תשתיות נפט ואנרגיה בע"מ
קו מוצרי דלק בע"מ
אגף הנדסה

פרק 4 – מפרט טכני

אחזקת מנועי דיזל וציוד סובב במתקני הצפון

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4.1 כללי

מפרט זה דן בביצוע עבודות שרות תקופתי לתחזוקת מנועי דיזל במתקני הצפון של תש"ן/קמ"ד.
העבודות הינן לאספקת חומרי חילוף לטיפול תקופתי ו/או הטיפול עצמו.
הטיפולים שיבוצעו יהיו ע"פ הנחיות יצרן הציוד כפי המופיעים בספרים.
הקבלן יעביר לחברה חשבונית עבור החלקים שנרכשו – כהוכחה שהחלקים חדשים ותקינים.
בתום העבודות שיבוצעו ע"י מכונאי מוסמך יונפק דוח ביצוע הטיפול המפרט את כל הנעשה בטיפול וכן את החלקים שהוחלפו.
בדוח יועבר לחברה חתום ע"י המכונאי המוסמך שביצע את הטיפול.

<u>המתקנים הם :</u>

טרמינל

אלרואי

נמל הדלק

קמ"ד חיפה

קמ"ד חדרה

4.2 היקף העבודה

העבודות כוללות:

ביצוע עבודות שירות ותחזוקה למנועי דיזל להנעת משאבות דלק, מים, קצף, גנרטורים, מדחסים וכד' ולחלק מהציוד הקשור לו כמו : גנרטורים ומדחסים ניידים (בהיבט שאינו קשור לחוזה אחזקת מדחסים) בהתאם לטבלת ריכוז הציוד עפ"י מתקנים כמופיע בנספח א'.
העבודות תהיינה עבודות תחזוקה מונעת ותיקוני ליקויים משביתים, ברמה הניתנת להיות מטופלת באתר.

מבצע השרות יהיה בעל הסמכה פורמלית לטיפול ולביצוע שרות למנועי דיזל עם תעודה של מכונאי מוסמך מטעם משרד העבודה, או חשמלאי רכב מוסמך, בהתאם לצורך ולקריאה, המכונאי יחתום ע"ג טופס הבדיקה.

עבודות השירות תעשנה ע"י בעלי מקצוע עם ניסיון באחזקה וטיפול במנועי דיזל. להלן מבצע העבודה. לא יבוצע טיפול כלשהו לציוד שלא על ידי בעל מקצוע בתחום וזכותו של המהנדס לפסול עבודות של עובד, מטעם הקבלן, בביצוע עבודות תחזוקה שלא מתאימה לציודם. במקרה כזה יוחלף בעל המקצוע מידית בעובד מתאים. מבצע העבודה ימלא דו"ח תיקונים וטיפול בהתאם לטופס המצ"ב ובכלל זאת חתימתו ומס' תעודת מכונאי.

כל עבודות אחזקה תתבצענה עפ"י הוראות היצרנים השונים עפ"י הכתוב בספרי הוראות הציוד ובהנחיות המהנדס.
בכל שלב שיסוכם, בין המהנדס לבין הקבלן, יינתן אישור בכתב או בע"פ בנוכחותו של המהנדס או לא בנוכחותו. ללא האישורים הנ"ל לא יאושרו חשבונות הקבלן.

כל העבודות תבוצענה במתקני החברה בלבד .

תבוצענה עפ"י כללי הבטיחות הקיימים במתקנים, המצורפים בנספח ב' לחוזה. כל עבודה מחייבת היתר יומי פורמלי לביצוע העבודה אשר יימסר לקבלן ע"י מנהל המתקן או מי שימונה העבודות במתקני החברה על ידו .
עבודת הקבלן תסתיים, בהחזרת כל החלקים והחומרים שלא השתמשו בהם לצורך העבודה וניקיון כללי של אזור העבודה.
לא יאושר לקבלן חשבון במצב של השארת ציוד, חומרים ולכלוך בשטח העבודה.
כאמור, הדיזלים מיועדים להנעת משאבות דלק ומים, מחוללים (גנרטורים) כאשר הדיזלים עבור משאבות הכיבוי ברובם הינם דיזלים של מנועים ימיים, קרי ללא מצנן.

4.3 חומרים , וציוד שיסופקו ע"י החברה

החברה תספק לקבלן רק ספרות טכנית לעיון ושימוש הקבלן בזמן ביצוע הטיפולים התקופתיים.

4.4 חומרים וציוד שעל הקבלן לספק

הקבלן יספק את כל החומרים לטיפולים השנתיים של מנועי הדיזל, מדחסי האוויר וגנראטורים, עפ"י הוראות היצרנים השונים והטיפול התקופתי כמו: שמנים, גריז, מסנני שמן, מסנני סולר, מסנני אוויר, מים ותוספים למים למצנן, חומרי ניקוי שונים וכד'.
כל שמני המנוע יהיו ברמת צמיגות 40W15 ובאיכות – API מינימאלית של CF-4.
סוגי השמן והמסננים ישונו רק עפ"י אישור מאת המהנדס.
כלי עבודה אישיים, כלי עבודה מיוחדים לביצוע מושלם של השרות לכל המנועים המצוינים בכתב הכמויות .
בגדי עבודה וציוד בטיחות אישי.

כל החומרים, הציוד והכלים לביצוע מושלם של השרות התקופתי למנועים השונים יהיו כלולים במחירי היחידה השונים אשר בכתב הכמויות.

4.5 ביצוע שרות תקופתי

השרות התקופתי למנועי דיזל יבוצע תקופתית (בתדירות של שנה או שנתיים) או פחות וזאת עפ"י הנחיות נציג המזמין להלן המהנדס והמפרט הטכני שם מפורטים דגמי המנועים.

השרות התקופתי למנועי דיזל יכלול בין השאר את העבודות הבאות :

- ✓ החלפת מסנני שמן בכמות הקיימת במנוע הדיזל – כל שנתיים.
- ✓ החלפת מסנני דלק בכמות הקיימת במנוע הדיזל.
- ✓ פרוק מסנני האוויר והחלפתם. ניקוי מסננים בלבד לא יתאפשר אלא רק באישור בכתב מהמהנדס ובקיזוז העלות מסעיף הטיפול.
- ✓ בדיקת מתיחת רצועות גומי המורכבות ע"ג המנוע מתיחתם בהתאם לצורך.

במידה ויש צורך יוחלפו באישור המהנדס, כעקרון כל 5 שנים, וישולם תמורתם עפ"י חשבוניות מקור מסודרות.

- ✓ בדיקת מדחס בוכנות ו/או חלזוני הכולל: בדיקת מתנע, אלטרנטור, בדיקת שמנים, הוספת שמנים, הוספת גריז,
- ✓ ביקורת פעולה, בדיקות וסתי לחץ.
- ✓ ריקון מי קירור במצנן, מילוי מים מחדש הוספת תוסף עפ"י המלצות המהנדס ו/או היצרן. ביקורת לנזילות ודיווח. כל החומרים, המים והתוספים, כלולים במחיר היח'.
- ✓ ביקורת כללית על כל הברגים במנוע כולל: ברגיי עיגון, ברגיי צנרת, מצמדים, ברגים למערכת הדלק, שמן, פליטה וכד' וביצוע חיזוק ברגים בהתאם.
- ✓ ביקורת לחיבורי הארקות לבסיס וללוח החשמל.
- ✓ ביקורת על חיבורי צנרת גומי גמישה למערכות השמן, דלק והמים החמים.

החלפה בהתאם לצורך. תשלום עפ"י חשבוניות.

- ✓ ביקורת ויזואלית בזמן עבודת המנוע במקומות הבאים :

מצנן מים – בדיקה לנזילות

מתנע, אלטרנאטור – בדיקת חופשים, יציאת מתח תקינה

מערכת שמן מנוע – בדיקה לנזילות מאגן השמן .

מערכת דלק – בדיקה לנזילות דלק ממיכל הדלק למשאבת הדלק

ולנקודות ההזרקה במנוע . ביצוע חיזוקים כנדרש .

מערכת פליטת גזים – בדיקה לאטימה מושלמת ואי פריצת גזים, ביצוע חיזוקים

והחלפת אטמים למניעת דליפות בהתאם לצורך.

גנראטור חשמלי - בזמן עבודת המנוע וע"י חשמלאי בלבד.

- ✓ הפעלת המנוע עם הגנראטור או המדחס תעשה בנוכחות נציג המסוף ובמהירות לא נמוכה מ- 1500 סל"ד.
- ✓ בסיום הביקורת ירשמו בדו"ח הביקורת כל העבודות שבוצעו במהלך השרות לכל מנוע.

4.6 עבודות יומיומיות וקריאת חירום

הקבלן ייתן מחירים לביצוע עבודות עפ"י שעות עבודה למכונאי ולחשמלאי . האישור לעבודה יהיה רק עפ"י אישור המהנדס ובכתב. תשומת הלב לחשמלאי ומכונאי.
הפעלת הקבלן ע"פ סעיף זה יהיה לתקלות בציוד המטופל ולציודים שונים שלא כלולים במסגרת כתב הכמויות העיקרי למנועי הדיזל במתקנים השונים.
כמו כן, על פי סעיף זה תשולם גם קריאת חירום במקרה של תקלה שתתבקש להיות מטופלת שלא בזמני עבודת המתקנים , בימי חול ובמשמרת הבוקר בלבד.
קריאת חירום תחושב מרגע קבלת ההודעה אצל הקבלן ועד גמר תיקון התקלה, במתקני המזמין.
על הקבלן להגיע תוך 4 שעות למתקן בו ארעה התקלה, עם צוות של 2 עובדים לפחות .

4.7 לוח זמנים

הקבלן יופיע לטיפולים ע"פ תוכנית טיפולים שנתית שתסוכם עמו עם תחילת העבודה. על הקבלן לתאם הגעתו למתקן עם המהנדס לפחות 48 שעות לפני ביצוע הטיפולים. הקבלן יוכל לבצע באותו יום כמה טיפולים וזאת בתיאום מראש עם המהנדס.

4.8 חשבונות

יוגשו חשבונות מצטברים בלבד. החשבונות יוגשו בטבלת Excel תוך ציון הכמות שאושרה, הכמות הנוכחית וכמות מצטברת חדשה. לחשבון המצטבר יצרפו כל תעודות הבדיקה והביצוע שבוצעו בציודים של המזמין בתקופה האמורה.
רק במידה ולא בוצעה עבודה לא יוגש חשבון לאותו חודש.
החשבונות יוגשו לא יאוחר משבועיים לאחר ביצוע העבודה בסוף החודש בו בוצע הטיפול.

דוגמא לטופס בדיקה אותו יש למלא בגמר הטיפול

טופס טיפול מנוע דיזל

מתקן : _____

תאריך הבדיקה : _____

הספק : _____ KW _____ HP

שעות מונה : _____

מספר שילדה : _____ יצרן: _____ מודל: _____

מהות העבודה : ביקורת / טיפול / תקלה / אחר _____

בדיקת גנרטור לפני התנעה

נקז מים / מכל מיכל (סולר) / מפריד מים

☐ בדוק מציין סתימה / מסנן אוויר והחלף לפי הצורך

☐ בדוק מתח רצועות של האלטרנטור ומתח לפי הצורך

☐ בדוק כי אין חופשים בציר המניפה

☐ בדוק רמת ☐ מים ברדיאטור במידה וקיים ☐ שמן בעוקת השמן

☐ בדוק רמת סולר במיכל : % _____ מתוך: _____

☐ בדוק ניקיון כללי של הגנרטור ושל הרדיאטור או מיכל עיבוי

☐ נקה מגעי מצבר והידוקם / בדוק את רמת מים במצבר

☐ במצבר/ים השלם מים מזוקקים לפי הצורך

☐ רשום נתוני "אנלייזר" וקבע תקינות לפי "טבלת ביצועים"

החלפת מצבר/ים מעל 2.5 שנים

☐ בדוק דרישות מתח מטען מצברים: _____ V (13.2V/27.4V)

☐ טיפול שנתי - בדוק נפילת לחץ מים במידה וקיים

☐ בטיפול – בחמם המנוע והחלפת שמן מנוע

☐ בטיפול – גרז את פטמות הגירוז בגנרטור

☐ בטיפול – החלף מסנן שמן, שמן מנוע ורשום שעות מנוע ותאריך

☐ בטיפול – החלף מסנן סולר

☐ בטיפול החלף נוזל קירור לפי הצורך

התנע את הגנרטור ובדוק / תקן / ווסת לפי הצורך

העדר נזילות: ☐ סולר ☐ שמן ☐ מים ☐ אוויר. **מתן דגש למשאבת הזרקה, אטם מכסה שסתומים, משאבת מים וצינורות מים לרדיאטור.**

☐ דווח על רעשים חריגים ועשן חריג

תקינות חיווים / הגנות : ☐ חום מנוע ☐ לחץ שמן ☐ נוספים

מתח טעינת אלטרנטור VDC _____ (27.8V/13.4V)

מתח גנרטור VAC _____ (390V – 400V)

<u>פרטים שהוחלפו</u>

מק"ט	פריט	כמות
	פ. סולר	
	פ. שמן	
	פ. אוויר	
	ש. מנוע	
	נ. קירור	

סוג נוזל לקירור הינו: _____

שם המכונאי: _____ מס' תעודה: _____

תשתיות נפט ואנרגיה בע"מ
קו מוצרי דלק בע"מ
אגף הנדסה

מסוף אלרואי

מדחס INGERSOLL

יצרן JHON DEER

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מדחס אינגרסול ראנד - [illegible]

MAINTENANCE SCHEDULE

		Daily	Weekly	Monthly	3 MOS. 250 hrs.	6 MOS. 500 hrs	12 MOS. 1000 hrs
Compressor Oil Level		C					
Engine Oil Level		C					
*Radiator Coolant Level		C					
Gauges/Lamps		C					
Fuel Tank (fill at end of day)		C				DRAIN	
*Fuel/Water Separator Drain		C					
Air Cleaner Precleaner Dumps			C				
Fan/Alternator Belts			C				
Battery Connections/Electrolyte			C				
Tire Pressure and Surface			C				
*Wheel Lug Nuts				C			
Hoses (oil, air, intake, etc.)				C			
Automatic Shutdown System	Test			C			
Air Cleaner System	Visual			C			
Compressor Oil Cooler	Exterior			C	CLEAN		
*Engine Rad/Oil Cooler	Exterior			C	CLEAN		
Fasteners, Guards					C		
Air Cleaner Elements						WI	
*Fuel/Water Separator Element						R	
Compressor Oil Filter Element						R	
Compressor Oil						R	
*Wheels (bearings, seals, etc)						C	
*Engine Coolant	Test					C	R
Shutdown Switch Settings	Test						C
Scavenger Orifice & Related Parts							CLEAN
Oil Separator Element							R
Lights (running, brake, & turn)		CBT					
Pintle Eye Bolts		CBT					
Engine (oil changes, filters, etc)		Refer to Engine Operator Manual in this book.					

*Disregard if not appropriate for this particular machine.

R=replace, **C**=check (adjust if necessary), **WI**=OR when indicated, **CBT** = check before towing.

Refer to specific sections of the operator's manual for more information.

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SECTION 7 - LUBRICATION

GENERAL INFORMATION

Lubrication is an essential part of preventive maintenance, affecting to a great extent the useful life of the unit. Different lubricants are needed and some components in the unit require more frequent lubrication than others. Therefore, it is important that the instructions regarding types of lubricants and the frequency of their application be explicitly followed. Periodic lubrication of the moving parts reduces to a minimum the possibility of mechanical failures.

The Preventive Maintenance Schedule shows those items requiring regular service and the interval in which they should be performed. A regular service program should be developed to include all items and fluids. These intervals are based on average operating conditions. In the event of extremely severe (hot, cold, dusty or wet) operating conditions, more frequent lubrication than specified may be necessary. Details concerning lubrication of the running gear are in Maintenance Section.

All filters and filter elements for air and compressor lubricant must be obtained through Ingersoll-Rand to assure the proper size and filtration for the compressor.

COMPRESSOR OIL CHANGE

These units are normally furnished with an initial supply of oil sufficient to allow operation of the unit for approximately 6 months or 1000 hours, whichever comes first. If a unit has been completely drained of all oil, it must be refilled with new oil before it is placed in operation. Refer to specifications in Lubrication Table.

NOTICE

Some oil types are incompatible when mixed and result in the formation of varnishes, shellacs, or lacquers which may be insoluble. Such deposits can cause serious troubles including clogging of the filters. Where possible, do NOT mix oils of different types and avoid mixing different brands. A type or brand change is best made at the time of a complete oil drain and refill.

If the unit has been operated for the time/ hours mentioned above, it should be completely drained of oil. If the unit has been operated under adverse conditions, or after long periods in storage, an earlier change period may be necessary as oil deteriorates with time as well as by operating conditions.

WARNING

High pressure air can cause severe injury or death from hot oil and flying parts. Always relieve pressure before removing caps, plugs, covers or other parts from pressurized air system. Ensure the following conditions are met:

- Discharge air pressure gauge reads zero (0).
- No air discharging from an "open" manual blowdown valve.

An oil change is good insurance against the accumulation of dirt, sludge, or oxidized oil products.

Completely drain the receiver- separator, piping, and oil cooler. If the oil is drained immediately after the unit has been run for some time, most of the sediment will be in suspension and, therefore, will drain more readily. However, the fluid will be hot and care must be taken to avoid contact with the skin or eyes.

After the unit has been completely drained of all old oil, close the drain valve. Add oil in the specified quantity at the filler plug. Tighten the filler plug and run the machine to circulate the oil. Check the oil level WHEN RUNNING AT FULL LOAD. If not near the middle of the sight tube, stop the unit and make corrections. DO NOT OVERFILL.

NOTICE

Ingersoll-Rand provides compressor oil specifically formulated for Portable Compressors and requires the use of these fluids in order to obtain extended limited airend warranty.

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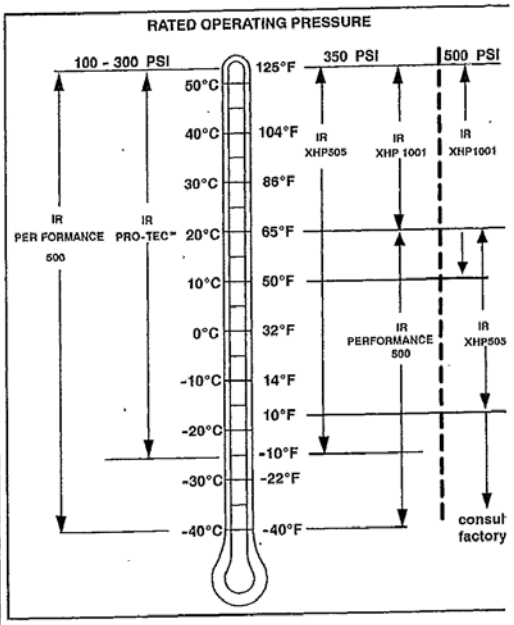
SECTION 7 - COMPRESSOR LUBRICATION

Portable Compressor Fluid Chart

Refer to these charts for correct compressor fluid required. Note that the selection of fluid is dependent on the design operating pressure of the machine and the ambient temperature expected to be encountered before the next oil change.



Design Operating Pressure	Ambient Temperature	Specification
100 psi to 300 psi	-10°F to 125°F (-23°C to 52°C)	IR Pro-Tec™ Mil –PRF 2104G SAE 10W
100 psi to 300 psi	-40°F to 125°F (-40°C to 52°C)	IR Performance 500 Mil-L-46167
350 psi	-10°F to 125°F (-23°C to 52°C)	IR XHP 505
	65°F to 125°F (18°C to 52°C)	IR XHP1001
	-40°F to 65°F (-40°C to 18°C)	IR Performance 500 Mil-L-46167
500 psi	50°F to 125°F (10°C to 52°C)	IR XHP1001
	10°F to 65°F (-12°C to 18°C)	IR XHP 505
	below 10°F (-12°C)	Consult Factory

Recommended Ingersoll-Rand Fluids – Use of these fluids with original I-R filters can extend airend warranty. Refer to operator's manual warranty section for details or contact your I-R representative.

Recommended Fluid	1 Gal. (3.8 Litre)	5 Gal. (19.0 Litre)	55 Gal. (208.2 Litre)
IR Pro-Tec™	36899698	36899706	36899714
IR XHP 505		35365188	35365170
IR Performance 500	35382928	35382936	35382944
IR XHP1001		35612738	35300516

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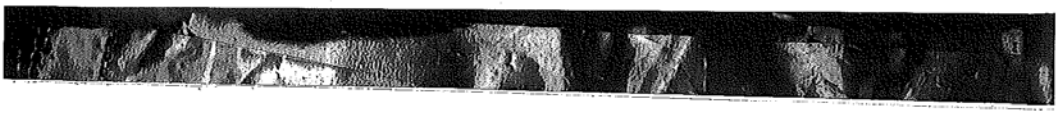

SECTION 8 – Trouble Shooting

INTRODUCTION

Trouble shooting for a portable air compressor is an organized study of a particular problem or series of problems and a planned method of procedure for investigation and correction. The trouble shooting chart that follows includes some of the problems that an operator may encounter during the operation of a portable compressor.

The chart does not attempt to list all of the troubles that may occur, nor does it attempt to give all of the answers for correction of the problems. The chart does give those problems that are most apt to occur. To use the trouble shooting chart:

A. Find the "complaint" depicted as a bold heading.

B. Follow down that column to find the potential cause or causes. The causes are listed in order to suggest an order to follow in trouble shooting.

ACTION PLAN

A. Think Before Acting

Study the problem thoroughly and ask yourself these questions:

(1) What were the warning signals that preceded the trouble?
(2) Has a similar trouble occurred before?
(3) What previous maintenance work has been done?
(4) If the compressor will still operate, is it safe to continue operating it to make further checks?

B. Do The Simplest Things First

Most troubles are simple and easily corrected. For example, most complaints are "low capacity" which may be caused by too low an engine speed or "compressor over- heats" which may be caused by low oil level.

Always check the easiest and most obvious things first; following this simple rule will save time and trouble.

Note: For trouble shooting electrical problems, refer to the Wiring Diagram Schematic.

C. Double Check Before Disassembly

The source of most compressor troubles can be traced not to one component alone, but to the relationship of one component with another. Too often, a compressor can be partially disassembled in search of the cause of a certain trouble and all evidence is destroyed during disassembly. Check again to be sure an easy solution to the problem has not been overlooked.

D. Find And Correct Basic Cause

After a mechanical failure has been corrected, be sure to locate and correct the cause of the trouble so the same failure will not be repeated. A complaint of "premature breakdown" may be corrected by repairing any improper wiring connections, but something caused the defective wiring. The cause may be excessive vibration.

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TROUBLE SHOOTING CHART

Bold Headings depict the COMPLAINT - Subheadings depict the CAUSE

Note: Subheadings suggest order to follow in cause of troubleshooting.

Short Air Cleaner Life:

- Dirty Operating Conditions
- Inadequate Element Cleaning
- Defective Service Indicator
- Incorrect Stopping Procedure
- Wrong Air Filter Element

Excessive Oil In Air:

- High Oil Level
- Out of Level > 15 degrees
- Clogged Scavenge Orifice
- Scavenge Tube Blocked
- Defective Scavenge Check Valve
- Sep. Tank Blown Down Too Quickly
- Defective Minimum Pressure Valve
- Defective Separator Element

Will Not Unload:

- Leaks in Regulator Piping
- Incorrect Pressure Regulator Adjustment
- Malfunctioning Pressure Regulator
- Malfunctioning Inlet Unloader/Butterfly Valve
- Ice in Regulation Lines/Orifice

Oil In Air Cleaner:

- Incorrect Stopping Procedure

Safety Valve Relieves:

- Leaks In Regulator Piping
- Incorrect Pressure Regulator Adjustment
- Malfunctioning Pressure Regulator
- Malfunctioning Inlet Unloader/Butterfly Valve
- Defective Separator Element
- Ice in Regulation Lines/Orifice
- Defective Safety Valve

Excessive Compressor Oil Temperature:

- Ambient Temperature Too High
- Out of Level > 15 degrees
- Low Oil Level
- Dirty Cooler
- Dirty Operating Conditions
- Loose or Broken Belts
- Operating Pressure Too High
- Malfunctioning Thermostat
- Defective Minimum Pressure Valve
- Blocked or Restricted Oil Lines
- Airend Malfunctioning

Engine RPM Low:

- Clogged Fuel Filter
- Operating Pressure Too High
- Incorrect Pressure Regulator Adjustment
- Dirty Air Filter
- Malfunctioning Speed Control Cylinder
- Defective Separator Element
- Ice In Regulation Lines/Orifice
- Engine Malfunctioning
- Airend Malfunctioning

Excessive Vibration:

- Low Engine RPM
- Rubber Mounts Damaged
- Out of Balance Fan
- Engine Malfunctioning
- Airend Malfunctioning

Low CFM:

- Low Engine RPM
- Dirty Air Filter
- Incorrect Linkage Adjustment
- Incorrect Pressure Regulator Adjustment
- Malfunctioning Inlet Unloader/Butterfly Valve
- Malfunctioning Speed Control Cylinder
- Defective Minimum Pressure Valve
- Defective Separator Element

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Unit Shutdown:

Out of Fuel
Compressor Oil Temp. Too High
Engine Oil Pressure Too Low
Broken Engine Fan Belt
Loose Wire Connection
Defective Switches
Defective Shutdown Solenoid
Malfunctioning Relay
Blown Fuse
Engine Malfunctioning
Airend Malfunctioning

Won't Start/Run:

Low Battery Voltage
Blown Fuse
Malfunctioning Start Switch
Clogged Fuel Filters
Out of Fuel
Compressor Oil Temp. Too High
Engine Water Temp. Too High
Engine Oil Pressure Too Low
Loose Wire Connection
Defective Switches
Malfunctioning Relay
Engine Malfunctioning
Airend Malfunctioning

Unit Fails To Shutdown:

Defective Switches
Defective Shutdown Solenoid
Malfunctioning Relay
Defective Start Switch

Engine Temperature Lamps Stays On:

Broken Engine Fan Belt
Malfunctioning Circuit Board
Defective Engine Belt Break Switch
Ambient Temperature Too High
Dirty Operating Conditions
Dirty Cooler
Out of Level >15 degrees
Operating Pressure Too High

Alternator Lamp Stays On:

Loose or Broken Belts
Loose Wire Connection
Defective Battery
Malfunctioning Alternator
Malfunctioning Circuit Board

Engine Oil Pressure Lamp Stays On:

Low Oil Level
Out of Level >15 degrees
Wrong Lube Oil
Engine Malfunctioning

Alternator Lamp Stays Off:

Loose Wire Connection
Malfunctioning Circuit Board

Engine Temperature Lamps Stays Off:

Bulb Burned Out
Loose Wire Connection
Malfunctioning Circuit Board
Defective Engine Belt Break Switch

Engine Oil Pressure Lamp Stays Off:

Bulb Burned Out
Malfunctioning Circuit Board
Defective Engine Oil Pressure Switch
Engine Malfunctioning

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תשתיות נפט ואנרגיה בע"מ
קו מוצרי דלק בע"מ
אגף הנדסה

מסוף אלרואי

משאבות כיבוי אש PATERSON

יצרן CATERFILLER

משאבה 38-S-19739
משאבה 38-S-19735

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MAINTENANCE RECOMMENDATIONS

Cooling

CAUTION

Never add coolant to an overheated engine; allow the engine to cool first.

