Rev.9/2018

INTRODUCTION

This instruction book has been prepared to help you obtain the best possible performance from your new Chinook wind machine. If you follow these instructions with reasonable care, a lot of unnecessary problems can be avoided.

If you have any questions on running your wind machine be sure to contact your dealer. He will assist you with start up, operation, and maintenance.

IMPORTANT: To insure maximum machine life and complete frost protection, keep your engine tuned and running smoothly at all times. A rough running engine will greatly increase machine vibration causing undue stress and fatigue.

CAUTION: DO NOT RUN MACHINE UNDER WINDY, FOGGY OR RAINY CONDITIONS!

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CALIFORNIA

Proposition 65 Warning

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

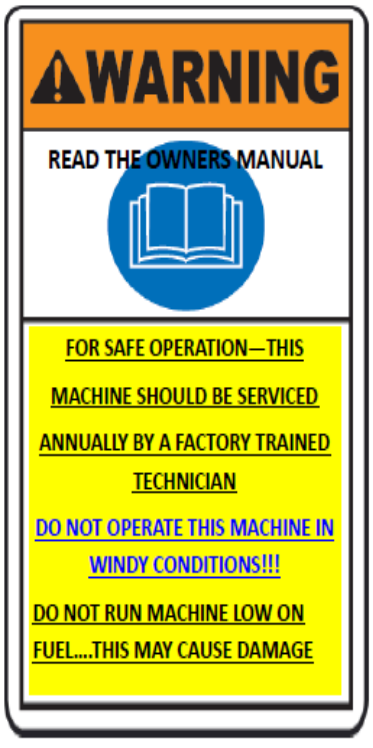
SAFETY FIRST

1. Never stand under or in line with the propeller blades plane of rotation when it is turning.
2. Never stand in line with the engine radiator fan's plane of rotation when running.
3. Never climb or work on the tower when the engine is running.
4. Never require or encourage any person that expresses a fear of working at heights to service or repair a wind machine tower.
5. Always wear and use a safety belt when working on the tower. Safety belts may be purchased at a safety equipment supply store or thru us.
6. Do not climb or work on the tower without disconnecting the battery ground cable to prevent a surprise start.
7. Do not climb the tower if the wind is causing the fan to rotate. Wait until the fan feathers out in the cross wind or engage the clutch.
8. Never, under any circumstances, try to stop the fan from rotating by reaching into the tower and grabbing the drive shaft.
9. Never throw any object into a rotating fan.
10. Always keep hands, feet and clothing away from moving parts.
11. Do not wear loose clothing, rings or wrist watches while working in or around your machine. Tie up or otherwise restrain long hair.
12. The cooling system is always pressurized during and after engine operation. Use extreme caution in turning the radiator cap to relieve the pressure before removing it.
13. Flammable and explosive battery gas is created when a battery is either charging or discharging. The battery may explode if short-circuited.
14. Use caution when working with fuel. Do not smoke while filling the fuel tank or while working on the fuel system.
15. The operator and/or service mechanic should be provided and required to carry an adequate fire extinguisher and first aid kit that contains an eye wash.
16. Never operate the machine without all the guard covers in place on the tower.

17. Always anchor the blade if you remove any part of the drive train. Wind can start the blade turning causing damage or injury.
18. Before and while climbing the tower of any wind machine inspect the ladder and all its welded and bolted connections for cracks and breaks. A person climbing a damaged ladder could fall.
19. Always check for fuel leaks before attempting to operate your wind machine. Always clean up any spilled fuel.









OPERATING CAUTIONS

The following operating cautions must be observed when operating your wind machine. Failure to do so could result in damage to your machine and possible severe personal injury.

1. **DO NOT RUN MACHINE UNDER WINDY CONDITIONS.** Operating under windy conditions can cause the fan and tower to vibrate violently, causing possible damage or breakage to the fan, tower, drive train, and gear drives.
2. **DO NOT RUN MACHINE UNDER FOGGY CONDITIONS.** Ice may form on the blades causing severe imbalance with the resultant damage or breakage to the fan, tower, drive train, and gear drives.
3. **DO NOT ALLOW ENGINE TO BE STARTED OR SHUT DOWN WITH FAN ENGAGE**

   New Machines with a centrifugal clutch are free of this type of damage. Auto engage and free wheels to stop.
4. **DO NOT ALLOW DIESEL UNITS TO RUN WITH WATER IN THE FUEL.** Engine power surging will result creating excess stresses and vibrations on the fan, tower, drive train, and gear drives.
5. **DO NOT ALLOW DIESEL UNITS TO RUN LOW ON FUEL OR ON DIRTY FUEL.** Low or dirty fuel can lead to poor fuel flow causing engine power surging. This creates excess stresses and vibrations on the fan, tower, drive train, and gear drives for all propane powered engines.
6. **IF ON PROPANE, SHUT FUEL TANK SUPPLY OFF AFTER EACH USE.** This will help keep the propane vaporizer unit clean from building up with possible contaminated propane by-products which could block the flow of vapor to the carburetor. Compressor oil from transports is often the cause of fuel contamination.
7. **WHEN RUNNING AN ENGINE EQUIPPED WITH ELECTRONIC PARTS ON BOARD, DO NOT REMOVE ANY WIRES OR BATTERY CABLES while running.** To do so will likely cause the electronic systems to fail.

Chinook Diesel Engine Machine

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IVECO NEF 6.7 TAA DIESEL

Starting Instructions

IMPORTANT: DO NOT OPERATE MACHINERY IN WINDY CONDITIONS.

