Dix Hills Fire Department
115 E. Deer Park Rd.
Dix Hills, NY 11746

DRIVER TRAINING MANUAL

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INTRODUCTION

The following manual is intended to familiarize Drivers and Motor Pump Operators of the Dix Hills Volunteer Department with the basic knowledge required to successfully operate a Department emergency vehicle.

The manual is not intended to be comprehensive or to address all the possible applications of, or exceptions to, the general policies and procedures of the Dix Hills Volunteer Fire Department and Chief's Orders as they pertain to the operation of emergency vehicles. Also, the procedures and practices outlined in this manual may, from time to time, be modified as circumstances dictate.

All of the information which is required to successfully pass the written examination and road tests is contained in this manual. Therefore, you should familiarize yourself with it and discuss the material with your Company Officer or Driver Instructor.

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DEFENSIVE DRIVING

A defensive driver is one who makes allowances for the lack of skill and knowledge on the part of the other driver and who recognizes that he has no control over the unpredictable actions of other drivers and pedestrians nor conditions of weather or roads. Drivers and their officers are responsible for the safety of the apparatus and personnel on board. Drivers must recognize, that while they may know what they are doing, the drivers of other vehicles - and pedestrians as well - may not.

Speed is NOT of prime importance when responding to alarms. Speed often results in serious and unnecessary accidents which not only prevents the apparatus from reaching the scene of the emergency, but can cause death or injury to firefighters or civilians. If the apparatus never arrives at the scene because of an accident, it and it's personnel are of no use to the incident commander.

Of even greater importance is the psychological effect which speed has on man. The natural result of speeding to an incident is that it induces a lack of logical judgment when the fire scene is reached. The most effective approach to the control of fire often goes unrecognized and windows and doors are unnecessarily damaged in an effort to apply fire streams rapidly. Speed in providing ventilation to a fire before hose lines and manpower are in position has proven disastrous in many fires. Speed in discharging hose streams before the fire is located, or before salvage covers are spread has caused much damage. The driver who makes certain that he knows exactly where the alarm is located and the best route and responds in a safe manner will arrive with a company prepared for action. Of major importance during the response is that the driver keeps his apparatus under control at all times and is not influenced by firefighters on board urging him to greater speed to arrive first at the scene.

Safe driving is measured in terms of quantity and quality. The number of times a driver gets in his apparatus, drives to the scene, secures the apparatus and prepares to use it is the quantity. However, it is the quality of the runs which count. They can be either perfect or less than perfect. Perfect driving means that you complete every response without accident, without traffic violations, without vehicle abuse and without excessive delays. As a member of an emergency service, you should be concerned about public relations whenever you are operating Fire Department apparatus. The name of the Fire Department is painted on the side of the apparatus but the public does not know who the operator is. You should be concerned about the public's perception of the Fire Department.

Courtesy and consideration towards other persons using the highway is the most important driving attitude there is. It is the foundation on which all other defensive driving techniques are based. Every operator's motto should be "TRAFFIC SAFETY BEGINS WITH ME". Defensive driving is driving to prevent accidents in spite of the incorrect actions of others and adverse driving conditions.

DRIVER TRAINING

The driver of a Fire Department emergency vehicle plays an important part in the safety program. *Driving a heavy vehicle loaded with personnel and equipment through congested traffic leaves no room for error*. To qualify for this position, the driver must be thoroughly trained in the skills necessary for emergency driving operations. In addition, he must have knowledge of basic mechanical information pertaining to the fire apparatus, understand all pertinent traffic regulations, establish good traffic habits and develop proper attitudes towards traffic responsibilities.

Every portion of the Fire Department's vehicle, including it's load, must enter into the driver's thinking. The very weight and balance to the apparatus are very important. The engine with it's high power, the transmission with it's intricate mechanisms, the brakes which must always be effective for the safety of all concerned, the tires that provide the frictional surface for traction and for stopping or turning, the steering mechanism, the starter and the various switches which are all under the sole control of the driver. You must be trained in their proper use.

The modern fire apparatus is equipped with several high performance features. It is a machine of great horsepower equipped with powerful brakes and designed for ease of operation. This ease of operation may conceal the fact that tons of weight under the driver's control responds only to his effort and efficiency. Safe operation of this equipment will result only if these controls are operated properly.

If improperly handled, there will be many tons of uncontrolled weight moving upon the street. This may be more apparent when one considers that the average fire engine running at 20 miles per hour is involved in a collision, it will have the same force as if the truck was dropped from a height of approximately 14 feet. At 40 miles per hour, the equivalent falling distance is four times as great, or 56 feet - about the height of a 4 story building.

The driver of emergency apparatus responding to an alarm experiences the hazard of cross traffic that is seldom controlled for his benefit by a signal light or stop sign. However, the driver has his own traffic control with him in the form of warning lights and siren and/or air horn. Unfortunately, these devices do not always control traffic instantly and the driver must be skilled enough to avoid a dangerous situation by suitable action. At no time must the driver loose sight of the fact that he has a certain basic responsibility for the safety of all users of the road. The law allows certain exceptions to drivers of emergency vehicles, but a driver must remember that he should not take any action that would endanger life or property. He should also remember that the emergency lights, sirens and air horns are only devices that permit him to ASK for the right of way to pass through an intersection that is protected by a stop sign or signal light. You cannot force other drivers out of the way. Remember, you are driving an emergency vehicle - not a bulldozer!

