OPERATING INSTRUCTIONS

MODEL 546

ZAMBONI®

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Contents

Introduction

This manual has been prepared to acquaint you with the operation of your ZAMBONI® ice resurfacer and to provide important safety information. Read, understand and comply with the information in this manual. All new operators must read this manual before operating the machine for the first time. Periodic review of the manual is essential for all operators.

The care exercised in the operation and maintenance of the ice resurfacer will extend its useful life, ensure highly satisfactory and dependable service at reduced cost and assure safe operation and maintenance.

We thank you for choosing a ZAMBONI® product and want to assure you of our continuing interest in your satisfaction with your ice resurfacer.

This manual should be considered a permanent part of this vehicle. It should remain with the machine when sold, to provide the next owner/operator with important safety and maintenance information.

All information, illustrations and specifications contained in this manual are based on the latest product information available at the time of printing. The right is reserved to make changes at any time without notice.

FRANK J. ZAMBONI & CO., INC.

Date of Purchase _____

Ice Resurfacer Serial Number _____

Safety Symbols

The safety symbols listed outline basic safety precautions.

READ AND UNDERSTAND ALL SAFETY PRECAUTIONS AND WARNINGS BEFORE OPERATING, OR PERFORMING LUBRICATION AND MAINTENANCE.

Personal Safety

These symbols indicate when your safety or the safety of others may be at risk.

DANGER!

This safety symbol warns of possible personal injury or death.

WARNING!

This safety symbol warns of possible personal injury.

Equipment Damage

CAUTION!

This symbol warns of possible damage that may occur to the machine.

Ice Resurfacer Guards

The safety guards used on the Zamboni ice resurfacer are illustrated in Figures 1, 2 and 3.

Figure 1 *Ice resurfacer guards*

Ice Resurfacer Guards

The safety guards used on the Zamboni ice resurfacer are illustrated in Figures 1, 2 and 3.

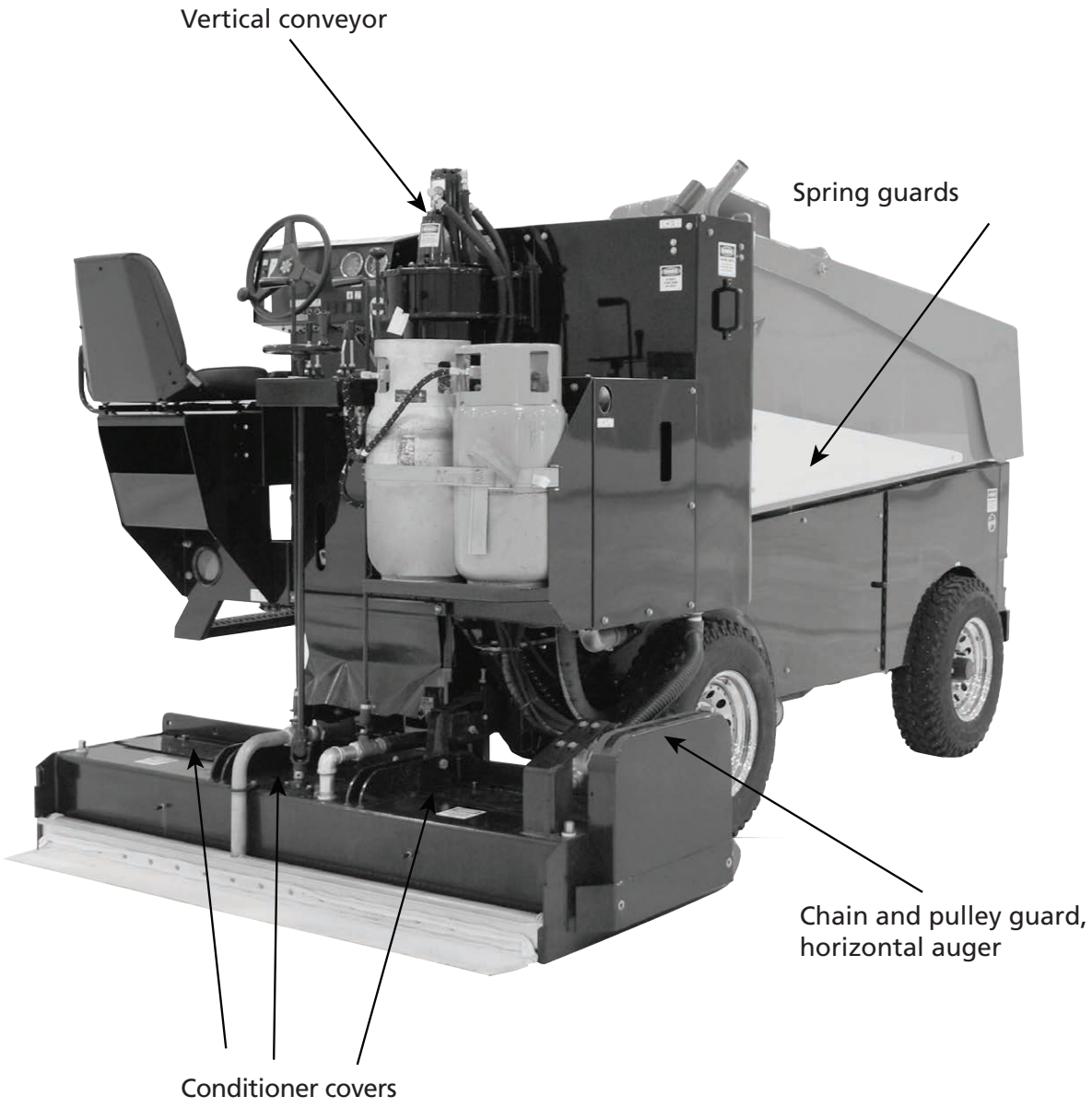


Figure 2 *Ice resurfacer guards*

Ice Resurfacer Guards

The safety guards used on the Zamboni ice resurfacer are illustrated in Figures 1, 2 and 3.

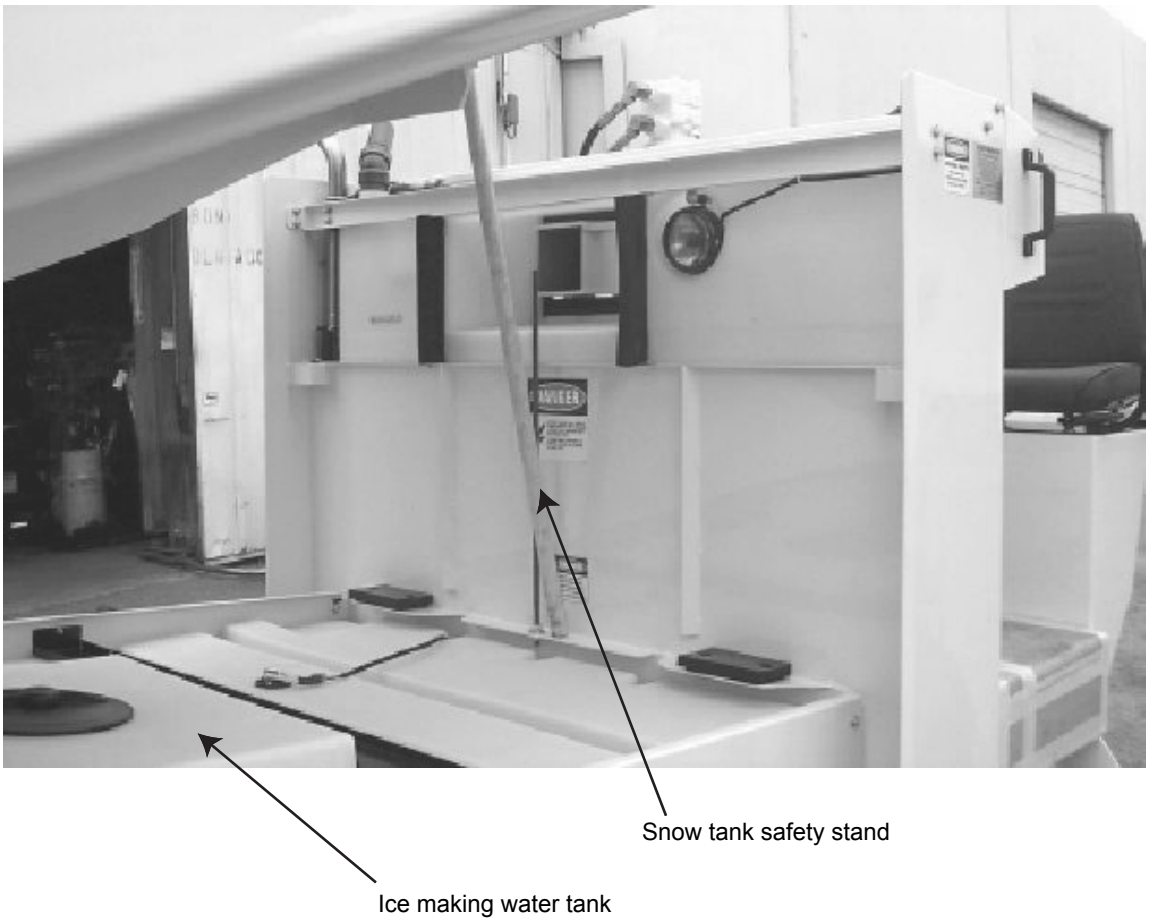


Figure 3 *Ice resurfacer guards*

Zamboni Machine Room Poster

You should have received a poster for the Zamboni machine room.

This poster highlights important safety information. Make sure it is displayed and visible to all Zamboni machine operators.

The Zamboni machine room is the preferred poster location. If you do not have this poster, contact the Zamboni Company or your Zamboni Authorized Distributor for a digital file you can have printed locally for your use.

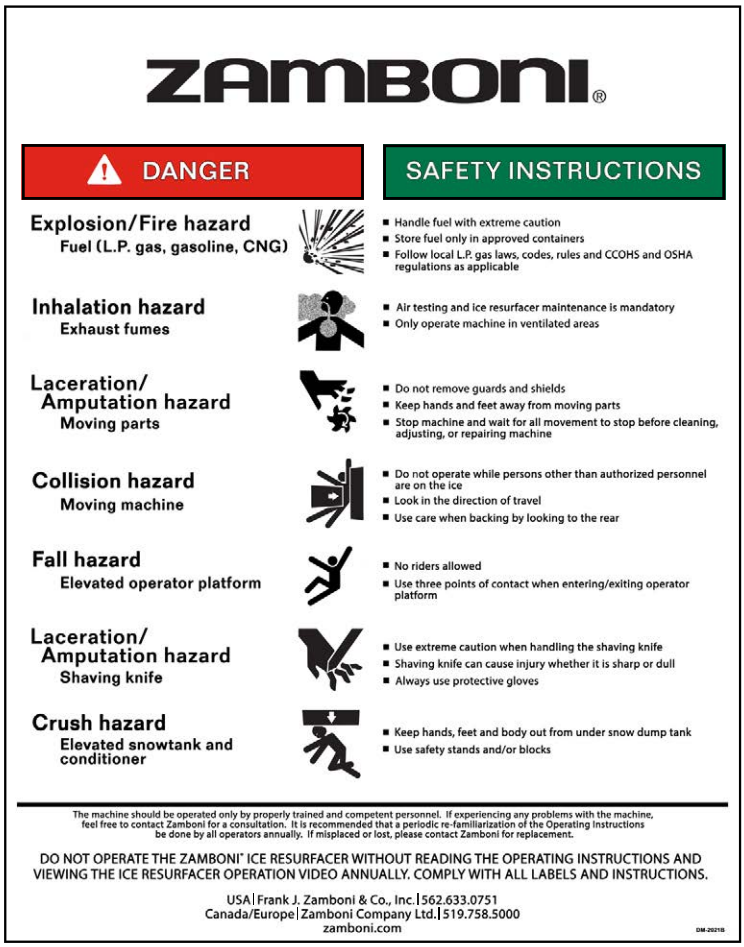


Figure 3 *Zamboni Machine Room Poster*

Zamboni Model 546 Ice Resurfacer Specification

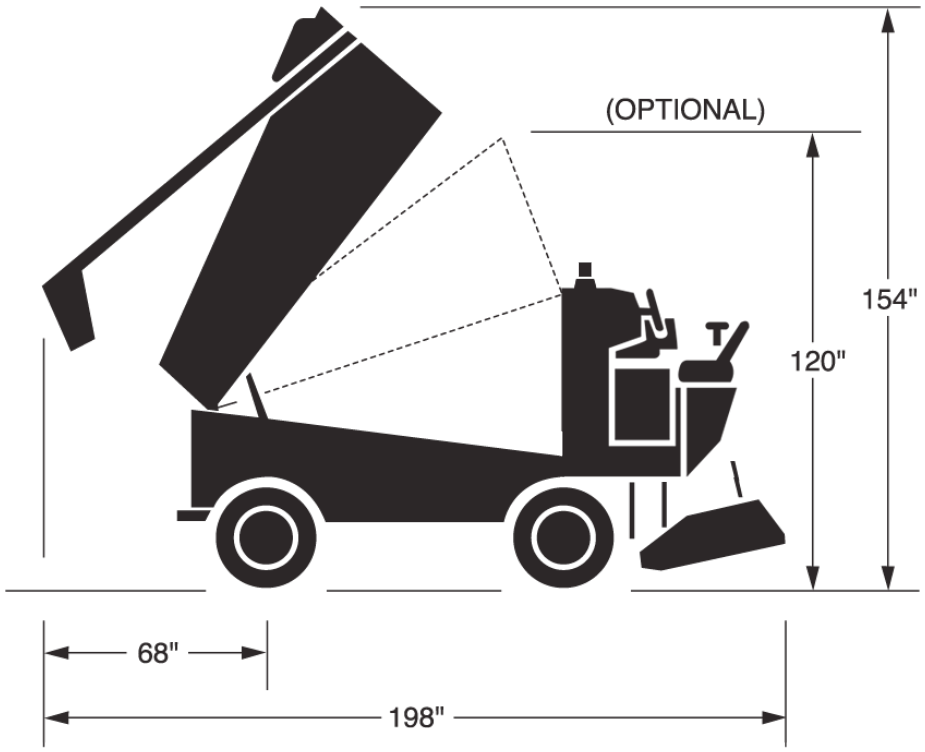
Components

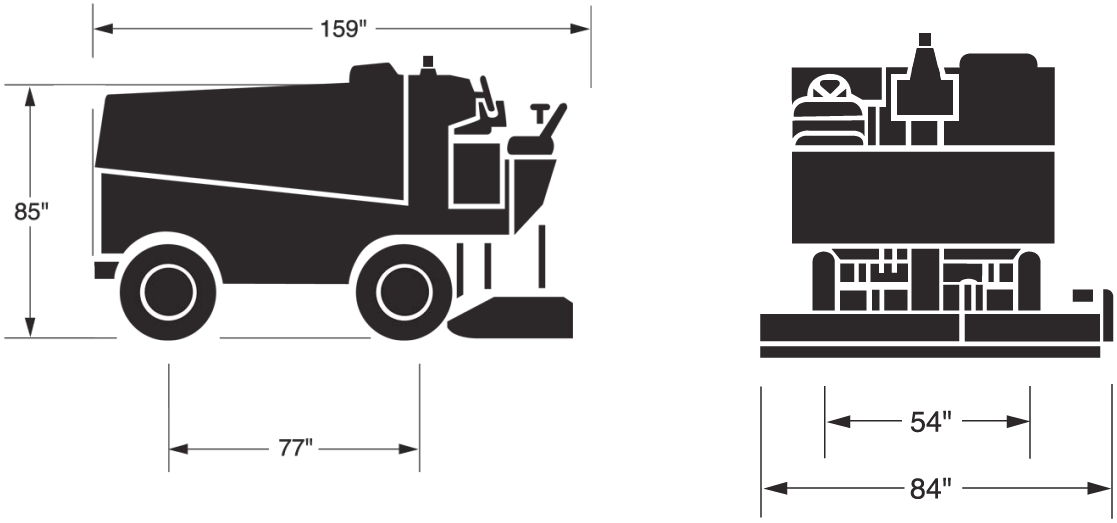
Machine Weight	6420 lb (2912 Kg) empty
Engine	Kubota industrial engine, water cooled, direct drive fan Model WG1605, 4 cylinders, 1.6L, 50 HP. CARB SI Tier 3 and EPA SI Tier 2 compliant engine with EPR fuel system, ECU, electronic governor and catalytic converter
Pump drive	"Piggy back" direct coupled to engine
Hydrostatic Transmission	Sundstrand variable displacement pump (series 46) and fixed displacement motor (series 44) with emergency bypass valve and loop flushing.
Transfer Case	4:1 Reduction
Chassis	Tubular frame with leaf spring suspension at the rear. Front steer axle (Model 44F) with 5.89:1 gear ratio. Rear axle and differential (Model 60) with 5.86:1 gear ratio
Tires	Steel-belted radial with tungsten tip studs, 215/85R16 8-ply rating
Hydraulics	Fixed displacement pump, Fixed displacement motors, Monoblock control valves with full power steering actuated by priority valving off the main pump
Electrical System	12-Volt system with alternator and following instruments: hourmeter, tachometer, voltmeter, gasoline fuel gauge (if gasoline powered), engine coolant temperature gauge with light and over-heat alarm, oil pressure warning light, water pump switch, ignition switch, horn button, fuses, "green-means-go" light, low coolant alarm
Blade	77 inch (1.95 m) shaving blade, adjustable at operator's station
Water Pump	Water pump with integral electro-magnetic clutch, 12VDC

Dimensions

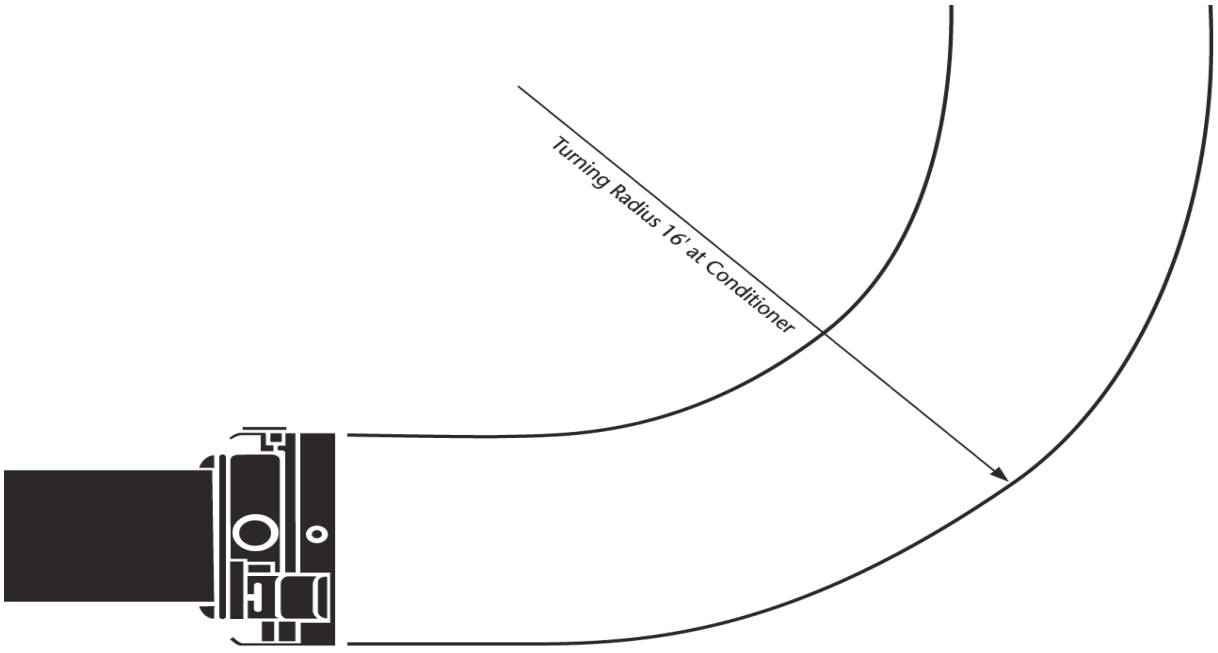
Overall	Dump Tank Lowered	Dump Tank Raised
Length	159" (4.04m)	198" (5.03m)
Height	85" (2.16m)	154" (3.91m)
Width	84" (2.13m)	
Wheelbase	77" (1.96m)	

Weight (empty) 6420 lb (2912 Kg)





Turning Radius



Tank Capacity Specification

Tank	US Gal	Liters	Other
Ice Making Water Tank	195	738	
Wash Water Tank	72 82*	273 310*	
Snow Tank			100 cubic Ft. of snow (2.83m³)
Hydraulic Oil Tank	25	95	
Gasoline Tank	14	53	Unleaded

*These wash water tank capacities apply to machines equipped with plastic wash water tank option.