IMPORTANT: DO NOT OPERATE MACHINERY IN FOGGY OR RAINY CONDITIONS.

TO START

IMPORTANT—TURBOCHARGED ENGINES

If the engine has not run for several days.

a) Turn ON "Ignition" (fuel valve) switch. DO NOT depress the Murphy switch button.
b) Pull the starter button to crank the engine until the oil pressure gauge shows pressure.
c) Continue with normal starting instructions.

1. This Engine is equipped with a centrifugal clutch system. Will engage automatically with increased engine speed
2. Turn Fuel Supply ON. TURN Vernier throttle control counter-clockwise 1 full turn to start.
3. Pull "Ignition" switch to ON position. !!Check Instructions above if engine was not used in the past few days!!
4. Pull "Ignition" Switch—OUT— fully to engage start.
   Let Engine crank for 3 seconds and push in Murphy switch button to start engine.
5. When the engine starts, release the Ignition switch, but continue to held in the Murphy switch button until oil pressure is established – approx. 15 seconds.
6. Idle the engine for 5 minutes at approximately 1100 RPM before operating with a load.

Δ **Caution:** Do not idle the engine for excessively long periods. Long periods of idling (more than 10 minutes) can damage an engine because combustion chamber temperatures drop so low the fuel will not burn completely. This will cause carbon to clog the Injector spray ports and piston rings, and can cause the valves to stick. If the engine coolant temperatures become too low (60° C, 140°F), raw fuel will wash the oil off the cylinders and dilute the crankcase oil.

7. Idle is set at approx. 1100 RPMs for engagement of centrifugal clutch
8. After warm up, gradually increase engine speed to 2450 RPM.
9. This is the Pre-set Max. Speed

SHUT DOWN

1. Turn Throttle Clockwise to gradually reduce engine speed to 1100 RPM —Idle Speed
2. Idle engine for approximately 5 minutes before stopping it.
3. Push "Ignition" switch OFF to stop engine.

Chinook WIND MACHINES

Auto Start "ON" Directions

1. Turn fuel on
2. Turn A/M switch to A to activate "auto operation" on Engine Control Panel.
3. On Cascade 101, Push the Auto Start Button—Green Light will come on. This means the Auto Start is Active.
4. The Carel temperature unit will be on and will display current temperature.
5. To check or set your start up temperature, HOLD down the "SET" button. In a few seconds the display will start flashing and show the temperature set for the wind machine to start.
6. To change the low temp start temperature (while still flashing) arrow up or down to the desired temp—push "Set". This will lock in your start up temperature. The display will then stop flashing and display current air temperature.

Auto Start "OFF" Directions

When Auto Start is no longer needed on the Chinook wind machine – turn A/M switch to "OFF" On the engine Control.

DIESEL:

1. Disengage clutch if equipped with Standard handle Clutch.
   Or, will be equipped with the centrifugal clutch and will work automatically.
   IMPORTANT - TURBOCHARGED ENGINES:
   If the engine has not run for several weeks:
   a) Turn ON "ignition" (fuel valve) switch. **DO NOT** depress the Murphy switch button.
   b) Push the starter button to crank the engine until the oil pressure gage shows pressure.
   c) Continue with normal starting instructions.
2. Press button on the Venier throttle control and pull control part way out or approximately 1 full turn counter clockwise. Release button. (Turn control counter-clockwise to increase speed, clockwise to decrease speed).
3. Pull the "ignition" switch to ON position.
4. Pull the ignition switch completely out and push in Murphy switch button to crank engine.
5. When the engine starts, release the ignition switch, but continue to hold in the Murphy switch button until oil pressure is established within 15 seconds.
6. Idle the engine 3 to 5 minutes at approximately 1000 RPM **BEFORE** operating with a load.
   CAUTION: Please watch Idling time - Do not idle the engine for excessively long periods. Long periods of idling (more than 10 minutes) can damage a engine because combustion chamber temperatures drop so low the fuel will not burn completely. This will cause carbon to clog the injector spray holes and piston rings, and can cause the valve to stick. If the engine coolant temperatures become too low (60□C, 140□F), raw fuel will wash the oil off the cylinders and dilute the crankcase oil.
7. Engage clutch slowly. Adjust engine speed to 1500 RPM for 10 to 15 minutes or until water temperature reaches 160°F- 165°F, 71°C - 74°C.
8. After warm up, gradually increase engine speed to 2450 RPM.

NOTE: All ground powered Chinook wind machines are equipped with Murphy safety shut down circuits. If the engine oil pressure should drop to 20 PSI, if the engine gets hotter than 210°F, 99°C , or if the engine speed exceeds set limits, the circuits will shut the engine down automatically. Familiarize yourself with the instruments, noting the safety reset over-ride button. The full operating speed has been set by the installer and must not be changed except by a Chinook representative.

WARNING: NEVER RUN THE UNIT WITH CONTAMINATED FUEL! NEVER LET THE UNIT RUN OUT OF FUEL! IF EITHER CONDITION HAPPENS THE ENGINE WILL SURGE – CAUSING POSSIBLE DAMAGE TO THE ENGINE, GEAR BOXES, DRIVE TRAIN, AND FAN.

IF YOUR MACHINE WON'T START

If your machine will not start on a critical night, do a quick check of the machine to see if you can determine what is wrong. If you cannot find what is wrong or if you need parts be sure to call a Chinook service man right away.

1. Check to make sure you have fuel turned on.
2. Check all wiring for loose, broken or shorted wires. Possible damage from rodent's chewing wires.