Modern traffic conditions necessitate that emergency apparatus drivers be skillful, mature and responsible if accidents are to be avoided. Good drivers attain the required skills largely through training, a development of proper attitude and driving habits and training in the exercise of restraint and good judgment. Some of the factors that govern successful driving are a) the condition and limitations of the emergency vehicle; b) the physical features of the road; c) the attitudes, behavior and reactions of other highway users; d) varying light and weather conditions and e) the personality and makeup of the driver himself.

DRIVER ATTRIBUTES

The chief attributes of a good driver are related directly to his attitude, skills, knowledge, judgment, habits and physical and mental condition.

ATTITUDE: A good attitude is possibly the most important requirement of being a good driver. A driver's attitude is reflected in his mental or emotional regard for himself and others, his vehicle and the surrounding conditions. A driver with a poor attitude always has some excuse for any adverse occurrence - the other driver was wrong, the road surface was poor, the intersection was blind and so on. Attitudes are learned and can, therefore, be improved. Some drivers, once they find themselves with the authority of emergency lights, sirens and air horns, lose all consideration for other drivers on the road. *This attitude is wrong*! This type of attitude indicates a need for retraining at best or, at the worst, elimination from driving assignments.

The attitudes of a bad driver are:

a) Overconfidence - the lights, siren and air horn will protect me.
b) Pride in past record - "I don't remember when I had an accident last".
c) Faith in experience - "I've been driving for many years".
d) False ideas - relying on hearsay, estimates, legends instead of facts.
e) Impatience - taking needless chances, repressing good judgment.

SKILLS: Skill in driving does not necessarily mean safe driving performance. Records show that some drivers of exceptional skill are repeatedly involved in accidents while other drivers who are less skillful have good safety records. Skill is ability *PLUS* training. A good driving performance is skill plus attitude. It is not how much skill that has been developed that is important, but the extent to which the skill is applied.

KNOWLEDGE: Thorough knowledge of the apparatus capabilities and limitations, response routes, hydrant locations and rules and regulations is essential if one is to be a skillful driver. A driver who does not have this knowledge is likely to be confused and distracted to such an extent that he becomes an accident waiting for a place to happen.

JUDGMENT: Good judgment is based on proper attitudes, mental fitness, knowledge and experience.

GOOD HABITS: Good habits are acquired and learned through training in self discipline. It is more difficult to break a bad habit than to learn and develop a good one.

PHYSICAL AND MENTAL FITNESS: Any driver of an emergency vehicle should refrain from driving if he feels that there is any impairment in his physical or mental well being. This does not release the company officer of his responsibility to replace a driver whom he feels is not physically or mentally fit or those who might be reluctant to ask for relief.

DRIVING TECHNIQUES

PREDETERMINED RESPONSE ROUTES: Drivers should follow the response routes of travel as closely as possible. If responding to an emergency in a particular location, the same general route should be followed. In this way, other units responding from other locations will not unexpectedly come upon apparatus moving out of side streets where they are not expected to be. Drivers must always be on the alert for other responding emergency vehicles, particularly at intersections, and make allowances for them. If more than one vehicle is using the same road, when responding or returning from an alarm, they should proceed in single file and no vehicle should pass another unless the latter is disabled. When approaching an intersection that may be used by other emergency vehicles, a driver should use his radio to inform other vehicles of his approach. He should not rely on the fact that he is well ahead of other responding apparatus at intersections. He should always remember - "EXPECT THE UNEXPECTED".

WARNING DEVICES AND OTHER SAFETY FACTORS: To guard against accidents when responding to alarms, sirens and air horn must be sounded as may be reasonably necessary. All drivers must be especially careful during cold or rainy weather as car windows are rolled up tight during these times. Also, in very warm weather, with air conditioners and radios on full, it is very difficult for other drivers to hear the approach of emergency vehicles.

USE OF WARNING LIGHTS: All emergency lights and headlights should be on when responding to alarms. When returning from calls, all department apparatus, pumpers and ambulances, should have their headlights on only. Emergency vehicles that are parked on the roadway should have all emergency lights on as a warning to oncoming traffic. Drivers should be aware that the engine should be throttled up to at least 1000 - 1200 RPMs to conserve battery power. The vehicle should be moved to a safer off-road position as soon as practical.

SPEED OF APPARATUS: Drivers will govern their speed according to the rules of the Dix Hills Fire Department - 45 miles per hour is the maximum when responding to alarms. Never exceed a speed which is reasonable and safe for existing conditions, even where the law permits a speed higher than that at which you are driving. Safe prudent speeds vary with such factors as driver reaction time, brake efficiency, condition of pavement, weather and traffic conditions. Over the same stretch of roadway, speeds that are safe at certain times may be unsafe at other times.

Under all circumstances, the speed of fire department apparatus at any intersection must be reduced to a minimum consistent with safety and with due consideration for traffic conditions. Returning from any emergency call and in any other non-emergency driving, drivers should proceed in a safe and cautious manner, obeying *ALL* traffic laws.

CROSSING CONTROLLED INTERSECTIONS: Whenever a traffic control red light is against a fire department apparatus responding to an alarm, the apparatus must be STOPPED - until all drivers and pedestrians proceeding on the green light realize that the fire department vehicle is signaling for the right of way and all traffic has stopped to let the emergency vehicle proceed through the intersection safely. Upon approaching a STOP sign, the apparatus must STOP and must not proceed until all other vehicles yield the right of way. If opposing traffic does not yield to the siren, air horn and emergency lights, the right of way must not be taken arbitrarily.

