3IRH2N, 3IRH8N, 4IRH8N & 4IRI8N ENGINES

CONTENTS

The INGERSOLL–RAND industrial diesel engines are a product of long years of experience, advanced technology, and up–to date production facilities. INGERSOLL–RAND takes great pride in the superior durability and operating economy of these engines.

In order to get the fullest use and benefit from your engine, it is important that you operate and maintain it correctly. This Manual is designed to help you do this.

Please read this Manual carefully and follow its operating and maintenance recommendations. This will ensure many years of trouble–free and economical engine operation.

Should your engine require servicing, please contact your nearest INGERSOLL–RAND branch or distributor.

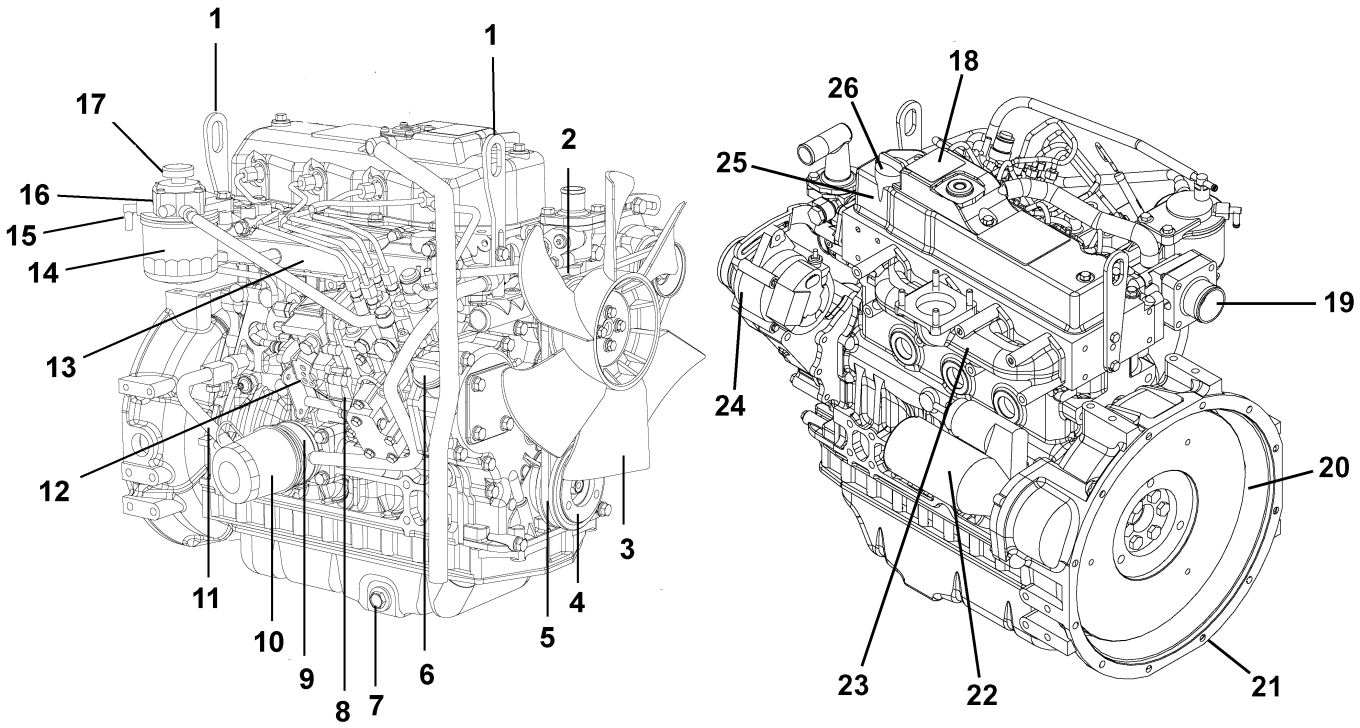
All information, illustrations, and specifications contained in this Manual are based on the latest product information available at the time of publication.

INGERSOLL–RAND reserves the right to make changes in this Manual at any time without prior notice.

This manual covers both 3 and 4 cylinder naturally aspirated engines.

The pictures contained within are for guidance only and might not reflect the physical characteristics of each individual engine covered.

DIESEL ENGINE Engine External View – Model



1. Lifting eye
2. Cooling water pump
3. Cooling fan
4. Crank shaft V–pulley
5. V–belt
6. Filler port (engine oil)
7. Drain plug (engine oil)
8. Fuel injection pump
9. Engine oil cooler **(4IRH8N)**
10. Engine oil filter
11. Dipstick (engine oil)
12. Governor lever
13. Intake manifold
14. Fuel filter
15. Fuel oil inlet
16. Fuel filter mounting with fuel priming pump
17. Fuel priming pump
18. Engine name plate
19. Air intake port
20. Flywheel
21. Flywheel housing 3IRH8N, 4IRH8N & 4IRI8N
22. Starter motor
23. Exhaust manifold
24. Alternator
25. Rocker arm cover
26. Filler port (engine oil)

EPA CERTIFIED ENGINE DATA and SPECIFICATIONS

Model: 3IRH2N

Engine model name		3IRH2N
Engine type		Vertical inline water cooled diesel engine
Combustion type		Direct injection
No. of cylinders – bore x stroke. mm		3–82x84
Engine displacement L		1.331
Compression ratio		19.2:1
Firing order		1 – 3 – 2
Exhaust emission control system		Fuel injection nozzles, fuel injector pump
Governor		Mechanical type
Injection nozzles		Hole type
Specified fuel		Diesel fuel (ISO 8217 DMA, BS2869 A1/A2)
Starter (V–kW)		12–1.2
Alternator (V–A)		12–40
Specified engine oil (API grade) (SAE grade)		(CD,CF) (10W–30 or 15W–40)
Coolant volume (Engine only) L		1.8
Engine dry weight kg		128
	Overall length mm	528
Engine dimensions	Overall width mm	489
	Overall height mm	565
Valve clearance (cold) mm		0.2 ± 0.05
Nozzle injection pressure MPa		21.6
Injection timing B.T.D.C. at 2.5mm cam lift		18 ±1

ENGINE IDENTIFICATION

Serial No Location

The engine serial number is stamped on engine name plate on top of rocker cover. See illustration on page 68

Confirmation of Engine Number

It is advisable to quote the engine serial number together with the machine serial number, as it is required when you contact the Ingersoll–Rand branch or distributor for repair, service or parts ordering.

CAUTION: Conduct confirmation of engine serial number with the engine stopped. To avoid being injured, do not check it, while the engine is still hot.

INGERSOLL–RAND ENGINE AFTER SERVICE

Please feel free to contact your Ingersoll–Rand dealer for periodical inspection and maintenance.

Ingersoll–Rand Genuine Parts

Genuine Ingersoll–Rand parts are identical with those used in the engine production, and accordingly, they are warranted by Ingersoll–Rand.

Genuine Ingersoll–Rand parts are supplied by your Ingersoll–Rand branch or distributor.

Please ensure that only genuine Ingersoll–Rand parts, lubricants and fluids are used for service and/or repair.

EPA CERTIFIED ENGINE DATA and SPECIFICATIONS

Model: 3IRH8N

Engine model name		3IRH8N
Engine type		Vertical inline water cooled diesel engine
Combustion type		Direct injection
No. of cylinders – bore x stroke. mm		3–88x90
Engine displacement L		1.642
Compression ratio		19.1:1
Firing order		1 – 3 – 2
Exhaust emission control system		Fuel injection nozzles, fuel injector pump
Governor		Mechanical type
Injection nozzles		Hole type
Specified fuel		Diesel fuel (ISO 8217 DMA, BS2869 A1/A2)
Starter (V–kW)		12–1.2
Alternator (V–A)		12–40
Specified engine oil (API grade) (SAE grade)		(CD,CF) (10W–30 or 15W–40)
Coolant volume (Engine only) L		2.0
Engine dry weight kg		155
	Overall length mm	564
Engine dimensions	Overall width mm	486
	Overall height mm	622
Valve clearance (cold) mm		0.2 ± 0.05
Nozzle injection pressure MPa		21.6
Injection timing B.T.D.C. at 2.5mm cam lift		18 ±1

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EPA CERTIFIED ENGINE DATA and SPECIFICATIONS