3. Check the fuse on the Murphy by-pass switch to see if it is blown. If it is, check to see that the tower light is not shorted out, as well as alternator wires, starter wires, and any other wires before replacing fuse.
4. Check for water build up in separator.
5. Check to make sure there is fuel in the tank.
6. Check battery voltage. Low battery voltage may not spin engine fast enough to start.
7. Air leak in fuel supply line. Diesel fuel systems must have air/fuel tight lines and hoses. Air seepage into fuel line will cause air bubbles in system and engine will not run.

In any emergency situation, the best practice is to immediately call your factory authorized dealer or service organization.

FUEL OPTIONS AND REQUIREMENTS

DIESEL: #2 DIESEL

We recommend that all fuel be purchased from a dealer or distributor of a major oil company.

THE USE OF UNSUITABLE FUEL IS THE BIGGEST SINGLE CAUSE OF POOR ENGINE PERFORMANCE AND LIFE. These difficulties are related to accumulation of deposit in the combustion chambers and valve ports. Make sure you buy/use clean fuel and keep it clean. Change the fuel supply filter at least yearly.

Fuel tanks should be kept full to avoid condensation. Tanks should be checked before starting each season for water in the fuel.

DIESEL:

A good grade of #2 diesel, free from dirt and moisture is required for diesel engines. Water in your diesel can cause serious damage to your engine. Make sure to check your tank at the start of each season for water contamination and periodically during the season. Also maintain a good filtration system with a water extraction filter.

ENGINE WARM-UP

Avoid racing your engine during warm-up. The greatest percentage of wear occurs when a cold engine is first started. After an engine has been shut down and allowed to cool, the majority of the lubricating oil drains off the reciprocating parts back into the oil pan. Engine oil does not flow freely or lubricate properly until it has reached normal operating temperature.

If an engine is operated at excessive speeds or under heavy loads when it is cold, wear will be accelerated. The greatest damage will be done to cylinder walls and pistons.

AFTER STARTING THE ENGINE:

1. Allow the engine to idle until the needle on temperature gauge begins to rise.
2. Increase speed to half throttle.
3. Operate at half throttle until engine temperature reaches 160° - 170°F, 71°- 77°C.
4. Open throttle to full operating speed.

With proper warm-up, engine life will be increased considerably.

DIESEL:

Do **NOT** operate the engine at full throttle below peak torque engine speed (RPM) for extended periods of time.

Allow the engine to idle 3 to 5 minutes before shutting it off after a full load operation.

SHUT-DOWN INSTRUCTIONS

DIESEL:

1. Gradually reduce engine speed to 800 - 1000 RPM.
2. Disengage clutch. Equipped with centrifugal Clutch it will automatically disengage.
3. Idle engine for 3 - 5 minutes before stopping it.
4. Push "ignition" switch **OFF** to stop engine.
5. If equipped with auto start, when the shut down temp is reached, the engine will go through the cool down step and then shut off on its own.

AFTER A NIGHT'S RUN

7. Check the engine oil level. Add if required. Diesel engines tend to use some oil. Each one is different.
8. Check the engine and gear drives for oil leaks.
9. Check the fuel level. Order early if needed. If tank is low it's better to fill up and make sure you don't run out.

IT'S BEST TO KEEP YOUR FUEL TANK FULL

BREAK-IN PROCEDURE FOR NEW ENGINE

DIESEL:

Use the following break-in procedure for diesel wind machines:

With **THE CLUTCH ENGAGED (manual or centrifugal)** completely warm up the machine as follows:

30 minutes at 1600 RPM
1 hour at 1800 RPM

4 hours at 2200 RPM
15 hours at full RPM

The engine is then ready for continuous full speed operation.

After the first 4 hours of operation, the engine oil level should be checked. This will establish an oil consumption pattern, so you will know approximately how often to add oil. **DO NOT** change the oil until the oil consumption slows down (approximately 100 hours), just add the type of oil that you plan to use after the break-in period.

A diesel engine will use 3 - 5 quarts of oil every 8 hours of running until broken in. This will take 60 - 200 hours. After break-in, normal oil consumption may be 2 - 3 quarts every 8 hours of running. PLEASE

BREAK IN of 20 HOURS is to qualify the Chinook Wind Machine is ready for service. CHECK ALL NUTS AND BOLTS for Tightness after the first 5 hours of break-in and again after 20 hours. The loss of a nut or bolt can result in the loss of a crop.

PREVENTIVE MAINTENANCE

The length and reliability of service that you received from your Chinook wind machine depends upon thorough lubrication and preventive maintenance. Without adequate oil and grease, the working parts of your machine can be ruined in a very short time.

We recommend that you initiate a system of a "scheduled maintenance" for the care of your machine. Following are charts with minimum intervals for various maintenance and lubrication requirements for your Chinook wind machine. Additional recommendations for your engine are included in the manufacturer's operators manual.

Your Chinook wind machine dealer can provide assistance and service in maintaining your machine as well as answer your questions concerning its operation.

Do not wait for a problem to happen! Correct it before it happens.