WET ROADS: During damp or wet weather, all department vehicle operators should be very cautious and the vehicles should be driven at reduced speed so as to prevent the vehicle skidding. Remember, snow and wet pavement increases stopping distances.

BACKING UP: It is sometimes necessary for an engine company to back into position at fire scenes or to reach a hydrant. However, unnecessary backing, such as backing to pick up hose, should be curtailed as much as possible. If it is found necessary to back up at any time, the driver MUST be guided by another firefighter. The guide should stand at one side of the apparatus in full view of the driver and use hand signals rather than voice signals. The guide should NEVER stand behind a vehicle which is backing up. When backing a vehicle, the driver should always be on the inside of the turn. Also, when ordered to turn a vehicle, it should be done at an intersection or other open space, if possible.

STANDARD DRIVING PRACTICES: The main difference between driving a car and driving an emergency vehicle lies not so much in the construction of the vehicle as in the technique required to operate it. In driving emergency apparatus, certain professional techniques are required to properly manipulate the controls whereas the absence of these techniques might go unnoticed in automobile operation. While most fire apparatus is now equipped with automatic transmissions, it is no less important for the driver to operate the apparatus in a safe and controlled manner. He must coordinate the minimum and maximum engine speeds and revolutions and should understand their applications when selecting gears while traveling at various road speeds.

AWARENESS: Awareness is an important aid to safe driving. A good driver must be subconsciously aware of his engine revolutions, road speed and the condition of the road. If a driver has to concentrate on these items, he will never be a good driver since he will have to give so much of his attention to them that he will neglect to pay attention to the road conditions ahead.

PROPER BRAKE OPERATION: It is assumed that brakes will always slow and stop the vehicle at the driver's discretion but little attempt is made to conserve them. Most fire department vehicles are now equipped with air brakes. Others, particularly small emergency vehicles, have hydraulic brakes. The degree of brake pressure required varies from a light touch to a rather hard application. The pressure needed also varies according to the load of the vehicle - the heavier the load, the more pedal pressure is needed for the desired deceleration. In normal stopping, more pedal pressure is need as the brakes are first applied than is needed as the vehicle stops. A driver should apply considerable pressure at the start of the application, ease off as the vehicle slows, and release the brakes almost entirely at the end of the stop, then apply more pressure to hold the vehicle. This method provides a smooth stop and eliminates lurching or jerking of the apparatus which can cause injury to personnel on board.

If a steady prolonged brake pressure is applied, the brake linings will heat up, and the more they heat up, the less effective they are. On the other hand, if a continuous pumping action is used on a vehicle equipped with air brakes, it may lose it's air reserve and it's brakes.

Negotiating descending grades will necessitate the prudent intermittent use of the vehicle's brakes.

USE OF JAKE BRAKE AND ENGINE SPEED RETARDERS

On vehicles equipped with a “Jake” brake or other forms of engine brake retarders, these devises should be left in the “off” position during periods when pavement is wet or icy since there is danger that the MPO may loose control of the vehicle under these conditions. The devises may be engaged during periods of dry weather.

CHOCKS: When parking an emergency vehicle, the driver should get in the habit of using wheel chocks. When parking on a hill, wheel chocks are mandatory. When parking with the vehicle facing uphill, the back of the front wheels should be against the curb and the back of the back wheels chocked. When facing downhill, the front of the front wheels should be at against the curb and the front of the back wheels should be chocked.

CAUSES OF APPARATUS ACCIDENTS: Four principal causes of accidents involving fire department apparatus are as follows: Backing accidents, reckless driving, excessive speed and misjudgment of distances and road conditions.

HELPFUL HINTS FOR APPARATUS DRIVING

The following driving hints, if consistently applied to the actual driving situations, will not only make driving of apparatus safer but will also make it consistently easier:

REMEMBER THE WHEEL BASE: When turning a corner, the driver should know where the rear wheels will be when he is making his turn. Since most drivers are used to driving personal automobiles, they tend to forget that an emergency vehicle is much longer and has a larger wheelbase than a car. Therefore, when turning a corner, they tend to forget that the vehicle requires a wider turn on a corner than does a car.

PREPARING FOR A TURN: When a change of direction is required after a complete stop, the wheel should be turned before the stop is completed. The apparatus will then be ready to move off in the desired direction the instant motion is resumed. This applies to forward stopping before backing or to a backing stop before moving forward. Avoid turning the wheel while the apparatus is in a stationary position since it applies undue strain to the steering mechanism.

STEERING DURING BACKUP: A driver must know the length of his vehicle in relation to the rear wheels. A driver must never become so involved in maneuvering his vehicle that the “overhang” or tailboard is forgotten.

Another factor that is often overlooked in backing is that the rear wheels are leading and the front ones are following. To change the direction of travel when backing, the front end must swing to the side in order to point the rear of the vehicle towards it’s goal. When backing, therefore, be aware of any obstruction which may interfere with the swing of the front of the vehicle.

FOUR WHEEL DRIVE: Four wheel drive should only be used on soft surfaces, i. e. dirt, sand, snow, mud and wooded areas. Four wheel drive should never be used on hard surfaces since it will be ineffective and doing so may cause damage to the apparatus.

MALFUNCTIONS: If, at any time your vehicle malfunctions, immediately notify the officer in charge or the incident commander and be prepared to shut down. You should, however, wait for the order to do so, especially if you are supplying charged hose lines within a fire building.