Model: 4IRH8N

Engine model name		4IRH8N
Engine type		Vertical inline water cooled diesel engine
Combustion type		Direct injection
No. of cylinders – bore x stroke. mm		88x90
Engine displacement L		2.19
Compression ratio		19:1
Firing order		1 – 3 – 4 – 2
Exhaust emission control system		Fuel injection nozzles, fuel injector pump
Governor		Mechanical type
Injection nozzles		Hole type
Specified fuel		Diesel fuel (ISO 8217 DMA, BS2869 A1/A2)
Starter (V–kW)		12–1.4
Alternator (V–A)		12–40
Specified engine oil (API grade) (SAE grade)		(CD,CF) (10W–30 or 15W–40)
Coolant volume (Engine only) L		2.7
Engine dry weight kg		170
	Overall length mm	658
Engine dimensions	Overall width mm	498.5
	Overall height mm	618
Valve clearance (cold) mm		0.2 ± 0.05
Nozzle injection pressure MPa		21.6
Injection timing B.T.D.C. at 2.5mm cam lift		19.5 ±1

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EPA CERTIFIED ENGINE DATA and SPECIFICATIONS

Model: 4IRI8N

Engine model name		4IRI8N
Engine type		Vertical inline water cooled diesel engine
Combustion type		Direct injection
No. of cylinders – bore x stroke. mm		4–98x110
Engine displacement L		3.319
Compression ratio		18.1:1
Firing order		1 – 3 – 4 – 2
Exhaust emission control system		Fuel injection nozzles, fuel injector pump
Governor		Mechanical type
Injection nozzles		Hole type
Specified fuel		Diesel fuel (ISO 8217 DMA, BS2869 A1/A2)
Starter (V–kW)		12–2.3
Alternator (V–A)		12–40
Specified engine oil (API grade) (SAE grade)		(CD,CF) (10W–30 or 15W–40)
Coolant volume (Engine only) L		4.2
Engine dry weight kg		220
	Overall length mm	719
Engine dimensions	Overall width mm	508
	Overall height mm	717
Valve clearance (cold) mm		0.2 ± 0.05
Nozzle injection pressure MPa		21.6
Injection timing B.T.D.C. at 2.5mm cam lift		15.3 ° ± 1

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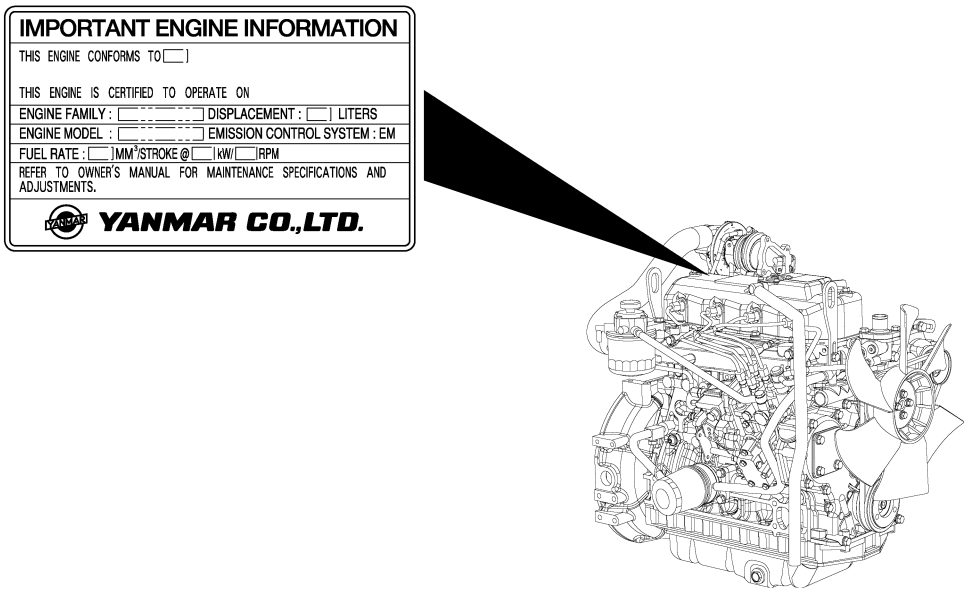
ENGINE LABEL (FOR EPA)

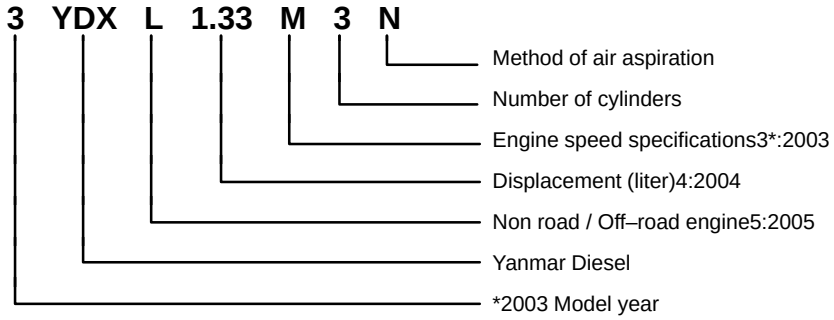
Emission control label is attached on the “top of rocker arm cover.”

The location of emission control label attached on the engine may vary depending on the engine specification

The following is the sample of a label required for engine emission control information, along with location.



* Engine family name as assigned by EPA and ARB identifying engine family group 3YDXL1.33M3N and this identifies

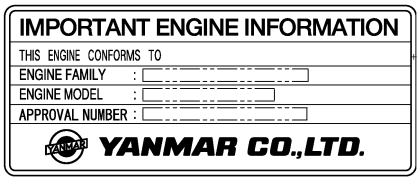


4IRL5N

EC EMISSION CONTROL LABEL: ENGINE LABEL

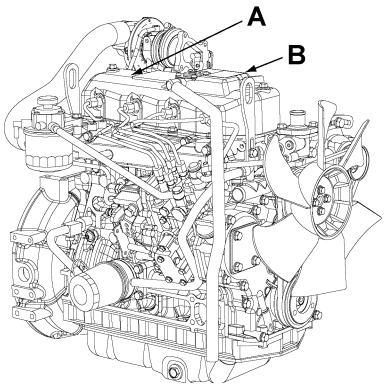
Emission control label is attached on the “top of the rocker arm cover”

The following is the detail of a label required for engine emission control information, along with location.



(97/68/EC Directive label)

Label location:



A. Emission control information label (4IRH8N, 4IRI8N)

B. Emission control information label (On rocker arm cover exhaust side) (3IRH2N, 3IRH8N)

FUEL

Fuel Selection

The following properties are required of the diesel fuel.

Must be free from minute dust particles.

Must have adequate viscosity.

Must have high cetane value.

Must have high cetane value., (45 or greater)

Must have high fluidity at low temperature.

Must have low sulphur content.

Must have little residual carbon.

It is strongly advisable to use ASTM D975 No. 2D (the general automotive diesel engine purpose fuel oil) or equivalent which fully meets the above requirements.

Applicable Standard	Recommendation
JIS (Japanese Industrial Standard)	K22O4 – 2
DIN (DEUTSCHE INDUSTRIE NORMEN)	DIN 51601
SAE (Society of Automotive Engineers) Based on SAE–J–313C	NO. 2–D
BS (BRITISH STANDARD) Based on BS/2869–1970	Class A–1 or A–2
ISO 8217	DMA

FUEL REQUIREMENTS

Notice: the fuel injection pump, injector or other parts of the fuel system and engine can be damaged if you use any fuel or fuel additive other than those specifically recommended by Ingersoll–Rand.

NOTE: *If any fuel other than the one specified is used, engine operation will be impaired. Engine failure or malfunction resulting from use of such improper fuel will not be warranted by Ingersoll–Rand.*

To help avoid fuel system or engine damage, please read the following:

Do not use diesel fuel which has been contaminated with engine oil. Besides causing engine damage, such fuel can also affect emission control. Before using any diesel fuel, check with the fuel supplier to see if the fuel has been mixed with engine oil.

Your engine is designed to use either Number 1–D or Number 2–D diesel fuel. However, for better fuel economy, use Number 2–D diesel fuel whenever possible. At temperatures less than –7 ~~C~~ (20 ~~F~~), Number 2–D fuel may pose operating problems (see “Cold Weather Operation” which follows). At colder temperatures, use Number 1–D fuel (if available) or use a “winterized” Number 2–D (a blend of Number 1–D and Number 2–D). This blended fuel is usually called Number 2–D also, but can be used in colder temperatures than Number 2–D fuel which has not been “winterized.”

Check with the fuel supplier to be sure you get the properly blended fuel.

NOTICE: Do not use home heating oil or gasoline in your diesel engine; either may cause engine damage.

Handling of the Fuel.