MAINTENANCE SCHEDULE AND RECORD

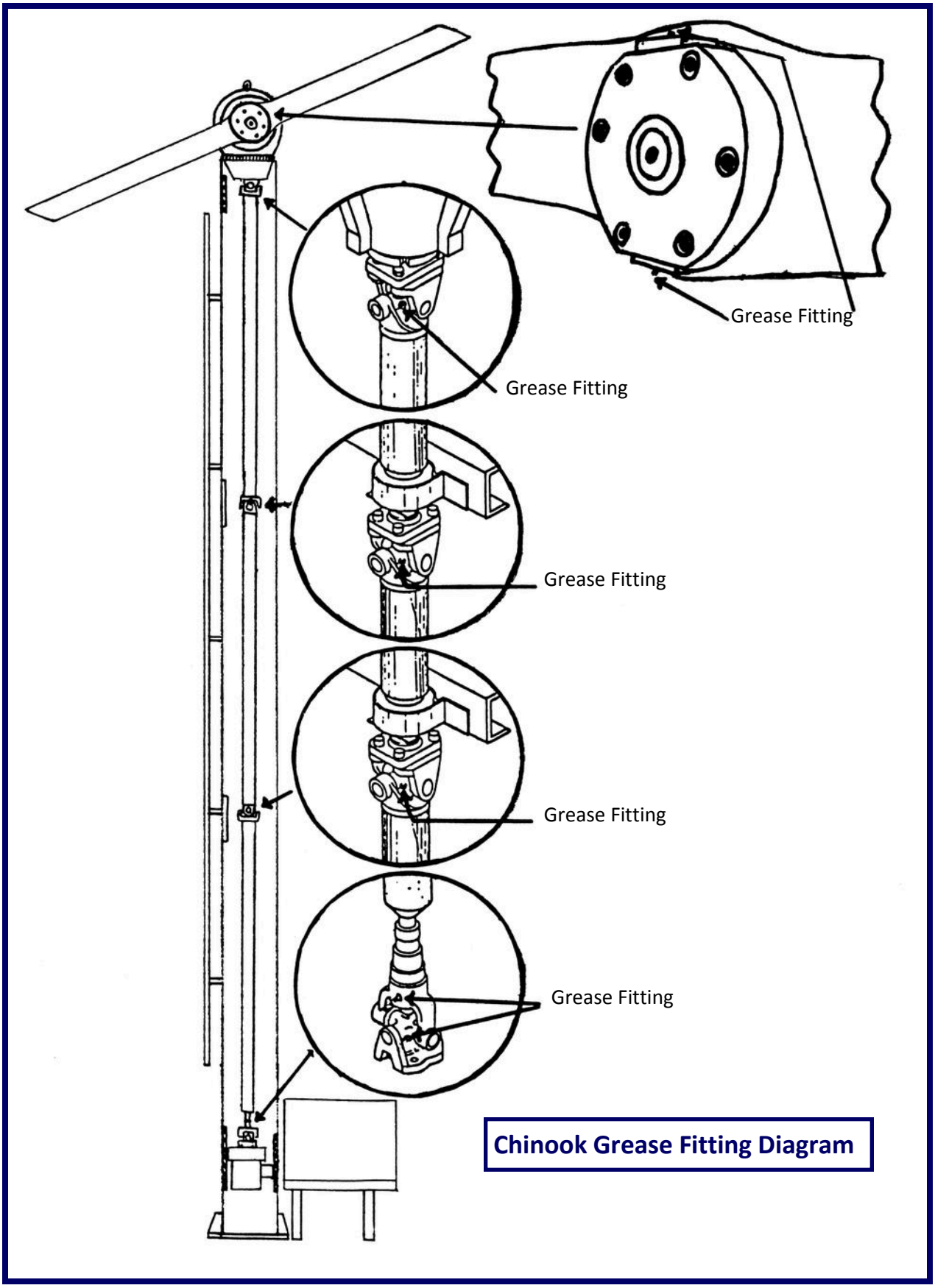
GASOLINE/PROPANE/DIESEL

Initial Start-up Sequence	Operation	100 Hrs.	200 Hrs.	300 Hrs.	400 Hrs.	500 Hrs.	600 Hrs.	700 Hrs.	800 Hrs.	900 Hrs.	1000 Hrs.
1	Oil, Check Level	DAILY									
2	Coolant, Check Level	DAILY									
3	Fuel, Oil and Coolant Leaks, Check	DAILY									
	Oil, Change [1] [2]	X	X	X	X	X	X	X	X	X	X
	Oil Filter, Change [1] [2]	X	X	X	X	X	X	X	X	X	X
4	Air Cleaner (Dry Type), Replace Element	X	X	X	X	X	X	X	X	X	X
5	Battery, Check Charge and Level	X	X	X	X	X	X	X	X	X	X
	Crankcase Vent System Breather Cap, Clean	X	X	X	X	X	X	X	X	X	X
	Battery cables, Clean [2]		X		X		X		X		X
6	Water Pump and Alternator, Belt, Check and Adjust [2]		X		X		X		X		X
	Throttle, and Choke, Linkage, Lubricate [2]	X	X	X	X	X	X	X	X	X	X
	Fuel Filter, Replace [1]		X		X		X		X		X
	Cooling System, Check or Refill [2]				X				X		
9	Idle Speed, Check and Adjust				X				X		
10	Idle Mixture, Check and Adjust				X				X		
11	Load Adjustment [2]				X				X		
	Spark Plugs, Clean, Adjust and Test or Replace		X		X		X		X		X
7	Ignition Timing, Check and Adjust (Check Centrifugal Advance) [2]				X				X		
	PCV Valve Hose and Fitting, Clean				X				X		
12	Throttle Adjust				X				X		
8	All Bolts and Nuts, Check for Tightness [2]	SEASONAL									

[1] More frequent intervals may be required in dusty areas (maximum depression 25" of water).

[2] Seasonal or as required.