APPARATUS POSITION: When at the scene of a fire, the position of the apparatus is the incident commander's concern. However, a general rule of thumb is never to position apparatus closer than 100' to a fire. In addition, a driver must always stay with his vehicle since it may need to be moved at any time. When pumping, a driver must always stay by the pump panel to monitor the various gauges on the pump panel to ensure that he is providing the correct amount of water and pressure. He must also monitor the issuing of equipment from the apparatus.

QUALIFICATIONS FOR DRIVING EMERGENCY APPARATUS: Before being certified as a driver of emergency apparatus of the Dix Hills Fire Department, an applicant must first fulfill all of the requirements laid down by Department rules and regulations relating to driver qualification, copies of which are attached to, and form a part of, this manual. In addition, an applicant must demonstrate his skills in the following driving evolutions: serpentine, alley dock, opposite alley pull in, diminishing clearance, straight line, turn around, lane change, stopping procedures and parking procedures.

START UP PROCEDURES

1. Disconnect landline.
2. Turn on both banks of batteries.
3. Turn on ignition switch.
4. Press “START” button.
5. When air pressure reaches at least 90 lb., place right foot on foot brake and release the air brake.
6. Check that all cabinet and compartment doors are closed and that all personnel are clear.
7. Place transmission gear into DRIVE and slowly move pumper onto outside pad.
8. Turn on MASTER emergency light switch and pumper head lights.
9. When given the order by OIC, place transmission into drive and proceed to alarm with all due caution.

MOTOR PUMP OPERATIONS

To qualify as a *Motor Pump Operator*, an individual must demonstrate his knowledge of the information contained in this section of the manual in addition to fulfilling the Department requirements relating to MPO qualifications, copies of which are attached to, and form a part of, this manual.

APPARATUS PUMPING

A centrifugal pump consists of two main components:

1. A specially constructed hollowed circular disc fitted with vanes called the IMPELLER and,
2. The CASING or VOLUTE in which the impeller rotates.

The water enters the pump through the eye of the impeller which, by it's rotation, creates a centrifugal force throwing the water to the rim of the impeller and through the volute to the discharge of the pump. The velocity of the water is gradually reduced in the volute and is converted to pressure energy.

As the impeller rotates, the water entering the eye of the impeller is thrown to the rim and is directed to the discharge opening where it leaves the pump. (The faster the impeller is rotated, the greater the amount of water delivered and the higher the pressure created within the pump capabilities).

The water from the intake side can pass to the discharge side of the pump without too much loss in pressure when the pump is not in operation. Because of this, the pump cannot create a negative pressure (vacuum) on the intake side and, therefore, is not capable of priming itself. Some auxiliary means must be provided to enable this type of pump to be primed.

When the pump is operating, the water is prevented from returning to the intake side because:

1. of the close fit between the casing and the impeller.
2. by the rapid circular movement of the impeller and,
3. by the equal pressure on the pump casing.

Another feature of the pump[is that liquid under pressure entering the pump will be passed through the pump with very little loss of pressure and be discharged from the outlet without the necessity of inserting any special valves. This intake pressure is added to the pressure developed by the pump when it is operating. In other words, a centrifugal pump will take advantage of the receiving pressure *and* pass it on.

Example: If water at 50 PSI is entering the intake side and the pump is developing 50 PSI, the discharge pressure from the pump would be 100 PSI.

Since fire department pumpers are required to supply booster lines, large size hose lines and master streams, greater variations in capacity and pressure are necessary which cannot be obtained from a single stage pump. Therefore, all fire department pumpers today have two stage centrifugal pumps. In this type, two single stage pumps, operating off the same shaft, are encased in a common housing. Each impeller has it's own volute, but they are so interconnected that, in one operational stage, the discharge from each impeller can be directed to a common discharge manifold. This is known as VOLUME, CAPACITY or PARALLEL operation. The three terms are synonymous and signify the same operation. In the other operational stage, the discharge of one impeller can be directed into the second impeller and, then, into the discharge manifold. This is known as PRESSURE or SERIES operation. These two terms signify the same operation. The

changing of the stage position is done by a TRANSFER VALVE or CHANGEOVER or STAGE VALVE.

If the operation calls for a large flow of water within a certain pressure range, the pump is operated in the VOLUME position. When a fire department pumper is supplying an attack pumper or acting in any other supply manner, the pump *must always* be in the volume mode.

♦ GAUGES

COMPOUND OR VACUUM GAUGE

This gauge is mounted on the pump operator's panel. It may be indicated as the INTAKE, SUCTION, HYDRANT or VACUUM gauge. The gauge is calibrated in such as manner as to register positive pressure (pounds per square inch - PSI - above atmospheric pressure) and negative pressure (inches of mercury or inches of vacuum below atmospheric pressure).

When a pumper is connected to a hydrant, or is being supplied in a relay operation by another pumper, this vacuum gauge which is connected to the intake side of the pump will register the positive pressure being supplied to the pump. When receiving water from a positive source, the pump operator must watch this gauge closely since any drop in pressure on this gauge could indicate that more water is trying to be pumped than is being supplied to the pump. In other words, the pump is running away from the water supply. This situation may occur at an operation where many pumpers are connected to hydrants in the area or the mains are too small to supply the amount of water needed. The intake pressure may fluctuate due to the layout of the mains, the location of other pumpers, the amount of water being pumped and other hydraulic factors.

Intake pressure should never be allowed to drop below 30 PSI. The practice of operating with less than 30 PSI can be dangerous because of the possibility of creating a vacuum (negative pressure) on the intake side of the pump. This vacuum can cause damage to the pump, hose, mains, water pipes in surrounding buildings, etc. This may also cause a loss of water in the hose lines being supplied thereby endangering firefighting personnel and permitting the extension of the fire.