Check specific gravity of antifreeze solution frequently in cold weather to assure adequate protection.

Coolant should be drained and replaced "Every 2000 Service Meter Units." With additions of Caterpillar Cooling System Inhibitor or the use of Coolant Conditioner Elements as recommended, the drain period can be extended to "Every 4000 Service Meter Units."

All water is corrosive at engine operating temperature. The cooling system should be protected with inhibitor at all times regardless of concentration of antifreeze. This can be done by maintaining a 3% concentration of liquid Caterpillar Cooling System Inhibitor or by using Coolant Conditioner Elements.

Never use both the liquid cooling system inhibitor and coolant elements at the same time.

Do not use Caterpillar Cooling System Inhibitor or Coolant Conditioner Elements with Dowtherm 209 Full-Fill Coolant.

Whenever draining and refilling cooling system, always recheck the coolant level when the engine reaches normal operating temperature.

Filling at over 5 U.S. gallons (19 liters) per minute can cause air pockets in the cooling system.

Premix antifreeze solution to provide protection to the lowest expected ambient temperature. Pure undiluted antifreeze will freeze at −10°F (−23°C).

Operate with a thermostat in the cooling system all year-round. Cooling system problems can arise without a thermostat.

Electrical

CAUTION

When using jumper cables to start the engine, be sure to connect in parallel: POSITIVE (+) to POSITIVE (+) and NEGATIVE (−) to NEGATIVE (−).

Scheduled Oil Sampling

Use Scheduled Oil Sampling to monitor the engine's condition and maintenance requirements.

Each oil sample should be taken when the oil is hot, and well mixed, to insure a sample which is representative of the oil in the compartment.

Consult your Caterpillar dealer for complete information, and assistance in establishing a Scheudled Oil Sampling program for your equipment.

Fuel

CAUTION

Fill fuel tank at the end of each day of operation to drive out moisture laden air and to prevent condensation. Do not fill the tank to the brim. The fuel expands when it gets warm and may overflow.

Water and sediment should be drained from the fuel tank at the start of each shift or after the fuel tank has been filled and allowed to stand for 5 to 10 minutes.

Drain fuel tank of moisture and sediment as required by prevailing conditions.

After changing fuel filters, always bleed fuel system to remove air bubbles from system.

Air Intake

Service air cleaners when RED band in indicator locks in visible position.

SPECIFICATIONS

LUBRICATION SPECIFICATIONS

Crankcase Lubricating Oils

Use oils which meet Engine Service Classification CD (MIL-L-2104D) or CD/TO-2. These are additive-type oils that have been approved for use in Caterpillar Diesel Engines.

Consult the "EMA Lubricating Oils Data Book," Form SEBU5939, for a listing of CD oil brands.

The proper SAE grade of oil to select is determined by the ambient temperature at which the engine is started and the maximum ambient temperature in which the engine will be operating. See chart for recommended viscosity and temperature range.

To determine if the oil in the crankcase will flow in cold weather, remove the oil dipstick before starting. If the oil will flow off, the oil is fluid enough to circulate properly.

Lubricating Grease

Use Multipurpose-type Grease (MPGM) which contains 3-5% molybdenum disulfide conforming to MIL-M-7866, and a suitable corrosion inhibitor. NLGI No. 2 Grade is suitable for most temperatures. Use NLGI No. 0 or No. 1 Grade for extremely low temperatures.

Recommended Lubricant Viscosities

Compartment or System	Oil Viscosities	For Temperature Ranges °F and°C*			
		Degrees F		Degrees C	
		Minimum	Maximum	Minimum	Maximum
Engine Crankcase CD or CD/TO-2	SAE 5W-20 (SPC)	–22	+50	–30	+10
	SAE 5W-20	–13	+50	–25	+10
	SAE 10W	–4	+50	–20	+10
	SAE 10W-30	–4	+104	–20	+40
	SAE 15W-40	+5	+122	–15	+50
	SAE 30	+32	+104	0	+40
	SAE 40	+41	+122	+5	+50

*When operating below –30°C (–22°F) refer to the Cold Weather Recommendation Operation and Maintenance Guide, Form SEBU5898, available from your Caterpillar dealer.

Air Starting Motor Oiler: Use SAE 10W in all temperatures.

Flywheel Clutch Bearing Reservoir: Use SAE 30 in all temperatures.

REFILL CAPACITIES			
MODEL	U.S. GAL.	LITRE	IMP. GAL.
3408	12	45.5	10
3412	16	60.5	13

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FUEL SPECIFICATIONS

No. 2 fuel oil and No. 2D diesel fuel are recommended for use in Caterpillar Diesel Engines. In extreme cold temperatures use No. 1 fuel oil or No. 1D diesel fuel.

In selecting a fuel, note that distillate fuels are especially desirable because the fuel is heated to a vaporous state and condensed, thus eliminating all sediment and residue.

There is considerable variation in the composition of fuels distributed under the No. 2 grade classifications. For desirable engine service it is most important to give special attention to cetane no., water and sediment; pour point, cloud point and sulphur content. USE THE LOWEST PRICE DISTILLATE FUEL WHICH MEETS THE FOLLOWING REQUIREMENTS.

Water and Sediment	0.1% sediment
Cetane No. (PC Engine)	35 minimum
(DI Engine)	40 minimum
Pour Point	10°F (6°C) below ambient temperature
Cloud Point	No higher than abmient temperature
Sulphur Content*	Adjust oil change period
Gravity	32-40 A.P.I. at 60°F (15.6°C)

*See the topic SULPHUR CONTENT.

Cetane No: This is an indication of a fuel's ignition quality and should not be less than 35 for the PC engine and 40 for the DI engine. For high altitude operation or cold weather starting, a higher cetane number is required.

Water and Sediment: A good clean fuel will contain no more than 0.1% sediment and water. Dirty fuels lead to early filter plugging and in addition can result in the formation of gums and resins reducing filter and engine life.

Pour Point: The pour point of the fuel has no effect on engine performance, as long as the fuel is fluid enough to flow from the fuel tank to the engine. The pour point of the fuel should be at least 10°F (6°C) below the lowest atmospheric temperature at which the engine must start and operate. In extremely cold temperatures it may be necessary to use No. 1 fuel oil or No. 1D diesel fuel.

Cloud Point: Cloud point is the temperature at which wax crystals become visible and is generally above the pour point of the fuel. The cloud point should be no higher than the lowest atmospheric temperature at which the engine must start to keep the fuel filter elements from plugging with wax crystals.

Sulfur Content: The percentage of sulfur in the fuel will affect the engine oil recommendations. If the fuel has over 0.5% sulfur content, the CD engine oil must have a TBN of 20 times the percentage of fuel sulfur (TBN as measured by the ASTM D-2896 method). Your oil supplier should be able to furnish the correct oils.

Gravity: Gravity is the measurement of heat units in a certain amount of fuel. The heavier the fuel (the lower the number) the more heat units per volume. If a fuel with a higher A.P.I. gravity is used the power produced will be lower. Select fuels with the lower A.P.I. gravity reading.

Some fuel specifications that meet the above requirements are:

ASTM—D396 - No. 1 & No. 2 fuels (burner fuels)
ASTM—D975 - No. 1D & No. 2D diesel fuel oils
BS2869—Class A1 to Class A2 engine fuels
BS2869—Class C & Class D burner fuels
DIN51601—Diesel fuel
DIN51603—EL heating oil

Authorized dealers are familiar with fuels that have given good results in Caterpillar Diesel Engines and should be consulted regarding fuel use when abnormal conditions occur.

COOLANT SPECIFICATIONS

Water used in the jacket water cooling system should be clean, and as free as possible from scale forming minerals or corrosive chemicals. Artificially softened water should not be used. Treating the water with Caterpillar Coolant Inhibitor, or equivalent will help prevent the formation of rust and pitting. It will also retard, and in some cases completely eliminate, mineral deposits in the engine.

The most efficient and satisfactory corrosion protection for the cooling system is to maintain proper level of coolant inhibitor and antifreeze solution. The use of auxiliary water filters is not recommended.

During freezing weather use the proper permanent type antifreeze and water solution to prevent freezing.

Before placing the engine in operation, make sure a 3% concentration of Caterpillar Corrosion Inhibitor or equivalent has been added to the cooling system. This 3% concentration must be maintained in cooling systems which are filled with water and systems protected with ethylene glycol antifreeze mixture, regardless of antifreeze concentration.

⚠ WARNING
Inhibitors contain alkali. Avoid contact with eyes. To prevent personal injury, avoid prolonged or repeated contact with skin.

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LUBRICATION AND MAINTENANCE INSTRUCTIONS

Regular service intervals, along with close daily visual inspection and the adherence to the instructions and schedules, will assure many hours of trouble-free service. If correction steps are taken immediately on discovery of any abnormal condition, fewer forced stops and more economical operation will result.

The Lubrication and Maintenance Chart is intended as a guide and adjustments in the schedule may be necessary, depending on conditions under which the engine is operating. A thorough analysis should be made before adjusting the maintenance schedule.

Some items to consider in establishing a new schedule are: Severe dust or dirty conditions, fuel consumption (a good measurement to establish intervals as it indicates the amount of work performed). As a guideline, the 3408 Engine with a 12 gal. (45 litre) (10 imp. gal.) capacity crankcase will use approximately 4000 gal. (15,000 litre) (3332 imp. gal.) between oil changes.* The 3412 Engine with a 16 gal. (60.5 litre) (13 imp. gal.) capacity crankcase will use approximately 5100 gal. (19,200 litre) (4248 imp. gal.) between oil changes.*

Reducing or extending the maintenance intervals should be done only after complete study and enough time to gain adequate experience to meet specific operations.

*With 0.5% or less fuel sulphur content.

Caterpillar scheduled oil sampling: Scheduled oil sampling is a program which analyzes oil samples taken from an engine at regular intervals (usually at oil change periods). This oil analysis does not indicate the condition of the oil; but rather, it is a scheduled procedure to determine engine condition at regular intervals by analyzing lubricating oil for foreign and wear particles.

The scheduled oil sampling will give the following benefits:

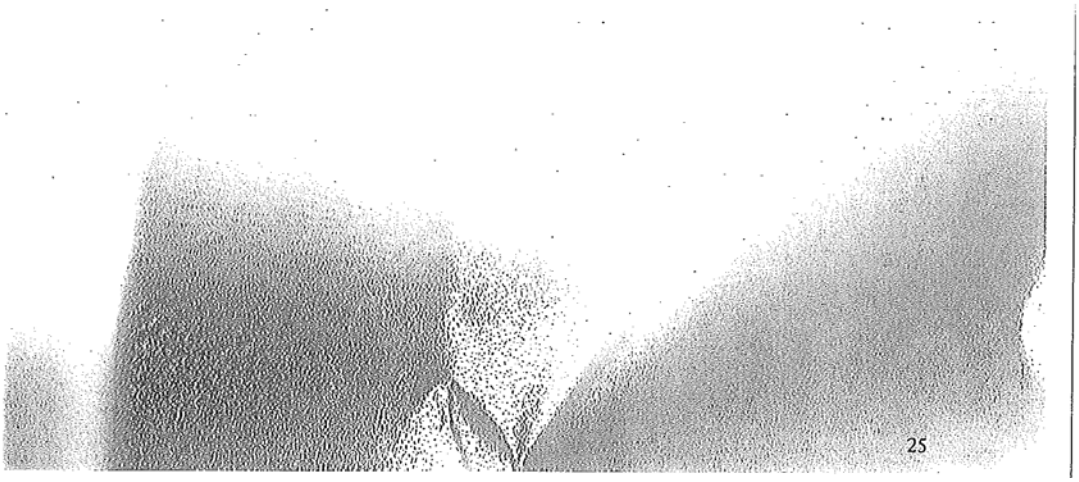
It assures the owner that maintenance has been performed.

It will show the first signs of excessive wear, meaning a possible upcoming failure, allowing time for a scheduled repair.

It will warn maintenance personnel of improper or lack of maintenance and presence of fuel dilution or antifreeze in oil.

It is particularly helpful in preventing wear due to dirt entry from air cleaner or inlet piping.

Regular sampling is especially advantageous for new engines to establish wear trends from the beginning. The results of the oil analysis are interpreted by experienced, highly trained personnel. Contact your Caterpillar dealer for detailed information.



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LUBRICATION AND MAINTENANCE CHART

The LUBRICATION AND MAINTENANCE CHART lists all serviceable items commonly ordered on this engine.

The maintenance time intervals are expressed in Service Meter Units. The Service Meter on the engine shows the total number of units the engine has run. Use the Service Meter readings for determining your maintenance schedules. Perform the maintenance at multiple intervals of the units shown. For example, when the Service Meter shows "100" on the dial, all items listed under "EVERY 10 SERVICE METER UNITS" should be serviced now for the tenth time, and all items under "EVERY 50 SERVICE METER UNITS" should be serviced for the second time.

Diesel fuels, lubricants and coolant make-up water to use are explained in the "Specifications".

SERVICE ITEM	Page No.	SERVICE METER UNITS									As Req.
		10	50	125	250	500	1000	2000	4000	Year	
LUBRICATION											
Check Engine Crankcase Oil Level	28	•									
Lubricate Front Clutch Engaging Collar (2 Strokes)	31	•									
Lubricate Rear Clutch Engaging Collar (2 Strokes)	31	•									
Check Shaft Bearing Reservoir (Rear Heavy Duty Clutch)	31	•									
Lubricate Clutch Control Lever Shaft Bearings (2 Strokes)	31			•							
Lubricate Front and Rear Clutch Pilot and Shaft Bearings (2 Strokes)	31			•							
Change Crankcase Oil and Filter	28				Note A						
Lubricate Fan Drive Bearings (2 Strokes)	30				•						
Crankcase Breather, Clean	28					•					
Change Clutch Shaft Reservoir Oil (Heavy Duty Clutch)	31					•					
Lubricate Woodward PSG Governor	30						•				
Air Start Oiler Jar, Fill	30										•
Empty Air Start Oil Collector Jar	30										•
COOLING SYSTEM											
Check Engine Coolant Level	34	•									
Inspect Zinc Rods in Raw Water System (Salt Water Only)	38		•								
Clean Radiator Core (External)	35				•						
Inspect Coolant Line Connections and Hoses	37				•						
Check Fan/Alternator Belt Tension and Wear	38				•						
Change Element and/or add Cooling System Inhibitor	32				•			•			
Inspect Coolant Pump	38							•			
Inspect Temperature Regulator	37									•	
Clean Cooling System (Internal)	35							•			

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SERVICE ITEM	Page No.	SERVICE METER UNITS									As Req.
		10	50	125	250	500	1000	2000	4000	Year	
FUEL SYSTEM											
Fill the Fuel Tank After Stopping	39	•									
Drain Sediment and Water From Fuel Tank	39	•									
Check Fuel Pressure Gauge Reading	39	•									
Wash Primary Filter	40				•		•				
Replace Final Fuel Filter	40	Note B									
Check/Replace Fuel Injection Nozzles If Necessary	41							•			
AIR INDUCTION AND EXHUAST											
Check Air Cleaner Service Indicator	43	•									
Check/Clean Dust Collector Cap	45	•									
Clean/Replace Air Cleaner Element	44						Note C				
Inspect Manifold and Air Piping for Leaks	48				•						
Adjust Valve Lash (Engine Stopped)	45				Note E						
Check Valve Rotation (Engine Idling)	48							•			
Inspect/Rebuild Turbocharger	49								•		
ELECTRICAL SYSTEM											
Check Battery Electrolyte	50				•						
Clean Electrical Connections and Battery	50				•						
Inspect Alternator Drive Belt	54				•						
Check Shutoff Controls	Note D					•					
Inspect/Rebuild Alternator	53							•			
Inspect Rebuild Starter	52								•		
Check Cold Weather Starting Aids	54									•	
POWER COUPLINGS											
Check and Adjust Clutch	55										•

NOTES

NOTE A: The percentage of sulfur in the fuel will affect the engine oil recommendations. If the fuel has over 0.5% sulfur content, the CD engine oil must have a TBN of 20 times the percentage of fuel sulfur (TBN as measured by the ASTM D-2896 method). If the sulfur content is greater than 1.5% by weight, use an oil with a TBN of 30 and reduce the oil change interval by one half. Consult your Caterpillar dealer for correct engine oil recommendations.

NOTE B: Check fuel pressure gauge daily. Replace when FUEL PRESSURE gauge registers OUT or 20 PSI (124 kPa).

NOTE C: The element can be cleaned approximately 3 times. Carefully inspect the element after each cleaning. If engine is not equipped with air cleaner service indicator, check element every 250 Service Meter Units, or more often under dusty conditions. If after servicing the air cleaner, the exhaust smoke and/or loss of power continues, install a new element.

NOTE D: Authorized Caterpillar dealers are equipped with the necessary tools, personnel and procedures to perform these services.

NOTE E: Initial valve lash adjustment on new, rebuilt or remanufactured engines is recommended at the first scheduled oil change interval, due to initial wear and seating of valve train components. Subsequent adjustments should be made at every 2000 Service Meter Units or One year, Whichever Occurs First.

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LUBRICATION INSTRUCTIONS

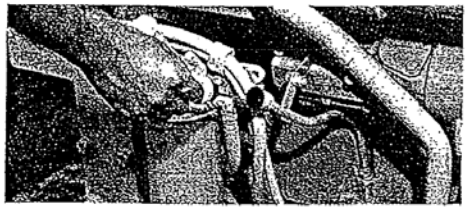
Crankcase Lubrication Oil

The Lubrication and Maintenance Charts list the normal oil change periods as determined by fuel sulphur content. (Make an initial oil and filter change after the first 10 service meter units of operation for reconditioned engines).

See the OIL SPECIFICATIONS to aid in the proper oil SAE viscosity selection. The proper SAE viscosity of oil to select is determined by the ambient temperature at which the engine is started and operated.

Checking Oil Level

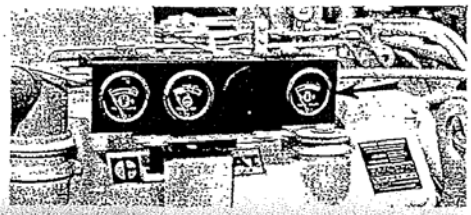
The dipstick is stamped on both sides of the blade. One side is marked and to be read when checking the oil level with the ENGINE STOPPED. The other side is marked and to be read with the ENGINE IDLING—HOT OIL. Each side is stamped to remind you not to OVERFILL the crankcase with oil.



CAUTION
Be sure to read the correct side of the dipstick. The ADD and FULL levels are not the same when checking the oil while stopped or while idling.

Checking Oil Pressure

Immediately after starting, and frequently during operation, observe the oil pressure gauge reading. The indicator should register in the NORMAL range.



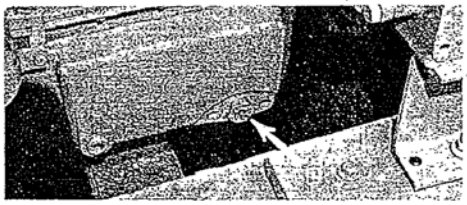
If the indicator fluctuates or registers below NORMAL range:

1. Move the governor control to low idle position.
2. Check the oil level. Be sure to read the ENGINE IDLING side of the dipstick.
3. Add oil until the oil level is at the FULL mark on the ENGINE IDLING side of the dipstick. Do not overfill.
4. Check for oil leaks.
5. If necessary, stop the engine and have repairs made.

Draining Engine Oil

With engine stopped and oil warm:

1. Remove the crankcase oil drain plug.
2. Allow the oil to drain.



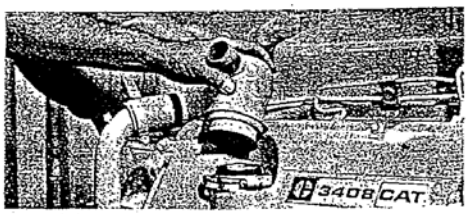
3. Clean and install the drain plug.

OR, if a sump pump is used:

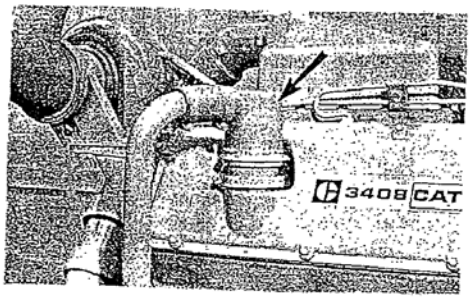
1. Connect a suitable drain line and container to the pump outlet.
2. With engine stopped and oil warm, open the sump pump valve to the engine crankcase drain line: The two marks on the valve must be turned so that one mark points to the pump, and the second mark points to the engine drain line.
3. Operate the sump pump handle until the crankcase is empty.
4. Close the valve to the engine crankcase drain line.

Cleaning the Breather

1. Release the hose clamp and disconnect the fumes disposal tube.
2. Remove the breather assembly.

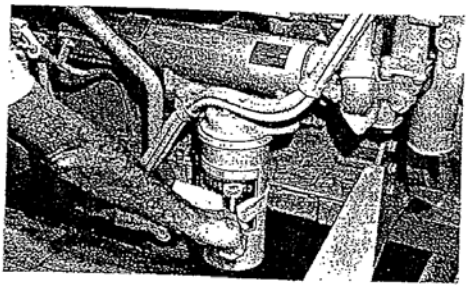


3. Wash the breather in solvent.
4. Allow to drain dry and then wipe.
5. Inspect the gasket. Install a new gasket if necessary.
6. Install the breather.
7. Connect the fumes disposal tube.

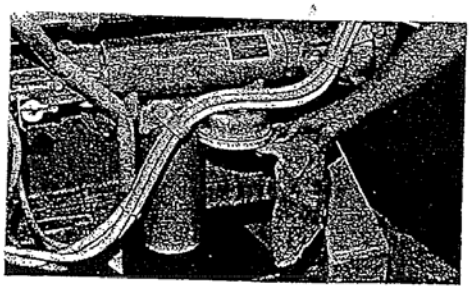


Changing Oil Filter

1. Unscrew and remove the filter.

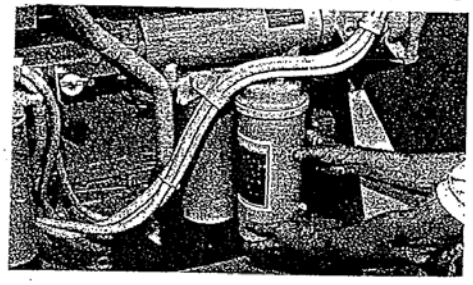


2. Be sure the old filter gasket did not remain attached inside the filter base: Leaking will occur between the new filter gasket and this old gasket.
3. Wipe the filter base.



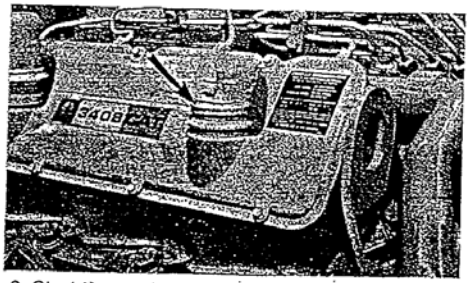
4. Apply a thin coat of clean oil to the gasket of the new filter.

5. Install the new filter: Hand tighten the filter ¾ turn after the filter gasket contacts the base. Use rotation index numbers, which are painted on the filter can, as a guide for proper tightening.



Filling the Crankcase

1. Fill the crankcase to the safe starting range on the ENGINE STOPPED side of the dipstick. See the Lubrication Specifications for refill capacity and proper oil viscosity.



2. Start the engine and check for oil leaks.
3. After the engine is warm, check the oil level with the engine idling.
4. Add oil if necessary to maintain the oil level at the FULL mark on the ENGINE IDLING side of the dipstick.

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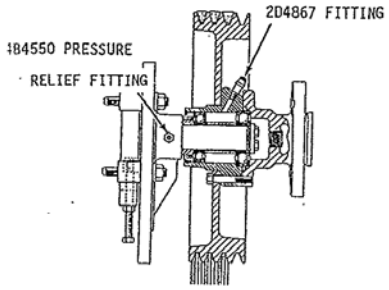
Fan Drive Bearings

Lubricate the fan drive bearings with lubricating grease through one fitting, 1 or 2 strokes.



LOCATION OF 4B4550 PRESSURE RELIEF FITTING AND 2D4867 FITTING SHOWN IN THE STANDARD LOCATION.

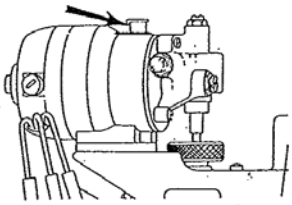
If the grease fitting is not readily accessible, it may be necessary to

1. Remove the 4B4550 Fitting (relief) from the fan mounting bracket assembly and install the 2D4867 Fitting in its place.

2. Install the 4B4550 Fitting (relief) in place of the 2D4867 Fitting.

Woodward PSG Governor Synchronizing Motor

Fill the oil cup on the synchronizing motor with clean engine oil with same viscosity as used in the engine.



Air Starting Motor

The motor oiler lubricates the vanes of the starting motor with a fine oil mist as the motor is operating.

When the oil jar becomes half empty, remove the oil filler plug and fill the jar with clean engine oil with the same viscosity as used in the engine.

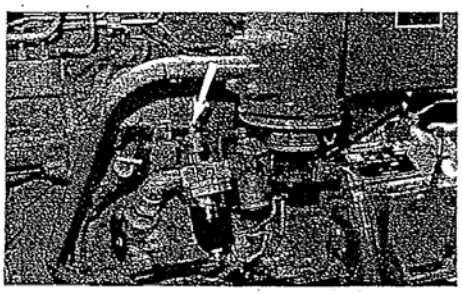
CAUTION

Never allow the jar to become empty. The starting motor will be damaged by lack of proper lubrication.

Adjusting Oiler Feed

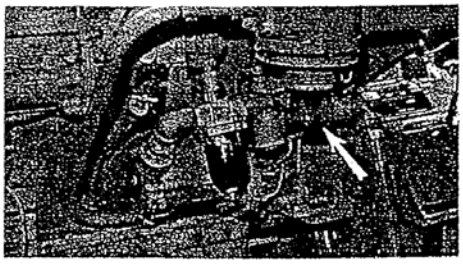
If necessary, adjust the oiler to release approximately four drops of oil per minute into the starting motor air stream.

1. The engine must be operated long enough to have the oil warm. Then stop the engine.
2. Move the governor control lever to the SHUT-OFF position.
3. Push in on the air start control and crank the engine.
4. Count the drops of oil released per minute into the air stream.
   a. Turn the needle valve (the uppermost knob on the oiler) counterclockwise to increase the number of drops.
   b. Turn the needle valve clockwise to decrease the number of drops.



Emptying Oil Collector Jar

Empty the oil collector jar whenever the jar becomes half full. The collector jar collects both the oil after it has lubricated the starting motor vanes, and the moisture condensation from the compressed air. Do not fill the oiler jar with this used oil.