NOTE: SCHEDULED MAINTENANCE BEYOND 1000 HOURS SHOULD BE CONTINUED AT SAME INTERVALS AS BEF



Chinook Grease Fitting Diagram

LUBRICATION SPECIFICATIONS

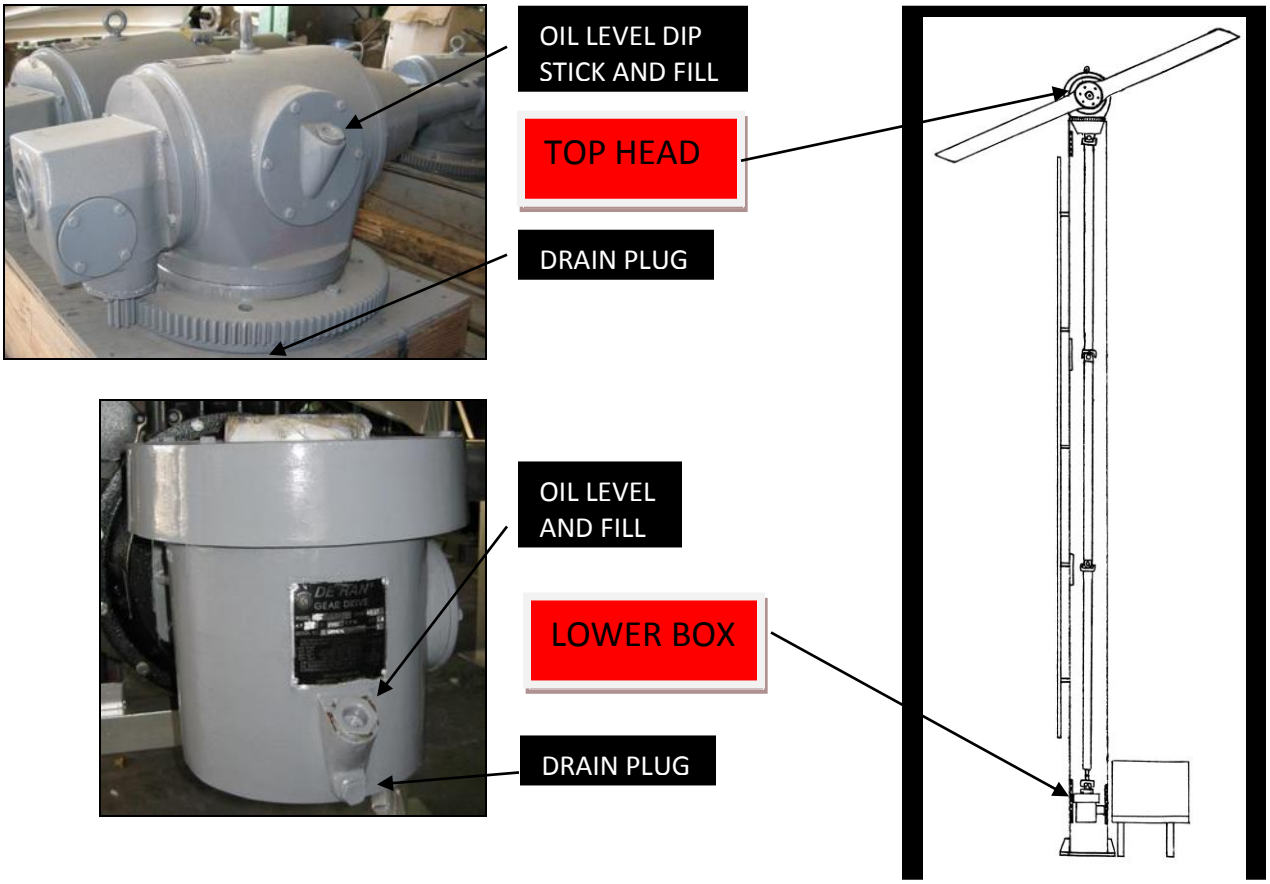
	LUBRICANT	AMOUNT	FREQUENCY
Fan Teeter Hub	Chassis Lube #2	Few Shots	Seasonal
Top Gear Box	SAE-30W, or High Grade Turbine Oil W/ Rust & Oxidation Inhibitors	12 Quarts	Check Seasonal & Fill To Level Drain & Refill As Required Or Every 500 Hours
Universal Joints & Slip Spline	Chassis Lube #2	Few Shots	Seasonal
Lower Gear Box	SAE-30W, or High Grade Turbine Oil W/ Rust & Oxidation Inhibitors	5 Quarts	Check Seasonal & Fill To Level Drain & Refill As Required Or Every 500 Hours
Crankcase			
Ford V10 Gas & Propane	SAE 10-40W Must Meet Ford Specification ESE-M2C153-C API Classification SJ, if SJ oils are not available SH oils are acceptable	9 Quarts	Change Oil & Filter Every 100 Hours & Seasonal
IVECO NEF 67 TAA	**SAE-10-40W API SAE-CE/SF**	**15 Quarts**	**Change Oil & Filter Every 100 Hours & Seasonal**
Chevy 454	SAE-30W, SAE-10-40W SE-CC	6 Quarts	Change Oil & Filter Every 100 Hours & Seasonal
Choke & Throttle Cable Housings	Light Weight Oil Penetrant	As Needed	Seasonal
Throttle Cable T-Handle & Brass Insert	Thick Coating of Grease	As Needed	Seasonal

CHINOOK GEAR DRIVES

All Chinook wind machines come equipped with pressure lubricated gear drives.
With a pressure lubricated gear drive system, the oil is force-fed over the gears and bearings rather than being submerged in oil and splash lubricated. Pressure lubrication reduces the friction and heat generated. Less friction results in more available horsepower reaching the fan. This makes for a more efficient gear drive than a comparable splash lubricated gear drive.