PRESSURE GAUGES

These gauges are connected to the discharge side of the pump and register positive pressure only. One such gauge on the pump operator's panel will register the pressure being created by the pump. Other gauges on the panel are used as individual gate gauges and will show the pressure being delivered to each hose line.

In instances where multiple hose lines requiring different discharge pressures are being supplied from the same pumper, the individual pressure gauges are used to control the pressure being supplied to each hose line by operating the individual line gate.

The vacuum and pressure gauges on the pump panel are normally equipped with dampening valves, usually located below each gauge. Their primary purpose is to control the opening in the piping feeding the water to the gauge to prevent wide fluctuations of the needle and to give a more accurate pressure reading when operating. Once these dampening valves are set, they should be left alone.

OIL PRESSURE GAUGES

These gauges register the oil pressure being developed by the oil pump in the crankcase of the engine which is fed to the various moving parts of the engine when it is running. The MPO must monitor this gauge carefully since, if the oil pressure suddenly drops, he will have to notify the OIC that he may have to shut down the engine.

NOTE: This gauge does not show the amount of oil in the crankcase, only the amount of pressure being developed by the oil pump. If the level of oil in the crankcase is low, it will still indicate pressure as if an adequate amount of oil is in the crankcase.

ENGINE TEMPERATURE GAUGE

This gauge shows the temperature of the coolant in the engine. The temperature should never be allowed to exceed or go below that recommended by the manufacturer.

BOOSTER TANK LEVEL GAUGE

This type of gauge shows the amount of water in the booster tank. Mainly, it's mechanism is similar to that of a gasoline tank on a car. A float in the water is connected by a rod to the needle on a gauge or electronically to a set of lights on the pump panel. As the float moves up or down, the needle or lights register the amount of water left in the tank.

TACHOMETER

This gauge registers the revolutions per minute (RPMs) of the engine and requires careful monitoring while operating so that the maximum engine speed recommended by the manufacturer is not exceeded. Tachometers are usually measured in units of one, with each unit representing 100 RPMs (a gauge reading 100 would indicate 1000 RPMs).

If an increase in the RPMs does not bring an increase in the pump pressure, the pump could be running away from it's water supply and could be approaching or be in a condition called cavitation. Cavitation is the result of the pressure on a liquid falling below it's vapor pressure. Other reasons why the pump will not build up pressure when the RPMs are increased are the pump not being engaged, the relief valve set too low, the pump valve closed, a blockage in the supply line or a leak in the pump housing.

♦ TERMINOLOGY

VAPOR PRESSURE

A liquid will release vapors from it's surface. Vapors are actually the faster moving molecules that are escaping from the free surface of the liquid to the space above. The slower moving molecules fall back into the liquid. If the liquid is placed in a closed container, the escaping molecules are confined in the enclosed space. When the rate of escape of the molecules from the liquid equals the rate of return, a point of equilibrium is reached. The pressure exerted by the escaping vapor at this point is called vapor pressure, measured in PSI. This vapor pressure increases as the temperature of the liquid increases. When the vapor pressure equals atmospheric pressure (14.7 PSI at sea level), the liquid boils.

CAVITATION

When the pressure in the pump suction drops below the vapor pressure of the water being pumped, vapor bubbles and/or vapor cavities form at the suction inlet leading to the impellers. As these bubbles or cavities flow through the impellers to the high pressure side, they collapse with considerable force and water rushes in to fill the voids or cavities. This force produces a shock within the pump which can cause considerable damage.

CAUSES OF CAVITATION

1. Attempting to pump more water than is being supplied.
2. Low hydrant pressure.
3. Water supply obstructed.
4. Pumping water that is too warm or hot.
5. Attempting to draft water at too great a lift.

INDICATIONS OF CAVITATION

1. A sudden pressure or capacity loss.
2. Vibration in the pump.
3. A rattling sound (like pebbles passing through the pump).
4. An increase in the engine RPMs without a corresponding increase in output pressure.

PREVENTING CAVITATION

To avoid cavitation, advance the throttle slowly, watching the engine tachometer, intake and discharge pump pressure gauges. When increasing the engine speed (RPMs) does not bring an increase in pump pressure (PSI), throttle down until the pump pressure drops to a level that the pump operator can maintain. If the pump pressure continues to drop and approaches 30 PSI, the engine RPMs must be reduced further.

When receiving water from a pressure source (hydrant, relay pumper, etc.) the ideal intake pressure should be approximately 30 PSI. Of course, if an attack pumper is being supplied from a pumper that is attached to a hydrant that provides more than 30 PSI, the hydrant pumper should maintain hydrant pressure to avoid overriding the pump on the attack pumper.

If the intake pressure should drop below 30 PSI, one or more of the following should be done:

1. Reduce the engine RPMs.
2. If safe to do so, shut down (partially or completely) one or more of the hose lines.
3. Use any other means that will reduce the amount of water being delivered by the pump (fog nozzles, GPM settings, smaller tips, etc.).
4. Increase the water supply and/or pressure from the water source (multiple supply lines, larger diameter hose, etc.).

♦ VALVES

DISCHARGE VALVES

Individual discharge VALVES or GATES are provided in the openings of the pump for hose line connections. The majority of the valves or gates on fire department pumpers are of the ball type which is a ball with a hole through the center, mounted in a socket. As the ball is rotated in the socket, the hole lines up with the intake or discharge pipes and allows water to flow. By limiting the

area of the hole that is permitted to line up with the pipe, the amount of intake or discharge can be controlled The valves or gates are operated by levers that can be either PUSH/PULL, SWING or UP/DOWN. All valves or gates must operate freely without binding or leaking. When the valve or gate is opened and the desired amount of discharge is reached, the locking knob on the tip of the lever should be engaged to maintain the desired pressure.