Any fuel containing dust particles or water might cause engine failure .

Therefore, the following must be observed.

Take care to protect the fuel from ingress of dust particles or water when filling the fuel tank.

If refueling is done from an oil drum directly, ensure that it has been kept stationary to allow any dust, sediment or water to settle at the bottom. Do not draw fuel direct from the bottom of the drum to prevent pickup of any settled foreign material.

Always fully fill the fuel tank. Drain the sedimented particles in the fuel tank frequently.

Water in Fuel

During refueling, it is possible for water (and other contaminants) to be pumped into your fuel tank along with the diesel fuel. This can happen if a fuel provider does not regularly inspect and clean its fuel tanks, or receives contaminated fuel from its supplier(s). To protect your engine from contaminated fuel, there is a fuel filter system on the engine which allows you to drain excess water.

CAUTION: The water/diesel fuel mixture is flammable, and could be hot. To avoid personal injury and/or property damage, do not touch the fuel coming from the drain valve, and do not expose the fuel to open flames or sparks.

Be sure you do not overfill the fuel tank. Heat (such as from the engine) can cause the fuel to expand. If the tank is too full, fuel could be forced out. This could lead to a fire and the risk of personal injury and/or equipment damage.

Biocides

In warm or humid weather, fungus and/or bacteria may form in diesel fuel if there is water in the fuel.

NOTICE: *Fungus or bacteria can cause fuel system damage by plugging the fuel lines, fuel filters or injector. They can also cause fuel system corrosion.*

If fungus or bacteria has caused fuel system problems, you should have your authorized dealer correct these problems. Then, use a diesel fuel biocide to sterilize the fuel system (follow the biocide manufacturer‘s instructions). Biocides are available from your dealer, service stations, parts stores and other automotive places. See your authorized dealer for advice on using biocides in your area and for recommendations on which biocides you should use.

Smoke Suppressants

The use of a smoke suppressant additive is not allowed because of the greater possibility of stuck rings and valve failure, resulting from excessive ash deposits.

LUBRICANT.

The quality of engine oil can affect engine performance, startability and engine life.

Use of unsuitable engine oil will result in piston ring, piston and cylinder seizure and accelerate surface wear causing increased oil consumption, lowered output and, finally engine failure. To avoid this, use the specified engine oil.

1) Engine Oil Selection

Pro Tec ™

2) Oil Viscosity

Engine oil viscosity affects engine startability, performance, oil consumption, wear and the potential for seizure, etc. Always ensure that lubricants with the correct viscosity for the operating temperature are used. Refer to fig 12.

NOTE

Using a mixture of different brands or quality of oils will adversely affect the original oil quality; therefore, never mix different brand or different type oils.

Do not use API, CA, CB grade and reconstituted engine oil

Engine damage due to improper maintenance, or using oil of the improper quality and/or viscosity, is not covered by the warranty.

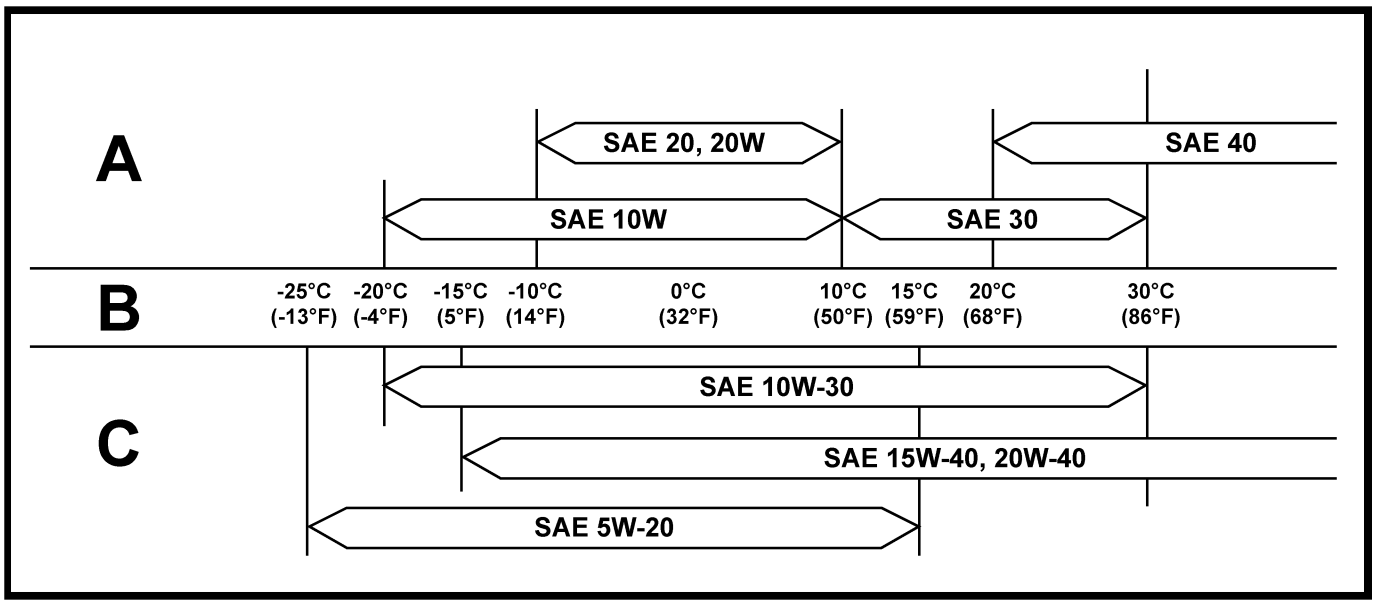


Fig. 12

A. (Single – grade)

B. Ambient Temperature

C. (Multi – grade)

COOLANT

All Ingersoll–Rand portable compressor engines are factory filled with a 50/50 Ethylene glycol base antifreeze/water mix. which provides protection to –33 ℃ (–27 ℉)

IMPORTANT:

- *Be sure to add Long Life Coolant Antifreeze (LLC) to soft water. In cold season, the LLC is especially important. Without LLC, cooling performance will decrease due to scale and rust in the cooling water line. Without LLC, cooling water will freeze and expand to break the cooling line.*
- *Be sure to use the mixing ratios specified by the LLC manufacturer for your temperature range.*
- *Do not mix different types (brand) of LLC, chemical reactions may make the LLC useless and engine trouble could result*
- *Replace the cooling water every once a year*

CAUTION:
When handling Long Life Coolant Antifreeze, wear protective rubber gloves not to contact with it. If contact with the eyes or skin should occur, wash with clean water

ENGINE OPERATION

Engine Exhaust Gas Caution (Carbon Monoxide)

CAUTION

Do not breathe exhaust gas because it contains carbon monoxide, which by itself has no color or odor. Carbon monoxide is a dangerous gas. It can cause unconsciousness and can be lethal.

Do not run the engine in confined areas (such as garages or next to a building). Keep the exhaust tailpipe area clear of snow and other material to help reduce the buildup of exhaust gases under the equipment. This is particularly important when parked in blizzard conditions.

CHECK BEFORE OPERATION

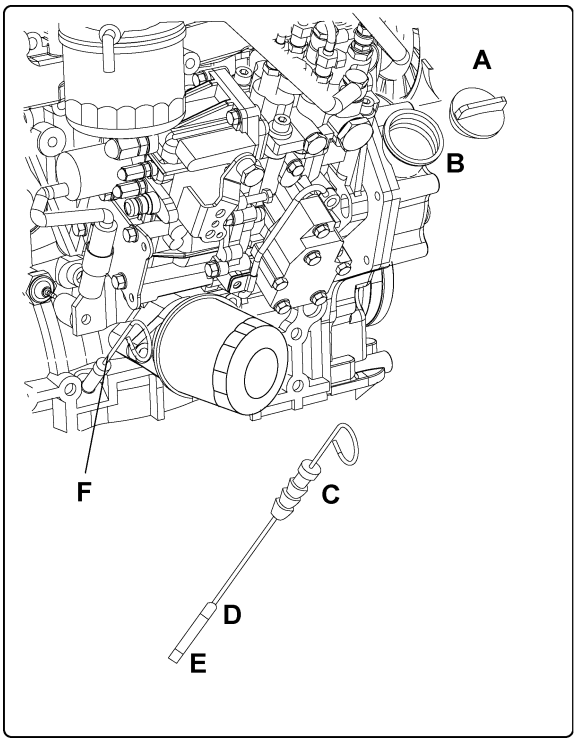
CAUTION: For safety reasons, conduct the inspection with the engine stopped.

Engine Oil Level.