All Chinook wind machine gear drives are installed with high grade gear oil (AGMA 4 rating)with rust and oxidation inhibitors in both the upper and lower main gear box.

The oil in the gear boxes will last for an indefinite period of time. However, gear box oil levels should be checked seasonally and filled to level if necessary. The oil should be changed in the gear boxes if it becomes discolored, water contaminated, or if foreign material becomes present. Change oil at least every 500 - 700 hours of operation and/or more frequently to eliminate water formed in the gear case due to condensation. Gear drives operated in climate with hot days and cool nights will accumulate moisture more rapidly than gear drives operated at constant temperatures.



TROUBLE SHOOTING ENGINES

The following pages describe the most probable causes of engine malfunction applicable to a particular type of failure. Only those problems that can readily be corrected in the field are listed.

We do not list the procedures for the correction of any faults as those procedures will be obvious to person qualified to make the repair. The list is intended as a quick reference only, as any emergency repair should be done by a fully qualified mechanic.

DIESEL:

A. STARTER WILL NOT CRANK ENGINE

1. Defective battery
2. Lead disconnected or terminals corroded
3. Faulty starter switch or solenoid
4. Starter drive dirty and /or sticking
5. Defective starter motor

B. STARTER CRANKS ENGINE BUT TOO SLOW TO START

1. Low battery charge
2. Terminal(s) loose or corroded
3. Too heavy grade of engine oil for climate
4. Defective starter motor

C. ENGINE CRANKS BUT WILL NOT START

1. Battery voltage too low to spin engine fast enough to start.
2. No Fuel
3. Dirty Fuel
4. Air leak in Fuel line
5. Fuse in Murphy switch bad

DO NOT KEEP CRANKING ENGINE FOR PROLONGED PERIOD
This will cause starter damage. CALL YOUR CHINOOK SERVICE REPRESENTATIVE

D. ENGINE MISFIRES

1. Most likely injector issue

Call your Chinook Service Representative for assistance

E. **ENGINE STARTS AND STOPS**

1. Fuel line blocked
2. Water in the fuel
3. Defective fuel pump
4. Depleted fuel supply
5. Air leaks in fuel system
6. Defective switch
7. Loose wire

F. **ENGINE DOES NOT PRODUCE FULL POWER**

1. Fuel line partially blocked
2. Air leaks in fuel line
3. Injector issues
4. Bad fuel

AFTER EACH RUNNING SEASON

Wind machine engines should either be run periodically year round or pickled after each heating season.

Before pickling your engine be sure to do the following:

1. Perform all the seasonal periodic maintenance operations as listed on the maintenance charts.
2. Clean and lubricate all choke and throttle cables.
3. Check the complete tower assembly for loose nuts and bolts. Tighten or replace if required.
4. Check the fan prop assembly for damage or deterioration.
5. Check gear boxes for oil level and oil condition, change as required. Adjust drag bearing as needed.
6. Operate the engine under load until the engine temperature has stabilized. Change engine oil and oil filter. Change air filter if dirty.
7. Check out engine thoroughly including belts, electrical and fuel systems. Check idle and full load speed, timing, vacuum and compression.
8. Check the engine coolant fluid. Replace if indicated by the presence of rust or low antifreeze protection.
9. Operate the engine under load for ten minutes to circulate the new clean oil. If the coolant is replaced, operate the engine for thirty minutes to insure complete mixing of the antifreeze solution.

NOTE: AT THIS POINT, DIESEL POWER PLANTS SHOULD HAVE THE EXHAUST AND THE AIR CLEANER INTAKE SEALED OFF WITH TAPE AND PLASTIC BAG, AND BATTERY REMOVED FOR STORAGE.

PROCEDURE FOR PICKLING / WINTERIZING

DIESEL:

1. Tape and seal off the ends of the exhaust pipes and air cleaner.
2. Remove the battery. Store the battery in a cool dry location after bringing up to a full charge. Check battery condition monthly. Keep the top of the battery clean.
3. Engage the clutch handle (if equipped)to keep fan from turning in the wind. Centrifugal clutch units need nothing. Free-wheeling of the blade we have found will not hurt fan or machine. When windy the fan will only spin till out of direct line of wind direction.

PROCEDURE FOR UN-PICKLING

DIESEL:

1. Make a visual inspection of the tower for any oil leaks, or damage to the fan or gear boxes.
2. Make a visual inspection of the engine for oil, fuel, or coolant leaks.
3. Remove the tapes and seals from all sealed openings.
4. Check oil and coolant levels in the engine.
5. Install a fully charged battery.
6. Start engine by using starting procedures for DIESEL engine that has not been operated regularly
7. Check all instrument functions.
8. Run engine long enough to check all system.

IVECO NEF6.7 TAA DIESEL:

See Iveco Operator & Maintenance Manual

PRINCIPLES OF WIND MACHINE FROST PROTECTION

Successful frost protection efforts depend in part upon the topography and general condition of the orchard. An ideal situation would consist of a smooth, moist, clean cultivated floor, with trees adequately pruned and tree rows laid out parallel to the flow of nocturnal cold air. The slope of the floor would be constant at 1 to 1½ degrees. Both the floor of the orchard and the border areas would be free from any obstruction to normal air drainage.