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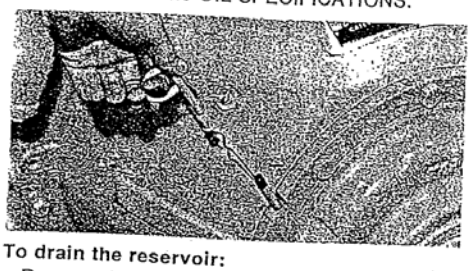
Power Coupling Attachment

Heavy Duty Clutch Main Shaft Bearings

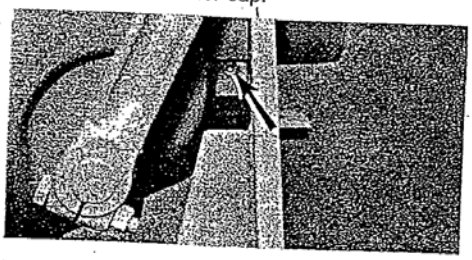
The heavy duty flywheel clutch main shaft bearing is oil lubricated. The remaining bearings are lubricated with grease.

Check the main shaft bearing oil reservoir level with engine stopped. Maintain the oil level at the FULL mark on the oil level gauge. Add oil through the filler tube on top of the bearing cage housing. Use the same type of oil as used in the engine crankcase. See the OIL SPECIFICATIONS.



To drain the reservoir:

Remove the drain plug located on the lower left side of the shaft bearing reservoir. Drain and install the drain plug. Fill to the FULL mark on the oil level gauge. Install the filler cap.

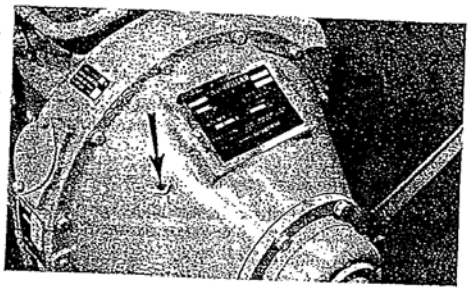


Enclosed Clutch Shaft Bearings (Grease Lubricated)

Lubricate the shaft bearings through 1 fitting.

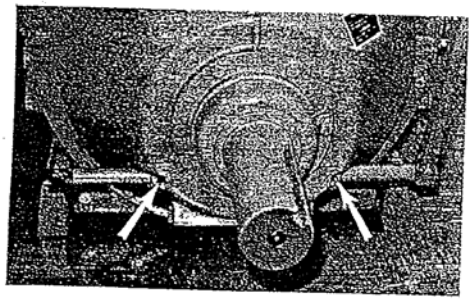
Front/Rear Clutch Engaging Collar

Lubricate through 1 fitting—2 strokes.



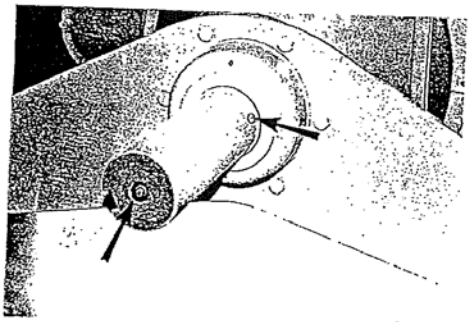
Control Lever Shaft Bearings

Lubricate through 2 fittings—2 strokes.



Clutch Pilot Bearing

Lubricate sparingly through 1 fitting on end of shaft. If fitting is not accessible, remove the plug on the circumference of the shaft near the housing and install a grease fitting. Reinstall plug after lubricating.



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)LING SYSTEM

nt Conditioner Element

WARNING

·ating Temperature, engine coolant is hot er pressure.

:an cause personal injury.

oolant level ONLY, when engine is stopped ·ator cap is cool enough to touch with your

filler cap slowly to relieve pressure.

System Inhibitor contains alkali. Avoid con- h skin and eyes to prevent personal injury.

CAUTION

r is corrosive at engine operating tempera- e either Caterpillar Cooling System Inhibitor r the coolant conditioner element to treat ain water or ethylene glycol solution.

dd both the liquid cooling system inhibitor coolant conditioner element at the same

CAUTION

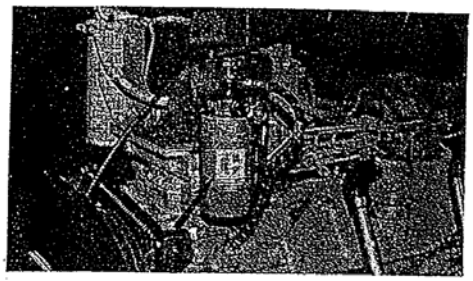
hanging antifreeze solution, replace the ance filter element with the correct pre- lement.

CAUTION

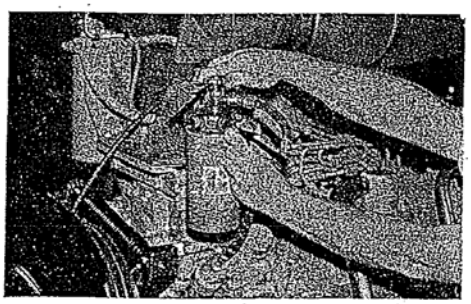
nal coolant conditioner element must not be h Dowtherm 209 coolant.

CAUTION

e coolant conditioner (greater than the rec- ed 6% initial fill) together with concentrations eze greater than 65% cause deposits to form result in radiator tube blockage and ng.



1. Close inlet valve and outlet valve at element base. Turn clockwise to close both valves.

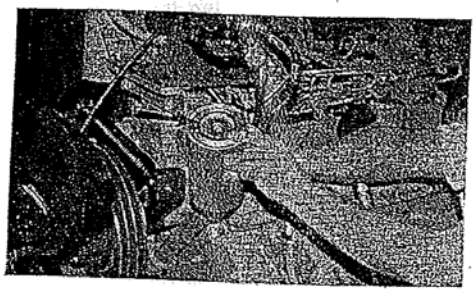


2. Remove the coolant conditioner element. Discard element.

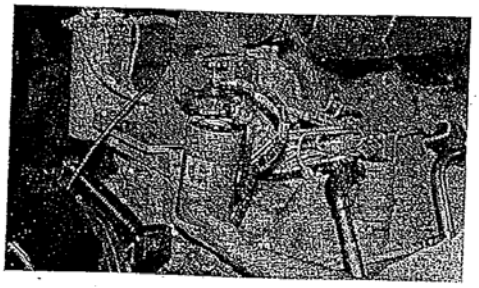
fresh engine coolant consisting of either plain water and antifreeze is installed, a precharge should be installed for use until the first normal change period.

3. Clean element mounting base. Make certain all of old element gasket material is removed.

4. Use the correct maintenance element for your cooling system. Maintenance elements are sized to the coolant system capacity.



5. Coat the seal of the element with a thin film of clean engine oil or antifreeze.-



6. Install the element until seal contacts base, then tighten an additional 3/4 turn.

7. Open the inlet valve and outlet valve.

8. Start engine and check for leaks.

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215909

תשתיות נפט ואנרגיה בע"מ
קו מוצרי דלק בע"מ
אגף הנדסה

מסוף הטרמינל ק"ח

משאבה ניידת צנטריפוגלית VICTOR

יצרן DEUTZ

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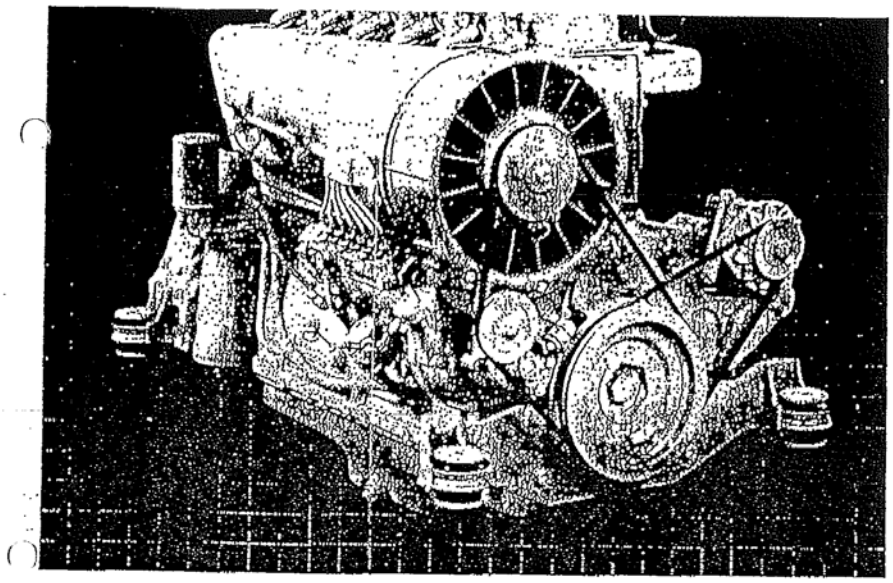
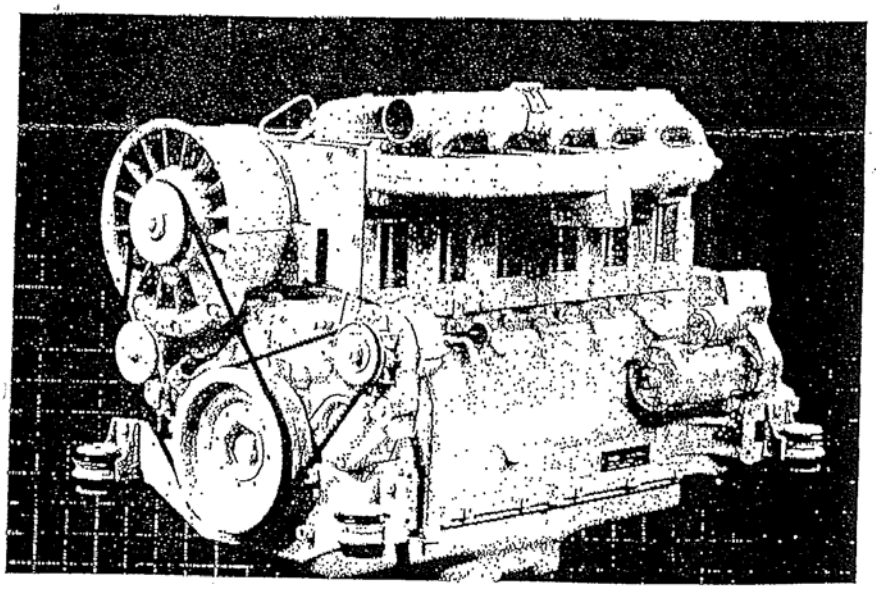
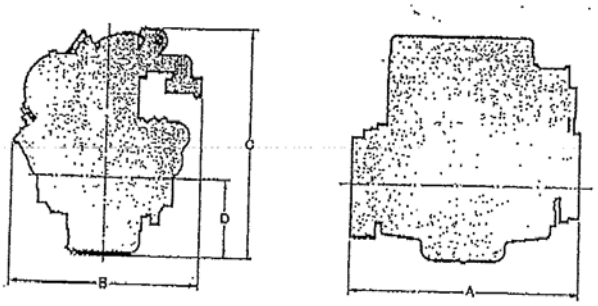




0031 0108

KHD DEUTZ

Klöckner-Humboldt-Deutz AG
5000 Köln · Deutz-Mülheimer-Straße 111
Postfach 800 509 · Telefon: Köln (0221) 8221
Telegramme: Deutzmotor Köln
Telex: 8812-0



	mm A * In.	mm B * In.	mm C * In.	mm D * In.	kg G ** lbs.
F 2 L 912	808 23 15/16	582 22 15/16 626 24 5/8	772 30 3/8	244 9 5/8	235 518
F 3 L 912	703 27 11/16	661 26 1/16	813 32	280 11 1/16	270 595
F 4 L 912	810 31 7/8	661 26 1/16	803 31 5/8	270 10 5/8	300 660
F 5 L 912	945 37 3/16	661 26 1/16	838 33	305 12	380 840
F 6 L 912	1075 42 5/16	661 26 1/16	813 32	280 11 1/16	410 900

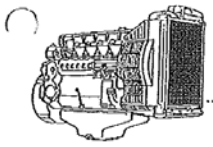
* mit Standard-Ölwanne und Standard-Schwungrad ohne angebauten Ölbadluftfilter.
** Gewicht netto nach VDMA. Seeverpackung vom Nettogewicht 25%.

* With standard oil sump and flywheel, without built-on oil bath air cleaner.
** Net weight to VDMA. . Seaworthy packing: 25% of net weight.

Nutzleistung nach ISO 3046/1 bzw. DIN 6271
Net brake power ratings to ISO 3046/1 and DIN 6271

Leistungsgruppe / Power class		II IFN								III IFN					
	n [1/min] [rpm]	2800	2650	2500	2300	2150	2000	1800	1500	2500	2300	2150	2000	1800	1500
	c_m [m/s]	11,2	10,6	10,0	9,2	8,6	8,0	7,2	6,0	10,0	9,2	8,6	8,0	7,2	6,0
F 2 L 912	P [kW] P_e [bar] (PS)			26,5 6,74 (36)	25 6,92 (34)	24 7,11 (33)	23 7,32 (31)	21 7,43 (28,5)	17 7,22 (23)	25 6,37 (34)	24 6,65 (33)	23 6,81 (31)	21 6,69 (28,5)	20 7,07 (27)	16,5 7,00 (22,5)
F 3 L 912	P [kW] P_e [bar] (PS)	43 6,52 (58)	41 6,57 (56)	40 6,79 (54)	38 7,02 (52)	36 7,11 (49)	34 7,22 (46)	31 7,31 (42)	26 7,36 (35)	38 6,45 (52)	36 6,65 (49)	35 6,91 (48)	32 6,79 (44)	29 6,84 (39)	25 7,08 (34)
F 4 L 912	P [kW] P_e [bar] (PS)	59 6,71 (80)	57 6,85 (77)	54 6,88 (73)	51 7,06 (69)	49 7,26 (67)	46 7,32 (63)	43 7,61 (58)	35 7,43 (48)	51 6,5 (69)	49 6,78 (67)	46 6,81 (63)	44 7,01 (60)	40 7,08 (54)	34 7,22 (46)
F 5 L 912	P [kW] P_e [bar] (PS)	74 6,73	71 6,81	68 6,93	65 7,20	62 7,35	58 7,39	53 7,50	44 7,47	65 6,62	61 6,76	58 6,87	55 7,01	50 7,08	42 7,13
F 6 L 912	P [kW] P_e [bar] (PS)	88 6,67 (120)	85 6,81 (116)	82 6,96 (111)	78 7,20 (106)	74 7,31 (101)	70 7,43 (95)	64 7,55 (87)	54 7,64 (73)	78 6,62 (106)	74 6,83 (101)	70 6,91 (95)	66 7,01 (90)	60 7,08 (82)	51 7,22 (69)

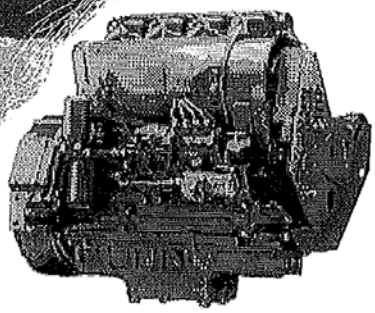
Leistungsgruppe / Power class		IV ICFN													
	n [1/min] [rpm]					2300	2150	2000	1800	1500					
	c_m [m/s]					9,2	8,6	8,0	7,2	6,0					
F 2 L 912	P [kW] P_e [bar] (PS)					23 6,37 (31)	21 6,22 (29)	20 6,37 (27)	18,5 6,54 (25)	15,5 6,58 (21)					
F 3 L 912	P [kW] P_e [bar] (PS)					35 6,46 (48)	32 6,32 (44)	30 6,37 (41)	28 6,61 (38)	24 6,79 (33)					
F 4 L 912	P [kW] P_e [bar] (PS)					46 6,37 (63)	44 6,52 (60)	41 6,53 (56)	38 6,72 (52)	32 6,79 (44)					
F 5 L 912	P [kW] P_e [bar] (PS)					58 6,42 (79)	55 6,52 (75)	52 6,62 (71)	48 6,79 (65)	40 6,79 (54)					
F 6 L 912	P [kW] P_e [bar] (PS)					70 6,46 (95)	66 6,52 (90)	63 6,68 (86)	57 6,72 (77)	48 6,79 (65)					



912. Der Gen Motor.

DEUTZ

29-77 kVA at 1500/1800 min^{-1}



The engine with integrated cooling system.

These are the characteristics of the 912 GEN:

3-, 4-, 6-cylinder naturally aspirated in-line engine.
Displacement: 0.94 l/cylinder.
Unit construction system with single cylinder heads.
Optimized injection and combustion system.
Electronic governor.
Worldwide proven: Over 2.7 Mill. engines sold.
Only a few service points.
Powerful and compact, low weight.
Global service net with over 3,000 locations.

These are the benefits for you:

- Low operating noise level. This eliminates the need for costly noise attenuation measures.
- Low fuel and oil consumption. User-friendly maintenance and lon service intervals ensures low operating costs.
- Easy and cost-effectively installation with minimum weight and small space requirements.
- Outstanding load acceptance ensures an immediately available energy supply.
- Incomparably low exhaust emission. Meets all industrial exhaust regulations.

תשתיות נפט ואנרגיה בע"מ
קו מוצרי דלק בע"מ
אגף הנדסה

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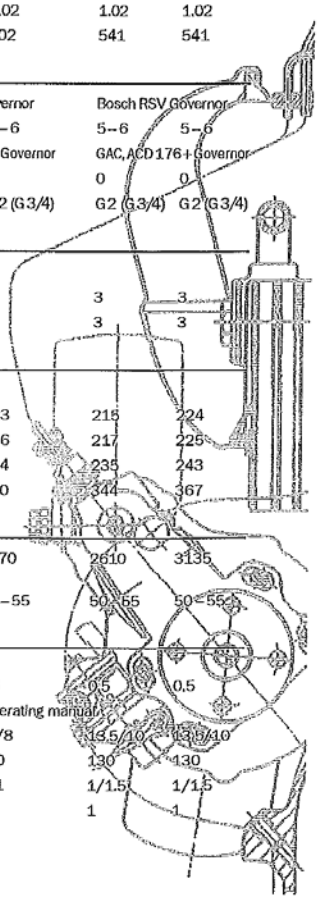
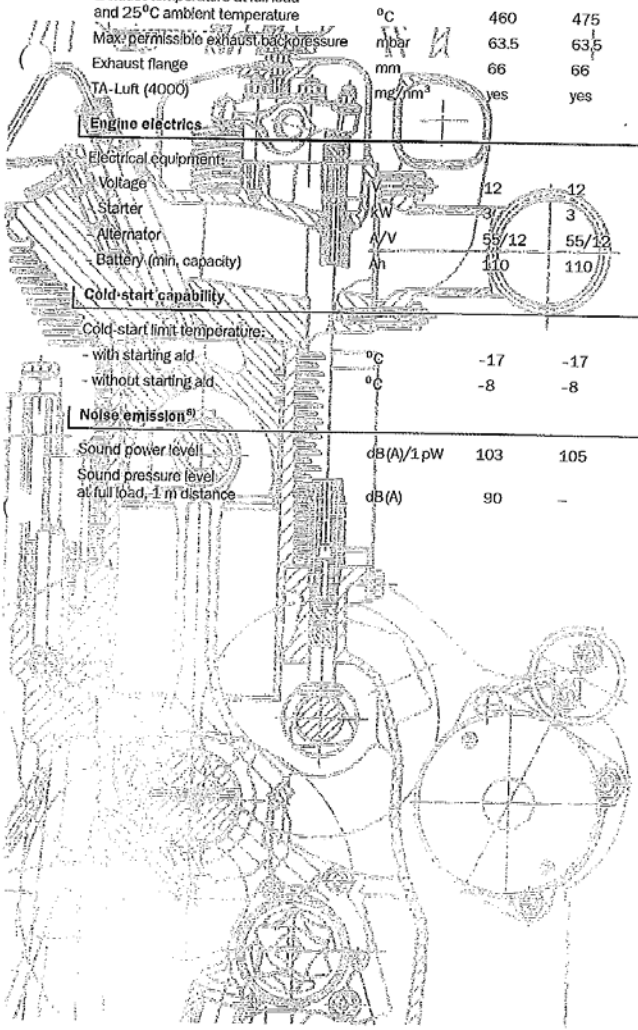
Technical data

Engine type		F3L912GEN		F4L912GEN		F6L912GEN	
Speed	min^{-1}	1500	1800	1500	1800	1500	1800
Frequency	Hz	50	60	50	60	50	60
Engine/genset ratings[4]							
Continuous power, ICN (COP)[2]	kW	25	29	33	39	50	60
Prime power, ICN (PRP)[3]	kW	26	30.5	35	41	52	63
Limited-time runing power, IFN (LTP)[4]	kW	27	32	36	43	55	66
Typical generator power output (COP)[5]	kVA	29	34	38	45	58	70
Typical generator power output (PRP)[5]	kVA	30	35	41	48	60	73
Typical generator power output (LTP)[5]	kVA	31	37	42	50	64	77
Basic engine data							
Inertia moment J							
- Engine without flywheel	kg/m^2	0.15	0.15	0.16	0.16	0.21	0.21
- Flywheel	kg/m^2	1.02	1.02	1.02	1.02	1.02	1.02
Weight, engine with radiator	kg	351	351	402	402	541	541
Governing							
Governor mechanical		Bosch RSV Governor		Bosch RSV Governor		Bosch RSV Governor	
- Speed droop (static)	%	5–6	5–6	5–6	5–6	5–6	5–6
Governor electronic		GAC, ACD176+Governor		GAC, ACD176+Governor		GAC, ACD176+Governor	
- Speed droop (static, option)	%	0	0	0	0	0	0
Control quality, mech. (electr.)[6]		G2 (G3/4)	G2 (G3/4)	G2 (G3/4)	G2 (G3/4)	G2 (G3/4)	G2 (G3/4)
Load acceptance							
Recovery time							
at 80 % continuous power (COP)	sec.	3	3	3	3	3	3
at 100 % continuous power (COP)	sec.	3	3	3	3	3	3
Fuel system							
Specific fuel consumption at COP[7]							
100 % load	g/kWh	215	223	215	223	215	224
75 % load	g/kWh	217	226	217	226	217	225
50 % load	g/kWh	235	245	236	244	235	243
25 % load	g/kWh	344	372	348	370	344	367
Cooling system/cooling capacity							
Coolant volume engine	m^3/h	1565	1875	1810	2170	2610	3135
Max. coolant temperature at engine outlet (alarm)	°C	50–55	50–55	50–55	50–55	50–55	50–55
Lubrication system							
Lube oil consumption of fuel consumption at full load	ca. %	0.5	0.5	0.5	0.5	0.5	0.5
Lube oil specification		For further details on fuel specification see operating manual					
Lube oil volume, oil pan (max./min.)	l	9/7	9/7	11/8	11/8	15.5/10	15.5/10
Oil temperature max.	°C	130	130	130	130	130	130
Full-flow filter	No./l	1/1	1/1	1/1	1/1	1/1.5	1/1.5
Min. oil pressure (alarm)	bar	1	1	1	1	1	1



Technical data

Engine type		F3L912GEN		F4L912GEN		F6L912GEN	
Speed	min^{-1}	1500	1800	1500	1800	1500	1800
Frequency	Hz	50	60	50	60	50	60
Combustion air system							
Combustion air volume flow	m^3/h	108	130	144	173	216	259
Max. intake vacuum (filter clean)	mbar	10	10	10	10	10	10
Exhaust system							
Exhaust gas mass flow at full load (COP)	kg/h	123	148	163	197	245	295
Exhaust temperature at full load and 25°C ambient temperature	°C	460	475	455	480	460	490
Max. permissible exhaust backpressure	mbar	63.5	63.5	75	75	75	75
Exhaust flange	mm	66	66	66	66	66	66
TA-Luft (4000)	mg/m^3	yes	yes	yes	yes	yes	yes
Engine electrics							
Electrical equipment:							
- Voltage	V	12	12	12	12	12	12
- Starter	kW	3	3	3	3	3	3
- Alternator	A/V	55/12	55/12	55/12	55/12	55/12	55/12
- Battery (min. capacity)	Ah	110	110	110	110	110	110
Cold-start capability							
Cold-start limit temperature:							
- with starting aid	°C	-17	-17	-16	-16	-14	-14
- without starting aid	°C	-8	-8	-7	-7	-6	-6
Noise emission[6]							
Sound power level	dB(A)/1 pW	103	105	104	106	106	110.5
Sound pressure level at full load, 1 m distance	dB(A)	90	–	91	–	93	–



1) Power reduction caused by altitude and temperature possible. For details refer to DEUTZ. Emission optimized version.
2) Net-continous power 100 % available at flywheel, no time limitation, plus 10 % extra power for governing purposes.
3) Net-prime power 100 %, permissible average power output equal to or below 60 %, no time limitation plus 5 % extra power for governing purposes.
4) Net-limited-time running power 100 %, which can be delivered during 500 running h/a, there of max. 300 running h/a continuously, no overload permissible; the required extra power for governing purposes must be taken into account however.
5) Taking into account typical generator efficiency, fan power input (NT-cooling system) and power factor cos (∂) = 0.8. Generator efficiency: 0.93.
6) Performance acc. to ISO 8528.
7) Fuel specification: see operation manual.
8) With standard cooling system.

The values given in this data sheet are for information purposes only and not binding. The information given in the offer is decisive.

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קו מוצרי דלק בע"מ
אגף הנדסה

מסוף הטרמינל ק"ח

משאבת כיבוי אש GOULDS

יצרן CATERFILLER

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DIESEL FUEL SYSTEM

(FOR ALL FIRE PUMP ENGINES)⊛
(TANK WITHOUT UL LABEL)

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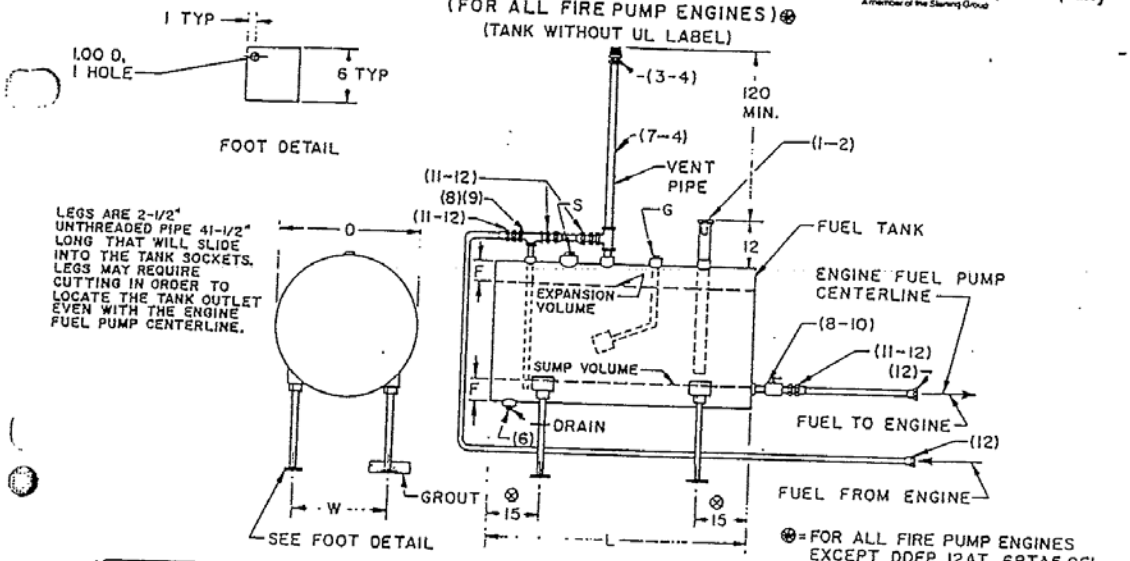

⊛=FOR ALL FIRE PUMP ENGINES EXCEPT DDFP 12AT, 6BTA5.9FI

FUEL SYSTEM – WEIGHT 30 LBS.