Place the engine or the machine on a level surface

Remove the dipstick, wipe it with a cloth. Insert it fully and take it out gently again.

Check the oil level against the marks on the dipstick. The oil level must be between the upper level mark and the lower level mark as illustrated.



A. Filler cap

B. Filler port (engine oil)

C. Dipstick

D. Upper limit

E. Lower limit

F. Dipstick

Remove filler cap (yellow coloured) on the rocker arm cover side of engine.

Fill with engine oil up to the upper limit on the dipstick.

Manually tighten the filler cap. Do not use a tool such as pliers to tighten it.

Table of oil pan capacities.

Engine oil pan capacity (oil pan) (L)	
3IRH2N	5.5
3IRH8N	6.7
4IRH8N	7.4
4IRI8N	10.2

A certain period of time is required before the engine oil completely flows down from the oil filler to the crankcase. Wait at least ten minutes before checking the oil level.

NOTE: Take care to avoid engine oil being splashed on the fan drive belt because it causes belt slippage or slackness.

CAUTION: When adding oil, take care not to spill it. If you spill oil on the engine or equipment, wipe it properly, to prevent the risk of fire and personal injury and/or equipment damage.

Fan Belt Check

Check the fan belt for tension and abnormalities.

When the belt is depressed 7 – 10 mm with the thumb (about 100 N [10 kg] pressure) midway between the fan pulley and alternator pulley, the belt tension is correct.

If the belt tension is too high, it will result in alternator failure.

A loose belt will cause belt slippage which may result in a damaged belt, abnormal noise, poor battery charging and engine overheating.

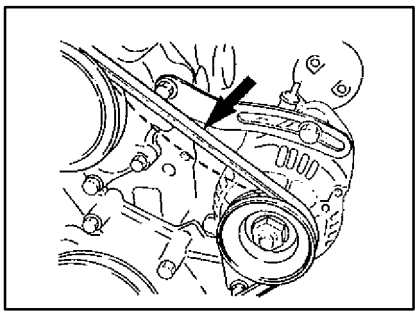


Fig. 16

Coolant Level Check

The coolant level must be between “MAX COLD” and “MIN” marks on the reserve tank depending on the temperature of the engine. Check and ensure that the level is correct.

CAUTION: When removing the radiator filler cap, while the engine is still hot, cover the cap with cloth, then turn it slowly to gradually release the internal steam pressure. this will prevent anyone from being scalded by hot steam spurting out from the filler neck.

Add coolant mixed to the correct ratio: 50/50 ethylene glycol/water.

Radiator Cap Condition

After the replenishment of the coolant, install the radiator filler cap. Make sure the cap is securely installed.

Battery Cable Connection

Check the battery cable connections for looseness or corrosion. A loosened cable connection will result in hard engine starting or insufficient battery charge. The battery cables must be tightened securely. Never reverse "+" and "–" terminals when reconnecting cables after disconnection. Even a short period of reverse connection will damage the electrical parts.

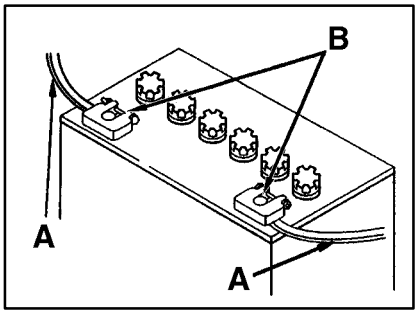


Fig. 17

A Battery cable

B Connections

Battery Electrolyte level

The amount of electrolyte in the batteries will be reduced after repeated discharge and recharge. Check the electrolyte level in the batteries, replenish with a commercially available electrolyte such as distilled water, if necessary. The battery electrolyte level checking procedure will vary with battery type. NOTICE: Do not replenish with dilute sulfuric acid in the daily service.

CAUTION:

When inspecting the batteries, be sure to stop the engine first.

As dilute sulphuric acid is used as electrolyte, be careful not to contaminate your eyes, hands, clothes, and metals with the electrolyte. If it gets in your eye, wash with a large amount of water at once, then seek medical advice.

As highly flammable hydrogen gas is released from the batteries, do not create a spark or allow any naked flame near the batteries.

When handling such metallic articles as tools near the batteries, be sure not to contact the "+" terminal because the compressor body is "–" and a dangerous short circuit might result.

When disconnecting the terminals, start with "–" terminal. When connecting them, connect the "–" terminal last.

Fuel level

Check the remaining fuel oil level in the fuel tank and re–fuel if necessary.

CHECKS AND OPERATION AFTER START–UP

Check after the Engine Start–up

Check the following items in the engine warming–up operation.

Engine noise and exhaust smoke color –

Listen to the engine and, if any abnormal noise is heard, check to determine the cause.

Check the fuel combustion condition by observing the exhaust smoke color. The exhaust smoke color after engine warm–up and at no–load condition should be colorless or light blue.

Black or white smoke indicates incorrect combustion.

Note: *After start–up from cold the engine might be noisier and the exhaust smoke color darker than when it has warmed up. However this condition will disappear after warm up.*

Leakage in the systems –

Check the following items:

Lubrication oil leakage –

Check the engine for oil leaks, paying particular attention to oil filter and oil pipe joints.

Fuel leakage –

Check the fuel injection pump, fuel lines and fuel filter for leakage.

Coolant leakage – Check the radiator and water pump hose connections and the water drain cock on the cylinder block for leakage.

Exhaust smoke or gas leakage

Checking coolant level

The coolant level could drop because any mixed air is expelled in about 5 minutes after the engine started.

Stop the engine, remove radiator cap, and add coolant.

CAUTION: Hot steam can rush out and you could get burnt if the radiator cap is removed when the engine is hot. Cover the radiator cap with a thick cloth and loosen the cap slowly to reduce the pressure, then remove the cap.

OPERATION AND CARE OF A NEW ENGINE.

Your Ingersoll–Rand engine is carefully tested and adjusted in the factory, however, further run–in is necessary. Avoid any harsh engine operation within the initial 100 operating hours.

Do not operate the unit at full load until the engine is warmed–up.

Do not allow the engine to run unloaded for extended periods so as to minimise the risk of cylinder bore glazing.

During operation, pay attention to the following points if the engine shows any sign of abnormalities.

(1) Engine Oil Pressure – The engine oil pressure is monitored by a switch that will stop the engine if the pressure falls below a pre–set value.

(2) Coolant Temperature – The engine performance will be adversely affected if engine coolant temperature is too hot or too cold. The normal coolant temperature is 75 to 85 ~~°C~~ (167 to 185 ~~°F~~).

Overheating

CAUTION:

If you see or hear escaping steam or have other reason to suspect there is a serious overheat condition, stop the engine immediately.

If the Engine Coolant Temperature gage (where fitted) shows an overheat condition, or you have reason to suspect the engine may be overheating, take the following step:

- ~~C~~lose the service valve to reduce the load.
- ~~L~~et the engine run at normal idle speed for two or three minutes. If the engine coolant temperature does not start to drop, turn off the engine and proceed as follows:

CAUTION: To help avoid being burned –

- ~~D~~o not open the canopy or door if you see or hear steam or engine coolant escaping. Wait until no steam or engine coolant can be seen or heard before opening the engine canopy or door.
- ~~D~~o not remove the radiator filler cap if the engine coolant in the reserve tank is boiling. Also do not remove the radiator filler cap while the engine and radiator are still hot. Scalding fluid and steam can be blown out under pressure if either cap is taken off too soon.

If no steam or engine coolant can be seen or heard, open the canopy or door. If the engine coolant is boiling, wait until it stops before proceeding. The engine coolant level should be between the “MAX COLD” and “MIN” marks on the reserve tank.

Make sure the fan belt is not broken, or off the pulley, and that the fan turns when the engine is started. If the engine coolant level in the reserve tank is low, look for leaks at the radiator hoses and connections, radiator, and water pump. If you find major leaks, do not run the engine until these problems have been corrected. If you do not find a leak or other problem, WAIT UNTIL THE ENGINE HAS COOLED DOWN then carefully add engine coolant to the reserve tank.

(Engine coolant is a mixture of ethylene glycol antifreeze and water. See “Engine Care in cold season” for the proper antifreeze and mixture.)

CAUTION: To avoid being burned, do not spill antifreeze or engine coolant on the exhaust system or hot engine parts. Under some conditions the ethylene glycol in engine coolant is combustible.

If the engine coolant level in the reserve tank is at the correct level but there is still an indication of an overheat condition and no cause was found, please consult your local Ingersoll–Rand branch or dealer.