All given capacities are approximate.

Foreword

- This manual contains safety, lubrication and maintenance information;
- The manual is a reference for the new operator and a refresher for the experienced one;
- It is mandatory that all operators review in detail this manual before performing any operation;
- **Read - understand - and keep** this manual with the Zamboni ice resurfacer;
- Some illustrations show details or attachments that may be different from your machine. Guards and covers may have been removed for illustrative purposes only;
- **KEEP ALL GUARDS IN PLACE!**
- Continuing improvement and advancement of product design may have caused changes to your Zamboni machine which may not be included in this publication;
- Whenever a question arises regarding your ice resurfacer or this publication, please consult the Zamboni Company for the latest information;
- A continuing review of this manual is recommended

Safety

The safety section lists minimum safety precautions. In addition, this section explains the **warning labels** used on the Zamboni machine.

Read and understand the basic precautions listed in the safety section before operating or performing lubrication, maintenance and repair on this product.

Operation

This manual includes sections which explain system gauges and switches, resurfacer and attachment controls and basic operating techniques.

Operating techniques outlined in this publication are basic. Skill and techniques develop as the operator gains knowledge of the Zamboni ice resurfacer and its capabilities.

1.
General Safety Practices

Safety

This symbol warns of possible personal injury.

The safety rules and regulations in this section are representative of some, but not all, rules and regulations. The Occupational Safety and Health Act ("OSHA") is paraphrased without representation that the OSHA rules and regulations have been reproduced verbatim. Please refer to Section 1910 of the Federal Register and subsequent revisions for a complete list of OSHA rules and regulations. Regulations vary from country to country, outside of the U.S.A., operate your Zamboni ice resurfacer in accordance with local regulations.

Important Safety Notice

Periodic and proper operation, lubrication and maintenance is important for the safety and reliability of your Zamboni machine. The manual outlines recommended procedures, some of which require the use of special tools or work methods.

DANGER!

Improper operation, lubrication and maintenance of this machine is dangerous and could result in injury or death.

READ AND UNDERSTAND ALL SAFETY PRECAUTIONS AND WARNINGS BEFORE OPERATING, OR PERFORMING LUBRICATION AND MAINTENANCE ON THIS MACHINE.

Basic safety precautions are outlined in the SAFETY section of this manual and in the description of operations where hazards exist. Warning labels have also been put on the machine to provide instructions and to identify specific hazards which could cause bodily injury or death to you or other persons.

It is the responsibility of the owner to perform a job safety analysis of all hazards associated with the total environment in which the Zamboni machine will operate and to train all personnel annually.

The warnings in the manual and on the machine are identified by the symbols:

DANGER!

This safety symbol warns of possible personal injury or death.

WARNING!

This safety symbol warns of possible personal injury.

CAUTION!

This symbol warns of possible damage that may occur to the machine.

DANGER !

Operations that may cause product damage are identified on the product and this publication. Zamboni cannot anticipate every possible circumstance that might involve potential hazard.

The warnings in this manual and on the machine are therefore not all-inclusive. If a procedure, tool or work method not specifically recommended by Zamboni is used, a competent person must be consulted to assure the safety of you and others and that the machine will not be damaged or made unsafe by the procedures you choose. You should also ensure that the product will not be damaged or made unsafe by the operation, lubrication, maintenance or repair procedure you choose. When in doubt, call our factory for free consultation and advice.

DANGER !

Do not operate or perform maintenance on this machine unless you have read and understand the instructions in THIS MANUAL. Improper machine operation and maintenance is dangerous and could result in injury or death. Contact Zamboni for a free replacement manual. Proper operation and maintenance is your responsibility.

Accidents involving product operation, maintenance and repair are caused by failure to observe safety rules or precautions. A person must be alerted to potential hazards. This person should also have the necessary training, skills and tools to perform safely.

The specifications are subject to change at any time. These changes may affect the service given to the product. Please obtain the most current information from your local distributor or the Zamboni factory before starting any job.

For a list of the most current publication, please contact:

The Zamboni Company, 15714 Colorado Avenue, Paramount, CA 90723 U.S.A., (562) 633-0751.

Warning Signs and Labels

There are several specific safety signs on your Zamboni machine.

Make sure that you can read and understand all of the safety signs. Clean or replace them if you cannot read the words or see the pictures. When cleaning the labels use a cloth, water and soap. Do not use solvent, gasoline, etc.

You must replace a label if it is damaged, missing or cannot be read. If a label is on a part that is replaced, make sure a new label is installed on the replaced part.

Contact Frank J. Zamboni & Co., Inc. for new labels free of charge.

DANGER !

Only trained and authorized personnel may operate this machine. For safe operation, read and follow the manual furnished with this machine and observe the following warnings:

- Keep all guards in place. Do not operate the machine if any guard is damaged or missing;
- Check all controls and warning devices for proper operation;
- Put directional control or shift lever in neutral before “ON-OFF” switch is turned on;
- Start, turn and brake smoothly. Slow down for turns, slippery or uneven surfaces. Use extreme caution when turning or on inclines;
- Watch out for pedestrians and obstructions, check overhead clearances. Use care when backing up;
- Do not permit riders on the Zamboni machine at any time;
- Do not permit skaters or people on the ice when the machine is

operating on the ice;

- Do not allow anyone to stand or pass under the elevated portion of any machine;
- Be sure operating surface can safely support machine;
- Observe safety rules when handling fuel on engine powered machines and when changing or charging batteries for electric machines;
- Never cover, hide or remove any safety label.

Crushing or Cutting Prevention

- Support equipment and attachments properly when working beneath them;
- Do not depend on hydraulic cylinders to hold up. Any attachment can fail if a control is moved or if a hydraulic line breaks;
- Never attempt adjustments while the machine is moving or is running unless otherwise specified;
- Where there are mechanical linkages, the clearance in the linkage area will increase or decrease with movement of the assembly;
- Stay clear of all rotating and moving parts;
- Keep objects away from moving fan blades. They will throw or cut any object or tool that falls or is pushed into them;
- Retainer pins, when struck with force, can fly out and injure nearby persons. Make sure the area is clear of people when striking retainer pins;
- Wear protective glasses when striking a retainer pin to avoid injury to your eyes;
- Chips or other debris can fly off objects when struck. Make sure no one can be injured by flying debris before striking any object;
- Keep all guards in place and good repair.

Fire or Explosion Prevention

Fuels (Gasoline, Propane - LPG, Compressed Natural Gas - CNG)

DANGER !

Gasoline, LPG , CNG and their vapors are extremely flammable. LPG and CNG vapors reduce oxygen available for breathing and may cause suffocation. Gasoline vapors are extremely flammable and cause flash fires.

- Physical damage such as dents, scrapes or gouges may materially weaken the structure of the tank and render it unsafe for use;
- All LP gas containers should be regularly inspected before recharging and examined again before reuse, for the following defects or damage;
- Keep container valve closed and plugged when not in use;
- Never use a match or open flame to check for leaks, use a soap solution;
- Always close the LPG tank service valve when the machine is parked for the night or for any extended length of time;
- Never smoke when filling, installing or changing the fuel tanks on the machine;
- Inspect for deterioration, damage or loss of flexible seals in the fill or servicng connection;
- Do not overfill LP gas containers;
- Keep all sources of open flame, spark or other ignition such as stoves, furnaces, water heaters or any appliance using a pilot light away from fuel storage, fuel use and refueling areas. Under well ventilated conditions, a minimum distance of 20 feet from all ignition sources is receommended;
- Do not operate the machine if an odor of gasoline or LPG or CNG is present or if other explosive conditions exist;
- Refuel outdoors or in a well ventilated area;

- DO NOT refuel when the engine is running or hot. Allow engine and engine exhaust system and catalytic convertor (if equipped) to cool for a minimum of five minutes before refueling;
- Never fill the gasoline tank completely full or to a point where the gasoline is overlowing. Always leave a small portion of the gas tank and the entire fill tube empty. This will allow for the expansion and movement of the gasoline and will minimize sloshing and potentially spilling the gasoline when the machine moves;
- If gasoline is spilled, avoid creating any source of ignition until the gasoline has been completely removed;
- LPG is heavier that air and spreads rapidly. Stop all leaks quickly. Shut off the source of gas;
- If a fire starts, evacuate the area and notify the fire department;
- For a fire in the engine compartment, shut off engine. Shut off the gas flow at the tank valves for LPG and CNG powered vehicles before trying to extinguish;
- Always have a properly maintained fire extinguisher located in the Zamboni machine room;
- Fire extinguishing media must be dry chemical, foam, or CO^2 for usage on large fires.

Propane (LPG) Tank Storage and Handling

- Avoid skin contact with liquid because of possibility of freeze burn. Use propane resistant gloves when working with the propane tank connections. Always use full face mask and wear a long sleeve shirt or jacket;
- The storage and handling of LP gas and tanks should be in accordance with the NFPA 58 Standard for the Storage and Handling of Liquified Petroleum Gases, 1995 Edition;
- The machine should be refueled in accordance with the NFPA 58 Standard for the Storage and Handling of Liquified Petroleum Gases, 1995 Edition;
- Only properly trained and designated persons should charge or exchange the LP gas tanks;

- The engine should be stopped and no persons should be on the machine during refueling;
- Always install tanks and make tank connections outdoors or in a well ventilated area away from heat, ignition sources and open flames;
- NO SMOKING ALLOWED during these operations!
- Store tanks in an authorized location (outside, detached storage is required) with adequate ventilation;
- Store tanks in an upright position, away from heat and ignition sources;
- Reasonable care should be exercised in handling the LP gas containers to avoid damage. Do not drop, throw, roll or drag LP gas containers or any associated parts of the containers or fuel system;
- The careless handling of LP gas containers can result in a serious accident. Extreme care should be exercised when transporting containers so that they are not accidently dropped or physically damaged. When it is necessary to move more than one container at one time, a proper carrying device should be provided and used;
- Physical damage such as dents, scrapes or gouges may materially weaken the structure of the tank and render it unsafe for use;
- All LP gas containers should be regularly inspected before recharging and examined again before reuse for the following defects or damage:
    1. Leaks, dents, scrapes, gouges or corrosion of the pressure vessel, with emphasis on the bottom of the cylinders;
    2. Damage to the various valves and liquid level guage;
    3. Debris in the relief valve;
    4. Indication of leakage at valves and/or threadded connection;
- Keep container valve closed and plugged when not in use;
- Never use a match or open flame to check for leaks, use a soap solution;
- Always close the LPG tank service valve when the machine is parked for the night or for any extended length of time.

CNG Fuel System

The installation of distribution, storage and dispensing (charging) systems must be done in accordance with the NFPA 52 Compressed Natural Gas (CNG) Vehicular Fuel Systems, 1995 Edition and any other applicable regulations. Your local gas utility company must be advised of your installation.

The machines's CNG cylinders must be charged in accordance with the NFPA 52 Compressed Natural Gas (CNG) Vehicular Fuel Systems, 1995 Edition.

Only properly trained and designated persons should charge the CNG fuel cylinders on the machine.

- Never smoke when charging the CNG fuel cylinders on the machine;
- Keep all sources of open flame, spark or other ignition such as stoves, furnaces, water heaters or any appliance using a pilot light away from fuel storage, fuel use and refueling areas. Under well ventilated conditions, a minimum distance of 20 feet from all possible ignition sources is recommended;
- Never charge the cylinders in excess of their maximum allowable service pressure at normal temperature. DOT and TC containers shall be charged in accordance with DOT and TC regulations.

Oils

- Hydraulic oil and its vapors are flammable and will ignite if they contact a hot surface such as an exhaust pipe or manifold. A flash fire can occur;
- Hot oil and components can cause personal injury. Do not allow hot oil or components to contact the skin;
- At operating temperature, the hydraulic tank is hot and can be under pressure;
- Remove the hydraulic tank filler cap only after the machine has been stopped and the filler cap is cool enough to remove with your bare hand;
- Remove the hydraulic tank filler cap slowly to relieve pressure.

Batteries

- Battery fumes may cause fire or explosion. Battery acid can cause burns;

- Only trained and designated personnel should recharge or exchange batteries;
- Service, exchange and handle batteries only in authorized areas where proper safety and ventilation facilities are provided (i.e. eye wash stand, showers, etc.);
- Do not smoke, or expose battery to sparks or flame when checking, charging or servicing battery. Keep chains and metallic tools away from the top of the battery;
- Highly explosive gases are present and are especially hazardous toward the end of the charging period as the battery approaches a full charge condition;
- Cover the top of the battery with plywood or other insulating material before removing it from the machine;
- Do not add acid to a “wet” battery, add distilled water only;
- When preparing a dry charged battery for service, follow the battery manufacturer’s instructions.

Lubricants

Most lubricants are flammable.

- Do not smoke in areas where batteries are charged, or where flammable materials are stored;
- Clean and tighten all electrical connections. Check daily for loose or frayed electrical wires. Have all loose or frayed electrical wires tightened, repaired or replaced before operating the ice resurfacer;
- Keep all lubricants stored in properly marked containers and away from unauthorized persons;
- Store all oily rags or other flammable material in an approved container, in a safe place;
- Do not weld or flame cut on pipes or tubes that contain flammable fluids. Clean them thoroughly with non-flammable solvent before welding or flame cutting on them;
- Remove all flammable materials such as oil and other debris before they accumulate on the Zamboni machine;
- Do not expose the ice resurfacer to flames, burning, etc. if at all possible;

- Have a fire extinguisher available and know how to use it. Inspect and have it serviced as recommended on its instruction plate.

Lines, Tubes and Hoses

- Do not bend or strike high pressure lines. Do not install bent or damaged lines, tubes or hoses;
- Repair any loose or damaged oil lines, tubes and hoses. Leaks can cause fires. Contact the Zamboni Company or your Zamboni authorized distributor for repair or replacement;
- Check lines, tubes and hoses carefully. Do not use your bare hand to check for leaks. Use a board or cardboard to check for leaks. Tighten all connections to the recommended torque. Replace if any of the following conditions are found:
  - End fittings damaged or leaking;
  - Outer covering chafed or cut and wire reinforcing exposed;
  - Outer covering ballooning locally;
  - Evidence of kinking or crushing of the flexible part of hose;
  - Armoring embedded in the outer cover;
  - End fittings desplaced;
- Make sure that all clamps, guards and heat shields are installed correctly to prevent vibration, rubbing against other parts and excessive heat during operation.

Safe Operation

Mounting and Dismounting

- Mount and dismount the ice resurfacer only where steps and/or handholds are provided;
- Use both hands and face the machine when mounting and dismounting. Use extra care when wet or slippery conditions exist;
- Never get on or off a moving machine. Never jump off the machine;
- Do not try to climb on or off the ice resurfacer when carrying tools or supplies.

Before Operating the Zamboni Ice Resurfacer

- Operate the machine only from the operator's station;
- Adjust the seat so that full pedal travel can be obtained with the operator's back against the seat back;
- The machine is equipped with a lighting system, make sure all lights are working properly;
- Make sure no one is working on, underneath or close to the ice resurfacer before turning on the key or beginning to move the machine. Make sure the area is free of personnel,
- Do not move the machine or move any of the controls if there is a “DO NOT OPERATE” or similar warning tag attached to the start switch or controls;
- Move the transmission control lever to NEUTRAL;
- Clear all personnel from the machine and the area;
- Clear all obstacles from the path of the ice resurfacer. Beware of hazards such as curbs, blocks, posts, wire, cans, etc.;
- Make sure the horn and all other warning devices are working properly;
- Check for proper operation of all controls;

Operation

- Obey all traffic rules and warning signs;
- Always observe floor load limits and overhead clearances;
- When turning the ice resurfacer, slow down to safe speed.

Parking

- Park the machine in authorized areas only;
- Move the hydrostatic transmission control lever to NEUTRAL;
- Turn the key switch OFF and remove the key;

- If possible, park the machine on a flat and level surface. If the machine is parked on any kind of grade, the wheels must be blocked with wheel chocks to prevent the machine from rolling away after it has been parked;
- Store in well ventilated area.

Maintenance

Walk-Around Inspection

For maintenance and operator personnel safety and maximum service life of the Zamboni machine, make a thorough walk-around inspection when doing lubrication and maintenance work. Look around and under for such items as loose or missing bolts, trash or dirt build-up, oil leaks and cut or gouged tires.

DANGER !

Improper performance of lubrication or maintenance procedures is dangerous and could result in injury or death. Read and understand all OPERATION & MAINTENANCE instructions before performing any lubrication or maintenance.

DANGER !

Do not operate this machine unless you have read and understand the instructions in the OPERATOR'S manual. Improper machine operation is dangerous and could result in injury or death.

The serviceman or mechanic may be unfamiliar with many of the systems on this machine. This makes it important to use caution when performing service work. A knowledge of the system and/or components is important before the removal or disassembly of any component.