Leaking discharge valves or gates which are capped can be very dangerous because of the pressure build-up behind the cap when the pump is in operation. If the cap should have to be removed, there is the possibility of the cap separating from the thread and blowing off, possibly causing injury to the person attempting to remove the cap. During freezing weather, the water behind the cap and in the valve may freeze solid, rendering the outlet useless should it be needed. Leaking valves will also permit air to enter the pump during priming operations and may prevent the pump from drafting water.

SUCTION VALVES

The distinction between discharge valves and gated suction valves is that there is a MALE thread connection on the discharge gate and a FEMALE thread connection on the intake or suction gate. The threads on the main suction connection are MALE. The small gated inlets are provided with drain valves, installed before the valve in order to permit the air in the supply hose line to be released and not permitted to enter the pump. The air entering the pump may cause a temporary loss in pressure and/or water, or difficulty may be encountered in building up pressure due to the air being trapped in the pump.

DRAIN VALVES

These valves are provided to drain the water from various parts of the pump, piping, discharge lines, transfer valves, gauges, etc. NOTE: if the relief valve on the pumper is provided with a drain valve, this valve MUST be closed before the pump will build up any pressure.

PRIMING VALVES

When activated, these valves permit the pump to draft water and to fill the pump with water after it has been drained during inclement weather, etc.

AUXILIARY VALVES

The auxiliary valve's main function is to reduce the water temperature in the engine cooling system and to prevent it's overheating. The auxiliary cooling system allows water from the discharge side of the pump to be recirculated around coils, through which the hot coolant of the engine cooling system is passed. This lowers the temperature of the engine coolant. The water from the auxiliary cooling system is returned to the intake side of the pump. No water from the pump enters the cooling system of the engine. This protects it from loss of anti-freeze or contamination if salt or polluted water is being supplied to the pump.

In most instances, it is not necessary to engage the auxiliary valve to cool the engine. With modern engines, it should, normally, only be required in very hot weather when the pump is being used for any extended period of time. However, care should be taken to monitor the engine temperature gauge closely.

DUMP VALVE

To prevent excess water pressure from entering the pump and, possibly, blowing the seals on the pump, the manufacturer installs a DUMP VALVE between the intake gate of the pumper and the pump. This valve, in most cases, may be manually preset for a particular PSI. In this department, the dump valves on the pumpers are set to operate at 125 lb.. When pressure in excess of 125 lb. is being received by the pumper, the valve opens and "dumps" the excess water onto the ground. If a hydrant pumper is pushing more than 125 lb. to the attack pumper, he is said to be "pumping through" the attack pumper and also will be wasting water since most of it will be dumped on the ground. To avoid overriding the pump on the attack pumper, a hydrant or supply pumper should provide the attack pumper with approximately 30 lb. pressure. If the hydrant provides more pressure (sometimes up to 90 lb..), the hydrant pumper should maintain the hydrant pressure and no more.

PRESSURE RELIEF VALVES

These are spring loaded pressure activated valves installed between the discharge and intake sides of the pump. They can be set to maintain a desired fixed discharge pressure on the pump. This is accomplished by means of a valve opening and bypassing the water from the discharge side of the pump back to the intake side. When multiple lines are operating off a pumper, and one or more nozzles on the lines are suddenly closed, the engine speed will increase and there will be an increase in pump pressure. This will occur if the pressure relief valve is not properly set or is turned off. This pressure may burst hose or cause personnel to lose control of the nozzle causing injuries and may also affect the efficiency of the water streams being delivered.

OPERATION:

1. Set the relief valve to approximately 200 lb.. This is accomplished by turning the control handle clockwise.
2. Water must be flowing in the hoseline(s) before setting the valve for the desired pressure. It is not necessary to set the relief valve for booster line operations.
3. If the relief valve is provided with a shutoff valve or an on and off switch, it must be on before the relief valve will operate.
4. Keeping a close watch on the discharge pressure gauge of the pump, turn the control knob of the relief valve counterclockwise until the pressure drops to the desired reading.
5. Stop and turn the control knob clockwise until the relief valve setting is 10 PSI above the required pump pressure setting. There will be a momentary drop in pressure before the setting will stabilize. Should any hoseline(s) be shut down, the pressure will increase momentarily over that for which the valve is set and then return to the set pressure.
6. If, after initially setting the relief valve, if becomes necessary to raise or lower the discharge pressure, then the relief valve must be reset each time.

NOTE: If two or more hoselines requiring different pressures are being supplied by the pumper, the relief valve should be set for the hoseline requiring the highest pressure and the hoseline requiring the lower pressure should be gated down.

PRESSURE GOVERNORS

Another method employed for regulating the pressure developed by a pump is an engine speed governor.

Governors or pressure regulators control the pressure discharge of a pump by controlling the speed of the engine through the setting of the carburetor valve. This, in turn, controls the speed of the impellers which determine the pressure developed by the pump. Most pressure control governors operate on the principle of hydraulic pressure on two sides of a piston. Through linkage, rods or cables, the piston shaft is connected to the throttle linkage of the carburetor, by which the speed of the engine is controlled.