Overcooling

Operating the engine at low coolant temperature will not only increase the oil and fuel consumption but also will lead to premature parts wear which may result in engine failure. Ensure that the engine reaches normal operating temperature 75 to 85 ~~°C~~ (167 to 185 ~~°F~~) within ten minutes of starting.

(3) Hourmeter

This meter indicates the machine operation hours. Make sure that the meter is always working during engine operation. Periodical machine maintenance is scheduled on the operation hours indicated on the hourmeter.

(4) Liquid and Exhaust Smoke Leakage

Make regular checks for lubricant, fuel, coolant and exhaust smoke leakage.

(5) Abnormal Engine Noise

In the event of any abnormal engine noise, please consult your local Ingersoll–Rand branch or dealer.

(6) State of the Exhaust Smoke

Check for any abnormal exhaust smoke color.

ENGINE STOPPING

(1) Close service valves.

(2) Before stopping the engine, cool down the engine by operating it at reduced load about three minutes. In this period, check the engine noise for abnormalities.

LONG TERM STORAGE

If the equipment is to be out of operation for an extended period, it should be started at least once per week and run on load for about 15 minutes after it has reached normal operating temperature.

If this is not possible,

- ~~D~~o not drain the cooling water
- ~~C~~lean dust or oil from the engine extension
- ~~E~~ither fill completely or drain the fuel tank
- ~~G~~rease accelerator joints and electrical connections
- ~~D~~isconnect the negative battery terminal

When performing the following items, the daily inspection items should also be carried out.

IMPORTANT:
Establish a periodic check plan according to the operating conditions and make sure to conduct checks at specified intervals. Otherwise, malfunctioning may occur to shorten the engine life.
As special knowledge and skill are required for items marked with ●, consult your local Ingersoll–Rand branch or distributor.

○ Check ◇ Replace ● Contact your dealer

System	Check item	Daily	Periodic inspection interval				
			Every 50 hours	Every 250 hours	Every 500 hours	Every 1000 hours	Every 2000 hours
Fuel oil	Fuel tank oil level check and refill	○					
	Draining from fuel tank		○				
	Draining from oil / water separator		○				
	Cleaning oil / water separator				○		
	Fuel filter replacement				◇		
Engine oil	Engine oil level	○					
	Engine oil replacement		◇ 1st time		◇ 2nd & after		
	Engine oil filter replacement						
Cooling water	Check & addition cooling	○					
	Radiator fin checking & cleaning			○			
	Cooling fan V–belt checking & adjusting		○ 1st time	○ 2nd & after			
	Cooling water replacement					◇ or every 1 yr	
	Cooling water path flushing & maintenance						●
Rubber hoses	Fuel & cooling water pipe replacement						● or every 2 yrs
Operating system	Governor lever & accelerator check & adjust	○		○			
Intake and exhaust	Air cleaner element cleaning & replacement			○	◇		
Electrical equipment	Battery electrolyte check and recharging		○				
Cylinder head	Adjust intake / exhaust valve clearance					●	
	Lapping intake / exhaust valve seats						●
Fuel valve pump *	Check fuel injection valve pressure & adjust					●	
	Check & adjust fuel injection pump						●

* The specific emissions related parts for the EPA/ARB regulations

EPA allows to apply Maintenance schedule for Emission related parts as follows.

–	Check Fuel Valve Nozzle and clean	Adjust, cleaning and repair of fuel injection Pump and fuel valve nozzle
kW ≦ 130	1500 hours of use and at 1500–hour intervals thereafter	3000 hours of use and at 3000–hour intervals thereafter

Inspection after initial 50 hours operation

(1) Replacing the engine oil and engine oil filter (1st time)

When the engine oil is still hot, be careful with a splash of engine oil which may cause burns. Cool the engine to replace engine oil until the engine oil becomes warm. It is most effective to drain the engine oil while the engine is still warm.

In early period of use, the engine oil gets dirty rapidly because of the initial wear of internal parts. Replace the engine oil earlier.

Engine oil filter should also, be replaced when the engine oil is replaced.

Engine oil and engine oil filter replacing procedures are as follows.

Remove the oil filler cap to drain easily while draining the engine oil.

1) Prepare a waste oil container collecting waste oil.

2) Loosen the drain plug using a wrench (customer procured) to drain the engine oil.

3) Securely tighten the drain plug after draining the engine oil.

4) Turn the engine oil filter counter–clockwise using a filter wrench (customer procured) to remove It.

5) Clean the engine oil filter mounting face.

6) Moisten the new engine oil filter gasket with the engine oil and install the new engine oil filter manually turning it clockwise until it comes into contact with the mounting surface, and tighten it further to 3/4 of a turn with the filter wrench.

Tightening torque: 19.6∼23.5N ~~m (2~~.0∼2.4kgf ~~m)~~

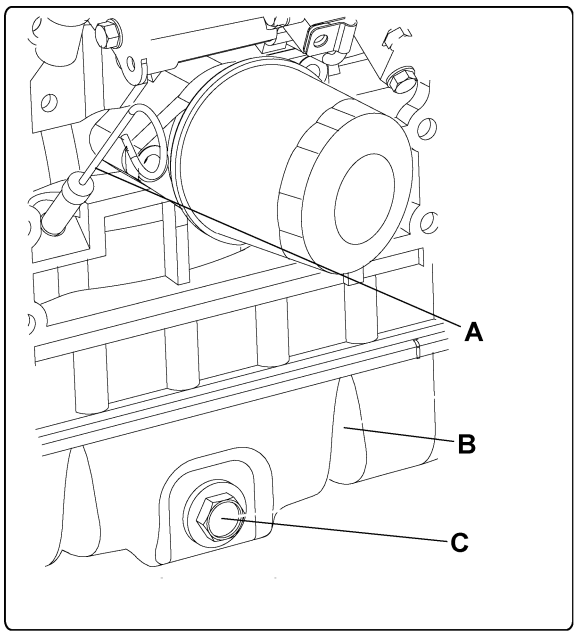
Applicable engine oil filter Part No.	
All engines	CCN 15897630

7) Fill with the new engine oil until it reaches the specified level as explained in OPERATION section.

IMPORTANT:
Do not overfill the oil pan with engine oil. Be sure to keep the specified level between upper and lower limit on the dipstick.

8) Warm up the engine by running for 5 minutes while checking any oil leakage.

9) Stop the engine after warming up and leave it stopping for about 10 minute to recheck the engine oil level with dipstick and replenish the engine oil. If any oil is spilled, wipe it away with a clean cloth.

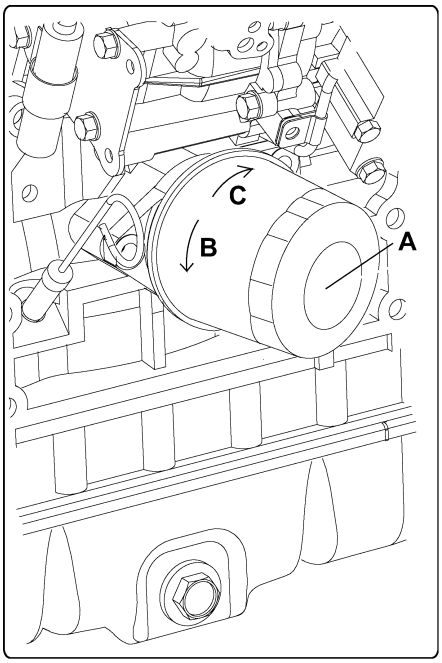


The location depends on the engine installed on the machine unit

A. Dipstick

B. Oil pan

C. Drain plug



A. Engine oil filter

B. Loosen

C. Tighten

(2) Checking and adjusting cooling fan V–belt

When there is not enough tension in the V–belt, the V–belt will slip making it impossible for the alternator to generate power and cooling water pump and cooling fan will not work causing the engine to overheat. Check and adjust the V–belt tension (deflection) in the following manner.

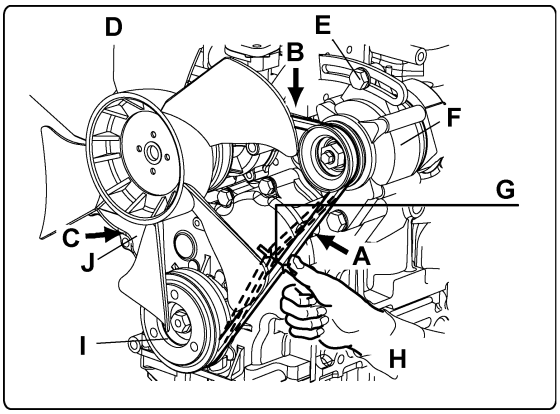
1) Press the V–belt down with your thumb [approx. 98N(10kgf)]. at the middle of the V–belt span to check the tension (deflection).