ITEM	QTY	MAT'L	DESCRIPTION
1	1	IRON	FILL CAP 2
2	1	STEEL	STRAINER 1/16 MESH
3	1	STEEL	WEATHER VENT 2 NPT
4	1	IRON	PIPE BUSHING 2 x 1-1/4
5	2	IRON	PIPE PLUG 2 NPT
6	1	IRON	PIPE PLUG 1 NPT
7	1	IRON	PIPE TEE 1-1/4 x 1-1/4 x 1/2
8	2	STEEL	PIPE NIPPLE 1/2 x CLOSE
9	1	IRON	PIPE TEE 1/2 x 1/2 x 1/2
10	1	BRASS	STOP COCK 1/2 NPT
11	4	BRASS	FLARED TUBE FITTING 5/8 O.D. TUBE x 1/2 MALE PIPE
12	6	BRASS	TUBE NUT FOR 5/8 O.D. TUBE

FUEL TANK — MAT'L STEEL — QTY. 1

SIZE (GAL)	D	L	F	W	WEIGHT (LBS) TANK	FUEL	TOTAL
70	24	36	2-3/4	17	247	422	669
115	24	60	2-3/4	17	297	690	987
140	24	72	2-3/4	17	352	844	1196
250	32	72	3-1/4	23	387	1507	1894
350	38	72	3-1/2	27	472	2110	2582
460	48	60	4-3/4	34	587	2773	3360
☑ 550	48	72	4-3/4	34	642	3385	4027
650	48	84	4-3/4	34	742	3920	4662
830	64	60	5-3/4	45	1107	5004	6111

⊗ =6" FOR 70 GAL. TANK ONLY

☑ FUEL GAGE – MAT'L STEEL – QTY 1 – WEIGHT 5 LBS. CALIBRATED F, 3/4, 1/2, 1/4, E

NOTES:

(A) THIS FUEL SYSTEM COMPLIES WITH THE RECOMMENDED PRACTICES DESCRIBED IN THE APPENDIX OF NFPA PAM 20.
(B) FUEL TANK OUTLET MUST BE EVEN WITH ENGINE FUEL PUMP CENTERLINE.
(C) FUEL TANK SHOULD BE LOCATED AS CLOSE TO ENGINE AS POSSIBLE.
(D) FUEL TANK SHOULD BE "PITCHED" 1/4 PER FOOT TOWARD DRAIN PLUG.
(E) FUEL TANK MUST BE LOCATED ABOVE GROUN WITH PROVISIONS TO PREVENT FREEZING.
(F) THE "USABLE FUEL VOLUME" IS 90% OF THE "FUEL TANK VOLUME" THIS WILL PROVIDE A "SUMP VOLUME" OF 5% AND AN "EXPANSION VOLUME" OF 5%.
(G) "FILL CAP" HAS PROVISIONS TO BE PADLOCKED CLOSED.
(H) "STOP COCK" HAS PROVISIONS TO BE PADLOCKED OPEN.
(I) "FUEL GAGE", IF ORDERED, SHOULD BE LOCATED AT THE 2" NPT OPENING, POINT "G"
(J) "LOW LEVEL FUEL SWITCH", IF ORDERED WITH CONTROLLER, SHOULD BE LOCATED AT THE 2" NPT OPENING, POINT "S"
(K) IN ORDER TO CONFORM TO INDIVIDUAL JOB REQUIREMENTS, THE FOLLOWING MATERIAL MUST BE FURNISHED BY OTHERS;
1. VENT, 1-1/4 PIPE
2. FUEL LINES, 5/8 O.D. SOFT COPPER TUBE
(L) THE FOLLOWING PARTS WILL BE MOUNTED ON THE ENGINE;
1. FUEL INLET & OUTLET, FLEX. HOSE
2. FUEL CHECK VALVES, IF REQUIRED
(M) ONLY ITEMS MARKED ☑ WILL BE FURNISHED FOR THIS JOB.
(N) ALL DIMENSIONS ARE IN INCHES.

DT4850074
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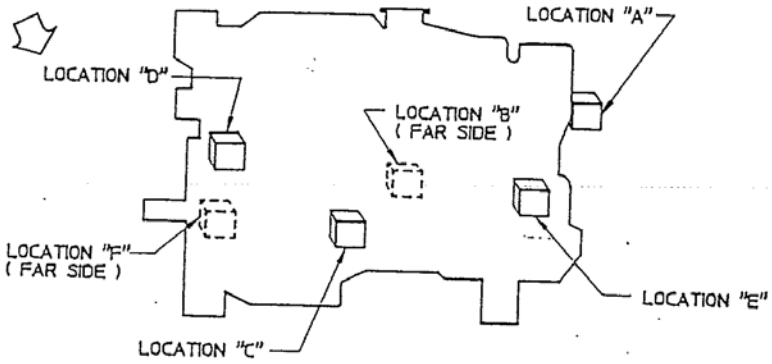
HORIZONTAL AND VERTICAL FIRE PUMPS

Diesel Engine Driven Units

Engine Pre-heater Outline



Connect a reliable source of 50/60 Hertz, single phase, AC current to the pressure and/or temperature switch. *This switch is approximately 4x4x4 and has knockouts for 1/2" conduit. Switch location is indicated above. Pre-heater volts and AMPs are indicated below. * (For Caterpillar, connect to thermostat switch 5" dia. x 4" high)

√	ENGINE MODEL	SWITCH LOCATION	VOLTS	AMPS	√
	6CTA8.3F1, F2, F3	B	115	13.0	
			230	6.5	
	3208DINA (175)(210) 3208DIT	A	115	21.7	
			230	10.8	
	ODFP-04AT	A	115	8.7	
			230	4.4	
	ODFP-T6AT, L6AT	A	115	13.0	
			230	6.5	
	3306BDIT, BDITA 3408BDITA	F	115	26.1	
			230	13.1	
	ODFP-06FA, 06FH, L6VT, T6VT ODFP-L8FA, 08FA, 08FH	A	115	21.7	
			230	10.9	
	ODFP-03DT, 03DN, T3DT, L3DT	E	115	13.0	
			230	6.5	
	ODFP-12FH, 12FT	B	230	17.4	
	3412DIT, DITA	F	230	26.2	
	6BTA5.9F1 & F2	B	115	8.9	
			230	4.5	
	NT855-F3, F4, F5, F6 NTA855F, NTTA855F	C	115	21.8	
			230	10.9	
√	3406BDIT, BDITA	D	115	26.1	
			230	13.1	√
	PDFP-L4YN, L4YT, 04YT PDFP-L6YN, L6YT, 06YT, L6YW	C	115	13.0	
			230	6.5	

Subject to change without notice.

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Rev. 7-9

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HORIZONTAL OR VERTICAL FIRE PUMPS
Diesel Engine Driven Unit

SECTION 1520
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Caterpillar Diesel Model 3406BDITA PA0084 Engine Data

6 Cylinder Inline Block, 4 Cycle, 14.5 to 1 Compression Ratio, Turbo-Charged, 5.4 Inch Bore, 6.5 Inch Stroke, 893 Cubic Inch Displacement.

NOMINAL ENGINE RPM	1760	1900	2100
UL Listed, FM Approved Bhp @ 77° F. and 300 Ft. Elevation	420	425	430
CFM Air @ 60° F. for Combustion	889	1005	1161
BTU/Minute Heat Rejection to Air	2161	2275	2502
Max. Fuel Consumption-GPM.	.346	.355	.375
Lube Oil-Quarts	36	36	36
Cooling Waste Water-GPM	30	35	35
Cooling System Capacity-Gallons	29.2	29.2	29.2
Max Allowable Exhaust Back Pressure In/Hg	2.0	2.0	2.0
Max. Cooling Water Temp.°F*	70	70	70
Max. Pump House Temp.°F*	115	115	115
Min. Pump House Temp. °F*	40	40	40

*These conditions must be satisfied to maintain a engine block temperature of 170° F. when engine is operating.

Standard Engine Equipment:

1) 24 Volt Negative Ground Electrical System
2) 3000 Watt Jacket Water Pre-heater
3) Dry Type Air Cleaner
4) One 6 In. NPT Exhaust Connection
5) One Element Type Fuel Filter
6) Starter 24 V Pre-wired To Manual Contactors
7) Alternator
8) Lube Oil Pressure Gauge
9) Tachometer
10) Over speed Switch
11) High Water Temperature Switch
12) Mechanical Governor
13) Heat Exchanger Suitable for Fresh or Salt Water 2 In NPT Outlet
14) A 13 Terminal Junction Box pre-wired to Electrical System and suitable for connection to a UL/FM Listed Dua Battery Automatic Controller
15) Raw Water Cooling System including Pressure Regulator,; Strainers; Solenoid Valve (furnished on Horizontal Pumps only); Shut Off Valves; Manual By-Pass Valve; pre-assembled and mounted on base and piped to engi heat exchanger. Piping from pump discharge to by-pass assembly furnished on horizontal pumps only. Coolir water is to be free of contamination. Waste water from engine is to be discharged under atmospheric pressure (no back pressure).
16) Factory Choice Flexible Coupling (Horizontal Pumps)
17) Factory Choice Universal Joint Drive Shaft (Vertical Turbine Pumps)
18) Lube Oil Filter with By-Pass
19) Jacket Water Temperature Gauge
20) Low Oil Pressure Switch
21) Dual Starter Contactors
22) Dry Shielded Exhaust Manifold
23) Stub Shaft 3-3/8 In. Dia x 8 In. Usable Length

Subject to change without notice

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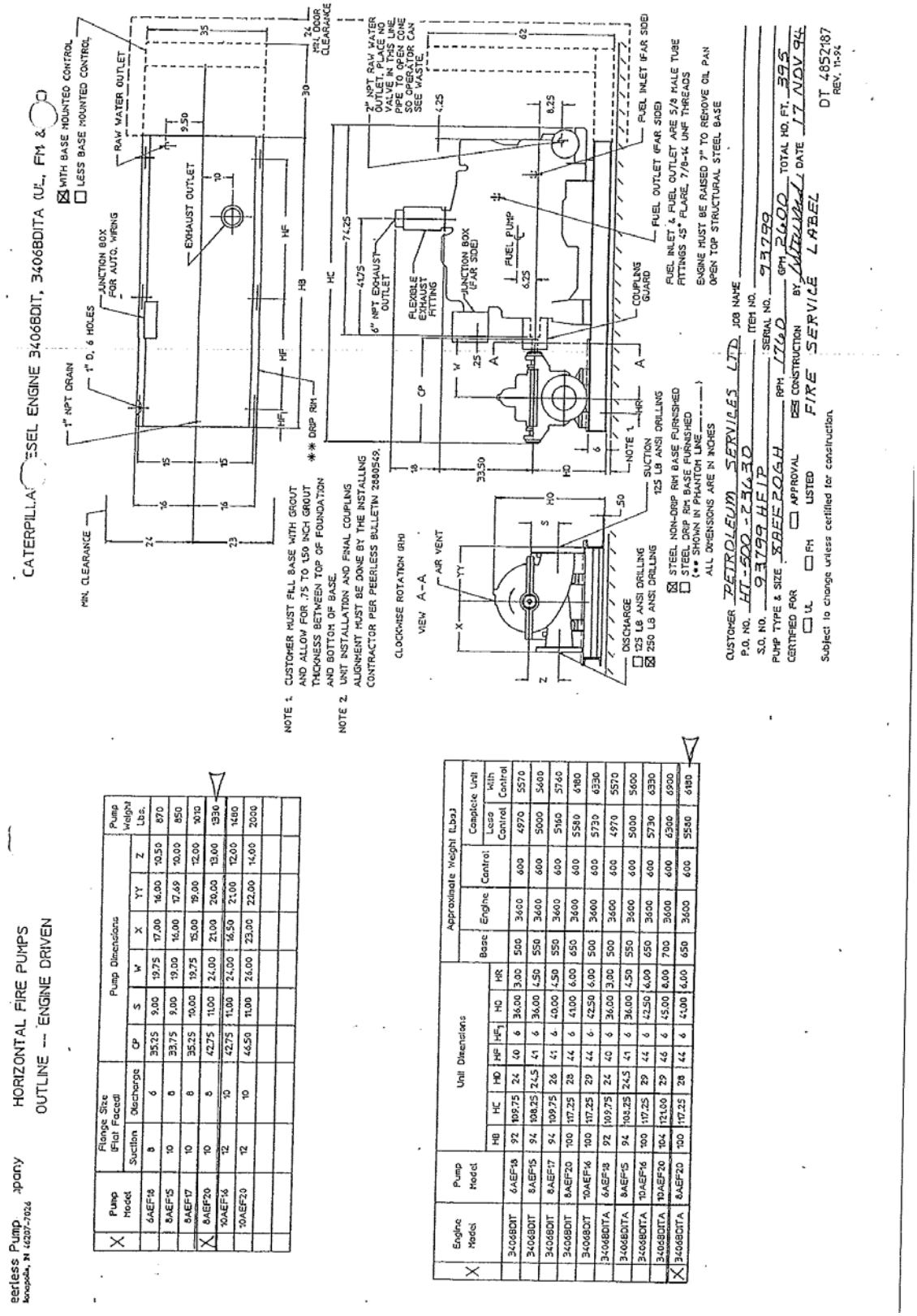

X	Pump Model	Flange Size (Flat Faced) Suction	Discharge	Pump Dimensions CP	S	W	X	YY	Z	Pump Weight Lbs.
	6AEF18	8	6	35.25	9.00	19.75	17.00	16.00	10.50	870
	8AEF15	10	8	33.75	9.00	19.00	16.00	17.69	10.00	850
	8AEF17	10	8	35.25	10.00	19.75	15.00	19.00	12.00	1010
X	8AEF20	10	8	42.75	11.00	24.00	21.00	20.00	13.00	1330
	10AEF16	12	10	42.75	11.00	24.00	16.50	21.00	12.00	1480
	10AEF20	12	10	46.50	11.00	26.00	23.00	22.00	14.00	2000

X	Engine Model	Pump Model	Unit Dimensions HB	HC	HD	HF	HF1	HG	HR	Approximate Weight (Lbs) Base	Engine	Control	Complete Unit Less Control	With Control
	3406BDIT	6AEF18	92	109.75	24	40	6	36.00	3.00	500	3600	600	4970	5570
	3406BDIT	8AEF15	94	108.25	24.5	41	6	36.00	4.50	550	3600	600	5000	5600
	3406BDIT	8AEF17	94	109.75	26	41	6	40.00	4.50	550	3600	600	5160	5760
	3406BDIT	8AEF20	100	117.25	28	44	6	41.00	6.00	650	3600	600	5580	6180
	3406BDIT	10AEF16	100	117.25	29	44	6	42.50	6.00	500	3600	600	5730	6330
	3406BDITA	6AEF18	92	109.75	24	40	6	36.00	3.00	500	3600	600	4970	5570
	3406BDITA	8AEF15	94	108.25	24.5	41	6	36.00	4.50	550	3600	600	5000	5600
	3406BDITA	10AEF16	100	117.25	29	44	6	42.50	6.00	650	3600	600	5730	6330
	3406BDITA	10AEF20	104	121.00	29	46	6	45.00	8.00	700	3600	600	6300	6900
X	3406BDITA	8AEF20	100	117.25	28	44	6	41.00	6.00	650	3600	600	5580	6180

תשתיות נפט ואנרגיה בע"מ
קו מוצרי דלק בע"מ
אגף הנדסה

מסוף הטרמינל ק"ח

גנרטור חרום

יצרן DETROIT

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DETROIT

Drive Belts

Adjust the alternator drive belts as recommended under the Preventive Maintenance Section 2.

Storage Battery

Check the batteries. The top should be clean and dry, the terminals tight and protected, and the electrolyte must be at the proper level. They should be tested weekly to determine the condition of cells, and the amount of charge.

NOTE: Once each week, check the batteries with a hydrometer; the corrected reading should be 1.265 or higher. Hydrometer readings should be corrected for the temperature of the electrolyte. Should a problem be detected, locate source and correct.

Oil Pressure

Normal engine operating oil pressure is 40-70 psi (276-433 kPa). If operating pressure falls below 30 psi (206 kPa), stop engine and investigate cause.

Coolant Temperature

When unit is not running, Jacket water heaters maintain engine coolant between 120 -140 degrees F (49-60° C). When running, engine coolant temperature should register between 180-200 degrees F (82-93° C). See Section 3 for detailed information.

Crankcase

The oil level should be maintained between the *Full* mark and *Low* mark. Check the oil level weekly prior to normal exercise. The oil dipstick is located on the right side of the engine. Do not check oil level when the engine is running. If the engine crankcase was refilled, stop the engine after normal operating temperature has been reached, allow the oil to drain back into the crankcase (approximately 10 minutes) and check the oil level. Add oil, if necessary, to bring it to the proper level on the dipstick.

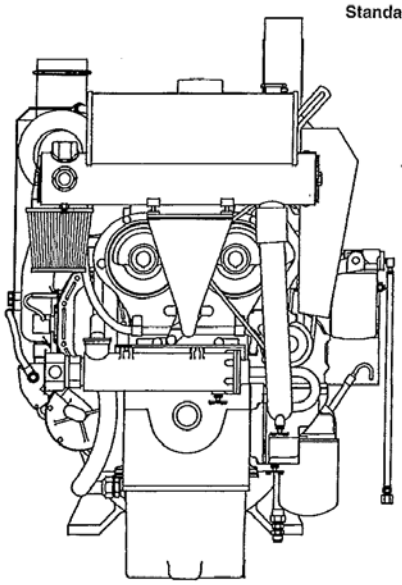
NOTE: DO NOT OVER-FILL CRANKCASE.

Use only the recommended lubricating oil specified under Section *3* - Lubricating Oil.

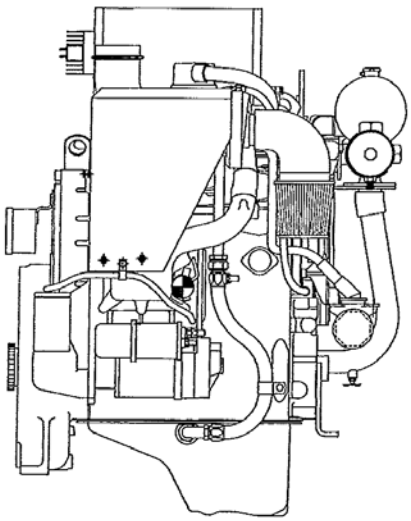
Running Inspection

While the engine is running at operating temperature, check for coolant, fuel or lubricating oil leaks. Tighten the line

Standard Model Views



Front View (I-53)



Right Side View (I-53)

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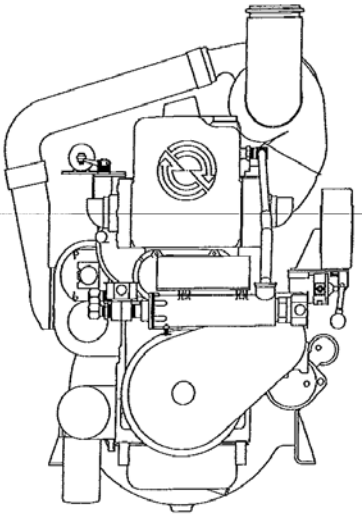
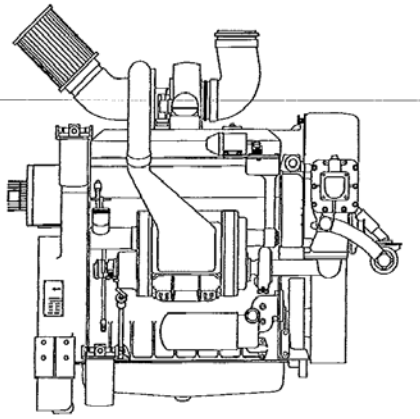
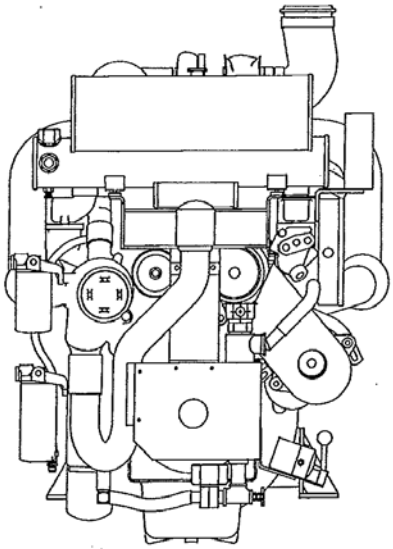


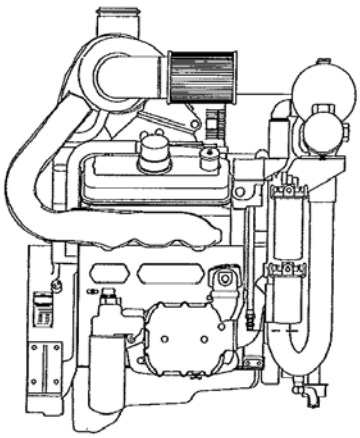
Front View (I-71)



Right Side View (I-71)



Front View (V-71)



Right Side View (6V-71)

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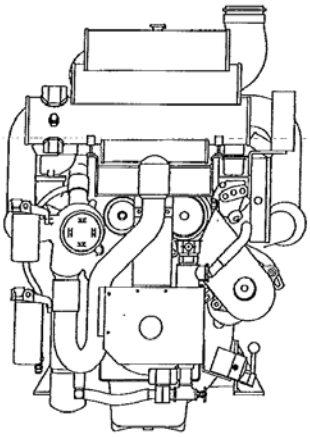
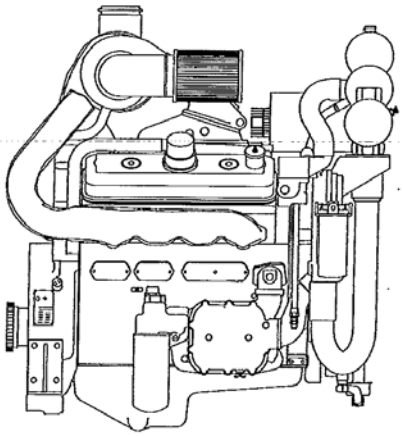
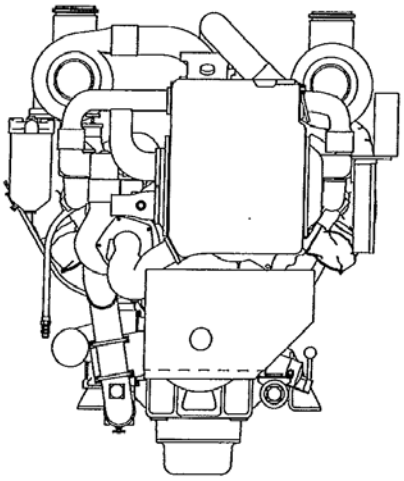


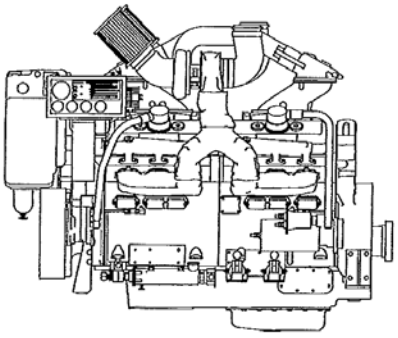
Front View (V-92)



Right Side View (V-92)



Front View (12V-92)



Left Side View (12V-92)

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ELECTRONIC SPEED SWITCH

The speed switch is located on the rear or back side of the instrument panel.

There are two (2) functions built into the speed switch. First to terminate starter cranking, once the engine is running. Second to signal the controller and ef fect an engine shutdown in the event of an engine overspeed condition.

Features of the speed switch are a "manual reset b utton" on the face of the switch, which must be pushed into reset the switch should the engine shutdo wn from an overspeed condition. Additionally, a varification circuit to assist in checking or setting the overspeed set point.

CALIBRATION

Both crank terminate (SW#1) and o verspeed (SW#2) set points, are set at the factory and should not require additional calibration. Adjustments can be made to the set points of SW#1 and/or SW#2 if required using a je welers screw driver. Turning the corresponding adjustment scre w CW to increase or CCW to decrease the set point. To access either adjustment screw remove the small co ver plate on the f ace of the speed switch.

Crank terminate (SW#1) adjustment should be done reading "engine crankshaft" speed at the front of the engine using a hand held tachometer . F or starter protection and optimum engine stability, this switch should be calibrated to 1000 RPM.

Overspeed (SW#2) adjustment should be done r eading "engine crankshaft" speed at the front of the engine using a hand held tachometer . This switch should be calibrated to 120% of rated speed, but ne ver higher than 3200 RPM. Refer to the stainless steel nameplate located at the right rear of the engine for the correct rated speed.

OVERSPEED VARIFICATION

To varify the function of the overspeed signal (SW#2) without overspeeding the engine, install a jumper wire on terminals "C & D" of the speed switch. This will provide the controller with an o verspeed signal and engine shutdo wn at 67% of calibrated RPM.

Start the engine via the controller , the speed switch will effect an overspeed signal and shutdown protecting both the engine and pump.

EXAMPLE

Rated Speed : 2100 RPM
Overspeed Shutdown : 2520 RPM (120% of 2100 RPM)
Varification Shutdown : 1688 RPM (67% of 2520 RPM)

CAUTION

After v arification of SW#2 the jumper wir e must be removed and the "reset b utton" pushed in to re-instate normal operation of the engine and speed switch.

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PREVENTIVE MAINTENANCE SCHEDULE

Item	Inspection Interval			
	Weekly	6 Months	1 Year	2 Year
1. Run Engine (per NFPA 20 Specifications)	X			
2. General Inspection	X			
3. Lubricating Oil	X		R	
4. Fuel Tank	X			
5. Fuel Lines		X		
6. Cooling System	X			R
7. Battery	X	C		
8. Air Cleaner - Dry Type (-03AN & -04AN)		X	R	R
- Oil Gauze (All Other Models)		X	C	R
9. Drive Belts		X		
10. Speed Control		X		
11. Fuel & Lube Oil Filters			R	
12. Exhaust System	X	X		
13. Battery Charging Alternator		X		
14. Manual Contractors		X		
15. Operating Gauges	X			
16. Crankcase Vent System			X	
17. Heat Exchanger Electrode				X
18. Governor Run-Stop Mechanism		X		
19. Jacket Water Heater	X			
20. Wiring System			X	
21. Coolant Hose Inspection	X			R

See Parts Information Section 6 for Lubricating Oil And Coolant Analysis' Kits

IMPORTANT: Set AEC to "of f" while servicing engine. Before turning the AEC to the "off" position, check with the maintenance and security supervisors to v erify that all departments concerned will be alerted of the temporary interruption of their fire protection equipment for normal maintenance or testing. Also, alert the local fire department in the event that the AEC is connected by silent alarm to headquarters. When servicing is complete, return AEC selector to "Automatic" position and the manual operating le ver to "auto - off" position.

X Check
R Replace
C Clean

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ENGINE SYSTEMS

In this **Engine Systems** section that follows, data is presented in a generalized way for a description of system operation. For specific operational data and system limits, refer to Section 5. In addition to knowing the specific DDFP model being operated, make special note of the certified engine operating speed (RPM). Much of the data varies by operating RPM - check the FM/UL/ULC certification tag on the engine flywheel housing for this speed.

FUEL SYSTEM

OPERATION

Fuel is drawn from the supply tank through the fuel strainer and enters the fuel pump at the inlet side. Upon leaving the fuel pump under pressure, the fuel is forced through the fuel filter and into the fuel inlet manifold where it passes through fuel pipes into the inlet side of each fuel injector. The fuel is atomized through small injector spray tip orifices into the combustion chamber. Surplus fuel, returning from the injectors, passes through the fuel return manifold and connecting fuel lines back to the fuel tank. The continuous flow of fuel through the injectors helps to cool the injectors and to remove air from the fuel system.

CHECK VALVE

A check valve is installed between the fuel filter and the fuel inlet manifold. The check valve is rated to open at approximately 2 psi (13.7 KPA). The fuel tank and supply lines should be arranged to limit static pressure so that the valve remains closed when unit is not running. This valve opens automatically from fuel pump pressure when the unit starts. Refer to Figure 1, Page 14, for fuel system components.

FUEL INJECTOR

The fuel injector combines in a single unit all of the parts necessary to provide complete and independent fuel injection at each cylinder. The injector creates the high pressure necessary for fuel injection, meters the proper amount of fuel, atomizes the fuel, and times the injection into the combustion chamber.

Since the injector is one of the most important and carefully constructed parts of the engine, it is recommended that the injector be replaced as an assembly if it is not operating properly. An authorized DDC Distributor/Dealer is equipped to provide new and reconditioned replacement injectors. Under no circumstance should an attempt be made to repair these injectors. Genuine factory new or "reliabilt" injectors should be used for repairs.

FUEL PUMP

DDFP Engines are equipped with a positive displacement gear type fuel transfer pump. Fuel pumps are furnished in either left or right hand rotation according to the engine model, and are stamped *RH* or *LH*. These pumps are not interchangeable and cannot be rebuilt to operate in an opposite rotation. The fuel pump used on the 53 series engine is driven by the governor assembly on the left rear. On I-71 it is attached and driven off the rear of the lower engine blower rotor. On VEE engines, the pump is attached and driven off the right front blower rotor located on the vee of the block.
A spring-loaded relief valve, incorporated in the pump body, normally remains in the closed position, operating only when the pressure on the outlet side (to the fuel filter) becomes excessive due to a plugged filter or fuel line.

The fuel pump incorporates two oil seals. Two tapped holes are provided in the underside of the pump body between the oil seals, to permit a drain tube to be attached. If fuel leakage exceeds one drop per minute, the seals must be replaced. An authorized DDC Distributor/Dealer is properly equipped to replace the seals or to provide reconditioned parts.

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SPIN-ON TYPE FUEL FILTER

A spin-on type fuel strainer and fuel filter (Fig. 2) is used on Clarke DDFP engines. The spin-on filter cartridge consists of a shell, element and gasket combined into a unitized replacement assembly. No separate springs or seats are required to support the filters.

The filter base incorporates a threaded sleeve to accept the spin-on filter cartridges. The word "Primary" or "Secondary" is cast on the fuel strainer base for identification.

No drain cocks are provided on the spin-on filters. Where water is a problem, residue may be drained by removing and inverting the filter. Refill the filter with clean fuel oil before reinstalling it. Should water be found, locate the source and correct by draining or cleaning as required.

Replace the Filter as Follows:

1. Unscrew the filter (or strainer) and discard it.
2. Fill a new filter replacement cartridge full with clean fuel oil. Coat the seal gasket lightly with clean fuel oil.
3. Install the new filter assembly and tighten it to two-thirds of a turn beyond gasket contact.
4. Start the engine and check for leaks.

NOTE: DDFP engines have the "Primary" filter at or below the fuel pump. One exception to this is current production I-53 engines. Due to factory designed, formed steel fuel lines, the I-53 filters are mounted the reverse of all others. The Primary Filter mounts to the cylinder head above the pump. The Secondary filter mounts to the coolant water inlet elbow below the fuel pump. Inlet fuel check valves are always located on the discharge side of the secondary filter.

DIESEL FUEL RECOMMENDATIONS

The quality and grade of fuel used is a very important factor in obtaining satisfactory engine performance, long engine life, and acceptable exhaust emission levels. Certified engine ratings are based at standard SAE conditions using the recommended #2-D Diesel Fuel. Refer to the Diesel Fuel Specifications chart Fig *3* for verification of fuel properties. For additional information on the fuel system, see technical data Section 5, Page 43. In addition, Sulfur content of the #2 Diesel Fuel used must be limited to 0.5% mass. The com-

General Fuel Classification	ASTM Test	No. 2 ASTM 2-D
Gravity, °API #	D 287	33 - 37
Flash Point, Min. °F (°C)	D 93	125 (52)
Viscosity, Kinematic cST @ 100°F (40°C)	D 445	1.9 - 4.1
Sulfur Content wt%, Max.	D 1266	0.5
Carbon Residue on 10%, wt%, Max.	D 524	0.35
Accelerated Stability Total Insolubles mg/100 ml, Max. #	D 2274	1.5
Ash, wt%, Max.	D 482	0.01
Cetane Number, Min. +	D 613	45
Cetane Index, Min. +	D 4737	40
Distillation Temperature, °F (°C)	D 86	
IBP, Typical #		375 (191)
10% Typical #		430 (221)
50% Typical #		510 (256)
90% +		625 (329) Max.
End Point #		675 (357) Max.
Water & Sediment %, Max.	D 1796	0.05

Not Specified in ASTM D 975
+ Differs from ASTM D 975

Fig. 3 - Diesel Fuel Specifications Chart

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FUEL SYSTEM SCHEMATICS

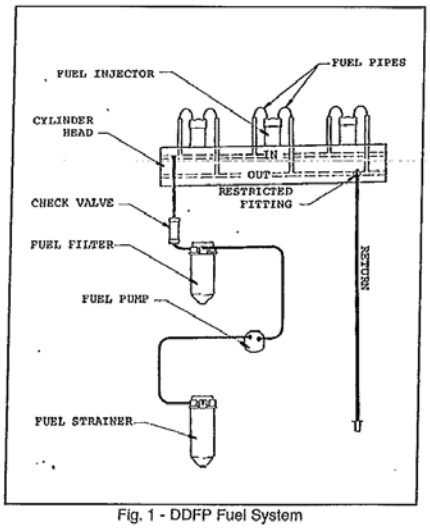

Fig. 1 - DDFP Fuel System

1. Fuel Strainer (Primary)
2. Fuel Transfer Pump
3. Fuel Filter (Secondary)
4. Check Valves
5. Cylinder Head with Internal Manifolds
6. Fuel Injectors
7. Fuel Pipes (Inlet and Return to Injector)
8. Restricted Fuel Fitting
9. Return to Tank

ENGINE MECHANICAL GOVERNOR

A v ariable speed mechanical go vernor pro vides speed control of the engine. The certified engine speed, shown on FM/UL/ULC label, has been preset at the f actory. Minor speed adjustments can be made in the f ield to meet specific installation condition, generally ± 50 RPM maximum.

The go vernor is controlled by the R UN-STOP solenoid. This solenoid is activated by a signal from the AEC. A manual over-ride switch on the instrument panel, placed in the **MANUAL** position, allows manual operation should the AEC malfunction.

Note: Always leave the instrument panel switch in the **AUTO** position when the unit is unattended.

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MAINTENANCE AND SERVICE PROCEDURES

Weekly

1). Fuel Tank: Keep the fuel tank filled to reduce condensation to a minimum. Open drain at the bottom of the fuel tank once a week to drain of f any possible w ater and/or sediment. Fill tank after each test run.

NOTE: Per NFPA 20 standards, the fuel tank level must never be less than 50% of capacity.

2). Fuel: Use a proper grade of #2-D diesel fuel only.

6 Months

Check condition of fuel lines for fraying, leaks or poor condition. Replace as necessary.

Yearly

Change primary and secondary fuel filters. Refer to Section 6 for recommended part numbers.

DIESEL FUEL CONTAMINATION

The most common form of diesel fuel contamination is water. Water is harmful to the fuel system and it also pr o-motes the growth of microbiological organisms (microbes). These microbes clog fuel f ilters with a "slime" and restrict fuel flow.

Water can be introduced into the fuel supply through poor maintenance (loose or open fuel tank caps), contaminated fuel supply or condensation.

Condensation is particularly prevalent on units which stand idle for extended periods of time, such as f ire pump units. Ambient temperature changes cause condensation in partially filled fuel tanks.

Water accumulation can be controlled by mixing isoprop yl alcohol (dry gas) into the fuel oil at a ratio of one pint per 125 gallons fuel (or 0.10% by volume).

Microbe growth can be eliminated through the use of commercially available biocides. There are tw o basic types on the mark et. The w ater soluble type treats only the tank where it is introduced. Microbe growth can start again if fuel is transferred from a treated to an untreated tank. Diesel fuel soluble type, such as "Biobor" manufactured by U.S. Borax or equivalent, treats the fuel itself and therefore the entire fuel system. Please follow manufacturer's recommendations on useage of these materials.

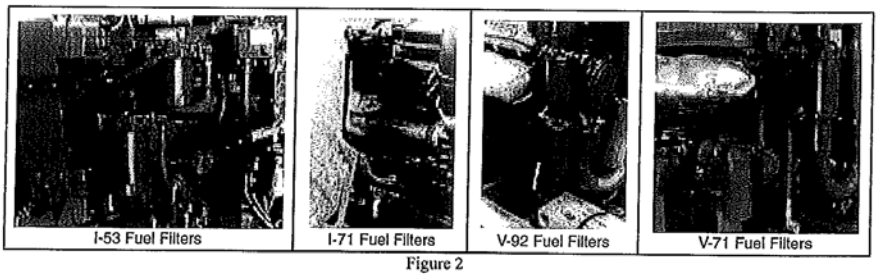
Engine Out of Fuel

The problems of restarting an engine that has run out of fuel involves the entire fuel system. After the fuel is e xhausted from the fuel tank, fuel is then pumped from the primary fuel strainer and sometimes partially removed from the secondary fuel filter before the fuel supply becomes insufficient to sustain engine firing.

To ensure prompt starting and smooth running, the fuel system must be pur ged of air and full of fuel from the supply tank to the restricted fitting at the fuel return line. To accomplish this, a manual priming pump, such as tool P/N J5956 or an electrical type priming pump can be adapted easily to the fittings provided on the secondary f ilter. To be sure the injectors are lubricated, priming through the secondary filter is preferred. The system should be primed until no air is present in the fuel flow from the return line. Pressure should not exceed 15 psi (103kPa) for ease of handling and safety reasons.

Priming is not al ways necessary if the f ilter elements are filled with fuel when installed and the fuel manifolds in the head are not drained of fuel. Prolonged use of the starter motor and engine fuel pump to prime the system can result in damage to the starter, fuel pump, injectors and erratic running of the engine, due to the amount of air in the lines and filters from the supply tank to the c ylinder head.

NOTE: Under no circumstances should a starting aid such as ether be used to run the engine until the fuel system is primed. Injector damage will occur if this method is used. The heat generated by the external fuel source will cause the tips to be damaged when the fuel cools them. The



I-53 Fuel Filters | I-71 Fuel Filters | V-92 Fuel Filters | V-71 Fuel Filters

Figure 2

AIR INTAKE AND EXHAUST SYSTEM

AIR INTAKE OPERATION

In the scavenging process employed in the engines, a charge of air is forced into the cylinders by the blower and thoroughly sweeps out all of the burned gases through the exhaust valves. This air also helps to cool the internal engine parts, particularly the exhaust valves. At the beginning of the compression stroke, therefore, each cylinder is filled with fresh, clean air which provides for efficient combustion.

The air, entering the blower from the air cleaner, is picked up by the blower rotor lobes and carried to the discharge side of the blower as indicated by the arrows in Figure 1 & 2, Page 1. The continuous discharge of fresh air from the blower enters the air chamber of the cylinder block and sweeps through the intake ports of the cylinder liners.

The angle of the ports in the cylinder liners creates a uniform swirling motion to the intake air as it enters the cylinders. This motion persists throughout the compression

AIR CLEANER

The air cleaner used on DDFP engines is either a dry type or the reusable type. Should a situation occur where the air cleaner becomes plugged with dirt (starving the engine for air), low power and heavy black smoke will be the result; the air cleaner should be serviced immediately.

CAUTION: Do not attempt to remove the air cleaner while an engine is running nor run the engine while the air cleaner is off. Exposed turbocharger could cause severe injury to personnel and major internal engine damage could occur should any foreign matter be drawn into the engine.

The air cleaner manufacturer recommends the following:

1. On engines using dry elements, replace the air cleaner element.
2. On engines with pre-oiled elements, service with a special oil. These elements can be serviced or replaced. Part number is shown in the parts section of this manual.
3. When servicing the element is not practical, you can improve filter efficiency by re-spraying with oil.

NOTE: Do not attempt this while engine is running.

NOTE: Do not over oil.

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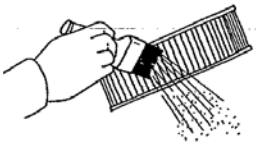
AIR FILTER SERVICE INSTRUCTIONS

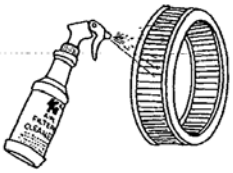
1. PRE-CLEANING

Tap the element to dislodge any large embedded dirt, then gently brush with a soft bristle brush. *(Note: If complete cleaning is not practical at this time, re-oil the element and re-install in your vehicle.)*



2. SPRAY ON CLEANER

Spray K&N air filter cleaner liberally onto the entire element and let soak for 10 minutes.



3. PAN CLEANING

Large K&N elements can be rolled or soaked in a shallow pan of K&N air filter cleaner. Remove immediately and let soak for approximately 10 minutes.

4. CLEANING HINTS

Use only K&N air filter cleaner.

NO gasoline cleaning.
NO steam cleaning.
NO caustic cleaning solutions.
NO strong detergents.
NO high pressure car wash.
NO parts cleaning solvents.

Any of these NO's can cause harm to the cotton filter media, plus shrink and harden the rubber end caps.

5. RINSE OFF

Rinse off the element with low pressure water. Tap water is OK. Always flush from the clean side to dirty side. This removes the dirt and does not drive it into the filter.

6. DRYING HINTS

Always dry naturally. After rinsing, shake off all excess water and let the element dry naturally.

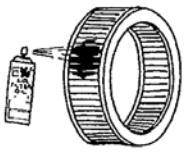
DO NOT USE COMPRESSED AIR
DO NOT USE OPEN FLAME
DO NOT USE HEAT DRYERS

EXCESS HEAT WILL SHRINK THE COTTON FILTER MEDIA.

COMPRESSED AIR WILL BLOW HOLES IN THE ELEMENT.

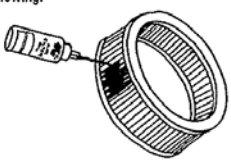
7. AEROSOL OILING

After cleaning air filter always re-oil before using. Spray K&N air filter oil down into each pleat with one pass per pleat. Wait 10 minutes and reoil any white spots still showing.



8. SQUEEZE BOTTLE OILING

After cleaning air filter always re-oil before using. Squeeze K&N air filter oil down into the bottom and along each pleat — only one pass per pleat. Let oil wick into cotton for 20 minutes. Re-oil any white spots still showing.



9. OILING HINTS

Never use a K&N air filter without oil. *(The filter will not stop the dirt without the oil.)* Use only K&N formulated air filter oil.

K&N air filter oil is a compound of mineral and animal oil blended with special polymers to form a very efficient tack barrier. Red dye is added to show just where you have applied the oil. Eventually the red color will fade but the oil will remain and filter the air.

NEVER USE Automatic Transmission Fluid.
NEVER USE Motor Oil.
NEVER USE Diesel Fuel.
NEVER USE WD-40, LPS, or other light weight oils.

Figure 1 - Air Filter Service Instructions

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AIR BOX DRAINS

During normal engine operation, water v apor from the intake air, as well as a slight amount of fuel and lubricating oil fumes, condenses and settles on the bottom of the air box. This condensation is remo ved by the air box pressure through air box drain tubes mounted on the side of the cylinder block.

Liquid accumulation in the air box will result if a drain tube becomes plugged. Remo ve the drain tubes and connectors from the c ylinder block and clean them thoroughly when necessary.

CRANKCASE VENTILATION

Harmful vapors which may form within the engine are removed from the crankcase, gear train, and injector compartments by a continuous, pressurized ventilation system.

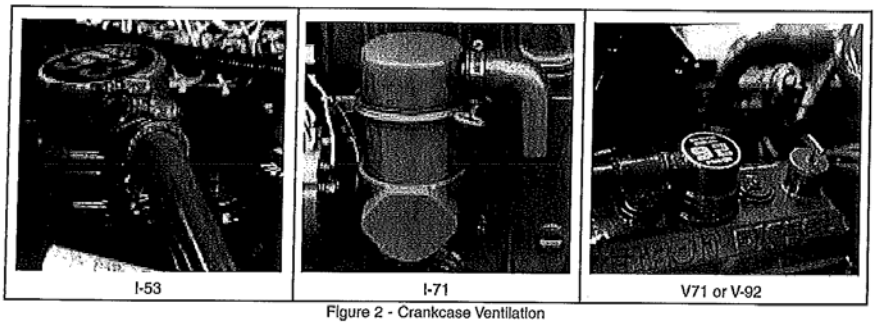

Figure 2 - Crankcase Ventilation

A slight pressure is maintained within the engine crankcase and injector compartment. This crankcase pressure and resulting ventilation is accomplished by the air seepage past the piston rings sweeping up through the flywheel housing and/or the balance weight co ver into the v alve and injector rocker arm compartment. Here it is e xpelled through a vent pipe attached to the rock er cover breather assembly. Turbo charged I-71 engines additionally use a breather attached to the front left side of the c ylinder block. Figure 2 sho ws the vent system for each engine series.

EXHAUST OPERATION

Internal combustion engines con vert fuel ener gy into both useful w ork and w asted heat. The useful w ork is the flywheel rotation that dri ves the pump. The w asted heat involves the engine water cooling system, radiated heat and the exhaust gases. Approximately 2/3 of the fuel ener gy is wasted. Critical re view must be made of these systems to assure that the engine delivers the useful power required and maintains the engine within the operating parameters established by the engine manufacturer.

The exhaust system is critical to the proper engine performance. When initially installed, consideration must be gi ven to the exhaust gas flow requirements, the exhaust temperatures and the e xhaust back-pressure limitations of the specific engine. Generally , N engines can tolerate a higher exhaust pressure than T engines. Refer to Section 5 for specific engine model and operating speed back-pressure limitations. All the components in an exhaust system contribute to the back-pressure determination including the fle x exhaust section, muffler, exhaust piping and its conf iguration. In addition to providing engine exhaust data and back-pressure limitations, Clarke of fers a service to installers, through the local Pump OEM Dealer , for making recommendations on e xhaust system sizing for specif ic installations.

MAINTENANCE AND SERVICE PROCEDURES

Weekly

Prior to each maintenance run mak e a visual check of the exhaust system to v erify condition of piping and muf fler (if used). Investigate thoroughly any areas that w ould appear to have rusty conditions such as rain w ater running do wn pipe and getting inside the engine. Se vere internal engine damage could occur.

Inspect the engine air cleaner for dirt b uildup or damage.

During actual maintenance run check engine crankcase ventilation tube for excessive blow-by or pressure.

6 Months

Inspect exhaust system for leaks or plugging,if any are found, repair immediately. Inspect and tighten if necessary e xhaust manifold, turbo mount (if equipped) and piping bolts/n uts. NFPA 37 requirements are to ha ve the e xhaust system co vered with high temperature insulation for personnel protection. Inspect the insulations condition for any deterioration or looseness, repair as necessary.

Exhaust system back pressure limits are not to be e xceeded.

If the exhaust system should become restricted, the hot exhaust gases cannot escape from the engine. This condition would cause a loss of po wer, extreme internal engine heat, and v ery high e xhaust gas temperatures. These conditions can and will cause internal cylinder damage and a reduction of engine life.

Some engines are turbocharged (T). Turbochargers increase the air flo w into the engine c ylinder and permit increased horsepower by burning more fuel than is possible in a naturally aspirated (N) engine. Turbochargers enhance the ef ficiencies of engines and add power to a similar displacement (N) engine.

Basically, turbochargers are maintenance free. Ho wever, should any exhaust manifold studs or bolts break or come loose, engine exhaust gases can start leaking into the pump room. Under these conditions, the engine should be attended to immediately . First indications of an e xhaust leak would be the smell of diesel exhaust and possible eye irritation. Unless f ire pump maintenance personnel are well versed in a repair of turbochar gers and e xhaust systems, contact your local Distributor/Dealer for assistance.

NOTE: Exhaust back pressure, air inlet restriction and crankcase pressure limits are listed for each DDFP Model in Technical Data Section 5. These limits are not to be e xceeded. To properly check these limits, the engine must be producing maximum required horsepower.

While the engine is running inspect e xhaust pipe outlet outside of the pump room itself for en vironmental hazards such as excessive smoke conditions. The following could be used as a guide for general engine operating conditions.

1. Blue Smoke — Possible engine oil consumption - too many areas to list for possibilities.
2. White Smoke — Possibility of water in cylinders
   Source — Possible w ater in fuel or internal engine problem.

Should any of these or any other conditions be found, contact your local DDC Distrib utor/Dealer for assistance. Check condition of the air inlet system ducting clamp tightness hose condition.

Yearly

Clean and re-oil the air cleaner element per the manufcturers directions. Each engine is shipped with the cleaning instructions. Refer to Figure 1, page 17.

Check crankcase v entilation tube for proper operation by making a visual inspection while engine is running.

LUBRICATION SYSTEM

OPERATION

The lubricating oil system is schematically illustrated in Figures 1, 2 and 3 for the Inline and VEE engines. The system consists of an oil pump, oil cooler, a full-flow oil filter, by-pass valves at the oil cooler and filter, and pressure regulator valves at the pump and in the c ylinder block main oil gallery. Positi ve lubrication is ensured at all times by this system.

Oil for lubricating the connecting rod bearings, piston pins, and for cooling the piston head, is pro vided through the drilled hole in the crankshaft from the adjacent forw ard main bearings. The gear train is lubricated by the o verflow of the oil from the camshaft pock et through a connecting passage into the flywheel housing from the camshaft, balance shaft, and idler gear bearings. The blo wer drive gear bearing is lubricated through an e xternal pipe from the rear horizontal oil passage of the cylinder block.

On the Inline engines the oil from the cam pocket enters the blower and overflows through two holes, one at each end of the blo wer housing, providing lubrication for the blo wer drive gears at the rear end and for the go vernor mechanism at the front. On the VEE engines, the blower drive gear is lubricated from the rear of the blo wer.

LUBE OIL PUMP

The positive displacement gear type pump is mounted to the main bearing caps on I-71 and dri ven from the front end of the crankshaft. On the I-53, V-71 and V-92 engines the pump is found in the lower front cover and driven by the front end of the crankshaft. The I-71, V-71 and V-92 have a pressure relief located on the dischar ge side of the pump, which maintains pressure being delivered to the oil filter and cooler. The I-53 engine does not use a pressure relief v alve but does incorporate the use of the f ilter and oil cooler bypass valve to maintain pressure.

All four engines use an oil pressure regulator valve to maintain oil g alley minimum pressures. See technical data Section 5 for specifics per engine model.

OIL COOLER

All engines use a plate type oil cooler. Between each engine model, the major difference lies in the number of plates in each cooler. The number of plates required is determined by engine horsepo wer de veloped. All the oil cooler systems incorporate oil bypass valves in the event of plate core plugging.

It should be understood that improper engine maintenance could adversely effect the ef ficiency of the oil cooler system. Please refer to the technical data Section 5, for specific lube oil temperature and engine coolant temperature ranges for each engine model.

LUBE OIL FILL

On I-71 engines, the oil fill is located on the right rear . On the VEE engines, it is found in the right bank v alve rocker cover. On the 53 Series engine, the oil fill is also located on the rocker cover. See technical data, Section 5 for oil v olumes and specif ications on each engine model. A typical oil fill location is shown in Figure 5, Page 24.

OIL LEVEL DIPSTICK

On most DDFP engines, the dipstick is located on the lower left side. Exceptions are the I-71 and 12V92 models where the dipstick is located on the right. Oil level can be checked only when the engine is at rest (not running). Oil levels must be maintained between the low and full marks.

NOTE: Due to the basic engine design, DDC engines retain large volumes of oil in the block while running. For this reason, proper oil level cannot be checked immediately after engine shut of f. Wait approximately 10 minutes before checking oil le vel. Do not add oil to a running engine; overfilling can occur!

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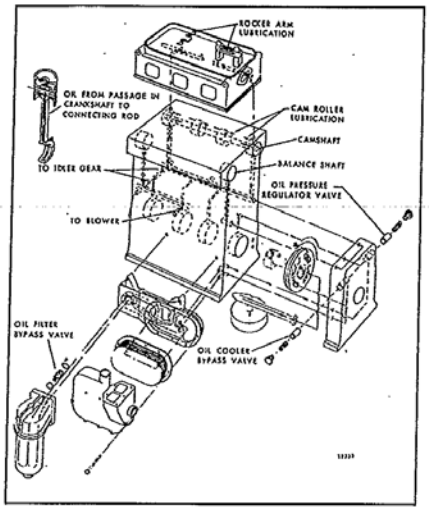

Fig. 1 - I-53 Lubricating System Schematic

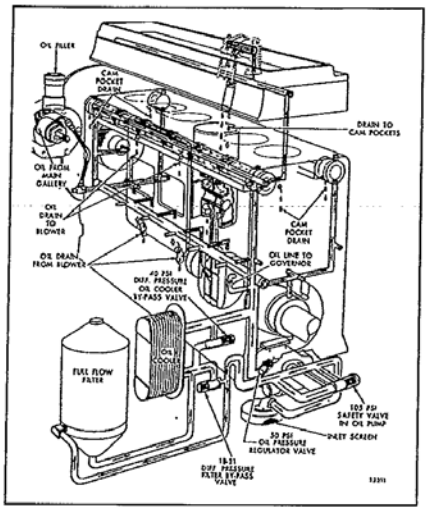

Fig. 2 - I-71 Lubricating System Schematic

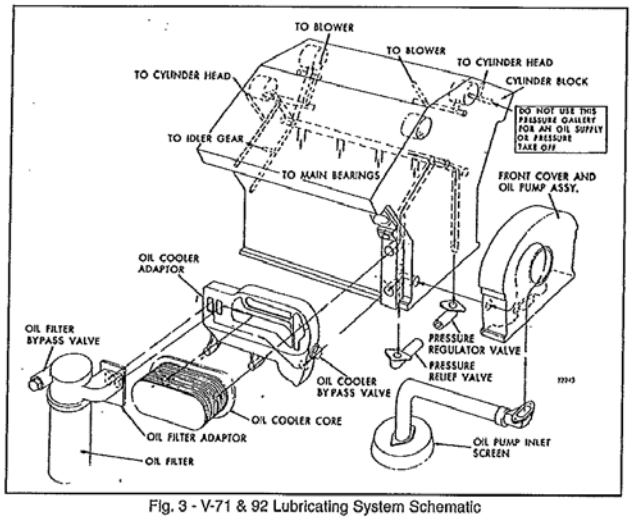

Fig. 3 - V-71 & 92 Lubricating System Schematic

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LUBE OIL FILTER

All engines use full flow oil filters of the "spin on" type element. They have a non-replaceable pleated paper cartridge. Each filter has an integral bypass valve in the event of plugging or for cold start purposes.

