engine test	Adjust valve to obtain proper pressure
	Improper lubricant	Operator's manual	Compare oil specifications in the manual with those of oil supplier	Fill crankcase with specified lubricant

SYMPTOM	PROBABLE CAUSE	TOOLS REQUIRED	TEST	SOLUTION
Engine operating temperature too high with ample coolant in system (Continued)	Loose or broken fan drive belts	Belt tension gauge	Compress belt and compare with specification	Adjust or replace fan drive belts
	Lime deposits in water passages of radiator, cylinder heads and/or cylinder block		Visual	Thoroughly clean affected parts
	Water passages in oil cooler restricted	Engine diagnostic kit	Run engine performance test with temperature probes connected to the cooler. Compare results	Remove and clean oil cooler core
	Water pump inoperative		Leaks around front seal or excessive pulley play	Repair or replace water pump
	Engine pulling excessive load		Observe load size	Reduce load
	Engine speed set too high	Engine diagnostic kit	Run engine performance test and compare results	Adjust speed to within specified rpm limits
Engine operating temperature too high due to loss of coolant	External leaks		Visual	Repair affected parts
	Ruptured oil cooler core (oil in coolant)		Pull oil sample and check for coolant in oil	Replace oil cooler core
	Engine cylinder head gaskets leaking		Visual	Replace gaskets and/or retorque head bolts
	Cylinder head cracked		Antifreeze in oil	Replace cylinder head
	Cylinder block cracked		Antifreeze in oil	Replace cylinder block
Engine operating temperature too low	Thermostat stuck in the open position		Pull thermostat and check if open all the time	Replace thermostat
	Operating in extremely cold weather		Observe ambient temperature	Provide necessary cold weather protection

SYMPTOM	PROBABLE CAUSE	TOOLS REQUIRED	TEST	SOLUTION
AIR INTAKE SYSTEM				
Insufficient air supply to cylinders	Air cleaner clogged	Engine diagnostic kit	Run engine performance test and compare results	Replace air filter element
Insufficient air supply to cylinders (engines with turbocharger)	Foreign material lodged in turbocharger impeller or turbine		Visual	Disassemble and clean
	Excessive dirt buildup in compressor in short period of time		Visual	Thoroughly clean compressor assembly
	Leaks in engine intake and/or exhaust manifold reducing turbocharger efficiency	Pressure gauge, air pump and hose and soap solution	Run test by pressurizing air cleaner. Apply soap solution over joints and check for soap bubbles.	Tighten loose manifold retaining nuts or capscrews. Replace manifold gaskets
	Turbocharger rotating assembly bearing seized		Visual, spin turbocharger by hand	Overhaul turbocharger
Rapid wear on parts	Dirt admitted with intake air	Pressure gauge, air pump and hose and soap solution	Run test by pressurizing air cleaner. Apply soap solution over joints and check for soap bubbles	Inspect air cleaner assembly and related parts thoroughly for cracks or openings which would allow air to enter engine without passing through air cleaner element. Make necessary repairs
	Dirty lubricating oil		Visual	Change engine oil and oil filter elements at recommended intervals
	Improper fuel	Operator's manual	Check the fuel specification with supplier specifications	Use the proper fuel
COOLING SYSTEM				
Engine operating temperature too high with ample coolant in system	Temperature gauge inoperative	Test gauge	Install gauge and compare results after machine warms up	Replace if necessary
	Radiator air passages restricted	Engine diagnostic kit	Run engine performance test and compare results	Clean exterior of radiator
	Thermostat inoperative	Remove thermostat and check operating temperature		If thermostat does not open, replace thermostat

SYMPTOM	PROBABLE CAUSE	TOOLS REQUIRED	TEST	SOLUTION
Starter will not crank engine(Continued)	Starter brush springs weak			Check spring tension and replace if necessary
	Starter commutator dirty or worn			Polish and/or machine commutator and under-cut mica if necessary
	Starter armature shaft bushings worn (armature drags on fields)			Replace worn bushings and related parts
	Starter armature burned out			Replace armature
Starter pinion will not engage with flywheel ring gear	Grease or dirt in starter drive mechanism			Disassemble and clean the drive assembly
	Broken or excessively worn parts			Replace broken or worn parts
FUEL SYSTEM				
Insufficient fuel supply to fuel injection nozzles	No fuel in fuel tank		Observe dipstick reading	Fill fuel tank with specified fuel. Vent fuel system
	Inoperative fuel transfer pump	Vacuum gauge	Install gauge between tank and pump and run engine tests	If vacuum is below specification, repair or replace transfer pump
	Fuel injection nozzle valve binding in valve body	Nozzle tester	Pop nozzles for pressure, pattern and sound	Replace valve assembly in nozzle holder body
	Fuel lines, filter, sediment bowl clogged	Engine diagnostic kit	Visual, run engine performance test and compare results	Clean fuel system components. Replace fuel filter
	Fuel injection pump malfunctioning	Engine diagnostic kit	Run engine performance test and compare results	Repair or replace fuel injection pump
	Fuel injection nozzles improperly adjusted	Nozzle tester	Pop nozzles for pressure, pattern and sound	Adjust fuel injection nozzles
Air in fuel system	Loose fuel line fitting or leak in fuel line on suction side of fuel transfer pump		Visual	Tighten loose fittings or replace damaged fuel lines
	Damaged gasket on fuel filter		Visual	Replace gasket