Available positions to check and adjust the V–belt tension (deflection) are at the A, B and C showing with the arrow direction as shown illustration right.

You may choose a position whichever you can most easily carry out the check and adjustment on the machine unit.

The specified deflection to be measured at each position should be as follows.

A	B	C
10∼14mm	7∼10mm	9∼13mm



D. Radiator fan

E. Set bolt

F. Alternator

G. Deflection

H. Press with thumb

I. Crankshaft V–pulley

J. V–belt

2) If necessary, adjust the V–belt tension (deflection). To adjust the V–belt tension, loosen the set bolt and move the alternator to tighten the V–belt.

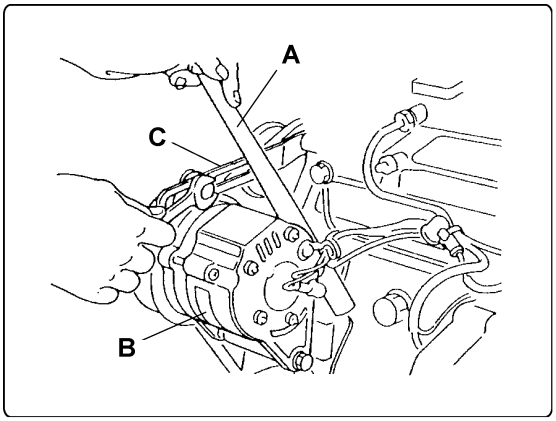
3) Visually check the V–belt for cracks, oiliness or wear. If any , replace the V–belt with new one.

"New, V–belt" refers to a V–belt which has been used less than 5 minutes on a running engine.

"Used V–belt" refers to a V–belt which has been used on a running engine for 5 minutes or more.

Install the new V–belt adjusting the deflection to the value in the table below according to the above manner. After adjusting. run the engine for 5 minutes end readjust the deflection to the value in the table above.

A	B	C
8∼12mm	5∼8mm	7∼11mm



(Adjusting the V–belt tension)

A. Adjust the V–belt tension by prying with a wooden bar

B. Alternator

C. Adjusting bracket

Use of genuine Ingersoll–Rand fan belt

Always use genuine Ingersoll–Rand fan belts as they provide high driving ability and long operating durability. Use of non–Ingersoll–Rand fan belts could result in premature belt wear or belt elongation leading to engine overheating or excessive belt noise.

CAUTION:
To help avoid being injured, check and adjust the fan belt tension with engine stopped.

Inspection every 50 hours operation

(1) Draining of the fuel tank (NOT 7/26)

1) Prepare a waste oil container.

2) Remove the drain plug of the fuel tank to drain (water, dust ,etc.) from the fuel tank bottom.

3) Drain until fuel with no water and dust flow out. Then tighten the drain plug firmly.

(2) Draining of the oil/water separator

Draining Water from Fuel Filter/separator.

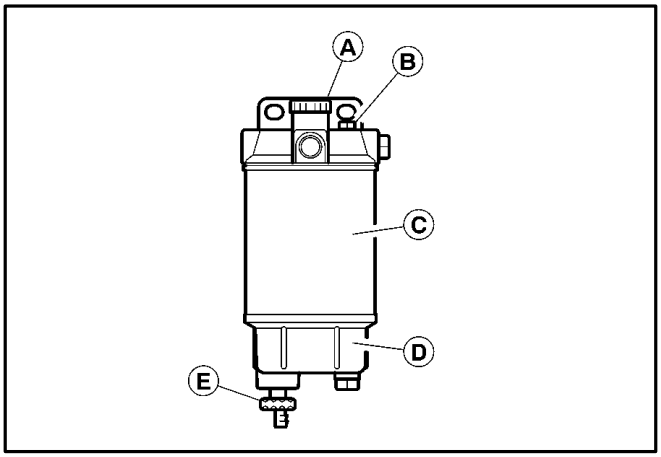
The fuel filter/separator is provided to allow water to be drained from the fuel system. Water is heavier than fuel so any water contained in the system will collect in the bottom of the bowl.

The clear bowl 'D' should be checked on a daily basis and if water is present, it should be drained from the separator.

Place a suitable container under the separator to prevent any spillage inside the machine.

Slacken the drain valve 'E' until water drains from the vent tube.

When all the water has been evacuated, tighten the drain valve 'E' and follow the "fuel system air bleeding" procedure below.



Fuel System Air Bleeding

The entry of air into the fuel system will cause difficult engine starting or engine malfunction.

When carrying out service procedures such as emptying the fuel tank, draining the filter/separator, and changing the fuel filter element be sure to bleed air from the fuel system.

To activate the "automatic air–bleeding system", turn the key switch to the "ON" position and energize the electromagnetic pump" to bleed the air.

Air bleeding method**:**

When the "starter switch" is set to the "ON" position to activate the electromagnetic pump, fuel is forced to the fuel valve of each injection pump and then to the leak–off pipe of each injector nozzle, so that any air in the fuel system bleeds off automatically to the fuel tank.

NOTE:
Although the fuel system can bleed air automatically when the key switch is in the "ON" position, air can also be manually bled by use of the primer pump facility in the filter/separator assembly.
By unscrewing the plastic primer pump head 'A' and stroking it up and down, any air bubbles in the system will be purged back to the fuel tank. When this has been completed, the pump head must be screwed back into the filter/separator assembly.

Start the engine and visually check the fuel system for leaks.

Governor Control Seals

As the governor is precisely adjusted, most of the controls are sealed, please do not break them. Should any adjustment be necessary, contact your local Ingersoll–Rand branch or distributor.

NOTE: Ingersoll–Rand will not accept any warranty claim on an engine with broken governor seals.

(3) Inspection of battery

Fire due to electric short–circuit

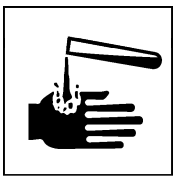
Make sure to turn off the battery switch or disconnect the negative cable (–) before inspecting the electrical system. Failure to do so could cause short–circuiting and fires.

Always disconnect the (–) Negative battery cable first before disconnecting the battery cables from battery. An accidental "Short circuit" may cause damage, fire and or personnel injury.

And remember to connect the (–) Negative battery cable (back onto the battery) LAST.

Proper ventilation of the battery area

Keep the area around the battery Well ventilated, paying attention to keep away any fire source. During operation or charging, hydrogen gas is generated from the battery and can be easily ignited.



Do not come in contact with battery electrolyte

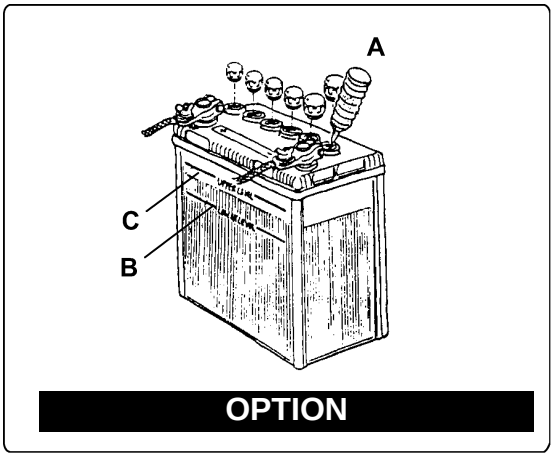
Pay sufficient attention to avoid your eyes. or skin from being in contact with the fluid. The battery electrolyte is dilute sulfuric acid and causes burns. Wash it off immediately with a large amount of fresh water if you get any on you.

Clean the battery terminals

Check the level of fluid in the battery.
When the amount of fluid nears the lower limit, fill with battery fluid (available in the market) to the upper limit. If operation continues with insufficient battery fluid, the battery life is shortened, and the battery may overheat and explode.

Battery fluid tends to evaporate more quickly in the summer, and the fluid level should be checked earlier than the specified limes.

- If the engine cranking speed is so slow that the engine does not start up, recharge the battery.
- If the engine still will not start after charging, replace the battery.
- Remove the battery from the battery mounting of the machine unit after daily use if letting the machine unit leave in the place that the ambient temperature could drop at –15 C or less. And store the battery in a warm place until the next use the unit to start the engine easily at low ambient temperature.



Follow the instructions an precautions in the manual from the battery maker.