ELECTRONIC PRESSURE GOVERNORS

Newer fire department pumpers are provided with electronic pressure governors which, essentially, operate on the same principle as the mechanical pressure governors in that they regulate the flow of water by the speed of the engine driving the pump impellers. *CAUTION: IT IS IMPORTANT TO NOTE THAT, IN THE THROTTLE MODE OF THE ELECTRONIC PRESSURE GOVERNOR, THERE IS NO PRESSURE PROTECTION*. This means that, if the MPO elects to control the pressures being provided to the hose lines by means of the throttle control mode of the governor and a hoseline suddenly shuts down, there is no protection from a sudden surge of pressure in the other lines which may be operating from the pumper. Therefore, it is recommended that the electronic pressure governor should always be operated in the PRESSURE CONTROL MODE for safety.

PUMP OPERATIONS

BOOSTER TANK OPERATIONS

Position the pumper as directed by the OIC, engage the brake. Set the Transfer Switch to PUMP and engage the transmission lever to DRIVE. When the green light comes on, watch for a momentary drop in engine revolutions as the pump engages. Exit the cab and proceed to the pump panel. After ensuring that the green light on the pump panel is lit, you may proceed to supply water in the following fashion:

Open TANK to PUMP gate and, after determining which hose line has been pulled off the pumper, open the appropriate gate feeding that hose line. Make certain that the pressure relief valve is in the PRESSURE position and engaged, advance the throttle until 175 lb. is reached on the gauge and wind the relief valve knob down until 175 lb. is reached and the relief valve engages at that point.

If using multiple lines, set the relief valve for the highest pressure required and gate down the other lines. There is no need to set the relief valve for booster operations.

All gates must be opened and closed SLOWLY. When water is no longer needed on hose lines, reduce the engine speed, close all gates and disengage the pump from the transmission. The booster tank should be filled to capacity to ensure that an adequate supply of water is available for the next operation.

HYDRANT OPERATIONS

Position the pumper as directed by the OIC and engage the brake. Set the TRANSFER SWITCH to pump and engage the transmission lever to DRIVE. When the green light comes on, watch for a momentary drop in engine revolutions as pump engages. Exit the cab and proceed to the pump panel to ensure that the green light on the panel is lit. Thereafter, you should follow the standard operating procedures for large diameter hose operations described in the following sections.

When tying in to a hydrant for any reason, care should be taken to ensure that the hydrant valve is opened completely to ensure that the drain at the bottom of the hydrant barrel closes properly thus preventing water from the hydrant from washing soil away from the hydrant base.

When operating off a hydrant, you should first ensure that the booster tank is full in preparation for the next operation when hydrant water may not be available.

It is preferable to maintain an intake pressure of at least 30 PSI to reduce the possibility of the pump running away from the water supply. At all times, the intake pressure or vacuum gauge must be watched closely for any drop in pressure which may effect the supply of water to the pump. Since compound or vacuum gauge readings may be inaccurate, especially at low pressures, the MPO should observe the supply hose line where it enters the pumper. If this line is hard and firm, the water supply is adequate. Should it become soft or spongy, the limit of water supply has been reached. Cavitation in the pump is starting to occur. The supply line may collapse momentarily causing an intermittent flow of water. Should it be evident that the pump is loosing it's water supply, the engine speed should be decreased, which in turn will reduce the water output of the pump and prevent a total loss of water. Another way to reduce water output of the pump is to partially close the discharge gates to the hose lines being supplied.

The MPO must stay close to the pump panel at all times to observe any irregularities in pump operations. He must keep a check on all gauges (discharge, intake, oil pressure, water temperature, tachometer, etc.) and be in a position to make any adjustments, if necessary.

If the shut down of lines being supplied is going to be of long duration, steps must be taken to keep the pump cool by opening a drain valve or circulating the water to the booster tank.

CAUSES FOR A PUMP PULLING A VACUUM ON A HYDRANT:

1. Mains too small and/or too long to supply amount of water needed.
2. Mains too old and corroded.
3. Obstructions in hydrant (stones, cans, etc.)
4. Strainer in intake clogged.
5. Supply hose too small.
6. Too many pumpers operating off the same main.

LARGE DIAMETER HOSE OPERATIONS

The pumper should be placed with the tailboard approximately two feet beyond the hydrant.

The 4 inch cap should be removed from the hydrant and the hydrant blown out.

The 4 inch Storz adapter should be place on the hydrant. Roll the 5" hose out flat so that there are no kinks (use two lengths of 5" hose if the hydrant is on the officer's side of the truck), attach the hose to the hydrant and await the order to charge the hydrant Attach the supply lines to the pump discharge outlets.

MPO: Place the truck in pump as outlined in the preceding section. Attach the 5" hose to the intake gate and give the order to open the hydrant. Open the intake gate by revolving the handle counterclockwise and begin pumping procedure.

If the first due pumper has already hooked into the hydrant and water is flowing, the Storz to 2 ½" adapter with the 45 degree elbow will be attached to the hydrant and the 5" hose will be attached to it. This eliminates the need for the adapter and the hydrant to be shut down. NOTE: make certain that all large diameter hose couplings are tight and the "VEES" are lined up to ensure that the hose does not blow off under pressure.

FOAM OPERATIONS

When it is necessary to use foam in firefighting operations, the following procedures should be followed. After positioning the pumper per orders of the OIC, the regular pump operation procedures should be initiated, generally with the pumper attached to a hydrant. With the pump engaged, place a 5 gallon drum of foam next to a discharge outlet of the pumper. Connect one end of the foam EDUCTOR to a 1½" outlet on the pumper. Place the rigid metal suction pipe into the drum of foam and connect the 1¾" attack line to the other end of the eductor. Dial a 3% setting on the eductor dial. Attach the foam APPLICATOR to the other end of the 1¾" hose.

Advance the throttle to provide at least 170 lb. of pressure and adjust the pressure to obtain an optimum volume of foam from the applicator. With 200' of 1¾" hose out, the optimum pressure at the pump should be approximately 180 lb..

DRAFTING OPERATIONS

While it is very seldom that it will be necessary for a modern fire department to be involved in drafting operations due to the availability of hydrants, the MPO must be knowledgeable in the practice of pump operations by drafting water. Also, in the unlikely instances that a volume of water must be drained in rescue operations, the MPO must know how to draft.

Contrary to a pumper being supplied by a pressure source of water, the theory of drafting is as follows: air pressure inside the pump housing, piping and suction hose is reduced by removing the internal air from these parts. This produces a partial vacuum in the pump which causes the atmospheric pressure (14.7 PSI at sea level) to force the water up the hard suction hose into the pump. This same principle is applied when drinking liquid through a straw.

Note that HARD suction hose must be used in drafting procedures.

PROCEDURE:

1. All hard suction sections should be made up before the pumper is moved into position.
2. Locate the pumper as close to the supply of water as possible.
3. A lift not in excess of 10 to 12 feet is preferable, although when necessary, higher lifts may be required.
4. Attach the strainer to the hard suction end which is to be submerged. This strainer must be used at all times to prevent debris from entering the pump.
5. Submerge strainer end of suction hose at least 18 inches into water. Place a weight over the end of the hose to prevent the strainer from rising. If the depth of water over the top of the strainer is insufficient, a whirlpool may form over the strainer and air may be drawn into the pump preventing the prime from being maintained.
6. Ensure that all openings on both intake and discharge side of the pump are closed and capped tightly.
7. Activate the primer for approximately 30 to 40 seconds.
8. If pump does not prime, check all openings for air leaks and reactivate the primer.
9. If the pump is priming, the indicator on the intake vacuum gauge should start to move below zero.
10. When a pressure of approximately 50 PSI is indicated on the pump discharge gauge, deactivate the primer and open a discharge gate slowly while advancing the throttle until the desired pressure is obtained. If a hose line is not in position, an outlet on the discharge side of the pump should be opened to maintain the prime. If water is not flowing for any length of time, the pump may lose it's prime due to air seepage.

CAUSES FOR FAILURE TO DRAFT:

1. Lift too high.
2. Clogged strainer.
3. Pump not in gear.
4. Primer not operated long enough to expel air from pump.
5. Opening a discharge gate too rapidly after pump is primed.
6. All openings not sealed tightly enough.
7. Suction hose not deep enough in water creating whirlpools.
8. Defective primer.

DYNAMOTE OPERATIONS

DYNAMOTE: An auxiliary source of electrical power is now provided on most pumpers to operate flood lights, power tools, etc. The Dynamote Series A Inverter is designed to provide 120 volt, 60 Hz power from the DC (rectified AC) output of a standard 12 volt alternator.

When the Inverter is on, all output from the vehicle alternator is switched away from the batteries and into the inverter. The alternator field is regulated by a voltage regulator inside the inverter. The dynamote regulator controls the alternator output at 45 volts rather than the standard 14.2 volts. The high voltage output enters the inverter transformer producing 120 volt, 60 Hz power

and, at the same time, charges the vehicle battery and services the vehicle's DC system at 14.2 volts.

The Dynamote produces 4800 watts of power at 40 amps.

OPERATION

At night, before leaving the cab, the MPO should activate the Dynamote switch and hold it until the AC voltmeter needle swings to the right. If the Dynamote unit is installed inside a cabinet, care should be taken to provide sufficient air circulation to the unit. When operating flood lights or electric tools from the unit, the engine should be throttled up to at least 1000 to 1200 RPMs. When the operation requiring the use of the Dynamote is finished, the unit should be shut down without a load on it. This means that all flood lights and power tools should be disconnected or shut off before the Dynamote is shut down.

GENERATOR OPERATIONS

Some vehicles, such as 2-8-6 and 2-8-7, have generators instead of Dynamotes. MPO's of these vehicles should be aware that the generator will not start until the plugs are pre-heated. Therefore, upon arriving and before exiting the cab, the pre-heat switch should be engaged. By the time the pugs will have been heated sufficiently to allow the generator to start.

On unit 2-8-7, care must be taken to ensure that the light mast will be clear of any wires or tree branches when raised. The MPO should trip the breakers in the cabinet to the "on" position and then should stand clear of the vehicle with the operator's control in hand and the cable uncoupled from the door. The MPO must observe the light mast as it is raised. When shutting down, the MPO should return the breakers to the "off" position before lowering the mast. The mast must be observed to seat properly into its bracket before the MPO returns the control box and cables to the door.

SHUT DOWN PROCEDURES

1. Ensure that all personnel are dismounted and that all cabinet and compartment doors are closed.
2. Sound TWO blasts on the air horn.
3. Back into station with assistance, making certain that the driver is on the INSIDE of any turns being made.
4. With right foot on foot brake, disengage transmission from DRIVE and place in park.
5. Engage the air brake.
6. Shut off MASTER emergency light switch and head lights.
7. Before shutting down engine, ensure that all gauges are operating properly and that the gas tank is at least ¾ full.
8. Press engine STOP button until engine stops.
9. Shut off ignition switch.
10. Turn off both batteries.
11. Plug in land line.