SYMPTOM	PROBABLE CAUSE	TOOLS REQUIRED	TEST	SOLUTION
Engine emits black smoke from exhaust	Air system clogged	Engine diagnostic kit	Run test and compare results	Check engine air intake system
	Fuel injection pump not properly timed or worn	Timing light	Check engine timing	Retime or repair fuel injection pump
	Improper fuel	Operator's manual	Check fuel specifications with supplier	Drain fuel system and refill with specified fuel
	Lack of good fuel injection spray pattern	Nozzle tester	Check nozzle popping pressure, pattern and sound	Clean and adjust nozzles
Engine emits bluish-white smoke from exhaust	Engine operating temperature too low	Engine diagnostic kit	Run diagnostic test	Check thermostat
	Clogged fuel injection nozzles	Nozzle tester	Check nozzle popping pressure, pattern and sound	Clean and adjust nozzles
	Low compression	Compression tester	Run compression test	If low, make necessary repairs
	Early fuel injection pump timing	Timing light	Time fuel pump to engine	Test and adjust pump timing
Engine detonates or knocks	Fuel pump improperly timed	Timing light	Time fuel pump to engine	Time fuel pump
	Loose bearings		Oil analysis	Replace bearings
	Loose piston		Oil analysis	Inspect piston assembly and replace defective parts
	Loose flywheel			Check tightness of flywheel bolts. Tighten or replace parts as required
	Improperly adjusted valve(s)			Check and adjust valves
	Foreign material in cylinder(s)			Make necessary repairs
STARTING SYSTEM				
Starter will not crank engine	Batteries weak	Hydrometer	Test specific gravity	Check batteries
	Cables or connections loose or corroded		Visual	Clean corrosion from all terminals and tighten all loose connections
	Starter switch inoperative	Volt-Ohm meter	Test starter switch for voltage across contact when in starter position	If no voltage, replace switch
	Starter brushes worn or not contacting properly			Install new brushes or fit brushes to contour of commutator

SYMPTOM	PROBABLE CAUSE	TOOLS REQUIRED	TEST	SOLUTION
Engine shows loss of power(continued)	Fuel injection pump improperly timed	Timing light	Flow time the pump to the engine	Time the fuel injection pump
	Inoperative fuel injection pump or fuel injection nozzles	Engine diagnostic kit	Run engine diagnostic test	Repair or replace defective parts
	Cylinder *"cutting"* out		Locate *"missing"* cylinder as follows: Run engine at low idle speed and cut out each injection nozzle in turn by loosening the fuel injection line nut attaching the line to the fuel pump	A decrease in engine speed indicates the nozzle for that cylinder is functioning properly. If engine speed does not decrease, nozzle is malfunctioning and must be replaced
	Loss of compression	Compression tester	Compression test	May be due to leaking valve or worn piston rings or cylinder sleeves. Repair or replace defective parts
Engine runs unevenly and vibrates excessively	Governor not operating properly		Check pump and throttle linkage	If tight or loose, adjust governor and linkage
	Fuel supply erratic or insufficient	Engine diagnostic kit	Run diagnostic test	If fuel system fault, check fuel system
	Engine operating temperature too low	Engine diagnostic kit	Run diagnostic test	If cooling system fault, check thermostat
	Fuel injection pump malfunctions	Engine diagnostic kit	Run diagnostic test	Check fuel injection pump
	Valves in bad condition			Recondition or replace valve
	Cylinder *"cutting"* out		Locate *"missing"* cylinder as follows: Run engine at low idle speed and cut out each injection nozzle in turn by loosening the fuel injection line nut attaching the line to the fuel pump	A decrease in engine speed indicates the nozzle for that cylinder is functioning properly. If engine speed does not decrease, nozzle is malfunctioning and must be replaced
	Fuel injection nozzle malfunction	Nozzle tester	Check nozzle popping pressure, pattern and sound	Repair or replace nozzle