Cover crops, loose soil, wood mulches and dry surface soil all reduce the flow of solar heat into and out of the ground. Those orchards with any of these conditions can be expected to reach lower temperatures than those where the surface conditions are represented by moist firm soil. Water has a

great capacity to absorb, retain, conduct and release heat. These advantages should be utilized.

During cold weather, improperly maintained wind breaks will add to frost problems. Wind breaks that are correctly pruned and thinned will allow the normal cold air drift to pass through.

Wind machine frost protection begins with the moving out or blowing out of the heavier cold air that settles in and around the trees in the orchard. The movement of this low level air prevents stratification and prevents frost formation. The wind machine will replace it with the warmer air found at higher elevations near the inversion ceiling.

In frost conditions, a "skin" of extremely cold air forms around buds, fruit and foliage. This "skin" is a super conductor of heat from the warmer object it surrounds to colder air mass. The wind machine can prevent the formation of this "skin" and thereby slow the heat loss from the objects of protection.

The past fifty years has seen considerable development and technological improvement of both wind machine and application techniques. The correct location in the orchard plus the choice of options that best accommodates the topographical features of the orchard are equal in importance to adequate horsepower in obtaining economical frost protection.

The development of orchard operations in colder locations requires that a reliable system of frost protection shall be a combination system such as wind machines and water or wind machines and orchard heaters. Either combination will provide much more protection than any single system.

THE WIND MACHINE SHOULD BE REGARDED AS A TOOL FOR MAINTAINING TEMPERATURES ABOVE THE DANGER POINT, NOT FOR RAISING THEM. WITH THE LOW OPERATING COSTS OF WIND MACHINES, THE PRACTICE OF EARLY STARTING AND LATE SHUT DOWN IS RECOMMENDED.

WIND MACHINES AND WATER IN COMBINATION

As long as additional applications of water are not detrimental to trees, buds, or fruit, this can be one of the cheapest sources of heat available. There will be a transfer of heat from water to the surrounding air as long as the ambient air temperature is colder than the water. Water in motion radiates more heat than still water. The most heat is transferred at the time water freezes and forms ice. The most efficient use of the heat released by water is achieved when the movement of air from the wind machine forces the heated air back down into the orchard.
The use of under-tree sprinklers or open ditch system maybe recommended as a water supplement to wind machines.

It is not recommended to use over-tree sprinklers since this system depends on the encapsulation in ice of the fruit or bud being protected. Although the formation of ice provides positive temperature control during the time of ice formation, it can act as a super conductor of heat transfer from the encapsulated object to the surrounding air if additional water for ice formation is not being supplied. This rapid cooling of buds, fruit, or foliage with ambient temperatures below the danger point, can result in the complete loss of crop if a loss of water should extend beyond twenty minutes. An additional danger in

the use of overhead sprinklers is the enormous loads of ice the trees are required to carry if long periods of application are necessary.

WIND MACHINES AND HEATERS IN COMBINATION

There are two economic factors involved in the use of a wind machine-heater combination. First, on low temperature nights, even though the wind machine might not provide complete protection, it can delay the time period that heaters are required. On most nights, the wind machine alone will be sufficient. Secondly, the rule of thumb is to use 45 heaters per acre when depending on heaters alone. In combination with a wind machine this requirement is reduced to 15 heaters per acre. The savings in fuel and labor costs are significant.

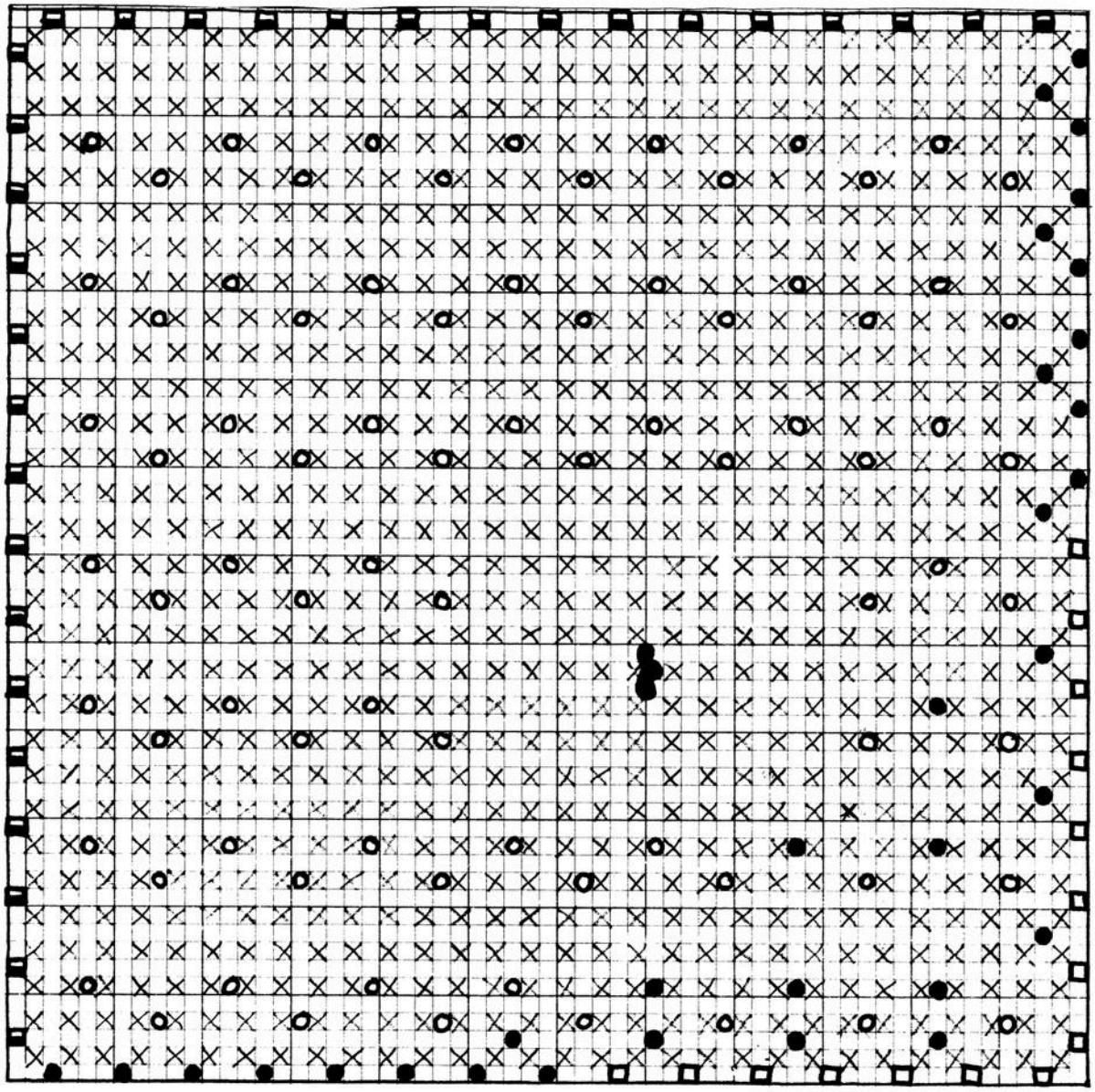
Care must be used in the distribution and lighting of heaters used in combination. No heaters should be placed within 150 to 200 feet of the wind machine. Heaters should not be lighted in double rows or concentrated in banks so dense that the heat will create a thermal updraft, turning it up and out of the orchard. Where two or more wind machines are operation together, the distribution of heaters between the machines should be very light.