A. Battery fluid

B. Lower limit

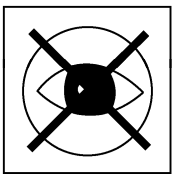
C. Upper limit

Inspection every 250 hours operation

(1) Replacing the engine oil and engine oil filter (2nd time and after)

Replace the engine oil every 250 hours operation from 2nd time and on. Replace the engine oil filter at the same time. Refer to 50 hour inspection, section (1).

(2) Checking and cleaning radiator fins.

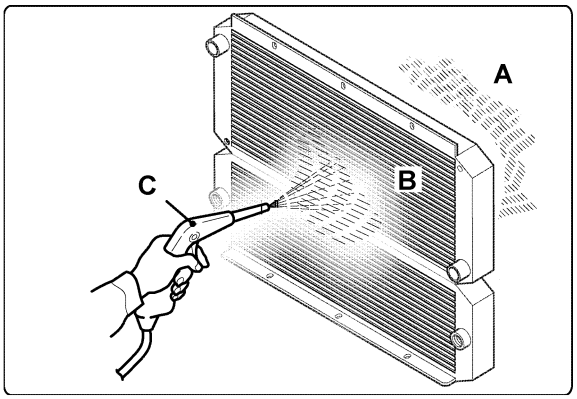


Beware of dirt from air blowing

Wear–protective equipment such as goggles to protect your eyes when blowing compressed air. Dust or flying debris can hurt eyes.

Dirt and dust adhering on the radiator fins reduce the cooling performance, causing overheating. Make it a rule to check the radiator fins daily and clean as needed.

- Blow off dirt and dust from fins and periphery with compressed air [0.19MPa (2kgf/cm^2) or less] not to damage the fins with compressed air.
- If contaminated heavily, apply detergent, thoroughly clean and rinse with tap water shower.



A. Dust, dirt.

B. Radiator fins

C. Air blow

IMPORTANT:
Never use high pressure water or air from close by fins or never attempt to clean using a wire brush. Radiator fins can be damaged.

(3) Checking the governor lever and accelerating device.

The governor lever and accelerating devices (accelerating lever, pedal. etc.) of the machine unit are connected by a fixed linkage to a pneumatic actuator. If the linkage becomes loose, the deviation in the position may result and make operation unsafe. Check the linkage connections for excess play. For adjustment of linkage see compressor operation section.

Governor Control Seals

As the governor is precisely adjusted, most of the controls are sealed, please do not break them. Should any adjustment be necessary, contact your local Ingersoll–Rand branch or distributor.

NOTE: Ingersoll–Rand will not accept any warranty claim on an engine with broken governor seals.

(4) Replacing fuel filter

Replace the fuel filter at specified intervals before it is clogged with dust to adversely affect the fuel flow. Also, replace the fuel filter after the engine has fully been cooled.

1) Remove the fuel filter using a filter wrench(customer procured). When removing the fuel filter, hold the bottom of the fuel filter with a piece of rag to prevent the fuel oil from dropping. If you spill fuel, wipe such spillage carefully.

2) Clean the filter mounting surface and slightly apply fuel oil to the gasket of the new fuel filter.

3) Install the: new fuel filter manually turning until it comes into contact with the mounting surface, and tighten it further to 1/2 at a turn, using a filter wrench. Tightening torque: 11.8∼15.6N ~~m(1.2∼1.6kgf m)~~

Applicable fuel filter Part No.	
All engines	CPN 15892747

4) Bleed the fuel system. Refer to section 2 of inspection at 50 hours

IMPORTANT:
Be sure to use genuine Yanmar part (super fine mesh filter). Otherwise, it results in engine damage, uneven engine performance and shorter engine life.

(5) Changing oil/water separator element.

***NOTE*:**
The cartridge and bowl contain fuel. Take care not to spill it during disassembly and reassembly.

The fuel filter/separator also provides primary filtration and the element 'C' should be changed every 500 operating hours or 6 months, whichever comes first.

Change procedure:

Unscrew the element 'C' from the head taking care not to spill fuel inside the machine. Drain any fuel within into a suitable container, then unscrew the clear bowl 'D' from the element.

Discard the old element into a suitable container.

Remove the old 'O' ring from the bowl 'D' and install the new one supplied with the element. Apply a light coat of clean engine oil to the 'O' ring and screw the bowl 'D' onto the new element 'C'.

Using a clean cloth, wipe the sealing face of the filter/separator head to ensure correct seating of the sealing ring.

Fill the element/bowl assembly with clean fuel oil then apply a light coat of clean engine oil to the new element seal ring.

Screw the new element onto the head firmly by hand.

Follow the "fuel system air bleeding" procedure. see "inspection after every 50 hours operation" section 2.

(6) Air cleaner element inspection

AIR INTAKE SYSTEM

Air cleaner

Engine performance and life vary with the air intake conditions.

A dirty air cleaner element reduces the amount of intake air, causing reduced engine output and possible engine damage.

Also, a damaged element leads to abrasion of cylinders and valves, resulting in increased oil consumption, reduced output and shortened engine life.

INSPECT THE CONDITION OF THE ELEMENT.

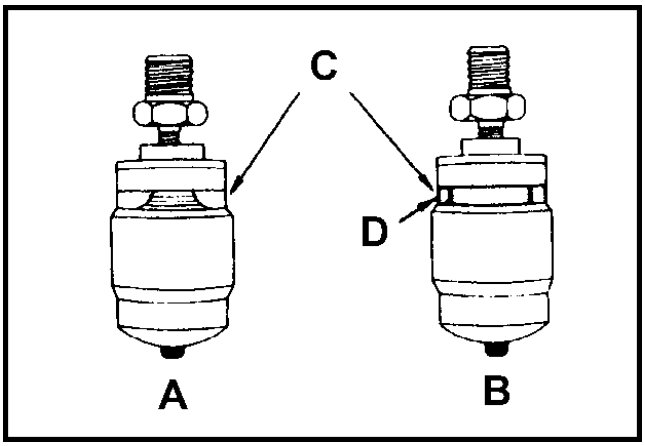


Fig. 32

A Normal

B Clogged

C Indicator

D Red signal

Air cleaner with dust indicator

This indicator is attached to the air cleaner. When the air cleaner element is clogged, air intake resistance becomes greater and the dust indicator signal turns to red indicating the element needs to be changed.

When the signal turns to red, replace the element. Then press the dust indicator button to reset the indication.

(1) Checking and adjusting cooling fan V–belt (2nd time and after)

Check and adjust the cooling fan V–belt tension every 250 hours operation from 2nd time and on.
See "inspection after initial 50 hours" section (2)

Inspection every 500 hours operation

(1) Replacing the air cleaner element

Replace the air cleaner element periodically even if it is not damaged or dirty. When replacing the element, clean the inside air cleaner case at the time. If having the air cleaner with double elements, do not remove the inner element. If the engine output is still not recover (or the dust indicator still actuates if having the air cleaner with a dust indicator) even though the outer element has replaced with new one, replace the inner element with new one.

Inspection every 1000 hours operation

(1) Replacing cooling water

Cooling water contaminated with rust or water scale reduces the cooling effect. Even when antifreeze agent (LLC) is mixed, the cooling water gets contaminated due to deteriorated ingredients. Replace the cooling water at least Once a year.

1) Remove the header tank cap.

2) Remove the bottom radiator hose of the radiator and drain the cooling water.

3) After draining the cooling water, reconnect the hose.

4) Fill radiator and engine with cooling water via the header tank.

Beware of scalding by hot water

Wait until the temperature goes down before draining the Cooling water. Otherwise, hot water may splash to cause scalding.

(2) Checking and adjusting the fuel injection valve

As the adjustment requires specialized knowledge and skill, .consult your Ingersoll–Rand dealer. This adjustment is needed to obtain the optimum injection pattern for full engine performance.

(3) Adjusting intake / exhaust valve clearance

As this adjustment requires specialized knowledge and skill, consult your Ingersoll–Rand dealer. The adjustment is necessary to maintain the correct timing for the opening and closing of valves. Neglecting the adjustment will cause the engine to run noisily and result in poor engine performance and other damage.

Inspection every 2000 hours operation

(1) Flushing the cooling system and checking the cooling system parts

As this maintenance requires specialized knowledge and skill, consult your Ingersoll–Rand dealer. Rust and water scale will accumulate in the cooling system through many hours of operation. This lowers the engine cooling effect.

And for the engine oil cooler (4TNV98T), they quickly deteriorate the engine oil.