SYMPTOM	PROBABLE CAUSE	TOOLS REQUIRED	TEST	SOLUTION
Engine Overheats	External leak in cooling system		Visual	Correct all leaks and fill cooling system
	Radiator core clogged	Engine diagnostic kit	Install the low temperature probes at the top and bottom of the radiator. Run engine and check temperature differences	Clean and flush radiator
	Radiator air passages clogged	Flashlight	Visual check	Remove debris from radiator core
	Fan drive belts too loose	Belt tension gauge		Adjust fan drive belts to proper tension
	Thermostat inoperative		Remove thermostat and check opening temperature	Replace thermostat
	Engine oil cooler clogged	Engine diagnostic kit	Install the low temperature probes at the top and bottom of the radiator. Run engine and check temperature differences	Clean or replace the oil cooler core
	Improper engine lubrication	Pressure gauge	Install pressure gauge in instrument panel pressure gauge port	If pressure is low and oil level good, remove the pan and check pump
	Water pump malfunctioning		Check for leaks at pump or pulley drive loose	Repair or replace water pump
	Fuel injection pump improperly timed	Timing light	Flow time the pump to the engine	Time fuel injection pump
Engine shows loss of power	Insufficient air supply to cylinders	Engine diagnostic kit	Run engine diagnostic test	Clean air system
	Insufficient supply of fuel to fuel injection nozzles	Engine diagnostic kit	Run engine diagnostic test	If test shows fuel problem, check fuel system
	Governor not operating properly	Engine diagnostic kit	Run engine diagnostic test	If test shows fuel problem, inspect and adjust governor
	Air in fuel system. Observe fuel sediment bowl for aeration if bowl is on engine or pump			Vent fuel system. Check for leaks on suction side of fuel transfer pump
	Clogged fuel filter	Engine diagnostic kit	Run engine diagnostic test	Change filter element
	Improper valve lash			Adjust valve lash

SYMPTOM	PROBABLE CAUSE	TOOLS REQUIRED	TEST	SOLUTION
Engine hard to start	Batteries weak	Hydrometer	Check specific gravity	Recharge or replace batteries
	Insufficient fuel in tank		Check dipstick	If low, fill with specified fuel
	Incorrect grade of fuel	Operator's manual	Contact fuel supplier for fuel data and compare with machine specifications	Drain fuel system. Fill tank with specified fuel
	Clogged filter or sediment bowl		Inspect sediment bowl	Replace filter or clean sediment bowl
	Fuel injection nozzles not operating properly	Nozzle tester	Pop the nozzles for pattern, pressure and sound	Repair or replace nozzles
	Fuel transfer pump not operating properly	In line pressure gauge	Check pump pressure	Repair or replace fuel transfer pump
	Air in fuel system		Bleed the air from the primary fuel system	Correct leaks in suction side of fuel system. Vent fuel system
	Insufficient air supply to cylinders		Check air restriction indicator for too high restriction	Clean air system
	Fuel injection pump improperly timed	Timing light	Flow time the pump to the engine	Time fuel injection pump
	Valve lash incorrect			Correct valve lash
	Piston rings or cylinder liners worn	Compression test equipment	Compression test	If compression is low teardown and replace defective parts
	Valves warped or pitted			If compression is low recondition or replace valves and/or valve guides
Engine stops frequently	Idling speed too low	Tachometer	Check RPM at low idle	Adjust low idling speed
	Restricted fuel supply	Engine diagnostic kit	Run engine performance test	Check fuel system lines and filters
Engine stops suddenly	Out of fuel		Check dipstick	Fill fuel tank with specified fuel and vent the fuel system
	Restricted fuel supply	Engine diagnostic kit	Run engine performance test	Check fuel system lines and filters
	Broken or loose fuel lines		Visual	Correct or replace defective parts
	Fuel transfer pump or fuel injection pump inoperative	Pressure gauge	Install pressure gauge in transfer pump to filter line and check pressure while engine is running	If low, repair or replace defective parts

SYMPTOM	PROBABLE CAUSE	TOOLS REQUIRED	TEST	SOLUTION
ENGINE				
Engine will not turn	Batteries weak	Hydometer	Check specific gravity	Recharge or replace batteries
	Starter switch inoperative	Volt-Ohm meter	Check voltage at switch	If bad replace defective switch
	Starter inoperative	Volt-Ohm meter	Check voltage at starter	Replace if voltage is present and starter does not turn over
	Engine locked or seized	Barring mechanism	Rotate the engine by hand. If it does not rotate, remove head and inspect for cause	Due to extended idle, storage periods, or improper preparation of engine for storage, parts may be rusted or corroded and seized Broken piston rings, gears, etc., may also cause locking. Repair or replace defective parts
	Hydro-static lock		Rotate the engine by hand opposite of crankshaft rotation. Check degree of movement. Remove head and inspect where liquid is coming from	Rain water entering uncovered exhaust pipe, leaking head. Repair or replace defective parts
Engine will not start	Slow cranking speed	Hydrometer	Check battery specific gravity	Specific gravity of batteries too low. Charge batteries
			Check starter torque	Starter not delivering maximum torque. Repair or replace defective parts
				Use cold weather start aids if applicable
	Engine controls out of adjustment		Check linkage adjustment	Correct all engine control linkage adjustment
	Insufficient supply of fuel to fuel injection nozzles		Remove fuel nozzle and check fuel volume during cranking	Check fuel system and clean sediment bowl
	Fuel injection nozzles not operating properly	Nozzle tester	Pop the nozzles for pressure, pattern and sound	Repair or replace defective parts
	Fuel injection pump improperly timed	Timing light	Flow time the pump to the engine	Time fuel injection pump