The following is a list of basic precautions that should always be observed:

- Read and understand all warning plates and decals on the machine before operating, lubricating or repairing this product;
- The vertical and horizontal augers will continue to rotate for a short period of time after the auger control valves have been shut off. Always allow for all auger rotation to stop before working near or on the augers. Never work near or on the augers when the engine is operating;
- Always wear protective glasses and protective shoes when working around machines. In particular, wear protective glasses when pounding on any part of the machine or its attachments with a hammer or sledge. Use welder's gloves, hood/goggles, apron and other protective clothing appropriate to the welding job being performed. Do not wear loose, fitting or torn clothing. Remove all rings from fingers when working on machinery;
- Do not work on any machine that is supported only by jacks or a hoist. Always use blocks or jack stands to support the machine before performing any disassembly;
- Lower the conditioner or other implements to the ground before performing any work on the machine;
- Use steps and grab handles (if applicable) when mounting or dismounting a machine. Clean any mud or debris from steps, walkways or work platforms before using. Always face machine when using steps, ladders and walkways. When it is not possible to use the designated access system, provide ladders, scaffolds or work platforms to perform safe repair operations;
- Use proper lifting procedures when removing components. To avoid back injury, use a hoist when lifting components which weigh 50 lbs. (23 kg.) or more. Make sure all chains, hooks, slings, etc. are in good condition and are of the correct capacity. Be sure hooks are positioned correctly. Lifting eyes are not to be side loaded during a lifting operation;
- To avoid burns, be alert for hot parts on machines which have just been stopped and hot fluids in lines, tubes and compartments;
- Be careful when removing cover plates. Gradually back off the last two bolts or nuts located at opposite ends of the cover or device and pry cover loose to relieve any spring or other pressure, before removing the last two bolts or nuts completely;

- Be careful when removing filler caps, breathers and plugs on the machine. Hold a rag over the cap or plug to prevent being sprayed or splashed by liquids under pressure. The danger is even greater if the machine has just been stopped because fluids can be hot;
- Always use tools that are in good condition and be sure you understand how to use them before performing any service work;
- Reinstall all fasteners with same part number. Do not use a lesser quality fastener if replacements are necessary. Do not mix metric fasteners with standard nuts and bolts;
- If possible, make all repairs with the machine parked on a level, hard surface. Block machine so it does not roll while working on or under machine;
- Repairs which require welding should be performed only with the benefit of the appropriate information and by personnel adequately trained and knowledgeable in welding procedures;
- Determine type of metal being welded and select correct welding procedure and electrodes, rods or wire to provide a weld metal strength equivalent at least to that of parent metal;
- Do not damage wiring during removal operations. Reinstall the wiring so it is not damaged nor will it become damaged in operation by contacting sharp corners, or by rubbing against some object or hot surface. Do not connect wiring to a line containing fluid;
- Be sure all protective devices including guards and shields are properly installed and functioning correctly before starting a repair. If a guard or shield must be removed to perform the repair work, use extra caution;
- Loose or damaged fuel, lubricant and hydraulic lines, tubes and hoses can cause fires. Do not bend or strike high pressure lines or install ones which have been bent or damaged. Inspect lines, tubes and hoses carefully. Do not check for leaks with your hands. Pinhole (very small) leaks can result in a high velocity oil stream that will be invisible close to the hose. This oil can penetrate the skin and cause personal injury. Use cardboard or paper to locate pinhole leaks;

- Tighten connections to the correct torque. Make sure all heat shields, clamps, and guards are installed correctly to avoid excessive heat, vibration or rubbing against other parts during operation. Relieve all pressure in air, oil or water systems before any lines, fittings or related items are disconnected or removed. Always make sure all raised components are blocked correctly and be alert for possible pressure when disconnecting any device from a system that utilizes pressure;
- Do not operate a machine if any rotating part is damaged or contacts any other part during operation. Any high speed rotating component that has been damaged or altered should be checked for balance before reusing;
- Caution should be used to avoid breathing dust that may be generated when handling components containing asbestos fibers. If this dust is inhaled, it can be hazardous to your health. Components in Zamboni machine products that may contain asbestos fibers are brake pads, brake bank and lining assemblies, and some gaskets. The asbestos used in these components is usually bound in a resin or sealed in some way. Normal handling is not hazardous as long as airborne dust which contains asbestos is not generated;
- If dust which may contain asbestos is present, there are several common sense guidelines that should be followed:

    1. Never use compressed air for cleaning;
    2. Avoid brushing or grinding of asbestos containing materials;
    3. For clean up, use wet methods or a vacuum equipped with a high efficiency particulate air (HEPA) filter;
    4. Use exhaust ventilation on permanent machining jobs;
    5. Wear an approved respirator if there is no other way to control the dust;
    6. Comply with applicable rules and regulations for the work place (for example in the U.S.A., OSHA requirements as set forth in a 29 CFR 1910.1001);
    7. Follow environmental rules and regulations for disposal of asbestos;
    8. Avoid area where asbestos particles may be in air.

Battery Operation and Maintenance

WARNING !

Hydrogen and oxygen gases are given off as battery plates get near a full charge condition. These gases are highly explosive and caution must be taken to make sure no ark, spark, or flame comes into contact with the generated gases. The possibility of explosion is always present with exposure of the battery to sparks or flame, but is especially hazardous at the end of the charging period.

WARNING !

When using air pressure for cleaning purposes, wear a protective face shield and protective clothing. Maximum air pressure must be below 30 psi (207 kPa).

Do not smoke near batteries that are being stored or when checking the electrolyte level.

Electrolyte is an acid solution and can cause personal injury. Avoid contact with skin and eyes.

Maximum life and performance of batteries is dependent on the operator, battery charging, maintenance and service.

Most dirt and dust picked up by the battery can usually be blown off with low pressure compressed air.

However, if cells are overfilled and electrolyte collects on the covers, the top of the battery will stay wet.

If necessary, clean the top of the battery with a solution of baking soda and hot water.

CAUTION !

Vent caps must be tight to prevent soda solution from entering battery cell.

To make the solution, add 1 lb (0.5 kg) of baking soda to 1 gallon (4 liters) of water. Use a brush having flexible bristles. Apply the soda solution to the top of the battery until the cleaning action of the soda stops.

After cleaning action has stopped, rinse batteries thoroughly with water. Dry the batteries with air pressure.

Cold Storage Applications

When a Zamboni machine is operated in very cold applications at temperatures as low as -4 degrees Fahrenheit (-20 degrees Celsius), the battery capacity is decreased. Operation at cold temperatures can also cause mechanical failures, short circuits and too much wear due to the formation of ice crystals.

The direct cause of these problems is the extreme changes in temperature in combination with humidity in the air which can result in condensation.

There is a reduction in battery capacity in very cold applications. For this reason, it is important to:

- Be sure the battery is completely charged at the start of each work cycle;
- If possible, keep the machine in a warm storage area when it is not in use.

2.
General Operating and Maintenance Information

Important :

The engine, drive train and differentials on the ice resurfacer are all new components and special care must be given to them during their "break-in" period.

Service schedules for machine lubrication and preventative maintenance have been established on the basis of hourly, daily, weekly and monthly intervals (see service documents). Along with performing regular machine lubrication and preventative maintenance according to these schedules, it is advised that you have the ice resurfacer and its components completely checked over periodically by a competent mechanic.

Study should be given to the Kubota Operating and Service manuals which are furnished with your ice resurfacer. It is also recommended that the new owner contact the local Zamboni Authorized Dealer to acquaint himself with their service policy. It would also be beneficial to have a serviceman inspect the engine and drive system so that he may become familiar with the operation for service and repair.

Note Regarding the Kubota Engine:

The engine is equipped with a low oil pressure warning light and an alternator warning light mounted on the instrument panel. The engine also has a "check engine" light which warns the operator about engine conditions which may require service. For more information on the check engine light, see Chapter 4 and Chapter 7.

Grade of Engine Oil

Use good quality 10W-30 engine oil, API rating SL or above. The engine oil capacity is approximately 6.0 liters (1.6 U.S. gallons).

Grade of Gasoline

Use unleaded gasoline only (minimum octane 87).

Your efforts spent in properly maintaining the ice resurfacer and its various components will be well repaid by longer wear and good service.

Starting the Engine

To start the engine

- Make sure the transmission control lever is in Neutral;
- Make sure the auger control levers are Off/Neutral;
- Turn ignition key to start;
- The engine will start and run at approximately 1000 RPM. After 10 seconds, raise the engine speed to 2000 RPM by using the throttle rocker switch located on the dash (see Fig. 6.2) ***before driving and resurfacing***. This warm up period will allow the engine and catalytic convertor to achieve the correct operating temperatures. After the correct warm up period, the "green-means-go" light will turn on, the engine will be operating in "closed loop" and the catalytic convertor will be more efficient in reducing engine exhaust emissions. Be sure that the engine emissions are exhausted to the outside, or the room is properly ventilated;
- Be sure dump tank is completely down and conditioner is raised.

Stopping the Engine

To stop the engine:

- Return the transmission control lever to Neutral. Set the parking brake, if so equipped;
- Return the auger control levers to Off/Neutral;
- After the dump tank has been emptied lower the conditioner onto blocks, (see 2-3);
- Lower the engine RPM to idle by using the engine speed switch. This switch is a rocker style switch, mounted on the dash. (See Figures 6.2 and 7.1). Let the engine idle for a few moments before turning the ignition off;
- If the snow tank is up, install the safety stand to the correct position (see Fig. 5-6);

- Turn off the ignition key switch and remove the ignition key to store in a secure location.

Machine Not in Use

When the machine is not in use:

- Park the machine in authorized areas only;
- Lower the conditioner onto blocks. The conditioner weighs approximately 1000 pounds. This weight should not hang on the lift bar nor be supported by the hydraulic system during storage. Lowering the conditioner onto the blocks must be done cautiously as putting hydraulic down pressure on the blocks (in excess of the weight of the conditioner) can stretch the down pressure leaf springs. Wood blocks should be placed under both conditioner runners between the blade edge and the squeegee;
- Move the transmission control lever to Neutral. Return the auger control levers to Off/Neutral. Set the parking brake, if so equipped;
- Remove and securely store the ignition key;
- If possible, park the machine on a flat and level surface. If the machine is parked on any kind of grade, the wheels must be blocked with wheel chocks to prevent the vehicle from rolling away after it has been parked.

Travel on Highways

Fast driving on the highway and bouncing the vehicle over bumps can seriously damage the machine. Travel over extended distances should be avoided, if possible. If such travel is required:

- Exercise Caution. Obey all traffic signs, signals and laws;
- Make sure that the conditioner is completely raised before driving;

3.
Safe Operation

Your Zamboni ice resurfacer is the result of many years of experience in the ice resurfacing field. The engineering and safety features that have gone into your Zamboni machine will be enhanced by you, the safe operator...

...who knows their machine and all of the controls,

...who maintains their machine properly,

...who uses their driving skills wisely and operates the machine with safety in mind.

Because SAFE DRIVING is important to YOU, we urge you to thoroughly acquaint yourself with the resurfacer and the instructions contained in the operation manual. Even the safest machine can be operated improperly so certain precautions are mentioned in this manual. Among these precautions are:

- Be sure that all guards originally installed on the machine are properly in place and in good working order;
- Make sure the hydrostatic transmission shift lever is in neutral before starting the engine. Always look completely around the machine prior to moving forward or reverse to insure that no one is in the path of your direction of travel;
- The ice resurfacer is to be operated by one, and only one person. **No riders!**
- Keep everyone off the ice while the resurfacer is operating. Always drive defensively. Expect the unexpected;
- Keep hands and feet away from conveyors, belts, chains and other moving parts while the engine is running;
- Allow the engine and catalytic convertor to achieve the correct operating temperatures ***before driving and resurfacing;***
- The machine is an industrial machine designed to be used by trained and skilled operators. It is never to be used for recreational purposes, such as racing.

DANGER!

Turn off and remove the ignition key before adjusting, repairing, cleaning, or servicing the conveyors. The vertical and horizontal augers will continue to rotate for a short period of time after the auger control valves have been shut off. Always allow for all auger rotation to stop before working near or on the augers. NEVER work near or on the augers when the engine is operating.

If any part of the conveyor system becomes plugged or clogged, or appears plugged or clogged, the conveyor must be flushed out with water. Do not wear gloves or jewelry when performing these functions.

Flushing the augers out with water must be done only after the machine has been removed from the ice, the auger control valves have been returned to their "neutral (off)" positions, and the ignition has been shut off.

Under no circumstances should the operator attempt to clean or clear the conveyor system or parts around it while the machine is on the ice or the power is on. To do so, exposes the operator and others to serious potential injury or death!

WARNING!

Keep hands, feet and body out from under the dump tank, conditioner and other raised parts unless they are blocked securely. Use the safety stand under dump tank.

Be extremely careful when handling the shaving knife. Unless handled with care, the blade can cause injury whether it is sharp or dull.

WARNING!

If machine is parked on any kind of grade, the wheels must be blocked with wheel chocks to prevent the machine from rolling away after it has been parked.

DANGER !

Internal combustion engines produce exhaust emissions that contain dangerous gases, including carbon monoxide (CO) and nitrogen dioxide (NO_2). These gases can cause serious injury or death.

The rink MUST be adequately ventilated during every operation of the ice resurfacer. Also the resurfacer must be kept properly maintained and serviced at all times and the engine timing should always be properly set. Each person who operates and maintains the resurfacer should be so instructed.

Please keep in mind that adequate ventilation, monitoring the facility's indoor air quality (for CO and NO_2 levels) and the condition of the machine is, at all times, the complete responsibility of the rink.

- Use extreme caution when handling fuel and store only in approved containers;
- Annual training of the operator is required;
- All new operators must be trained before operating the machine for the first time;
- Warning labels should be followed. Do not operate if the labels are missing or cannot be read.

DANGER !

This machine has an electronic engine control unit (ECU). If the ECU detects that the engine is operating outside of it's desired parameters, the "check engine" light will be turned on. Do not operate the machine with the "check engine" light illuminated for a continous period. Have the machine serviced as soon as possible.

4.
Ice Rink Air Quality

In order for a rink to have the best air quality possible, the Zamboni machine must be operated properly in a rink that:

- Is adequately ventilated;
- Performs daily air quality monitoring/measuring;
- Knows which air quality standards or quidelines apply to them;
- Knows which items on the Zamboni machine affect air quality and how and when these items should be measured and serviced;
- Allows the engine and catalytic converter to properly warm up before operating the machine on the ice.

Adequate Ventilation

Adequate ventilation is the amount of ventilation required to ensure that the air is healthy to breathe and meets all applicable health and safety standard or quidelines.

Air Quality Monitoring

Regular air quality monitoring is a program that each rink sets up to ensure that their air quality is healthy and meets the standards.

Air quality standards or quidelines define the amount of Carbon Monoxide gas (CO) and Nitrogen Dioxide gas (NO_2) that can exist in the air inside the ice rink. These gases are exhaust emissions from the combustion of fossil-based fuels such as gasoline, LPG and CNG.

Ice rink air quality can also be affected by many other factors. These include:

- Ice edgers powered by internal combustion engines;
- Unvented propane heaters, furnaces, or boilers;
- CO_2 tanks;
- Fuels with impurities;
- The ice refrigeration system and its gases (ammonia or "Freon");
- Cigarette smoke;

- Restaurant and/or vendor equipment;
- Improper storage of paints, chemical, solvents, etc.

The arena's ventilation system can also dramatically affect the indoor air quality by:

- Not being properly operated;
- Not being properly maintained;
- Not being properly designed such as:
    1. Inadequate size or performance;
    2. Intake air systems drawing in air from other polluted areas, such as a vehicle parking lot or garage.

Even cars, buses or trucks idling next the arena doors or ventilation system intakes can have a dramatic affect upon the indoor air quality.

Engine Emission System Components

This machine is equipped with an engine system that complies with the CARB and EPA standards. In order to comply with these standards, the machine is equipped with the following items:

- Electronic Control Unit (ECU)
- Electronic, multi-port fuel injection system - for use on gasoline powered engines (EFI)
- electronic throttle body and governor
- three-way catalytic converter
- Oxygen sensors - pre and post catalytic converter
- MAP sensor
- engine coolant temperature sensor
- ambient air temperature sensor
- on-board diagnostic system
- check engine light (MIL)

For machines powered with LPG (propane):

- Electronic Pressure Regulator (EPR) - for use on LPG powered engines
- electronic fuel lock off
- LPG temperature sensor

All of these items are used to ensure that the engine operates properly and meets the emission level standards. However, exhaust emissions are still being produced by the engine and while the level of the harmful pollutants are reduced, the air quality in the rink must still be monitored to make sure that the air is healthy.

Engine Control Unit (ECU)

The ECU works to control the engine's air-fuel ratio (AFR) to the ideal levels based on the engine's operating conditions. The ECU monitors the engine for speed, load, air and coolant temperature (and on LPG machines, fuel temperature) and then adjusts the AFR via the electric fuel injection (gasoline powered) or the EPR (propane powered) to produce the ideal mixture. If the AFR is near the ideal ratio (stoichiometric), then the catalytic converter will operate at it's maximum efficiency thus reducing the emission levels of the harmful exhaust gases.

This machine has a "green-means-go" light that indicates when the engine is operating in the "closed loop" mode. Typically, it takes a few minutes for the engine and catalytic converter to achieve proper operating temperatures and conditions. After these conditions are reached, the ECU turns on the "green-means-go" light. Resurface only when the "green-means-go" light is on.

If the ECU detects conditions where it cannot control the AFR, it will then turn on the "check engine" light, thus alerting the operator. If the ECU detects that a portion of the engine equipment, which it monitors, is malfunctioning, it will turn on the "check engine" light. DO NOT OPERATE the machine with the check engine light on continously.

DANGER!

If the check engine light turns on during normal operation of the machine, the machine must be serviced immediately!

Open Loop versus Closed Loop Operation

When the engine is first started, it is operating in "***open loop***" condition. This means that the ECU is controlling the AFR via preprogrammed levels. When the engine achieves a certain operating temperature, the ECU then goes into the "***closed loop***" mode. This means that the ECU is controlling the AFR based on the

engine operating conditions and is monitoring the signal from the oxygen sensor to determine if changes to the AFR need to be made. The "green-means-go" light will be on, indicating "closed loop" mode.

With the precise, closed loop control of the AFR, the catalytic converter will be the most effective in reducing the exhaust emission levels. The lowest levels of harmful emissions are produced when the machine is operating in the closed loop mode. For this reason, start the engine and warm it up in accordance with the starting instructions described on page 2-2. ONLY operate the machine on the ice when the "green-means-go" lamp is on, which indicates that the machine is operating in the closed loop mode.

Oxygen Sensors

There are two oxygen sensors on the machine. One is the pre-cat O2 sensor, which is upstream of the catalytic converter. The other is the post-cat O2 sensor, which is downstream of the catalytic converter. The oxygen sensors are critical components used by the engine controller to measure and control the operation of the engine. An oxygen sensor that is malfunctioning will cause the "check engine" light to be turned on.

Catalytic Converter

Your Zamboni ice resurfacer is equipped with a “three-way” catalytic convertor. The catalytic convertor is designed to reduce the amount of certain exhaust gases. A three way catalytic reduces CO, hydrocarbons and NO_X, (NO_2 is a member of the NO_X family).

Catalytic convertors are items that need regular service. A catalytic convertor may be damaged by incorrect engine timing or by an engine air-fuel ratio that is incorrect. Operating the machine with the check engine light on may reduce the performance of the catalytic convertor and may also shorten the life expectancy of the catalytic convertor.

A catalytic convertor has a **fixed** lifespan. It may lose efficiency and start to allow more pollution to pass through it without being treated.

DANGER!

If the check engine light turns on during normal operation of the machine, the machine must be serviced immediately!

Engine Ignition Timing

The engine's timing is factory set and computer controlled. It is not adjustable.

Engine and State of Tune

The engine’s condition and state of tune refer to how the engine is operating and whether the operating variables of the engine have been adjusted to provide optimal performance.

An engine tune-up includes:

- Changing the spark plugs and noting their condition and appearance;
- Changing the coil pack assembly (if required);
- Inspecting all emission related components for correct function and for correct attachment to the engine;
- Noting and recording the condition of the "check engine" light;
- Noting and recording any fault codes displayed by the engine's ECU;
- Correcting any engine condition that produces a fault code or the display of the "check engine" light;
- Recording work performed, dates of service and who performed the service.