Cooling system parts: radiator, cooling water pump, thermostat, cylinder block, cylinder head, oil cooler (4TNV98T).

(2) Checking and replacing fuel hoses and cooling water hoses

As this maintenance requires specialized knowledge and skill, consult your Ingersoll–Rand dealer. Regularly check the rubber hoses of the fuel system and cooling water system. If cracked or degraded, replace them with new one. Replace the rubber hoses at least every 2 years.

(3) Lapping the intake and exhaust valves

As this maintenance requires specialized knowledge and skill, consult your Ingersoll–Rand dealer. The adjustment is necessary to maintain proper contact of the valves and seats.

(4) Checking and adjusting the fuel injection timing

As this maintenance requires specialized knowledge and skill, consult your Ingersoll–Rand dealer.

Checking and adjusting the EPA emission related parts.

The inspection and servicing require specialized knowledge and techniques. Consult your Ingersoll–Rand dealer or distributor.

EPA allows to apply maintenance schedule for emission related parts as follow.

–	Check Fuel Valve Nozzle and clean	Adjust, cleaning and repair of Fuel injection Pump and Fuel Valve Nozzle.
kW ≦ 130	1500 hours of use and at 1500–hour intervals thereafter	3000 hours of use and at 3000–hour intervals thereafter

ENGINE MAINTENANCE SCHEDULE

Note:
This is a recommended maintenance. The failure to perform this maintenance item will not nullify the emission warranty or limit recall liability prior to the completion engine useful life. Ingersoll–Rand, however, urges that recommended maintenance service is performed at the indicated intervals.

EXPLANATION OF MAINTENANCE SCHEDULE

The following is a brief explanation of the services listed in the preceding Engine Maintenance schedule.

1.	**Oil level.**	Check that the oil level is between the max. and the min. level marks. Add oil to the max. level mark if it is below the min. level. If it is above the max. level mark, drain oil until the max. level is reached.
2.	**Engine oil replacement**	Change at 500 hours or 6 months, whichever comes first.
3.	**Oil filter element replacement**	Change at 500 hours or 6 months, whichever comes first.
4.	**Fuel leakage**	Replace any damaged or malfunctioning parts which could cause leakage.
5.	**Draining water in fuel filter/separator.**	Drain off water in the fuel filter/separator bowl.
6.	**Fuel filter element replacement**	Replace both primary (filter/separator) and secondary elements at 500 hours or 6 months whichever come first.
7.	**Injection nozzle check**	Check injection opening pressure and spray condition. (This is a recommended maintenance item ~~.~~ Consult your local Ingersoll–Rand branch or distributor.
8.	**Coolant level.**	Check coolant level and add coolant if necessary.
9.	**Coolant leakage check**	Replace any damaged or malfunctioning parts which could cause leakage.
10.	**Radiator filler cap fitting condition**	The radiator cap must be installed tightly and sealing correctly.
11.	**Fan belt tension check**	Check and adjust fan belt deflection. Look for cracks, fraying and wear. Replace if necessary.
12.	**Coolant temperature**	Normal running temperature is 75 to 85 ~~C~~ (167 to 185 ~~F~~). Check and repair the cooling system if temperature is abnormal.
13.	**Coolant replacement**	Change coolant at intervals of 1000 hours or 12 months, whichever comes first.
14.	**Radiator external face cleaning**	Check monthly. Clean at intervals of 250 hours or 3 months, whichever comes first. In very dusty environments, more frequent cleaning might be necessary.
15.	**Cooling system circuit cleaning**	Clean at intervals of 1000 hours or 12 months, whichever comes first.
16.	**Radiator filling cap function check**	Check radiator pressure cap periodically for proper operation. Consult your local Ingersoll–Rand branch or distributor.
17.	**Battery electrolyte level check**	Replenish with distilled water if necessary.
18.	**Battery cleaning**	Clean the terminals
19.	**Battery charge condition**	If cranking speed is too slow to start the engine, charge the battery.
20.	**Air filter element replacement**	Change element at 500 hrs or sooner if the restriction indicator shows red.
21.	**Cylinder compression pressure**	Consult your Ingersoll–Rand dealer or distributor
22.	**Valve clearance check**	Check and adjust every 1000 hours. Consult your Ingersoll–Rand dealer or distributor

This item contains a simple troubleshooting. When a failure takes place on your Ingersoll–Rand engine, diagnose the cause referring this troubleshooting. Should the cause of failure not be detected or you are unable to manage the failure, consult your machine supply source or nearest Ingersoll–Rand engine service outlet.

Engine does not start	Starter does not turn.	Battery discharged	
		Bad cable connections.	
		Starter or starter switch failure.	
		Safety relay failure.	
	Starter turns but engine does not fire.	No fuel injection.	Engine stop solenoid malfunction.
			No fuel in the fuel tank.
			Clogged fuel filter element.
			Air in the fuel system.
			Control rack is stuck at no fuel position.
		Fuel is injected but engine does not fire.	Incorrect preheating operation.
			Faulty air heater.
			Incorrect injection timing.
			Low cylinder compression pressure.
			Engine stop solenoid not fully returned.
	Engine fires but stalls immediately.	Air in the fuel system.	
		Incorrect low idle speed adjustment.	

Unstable engine running	Unstable low idling	Crack in injection pipe.	
		Injection nozzle failure.	
		Engine stop solenoid return failure.	
		Uneven compression pressure between cylinders.	
	Incorrect high idle speed adjustment.	Incorrect control lever adjustment.	
		Governor internal malfunction.	
	Engine hunting in medium speed range.	Governor spring deteriorated.	
	Engine malfunction in high speed range.	Insufficient fuel supply.	Air in the fuel system
			Clogged fuel filter element
			Piping failure (squeezed/restricted etc.)
		Uneven fuel injection amount between cylinders.	
		Deteriorated governor spring.	
		Incorrect valve clearance adjustment.	
		Deteriorated valve spring.	
	Engine speed stuck at high idle.	Engine control restriction or seizure.	
Engine overheat.	Cooling system defect	Insufficient coolant volume.	
		Fan belt slippage.	
		Thermostat malfunction.	
		Radiator filler cap malfunction.	
		Cooling system interior fouled.	
		Radiator clogged.	
	Improper servicing	Engine over–loaded.	
		Air cleaner element clogged.	
		Insufficient airflow/restriction.	
		Restricted coolant flow (high concentration of antifreeze, etc.)	
Low oil pressure	Lack of oil	Oil leakage	
		High oil consumption	
	Wrong oil	Wrong type and viscosity.	
	High coolant temperature.	Over heat.	
	Clogged filter and strainer.		
	Worn bearings and oil pump.		
	Faulty relief valve.		

Low engine output	Incorrect injection pump adjustment	Incorrect injection timing	Too far advanced.
			Too far retarded.
		Injection nozzle malfunction	Incorrect injection pressure.
			Incorrect spray condition.
		Insufficient fuel supply to the injection pump	Lack of fuel in tank.
			Air in injection pump.
			Fuel filter clogged.
			Overflow valve malfunction.
		Governor malfunction	Incorrect engine control adjustment.
			Deteriorated governor spring.
	Low cylinder compression pressure	Cylinder compression leakage	Incorrect valve clearance adjustment.
			Injector nozzle misalignment.
			Cylinder bore wear.
		Insufficient air intake volume.	Air cleaner clogged.
			Restricted air flow.
Excessive oil consumption	Incorrect oil	Wrong selection of type and viscosity.	
		Too much oil quantity.	
	Engine burning oil	Faulty piston rings/damaged cylinder bores.	
		Faulty valve stem seal.	
	Oil leakage	Damaged seal / Damaged turbocharger seal	
		Loose joints/gaskets.	
		Improper installation of filter and piping.	
Excessive fuel consumption	Fuel leakage	Damaged seals.	
		Improper component installation or tightening.	
	Excessive injection volume.	Injection pump defective.	
	Excessive mechanical loads		

Improper exhaust	Excessive black smoke	Clogged air cleaner.
		Damaged injector nozzle.
		Wrong injector nozzle.
		Injection timing incorrect.
		Excessive injection volume.
		Incorrect fuel.
	Excessive white smoke	Water mixing in fuel
		Low compression pressure.
		Injection timing incorrect.
		Low coolant temperature
		Faulty turbocharger
Battery over discharge	Low electrolyte level	Crack in battery body.
		Natural consumption.
	Charging failure	Loose or damaged belt.
		Faulty alternator.
		Damaged wiring or contact failure.
	Excessive electrical loads	Insufficient battery capacity for the application.