NOTE: Use only appro ved f ilters with the recommended filtration micron rating. See parts list Section 6 for proper service part numbers.

Replacing Spin on Oil Filter(s)

1. Obtain the Detroit Diesel recommended replacement lube oil filter. See Chart, Page 44.
2. Use a properly sized oil f ilter wrench, such as Kentmoore P/N J24783, and remove filter(s).
3. Discard used filter(s) as recommended by EPA.
4. Clean the f ilter base mounting surf ace with a lint free cloth.
5. Lightly coat the oil filter seal with clean engine oil.
6. Start threading the ne w replacement f ilter onto the threaded portion of the base and hand tighted until the seal contacts the filter head. With the filter wrench, continue to tighten two-thirds of a turn.
7. Start engine and check for leaks. If any are found do not put engine into service until corrections are made.

LUBRICATING OIL REQUIREMENTS

Hundreds of commercial oils are mark eted today, but labeling terminology differs among suppliers and can be confusing. Some mark eters may claim that their lubricant is suitable for all mak es of diesel engines and may list engine makes and types, including Detroit Diesel, on their containers. Such claims, by themselves, are insufficient as a method of lubricant selection for DDFP engines.

The proper lubricating oil for all DDFP engines is selected, based on SAE Viscosity Grade and API (American Petroleum Institute) Service Designation. Both of these properties are displayed in the API Symbol, which is illustrated within the specif ic requirements. For DDFP engines, the proper lubricant must also possess a sulfated ash content below 1.0% mass.

Lubricating oils for Non-T actical Military usage currently specify a Mil-L-2104F type oil. Because the y may display different viscosity grades, it is necessary to use a SAE 40 grade only.

TWO-CYCLE ENGINES

DETROIT DIESEL SERIES 53, 71, 92
LUBRICANT REQUIREMENTS

API Symbol:

SAE Viscosity Grade: 40
API Classification: CDII or CF2
Sulfated Ash: less than 1.0%
*CF-2 when available

This is the only oil recommended for Detroit Diesel Engines used in DDFP service. Lubricants meeting these criteria have provided maximum engine life when used in conjunction with recommended oil drain and f ilter maintenance schedules.

Certain engines operating conditions may require e xceptions to this recommendation. They are as follows:

1. For continuous high temperature operation (o ver 100° F 38° C Ambient), the use of SAE 50 grade lubricant in all DDFP engines is recommended.
2. The API Performance Cate gory CF2 represents an enhanced level of lubricant performance o ver CD-II category which it replaces. Lubricants meeting this new performance level may not be readily available. During this interim period oils labeled as API CD-II may be used.
3. When the use of High Sulfur Diesel Fuel (greater than 0.5% mass) is una voidable, the use of lubricants with higher Total Base Numbers (alkalinity) are recommended. Refer to Fig. 4 for minimum TBN numbers to be used for normal service.

MAINTENANCE AND SERVICE PROCEDURE

Weekly

1). Check oil le vel with the engine stopped. Please refer to "note" listed in Section 3 under oil le vel dipstick for proper oil level check.

2). During and after weekly maintenance run, check over entire engine for signs of oil leaks. Repair immediately if found or call your authorized DDC Distributor/Dealer for service.

NOTE: If oil is observed coming from the air box drain tubes while running, review maintenance procedure on page 19.

Yearly

Stationary diesel engines collect condensation in the engine oil pan while at rest. When in use, lubricating oil undergoes deterioration from combustion by-products and contamination. For these reasons, regardless of the appearance of the oil, change oil and filter(s) annually.

CAUTION: Use only recommended lube oil and oil filters. Internal engine damage and/or excessive wear could occur using unauthorized materials.

LUBRICATING OIL ANALYSIS

Oil Analysis kits are available through the DDC Distributor Network for efficient monitoring of the lubricating oil in a DDFP engine. Refer to Parts Information Section 6 to order.

Oil Analysis consists of a series of laboratory tests conducted on the engines lubricant. Some tests show the condition of the engine and others show the condition of the lubricant. Refer to Fig. *4* for warning limits.

TWO CYCLE ENGINES ONLY	ASTM Designation	Condition Measured	53, 71, 92
Pentane Insolubles % Max.	D 893	Engine Combust.	1.0
Carbon (Soot) Content, TGA Mass % Max.	E-1131	Engine Combust.	0.8
Viscosity at 40°C cS	D 445 & D 2161	Engine & Oil	40.0
% Max. Increase			15.0
% Max. Decrease			
Total Base Number (TBN)			
Min.	D 664 or D4739	Oil	1.0
Min.	D 2896		2.0
Water Content (dilution) Vol. % Max.	D 95	Engine	0.30
Flash Point °C		Engine	
Reduction Max.	D 92	Fuel Dil.	20.0
Fuel Dilution Vol. % Max.	*	Engine	2.5
Glycol Dilution PPM Max.	D 2982	Engine	1000
Iron Content PPM Fe Max.	**	Engine Wear	150
Copper Content PPM Cu Max.	**	Engine Wear	25
Sodium Content PPM NA Over Baseline Max.	**	Engine Coolant	50
Boron Content PPM B Over Baseline Max.	**	Engine Coolant	20

* Various Methods
** Elemental Analyses are conducted using either emission or atomic absorption spectroscopy. Neither method has an ASTM designation.

Fig. 4 - Oil Analysis Warning Limits

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SECTION 3.3 DDFP

OIL VOLUME

For specific oil quantities please refer toTechnical Data Section 5 for each engine model listing.

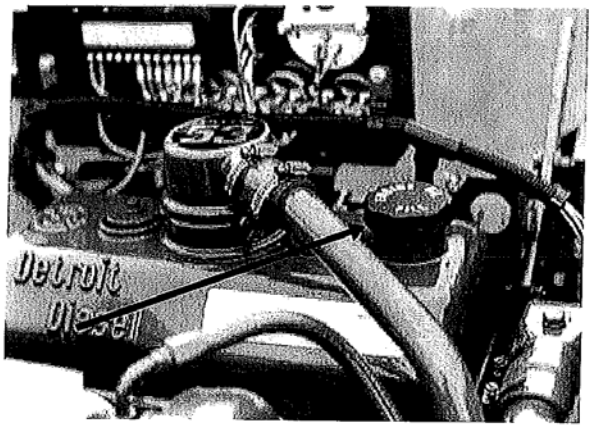

Fig. 5 - Typical Oil Fill Location

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תשתיות נפט ואנרגיה בע"מ
קו מוצרי דלק בע"מ
אגף הנדסה

COOLING SYSTEM

The Engine Cooling System Includes:

Coolant Pump

Heat Exchanger with Overflow Pipe

Oil Cooler

Pressure Cap-Fill Cap

Thermostat & Water Bypass

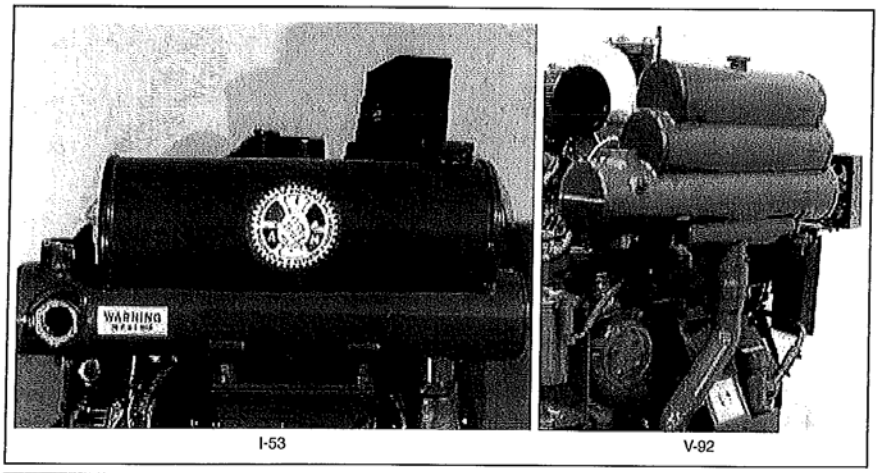
Raw Water Inlet and Discharge

Zinc Electrode

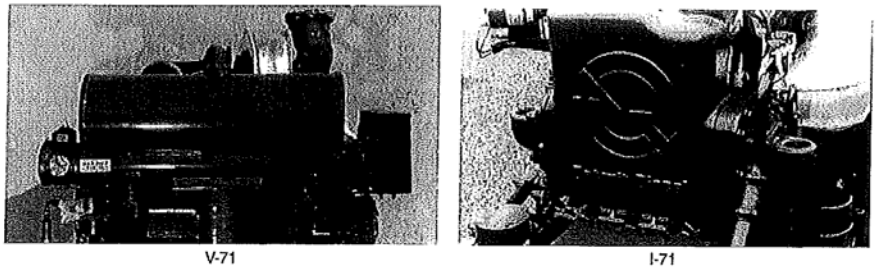
OPERATION

The heat resulting from combustion in the engine cannot be fully converted into kinetic energy. A major portion of that heat is absorbed by the coolant from the cylinder walls and cylinder heads and must be carried away from the engine. It is the function of the Heat Exchanger to transfer waste engine heat to the raw cooling water.

Inside the heat exchanger tank Fig. *1* is a heat exchanger core, somewhat similar to a miniature radiator. Engine coolant circulates around the heat exchanger core while cool raw water, from a tap on the pressure side of the fire pump, is circulated inside the core carrying away the heat. The installing contractor makes the raw water discharge connection at time of system installation.



I-53 V-92



V-71 I-71

Fig. 1 - Heat Exchanger Cooling System

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Engine coolant is circulated by the engine coolant pump. Engine coolant enters the side of the block upon dischar ge from the oil cooler and coolant pump. Under lo w pressure, the coolant flo ws past the c ylinders, up through the heads, and then through the open thermostat into the heat exchanger tank. After passing o ver the heat e xchanger core, the coolant then re-enters the coolant pump and starts the c ycle over. If the thermostat is closed, coolant would flow down a bypass tube, back to the coolant pump. Under that condition, the coolant bypasses the heat exchanger core and allows the engine to retain some of the heat so it can quickly reach optimum operating temperature.

ENGINE COOLANT

The following information is provided as a guide for Detroit Diesel engine users in the selection of a suitable coolant.

The water/ethylene glycol/inhibitor coolant mixture used in DDFP engines must meet the following basic requirements:

- Provide for adequate heat transfer.
- Provide protection from cavitation damage.
- Provide a corrosion/erosion resistant environment within the cooling system.
- Prevent formation of scale or sludge deposits in the cooling system.
- Be compatible with engine hose and seal materials.
- Provide adequate freeze and boil o ver protection.

WARNING
A 50% water and 50% anti-freeze solution is required for pump installations. Premixing this solution prior to installing is required. This prevents possible pure anti-freeze chemical reactions to block heater elements which can burn out the element. Please see the technical data Section 5 for proper cooling system capacities of each model.

WATER

Water can produce a corrosi ve environment in the cooling system, and the mineral content may permit scale deposits to form on internal cooling surfaces. Therefore, inhibitors must be added to control corrosion, cavitation, and scale deposits.

Chlorides, sulfates, magnesium and calcium are among the materials which mak e up dissolv ed solids that may cause scale deposits, sludge deposits, corrosion or a combination of these. Chlorides and/or sulf ates tend to accelerate corrosion, while hardness (percentage of magnesium and calcium salts broadly classif ied as carbonates) causes deposits of scale. Water within the limits specif ied in Fig. 2 is satisfactory as an engine coolant when properly inhibited. Use of distilled water is ideal.

	GRAINS PER GALLON	PARTS PER MILLION
Chlorides (Maximum)	40	2.5
Sulfates (Maximum)	100	5.8
Total Dissolved Solids (Maximum)	340	20
Total Hardness (Maximum)	170	10

Fig. 2 Satisfactory Water Limits

ANTIFREEZE

Use an eth ylene glycol coolant (lo w silicate formulation) that meets or exceeds the standard of either the GM 6038-M formulation (GM 1899-M performance) or ASTM D 4985 requirements.

A 50% coolant/water solution is normally used. Concentrations over 70% are not recommended because of poor heat transfer capability, adverse freeze protection and possible silicate dropout. Concentrations belo w 30% of fer little freeze, boil over or corrosion protection.

COOLANT INHIBITOR

The importance of a properly inhibited coolant cannot be over-emphasized. A coolant which has insuf ficient or no inhibitors at all, invites the formation of rust, scale, sludge and mineral deposits. These deposits can greatly reduce the cooling systems efficiency and protection capabilities.

DDC-recommended supplemental coolant inhibitors are a combination of chemical compounds which pro vide corrosion protection, cavitation suppression, pH controls and prevent scale. These inhibitors are a vailable in v arious forms, such as liquid packages or integral parts of anti-freeze.

It is imperative that supplemental inhibitors be added to all DDFP engine systems. A pre-charge dosage must be used at the initial fill and the maintenance dosage used at each service interv al. Serious damage will occur unless inhibitors are used. Some of the more common corrosion inhibitors are borates, nitrates and silicates.

Inhibitors become depleted through normal operation, additional inhibitors must be added to the coolant as required to maintain original strength le vels. Refer to Fig. 3 for proper concentrations of inhibitors.

Do not use soluble oils or chromate inhibitors in DDFP engines. Detrimental effects will occur.

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	Min. PPM	Max. PPM
Boron (B)	1000	1500
Nitrite (NO^2)	800	2400
Nitrates (NO^3)	1000	2000
Silicon (Si)	50	250
Phosphorous (P)	300	500
pH	8.5	10.5

Fig. 3 - Proper Concentrations Of Inhibitors

To properly check inhibitor concentrations it may be necessary to contact your local DDC Distributor/Dealer for assistance. Refer to P arts Information Section 6, Page 45, to obtain the DDC part number for the F actory Coolant Analysis Kit. This kit can be purchased for nominal fee for analyzing the condition of the engine's coolant.

PROCEDURE FOR FILLING ENGINE

During filling of the cooling system, air pockets may form. The system must be pur ged of air prior to being put in service. This is best accomplished by f illing with a pre-mix solution, to the top of f iller neck. Install the pressure cap, start and run engine until the temperature staabilizes at approximately 170° - 190° F (77° - 91° C). During this warming process, you may

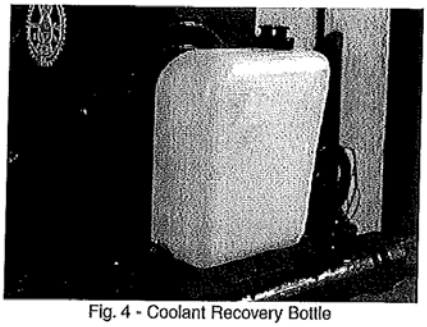

Fig. 4 - Coolant Recovery Bottle

see coolant coming from the o verflow tube attached at the pressure cap location. This is a normal condition since the coolant expands as it heats up. When the o verflow ceases, stop the engine.

NOTE: Air entrapment in I-53 engines is v ery lik ely to occur due to cooling system design. Upon initial fill with a pre-mix solution. It is recommended that the coolant be allowed to stand for a four hour period prior to starting.

To verify that the coolant is at a safe operating level, it's best to wait until the engine temperature drops to approximately 120°F (49°C), or lower, before remo ving the pressure cap. After the cap is remo ved, the level should be within 2 inches (51mm) of the filler neck.

NOTE: I-71 engines have incorporated the use of a coolant recovery bottle (white plastic bottle) Fig *4*. During initial filling of the cooling system, it will be necessary to f ill the Reco very Bottle to the Cold Full line with the pre-mix solution. Start and run the engine as indicated abo ve. After reaching normal operating temperature check the coolant le vel in the recovery bottle to v erify that the le vel is at the Hot Full line, if not add coolant to the bottle. Following the same instructions as abo ve, wait for the engine coolant temperature to drop before removing the pressure cap. The coolant le vel should be at the pre viously mention height. The coolant level must remain between Hot and Cold run lines on the reco very bottle.

CAUTION: Do not remove pressure cap while coolant is at normal operating temperatures. Possible personal injury could result from the expulsion of hot coolant.

PRESSURE CAP

Like most cooling systems, the Heat Exchanger type operates under pressure. A typical cap shown in Fig. *5* maintains system pressure to raise the coolant boiling point and permits a some what higher operating temperature without coolant loss. Pressure cap values can vary in different engine series. Refer to Section 5 for your engine type.

All pressure caps include a v acuum valve which opens during cool down. This prevents an internal vacuum from being formed which could contrib ute to leaking seals and hoses collapsing.

NOTE: I-71 engines use a coolant reco very bottle. The pressure cap includes a rubber ring-type seat. When the cap installed this ring forms a positi ve seal between the filler neck and cap. During engine cool down, if the wrong type cap is used, coolant cannot transfer back into the heat e xchanger from the recovery bottle. This can progress into an overheated engine and possible damage.

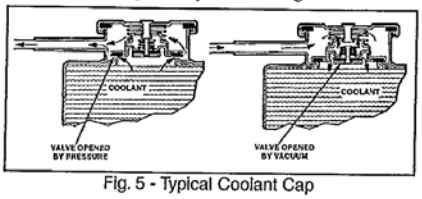

Fig. 5 - Typical Coolant Cap

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COOLANT PUMP

The engine water pump is a centrifugal impeller type pump. It is gear dri ven on the I-71, V-71 and V-92 Series engines and belt dri ven on the I-53 Series engines. The rebuildable pump utilizes a shaft and sealed bearing assembly. The V-71 and V-92 incorporate an oil seal and tw o splash lubricated ball type bearings. Each pump also included a w ater pump seal weep hole. Should a coolant leak occur at this location, the pump seal must be replaced. Contact your local DDC Distrib utor/Dealer for assistance. Should a replacement pump be required for repair , use only the e xact same type of pump.

THERMOSTAT

Each pump engine is equipped with a temperature controlling thermostat(s). Normal operating ranges will vary due to engine horsepo wer and operating speed. The thermostat(s) are located at the front of the c ylinder heads. Refer to Section 5 for specif ic operating temperatures for each engine.

ENGINE COOLANT HEATER

Fire pump engines must be able to assume full load immediately when used for emergency service. NFPA-20 specifications require an engine coolant heater Figure 6, Page 29, to maintain a minimum temperature of 120° F . (49° C). Maintaining this temperature assists the engine to start easily and produce rated horsepo wer immediately . F or f ire pump units operation in cold climates optional oil heaters are a vailable to k eep the engines lubricating oil at a safe temperature for emer gency start purposes. If pump room temperatures drop belo w 50° F (10° C), oil heaters are required.

On the initial installation of each f ire pump engine, it is the responsibility of the installing contractor to wire the heater to the pump room AC circuit. See Section 3 Electrical AC Wiring Diagram, Page 39, for correct wiring to the heater disconnect switch.

CAUTION: Do not acti vate the AC circuit unless the engine cooling system has been filled.

A pre-mix solution must be used. Chemical reactions will occur if pure Ethylene Glycol anti-freeze is allo wed to f ill the heater ca vity with AC circuit is activated.

HEAT EXCHANGER COOLING

The heat e xchanger cooling system is illustrated in Fig. *1*, Page 25.

Raw water from the f ire pump passes through the heat e xchanger core where it lowers the engine coolant temperature 10-15° F (-12° – -9° C).Typical raw water connection points on the heat exchanger are shown in Fig. *7*, Page 29.

HOSES

Specific areas on each DDFP engine use hoses to transfer coolant to and from heat exchangers and immersion heaters. Regular inspections are necessary to v erify that no leaks exist. Should replacements be required contact your local DDC Distributor/Dealer for assistance.

NOTE: Silicon Hose material for the immersion heaters must meet SAE J20 Requirements with a maximum heat operating range of 350° F (177° C). Do not replace these hoses with any other type material.

NOTE: Hose clamps required for silicon type hose, must have a shielded inner band or be of a constant torque type (spring loaded). If the second type is used, do not collapse spring by o ver tightening.

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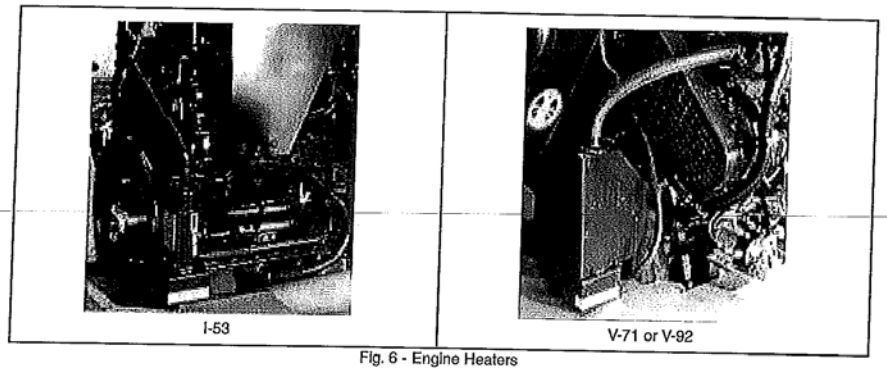

Fig. 6 - Engine Heaters

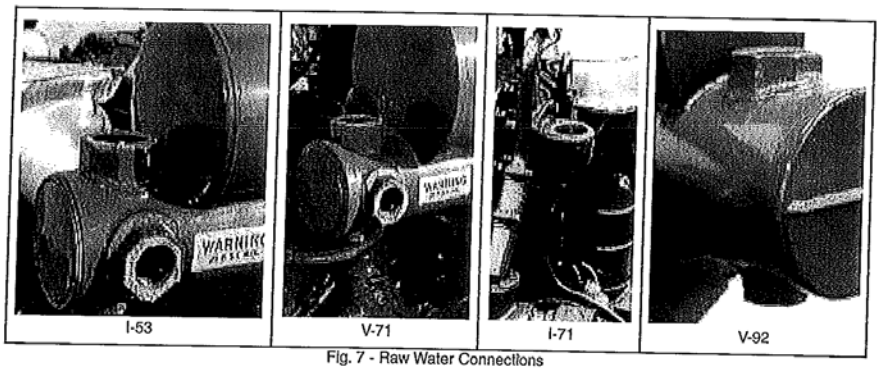

Fig. 7 - Raw Water Connections

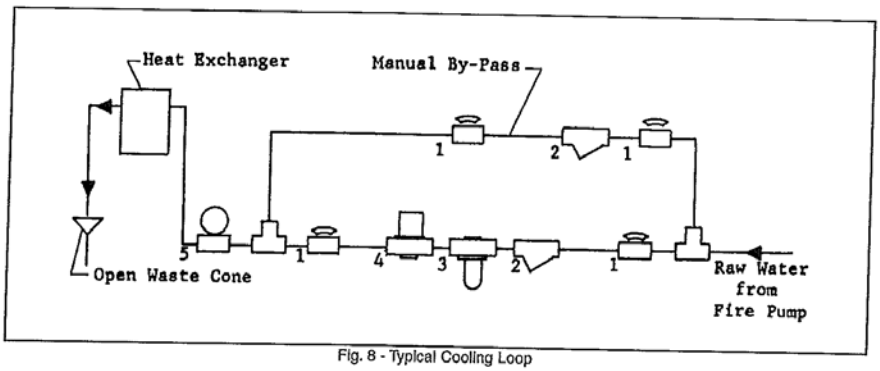

Fig. 8 - Typical Cooling Loop

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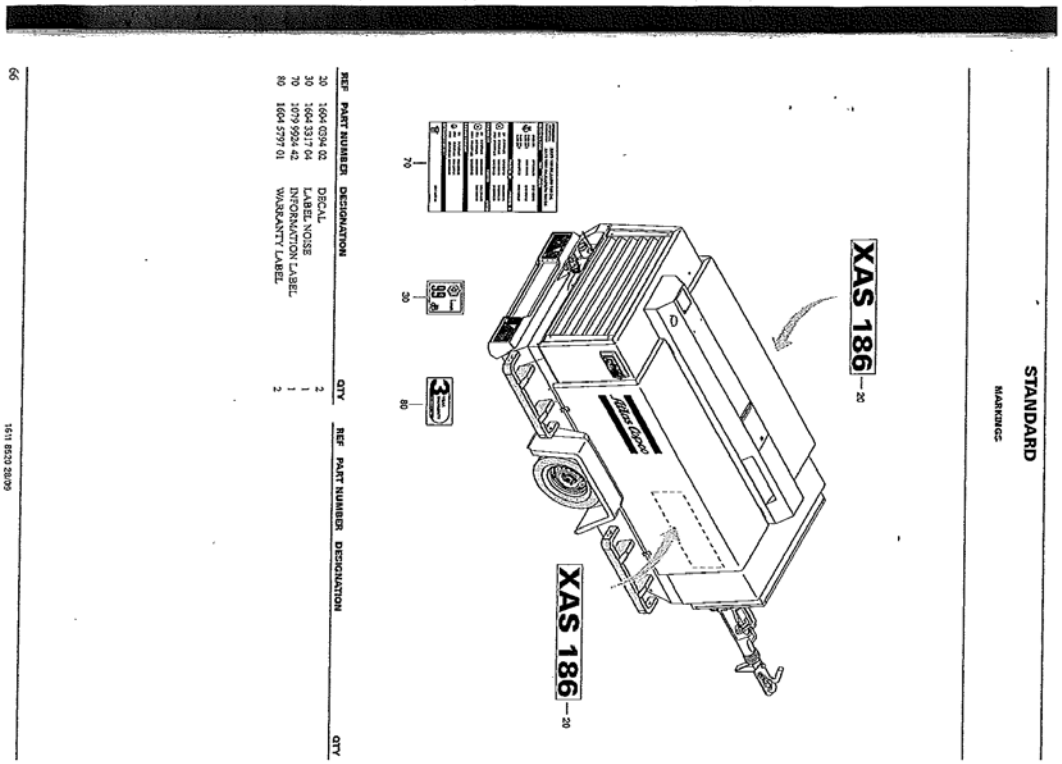
אגף הנדסה

מסוף נמל הדלק - חיפה

מדחס

יצרן ATLAS COPCO



STANDARD

MARKING

XAS 186 — 20

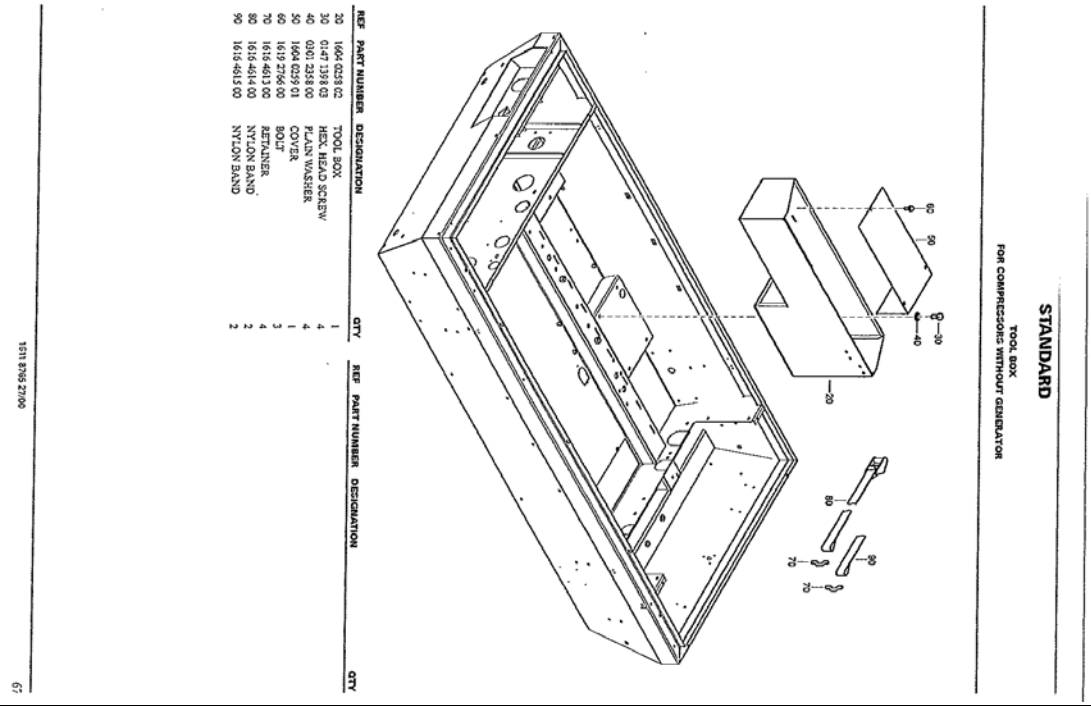
XAS 186 — 20

REF	PART NUMBER	DESIGNATION	QTY
20	1604 0394 02	DECAL	2
30	1604 3317 04	LABEL NOISE	1
70	1079 9924 42	INFORMATION LABEL	1
80	1604 5797 01	WARRANTY LABEL	2

REF	PART NUMBER	DESIGNATION	QTY

66

1611 8532 28/09



STANDARD

TOOL BOX

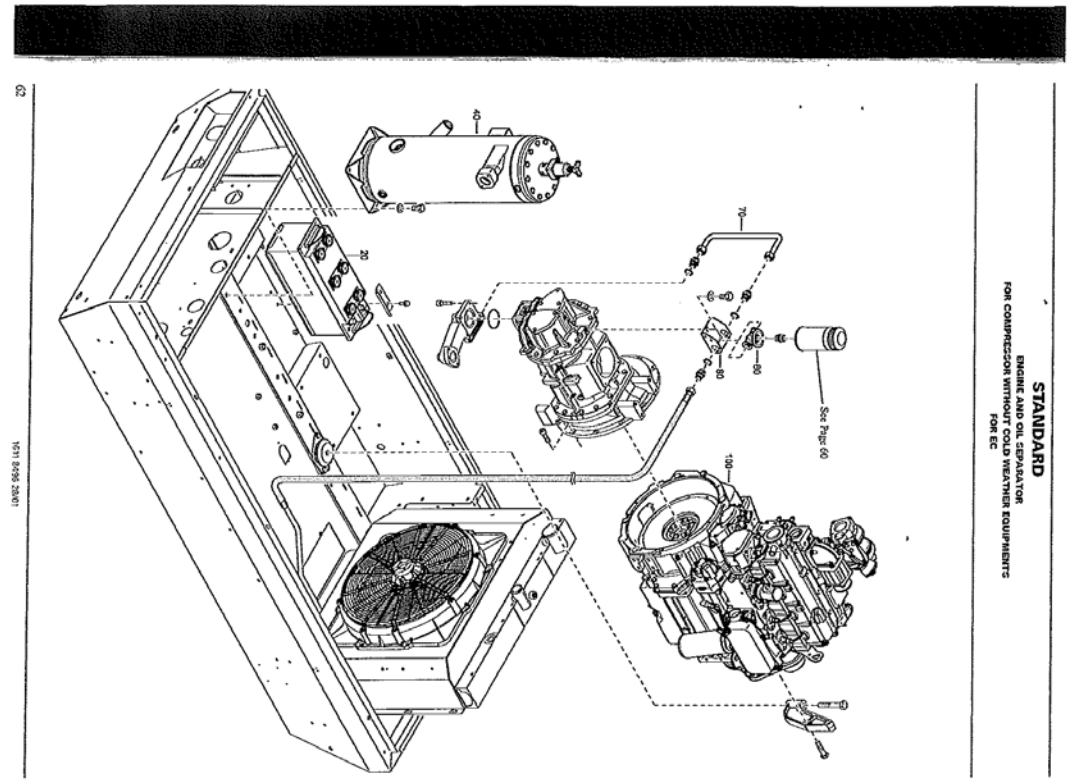
FOR COMPRESSORS WITHOUT GENERATOR

REF	PART NUMBER	DESIGNATION	QTY
20	1604 0259 02	TOOL BOX	1
30	0147 1398 03	HEX. HEAD SCREW	4
40	0101 2858 00	PLAIN WASHER	4
50	1604 0259 01	COVER	1
60	1619 2766 00	BOLT	3
70	1616 4613 00	RETAINER	4
80	1616 4614 00	NYLON BAND	2
90	1616 4615 00	NYLON BAND	2

REF	PART NUMBER	DESIGNATION	QTY

67

1611 8765 27/00



STANDARD
ENGINE AND OIL SEPARATOR
FOR COMPRESSOR WITHOUT COLD WEATHER EQUIPMENTS
FOR EC

REF	PART NUMBER	DESIGNATION	QTY
20	0975 8100 17	BATTERY	1
40	1604 0332 00	OIL SEPARATOR (For details see page 70)	1
60	1613 6828 00	FILTER HEAD	-
70	1604 7044 01	PIPE	-
80	1604 0374 02	BRACKET	-
100	1626 0139 00	ENGINE	-

STANDARD
ENGINE AND OIL SEPARATOR
FOR COMPRESSOR WITHOUT COLD WEATHER EQUIPMENTS
FOR EC

REF	PART NUMBER	DESIGNATION

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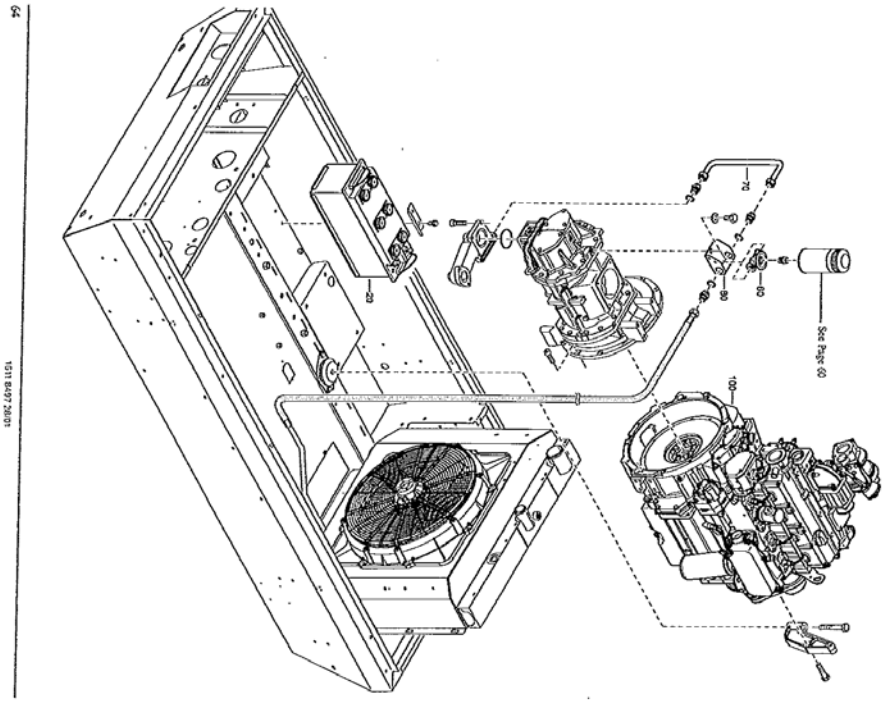

STANDARD
ENGINE AND PIPE
FOR COMPRESSOR WITHOUT COLD WEATHER EQUIPMENT
FOR ASME

1511 8497 26/01

STANDARD
ENGINE AND PIPE
FOR COMPRESSOR WITHOUT COLD WEATHER EQUIPMENT
FOR ASME

REF	PART NUMBER	DESIGNATION	QTY
20	0974 8300 17	BATTERY	1
60	1613 6823 00	FILTER HEAD	1
70	1604 7944 01	PIPE	1
90	1604 0074 02	BRACKET	1
100	1625 0129 00	ENGINE	1

REF	PART NUMBER	DESIGNATION

1511 8497 26/01

תשתיות נפט ואנרגיה בע"מ
קו מוצרי דלק בע"מ
אגף הנדסה

תחנת קמ"ד חדרה

משאבת כיבוי אש PEERLESS

יצרן VM

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MAINTENANCE PROCEDURES

Weekly

1). Fuel Tank: Keep the fuel tank filled to reduce condensation to a minimum. Open drain at the bottom of the fuel tank once a week to drain off any possible water and/or sediment. Fill tank after each test run.

NOTE: Per NFPA 25 standards, the fuel tank level must never be less than 67% of its capacity.

6 Months

Check condition of fuel lines for fraying, leaks or poor condition. Replace if necessary.

Yearly

1). Change the spin-on fuel filter. Refer to Section 6 for recommended part numbers.

2). Clean the screen strainer of the fuel lift pump.

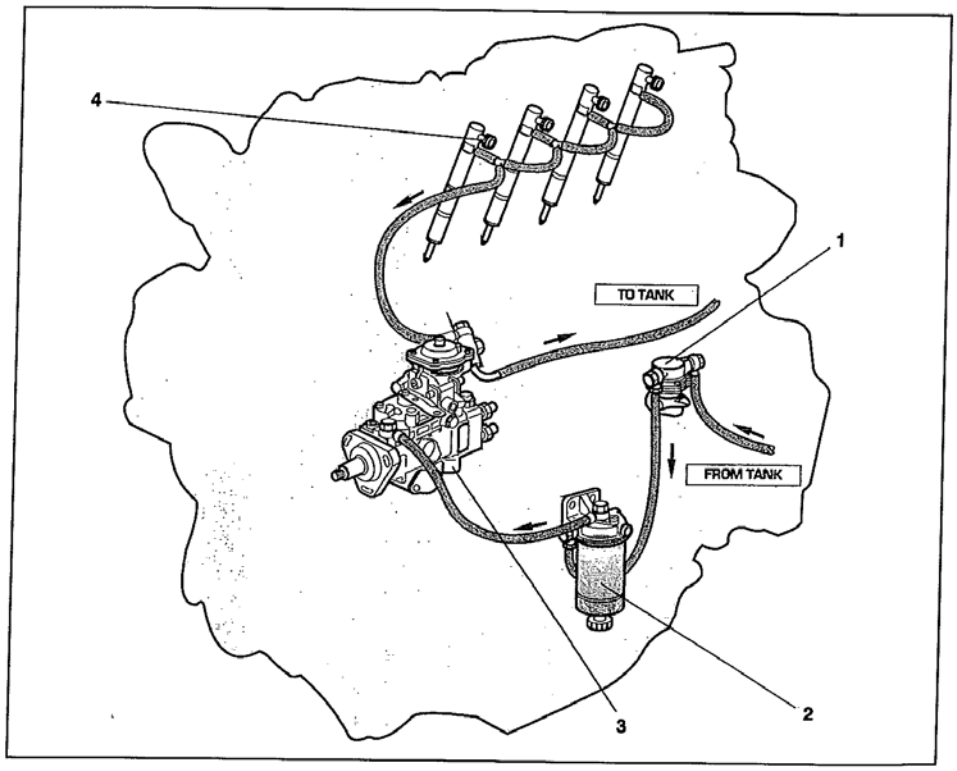

Figure 2 - Filtration System & Filter Drain

KEY

1) Fuel supply pump
2) Fuel filter
3) Injection pump
4) Injector

WARNING! OIL, FUEL, COOLANT MIXTURES, ETC. ARE HARMFUL IF INGESTED.

System pressure
30 ÷ 40 kPa (0.3 ÷ 0.4 bar)
Injection pressure
25.000 kPa (250 bar)

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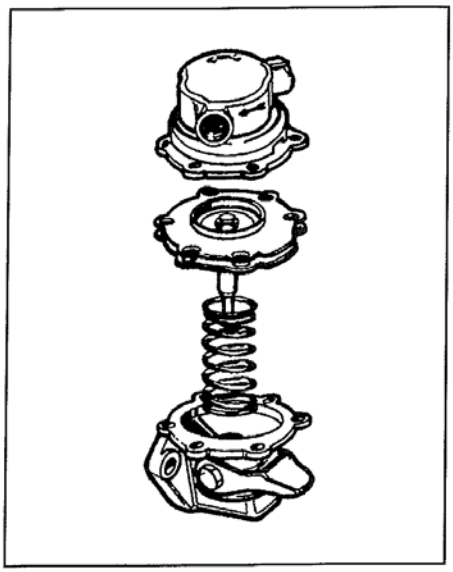

Figure 3 - Screen Strainer of the Fuel Lift Pump

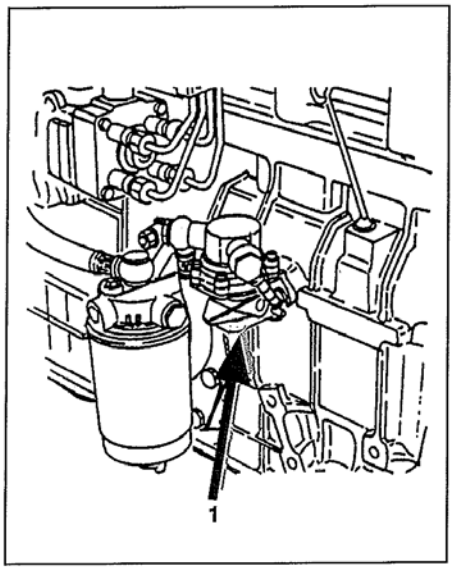

Figure 4 - Hand Priming Pump

SERVICE PROCEDURE:

A. How To Clean The Screen Strainer Of The Fuel Lift Pump:

1.) Remove the cover and seal from the top of the lift pump. (Fig. 3) Remove screen strainer.

2.) Carefully wash the screen and lift pump body.

3.) Reinstall screen being careful to align the hole.

4.) Install cover and seal making sure it is seated properly, if not leaks will occur and pump will not function. Do not over tighten cover screw.

5.) Operate the hand priming pump to purge air from the system. (Fig. 4) Item 1.

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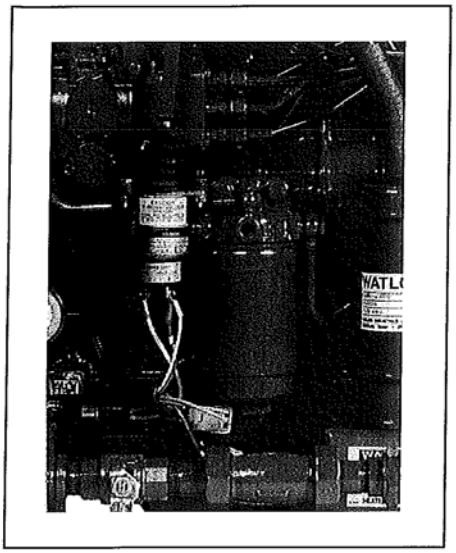

Figure 5 - Fuel Filter

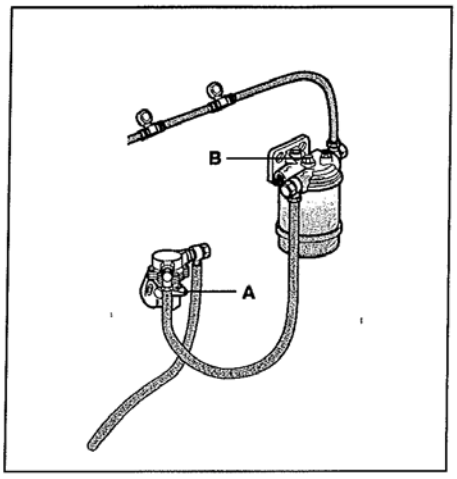

Figure 6 - Bleed Fuel System

B. Fuel Filter Change:

Each VMFP engine has a spin-on fuel filter (Fig. 5).

1.) Disconnect the pipe connecting the filter to the injection pump at the pump.

2.) Replace the cartridge.

3.) Before reconnecting the cartridge to the filter, allow 2 ÷ 3 liters of diesel fuel to flow through the filter and the fuel pipe.

4.) Before bleeding (Fig. 6) the system, check that the fuel supply pump is primed so it can deliver the maximum quantity of fuel. Prime the pump by operating the priming lever **A**; the lever will move freely for the initial part of its travel and then will encounter more resistance, confirming the pump is being operated.

Note: If this second working stroke is only short, turn the crankshaft through 180° to release the pump from the pump control cam on the camshaft.

5.) Bleed air from the fuel filter by loosening off the bleed screw **B** and operating the lever **A** until a continuous flow of fuel is obtained at the bleed screw.
The injection pump is self-purging.

6.) Loosen off the unions of the injector fuel feed pipes.

7.) Turn the engine over by means of the starter motor until the fuel flowing from the injector feed pipe unions is completely free of air.

8.) Re-tighten the injector fuel feed pipe unions and start the engine.
When the fuel flowing from bleed screw **B** is free of air, re-tighten the bleed screw.

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FUEL SYSTEM PRIMING

If air enters the fuel system, it must be eliminated prior to putting engine in service.

Air can enter system if:
—The fuel supply tank is emptied thru normal operation.
—Any low-pressure fuel lines are disconnected.
—Any component of the low-pressure system leaks during operation.

To Remove Entrapped Air Proceed As Follows:

1.) Make certain the condition that caused air has been corrected. Do not attempt to loosen fuel injector lines to eliminate air.

2.) Operate the hand priming pump located on the bottom of the fuel lift pump on the engines' left side.

3.) Start engine by manual crank Sw-#1 or Sw-#2, manual start instructions on instrument panel.

4.) If engine fails to start or does start but runs erratic, recheck all fuel lines, connections and filters for something obvious. If a simple solution cannot be located it may be necessary to contact your local Distributor / Dealer for service assistance.

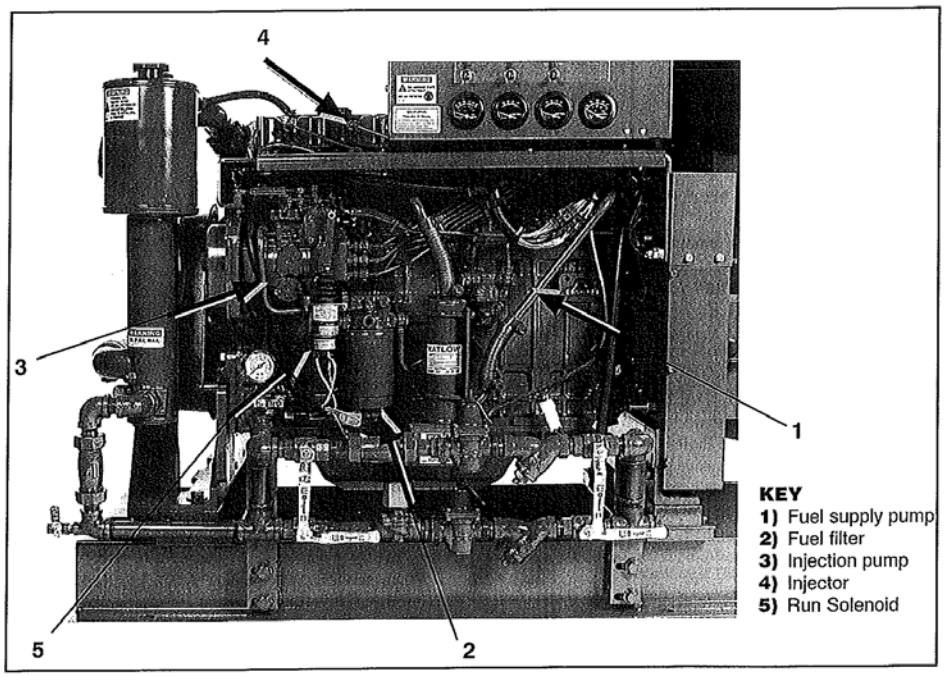

Figure 7 - Fuel System

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AIR INTAKE AND EXHAUST SYSTEM

Air Intake Operation
Air Cleaner
Crankcase Ventilation
Exhaust Operation
Maintenance And Service Procedures

AIR INTAKE OPERATION

During the intake stroke, the piston travels downward, the intake valve is open, and the exhaust valve is closed. The downstroke of the piston permits air to enter the cylinder that has been drawn from the air cleaner through the open intake valve. The intake air is never restricted by any controlling valve or mixing devices. The intake charge consists of fresh, clean air which provides for efficient combustion.

On some engines a turbocharger is introduced in the air system. Power to drive the turbocharger is extracted from the waste energy in the engine exhaust gas. The expanding exhaust gases turn a single stage turbo wheel which drives an impeller thus supplying air under pressure to the cylinders.

AIR CLEANER

The air cleaner is designed to remove foreign matter from the air, pass the required volume of air for proper combustion, and maintain efficient operation for a reasonable period of time before requiring service.

The importance of keeping foreign matter out of the engine cannot be over-emphasized, since clean air is essential to satisfactory engine operation and long engine life. Should dust in the air supply enter the engine it would be carried into the cylinders and due to its abrasive properties, cause premature wear of the moving parts. Dirt, which is allowed to build-up in the air cleaner passages, will eventually restrict the air supply to the engine and result in heavy carbon deposits on the valves and pistons due to incomplete combustion.

The air cleaner used on VMFP engines is a reusable type. Should a situation occur where the air cleaner becomes plugged with dirt (starving the engine of air), low power and heavy black smoke will result; the air cleaner should be serviced immediately.

CAUTION: Do not attempt to remove the air cleaner while an engine is running nor run the engine while the air cleaner is off. Exposed components could cause severe injury to personnel and major internal engine damage could occur should any foreign matter be drawn into the engine.

The air cleaner manufacturer recommends the following:

1. The pre-oiled reusable elements are serviced with a special oil. The elements can be serviced or replaced.
2. Figure 1 shows the air filter Service Instructions.
3. When servicing the element is not practical, you can improve filter efficiency by re-spraying with oil.

NOTE: Do not attempt this while engine is running.

NOTE: Do not over oil.

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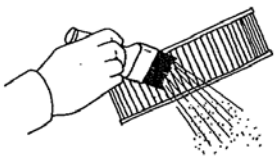
AIR FILTER SERVICE INSTRUCTIONS

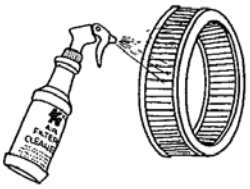
1. PRE-CLEANING

Tap the element to dislodge any large embedded dirt, then gently brush with a soft bristle brush. *(Note: If complete cleaning is not practical at this time, re-oil the element and re-install in your vehicle.)*



2. SPRAY ON CLEANER

Spray K&N air filter cleaner liberally onto the entire element and let soak for 10 minutes.



3. PAN CLEANING

Large K&N elements can be rolled or soaked in a shallow pan of K&N air filter cleaner. Remove immediately and let soak for approximately 10 minutes.

4. CLEANING HINTS

Use only K&N air filter cleaner.

NO gasoline cleaning.
NO steam cleaning.
NO caustic cleaning solutions.
NO strong detergents.
NO high pressure car wash.
NO parts cleaning solvents.

Any of these NO's can cause harm to the cotton filter media, plus shrink and harden the rubber end caps.

5. RINSE OFF

Rinse off the element with low pressure water. Tap water is OK. Always flush from the clean side to dirty side. This removes the dirt and does not drive it into the filter.

6. DRYING HINTS

Always dry naturally. After rinsing, shake off all excess water and let the element dry naturally.

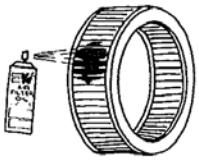
DO NOT USE COMPRESSED AIR
DO NOT USE OPEN FLAME
DO NOT USE HEAT DRYERS

EXCESS HEAT WILL SHRINK THE COTTON FILTER MEDIA.

COMPRESSED AIR WILL BLOW HOLES IN THE ELEMENT.

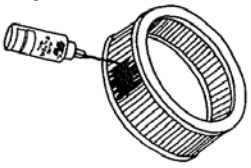
7. AEROSOL OILING

After cleaning air filter always re-oil before using. Spray K&N air filter oil down into each pleat with one pass per pleat. Wait 10 minutes and reoil any white spots still showing.



8. SQUEEZE BOTTLE OILING

After cleaning air filter always re-oil before using. Squeeze K&N air filter oil down into the bottom and along each pleat — only one pass per pleat. Let oil wick into cotton for 20 minutes. Re-oil any white spots still showing.



9. OILING HINTS

Never use a K&N air filter without oil. *(The filter will not stop the dirt without the oil.)* Use only K&N formulated air filter oil.

K&N air filter oil is a compound of mineral and animal oil blended with special polymers to form a very efficient tack barrier. Red dye is added to show just where you have applied the oil. Eventually the red color will fade but the oil will remain and filter the air.

NEVER USE Automatic Transmission Fluid.
NEVER USE Motor Oil.
NEVER USE Diesel Fuel.
NEVER USE WD-40, LPS, or other light weight oils.

Figure 1 - Air Filter Service Instructions

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CRANKCASE VENTILATION

Vapors which may form within the engine are removed from the crankcase and gear train compartment by a continuous, pressurized ventilation system.

A slight pressure is maintained within the engine crankcase compartment. This crankcase pressure and resulting ventilation is accomplished by the air seepage past the piston rings sweeping up through the cylinder block and into the rocker arm compartment. Here it is expelled through a vent pipe attached to the rocker cover breather element (Fig. 2).

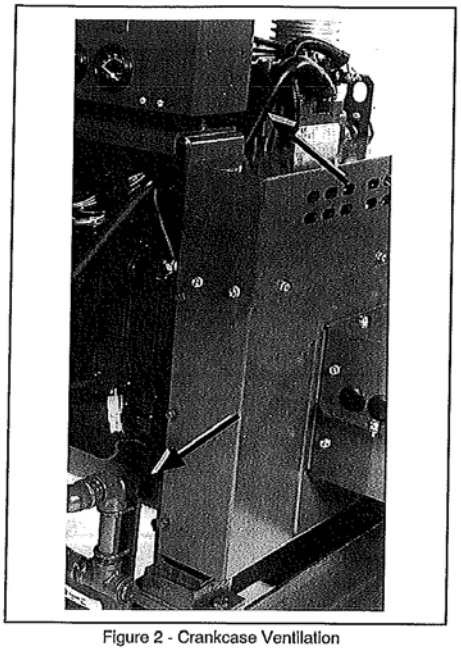

Figure 2 - Crankcase Ventilation

EXHAUST OPERATION

Internal combustion engines convert fuel energy into both useful work and wasted heat. The useful work is the flywheel rotation that drives the pump. The wasted heat involves the engine water cooling system, radiated heat and the exhaust gases. Approximately 2/3 of the fuel energy is wasted. Critical review must be made of these systems to assure that the engine delivers the useful power required and maintains the engine within the operating parameters established by the engine manufacturer.

Some engines are turbocharged (T). Turbochargers increase the air flow into the engine cylinder and permit increased horsepower by burning more fuel than is possible in a naturally aspirated (N) engine. Turbochargers enhance the efficiencies of engines and add power to a similar displacement (N) engine.

The exhaust system is critical to the proper engine performance. When initially installed, consideration must be given to the exhaust gas flow requirements, the exhaust temperatures and the exhaust back-pressure limitations of the specific engine. Refer to Section 5 for specific engine model and operating speed back-pressure limitations. All the components in an exhaust system contribute to the back-pressure determination including the flexible section, muffler, exhaust piping elbows and outlet. In addition to providing engine exhaust data and back-pressure limitations, Clarke offers a service to installers, through the local Pump OEM Dealer, for making recommendations on exhaust system sizing for specific installations.

If the exhaust system should become restricted, the hot exhaust gases cannot escape from the engine. This condition would cause a loss of power, extreme internal engine heat, and very high exhaust gas temperatures. These conditions can and will cause internal engine damage and a reduction of engine life.

Should any exhaust manifold studs or bolts break or come loose, engine exhaust gases can start leaking into the pump room. Under these conditions, the engine should be attended to immediately. Indications of an exhaust leak would be the smell of diesel exhaust, possible eye irritation and soot collecting on the engine around the leak. Contact your local Distributor/Dealer for repair.

NFPA-20 requirements are to have exhaust system high temperature personnel protection. Do not run VMFP engines without insulation blankets installed. Serious injuries may result by contact with hot exhaust system components.

[redacted]

MAINTENANCE AND SERVICE PROCEDURES

Weekly

Prior to each engine run make a visual check of the exhaust system to verify condition of piping and muffler. Investigate thoroughly any areas that would appear to have rusty conditions such as rain water running down pipe and getting inside the engine. Severe internal engine damage could occur if water enters the engine exhaust system.

Inspect the engine air cleaner for dirt buildup or damage.

6 Months

Inspect exhaust system for leaks or plugging, if any are found, repair immediately. Inspect and tighten if necessary exhaust manifold, turbo mount (if equipped) and piping bolts/nuts. Inspect the insulations condition for any deterioration or looseness, repair as necessary. Check for any petrolium products on the blankets and replace if any are found.

Exhaust system back pressure limits are not to be exceeded.

Yearly

Re-oil and clean the air cleaner element per the manufacturers directions. Each engine is shipped with the cleaning instructions. Refer to Figure 1, Page 17.

NOTE: Exhaust back pressure, air inlet restriction and crankcase pressure limits are listed for each VMFP Model in Technical Data Section 5. These limits are not to be exceeded. To properly check these limits, the engine must be producing maximum required horsepower.

While the engine is running inspect exhaust pipe outlet outside of the pump room itself for environmental hazards such as excessive smoke conditions. The following could be used as a guide for general engine operating conditions.

1. Blue Smoke — Possible engine oil consumption - too many areas to list for possibilities.
2. White Smoke — Possibility of water in cylinders
   Source — Possible water in fuel or internal engine problem.

Should any of these or any other conditions be found, contact your local Distributor/Dealer for assistance. Check condition of the air inlet system ducting, clamp tightness hose condition.

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LUBRICATION SYSTEM

OPERATION

The lubricating oil system is schematically illustrated in Figure 1.

Pressure lubrication is supplied by a rotor pump. The oil from this pump circulates through a full flow filter to the various lube points of the engine. The filter has a by-pass valve which lets oil pass if the filter becomes restricted. From the filter, lubricating oil passes to the main bearings of the crankshaft. The pistons and the cylinder bores are lubricated by splash and a oil mist jet.

Lubricating oil for the camshaft journals is supplied from the main bearings and a reduced supply is sent through external pipes to the rocker arms and the turbocharger. The lubricating oil returns from the turbocharger to the sump. The valve stems and valve springs are lubricated by splash and oil mist.

The maximum pressure in the system is controlled by a relief valve. This valve controls the pressure of the oil and is located between the oil pump and the oil filter.

All VMFP engines include oil coolers. The oil passes through the cooler before the filter. When cold oil increases the restriction in the cooler, a by-pass valve lets the lubricating oil pass directly to the oil filter.

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VMFP SECTION 3.3

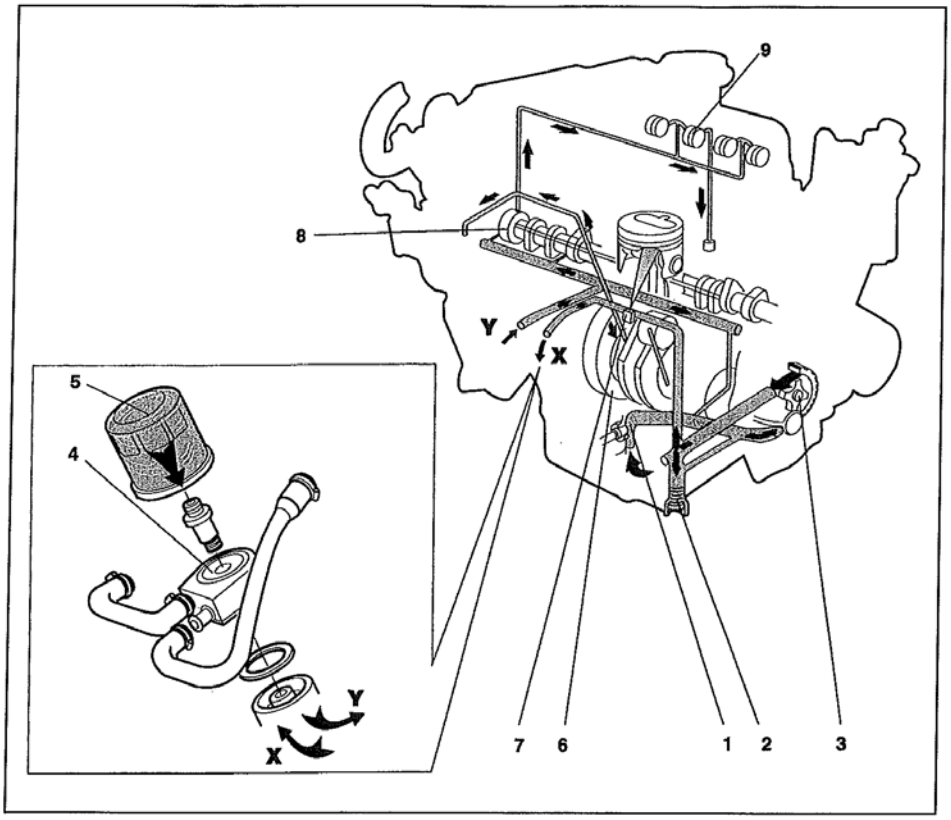

Fig. 1 - Typical Lubricating System Schematic

KEY

1) Oil pick-up pipe
2) Pressure relief valve
3) Oil pump
4) Water-cooled oil cooler
5) Filter cartridge
6) Crankshaft main bearings
7) Oil jet valve
8) Camshaft bearing/s
9) Rocker arms

Lubrication circuit pressure (with engine hot)

51 - 58 psi / 350 - 400 kPa

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	ASTM Designation	Condition Measured	VMFP Limit
Pentane Insolubles % Max.	D 893	Engine Combust.	1.0
Carbon (Soot) Content, TGA Mass % Max.	E-1131	Engine Combust.	1.5
Viscosity at 40°C cS	D 445 & D 2161	Engine & Oil	
% Max. Increase % Max. Decrease			25.0 15.0
Total Base Number (TBN) Min. Min.	D 664 or D4739 D 2896	Oil	1.0 2.0
Water Content (dilution) Vol. % Max.	D 95	Engine	0.10
Flash Point °C Reduction Max.	D 92 *	Engine Fuel Dil.	20.0
Fuel Dilution Vol. % Max.		Engine	--0--
Glycol Dilution PPM Max.	D 2982	Engine	--0--
Iron Content PPM Fe Max.	**	Engine Wear	150
Copper Content PPM Cu Max.	**	Engine Wear	30

* Various Methods
** Elemental Analysis are conducted using either emission or atomic absorption spectroscopy. Neither method has an ASTM designation.

Fig. 5 - Oil Analysis Warning Limits

LUBRICATING OIL ANALYSIS

Oil Analysis kits are available through the DDC Distributor/ Dealer Network for efficient monitoring of the lubricating oil in a VMFP engine. Refer to Parts Information Section 6 to order.

Oil Analysis consists of a series of laboratory tests conducted on the engines lubricant. Some tests show the condition of the engine and others show the condition of the lubricant. Refer to Fig. 5 for warning limits.

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אגף הנדסה

תחנת קמ"ד חיפה

גנרטור חירום

יצרן PERKINS

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4.236 SERIES

USER'S HANDBOOK
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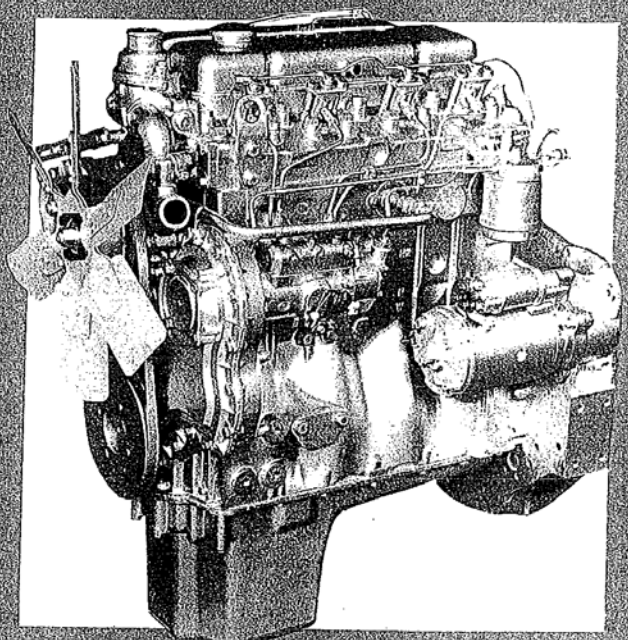

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4

Preventive maintenance periods

These preventive maintenance periods apply to average conditions of operation. Check the periods given by the manufacturer of the equipment in which the engine is installed. If necessary, use the shorter periods. When the operation of the engine must conform to the local regulations these periods and procedures may need to be adapted to ensure correct operation of the engine.

It is good preventive maintenance to check for leakage and loose fasteners at each service.

These maintenance periods apply only to engines that are operated with fuel and lubricating oil which conform to the specifications given in this handbook.

Schedules

The schedules which follow must be applied at the interval (kilometres, miles, hours or months) which occurs first.

First service at 800/1600 km (500/1000 miles) or 25/50 hours	Every day or every 8 hours	Every 7500 km (5000 miles), 250 hours or 4 months	Every 15000 km (10,000 miles), 500 hours or 12 months	Every 90000 km (60,000 miles) or 2500 hours	Operation
•	•	•	•	•	Check the amount of coolant
•		•	•	•	Check the drive belt(s)
			•	•	Clean the sediment chamber and the strainer of the fuel lift pump
•	•	•	•	•	Check for water in the fuel pre-filter (1)
			•	•	Renew the fuel filter element(s)
				•	Ensure that the atomisers are checked (2)
•					Ensure that the idle speed is checked and adjusted, if it is necessary (2)
	•				Check the amount of lubricating oil in the sump
•	•	•	•	•	Check the lubricating oil pressure at the gauge (1)
•		•	•	•	Renew the lubricating oil (3)
•		•	•	•	Renew the canister of the lubricating oil filter
•	•	•	•	•	Clean the air cleaner or empty the dust bowl of the air filter – extremely dusty conditions
		•	•	•	– normal conditions
			•	•	Clean or renew the air filter element, if this has not been indicated earlier (4)
				•	Clean the vent valve of the engine breather system (1)
				•	Ensure that the turbocharger impeller and turbocharger compressor casing are cleaned
		•	•	•	Clean the compressor air filter (1)
				•	Ensure that the exhauster or compressor (1) is checked (2)
•				•	Ensure that the valve tip clearances are checked and adjusted, if it is necessary (2)
•					Check the tension of the cylinder head fasteners (5)
				•	Ensure that the alternator, starter motor etc. are checked (2)

(1) If there is one fitted.
(2) By a person who has had the correct training.
(3) 4.2482 engines, every 500 hours or 12 months
(4) 4.2482 engines, every 1000 hours
(5) 4.236/4.248 engines only

How to check the tension of the cylinder head fasteners.

4.236/4.248 engines only

1 Operate the engine until the coolant temperature is more than 77°C (170°F).

2 Stop the engine and remove the rocker cover.

3 Release the setscrews and remove the rocker assembly. Ensure that the rubber seal is not lost from the oil connection.

4 With a suitable torque wrench, check the tension of the cylinder head setscrews in the correct sequence (A). The correct tension is 136 Nm (100 lbf) 13,8 kgf m.

5 If a setscrew turns when it is checked, tighten it to the correct tension. If a setscrew does not turn when it is checked, loosen it 30° to 60° (1/2 to 1 flat) and then tighten it to the correct tension. When all the setscrews have been checked, check the first 10 setscrews in sequence to ensure that they are still at the correct tension.

6 Put the rubber seal on the oil connection and fit the rocker assembly. Tighten the setscrews to 40 Nm (29.5 lbf ft) 4,1 kgf m.

7 Check the valve tip clearances, see page 4.18, and adjust the clearances as necessary.

8 Fit the rocker cover.

Comment contrôler le serrage des fixations de culasse.

Moteurs 4.236/4.248 seulement

1 Faire fonctionner le moteur jusqu'à ce que la température du liquide de refroidissement soit supérieure à 77°C (170°F).

2 Arrêter le moteur et déposer le cache-culbuteurs.

3 Desserrer les vis de blocage et déposer la rampe de culbuteurs. Prendre soin de ne pas perdre le joint en caoutchouc de la connexion d'huile.

4 Avec une clé dynamométrique appropriée, contrôler le serrage des vis de fixation de culasse dans la séquence correcte (A). La tension correcte est de 136 Nm (100 lbf) 13,8 kgf m.

5 Si une vis de fixation tourne lorsqu'elle est contrôlée, la serrer à la tension correcte. Si une vis de fixation ne tourne pas lorsqu'elle est contrôlée, la desserrer de 30° à 60° (1/2 à 1 plat) et puis la serrer à la tension correcte. Quand toutes les vis de fixation ont été contrôlées, contrôler les 10 premières vis en séquence correcte pour s'assurer qu'elles sont toujours à la tension correcte.

6 Mettre le joint en caoutchouc sur la connexion d'huile et monter la rampe de culbuteurs. Serrer les vis de fixation à 40 Nm (29.5 lbf ft) 4,1kgf m.

7 Contrôler le jeu des poussoirs, voir page 4.18, et régler les jeux si nécessaire.

8 Monter le cache-culbuteurs.

Prüfen des Anzugsdrehmomentes der Zylinderkopfschrauben.

Nur beim Motortyp 4.236/4.248

1 Lassen Sie den Motor so lange laufen, bis die Kühlwassertemperatur mehr als 77°C (170°F) beträgt.

2 Stellen Sie den Motor ab und nehmen Sie den Ventildeckel ab.

3 Lösen Sie die Befestigungsschrauben der Kipphebeleinheit. Achten Sie darauf, daß die Gummidichtung der Leitung nicht verloren geht.

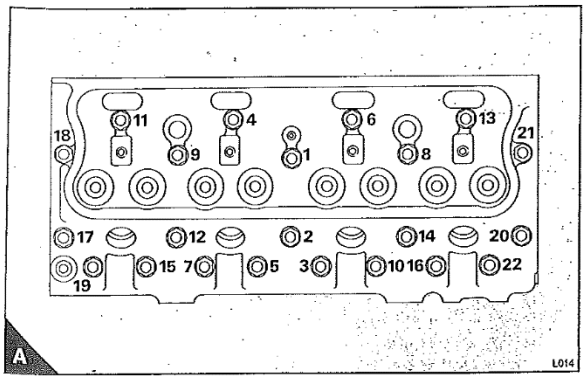
4 Prüfen Sie den richtigen Drehmomentwert der Zylinderkopfschrauben in der richtigen Reihenfolge (A) mit einem geeigneten Drehmomentschlüssel. Der richtige Anzugswert beträgt 136 Nm (100 lbf) 13,8 kgf m.

5 Dreht sich bei der Prüfung eine Zylinderkopfschraube, so ziehen Sie diese mit dem richtigen Drehmomentwert an. Dreht sich eine Zylinderkopfschraube nicht, so lösen Sie diese um 30° bis 60° (eine halbe bis eine ganze Schlüsselweite) und ziehen Sie mit dem richtigen Drehmoment an. Wurden alle Zylinderkopfschrauben überprüft, so gehen Sie die ersten 10 Zylinderkopfschrauben erneut durch und überprüfen Sie diese nochmals auf den richtigen Drehmoment.

6 Montieren Sie die Gummidichtung der Ölleitung und bauen Sie die Kipphebeleinheit auf. Ziehen Sie die Befestigungsschrauben mit 40 Nm (29.5 lbf ft) 4,1 kgf m an.

7 Prüfen Sie das Ventilspiel, siehe Seite 4.18, und stellen Sie es soweit notwendig ein.

8 Montieren Sie den Ventildeckel.



4

How to drain the cooling system

Attention: Do not drain the coolant while the engine is still hot and the system is under pressure because dangerous coolant can be discharged.

1 Ensure that the machine is on level ground.

2 Remove the filler cap of the cooling system.

3 Remove the drain plug from the side of the cylinder block (A1) or (B1) in order to drain the engine. Ensure that the drain hole is not restricted.

4 Open the tap or remove the drain plug at the bottom of the radiator in order to drain the radiator. If the radiator does not have a tap or drain plug, disconnect the hose at the bottom of the radiator. Where a lubricating oil cooler/filter assembly is fitted, this must also be drained. To do this, disconnect the hose at the bottom of the cooler (C1)

5 If necessary, flush the system with clean water.

6 Fit the hose to the bottom of the cooler.

7 Remove the hose at the top of the cooler (4.07/A1) and put 165 ml (1/3 pint) of antifreeze into the cooler. This will give protection against frost if water drains down when the machine is moved.

8 Fit the hose to the top of the oil cooler.

9 Fit the drain plugs and the filler cap. Close the radiator tap or connect the radiator hose.

Comment vidanger le circuit de refroidissement

Attention: Ne pas vidanger le liquide de refroidissement pendant que le moteur est encore chaud et que le système est sous pression parce que du liquide de refroidissement dangereux peut être projeté.

1 S'assurer que le véhicule ou la machine est sur terrain plat.

2 Déposer le bouchon de remplissage du circuit de refroidissement.

3 Déposer le bouchon de vidange du côté du bloc cylindres (A1) ou (B1) afin de vidanger le moteur. S'assurer que le trou de vidange n'est pas restreint.

4 Ouvrir le robinet ou déposer le bouchon de vidange au bas du radiateur afin de vidanger le radiateur. Si le radiateur n'a pas de robinet ou de bouchon de vidange, débrancher la durite au bas du radiateur. A l'endroit où un refroidisseur d'huile de graissage/un ensemble de filtre à huile est monté, une opération de vidange doit également être effectuée. Pour faire ceci, débrancher la durite au bas du refroidisseur (C1)

5 Si nécessaire, rincer le système avec de l'eau propre.

6 Monter la durite au bas du refroidisseur.

7 Déposer la durite en haut du refroidisseur d'huile (4.07/A1) et mettre 165 ml d'antigel dans le refroidisseur. Cela protégera contre le gel si l'eau s'échappe vers le bas quand la machine est déplacée.

8 Monter la durite en haut du refroidisseur.

9 Remonter les bouchons de vidange et le bouchon de radiateur. Fermer le robinet de radiateur ou rebrancher la durite de radiateur.

Wie das Kühlsystem entleert wird

Achtung: Das Kühlmittel nicht vom heißen Motor ablassen, wenn es noch unter Druck steht, weil gefährlich heißes Wasser austritt.

1 Sicherstellen, daß der Motor waagerecht steht.

2 Verschlußdeckel vom Kühler abnehmen.

3 Die Alaßschraube auf der Seite des Zylinderblocks (A1) oder (B1) und das Kühlmittel ablassen. Die Ablaßöffnung darf nicht behindert sein.

4 Den Ablaßhahn oder Stopfen unten am Kühler öffnen oder herausdrehen, um den Kühler zu entleeren. Wenn der Kühler keine Ablaßstelle hat, den unteren Wasserschlauch abnehmen. Wo ein Schmierölkühler/Filter montiert ist, muß dieser auch entleert werden. Um dies zu tun, nehmen Sie den Schlauch am Boden des Ölkülers ab (C1).

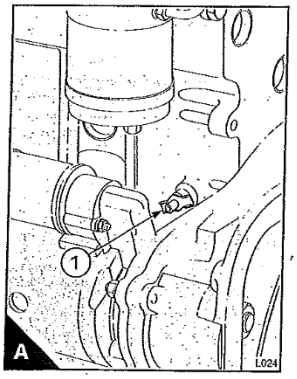
5 Wenn das Kühlsystem verschmutzt ist, mit sauberem Wasser durchspülen.

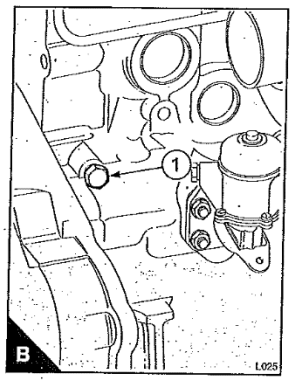
6 Montieren Sie den Schlauch am Boden des ölkühlers.

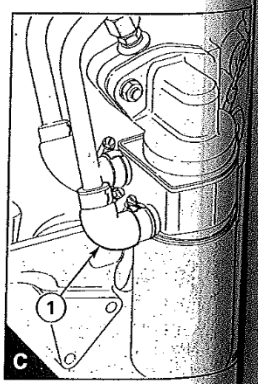
7 Nehmen Sie den Schlauch oben vom Schmierölküler (4.07/A1) ab und geben Sie 165 ml Frostschutzmittel in den Küler. Dies gibt Schutz gegen frost, wenn das wasser absinkt, Wärend die Machine bewegt wird.

8 Befestigen Sie den Schlauch oben am Schmierölküler.

9 Ablaßschrauben wieder eindrehen, Kühlerverschlußdeckel montieren, Kühlerablaßhahn wieder schließen oder Wasserschlauch wieder montieren.







Perkins 4.236 Series

תשתיות נפט ואנרגיה בע"מ
קו מוצרי דלק בע"מ
אגף הנדסה

פרק 6 – כתבי כמויות

אחזקת מנועי דיזל וציוד סובב במתקני הצפון

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חלק 6 – כתבי כמויות

6.0 מדידה ומחירים

6.1 תכולת המחירים

אופני המדידה כפי שהינם מפורטים להלן בסעיף זה (6.1) יחולו על אותם עבודות המתוארות במפרט הטכני והתוכניות, ואשר נכללו בכתב הכמויות המצורף למסמכי החוזה.

בנוסף לאמור בפרק המוקדמת יכללו המחירים את התארגנות הקבלן באתר.

6.2 אופני המדידה

העבודות ימדדו נטו בהתאם למפרט ולהנחיות המהנדס, כשהן גמורות ו/או קבועות במקומן, ללא תוספת עבור פחת וכו'. יושלמו רק עבודות עבורן ניתנו סעיפים מוגדרים בכתב הכמויות ואילו יתר העבודות ההוצאות וההתחייבויות של הקבלן, נחשבות ככלולות במחירי היחידה הנקובים בכתב הכמויות.
הכמויות תיקבענה לפי תוכניות ו/או לפי ההוראות של המהנדס אשר ניתנו בכתב.
לא תחושב כל תוספת עבור עבודה שנעשתה מחוץ לגבולות שצוינו בתוכנית ו/או בהוראות המהנדס בכתב ולא תחושב כל תוספת עבור עבודה שטיבה עולה על המינימום הנדרש.
החברה אינה מתחייבת כי כל סוגי העבודות ו/או כל הכמויות הרשומות בכתב הכמויות תבוצענה בחלקן ושאו בשלמותן. שינוי או ביטול בסעיפים בודדים לא יוכלו לשמש עילה לקבלת תוספת וכל מחיר ומחיר יחייב בלי קשר לשינוי בכמויות בפועל.

תיאום והגדרות

התיאורים וההגדרות שבכותרות המשנה של סעיף זה ניתנו בקיצור לצורכי זיהוי בלבד. אין בהם תיאור מלא של הפעולות הנדרשות ויש לפרשם ככוללים את כל העבודות וההתחייבויות של הקבלן לפי החוזה.

6.3 כתבי כמויות

6.3.1 תיאור סעיפים בכתבי הכמויות

מתן תיאורים כלשהם, חלקיים או נרחבים, באחד מסעיפי הכמויות ואי מתן אותו תיאור בסעיף לעבודה דומה אינו גורע מכלליות התיאורים.

6.3.2 ביצוע טיפולים תקופתיים

הטיפולים יהיו בטווח של שנתיים, או עפ"י הנחיות המהנדס הכלולים לפי סעיפי המפרט המצוינים בפרק 4 וישולם לפי מחיר קומפלט.

6.3.3 הקבלן יתמחר טיפול וח"ח בנפרד לא מן הנמנע שתש"ן תרכוש את ח"ח ותנפק אותם לקבלן לשם ביצוע הטיפול

6.3.4 כל בדיקה וביצוע טיפול תערך ותחתם ע"י מכונאי מוסמך לדיזלים.

- ✓ מחירי היחידה לטיפולים יכללו את כל העבודות הנדרשות לביצוע טיפול מושלם לרבות:

כלי עבודה, כח אדם , ציוד הרמה אם נדרש לטיפול בציוד, ציוד ניקיון , ציוד מיגון אישי, ציוד הגנה על הציוד וכן כל הנדרש לביצוע הטיפול ע"פ הנחיות היצרן.

- ✓ מחירי היחידה לאספקת חומרי חילוף יכללו את כל החלקים הנדרשים לביצוע הטיפול, חלקים חדשים ומקוריים כולל אספקתם במתקנים השונים.

6.3.3 <u>עבודות יומיות</u>

ש"ע ישולמו לפי שעות נטו משעת התייצבות במסוף עד לסיום העבודה במסוף.
לא ישולמו שעות נסיעה ואלו יהיו כלולים במחירי שעה נטו לפי סעיף זה התשלום הינו לסוג של בעל מקצוע בתחום המכונאות דהיינו מכונאי מוסמך. מחיר לחשמלאי יכלול בעל מקצוע עם תעודת חשמלי רכב מוסמך מטעם משרד העבודה .
עוזר מכונאי יושלם בנפרד.
קריאת חירום תשלום אף היא, על פי סעיף זה כאשר ספירת השעות תעשה מרגע הקריאה עד גמר התקלה, על פי סעיף 4.6.

6.3.4 <u>חומרים</u>

חומרים ציוד ואביזרים וחלקי ציוד שאינם כלולים במחירי השרות ישולמו עפ"י חשבוניות מס מקוריות ובאישור מראש של המהנדס ובתוספת 12% דמי טיפול.