Consult the Engine Maintenance Schedule for appropriate engine service intervals.

Engine Emission Systems - Inspection and Maintenance

DANGER !

Internal combustion engines produce exhaust emissions that contain dangerous gases, including carbon monoxide (CO) and nitrogen dioxide (NO_2). These gases can cause serious injury or death.

The rink MUST be adequately ventilated during every operation of the ice resurfacer. Also the resurfacer must be kept properly maintained and serviced at all times and the engine timing should always be properly set. Each person who operates and maintains the resurfacer should be so instructed.

Please keep in mind that adequate ventilation, monitoring the facility's indoor air quality (for CO and NO_2 levels) and the condition of the machine is, at all times, the complete responsibility of the rink.

The safe and correct operation and maintenance of the resurfacer, the engine and the engine exhaust system includes:

- Measuring the facility's indoor air quality **daily** (for CO and NO_2 levels);
- Measuring and recording the engine emission levels every 300 hours. The emission levels must not have increased more than 20% from the previous readings;
- Adjusting engine components (when applicable) to ensure correct operation and optimum engine emission levels;
- Inspecting, adjusting (when applicable), maintaining and replacing engine and exhaust system components when required;
- Starting and warming up the engine properly so that the machine is in "closed loop" mode when on the ice. The "green-means-go" light should be lit while resurfacing;
- Never operating the machine with the check engine light on continuously.

If you do not have the tools, education or expertise to inspect, maintain, repair or replace these items, contact a reputable, licensed mechanic for assistance.

Engine Emission System - Inspection and Maintenance Chart

Serial No.: ____________________ **Fuel Type:** ________________ **Catalytic Converter Type:** __________________________

Date	By	Hours	Engine		Cond.	After Catalytic Converter											
							HC PPM	CO %	CO_2 %	O_2 %	NO_x %	Levels OK compared to previous testing?					
					Idle												
					Load												
					Idle												
					Load												
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Note: To load the engine, move the conditioner to the fully lifted position and hold for 15 seconds.

5.
Ice Resurfacer Components

Front View

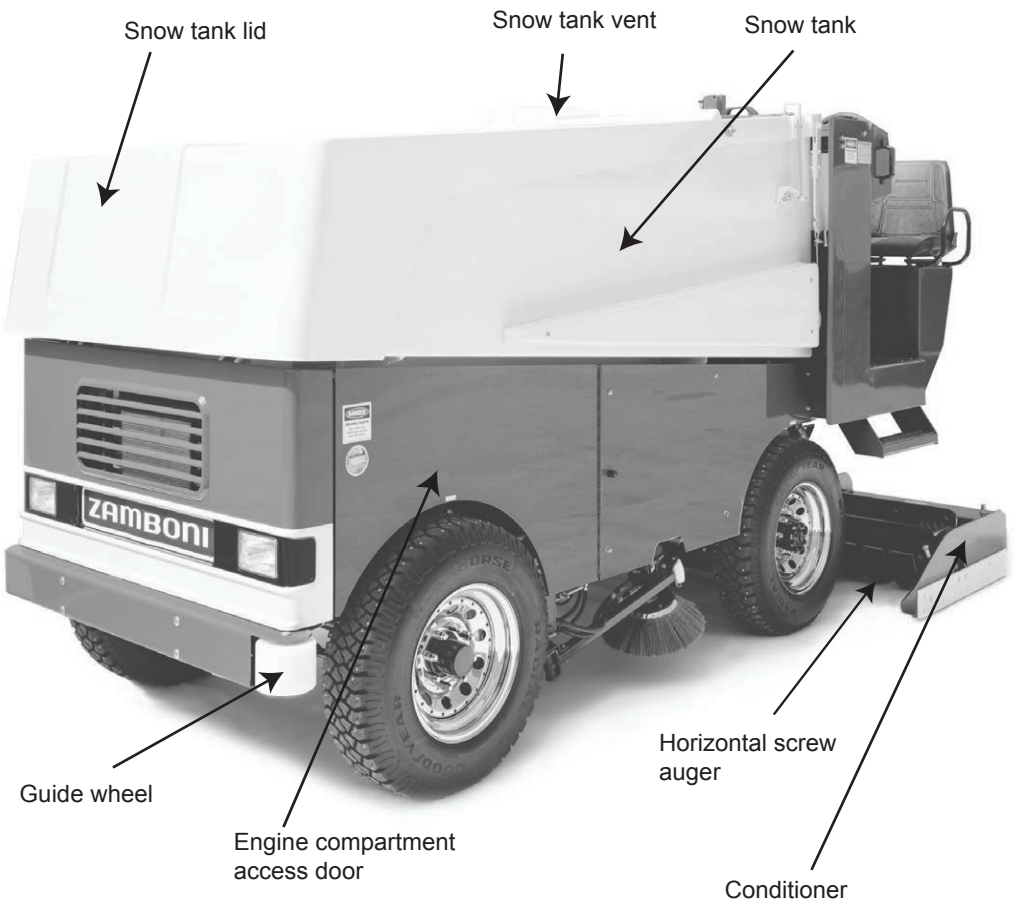


Figure 5.1 *Ice Resurfacer Components (front view)*

Rear View

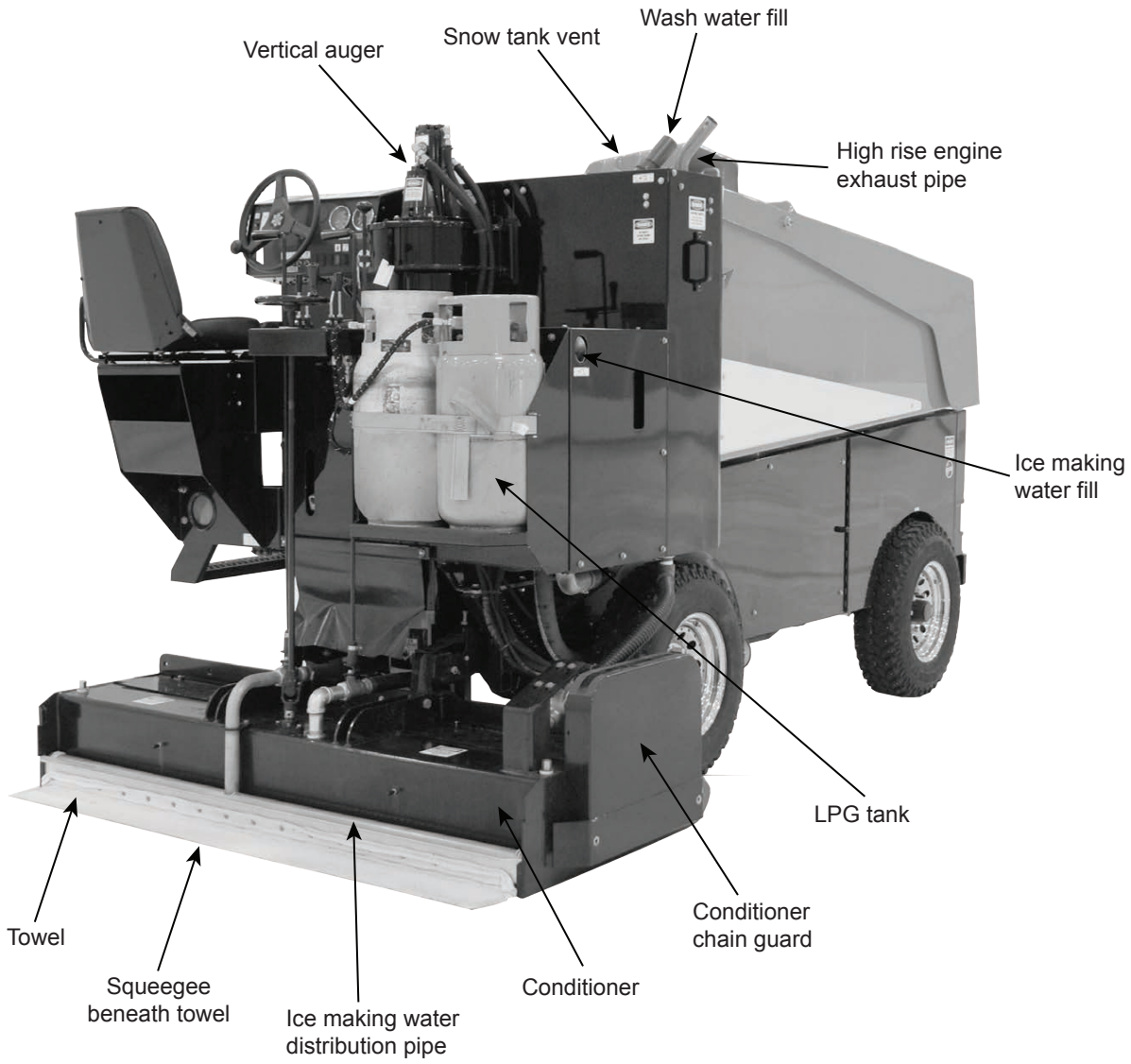


Figure 5.2 *Ice Resurfacer Components (Rear View)*

Operator's Platform

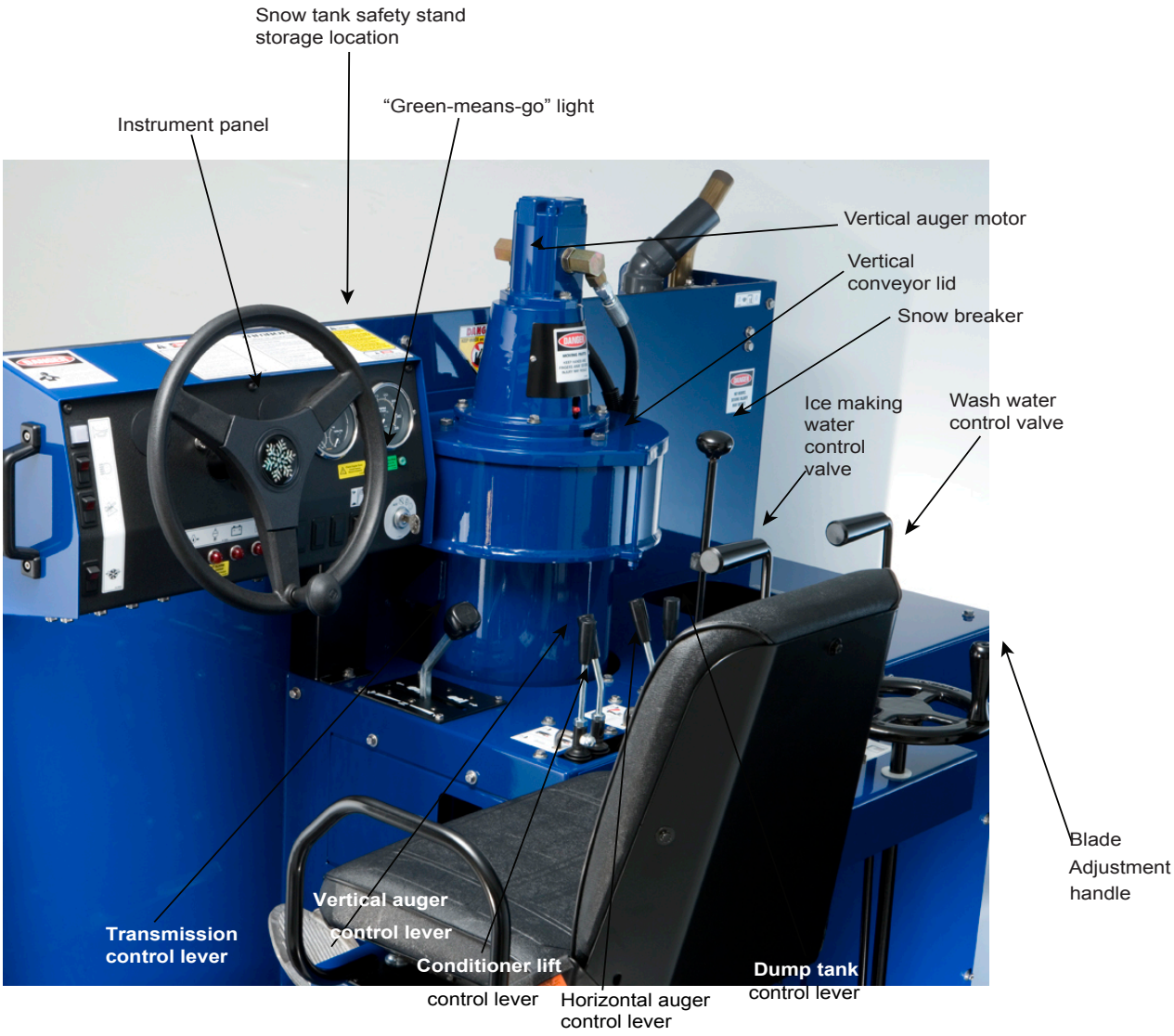


Figure 5.3 *Ice Resurfacer Components - Operator's Platform*

Power Package (Gasoline Engine)

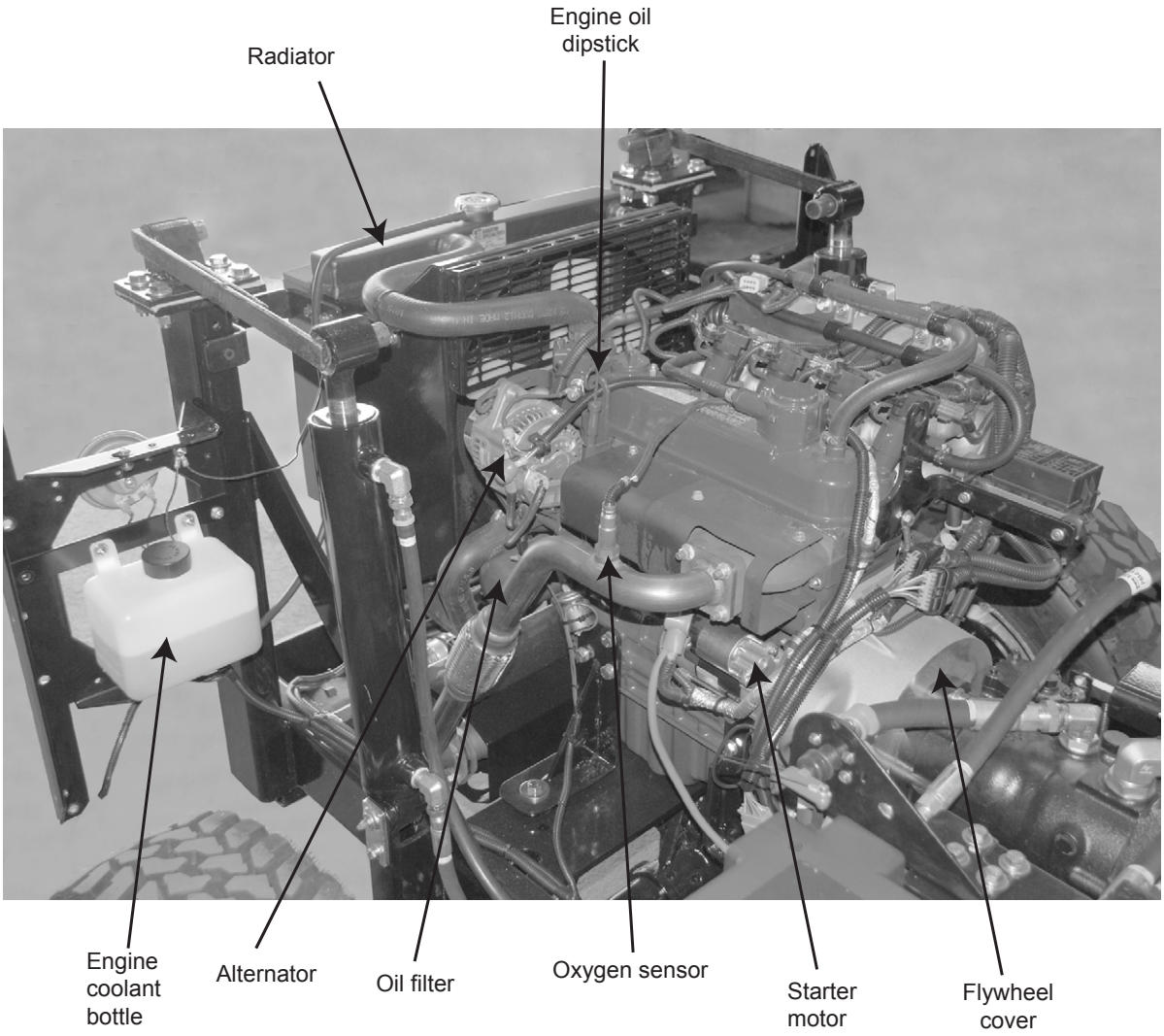


Figure 5.4 *Ice Resurfacer Components - Power Package - Gas Engine*

Power Package (Gasoline Engine)

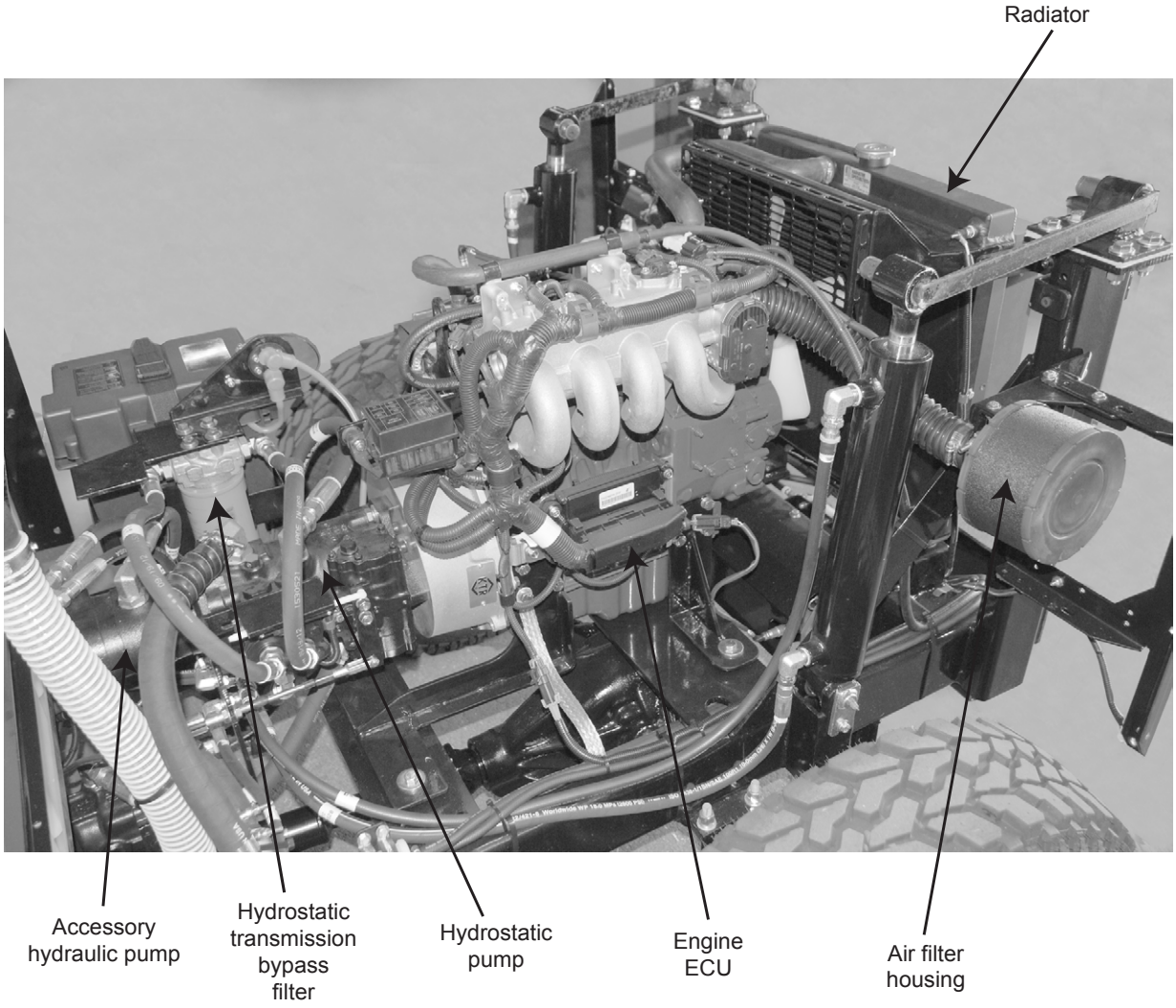


Figure 5.5 *Ice Resurfacer Components - Power Package - Gas Engine*

Power Package (Liquid Propane Engine)

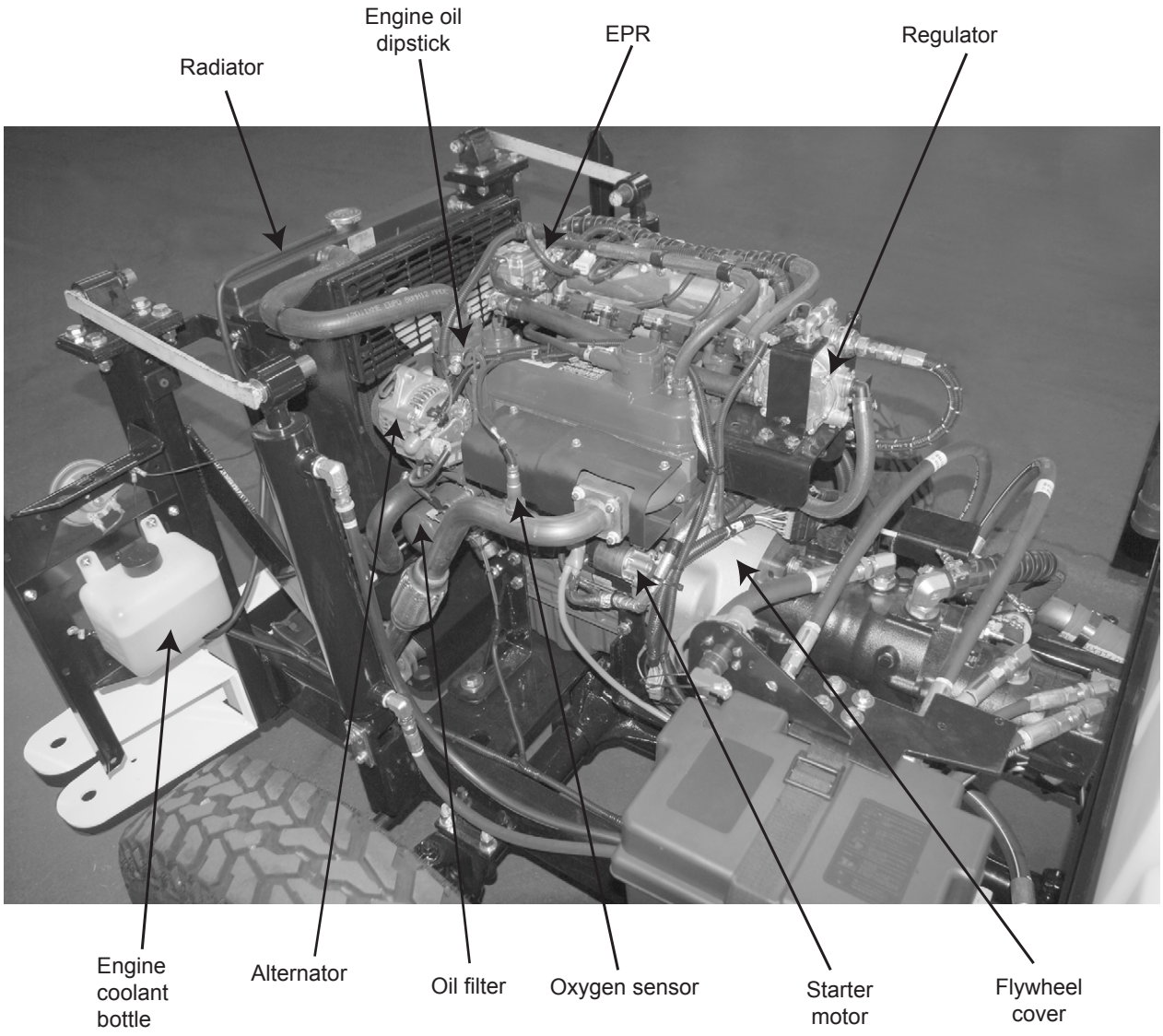


Figure 5.6 *Ice Resurfacer Components - Power Package - LP Engine*

Power Package (Liquid Propane Engine)

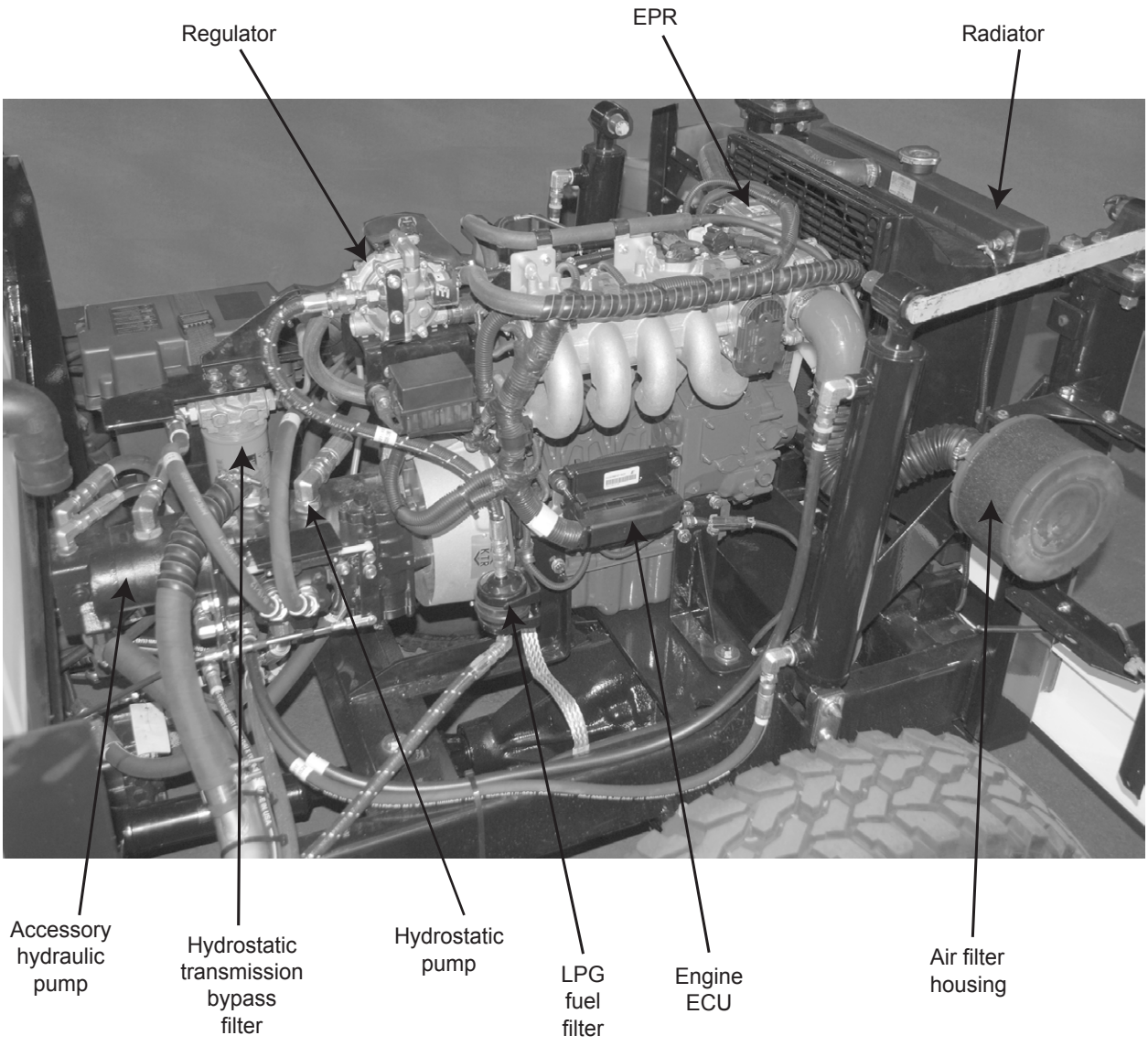


Figure 5.7 *Ice Resurfacer Components - Power Package - LP Engine*

Snow Tank Safety Stand

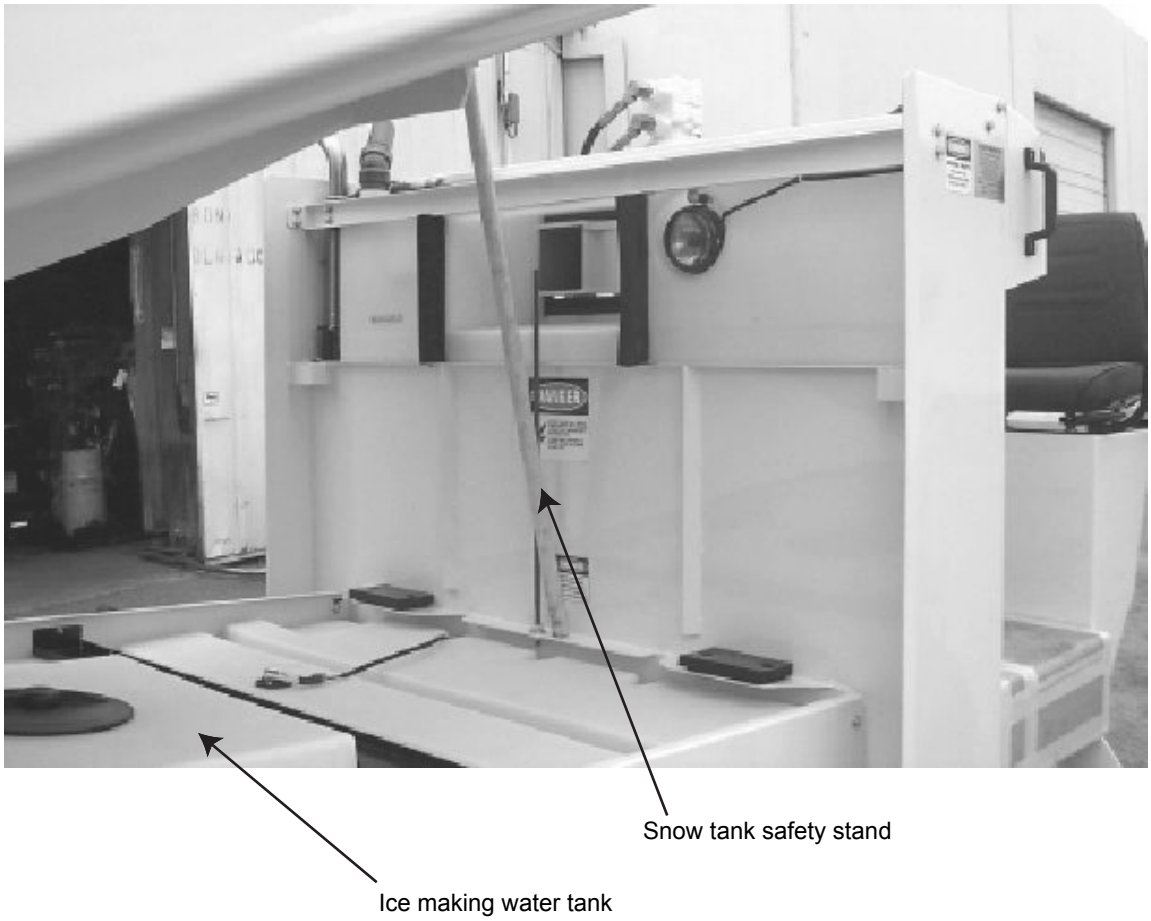


Figure 5.8 *Ice Resurfacer Components - Snow Tank Safety Stand*

6.
Operator's Station

Operator's Compartment

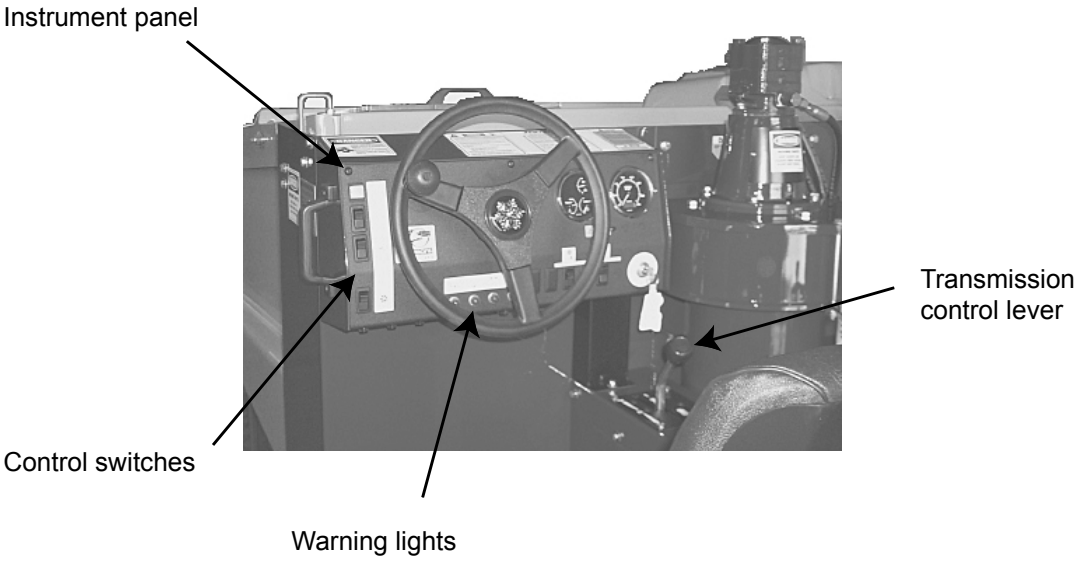


Figure 6.1 *Operator's Compartment*

Instrument Panel

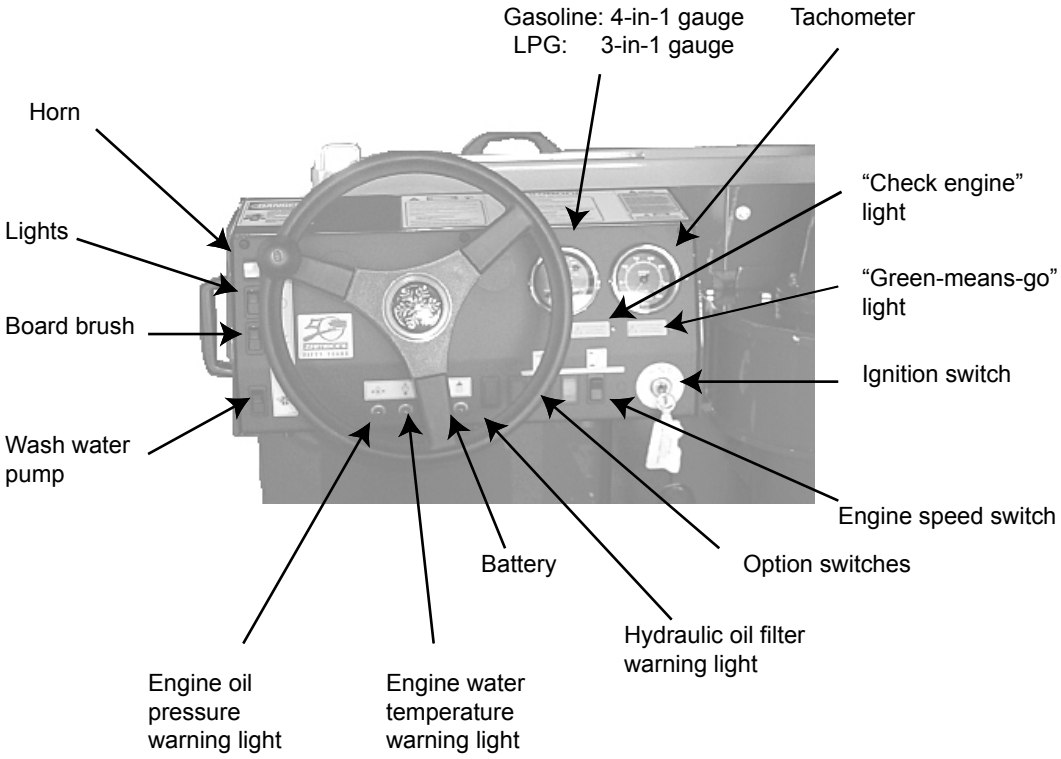


Figure 6.2 *Instrument Panel*

Tachometer/Hourmeter

The tachometer/hourmeter is used to view the engine's speed (RPM). The hourmeter displays the machine's operating hours. The machine's service and maintenance schedule is based on the machine hours.

4-in-1 Gauge/3-in-1 Gauge

This gauge gives the operator a variety of engine operating conditions. The 4-in-1 gauge displays the engine's coolant temperature, the engine oil pressure, the fuel tank level and the battery voltage. The 3-in-1 gauge is used on machines using LPG as a fuel and displays the engine's coolant temperature, the engine oil pressure, and the battery voltage.

Operator's Station

Warning Lights, Buzzers, "Limp Home" and Automatic Shut-down Modes

The machine is equipped with a variety of warning lamps and buzzers that alert the operator of improper operating conditions. All warnings are indicated via a light, while some have a buzzer in addition. Extreme conditions that may cause severe damage to the machine also trigger "limp home" or automatic shut-down modes. If "limp home" mode is activated, the engine's RPM will automatically be reduced and there is approximately 60 seconds of operation remaining before the engine shuts down. Use this time to turn off the augers, lift the conditioner and drive off the ice surface. If the ECU detects a low oil pressure condition, it will shut off the engine immediately.

Function	Light	Buzzer	Lamp test on start up	Limp home/ Shut down	Remedy/Notes
Engine Oil Pressure	YES	NO	YES	Shut down	Check oil level, call for service
Engine Overheat	YES	YES	YES	Limp home	Turn off engine, check coolant
Low Coolant Level	NO	YES	NO	NO	Check coolant level
Battery	YES	NO	YES	NO	Check battery voltage, alternator output
Check Engine	YES	NO	YES	NO	See fault codes
Hydraulic Oil Filter Service	YES	NO	NO	NO	Replace filter*
Green-Means-Go	YES	NO	NO	NO	Only resurface when GMGO light is on

*In the case of low oil temperatures (due to low ambient temperature) the hydraulic oil filter service light may turn on due to the oil becoming thick. In this case, normal operation will heat the oil and the lamp will turn off.

In all cases, if you are unsure of the cause and remedy for a warning lamp or buzzer, please contact the Zamboni Company for more information.

Engine Oil Pressure

If the engine oil pressure is low, the ECU will take the following action:

- Turn off the engine and turn on the warning light.

If you have an engine warning or shutdown due to low engine oil pressure, you must take the following actions;

- verify the correct oil level and oil grade in the engine;
- if the condition persists, contact a mechanic for engine service.

Engine Overheat

If the engine overheats, the ECU will take the following actions:

- turn on the warning light and buzzer;
- place the engine in limp home mode (meaning a reduction in RPM) if the temperature continues to rise;
- Shut off the engine 60 seconds after the limp home mode begins.

Check the coolant level in the radiator when it is safe to do so. Check the radiator for signs of leaking or damage.

Low Coolant Level

If the low coolant buzzer stays on after startup, TURN ENGINE OFF IMMEDIATELY! Check the level of the coolant in the radiator and add if necessary. If the buzzer and light turn on while resurfacing, this is an overheat issue.

Battery

The machine is equipped with a low battery indicator light. The light will be activated whenever the battery voltage is low. Check that the alternator is working correctly and that the battery is fully charged. Replace either these items as necessary.

Check Engine

The machine is equipped with a “check engine light.” This light will be activated whenever the engine control unit (ECU) determines that the engine is operating outside of its desired parameters. The operator must note this condition in the machine log and have the machine serviced immediately. Continued operation of the machine with the check engine light illuminated may cause severe engine damage and may lead to dangerous operating conditions.

Hydraulic Oil Filter

If filter element light comes on while you are driving or operating the machine, check hydraulic oil level and the filter. Refer to appropriate section of the machine service manual and service the filter.

Green-Means-Go

Do not start resurfacing until this light turns on. The green-means-go light indicates that the engine is operating in closed loop state.

Machine Operation Switches

The switches located on the left side of the dash operate the following machine functions:

- horn
- lights
- board brush (if equipped)
- wash water pump (if equipped)

The switches will illuminate when the circuit and function is activated. Each switch has a label indicating its function.

The machine's ignition key switch has the following switch positions: off, on/run, start, accessory.

The rocker switches located on the right side of the dash face are used to operate the machine options installed on the machine. Some of these options may include the following:

- tire wash system
- advanced water system
- snow tank light
- low fuel warning light

The switches will illuminate when the function is activated.

Ice making water gauge

This optional gauge shows the water level in the ice making water tank.

7.
Operating the Ice Resurfacer

Driving the Machine

Before Driving the Machine

Do not operate this machine before reading and understanding these instructions and also viewing the instructional tape.

Always operate the machine with the seat adjusted to allow for proper foot pedal action.

Always operate the machine from a seated position. Do not stand up to operate!

NO RIDERS OR PASSENGERS ARE PERMITTED! Do not operate the machine if the guards are not in place or broken.

Machine Controls

The Zamboni ice resurfacer has familiar automobile-style driving controls.

The ice resurfacer is steered with the steering wheel. It has two foot pedals, one that controls the acceleration and the other one is a brake pedal. It has a hydrostatic transmission that allows for smooth operation.

The machine's ground speed is controlled through the use of the accelerator foot pedal and the combination of the engine RPM and the location of the hydrostatic transmission lever. The further the hydrostatic transmission lever is away from neutral, the faster the machine can travel. The engine speed (RPM) is controlled by the engine speed switch (See Figure 7.1).

Hydrostatic Transmission

The hydrostatic transmission is an infinitely variable hydraulic pump and motor combination. The machine's direction of travel is selected with the transmission control lever (Figure 7.2). Along with engine RPM and depressing the acceleration foot pedal, the machine speed is controlled by the how far away from neutral the lever is placed. For maximum pulling power (torque), similar to "low gear" the transmission lever should be placed only a little way from neutral.

The transmission must be in **neutral** for starting the engine.

The machine is equipped with a neutral start safety switch (Part No. 7P-7962A).

Engine Speed

This machine is equipped with an electronic governor. The engine speed is controlled via an engine speed switch (See Figure 6.2). The engine speed is increased by pushing the top of the rocker switch. The engine speed is decreased by pushing the bottom of the switch.

The electronic governor maintains the engine RPM independent of the load of the engine.

When resurfacing, the engine speed should be set between 2,400-2,800 RPM. The operator must not "lug" the engine by operating with the engine RPM set too low. This will impair the operating and resurfacing performance and may damage the engine.

Machine Speed

The direction of travel for the ice resurfacer is determined by moving the transmission control lever as indicated in Figure 7.2. The engine speed should be maintained at 2,400 to 2,800 RPM.

The speed of the machine is controlled by the combination of engine RPM, the position of the transmission control lever and the accelerator foot pedal.

Accelerator Foot Pedal

The accelerator foot pedal activates the hydrostatic transmission. Depress the foot pedal and the machine will travel in the direction selected by the transmission lever. The foot pedal controls the amount of power applied from the transmission. Full pedal travel will produce full speed, maximum acceleration, etc. Lifting your foot from the foot pedal will slow the amount of power delivered from the transmission and will slow the machine. The hydrostatic transmission will act as a braking system when you lift your foot from the pedal. You can also apply the foot brake.

Throttle Switch and Hydrostatic Transmission Control Levers

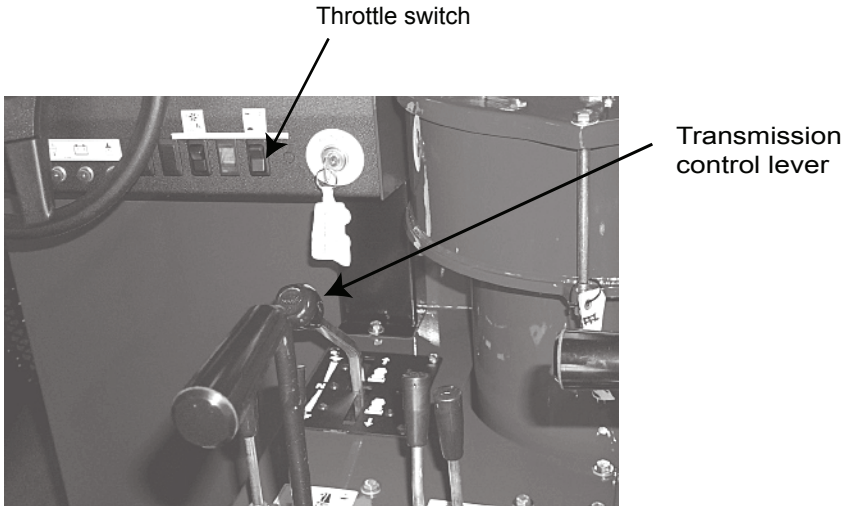


Figure 7.1 *Throttle Switch and Transmission Control Lever*

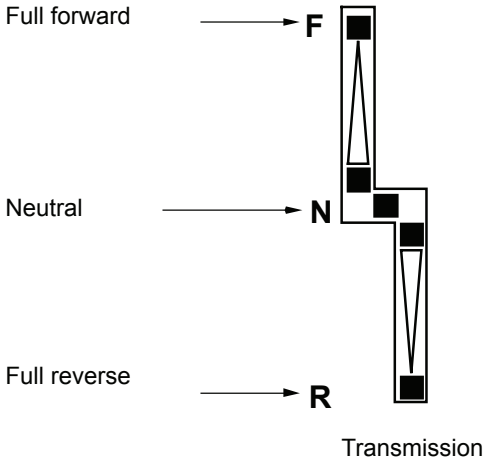


Figure 7.2 *Power - Transmission Control Lever*

Resurfacing Procedures

The Zamboni ice resurfacing machine produces the finest quality ice surface known. It eliminates the labor-intensive and time consuming methods of the past which were required to maintain an ice surface. And it does it all easily and efficiently. You will produce higher quality ice if you read, understand and practice the following information.

Historically, the best sheet of ice produced prior to the development of the Zamboni ice resurfacer was usually produced by the following procedures:

- A tractor-pulled planer shaved the ice to remove as many skate grooves as possible;
- The accumulated shavings were plowed or scraped to a snow pit located next to the ice surface;
- Dirt and contaminants were flushed out of the remaining skate grooves by washing the entire ice surface using a heavy hose and nozzle;
- Large hand squeegees were used to push the dirty water to the snow pits;
- Using a hose, the final coat of water was sprayed or flooded onto the ice surface to complete the resurfacing operation.

The Zamboni ice resurfacer performs all of these tasks. The ice is shaved, the shavings are collected into the dump tank, the ice is washed using the wash water system and the final coat of water is applied to the ice surface.

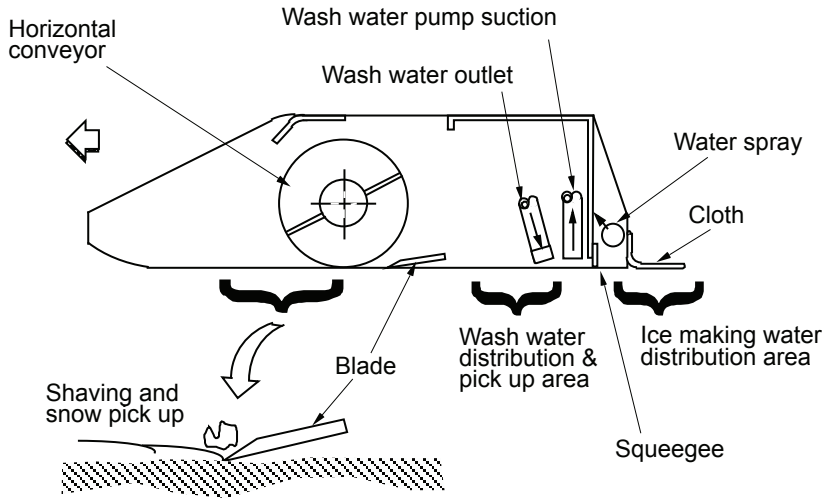


Figure 7.3 *Resurfacing Procedures*

Learning to Resurface

Before Going to the Ice

- Check the water level in the water tanks;
- The blade must be **level** (see Figure 9.5) and at the correct **angle** (see Figure 9.6);
- The conditioner must be raised completely;
- The towel bar should be attached if water is to be applied to the surface.
- NO RIDERS!

On the Ice

WARNING!

Do not operate the machine if anyone is on the ice.

The following operations may be performed while on the ice:

- Shaving or cutting;
- Washing the ice;
- Distributing ice-making water;
- Use of the board brush, edger, or other optional equipment;
- Removing excess water from the ice;
- Removing slush (mixed ice and water) from the ice.

Shaving or Cutting

- Proceed from the storage area onto the ice (see Figure 7.4);
- When starting the resurfacing pattern, it is recommended to start down the center of the ice surface so the functions can be started and blade adjustments can be made at some distance from the walls or boards;
- Before lowering the conditioner, make sure that the blade is "out-of the ice" or elevated so that it will not cut immediately upon lowering the conditioner to the ice surface. See the "Blade Control" information in Chapter 9;

  Note: To avoid catching the towel underneath the conditioner, lower the conditioner **only** while driving slowly forward;
- While on the ice surface and driving slowly forward, lower the conditioner and start the conveyors immediately.

To lower the conditioner:

Pull back on the conditioner valve handle completely. Allow time for the cylinder to travel to the end of its allowable movement. You will normally hear a hissing sound produced by the hydraulic fluid passing over the relief valve when the conditioner has traveled fully up or down. Return the valve to neutral after the conditioner is completely down.

To start the conveyors:

Pull back on the two conveyor handles. The operator should be able to hear the conveyors rotating. The operator should be able to observe wisps of snow coming out of the snow vent as the snow tank fills with snow. The conveyors should be stopped before the snow tank is completely full to avoid plugging the vertical conveyor.

DANGER !

Turn off and remove the ignition key before adjusting, repairing, cleaning, or servicing the conveyors.

If any part of the conveyor system becomes plugged or clogged, or appears plugged or clogged, the conveyor must be flushed out with water. Do not wear gloves or jewelry when performing these functions.

Flushing the augers out with water must be done only after the machine has been removed from the ice, the auger control valves have been returned to their neutral (off) positions, and the ignition has been shut off.

Under no circumstances should the operator attempt to clean or clear the conveyor system or parts around it while the machine is on the ice or the power is on. To do so, exposes the operator and others to serious potential injury or death!

Reversible Vertical Auger Operating Instructions

The vertical auger is equipped to rotate in both directions. The normal rotation for resurfacing is FORWARD, as shown by the information decal located near the valve operating handle.

Reversing the auger rotation **may** clear a puck, water bottle, piece of hockey stick or other large objects that gets lodged in the auger flighting.

Reversing the auger rotation **will not clear a snow jam** in the auger, as the bottom of the auger is designated to pull in snow and not throw it out.

To run the auger in the reverse direction, the valve stop needs to be relocated on the valve lever which will allow the valve to be actuated in the opposite direction.

The following steps should be observed when you decide to run the auger in the reverse direction:

- Loosen and rotate the valve lever stop out of the way;
- Being sure that the auger is not moving, actuate the lever to reverse the auger (auger lever moves forward);
- To change auger rotation to forward, move the valve lever to NEUTRAL position, IF THE AUGER IS NOT RUNNING, pause a moment (2-3 seconds) then move the lever backwards for normal auger rotation. If the auger is running, you **MUST** move the lever into NEUTRAL and wait until the auger has come to a full stop.

CAUTION!

Never slam the lever back and forth rapidly to unclog something. You will most definitely over pressurize the auger motor and cause breakage. Besides the unnecessary down time associated with this action, the damaged motor will not be covered under warranty. Damage created in this manner is very obvious upon inspection of the motor.

- Augers should be washed out between floods to prevent ice build up and snow jamming of the augers;
- After using the reversing feature, locate the valve lever stop in its original position (blocking the forward position of the lever);
- Depending on how long the reversing feature was used, you should check the auger bearings and the motor coupling screws to ensure that they are still tight. Reversing the auger may have loosened them off;
- The vertical auger should be washed out at the end of the shift and the auger bearings immediately greased to displace any water accumulated during the day. Greasing the auger bearings once a day will ensure a long service life. Use a high quality marine or boat trailer grease for the vertical auger bearings.

Typical Resurfacing Operation

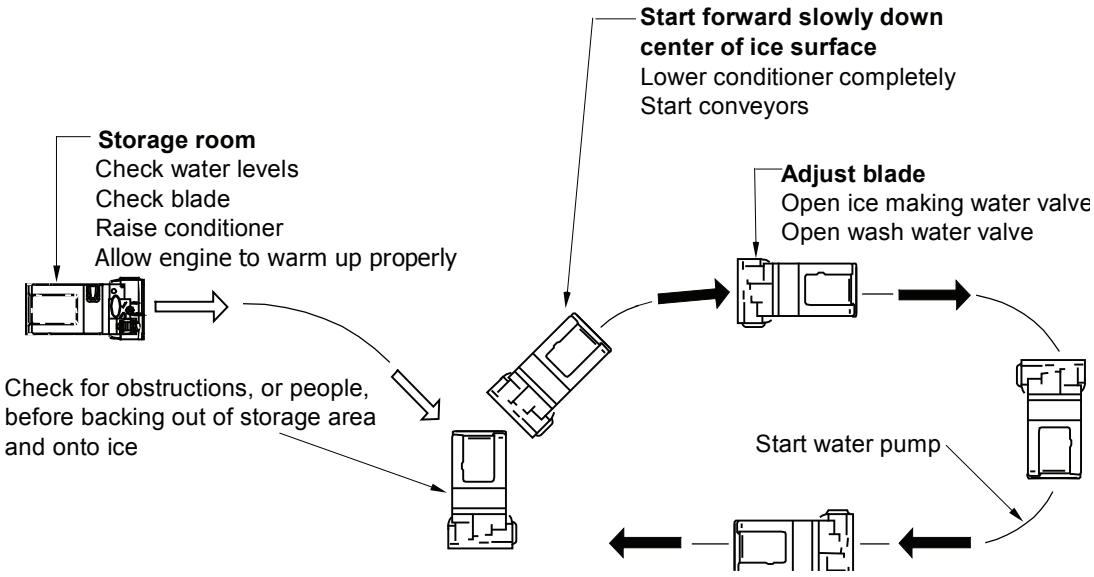


Figure 7.4 *Going onto the Ice*

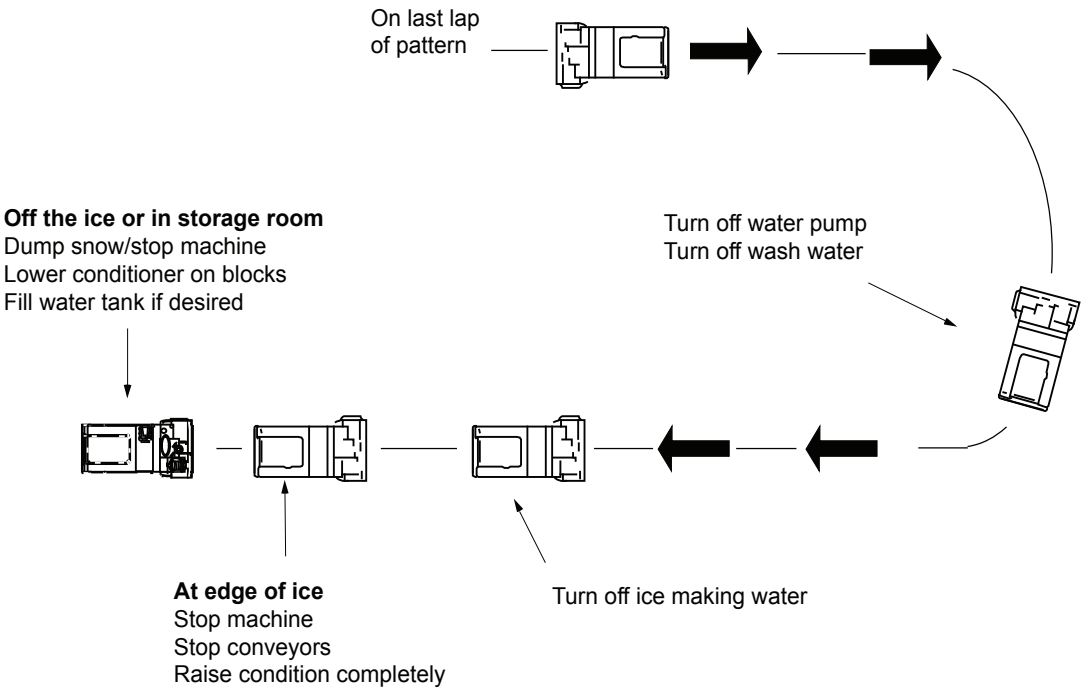


Figure 7.5 *Leaving the Ice*

Using the Snow Breaker

The operator should use the snow breaker several times a minute (or more as required). The snow breaker helps remove snow or ice that will build up in the corners of vertical auger opening. To use the snow breaker, push down on the snow breaker rod and release. Repeat this action several times.

Washing the Ice

The wash water system removes dirt and debris from the ice surface. Regular use of the wash water system will produce a clean, high quality ice surface.

Before using the wash water system, fill the wash water tank with cold water.

To use the wash water system:

- With the conditioner down, the horizontal conveyor rotating, and the machine moving forward, fully open the wash water valve. The wash water valve is located on the right side of the conditioner;
- Allow the valve to remain open for at least 10 seconds;
- Turn on the wash water pump switch. The green light in the switch indicates that the wash water pump is operating;
- You will be able to see the wash water flow into the wash water tank screen basket located in front of the operator's area. If there is no flow, turn off the pump immediately. Check the system for obstructions after the machine has been removed from the ice;
- When resurfacing has been completed, first turn off the wash water pump and then close the wash water valve. The conditioner can then be raised.

To avoid damaging the wash water pump impeller (caused by running it dry), always have water in the wash water tank and always wait at least 10 seconds after opening the valve before turning on the wash water pump.

After each resurfacing, inspect and discard any debris collected by the wash water tank screen.

Periodically inspect the rubber squeegee located at the lower rear of the conditioner for tears and damage. Replace as required to maintain good wash water system performance.

Ice Making Water

Using hot water for the ice making water will generally produce the best ice surface. Do not use water hotter than 140^0 F (60^0 C) as this could damage the plastic ice making water tank.

To use the ice making water during a resurfacing:

- With the conditioner down and the machine moving forward, open the ice making water valve, located on the left side of the conditioner;
- You can regulate this water flow by opening and closing the valve. Some operators reduce the water flow in areas of the ice surface where their driving pattern overlaps many times, such as in the corners, at the ends of the ice or the hockey goal areas to avoid leaving too much water;
- When the resurfacing is completed, close the valve before raising the conditioner.

Using the Board Brush

The optional board brush will help you produce a high quality ice surface by sweeping away the snow and ice that gathers at the base of the dasher boards, next to the kickplate, around the perimeter of the ice. It is important to sweep this snow and ice away before water is applied. This will prevent ice buildup on the boards. Ice buildup increases the need for ice edging.

The board brush is usually used during the first pass around the perimeter of the ice surface.

To operate the board brush:

- Activate the solenoid operated control valve by turning on the board brush switch on the instrument panel. (See Figure 6.2). The switch will light;
- At the activation of the control valve, the board brush arm will extend from the left side of the machine while lowering to the ice and the board brush motor will start;
- Carefully and slowly drive the machine parallel to the dasher boards so that the brush reaches the boards and sweeps the snow away from them. The roller on the board brush arm should contact the dasher boards;

When the roller is in contact with the dasher boards, the machine is in the correct location for best brush performance. The board brush arm has a spring action so that the machine's distance from the dasher boards can vary a little;

- After a complete lap of the ice surface next to the boards, retract the board brush by moving the board brush valve handle to the right or turning off the board brush switch. This will also stop the brush motor. Only hold the valve in this position for the few seconds that it takes to retract the board brush arm. Holding the valve in this position for longer than required can adversely affect performance of the horizontal auger;
- Proceed with the other resurfacing operations over the remainder of the ice surface.

Removing Excess Water from the Ice

If there is an excess amount of water on your ice either from rainfall or excessive melting, it can be removed quickly by using the following procedure. The wash water tank should be emptied before this operation is begun.

*The ice resurfacer must be **MOVING** during these operations:*

- While on the ice surface, with the engine RPM at 2,400-2,800 (highest RPM is recommended), lower the conditioner;
- Start the vertical and horizontal conveyors;
- Raise the blade off (or out) of the ice by turning the blade adjustment handwheel, rotating the handwheel counter-clockwise. This will allow the water to pass under the blade and accumulate at the water pump suction pipe. (Figure 7.3);
- Turn on the water pump;
- After water from the wash system flows into the screen, begin to drive forward over the areas of excessive water;
- Fill the wash water tank;
- Drive off the ice and empty the wash water tank by turning on the wash water valve on the conditioner;
- Empty the wash water tank if it is necessary to continue removing excess water from the ice;
- When through removing excess water from the ice, empty wash water tank and refill with fresh, cold water.

Removing Slush (ice and water mixed) from the Ice

*The ice resurfacer must be **MOVING** during these operations:*

- While on the ice surface, with the engine RPM at 2,400-2,800, lower the conditioner;
- Start the vertical and horizontal conveyors;
- Raise the blade off (or out) of the ice by rotating the blade adjustment handwheel counter-clockwise;
- Drive forward over the areas of slush to be removed;
- Before leaving the ice surface and before raising the conditioner, continue running the conveyor augers for a few moments. This will help avoid freezing the slush in the tube, between resurfacings. Stop the conveyors. Raise the conditioner and proceed to the dump area;
- After removing the slush from the ice surface and dumping it, flush the conveyors with water.

DANGER !

Turn off and remove the ignition key before adjusting, repairing, cleaning, or servicing the conveyors.

If any part of the conveyor system becomes plugged or clogged, or appears plugged or clogged, the conveyor must be flushed out with water. Do not wear gloves or jewelry when performing these functions.

Flushing the augers out with water must be done only after the machine has been removed from the ice, the auger control valves have been returned to their neutral positions, and the ignition has been shut off.

Under no circumstances should the operator attempt to clean or clear the conveyor system or parts around it while the machine is on the ice or the power is on. To do so, exposes the operator and others to serious potential injury or death!

Note: Whenever excess water or slush is being removed from the ice surface and conveyed into the snow tank, the Zamboni ice resurfacer ice making water tank **must be empty.** Water in both the ice making water tank and the snow tank may load the machine excessively.

Leaving the Ice Surface

When leaving the ice surface after finishing a resurfacing (or any other time): (See Figure 7.5)

- Raise the cutting blade out of the ice;
- Turn off augers;
- Turn off water pump (if used). Close the wash water system valve;
- Close the ice making water valve;
- With the vertical auger stopped, raise the conditioner fully by operating the conditioner lift valve lever;
- If dumping outside, remove the towel bar assembly from the conditioner to avoid getting it dirty.

Off of the Ice

The following operations are performed off of the ice surface:

- Dumping the snow tank;
- Raise the snow tank by operating the snow tank valve lever. After the snow has been dumped, lower the tank. If the tank is to be left up, the snow tank support stand must be properly placed to support the snow tank.

DANGER!

The snow tank should NEVER be raised while the conveyors are ON. When the snow tank is raised, the vertical conveyor blades are exposed and can cause personal injury if operating.

CAUTION:

The ice resurfacer should not be moved while the dump tank is being lifted or when the tank is in a raised position.

The machine should be level when raising or lowering the snow tank.

Operating Pointers

Resurfacing Patterns

The following diagram shows a good resurfacing pattern:

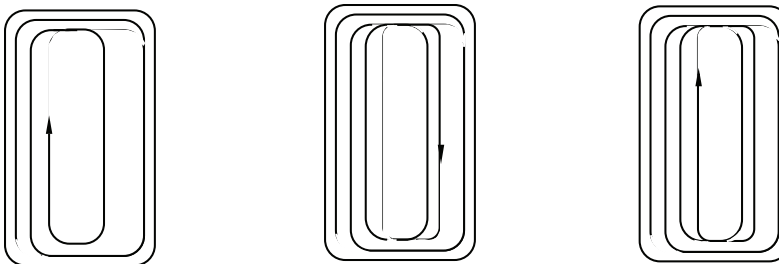


Figure 7.6 *Resurfacing Patterns*

Sharp Turns

The ice resurfacer has a power steering system which contains a hydraulic relief valve. This valve only operates when the wheels are jammed up against an object or when the operator turns the steering wheel completely to the left or the right and holds it there against the stop.

If the steering is placed and held against the stop, the operator will notice a light, hissing noise coming from the instrument panel. This noise is made by steering relief valve opening and allowing hydraulic fluid to pass through it. The operator may also notice a drop in engine and conveyor speed. This is because extra engine power is being used to open the relief valve and push fluid through it.

Your turns will be much smoother and there will not be a drop in engine or conveyor speed, if you learn to drive the vehicle without placing the steering "on relief."

To do this you simply back off the steering stop a slight amount after you have turned the wheel completely and you hold the wheel steady in the turn. You can easily hear the relief valve open so you will know how tight you can hold a turn without always being on relief.

Excessive Loads

Taking too deep a cut with the shaving blade while driving the machine at it's full ground speed may place an excessive load on the engine. The engine RPM is maintained with only a small RPM drop while resurfacing normally. With an excessive machine load, the engine RPM may drop excessively which will cause the operation of the machine to suffer. If the engine RPM is dropping excessively, reduce the load of the machine by:

- slowing the ground speed of the machine by lifting the foot pedal;
- reducing the depth of cut.

8.
Water System

A. Hose (A) supplies water from the wash water tank to the conditioner;

B. Hose (B) carries water picked up in the conditioner to the suction side of the water pump. The pump then pumps the water to the top of the wash water tank, at which point the water can be recirculated through the filtering screen;

C. Hose (C) supplies water through the ice making water valve from the ice making water tank to conditioner;

Optional Connection Valve

D. Valve (D) may be opened to connect the wash water tank to the ice making water tank for additional ice making water capacity. Flush wash water tank clean before opening the valve when using this system.

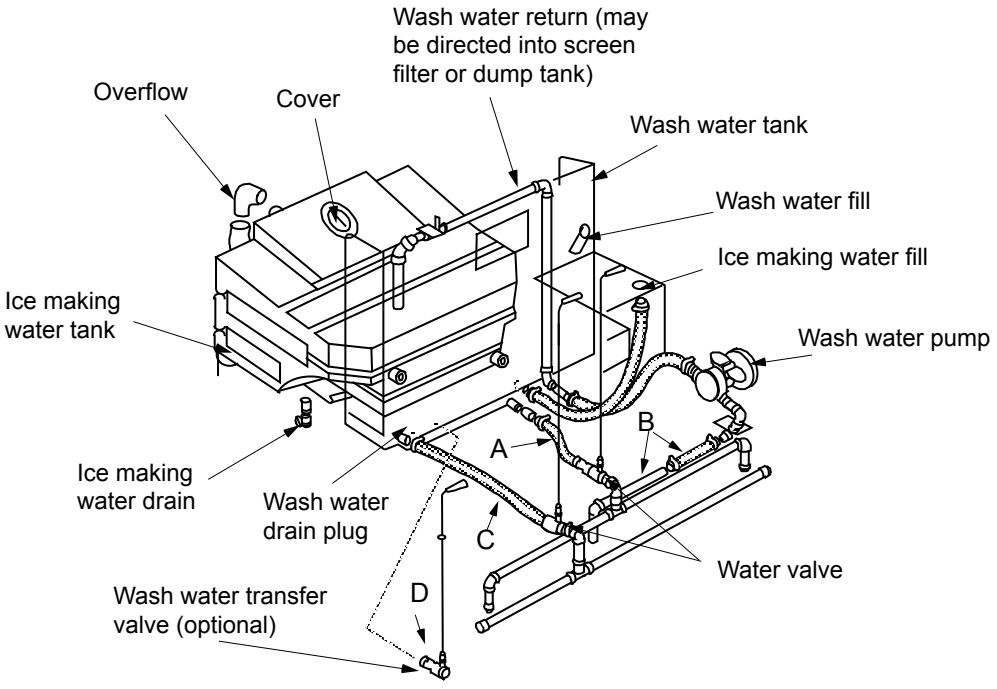


Figure 8.1 *Water System*

9.
Maintaining the Cutting Blade

It is essential that the blade be sharp if the resurfacer is to operate properly. Conditions vary from one rink to another, but experience has shown that normally the cutting blade is dull and needs resharpening after 5 to 7 days of operations.

WARNING!

The cutting blade is extremely sharp and must be handled with care. The blade can INJURE whether sharp or dull. Use extreme caution! Use gloves and handle in scabbard as much as possible. Place blocks under conditioner while changing blade or reaching under conditioner.

Changing the Blade

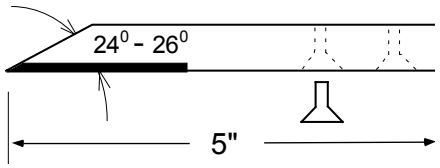
When changing your blade, see that the surface of the long bar, to which the blade is bolted (Figure 9.4), is clean. As the blade bolts are replaced, tighten the center nuts first and work toward the ends of the blade. The outside bolts are to be tightened last.

After removal, the dull blade should be sent immediately to be sharpened so that a sharp blade will be on hand at all times. For sharpening blades, contact a company that sharpens paper cutting knives for newspaper publishing firms.

Blades should be sharpened at an angle of 24^0-26^0 .

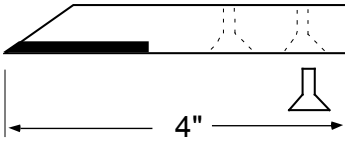
New Blade

Use FRONT row of holes when blade is new.

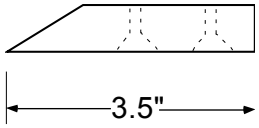


Used Blade

Use REAR mounting holes when blade is 4" wide, or less.



Note: Hardened material is exhausted when blade is approximately 3.5" wide.



Blade Controls on Conditioner

Side hex head controls level each side of the blade in relation to the runners.

Side Controls

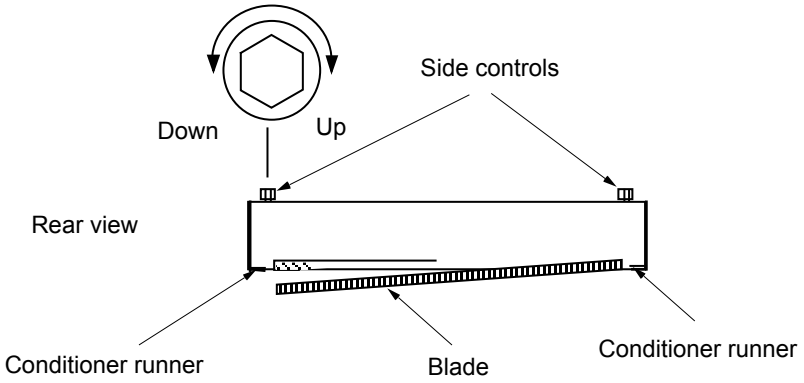


Figure 9.1 *Blade Controls on Conditioner*

Hand Wheel

Center hand wheel control varies the angle of the blade. If blade is leveled with each runner, the handwheel will make uniform change in depth of cut.

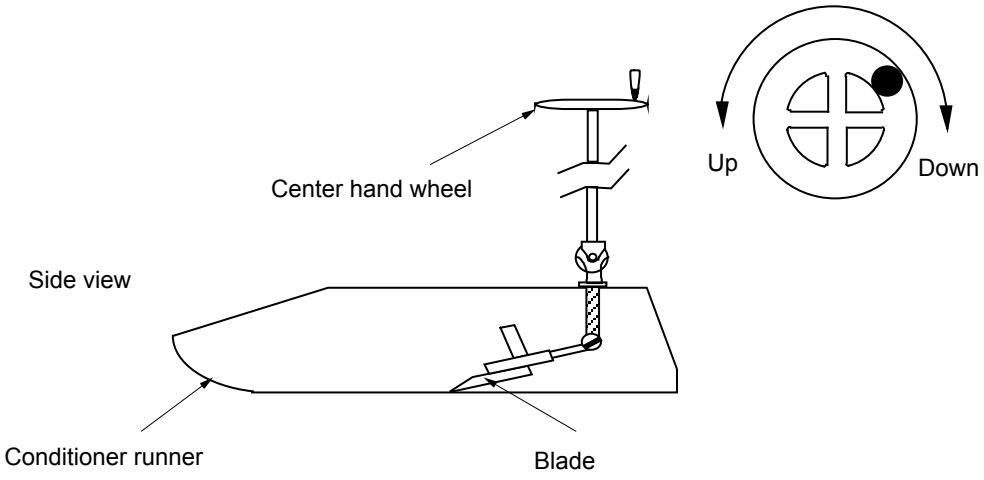


Figure 9.2 *Center Hand Wheel Control*

ARROWS SHOWN BELOW INDICATE ROTATION TO LOWER BLADE

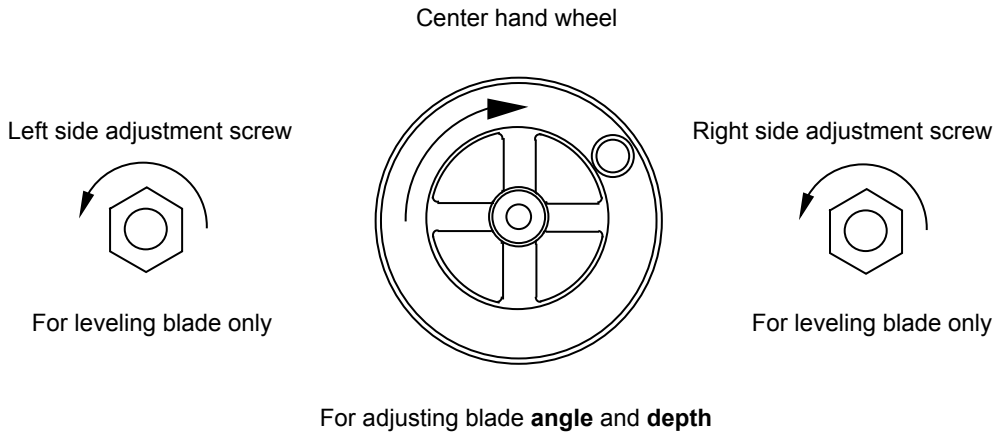


Figure 9.3 *Blade Adjusting System*

Holding and Securing the Blade

Blade Holding Bar (5K-78890)

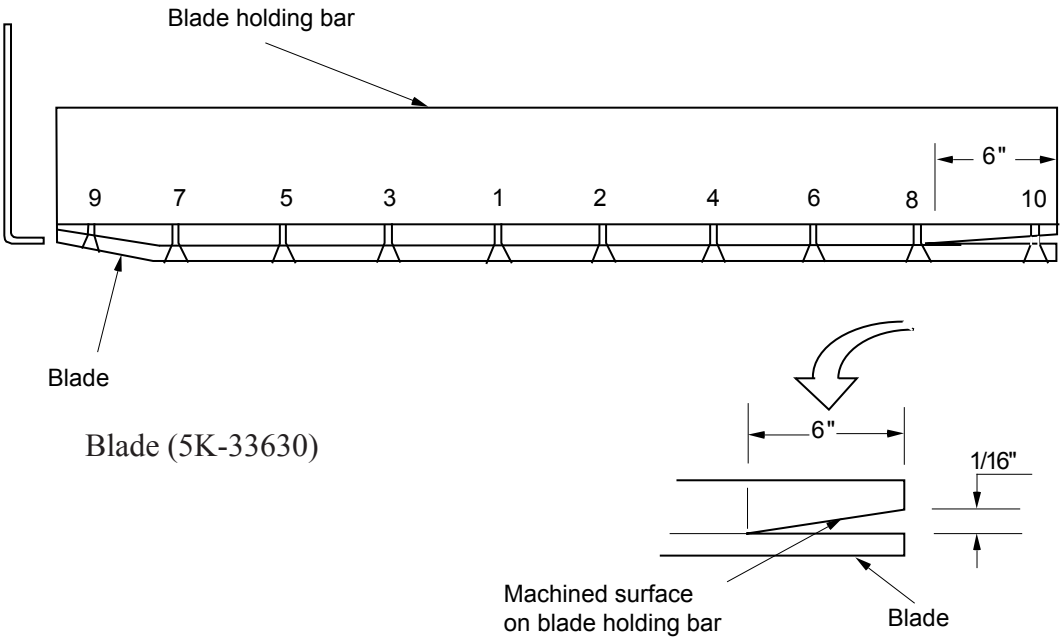


Figure 9.4 *Blade Holding Bar*

The ends of blade holding bar are machined upward approximately 1/16" so that one cut of the ice is feathered into the adjoining cut.

When attaching blade, tighten two middle bolts first, then work to outside.

WARNING!

Blade is extremely sharp. Avoid being cut by handling as much as possible in scabbard. Place blocks under conditioner while changing the blade.

Procedure for Setting Blade Angle and Depth of Cut

Step 1: Set blade at approximately 10^0 angle as shown on the blade angle adjusting plate (Figure 9.6) by rotating center hand wheel control.

Step 2: Align leading edge of blade EVEN with BOTH conditioner runners. It is quite helpful to use a flat washer, a large coin or the blade adjusting tool (Part No. 84-01100) to check this alignment as shown below.

WARNING!

Use caution as blade is sharp.

Note: If blade is even with both runners, the majority of the blade will be about 1/16" below the runner as shown in Figure 9.4. Since a 1/16" cut would normally be quite a heavy cut, turn the hand wheel counter-clockwise to raise the blade slightly. (With a new 5" wide blade, 1-1/4 turns of the hand wheel is equal to approximately 1/16").

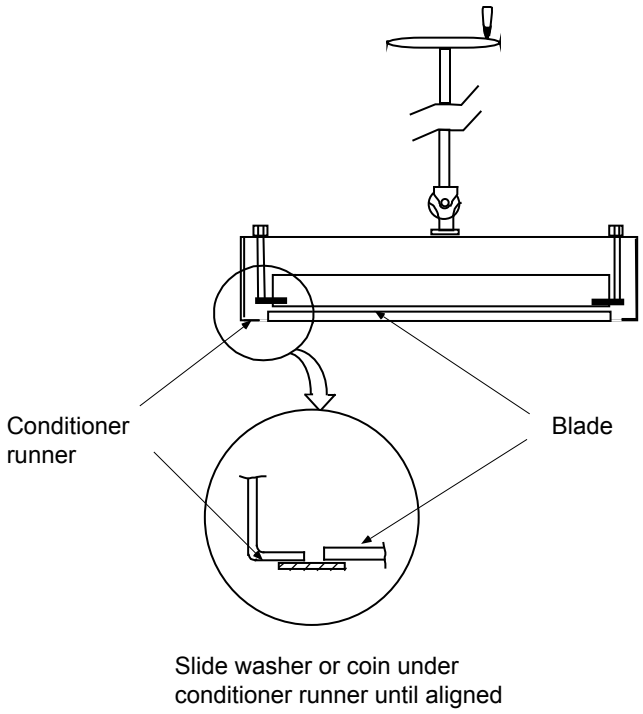


Figure 9.5 *Aligning the Blade with Conditioner Runners*

Blade Angle Adjustment Plate

A blade angle plate is located on the inside of the conditioner left side plate (see Figure 9.6). When the blade holding bar is lined up, parallel to the series of lines, the blade angle is approximately 10°.

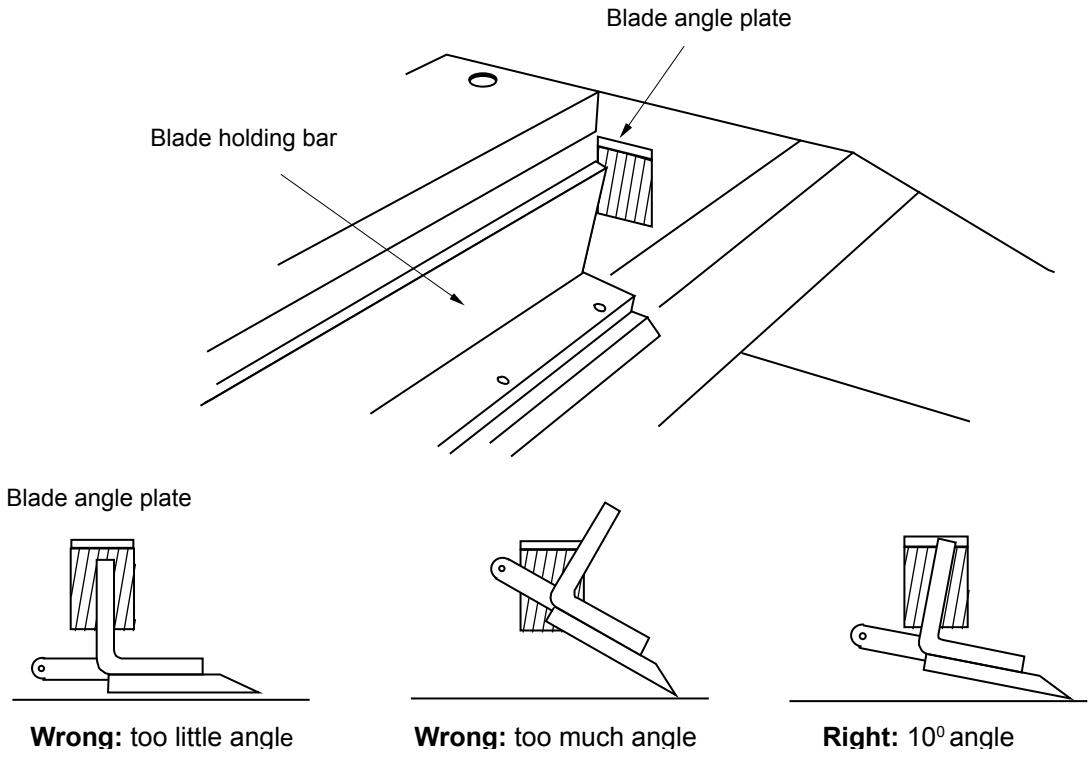


Figure 9.6 *Blade Angle Adjustment Plate*

Using the Edger

During the normal operation of an ice rink, the edges of the ice surface have a tendency to build up.

If not removed, this buildup makes proper shaving of the rink perimeter difficult and may become a safety hazard to skaters.

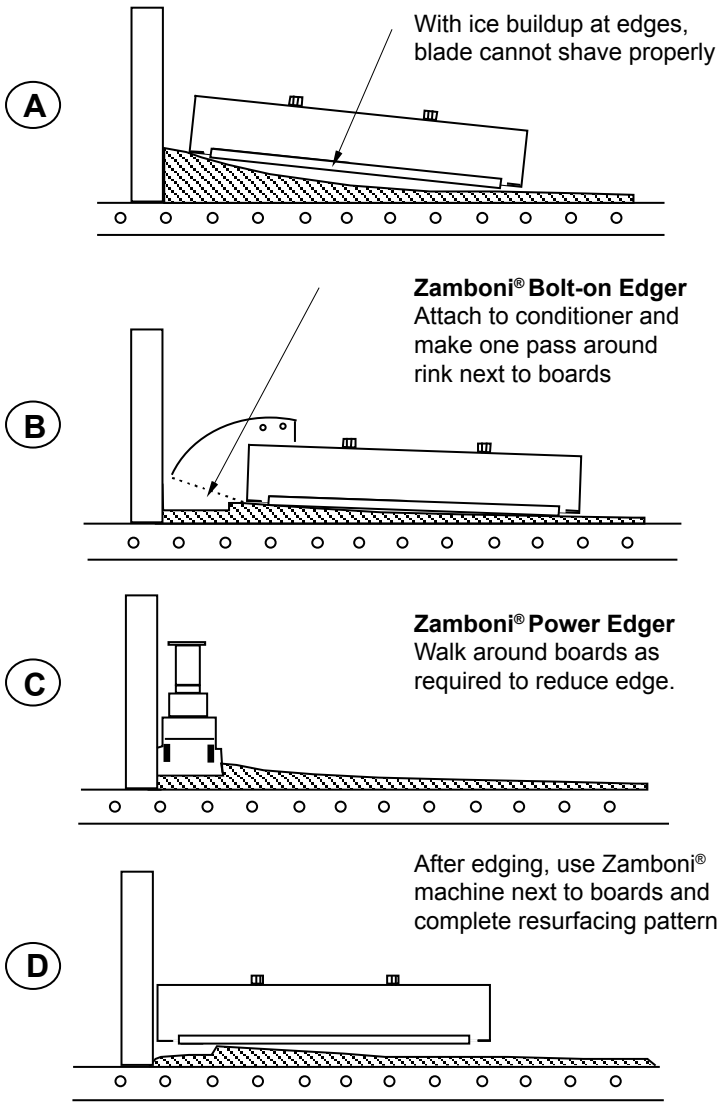


Figure 9.7 *Zamboni Edger*

Edger Attachment

Mount the edger on the driver's side of the conditioner and bolt tightly at the three locations shown below. The depth of cut on the edger blade may be adjusted by turning the two blade adjustment set screws.

Use the edger as a separate operation in the following manner:

- Start driving **slowly** next to boards. Fully lower conditioner, but tilt the conditioner blade off of the ice, slightly, by turning the blade adjustment handwheel counter-clockwise;
- Start conveyors;
- Take one or two laps along the side of your boards, keeping the edger against the railing or dasher;
- Remove the edger assembly;
- Resurface the ice rink completely in the normal manner.

CAUTION:

Drive slowly when using the edger. While using the edger, the front of the resurfacer will tend to pull into the wall.

Note: Keep edger blade sharp.

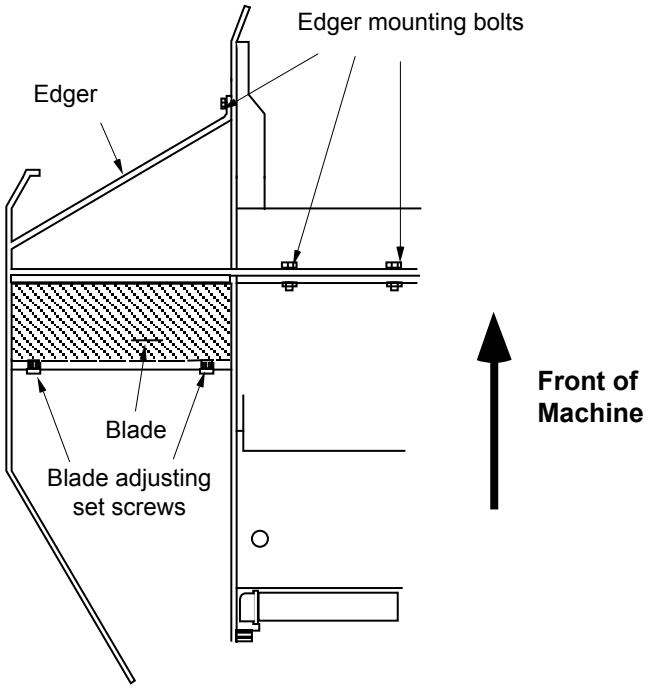


Figure 9.8 *Edger Attachment*

10.
Emergency Operation

Emergency Hand Pump

The emergency hand pump is located at the rear of the machine.

Purpose: The emergency hand pump is used to raise the conditioner or the dump tank in the event the engine will not operate.

Operating the Emergency Hand Pump

The machine has a “system manifold” block as shown in Figure 10.2.

To use the hand pump to lift the dump tank:

- Push dump tank valve lever forward while pumping the hand lever (Figure 10.1).

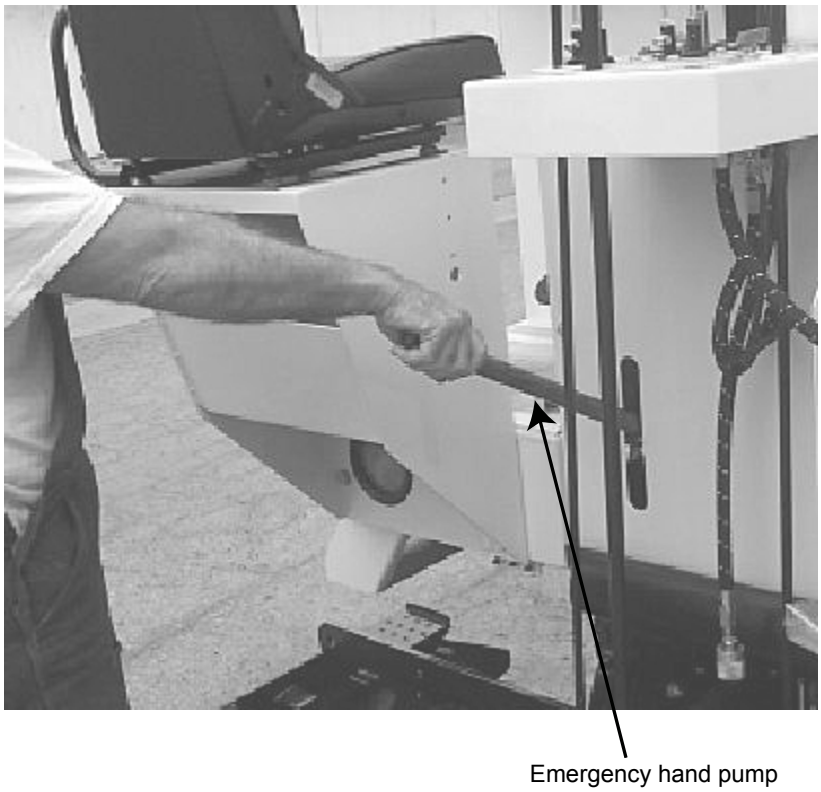


Figure 10.1 *Hand Pump Actuation*

To raise just the conditioner:

- Close the emergency bypass valve located on the underside of the system manifold block (Fig. 10.2);
- Push the conditioner lift valve lever forward while pumping the hand pump lever.

If the pump does not work, check the oil level in the hydraulic tank.

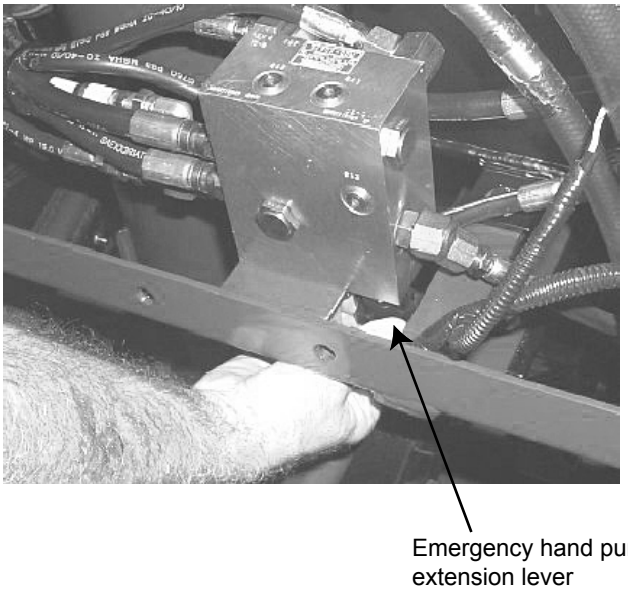


Figure 10.2 *Manifold Block*

Emergency Hydrostatic Bypass Valve

Should it be necessary to move the machine when the engine is not operable, the emergency bypass valve, located on the hydrostatic pump, must be opened (see Figure 10.3).

This valve is located on the hydrostatic pump, in the engine compartment, in front of the water tank. (See Figures 5.5 and 10.3 for location). To open the bypass valve, rotate it two turns counter clockwise using the adjustment tool (Part No. C4-00157) supplied in the machine's tool kit.

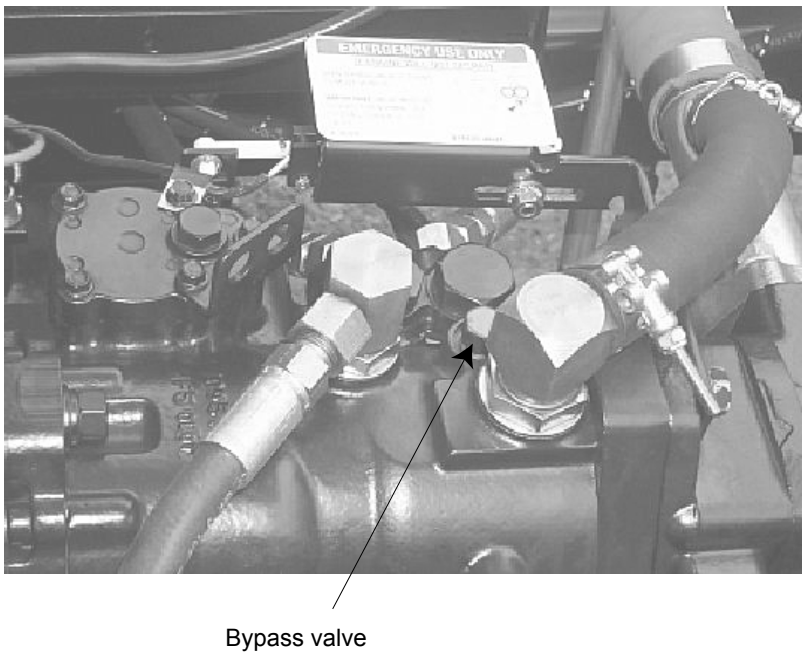


Figure 10.3 *Hydrostatic Pump Bypass Valve*

Note: This system is to be used **ONLY** when pushing or pulling the machine **SLOWLY.**

The bypass valve must be **FULLY** closed for normal operation.

Disconnect the drive shafts for extended towing distances.

Fast towing should not be done.

11.
Storage Information

Storage Room Information

Storage Area

Due to the great amount of water associated with this machine, it should be stored between resurfacings in a room heated above freezing. The room should be as close to the edge of the rink as possible and the surfaces between the storage area and the rink should be paved so dirt will not be tracked onto the ice. It is highly recommended that the storage room be on the same elevation as the surface of the ice to eliminate the need for a ramp.

Keep all sources of open flame, spark or other ignition such as stoves, furnaces, water heaters or any appliance using a pilot light away from fuel storage, fuel use and refueling areas. Under well ventilated conditions, a minimum distance of 20 feet from all ignition sources is recommended.

Floor Drain

The floor of the storage room should be pitched toward a floor drain of sufficient size to carry excess water and melting snow away from the machine.

Daily Storage (Indoor)

It is suggested that the dump tank be left in the lifted position for storage with the safety stand in place. This will allow for better air circulation for drying and will cut down on corrosion and rusting.

Summer Storage Tips

- Empty the water tanks. The ice making tank and the wash water tank are made of high density polyethylene and will not present a corrosion problem;
- As recommended in maintenance literature, completely lubricate the chassis and ice resurfacer parts to discharge any possible moisture from the bearings surfaces;
- If possible, store the machine in a dry enclosed area;
- If possible, park the machine on a flat and level surface. If the machine is parked on any kind of grade, the wheels must be blocked with wheel chocks to prevent the vehicle from rolling away after it has been parked;
- If possible, raise the machine onto blocks thereby taking the weight off the tires.