A recommended charting of heater distribution in combination with a wind machine is illustrated on the following page.

ILLUSTRATION OF WIND MACHINE AND HEATER COMBINATION

The following is a lay-out of a square, 10 acre plot showing the placement of an 86-HP wind machine and auxiliary pots. For illustrative purposes, it is assumed that the frost condition will be for a 25°F, -4°C critical temperature night or lower with a prevailing south-east drift.

Wind Machine To Start At 33°F Or 32°F, -.6°C or 0°C
☐ 15 Pots To Light At 29°F, -1.7°C
● 32 Pots To Light At 28°F, -2.2°C
○ 82 Pots To Light At 27°F, -2.8°C
⬓ For Reverse Drift Only: 30 Pots To Light At 29°F, -1.7°C



NOTE: THE WIND MACHINE IS LOCATED AWAY FROM THE CENTER OF THE ORCHARD TO COMPENSATE FOR A NORMAL AIR DRIFT.

ADDITIONAL INFORMATION ON THE USE OF WIND MACHINES

FOR DECIDUOUS OPERATIONS:

Bulletin No. 634

Title: Frost & Frost Control in Washington Orchards

Available From: Cooperative Extension Service
U.S. Department of Agriculture
Washington State University
Pullman, WA 99164-6230

FOR CITRUS OPERATIONS:

Leaflet No. 2372

Title: Protecting Citrus from Cold Losses

Available From: Cooperative Extension Service
U.S. Department of Agriculture
University of California
Berkley, CA 94720

Another good source of information about frost control would be one of our knowledgeable Chinook wind machine representatives.

Thank you for the purchase of your new Chinook Diesel Wind Machine

Carel Thermostat Instructions



Setting Carel to desired temperature:

- Hold down the SET button until the screen starts flashing; the flashing number is the temperature at which the unit will turn on.
- To program (CHANGE) desired temperature, use the up or down arrow.
- After you have entered the desired temperature, hit the SET button once again and the temperature is set.
- To test accuracy, you may spray starting fluid on the Carel sensor; engine should start up when it reaches your desired set temperature.

Auto-Start Procedures:

- Set Manual/Auto switch to AUTO to give power to the Auto Panel. The lights on the Cascade will light up and blink. This indicates that the computer is booting up. Wait 20 Seconds….Then
- Push the AUTO button on the Cascade. A green light will illuminate at the 1:00 position. You are now armed in the AUTO position.
- Set the digital Carel thermostat to desired temperature by holding down the SET button until the temperature flashes. The flashing temperature is the temperature at which the machine will start. Push the UP or DOWN button until your desired temperature shows. Then press the SET button to bring the display back to the temperature of the day.

TO TEST YOUR AUTO START SYSTEM

- **Set your Wind Machine to Auto Start.**
- **Set the Carel Temperature unit to 45 degrees.**
- **Put Ice in a 1 liter/quart container and then fill it with water. Stir for 2 minutes…Mixture will be close to 32 degrees F. Put temperature probe in Ice water mixture. When the temperature drops below 45 degrees F your machine will start. Has a 5 minute warm up and then will go full speed. We Program in a 5 degree differential which means the machine will stay on for 5 degrees over the start temp, where ever that is set.**
- **Remove the probe.**
- **Warm the probe and as soon as temperature is above 45 degrees, + 4 degrees the engine will go to idle for approx. 5 minutes.**
- **Engine will shut off. Test is Complete**
- **Re-set your start up temperature to your desired temperature on the Carel.**

Notes: