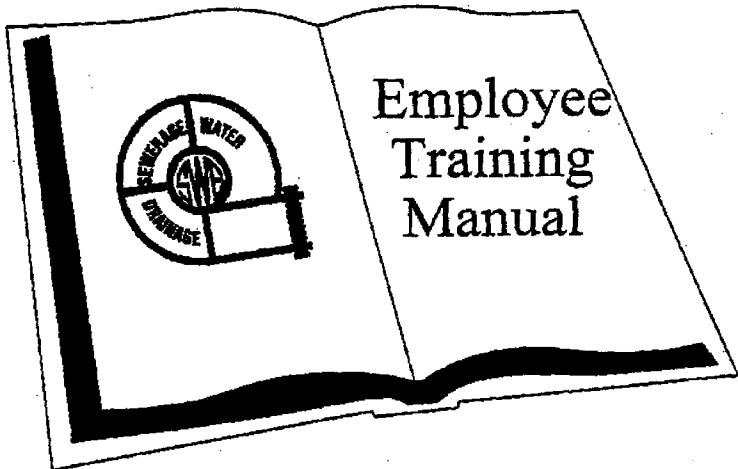


SEWERAGE AND WATER BOARD OF NEW ORLEANS



Drainage and Sewerage Pumping Operations

SEWERAGE AND WATER BOARD OF NEW ORLEANS

DEPARTMENT OF DRAINAGE AND SEWERAGE OPERATIONS

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PHASE I

(FIRST DAY)

PREFACE

This manual is designed to educate the new and existing employees in Drainage and Sewerage Operations, and to assist them in acquiring a more thorough knowledge and proficiency in analytical and applied mechanics. Employees will receive the majority of their knowledge and skills through hands-on experience and are encouraged to take field notes and participate in day to day operations activities. This manual contains technical, critical, and necessary information applicable to the job. This manual will be constantly updated and/or revised with new information as it becomes available and affects our operations.

The original manual was written by Mr. Clyde Martin back in 70's and later was modified by Mr. Charles Hartman. In this edition I would like to express my sincere thanks to all Drainage and Sewerage Operations' supervisors and assistants for their cooperation and input.

Bob Moeinian
Pumping Superintendent

April 1995

INTRODUCTION



New Orleans



A unique drainage system, with pumping stations having a combined capacity of more than 29 Billion Gallons a Day (BGD), removes rain and stormwater during frequent deluges. The city's average rainfall of 58.12 inches is exceeded by only one other metropolitan area in the country.

An intricate sewerage collection system is able to dispose of more than 130 Million Gallons per Day, and in order to minimize pollution, constant improvement is being done to the both sewage treatment plants.

New Orleans was settled by the French in 1718 on the high ground adjacent to the Mississippi River-only 14 feet above sea level. As a result of its unusual topography, the city was subject to periodic flooding from the Mississippi River and Lake Pontchartrain, as well as frequent inundation from the high intensity rainfall.

As late as 1884, illustrations in the daily newspapers showed the main business section flooded with two to three feet of water and the residents wading or rowing through the streets.

Water for drinking or general use was either collected in large cypress cisterns that stored rain water from the roof tops or taken from the river and allowed to settle in large earthenware jars. At this time, there were no purification or sterilization procedures.

Without a municipal water supply, the greater part of the city burned to the ground in 1788 and again in 1794.

A sewage collection and disposal system was also non-existent. Human waste was disposed of in the open pit privy, while household wastes found their way into open gutters. Such unsanitary conditions gave rise to typhoid fever, yellow fever, cholera, and other diseases, which decimated the population at regular intervals.

These conditions no longer exist.

Today, New Orleans is provided with water, drainage and sewerage facilities 24 hours a day, 365 days a year, where and when they are needed.

In 1869, the New Orleans Drainage Commission was organized to carry out a master

drainage plan that had been developed for the city. In 1898, the Sewerage and Water Board was authorized by the Louisiana Legislature to furnish, construct, operate, and maintain a water treatment and distribution system and a sanitary sewerage system for New Orleans. In 1902, the Drainage Commission was merged with the Sewerage and Water Board in order to consolidate drainage, water, and sewerage programs under one agency for more efficient operations. This combined organization retained the title Sewerage and Water Board, and remains as such today.

The seawall at Lake Pontchartrain was built ten (10) feet above sea level. The Metairie - Gentilly Ridge (a double ridge where a small branch mouth of the Mississippi River flowed for many prehistoric years, building up its banks to form the ridge) rises about four (4) feet above sea level. Between the two banks, the ground dips as low as five feet below sea level.

South of the ridge, the surface dips again to two feet below sea level, then rises gradually to the high natural bank of the Mississippi, about 14 feet above. On this bank, the artificial levees have been built up to 25 feet above sea level.

The area to be drained consists of approximately 58,785 acres in the developed portion of the city and 2,550 acres in adjoining Jefferson Parish. The average annual rainfall is 58.12 inches, and the heaviest recorded rain totalled 14.01 inches in 19 hours. This average annual rainfall over 61,335 acres amounts to more than 12.9 billion cubic feet of water weighing nearly 404 million tons !

Twenty (20) major drainage pumping stations on the East Bank of the river and two (2) on the West Bank have a combined capacity of 29 billion gallons per day. Stations such as DPS No. 3, 4, and 6 are considered "OUTFALL" stations since they pump directly to a waterway such as Lake Pontchartrain, and stations such as DPS 1, and 2 are considered "RELAY" stations since they relay the pumped water to another drainage station.

The unusual New Orleans topography, which made area drainage such a serious problem, also made a similar plan necessary for sewage disposal.

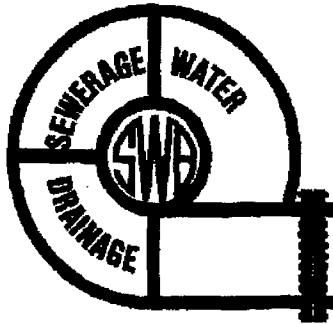
The sanitary sewerage system of the city is a gravity collection system, consisting of 2,450 miles of lateral and trunk sewers, ranging in size from 8 inches to 7 feet in diameter. Lifting and conveying the sewage by trunk sewers and sewer force mains requires 82 electrically operated pumping and lift stations, which all are automatically operated with no attendance. Pumping Stations discharge into a force main and lift stations pump to other station(s).

Sewer stations "A" and "D" on the East Bank and Station "C" on the West Bank are large attended stations. These, as well as all automatic stations, transfer the total collected sewage from the entire city to the two (2) treatment plants; one on either

side of the Mississippi River.

The present City of New Orleans, with an abundant drinking water supply, as well as sewerage and drainage systems which seem to defy gravity, continues to grow. Thanks in large part to the city leaders of the late 1800's New Orleans' development did not stop due to the severe drainage problems that existed. Instead, the challenge was met and overcome.

The Sewerage and Water Board, along with the city, continues to grow. Dedicating itself to the three public services of drainage, water, and sewerage, the Board can expect many more years of service to New Orleans.



TEAMWORK IS THE ABILITY TO WORK TOGETHER TOWARD A COMMON VISION. THE ABILITY TO DIRECT INDIVIDUAL ACCOMPLISHMENT TOWARD ORGANIZATIONAL OBJECTIVES. IT IS THE FUEL THAT ALLOWS COMMON PEOPLE TO ATTAIN UNCOMMON RESULTS.

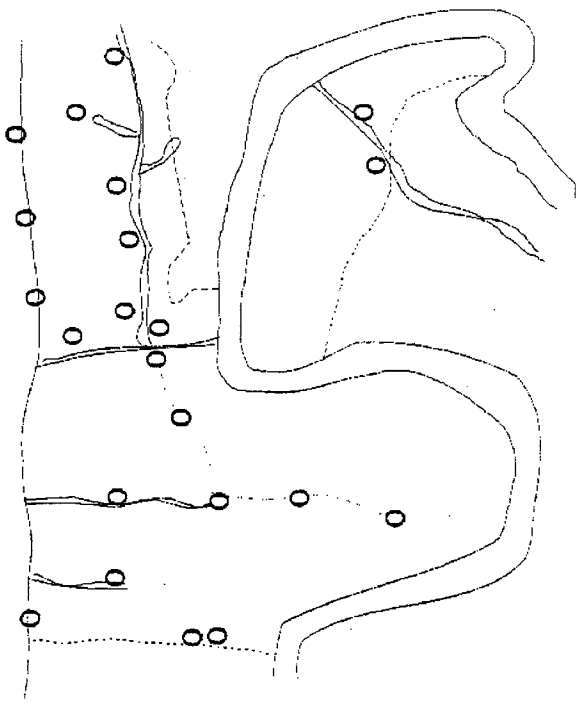
Drainage Pumping Stations:

- DPS No. 1
- DPS No. 2
- DPS No. 3
- DPS No. 4
- DPS No. 5
- DPS No. 6
- DPS No. 7
- DPS No. 10 (Citrus)
- DPS No. 11
- DPS No. 12
- DPS No. 13
- DPS No. 14 (Jainetke)
- DPS No. 15
- DPS No. 16 (St. Charles)
- DPS No. 17 (Station "D")
- DPS No. 18 (Mexent)
- DPS No. 19
- DPS No. 20 (AMID)
- Dwyer Rd. DPS
- Grant DPS
- Elane DPS
- Oleander DPS

Underpass Drainage Pumping Stations:

(Not Shown in the map)

- Canal Blvd.
- Franklin Ave.
- Hospital St.
- New Carrollton
- Old Carrollton
- Paris Ave.
- Press Dr.
- St. Bernard Ave.



Drainage Pumping Stations

SEWERAGE AND WATER BOARD MISSION

The Sewerage and Water Board was founded in 1898 to provide sewerage and water services to the citizens of New Orleans. In 1902, the Board was assigned the additional, unique, and very critical responsibility of providing drainage service to a city located six (6) feet below sea level in a very semi-tropical environment. During the ensuing 94 years, the Sewerage and Water Board has strived to meet the challenge of providing these life sustaining services. As the Board approaches its 100th anniversary in 1998, the challenge to continue striving for excellence takes on even more significance.

To meet these awesome challenges, the Sewerage and Water Board is committed to a mission of becoming the best utility in the Gulf South by 1998, our 100th anniversary. This mission or vision will help us to focus and direct our energies. Our values will guide us and give purpose and meaning to our daily work.

The Values of the Sewerage and water Board are:

Open, Honest Communication

Trust and Respect for Each Other

Offering and Encouraging Education and Opportunity to Employees

Fostering Enthusiasm Among Employees Through Example of the Managers/Supervisors

Providing Direction and Planning and Encouraging Interdepartmental Team Work

Assuring Reliability in Providing Services TO Customers

The Key Result Areas (KRA) of the Sewerage and Water Board Are:

- - Customer Satisfaction
- - Cost Effectiveness
- - Employee Satisfaction
- - Capabilities Improvement Through Training

SEWERAGE AND WATER BOARD OF NEW ORLEANS

MISSION STATEMENT

TO BE ONE OF THE BEST AND MOST RESPECTED SUPPLIERS OF SEWER, WATER, AND DRAINAGE SERVICES IN THE SOUTH-CENTRAL UNITED STATES BY PROVIDING QUALITY, RELIABLE, AND COST EFFECTIVE SERVICES TO OUR CUSTOMERS WHILE MAINTAINING FAIR AND ETHICAL TREATMENT OF OUR WELL-TRAINED AND HIGHLY MOTIVATED EMPLOYEES.

At the December 9, 1992 Board meeting, the Sewerage and Water Board adopted the Values, Key Result Areas, and the Mission Statement.

PHASES OF THE TRAINING PROGRAM

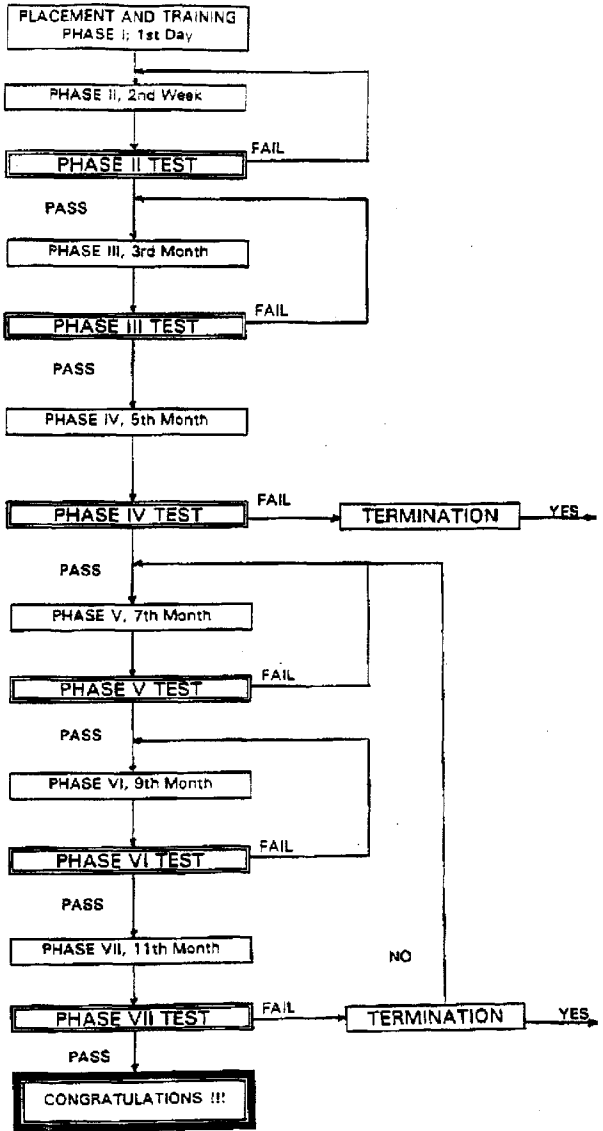
The training of a U.P.W. II for promotion to P.P.O. is divided into seven (7) different phases . The following outline shows each phase, and material the U.P.W. II should be studying during each phase.

The outline begins with the U.P.W. II's first day of employment with this department and ends when the employee has all the necessary skills and knowledge to qualify for the position of P.P.O. This outline is designed for the training of all U.P.W. II's in Drainage and Sewerage Operations.

It should be noted that this is only an outline of the skills and knowledge a U.P.W. II is expected to acquire during training. Additional material is needed to obtain detailed information on all subject matter listed in this outline. Much of the required additional material will be supplied in classrooms, and through on-the-job training, and the U.P.W. II is expected to maintain his/her own notes and recordings of this material. Blank pages are provided in this manual intentionally for that purpose.

All U.P.W. II's will be required to attend the appropriate training classes for their particular phase of training. Testing for advancement to the next phase will not be allowed until all required classes have been attended.

The illustration on next page will show the Training Outline as it was explained herein.



Phase I - 10

PHASE I OUTLINE

Phase I - First Day, First Week

- A. Report to Drainage and Sewerage Operations' Office, 2800 Peoples Ave., next to Station "D", at 7:00 AM.
 - B. Introduction to Training Officer, and Orientation program; includes brief information about the Board and the Drainage/Sewerage Operations.
 - 1. Complete "Employee Information" Form
 - 2. Complete "Civil Service Job Description" Form
 - 3. Explanation of Board and Departmental Policies and Guidelines
 - 4. Explanation of the Training Program
 - a. Training program
 - b. Testing procedure
 - c. Training schedule
 - 5. Signing of Orientation Receipt
- Note: The U.P.W. II must know the location of all policies (Board and Departmental) either at various pumping stations or office, and have all related training material at the time of orientation.
- C. Introduction to supervisors
 - D. Assignment of duties
 - 1. Assigned to shift and facility
 - 2. Shown location of facility
 - 3. Introduction to operator and other employees on duty at assigned facility
 - 4. Explanation of facility
 - a. Purpose
 - b. Duties
 - c. Major equipment

ORIENTATION PROCEDURE
Drainage And Sewerage Operations

1. **Employee Information Sheet**

All new employees must complete an employee information sheet. Information sheets should be checked for accuracy upon completion.

2. **Attendance Policy**

- A. Each employee must be informed about the Sewerage and Water Board Attendance Policy and Departmental Policy.
- B. A brief explanation of the departmental policy should be given and the proper telephone number for sick calls should also be given to the newly hired employee.
- C. Penalties for unsatisfactory attendance must be clearly explained.

3. **Dress Code:** Each employee must be informed of departmental policy regarding dress code. A brief explanation of expected dress code with regards to proper uniforms, pants, shirts, safety shoes, and hair length must be given.

4. **Overtime Policy**

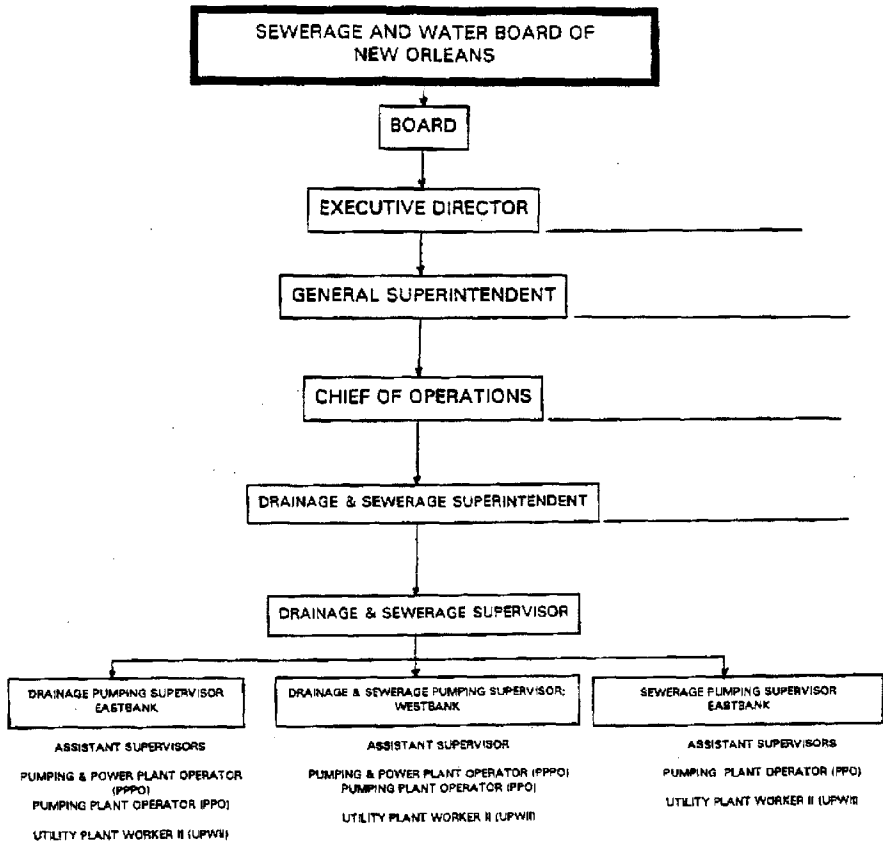
- A. A brief explanation of the Civil Service rules and Water Board policy on overtime must be explained.
- B. A brief explanation of departmental policy on overtime distribution must be given to each employee.
- C. Mandatory overtime requirements for emergency work and required shift coverage must be explained.

5. **Policy Manuals:** The policy manuals (Board's and Departmental) should be explained to each employee as well as their location and availability to the employee. Each employee should be instructed to read the manual at his/her assigned facility since they will be tested on them.

6. **Grievance Procedure:** The Board Grievance Procedure must be explained clearly to each employee and reference must be made to organization chart for a list of employee's supervisors and proper chain of command. The trainee should be given the current name of all supervisors along with their office and beeper telephone number and address. This information must be written on the

organization chart in the space provided for that purpose in this manual. It is imperative that ALL supervisors encourage the subordinates on the policy of Open, Honest, Communication; that before any grievances are filed they can discuss the matter with their supervisors and speak freely on any work related matter.

7. **Safety:** It is the Sewerage and Water Board's policy and commitment to provide safe and healthful working conditions for its employees. It is imperative that all personnel recognize the need for maximum safety. It is the responsibility of all supervisors to enforce the safety rules, set good example, and take corrective actions on safety matters at the lowest level consistent with good operating policy. Remember "YOU CAN PREVENT ACCIDENTS."
8. **Training Program (U.P.W.II Only)**
 - A. The appropriate training outline and the training flow chart must be explained to each employee. The training program must be explained with emphasis on the employee's initiative and cooperation and the fact that this is an on-the-job and hands-on training program.
 - B. The employee should be given a training schedule with the date of the Phase II test filled in.
9. **Orientation Receipt:** An orientation receipt should be signed by each employee showing that the appropriate material, as listed above, has been received and properly explained.
10. The UPW II Civil Service Job Description should be signed by each employee.
11. **Introduction To Supervisor(s):** The employee should be given an overall brief explanation of the department (Drainage OR Sewerage) they are assigned to and the type of work performed by that department. The employee should be personally introduced to all supervisors in his/her department. The employee's supervisor should assume immediate responsibility of the employee's work assignment.



SEWERAGE AND WATER BOARD OF NEW ORLEANS



Employee Information Form

Rev. January 1994

(Please use ink and print clearly; all information MUST be filled)

NAME: _____
Last name First Name MI

HOME ADDRESS: _____

CITY: _____, ZIP CODE: _____

SOCIAL SECURITY NUMBER: _____ - - HOME PHONE NUMBER: _____ -

DATE OF BIRTH: _____ CURRENT AGE: _____

DATE OF EMPLOYMENT: _____ CURRENT GROUP NUMBER: _____

CURRENT POSITION: _____ WORK TELEPHONE NUMBER: _____

EMERGENCY INFORMATION

NAME OF PERSON TO CONTACT: _____

ADDRESS OF ABOVE PERSON: _____

CITY: _____, ZIP CODE: _____

HOME TELEPHONE NUMBER: _____ - WORK TELEPHONE: _____ -

RELATIONSHIP TO EMPLOYEE: _____

ALTERNATE CONTACT (To be used in the event the person listed above cannot be contacted)

NAME OF PERSON TO CONTACT: _____

ADDRESS OF ABOVE PERSON: _____

CITY: _____, ZIP CODE: _____

HOME TELEPHONE NUMBER: _____ - WORK TELEPHONE: _____ -

RELATIONSHIP TO EMPLOYEE: _____

UTILITIES PLANT WORKER II

Class Code 3016
Rev. August 9, 1994

Civil Service Job Description

KIND OF WORK

Semiskilled work under the supervision of journeymen operators in a large utility system, including operation of equipment associated with the pumping and treatment of water and wastewater, the generation and distribution of power; and related work as required.

DISTINGUISHING FEATURES OF WORK

Employees in this class perform various semiskilled tasks in the operation of utility plant machinery. Employees entering this classification are immediately placed into a formalized on the job training program which is designed to develop the skills necessary to advance to a journeyman operator.

Each employee is supervised and trained by journeyman operators and departmental training officers. Employees are expected to steadily advance and complete each phase of training in the allotted time period by developing skills, abilities and experience needed to operate the equipment used in water purification, waste treatment, steam/power generation, pumping operation and related processes. As the employee progresses in the training program and acquires the necessary skills, duties of greater responsibility may be assigned.

EXAMPLES OF WORK (Note: These examples are intended only as illustrations of the various types of work performed in position allocated to this class.)

Performs operational maintenance duties such as: painting, lubrication, minor piping repairs, packing valves and pumps, changing fuses, etc.

Monitors and reads plant flow, pressure, vacuum and temperature gauges and adjusts such instruments as indicated.

Calculates, sets and maintains chemical feeders and feed rates from plant operating information.

Performs simple chemical tests such as turbidity, chlorine content and alkalinity. Assists in the operation of equipment such as vacuum pumps, hydraulic or electric operated gates and valves, booster pumps, trash cutter, battery charging systems. Performs housekeeping duties such as dusting, sweeping, mopping, general cleaning, grass cutting, etc.

Necessary Knowledge, Skills and Abilities (At time of appointment)

Ability to read and interpret charts and gauges.

Ability to use mechanical aptitude and knowledge with common sense in an assigned operation.

Ability to react quickly and clearly in emergency situations.

Ability to read, interpret and visualize mechanical and electrical schematic drawings.

Ability to read and comprehend written instructions and write legible and accurate reports.

DESIRABLE PREPARATION FOR WORK: Any combination of experience and training which would indicate possession of the knowledge, skills and abilities listed above. An example of an acceptable combination:

Completion of high school or GED.

Completion of trade school course for industrial operators.

Experience in a mechanical or electrical skilled trade.

Class established: 1/14/71

Specification Written: 2/2/71

Specification Revised: 3/1/91

I _____, will comply with all working rules and

(Print Name)

job descriptions as indicated above while employed with the Sewerage and Water Board of New Orleans as a Utility Plant Worker II (UPW II).

Date: _____, Signature: _____

Training Program

DEPARTMENT OF OPERATIONS DRAINAGE & SEWERAGE OPERATIONS

The following is a description of the Drainage and Sewerage Operations' training program which outlines **ALL** employees' responsibilities and the procedures to be used for training, evaluation, and testing. All employees are expected to be knowledgeable of their responsibilities contained herein. Therefore it is imperative that all employees periodically review this policy and consistently perform the assignments listed.

1- Training Duration

This training program is structured such that it will take exactly one calendar (1) year, from the very first day of employment in this department, for a UPWII to be eligible for advancement to a higher position, provided he/she would retain the material learned throughout the course of training. A newly hired UPW II **MUST** have passed, at least, Phase IV of the Training Program within the first seven (7) months, otherwise it would be reason for termination. This training program also includes a minimum of twenty (20) hours of classroom training for ALL current operators, supervisor assistants, and supervisors at two year intervals.

2- Purpose

The Training Program is designed to begin training a newly employed U.P.W.II on his/her first working day and, continue training this same individual until such time as the employee can safely and efficiently assume the duties and responsibilities of a Pumping Plant Operator (P.P.O.). This training program is also designed as a refresher course for all current PPOs, PPPOs, supervisor assistants, and supervisors.

3- Goal

To maintain highly qualified and knowledgeable employees on staff at all times.

4- Responsibilities

A. U.P.W. II

Each U.P.W. II is expected to become proficient in the operation of his/her assigned facility or route, and is expected to gain a thorough and complete working knowledge of all equipment in the facility or route. The U.P.W. II is expected to spend time during each on-duty shift in

training with his/her assigned operator. Notes should be taken for individual review, and the U.P.W. II should maintain these notes throughout the length of his/her training. Blank pages are provided in this manual for that purpose.

The U.P.W. II must also attend scheduled classroom training classes. All training classes will be scheduled by Training Officer (T.O.).

Note: Employees not properly attending these classes may not receive credit for the class. Advancement in the training program will be contingent upon the U.P.W. II's attendance at the required training classes for the appropriate phase of training. It is the responsibility of the UPW II to inform the T.O., at least one (1) week in advance, of his/her scheduled leave on the scheduled class date .

The U.P.W. II should have a clear and concise understanding of the training outline. He/she should, at all times, be aware of what he/she is expected to learn during the present phase of training, and should know the date and time of his/her next scheduled training class, next scheduled Hands-on test date, and next scheduled written test date. The training outline should be rigidly adhered to by the U.P.W. II with periodic reviews of previous phases of training.

The U.P.W. II is expected to spend time each shift, while on duty, studying and reviewing notes, schematics, and diagrams that pertain to the operation of the facility or route. During the study period the U.P.W. II should list any questions or areas which need clarification and obtain clarifications. Knowledge of the operational functions of the facility or route alone will not be sufficient to qualify the U.P.W. II for position of P.P.O. He/she must also have a working knowledge of all equipment, what each piece of equipment is used for, all required operational and maintenance features, and all trouble shooting procedures.

B. Pumping Plant Operator (P.P.O.), and Pumping and Power Plant Operator (P.P.P.O.)

The on-duty operator is the primary trainer for the assigned U.P.W. II. The operator must set aside an adequate amount of time during each shift to train the U.P.W. II. These training duties should be considered a routine work assignment that must be performed.

Each operator needs to be knowledgeable of the training outline and their assigned U.P.W. II's relative position with regards to the training outline.

The operator must insure proper training on the equipment as designated by the training outline, and skipping to advanced levels of training should not be permitted.

All P.P.O.s and P.P.P.O.s are expected to repeat the twenty (20) hours of training classes in each two (2) year interval to review material used and to keep abreast of current training methods. Attendance at the training classes must be scheduled by T.O., and failure to comply with this requirement will result in unsatisfactory evaluations and possible disqualification for future promotions.

A status list of all U.P.W. II's assigned to the facility or route must be posted on the bulletin board at each manned facility. Said list should indicate each U.P.W. II's current training phase, schematic drawings, and the next scheduled Hands-on OR written test date. The list is compiled and distributed to the facilities by the T.O..

All daily training sessions must be logged in the facility log book or logged on the daily route reports by the operator. Training log entries must be made in black ink and should begin with an asterisk (*) and the wording "Training Duties". Training log entries must be made as described above, and this requirement will be rigidly enforced.

C. Supervisor Assistants

The supervisor assistants are to insure that each operator spends the proper amount of time during each shift training the U.P.W. II. Supervisor assistants should review log entries and insure all training is in accordance with the training outline and the current training phase.

The supervisor assistant should question the U.P.W. II about the material he/she reviewed that day or the previous day during his/her training sessions with the operator. The purpose of this questioning should be to determine the U.P.W. II's retention of the information, the accuracy of the information, and the U.P.W. II's interest in learning.

Log reviews and training sessions should occur during the supervisor assistant's routine inspection of the facility or route.

The supervisor assistants must also offer any additional information needed to enhance the U.P.W. II's working knowledge and operating ability of the equipment. This information may be in the form of sketches, schematics, or books; or it may be verbal information about some piece of equipment or operational function which the operator

cannot fully explain.

D. Training Officer (T.O.)

The T.O. is responsible to schedule the UPW II's/trainee's for the proper classroom training at the earliest possible time. All training classes must be scheduled prior to the last working day of the month preceding the class. Please note that class size is limited, and early scheduling is advised to insure availability of space.

Although training classes are scheduled by the T.O., it is the trainee's responsibility to get excused from the attending class(es). It is the trainee's responsibility to contact the T.O./Supervisor, at least 24 hours in advance. Please note that only in extreme emergency situation will an excuse be granted.

The T.O. is responsible for writing and revising, as necessary, all training outlines, flow charts, training materials, and tests. All changes shall be approved by the department superintendent.

The T.O. must maintain an up to date listing of all U.P.W. IIs showing their current phase of training.

Hands-on tests, except Phase VII, will be administrated by the supervisor assistant on or about their assigned date. Any delays of more than five (5) working days must be explained, in writing, by the supervisor assistant. Said explanation must include the supervisor assistant's planned date that the Hands-on test will be completed. All Hands-on test must be completed in accordance with the training outline.

The T.O. must submit a weekly training report that shows the following:

1. The current position of all U.P.W.IIs in training.
2. The next scheduled test date for each U.P.W.II.

All training classes must be scheduled by the T.O. The T.O. must keep accurate records of those scheduled to attend these classes, and attendance roles must be given to each instructor by the Monday preceding the first class each month. Copy of the attendance roll must be submitted to the T.O. after classes are held.

Training classes will be held by T.O., and/or supervisor assistant, and/or supervisor, and/or other training instructor(s) at various facilities within the department.

E. Department Supervisor

The department supervisor should be routinely advised of the status of each U.P.W. II in the training program. He/she should question the U.P.W. IIs about equipment operation and maintenance during his/her routine visits to the facilities, and he/she should become familiar with each U.P.W. II's training and work progress.

The department supervisor may be present during all Hands-on Tests to insure the safe operation of the equipment and the safety of all employees.

The department supervisor is also responsible for overseeing the training duties. He/she must review the weekly report submitted by the T.O. for accuracy. Any delays in training must be approved by the department supervisor, and action must be taken to insure the continuous and timely performance of all training duties. In case of any conflict, in any matter, the department supervisors' and/or department superintendents' decision(s) shall be final.

5- Procedures

A. PHASE Tests

1. Phase II Test: This test will be a written test.
2. Phase III, IV, V, and VI Tests: Each test consists of two parts:
 - a. Written test
 - b. Hands-on test
3. Phase VII: This test consists of three parts:
 - a. Comprehensive written
 - b. Comprehensive hands-on (trouble shooting)
 - c. Operational safety test

B. Written Tests

Written tests will evaluate the U.P.W. II on operational, technical, and safety aspects of training. The test will be administered by the T.O. and/or supervisor assistant, and/or supervisor. All written tests require a score of 80% or higher to be considered satisfactorily completed. The appropriate hands-on test will not be administered unless the minimum passing grade in the written part is achieved. The appropriate supervisor(s) in charge of the test should review and discuss all questions answered incorrectly with the U.P.W. II regardless of his/her

score. The comprehensive written test (in Phase VII) consists of a review of materials from all previous phases. The time limit for Phase II, III, V, and VI written tests is 1/2 hour. The time limit for Phase IV written test is one (1) hour. The time limit for Phase VII written test is two (2) hours.

C. Hands-On Tests

All hands-on tests will be administered in accordance with the training outline and only if the minimum passing grade of 80% in the written portion is achieved. The hands-on Tests will consider the trainee's dependability and work performance for the appropriate training phase period. The supervisor assistant in charge will complete all hands-on test forms (excluding the Phase VII tests) as accurately as possible. The supervisor assistant completes the hands-on test forms after reviewing work and attendance records for the required period, and after the U.P.W. II has attended all training classes and has taken the written test and passed for that phase of training.

The supervisor assistant shall discuss the U.P.W. II's training with the assigned operator and he/she should review the U.P.W. II's ability to operate, troubleshoot, and perform routine maintenance duties for all equipment the U.P.W. II should be familiar with.

After completion of the hands-on test the supervisor assistant should submit the completed form to proper chain of supervisory personnel as shown on the hands-on test form for review, and comment.

The comprehensive hands-on test in Phase VII will be conducted by T.O. and supervisor assistant and/or supervisor, and consists of a review of all proper operational procedures including trouble shooting and safety precautions from all previous phases of training.

The time limit for Phase III, IV, V, and VI hands-on tests is two (2) hours each. The time limit for Phase VII hands-on test is one (1) hour. The minimum passing grade for each hands-on test, excluding Phase VII, is Competent, "C", (2.6-3.5). In Phase VII the trainee **MUST** obtain a minimum passing grade of 80% on both components of the hands-on test.

D. Schematic Drawings:

At the end of Phase V, before the UPW II will be allowed to take either the Phase V written test or the hands-on test, he/she must reproduce,

with passing grade, from memory the water system and vacuum system drawings for his/her assigned facility or a randomly selected facility for route personnel. At the end of Phase VI, before the UPW II will be allowed to take either the Phase VI written test or the hands-on test, he/she must reproduce, with passing grade, from memory the electrical system schematic for his/her assigned facility or a randomly selected facility for route personnel. The grade for all schematic drawings will be PASS or FAIL, all at discretion of the attending supervisor(s).

- E. Please note that newly hired employees (probationary) who fail the Phase II and Phase III tests must be re-tested within two (2) weeks. Re-testing of Phase II and Phase III tests are allowed only once.
- F. Operational Safety Test: During this test the safety precautions of the trainee is observed very closely. Note that during the Phase VII's Operational Safety Test, if any major unsafe procedure is observed by attending supervisor(s) the test shall be stopped immediately and it will be cause for trainee's failure on the test. A minimum passing grade of 80% is required.
- G. Test Forms: The following forms will be used to track the employee's progress during the different phases in the Training Program:

Training Hands-on Test Results

Phase No. _____ Date: _____

Trainee's Name: _____ Classification: _____

Social Security No.: _____ Payroll Group No.: _____

Div./Section: _____ Facility / Route No.: _____

Date of Employment: _____ Training Officer: _____

Div. Supv. Assistant: _____ Div. Supv.: _____

Date of Hands-on test: _____

Average Score: _____

If Average Score is:

- 4.6 - 4.7 = Outstanding
- 3.6 - 4.5 = Exceeds Requirement
- 2.6 - 3.5 = Competent
- 1.6 - 2.5 = Needs Improvement
- 1.0 - 1.5 = Unsatisfactory

CC: Trainee, Operator, Assistant Supervisor, Supervisor, T.O.,
Department Supervisor
Trainee's File

NOTE: The trainee may discuss the results of the Hands-on Test with supervisor(s) if he/she does not agree with them.

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Trainee's Name: _____ PHASE No.: _____ Date: _____

TRAINEE'S HANDS-ON TEST FORM

(Comments must be made for any ratings other than "Competent")

Dependability

1. Sick Leave Usage:

Outstanding	<input type="checkbox"/>	No occasions of leave usage
Exceeds Requirements	<input type="checkbox"/>	No more than one (1) occasion
Competent	<input type="checkbox"/>	No more than two (2) occasions
Needs Improvement	<input type="checkbox"/>	Three (3) or more occasions
Unsatisfactory	<input type="checkbox"/>	More than three (3) occasions

2. Unexcused Absences:

Exceeds Requirements	<input type="checkbox"/>	No excused absences
Competent	<input type="checkbox"/>	One (1) unexcused absence
Needs Improvement	<input type="checkbox"/>	Two (2) unexcused absences
Unsatisfactory	<input type="checkbox"/>	Three (3) or more unexcused absences

3. Attendance Discipline:

Competent	<input type="checkbox"/>	No verbal or written reprimands
Needs Improvement	<input type="checkbox"/>	A verbal reprimand only
Unsatisfactory	<input type="checkbox"/>	More than one reprimand

4. Any Other Discipline:

Competent	<input type="checkbox"/>	No warnings or written reprimands
Needs Improvement	<input type="checkbox"/>	No more than one (1) warning or reprimand
Unsatisfactory	<input type="checkbox"/>	More than one (1) warning and/or reprimand and/or suspension

Cooperation

Overall Training Attitude:

Outstanding	<input type="checkbox"/>
Exceeds Requirements	<input type="checkbox"/>
Competent	<input type="checkbox"/>
Needs Improvement	<input type="checkbox"/>
Unsatisfactory	<input type="checkbox"/>

Comments _____

Trainee's Name: _____ PHASE No.: _____ Date: _____

Quality of Work

Starts and Completes Work Assignment Timely:

Outstanding	<input type="checkbox"/>	Comments _____
Exceeds Requirements	<input type="checkbox"/>	_____
Competent	<input type="checkbox"/>	_____
Needs Improvement	<input type="checkbox"/>	_____
Unsatisfactory	<input type="checkbox"/>	_____

Safety

Follows Safety Procedures and Policies When Performing Work:

Outstanding	<input type="checkbox"/>	Comments _____
Exceeds Requirements	<input type="checkbox"/>	_____
Competent	<input type="checkbox"/>	_____
Needs Improvement	<input type="checkbox"/>	_____
Unsatisfactory	<input type="checkbox"/>	_____

Volume of Work

Work Performance Under Normal Conditions:

Outstanding	<input type="checkbox"/>	Comments _____
Exceeds Requirements	<input type="checkbox"/>	_____
Competent	<input type="checkbox"/>	_____
Needs Improvement	<input type="checkbox"/>	_____
Unsatisfactory	<input type="checkbox"/>	_____

Job Knowledge

Emergency Work Performance:

Outstanding	<input type="checkbox"/>	Comments _____
Exceeds Requirements	<input type="checkbox"/>	_____
Competent	<input type="checkbox"/>	_____
Needs Improvement	<input type="checkbox"/>	_____
Unsatisfactory	<input type="checkbox"/>	_____

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Trainee's Name: _____ PHASE No.: _____ Date: _____

Use of Equipment and Material

Checks Station/Reports Problems:

Outstanding	<input type="checkbox"/>	Comments: _____
Exceeds Requirements	<input type="checkbox"/>	_____
Competent	<input type="checkbox"/>	_____
Needs improvement	<input type="checkbox"/>	_____
Unsatisfactory	<input type="checkbox"/>	_____

Training Progress

Understanding of Mechanical Operation of Assigned Equipment:

Outstanding	<input type="checkbox"/>	Comments: _____
Exceeds Requirements	<input type="checkbox"/>	_____
Competent	<input type="checkbox"/>	_____
Needs Improvement	<input type="checkbox"/>	_____
Unsatisfactory	<input type="checkbox"/>	_____

Understanding of Mechanical Maintenance of Assigned Equipment:

Outstanding	<input type="checkbox"/>	Comments: _____
Exceeds Requirements	<input type="checkbox"/>	_____
Competent	<input type="checkbox"/>	_____
Needs Improvement	<input type="checkbox"/>	_____
Unsatisfactory	<input type="checkbox"/>	_____

Understanding of Electrical Operation of Assigned Equipment:

Outstanding	<input type="checkbox"/>	Comments: _____
Exceeds Requirements	<input type="checkbox"/>	_____
Competent	<input type="checkbox"/>	_____
Needs Improvement	<input type="checkbox"/>	_____
Unsatisfactory	<input type="checkbox"/>	_____

Understanding of Electrical Maintenance of Assigned Equipment:

Outstanding	<input type="checkbox"/>	Comments: _____
Exceeds Requirements	<input type="checkbox"/>	_____
Competent	<input type="checkbox"/>	_____
Needs Improvement	<input type="checkbox"/>	_____
Unsatisfactory	<input type="checkbox"/>	_____

Trainee's Name: _____ PHASE No.: _____ Date: _____

Understanding of Hydraulic and Pneumatic Systems:

Outstanding	<input type="checkbox"/>	Comments: _____
Exceeds Requirements	<input type="checkbox"/>	_____
Competent	<input type="checkbox"/>	_____
Needs Improvement	<input type="checkbox"/>	_____
Unsatisfactory	<input type="checkbox"/>	_____

Number of "Outstanding": _____ X 5 = _____

Number of "Exceed Requirements": _____ X 4 = _____

Number of "Competent": _____ X 3 = _____

Number of "Needs Improvement": _____ X 2 = _____

Number of "Unsatisfactory": _____ X 1 = _____

TOTAL _____

Score: _____ / _____ = _____ *

* Number must be rounded off to nearest tenth

If Average Score is:

- 4.6 - 4.7 = Outstanding
- 3.6 - 4.5 = Exceeds Requirement
- 2.6 - 3.5 = Competent
- 1.6 - 2.5 = Needs Improvement
- 1.0 - 1.5 = Unsatisfactory

Operator's Comment: _____

Signature: _____ Date: _____

Trainee's Name: _____ PHASE No.: _____ Date: _____

Supervisor Assistant Comment: _____

Signature: _____ Date: _____

Trainee's Comment: _____

Signature: _____ Date: _____

Supervisor Comment: _____

Signature: _____ Date: _____

Department Supervisor Comment (If Needed): _____

Signature: _____ Date: _____

(Attached additional sheets if needed)

**DEPARTMENT OF DRAINAGE AND SEWERAGE OPERATIONS
U.P.W.II TRAINING SCHEDULE**

NAME: _____ SUPERVISOR: _____

SSN: _____ TRAINING OFFICER: _____

GROUP No.: _____ T.O.'s Phone No.: _____

DATE OF EMPLOYMENT: _____ ASSIGNED FACILITY/ROUTE: _____

All scheduled dates should be based on the U.P.W.II's original date of employment and accordance with our training outline. Every effort should be made to maintain the schedule as close as possible to the dates listed below:

EVENT	EARLIEST POSSIBLE DATE	DATE GIVEN	RESULTS
PHASE I (1st day) ORIENTATION			
PHASE II (1st two weeks)			
PHASE II Test			
PHASE III (3rd month) CLASSES: Basic Electricity I			
Operational Safety			
Battery Maintenance			
Policies & Procedures			
PHASE III Written TEST			
PHASE III Hands-on TEST			
PHASE IV (5th month) CLASSES: Basic Electricity II			
Motors/Generators			
Pump Packing			
Bearing Maintenance & Lubrication			
PHASE IV Written TEST			
PHASE IV Hands-on TEST			

EVENT	EARLIEST POSSIBLE DATE	DATE GIVEN	RESULTS
PHASE V (7th month) CLASSES:			
Recorder Systems Automation			
Suction Lift, Elevation			
Water and Vacuum Systems			
Water Schematic Drawing			
Vacuum Schematic Drawing			
PHASE V Written TEST			
PHASE V Hands-on TEST			
PHASE VI (9th month) CLASSES:			
Record Keeping			
Pump Classifications			
Valve Classifications, Maintenance			
Electrical Systems			
Electrical Schematic Drawing			
PHASE VI Written TEST			
PHASE VI Hands-on TEST			
PHASE VII (11th month)			
Written TEST			
Hands-on TEST			
Operational Safety Test			

* * * END OF PHASE I * * *

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PHASE II

(FIRST TWO WEEKS)

PHASE II OUTLINE

The following duties are required to be performed by Utility Plant Worker II in this phase of the Training Program:

- A. General Housekeeping Duties:
 - 1. Grass cutting and yard maintenance of facility - See Paragraph "C" below
 - 2. Cleaning of pumps, motors, generators, etc.
 - 3. Cleaning of sump pits in general
 - 4. Cleaning of wet wells
 - 5. Cleaning of pipes, valves, and floors
 - 6. Upkeep of building interior
 - 7. Upkeep of building exterior
 - 8. Cleaning and maintaining the air conditioning unit(s)

- B. Location of each facility as applicable to assignment

- C. Upkeep of lawn maintenance equipment
 - 1. Proper mixing of oil and gasoline
 - 2. Checking of oil
 - 3. Changing of oil
 - 4. Cleaning of equipment, included but not limited to lawn mower, sprayer, etc.
 - 5. Replacement of weed eater line

This phase of training is all hands-on work, and the instructions will be given to UPWIs by their assigned operator. Individuals are encouraged to pay attention to the work description and its requirement, and use the blank pages provided at the end of this section for taking field notes.

SAFETY PRECAUTIONS

FIRST AID KIT: A suitably equipped first aid kit shall be on hand and immediately available for use when an accident occurs. Familiarize yourself with the location and proper use of the first aid kit at your assigned facility.

FIRE FIGHTING: Everyone must know what to do in case of a fire. If proper action is taken quickly, fires are less likely to cause damage and injury. Fire extinguishers are located strategically in all of our facilities. Take time to familiarize yourself with the location of them and how to use them in case of an emergency.

Electrical Safety

All employees are encouraged to use common sense when working around electrical equipment and/or any other type of machinery. If you are not sure of the danger ahead please ask the station operator. DO NOT RISK YOUR LIFE!!!



CAUTION: To reduce the risk of electric shock, do not touch any equipment without proper approval.

THROUGHOUT THE FACILITIES YOU WILL COME ACROSS SAFETY GRAPHICAL SIGNS. IF YOU ARE NOT SURE WHAT THEY MEAN ASK THE STATION OPERATOR.



REMEMBER



Electricity, enough to kill, will flow through any metal or other conducting material that touches energized equipment. Sometimes it will flow through wood.

The hazard is such that no person should ever let any object contact ENERGIZED electric equipment except trained personnel using tools and equipment specially made for this purpose, properly maintained, tested and/or inspected.

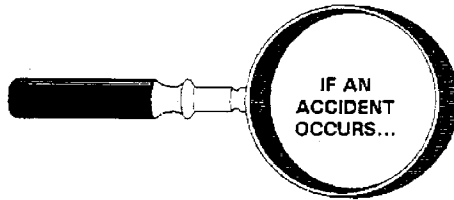
When machinery, equipment or material touches electric equipment, all metal parts become electrified and are dangerous.

USE COMMON SENSE

* * * WHAT TO DO IN AN EMERGENCY * * *

If an accident occurs take the following steps at once:

1. Keep everyone else away from equipment.
2. Caution the personnel involved with the accident not to leave the equipment, if possible, till the proper authority is contacted.
3. Call the emergency number, 911, and inform appropriate supervisory personnel. Keep everyone away from the equipment.



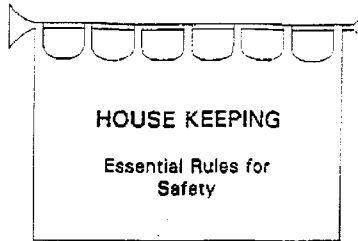
As much as we'd like to eliminate accidents on the job, sometimes they do occur. When an on-the-job accident happens, certain procedures must be followed.

Each state or parish has unique regulations regarding worker's compensation. However, regardless of the state or parish, all worker's compensation insurance programs (covering all employees) have some features in common. Workers injured on the job who pass a substance abuse screening test are fully covered for medical costs. In addition, they are compensated for a portion of their wages lost while recuperating. Coverage also is provided for permanent disability and death. Your supervisor or your personnel department should be able to explain the provisions of the laws in your area.

If an accident occurs, contact the proper facility/route supervisor so that the required substance abuse screening can be performed prior to any medical treatment unless the injury is life threatening. After the victim is provided for, take action to protect utility property. For example, if an auto accident occurs, after the victims are taken care of, make sure the vehicle is protected from further damage, vandalism or theft.

All workers' compensation regulations require that accidents be reported promptly to an employer. This enables the essential paperwork to be processed quickly. **Here at Sewerage and Water Board, failure to promptly report an accident may be cause for severe disciplinary actions.**

For more information about Board's policy on Workers' Compensation program see Policy No. 11 in Board's Policy Manual. (See also Phase III)



Good housekeeping is an essential part of your work place. Many times each day we find ourselves faced with trip, slip, or fall hazards related to poor housekeeping. Good housekeeping is not only a safety issue; but it is also an efficiency issue. Simply stated, a clean, uncluttered work space will help prevent accidents.

Everyone, regardless of job title or classification, is responsible for keeping his or her work area clean and uncluttered. It usually takes only seconds to replace tools in their regular storage place after a task is done. It takes much longer to replace a day's worth of tools at the end of the day. Replacing tools immediately after use increases efficiency. Have you ever spent time looking for a tool that was laying in a pile of tools ?

People feel more productive in a clean work place. A clean work place looks and feels inviting. But remember, good housekeeping is a team effort. Don't walk by a hazardous mess simply because you did not put it there. Take a moment and clean it up.

Although you may have a habit of cleaning your area periodically, it is a good idea to have a daily and weekly cleanup session. Some additional housekeeping can always be accomplished at the end of the day and end of the week.

Good housekeeping is an important component of every safety program.

The employees are required to be thoroughly familiar with the following departmental policies and procedures since they will be tested on them:

ATTENDANCE

It is your responsibility to learn and follow the established Board's and Department's attendance policy. As an employee, you are expected to come to work regularly and on time on your scheduled days of work. Whether you are assigned to shift work, or straight day work, your attendance is important to this department, as we have a limited number of employee positions.

If you are a shift worker, you know your watch schedules well in advance. The personnel that you relieve depend on you to arrive at work on time. When you are late, or absent, it becomes necessary to schedule someone else to work in your place. Often this is an inconvenience to your fellow workers. Chronic tardiness or absenteeism will result in disciplinary action(s).

Employees assigned to day work also have an obligation to be on time, as the scheduling of personnel on routes is dependent upon the employees that are present on any given day. Your absence places a burden on your fellow workers who must carry out your work during your absence.

Tardiness costs you a lot more than the actual amount of time that you are tardy. When you are docked time for being tardy, you are placed in a "no-pay" status for that amount of time. If you do not have a full eighty (80) hours of paid time during a two week pay period, you do not earn annual or sick leave for that period. Consequently, being ten (10) minutes late costs you 8 hours of leave in addition to the lost pay for the time involved !

Chronic tardiness will result in disciplinary action as dictated by Sewerage and Water Board policy, which includes suspension with no pay and eventually dismissal from the Board. Please be advised that a poor attendance record while in probationary status may be cause for your dismissal prior to the end of your probationary period.

The Operation's departmental attendance policy follows on the next few pages. Should you have any questions concerning the attendance policy, you are encouraged to speak to supervisory personnel to get the proper answers.

ATTENDANCE REPORTING PROCEDURES

Department of Drainage and Sewerage Operations

This procedure is established as instructed by the Executive Director in the Board's Attendance Policy which became effective July 15, 1985. All rules and regulations established herein are aligned with the Executive Director's policy and with the Civil Service Rules.

I) Sick Leave

- A) Any employee who is unable to report for work must notify this department of his/her inability to report on a daily basis.

Reporting must be done as follows:

1st Day Of Sick Leave Usage

Shifts scheduled to begin between midnight and 8:00 AM must report no later than one (1) hour prior to their scheduled start of shift.

Shifts scheduled to begin between 8:00 AM and midnight must report no later than two (2) hours prior to their scheduled start of shift.

Non-shift employees must report no later than one (1) hour prior to their scheduled start of work.

2nd And All Continuing Days Of Sick Leave Usage

All shift workers must report no later than eight (8) hours prior to the start of their assigned shift.

All non-shift employees must report no later than one (1) hour prior to their scheduled start of work each day.

Returning To Work From Sick Leave

All shift workers must report their intent to return to work no later than eight (8) hours prior to the start of their assigned shift.

All non-shift employees must report their intent to return to work no later than one (1) hour prior to their scheduled start of work.

If you are out sick the day before a scheduled annual leave day, you

must follow the returning from sick leave procedure, as sick leave takes precedence over annual leave.

Note: Any reporting calls received after the time specified above will result in the employee being considered to have not called and disciplinary action will be taken in accordance with the Executive Director's attendance policy.

- B) All sick leave calls will be received at the following locations:

Drainage Operations East Bank

Notify the on duty operator, not the U.P.W.U., at D.P.S. No. 1 (865-0580). The operator at D.P.S. No. 1 will record the employee's name, address, telephone number, and nature of illness in accordance with our sick leave reports. The operator will then notify the appropriate supervisor, assistant. All Sick leave calls received from shift employees will be referred to the appropriate supervisor assistant. All calls received from shift employees after normal working hours shall be immediately referred to the on-call supervisor assistant. All calls received from non-shift employees will be referred to the appropriate supervisor. If unable to contact D.P.S. No. 1, contact any other drainage station and request them to relay the message via radio.

Sewerage Operations East Bank

Notify the on duty operator, not the U.P.W.U., at S.P.S. "A" (585-2420). The operator at S.P.S. "A" will follow the procedure stated above for the operator at D.P.S. No. 1. If unable to contact S.P.S. "A", contact any drainage station and request them to relay the message to S.P.S. "A" via radio.

Drainage And Sewerage Operations West Bank

Notify the on duty operator at D.P.S. No. 13 (585-2415). The operator at D.P.S. No. 13 will follow the procedure stated above for the operator at D.P.S. No. 1. If unable to contact D.P.S. No. 13, contact any other drainage station and request them to relay the message to D.P.S. No. 13 via radio.

- C) The individual that is authorized to accept sick leave reports as established above must fill out one of our "Sewerage And Water Board Absence Reports" for each call received. These reports must be completed accurately and legibly as the information contained in these

reports will be used to verify the employee's illness.

The original "white copy" of all Sewerage And Water Board Absence Reports" must be submitted to the appropriate supervisor no later than the next working day following the employee's initial report.

The carbon "yellow copy" of all "Sewerage And Water Board Absence Reports" must be submitted to the appropriate supervisor no later than the next working day following the employee's return from sick leave. Any doctor's statements submitted by the employee should be given to the appropriate supervisor assistant. The employee submitting the doctor's report is responsible for the proper and timely submittal of these reports to the supervisor assistant.

II) Annual Leave

- A) All requests for one (1) day or a fraction of a day of annual leave must be submitted in writing to the appropriate supervisor no less than twenty four (24) hours prior to the time requested for leave.
- B) All request for more than one (1) day of annual leave must be submitted in writing to the appropriate supervisor no less than five (5) working days prior to the time requested for leave.
- C) Any annual leave requested for emergency purposes must be verbally approved by the appropriate supervisor. Annual leave granted for emergencies must be noted as such on the employee's time sheet by the supervisor granting said leave.

Note: Any request submitted past the specified time will result in automatic denial of the request. Due to the importance of the our jobs in Operations Department the number of employees granted annual leave per facility and/or route, per watch, will be at the discretion of the supervisor.

III) Funeral Leave

In the event it becomes necessary for an employee to take funeral leave for the death of a family member as specified in the Executive Director's attendance policy, the employee must contact his/her supervisor prior to the start of his/her leave usage. The supervisor must be informed of the exact dates leave is requested and the date the employee plans to return to work.

The supervisor may require the employee to produce documentation to verify

the relationship of the employee and the date of death. Said documentation must be submitted to the supervisor upon employee's return to work.

IV) Leave Of Absence

Any leave of absence, for any reason must be submitted to the supervisor in writing prior to the start of the requested leave, and will not be approved until approval has been granted through the chain of command (by the Executive Director and/or General Superintendent) depending on the reason for the leave.

V) Civil Leave

In the event it becomes necessary for an employee to take civil leave as specified in the Executive Director's attendance policy, the employee must contact his/her supervisor immediately upon receipt of a subpoena, notice of examination, or other notice to report.

The supervisor must require the employee to produce documentation of his/her appearance on the times and dates leave is granted. Said documentation must be submitted to the supervisor with the employee's time sheet.

VI) Military Leave

- A) Any employee requiring military leave for weekend drills, e.g. shift workers, must produce a schedule signed by his C.O. giving the supervisor six (6) months advance notice prior to the use of military leave.
- B) Employees requesting military leave for two (2) week active duty assignments, e.g. summer camp, must make these requests in accordance with our annual leave section of this procedure. In addition to the annual leave requirements, the supervisor must require the employee to produce a copy of his/her orders placing him/her on active duty. A copy of these orders must be submitted to the supervisor as soon as possible.

VII) Employees Injured On The Job

- A) Employees injured on the job that require absence from work must report their absence to their supervisor following the procedures outlined for sick leave. This reporting is in addition to any reporting requirements to our Claims Department and/or Doctor's office. Daily reporting may be waived by the supervisor if proper medical documentation is supplied and the absence will be prolonged. Employees failing to follow the sick leave

reporting procedures will be subject to disciplinary action in accordance with the sick leave provisions of this policy and the Executive Director's Attendance Policy.

- B) All on the job injuries must be reported in accordance with Sewerage And Water Board Policy Nos. 11 and 61 and a written accident report must be submitted to the department head within one (1) working day of the accident. Failure to follow the proper procedures may be cause for severe disciplinary actions.
- C) Employees, who are absent from work due to an on the job injury, will not be allowed to return to work until they have obtained a "Return to Work" clearance form from Board's Risk Management Department. Said form must be submitted to the employee's supervisor prior to the employee being allowed to work. If said form is not produced upon return to work, the employee may be shown as no pay (unauthorized leave) for the time missed while obtaining the required form and in such case will be subject to disciplinary action in accordance with the Executive Director's attendance policy.

VIII) Employees Reporting Late For Work

All employees reporting for work after their scheduled start time will be shown leave without pay for the time missed and will be subject to disciplinary action in accordance with the Executive Director's Attendance Policy.

If the employee reports within thirty (30) minutes after the scheduled start of his/her shift, he/she will be allowed to work the remainder of his/her shift and will receive no pay for the time missed.

If the employee reports after thirty (30) minutes past his/her scheduled start of shift, he/she will not be allowed to work the remainder of his/her shift and will receive no pay for the entire shift. However, the disciplinary action will reflect the employee's tardiness, the time he/she reported, and the fact that he/she was not allowed to work.

DRESS CODE

Drainage And Sewerage Operations

This procedure is intended to advise all employees of their responsibility with regards to proper dress and uniform to provide safe working conditions.

- 1) Every employee must wear their proper uniform at all times. No undershirts, tank tops, or shorts can be substituted for the uniform.
- 2) Every employee must have their shirt tucked in their pants at all times, unless the shirt is snug fitting around the waist.
- 3) No one is allowed to wear short pants. Pants must be uniform pants, long enough to reach the ankles. No baggy pants or skirts that can get caught in machinery will be allowed.
- 4) Board provided safety shoes must be worn at all times, and must cover the foot completely. No one will be allowed to wear sandals, clogs, thongs, or similar type footwear at any time.
- 5) Hair exceeding collar length must be tied up, or covered with a hat or cap so that it cannot get caught in machinery.
- 6) Rags and other loose articles should never be carried in the pockets or tied around the waist or belt loops, as this is a safety hazard.
- 7) Employees issued uniforms and/or safety shoes are required to wear them while on duty.

SCHEDULED WORK TIMES

This procedure is established in accordance with the June 22, 1982 memo from the General Superintendent and is intended to advise all employees of their responsibilities with regards to their scheduled times of work.

All employees are expected to be on the job ready to work at the times specified herein. Any tardiness and/or failure to report at the specified times will be subject to loss of pay and disciplinary action in accordance with the Sewerage And Water Board's attendance policy.

1. All Non-Shift Employees

All non-shift employees are expected to work from 7:00 AM to 3:30 PM Monday through Friday, except for official holidays as designated by the Sewerage And Water Board. Lunch time is scheduled from 11:45 AM to 12:30 PM. Any deviation from the scheduled lunch period must be approved by the employee's supervisor who will arrange a comparable lunch period.

The department head may, when deemed to be in the best interest of the overall operation and the Board, grant permission for certain non-shift employees to work other schedules. However, the schedules must comply with the time frame shown above, e.g. 8.5 hours per day with 0.75 hours scheduled for lunch.

2. All Shift Employees

All shift employees are expected to work a six (6) days on, two (2) days off rotating shift of eight (8) hours per day. All employees are expected to report prior to the start of their shift and are expected to be prepared to accept the shift responsibilities at the scheduled start time. Scheduled shift start times are as follows:

11:00 PM to 7:00 AM
7:00 AM to 3:00 PM
3:00 PM to 11:00 PM

Relief one half (1/2) hour prior to the scheduled start time will be allowed without specific permission; however, relief prior to the one half (1/2) hour limit will not be allowed without permission from the supervisor.

All shift workers work eight (8) hours per shift. No specific lunch/dinner time

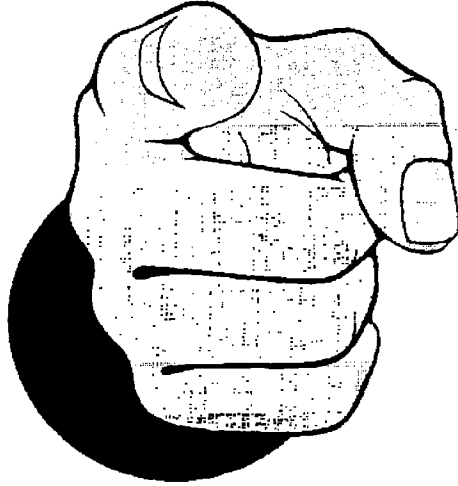
is scheduled for shift employees; however, a reasonable lunch/dinner period is allowed, when possible, during the shift. Shift workers will not be allowed to leave their assigned facilities while on duty for any reason, including to buy food unless permission has been obtained from a supervisor or supervisor assistant.

All shift employees are expected to be on work site at all times during their shift and permission must be obtained from their department supervisor assistant/supervisor to leave their assigned facility at any time and for any reason during their shift. If it becomes necessary for a shift employee to leave his/her assigned facility due to illness or other emergencies, the on duty operator must contact the appropriate supervisor assistant/supervisor. The supervisor assistant/supervisor will determine when the employee can leave the facility, and he/she may require the employee to remain on site until a relief employee arrives. Under no circumstances, unless the employee is gravely ill and must be rushed to a medical facility, will an employee be allowed to leave his/her assigned facility without permission from his/her supervisor assistant/supervisor.

All shift employees are expected to work their assigned shift and permission must be granted by the department supervisor assistant to change their shift schedule (e.g. swap watches). Request for permission to change shift schedules must be made in writing stating the reasons for such request. Permission to change days will not be granted under any circumstances.

* * * END OF PHASE II * * *

YOU



***CAN PREVENT
ACCIDENTS***

Phase II - 15

NOTE

Phase II - 16

NOTE

Phase II - 17

NOTE

Phase II - 18

PHASE III

(THIRD MONTH)

PHASE III OUTLINE

The following duties are required to be performed by Utility Plant Worker II in this phase of the Training Program:

A. Lubrication of the following equipment as follows:

1. Pumps
2. Motors
3. Generators
4. Sump pumps
5. Valves
6. Vacuum pumps
7. Air compressors (if applicable)
8. Mechanical floats
9. Ventilators and blowers
10. Types of oils and greases
11. Frequency of checks
12. Proper method of checks
13. Adding of oil or grease
14. Changing of oil
15. Clean up after lubrication

B. Proper disposal of all oil-based waste products

C. Performance of all housekeeping duties unsupervised

D. Operation of auxiliary equipment

1. Trashcutters
2. Booster pumps
3. Hydraulic-operated gates
4. Motor-operated gates
5. Screen cleaners

E. General routine maintenance of facility

1. Replacement of light bulbs
2. Replacement of protective guards and/or glass
3. Painting of equipment and/or building
 - a. Proper cleaning and surface preparation for painting
 - b. Priming of all metallic, wood, and masonry surfaces for painting
 - c. Color coding of equipment and piping

F. Operational Safety

1. Signing out equipment for repair or maintenance
2. Testing equipment for safety and proper operation

3. Use of safety equipment
 4. Reporting of accidents
- G. Battery Maintenance
1. Charging equipment
 2. Hydrometer checks
 3. Cleaning
 4. Refilling
 5. Purpose
- H. Basic Electricity I (Direct Current)
- I. Policies and Procedures: The following policies will be emphasized thru classroom training; however, individuals are required to become familiarize themselves with all policies, both departmental and Board wide:
1. Departmental Policy I (Attendance)
 2. Departmental Policy IV (Training)
 3. Departmental Policy III P (Reporting of Accidents)
 4. Attendance Policy (Board Policy No.20)
 5. Carrying Weapons on Sewerage and Water Board Property (Board Policy No. 29)
 6. Substance and Alcohol Abuse Policy (Board Policy No. 67)
 7. Work Place Search Policy (Board Policy No. 80)
 8. Workers' Compensation (Board Policy No. 11)
 9. Grievance procedure (Board Policy No. 26)
 10. Safety (Board Policy No. 77)

Training Classes: The following classes will be held 2nd Tuesday every month for this phase of training as scheduled below:

Basic Electricity I (DC)	7:00 - 9:00
Operational Safety	9:00 - 11:00
Battery Maintenance	11:00 - 1:00
Policies and Procedures	1:00 - 3:00

Please note that certain topics in this section of the manual are indicated by symbol which means those topics are intended specialty for Sewerage Operations personnel.



BASIC ELECTRICITY I

An understanding of electrical fundamentals will enable you to do basic repair and maintenance work yourself. Many people shy away from electrical work, usually due to ignorance of basic electrical principles. Once the ignorance is replaced with knowledge, electrical maintenance and repair becomes easy, and safe.

Whatever the job you are to perform, you will do it better if you have prepared yourself with a fundamental knowledge of electricity. When you know how an electric current flows, the wiring of a light fixture becomes logical and meaningful. When you understand why a fixture is "grounded" (having a direct connection to the earth), some of the safety rules that apply to all electrical work will become obvious. And you will find a fund of directly useful information once you learn the meanings of a small group of terms: amperes (amps), volts, resistance, watts and cycles.

What is "Electricity"?

In one sense, electricity is what the world is made of. Every speck of matter, including the substance of your own body, contains small particles of electricity. Some particles are said to carry a "positive" electric charge, others a "negative" one. The flow of these particles (called electrons) between two points constitutes a current. However, except in special superconductor materials, electrons do not flow freely, as there is a certain amount of resistance in any material. The amount of resistance determines whether the material is considered a conductor or an insulator. Resistance is measured in OHMS.

A **conductor** will allow the movement of electrons with the slightest voltage. In conductors with high resistance, few electrons will move. Conductors with low resistance allow many electrons to flow with very small voltages.

In **insulators**, such as certain ceramics, glass and plastics, the electrons are tightly bound, and will not move until the voltage is very high, typically thousands of volts. This is why insulators are used to contain electricity safely.

All the measurements of electricity refer to this stream of electron flow. An ampere is the measurement of the volume of flow, a volt is the force that makes it flow, and a watt measures its power to do work.

An electric current travels with lightening speed, 186,300 miles per second along a copper wire, but individual electrons do not - they amble along at less than an inch per second. The current streaks through the wire because the electrons jostle each other all the way.

This action can best be understood by imagining a pipe completely filled with golf balls. If an additional ball is pushed in at one end of the pipe, a ball will pop out almost instantly at the other end. Similarly, when a distant power plant forces electrons into one end of a wire, other electrons almost immediately come out at the other end to light a light bulb or start a motor, etc.

Amperage is not just a measurement of electrons, but the number of electrons that flow past any point in a wire each second, just as gallons per second measure the flow of water through a pipe.

The water analogy also helps to explain the unit called "**volts**", for voltage is to electricity what pressure is to water. The higher the pressure at the source, the greater the flow of water that is forced through a pipe. Similarly, the higher the voltage, the greater the flow of electrons through a wire.

Watts, the third major measure of electricity, is the rate at which a device consumes (uses) electrical energy, and energy is what you pay for when you use electricity. Many devices, such as small appliances will have their wattage marked on them. Other devices, such as fuses and motors, are rated by the current they carry, amperes.

Total energy consumption depends on how long an electrical device is kept running, and is calculated by multiplying the power (expressed in 1,000 watt units called **kilowatts - kw**) by the time in hours. The result is a number that is labeled **kilowatt-hour OR (kwh)**. As an example, if you use a 1,000 watt heater for exactly one hour, you will use exactly one (1) kilowatt-hour.

There is a direct relationship between voltage, current and resistance in a circuit. Voltage is equal to Current times Resistance.

There is also a direct relationship between wattage, voltage, and current in a circuit. Wattage is equal to Voltage times Current.

AC and DC: Two kinds of current

The measures - volts, amperes, watts and kilowatt-hours - apply to all forms of electricity, whether from a battery, a transformer or a wall outlet. But the source of the current makes a crucial difference. The current produced by batteries is a **direct current (DC)**, which flows in only one direction. One side of the current is "positive", the other side is "negative".

The current that is primarily used to power electrical devices is **alternating current (AC)**, a current that rapidly and repeatedly changes its direction. The current will go from a zero voltage to the maximum voltage of the system in a "positive" direction.

back to zero, then go to the maximum voltage in a "negative" direction and back to zero again. This makes one complete cycle of AC. This topic will be discussed in the next phase of training program.

The power supplied by our local utility companies for use in homes and businesses is 60-cycle current, which is also expressed as 60 Hertz (Hz.). The cycles are per each second, so every second the current flows first in one direction, then in the opposite direction, making 60 complete cycles in each second.

Here at the Sewerage and Water Board, we use not only the 60 Hz. power from the local utility companies (NOPSI, and LP&L), but we also generate our own power at 25 Hz., which means the current changes direction 25 cycles each second. You can notice this slower cycling by observing many of the light bulbs that are operating at 25 Hz. They seem to flicker, rather than having a constant glow as with 60 Hz. power.

A Bit of Electrical History

Back in the 1880's when the United States was becoming "electrified", there was much debate as to which system, AC or DC, would be used to supply the country.

Thomas Edison had perfected a generation and transmission system that could power anything from a light bulb to a street car with direct current. The only drawback to his system was that the power could only be transmitted a mile or two. This would mean needing power stations in practically every neighborhood.

However, George Westinghouse, who was Edison's chief rival, had a new group of inventors and engineers working for him that insisted they could transmit electricity over hundreds of miles, if they sent it out in alternating current. The individual who is known by few, yet is considered to be the "father" of AC systems, is Nikola Tesla, a Russian immigrant !

Though DC was the source of electricity in many parts of the country until after World War II, all electricity supplied to homes and businesses is now AC because of the necessity of locating central power stations far from some of the points of use.

A great amount of electric power for running our pumping equipment at Water Board is produced by the Board's power generator plant. Generators that provide much of the power for pumps throughout the city are located at the S&WB power plant. The power plant maintained and operated at the Main Water Purification Plant has a 61,000 kilowatt hour capacity at 6,600 volts, an output sufficient to serve the electrical needs of a city of approximately 80,000 people like Lake Charles. The power is transmitted to various facilities around the Board by means of underground electrical cables (feeders) which are not subject to lightning, wind, and other hazards

that cripple overhead transmission lines and cause power failures. Reliability of facilities is therefore increased.

Grounding

To guarantee that the white wire is at the same voltage as the earth, it is installed with direct connections to the earth, thus the term "grounded". This is done by connecting the white wire to a metal bar in the service panel. This metal bar in turn is bonded to a metal plumbing pipe leading to an underground water supply, or connected directly to a pipe or metal stake driven deep into the ground. Consequently, that side of the circuit will always be at the same voltage as the earth, keeping it neutral.

The bare wire - or sometimes green coated wire - serves as an extra safety device. It guards against mistakes in installation and also against deterioration. All electrical devices gradually become worn, and when they are worn they are potentially dangerous. After repeated uses, their parts break and their insulation may crumble or wear thin. The current that should pass through them can leak from its normal path. The leak may cause a spark or generate intense heat, raising the possibility of a fire. It may also cause a 120 volt potential to be applied to something you might touch that would normally be safe.

To ensure that a leak does not become dangerous, the bare wire is connected to a grounded wire of the incoming power supply (thus, it is grounded itself), and it is securely fastened to every possible point of leakage - that is, to every box in the circuit and in many modern installations, to the metal frames of switches, receptacles, light fixtures and many large and small appliances.

Suppose that a switch is incorrectly installed, or a bit of the exposed end of a black (hot) wire is making contact with the outlet box. Immediately, the entire box can become hot and a potential source of shock or fire. The bare grounding wire protects the facility and people in it by completing a new circuit from the hot side to ground. Since there is no use of electrons by an electrical device, the new circuit is called a "short circuit". The surge of electrons will pass through the bare wire back to the service panel causing a fuse to blow out or a circuit breaker to trip.

Fuses and circuit breakers are simply automatic electrical devices that interrupt current flow whenever it exceeds a specified limit. Until a problem such as described above is found and corrected, replacement fuses will blow, and reset circuit breakers will trip out again.

Circuit Protectors

To protect you against fire or electrical shock, every electrical circuit includes one or the other of two types of safety devices - a **fuse** or a **circuit breaker**. They operate somewhat differently but serve the same purpose - to shut off the electricity to a circuit when the circuit carries more current than it is intended to.

When too much current flows through a fused circuit, the fuse "blows" - that is to say the metal strip that provides continuity through the fuse melts, thus creating an "open" circuit. The fuse must be replaced before current can flow through the circuit again. If upon replacing the fuse the new one blows, an inspection must be made to determine the cause of the current overload in the circuit.

Most modern day circuits are protected by circuit breakers. Circuit breakers function as switches that snap open (trips) when the current in the circuit exceeds their rating. Once the overload condition has ended, the circuit breaker can be reset manually. As with the fuse, should the same breaker trip out again soon after resetting it, an inspection of the circuit is deemed necessary.

The excess current that causes fuses to blow, or breakers to trip, can arise in two ways:

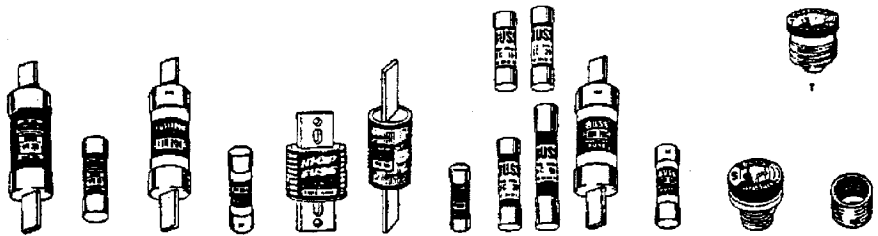
- A. An overload; usually the result of plugging in too many devices into a single circuit, or trying to operate a device that draws more current than the circuit is designed to handle. This excess current could produce enough heat to start a fire; before it can reach that point, the circuit opens via the fuse or breaker.
- B. A short-circuit; perhaps caused by worn insulation that lets bare wires touch each other to the grounded frame of an outlet box, or electrical device. This condition introduces the danger of shock or electrocution and produces a heavy, heat generating surge of current.

Fuses are marked with the maximum in amperes ("AMP" or "A") they permit. All have metal strips that melt when heated by excess current. The plug-type fuse is the type most people are familiar with, as it has been used for so many years in home service panels. A time-delay fuse has a spring to support the strip and keep it from breaking if softened by a brief surge (such as many devices carry upon starting). Only if the excess current lasts will the strip melt to blow the fuse. The "S" type of plug fuse has a ring adapter - in different threads for different amp ratings. This was done to prevent the use of a fuse of the wrong rating being used in a circuit.

Cartridge fuses are generally used for higher currents than the typical "house" circuit is designed to handle. They have "capped" or "blade" type ends that go into different fuse holders than the plug type. Special tools must be used to remove and replace these type of fuses.

Never replace a fuse or circuit breaker with one that has a higher amp rating !!!

Doing so defeats the ability of the fuse or breaker to act as a safety device for the circuit.



Different Types of Fuses

Basic Electrical Safety

Electricity can cause a fire when its normal passage is impeded by a break in a wire, or a faulty connection, so that it generates intense heat. It can shock only when permitted to flow from a supply wire to a neutral wire or ground where there is no voltage. This difference in voltage (potential) is what gives a jolt to anyone touching a live wire and a neutral wire, or grounded object that allows electricity to flow to earth. That individual literally makes him/herself a part of the electrical circuit. Current passes through a body whose moist internal tissues are good electrical conductors just as it would flow through a copper wire. Obviously, it is impossible to get a shock if no electricity is present.

Armed with this basic knowledge, and having a healthy respect for the potential danger in electricity, you should be able to safely check circuits, some electrical devices and make minor repairs. Electrical repairs can be made in safety if you follow the one cardinal rule for electrical work of any kind: **make absolutely sure that the device, or circuit you are going to work on contains no current.** Do this by using a voltage tester known to be in working order. To ensure that it is in working order, test a known live circuit first.

When you have positive proof that the tester is in good working order, you can then check a circuit to make sure it is not hot. **NEVER USE A "CONTINUITY TESTER" TO CHECK FOR VOLTAGE!!** The continuity tester is used to check fuses once they have been removed from the circuit.

Use and Maintenance of Wet Storage Batteries

I. What is a wet storage battery?

A wet storage battery is an electro-chemical device that provides direct current (DC) electricity. Our facilities normally uses lead-acid batteries of the lead-antimony type. Each of these batteries consists of one or more cells.

The following are the basic components of a lead-acid cell:

- A. Element
- B. Cell Covers
- C. Cell Jar
- D. Electrolyte (a liquid)

The electrolyte solution in the battery serves as a catalyst for the electro-chemical reaction that takes place inside the battery. All lead-acid storage batteries are rated for a certain acid content in the electrolyte solution. This rating is given as the "nominal specific gravity" for the battery. The "nominal specific gravity" of a cell is that value of specific gravity at which the cell is designed to operate when fully charged. The "nominal specific gravity" is normally given for a standard temperature of 77 degrees Fahrenheit (77°F) which is equivalent to 25 degrees Celsius (25°C).

An electrolyte's specific gravity measures the acid content in the electrolyte. It compares the weight of the acid solution to an equal volume of water. Water has a specific gravity of 1.000. An electrolyte with a specific gravity of 1.215 would weight 1.215 times as much as an equal amount of water.

II. What Are Wet Storage Batteries Used For?

Our facilities uses wet storage batteries for two (2) main operational purposes:

- A. As a power source for control circuitry.
- B. As the "back-up" power source for communicator radios.

The radio battery is a 12 volt, 6 cell battery and has a "nominal specific gravity" of 1.265.

The control batteries are actually a set of twenty (20) batteries. Each individual battery contains three (3) cells. Each cell is rated at 2.15 volts. The batteries are connected in "series" giving a combined voltage of 129 ($20 \times 3 \times 2.15 = 129$) volts of D.C.

Both the radio battery and the control batteries are normally of the lead-antimony class. The "nominal specific gravity" of the control batteries is 1.215. The control battery set can operate effectively at a voltage as low as 116 volts for a short period of time. This means that the control system could function temporarily with 18 ($116/3/2 = 18$) batteries. However, for extended use, 20 batteries are required.

III. Effects of Temperature on Battery Performance

Battery output capacity is reduced when the battery compartment temperature is consistently below 77 degrees F (25 degrees C). Battery life expectancy is shortened when the batteries are situated in a compartment where the ambient temperature is consistently above 86 degrees F (30 degrees C).

The viscosity, or thickness, of an electrolyte solution affects the diffusion rate of the acid through the pores of the battery plates. Viscosity doubles as the electrolyte temperature drops from 77 degrees F to 32 degrees F (freeze). If the temperature continues to decrease, the viscosity increases at a faster rate causing the battery to discharge faster.

As the temperature rises above 77 degrees F, the viscosity of the electrolyte decreases, allowing for faster diffusion through the pores of the plates. As this happens the amount of current needed to maintain the batteries at full charge increases. This reaction makes for excessive wear on the plates and a reduction in the battery life expectancy.

For the best performance and life expectancy, wet storage batteries should be operated in a temperature range between 59 degrees F and 86 degrees F.

IV. Ventilation of Battery Compartment.

The electro-chemical reaction in wet storage batteries releases highly explosive hydrogen and oxygen gases. These gases are released through the vent plugs in the battery tops. Sufficient ventilation should be provided in the battery compartment. To accomplish this, the air in the compartment must be completely exchanged at least 3 or 4 times a day. This air exchange is usually accomplished either with exhaust fans, louvers, or both if the batteries are located in a enclosed compartment or room.

V. Maintenance of Wet Storage Batteries

The life expectancy of a wet storage battery of the lead-acid type depends heavily on the thoroughness and frequency of maintenance performed on it during its' service life.

A battery's condition can be determined by analyzing the specific gravity readings in the battery log. When the readings show a steady decline over a period of time, that is an indication that the battery is failing. If the readings show no decline and the plates appear to be mechanically intact, this indicates that the battery is performing up to its expected capacity.

Maintenance should be performed on the batteries in the following sequence:

- A. Take the Specific Gravity Readings
- B. Record Readings
- C. Add Distilled Water As Needed
- D. Clean the Battery Casings and Terminals
- E. Recharge the Batteries (equalize charge on a rectifier)
- F. Check Conditions of Batteries After Recharge By Taking Another Specific Gravity Reading

Safety procedures must be observed at all times when handling or performing maintenance on batteries.

A. Specific Gravity Readings

In general, it should be noted that temperature and electrolyte levels both have bearings on specific gravity readings. Also, the amount of charge on the batteries at a given moment affects the specific gravity readings.

Specific gravity readings are taken with a **hydrometer syringe**. The readings on the hydrometer are meaningless unless the temperature of the electrolyte solution is also considered. A compensating scale is included on some hydrometers. Depending on the temperature of the electrolyte, points are either added or subtracted from the observed reading on the hydrometer.

If distilled water has just been added to the electrolyte, the true specific gravity reading cannot be obtained until the water has had time to mix in with the electrolyte. When first added, water tends to float on top of the electrolyte solution because it is lighter.

Specific gravity readings decrease as the battery goes through its normal discharge process. The readings also diminish, though only by a few points, over the life of the battery.

Specific gravity readings must also be corrected for decreases in electrolyte levels. When the electrolyte level drops to 1/4" below the high level mark on the battery casing, the specific gravity reading will be

approximately 6 points (.006) higher than the reading it would normally be at the high mark.

Specific gravity readings for the radio batteries should range from 1.250 to 1.275. Control battery readings should be between 1.200 and 1.225. Readings below the respective ranges for each of the batteries indicate unsatisfactory performance of a given cell. A reading of 1.100 indicates a completely discharged or "dead" cell.

When taking hydrometer readings, always hold the syringe vertically and make sure the float is floating freely with no pressure applied on the bulb. Always return the electrolyte in the syringe to the cell from which it came. The base of the hydrometer syringe should be pressed firmly against the cell opening of the battery when returning the solution to prevent the electrolyte from splashing.

B. Recording of Readings

A complete recorded history of the battery operation is most desirable and helpful in obtaining satisfactory performance. Good records will also show when corrective actions may be required to eliminate possible charging, maintenance, or environmental problems.

After the specific gravity readings are taken, they should be entered in the battery log book. Care should be taken to match the readings with the respective cells. All cells should be numbered, then the readings entered in the log should correspond by number to the cell from which they were taken. (See record keeping)

C. Addition of Distilled Water

Only distilled water should be added to the batteries to bring the electrolyte level to the proper height. The proper level is between the high and low markings on the battery case. Never fill above the high level mark or allow to drop below the low level mark. For best performance, the electrolyte solution should be kept at the high level mark.

Distilled water must be added to the electrolyte solution because of evaporation and the losses resulting from the breaking down of the water molecules through the electro-chemical process that occurs during the normal operation of the batteries. The water molecules are broken down into hydrogen and oxygen gas, and released through the vents in the top of the battery casing. As a result of the emission of these gases, the

electrolyte level drops.

D. Cleaning of Battery Casings and Terminal

Wipe the outside of the cells as necessary with a water-moistened cloth to remove dust and ordinary dirt. If electrolyte is spilled on the top of the casing, neutralize it with a cloth moistened with a solution of baking soda and water mixed in a proportion of one pound of baking soda to one gallon of water. When the fizzing action stops after the soda solution is applied, wipe with a water-moistened cloth to remove all traces of soda.

Never use solvents, detergents, or other cleaning compounds or oils, waxes, or polishes on the plastic battery casing or covers. Such material may have a reaction with the plastic causing it to become brittle and crack.

Always keep the terminals and posts corrosion-free by coating them with a corrosion-resistant oil or grease, or a product made specifically for that purpose. The terminals and posts may be cleaned with the water-moistened cloth, provided that the corrosion-resistant substance is added after cleaning. A visual inspection should be made of all posts and terminals when cleaning the batteries.

E. Recharging the Batteries

Wet storage batteries are continuously connected to control circuits or to the communications radio which must be energized at all times. This is accomplished by connecting the battery in parallel with a continuously operating charger and the desired load circuits. The charger is then adjusted to a voltage which will enable the battery to obtain just enough current to keep it fully charged. This method is known as a "float charge". Our control batteries are float charged at a rate of 2.15 volts per cell. Sixty (60) cells with a float charge of 2.15 volts per cell yield a total float charge voltage of 129 volts.

Once a week and immediately following a power outage, give the lead-acid battery an "equalizing charge" or a recharge at a higher voltage per cell rating than the float charge. Lead-acid batteries are equalized at 2.33 volts per cell. Sixty cells with a 2.33 volt per cell charge result in an equalizing voltage of 140 (60X2.33 = 140) volts. Administer the equalizing charge once a week for a 24 hour period.

The purpose of the weekly equalizing charge is to ensure that all of the

battery cells are brought up to full charge level. During float charging most cells are kept at full charge, but some cells gradually lose a little capacity. These "weak" cells can be upgraded with the other cells by periodically feeding a prolonged charge at a higher rate (the equalizing charge).

Whenever the normal AC power supply to the charger is interrupted, the battery becomes the main source of power to the DC load. The load on the battery causes its strength to decline. As the discharge continues, the battery voltage drops and so does the specific gravity.

If there is a discharge of the batteries for whatever reason, the batteries should be built back up to optimum voltage with an equalizing charge for a full charge (24 hour) period.

After the recharge is completed the batteries should be inspected. Proper electrolyte level and specific gravity readings should be checked. If the specific gravity readings still indicate a discharged condition, the equalize charge should be repeated.

Float charging and equalizing charging are both accomplished by use of the static rectifier units. The static rectifier unit is the modern method of charging our battery systems. It uses solid-state electronic circuitry to convert AC input voltage to DC output voltage. When used in the "float" mode, the rectifier is set for 130 volts output. When used in the "equalize" mode it is set for 140 volts output.

F. Inspection After Recharge Cycle

As it was stated earlier, a visual inspection of the electrolyte levels should be made, as well as a check of specific gravity readings from all of the cells in the battery set after the recharge cycle has been completed.

DIRECTIONS FOR USING 40B-VP BATTERY TESTER (Hydrometer)

TO PREPARE TESTER FOR USE:

1. Carefully remove instrument from card.
2. Remove bulb, rubber bumper, and float from jar. Remove foam strip from float.
3. Hold instrument with tip pointing downward. Insert float, large end first, into jar.
4. Place rubber bumper flush into jar, then slip the bulb over the jar; slightly wetting the jar makes bulb go on easier.
5. The instrument is now ready for use.

TO TEST:

Squeeze bulb, then insert the tip of tester into the cell. Release pressure on bulb until enough electrolyte is drawn into the jar to freely float the hydrometer. The mark on the hydrometer in line with the surface of the liquid is the apparent specific gravity reading of the battery. Make reading at eye level for accuracy. A temperature error correction must be applied to this reading as follows: To the right side of the thermometer, note the scale reading which coincides with the top of the red liquid column. Add the black figures to the apparent specific gravity and subtract the red figures.

EXAMPLE:

Hydrometer float indicates apparent specific gravity of 1270 and the thermometer shows on scale reading, in black, the figure 4. Therefore, add 4 to apparent float reading of 1270 which gives specific gravity of 1274. (This is a specific gravity of 1.274 at 80 degrees Fahrenheit in the physical sense).

Replacement parts for Edelman No. 40B-VP Battery Tester can be obtained from your job No. 1040 or 1034N Float (Float can vary, check old float before ordering) - No. 2045 Jar - No. 4000 Bulb - No. 5041 Hydrometer tip with thermometer and correction table - No. 7140 Rubber Bumper.

NOTE: A proper test cannot be made unless each battery cell has sufficient electrolyte to permit hydrometer float to rise freely. An accurate reading cannot be obtained if water has just recently been added to cells.

GRAVITY FLOW

(This section is intended specially for Sewerage Operations)



Pipes can be designed to transmit flows by gravity, or they can be pressurized (a "force" main). A gravity flow is liquid flowing through a pipe caused by the pipe's slope, and the gravitational pull of the earth. This type of flow is the same as water flowing off the roof of a house during a rain. The earth's gravity pulls the water to the lowest part of the roof.

Most gravity flow lines, or pipes, are designed and constructed to maintain a self-cleaning velocity (speed) of two (2) feet per second (fps). This velocity keeps all the suspended solids flowing and tends to clean the inside of the pipes by the frictional rubbing of the solids on the inside walls of the pipe.

Flows of lesser value will allow the suspended solids to settle inside the pipe and eventually will cause stoppages in the pipe. Flows of greater value tend to move the solids to the center of the liquid and reduce the frictional rubbing of the inside walls of the pipe, which allows solids and greases to accumulate in the pipe.

Flows less than or greater than the self-cleaning velocity can result in the accumulation of solids in the pipe which become septic (anaerobic). This causes harmful gases to accumulate in the lines, particularly H_2S (hydrogen sulfide). H_2S will cause rapid deterioration of certain types of pipes such as concrete and uncoated steel pipe.

QUANTITY

When considering quantities a pipe or a pump can deliver, certain terminologies are used.

In order to measure amount of liquid (quantity) flow thru a pipe or pumped, two (2) things must be known:

- Velocity (Speed) of liquid being pumped or flowing, and
- Area of the pipe carrying the liquid

The following terms are used to express volume or quantity of water. Become familiar with both the abbreviations and what the abbreviations stand for:

Terms Used To Measure Quantity

MGD = million gallons per day
CFS = cubic feet per second
GPS = gallons per second
GPM = gallons per minute
GPH = gallons per hour
GPD = gallons per day

The following table shows the formulas used to change the way a quantity is expressed:

CONVERSION FORMULAS

From CFS to GPS ----- CFS X 7.48 = GPS
From GPS to GPM ----- GPS X 60 = GPM
From GPM to GPH ----- GPM X 60 = GPH
From GPH to GPD ----- GPH X 24 = GPD
From GPD to MGD ----- GPD / 1,000,000 = MGD
From GPS to CFS ----- GPS / 7.48 = CFS
From GPS to GPD ----- GPS X 86,400 = GPD
From GPM to GPD ----- GPM X 1440 = GPD
From MGD to GPD ----- MGD X 1,000,000 = GPD

LUBRICATION

Lubrication is the life-blood of all moving mechanical machinery. Without proper lubrication, the heat in the bearings from the friction of metal rubbing against metal would soon build up and eventually cause major failure of the machinery due to the metal surfaces of the bearing "seizing" or binding with each other.

Lubricants that are used in our facilities are water, oil, or grease.

Some of our pumping units are equipped with water lubricated rubber bearings. For optimum life and service the bearings must be lubricated by clean potable water. Detailed information as to pressure, quantity and controls will be found at each facility. The bearing lubricating water must be kept at the prescribed operating capacity and pressure at all times when the equipment is running. In addition to the above, water at lower capacity and pressure must continuously lubricate the bearings. This action prevents sand and silt from filling the bearings, shaft tube, and bearing housings.

Since there are many types of oils and greases, it is extremely important to use the right type that is designed for use with the specific machinery. Equipment manufacturers specify the proper type of lubricant to be used on their equipment. Using the wrong lubricant can be just as bad as failing to use any lubricant at all.

Proper storage of lubricants is also very important. Lubricants that become contaminated with water or dirt should never be used in performing maintenance on any equipment, as they can ruin machinery in short order. Contaminated lubricants should be disposed of properly in accordance with all rules and laws governing same.

Oil systems

Machinery that uses oil for bearing lubrication should be checked prior to start-up for proper oil level. There will usually be a sight glass, or a dip stick for this purpose. If the oil level is not above the minimum level, add enough of the proper oil to bring it up to the proper level before starting the unit.

On some units there will also be a sight glass to check for oil flow while the unit is running. It is important that you do not mistake a sight "flow" glass with an oil level indicator, or vice versa.

Changing Oil

As per manufacturers instructions, the oil must be changed periodically. Having a sufficient quantity of the proper oil on hand, an oil change is performed in the following manner:

- 1) Shut off the unit to be serviced at the control panel, following all safety and operating procedures.
- 2) Wipe the area around the fill and drain plugs, or valves, with a clean rag. You must also wipe off the funnel, top of oil drum and the oil can. Remember, dirt is a contaminant that can ruin machinery.
- 3) Place a container of sufficient size under the drain plug or valve. Remove the drain plug or open the drain valve, and remove the fill plug or open the fill valve, and allow the oil to drain out.
- 4) After the oil has drained, using a clean funnel with a screen, flush the bearing by adding clean oil to the unit and allowing it to drain out until it comes out clean.
- 5) Place the used oil in a waste oil drum that is properly marked. When the drum is filled, notify your supervisor so that arrangements can be made to have the used oil picked up by a disposal company.
- 6) Clean out the sight glass and/or flow indicators if needed.
- 7) Install drain plug or close drain valve. Fill the unit with clean oil to the proper level. Do not pour in too much too fast, as overfilling the oil system will cause additional problems.
- 8) Install fill plug, or close the fill valve. Wipe off any oil that may have spilled on, or around the equipment, and dispose of the rags. Do not leave them laying about the station.
- 9) Place the unit back in service following all safety and operating procedures.
- 10) Run the unit long enough to bring the bearings up to normal operating temperature. While the unit is running, frequently monitor the temperature gauge, or feel for heat by placing your hand on the bearing. Check the drain and fill areas for possible leaks.
- 11) Record this maintenance in the station log book and/or route report.

- 12) Monitor the unit for the next several hours or over the next several days station inspections. If anything unusual is observed, shut the unit down and contact your supervisor immediately.

Grease systems

As per manufacturers instructions, the bearings must be greased periodically. Once you have obtained the proper grease and a grease gun, greasing is performed in the following manner:

- 1) Run the unit for a few minutes to raise the temperature of the grease in the bearings. This is especially important during colder months.
- 2) Wipe off the grease fitting and the relief plug with a clean rag. Wipe off the end of the hose for the grease gun and pump one or two shots from the gun into the rag.
- 3) Shut off the unit to be serviced at the control panel, following all safety and operating procedures.
- 4) Attach the hose from the grease gun to the grease fitting and pump in new grease until all old grease is removed from the bearing. If there is no relief plug, pump in three shots of grease. As you pump in the grease, watch around the bearing seals so you do not blow out a seal due to hardened grease not exiting the relief hole.
- 5) Place the unit back in service following all safety and operating procedures.
- 6) Run the unit long enough to bring the bearings up to normal operating temperature, allowing any excess grease to exit the relief hole. Too much grease can damage the bearing due to excessive heat buildup.
- 7) Monitor the unit for the next several hours or over the next several days station inspections. If anything unusual is observed, shut the unit down and contact your supervisor immediately.
- 8) Record this maintenance in the facility log book and/or route report.

Personal Safety Drainage and Sewerage Operations

Personal safety in the work place is highly dependent upon your awareness of the task which you are doing, as well as your awareness of the environment in which you work. If you are knowledgeable about the job that you are to perform and focus your awareness on your work, "accidents" will not be yours to experience. Accidents are usually the result of the act of an individual whose awareness is not focused on the job at hand, or lacks the proper knowledge to perform a task in a safe manner.

The employee working in the wastewater / drainage industry works in an unusual environment which presents obvious hazards, as well as some hazards which are not visibly seen. It is the intent of this manual and field classes to make you knowledgeable of those unseen hazards which are a part of sewerage and drainage pumping operations.

We must first understand what the hazardous materials are composed of in order to better understand the unseen hazards that are part of our everyday work environment.

Sewage - Refuse liquids or waste matter carried off by sewers

Drainage - Accumulated rain water carried off by gravity pipe lines

Wastewater is water that has been used for some process, whether residential, commercial or industrial, and is no longer considered to be safe for human consumption.

The sewage which is pumped through our facilities includes wastewater from both residential, business, and industrial sources. It comes from toilets, bathtubs, wash basins, and manufacturing processes through underground piping and is carried via gravity to the station's wet well. The pumping stations then pump the sewage into a forced main which delivers the sewage to the treatment plant(s). The treatment plant processes the sewage, removing all solids, then pumps the processed water to the Mississippi River.

The composition of sewage is essentially water that carries a small percentage of solid material in solution, suspension or floating on its' surface. It is considered that sewage consists of 99.9% water and 0.1% solids. These solids can be classified into two main groups:

1. **Inorganic solids** - Those substances that are not subject to decay by natural process, such as sand, clay, grit, and glass.
2. **Organic solids** - Those substances that are of plant or animal origin.

including the waste products, plant, and animal life. These solids are subject to decay or decomposition through the activity of bacteria and other living organisms. Examples of organic solids are human and animal feces, paper, rags, food scraps, etc.

Solids can be grouped as suspended, dissolved, and volatile. Each group may include organic and inorganic material.

1. **Suspended solids** - Solids that can be removed by sedimentation and/or filtration process.
2. **Dissolved solids** - Solids that will not settle out and can readily pass through filtration.
3. **Volatile solids** - Solids that can be destroyed by heat and form a gas, generally, any substance that has a carbon base.

Sewage has certain characteristics which can give an indication of its condition. A fresh domestic sewage will usually have a grayish dishwater color with a slight fecal odor. Septic (stale) sewage will be dark in color and have an offensive odor due to bacterial processes that are decomposing the organic matter.

Sewage may contain many chemicals and bacteria that can be very harmful to us, yet because we cannot see them in the water, we usually do not think about them when working.

Stop and think for just a minute about the many cleaning products and other substances that you use in and around your home that either go down the drain, get flushed down the toilet, or get washed into the storm drains out in the street. Insecticides, herbicides, shampoo, detergent, cleaning products, etc. Also consider the many chemicals used in industry that wind up in the system.

BACTERIA

(This section is intended specifically for Sewerage Operations)



Bacteria are microscopic plants that cannot be seen by the naked eye. Bacteria are a concern to the wastewater worker, as many of them can live and thrive in sewage. They are a unique form of life and can be classified, or categorized in many different ways. Two particular classifications that are important to us are: oxygen requirements and disease producing capabilities.

- 1) **Oxygen requirements**
 - a) **Aerobic Bacteria:** need oxygen to live
 - b) **Anaerobic Bacteria:** live with little or no oxygen
 - c) **Facultative Bacteria:** present in most all conditions

- 2) **Disease producing capability**
 - a) **Non-pathogenic:** do not produce disease
 - b) **Pathogenic:** disease causing
 - c) **Opportunistic:** may produce disease under certain conditions

Pathogenic bacteria, or pathogens, are introduced into the wastewater through the feces and urine of individuals that have an illness, or carry the particular organisms. As a wastewater worker you may come in contact with these bacteria through contact, either directly or indirectly, with wastewater or with equipment that has been contaminated with wastewater. Once contact has been made, entry into the body can occur through open wounds such as cuts, scrapes, and skin irritations, or passed directly into the body by contact with the mouth, nose, eyes, etc.

Good personal hygiene, as well as some precautionary measures should be observed. You may want to wear rubber gloves where possible. They are especially good to wear if you have any type of cuts or scrapes on your hands, but rubber gloves will not offer you 100% protection. Whenever finishing a job, or taking a break, wash your hands thoroughly, and if possible use a disinfectant such as alcohol gel. Ultimately, your best protection is in good personal hygiene.

Organic matter in sewage decomposes quickly in warm weather, producing disagreeable odors as well as providing an environment for pathogens to grow. In warm weather sewage will start to become stale, or septic, within about two hours. Untreated sewage that finds its way into lakes and rivers may cause a fish kill because of the reduction of the dissolved oxygen in the water. It may also render the waterway unfit for recreational use, or as a watering source for livestock, due to pathogens.

Pollution of our waterways should be of a major concern to every person. Not only do we need a source of water for drinking and recreation, but also realize that wildlife and marine life are affected by the quality of the water in their respective areas. When we eat any of these types of animal life, we ingest the contaminants that they may have consumed through the water.

Being aware of the unseen hazards in sewage, you should now realize the importance of preventing sewage from entering the drainage system, where the untreated sewage is pumped into the lake or river. Sewage is both a potential nuisance and a danger to public health if not disposed of properly.

Your awareness is the key to protection, prevention, and education of others.

GASSES

Fresh sewage usually contains oxygen and will have aerobic bacteria present. The aerobic bacteria begin the decomposition process of the organic material. In doing so they deplete the oxygen in the water and begin to die off. The sewage is then becoming stale, or septic. The anaerobic bacteria will then begin to flourish and continue with the decomposition process. This anaerobic process causes another concern for the wastewater worker, for the decomposition of organic matter will produce gasses.

Three of the most dangerous gasses are:

- 1) **Methane** - an explosive gas that depletes oxygen.
- 2) **Ammonia** - can suffocate by depleting oxygen in the atmosphere.
- 3) **Hydrogen Sulfide (H_2S)** - probably the most dangerous of the gasses produced.
 - a) Can cause paralysis of the respiratory system.
 - b) Highly corrosive.
 - c) Flammable and explosive in the right combinations.

Hydrogen sulfide is highly toxic. Its toxicity is equivalent to that of hydrogen cyanide, which is the gas used in prison gas chambers to kill prisoners. It is measured in the atmosphere in parts per million (ppm).

To help you understand, or visualize the concept of parts per million, imagine if you had one million pennies (which equals \$10,000). One part per million would be one penny out of the \$10,000. The following shows the increasing toxicity of H_2S at increasing levels:

- 10 PPM** - Breathing this level for 8 hours may produce headaches and irritation of the mucous membranes (eyes, nose, throat and mouth). That would be equivalent to ten (10) cents out of \$10,000.
- 50 PPM** - Breathing this concentration for 8 hours will produce poisoning symptoms (vomiting and diarrhea). That would be equivalent to fifty (50) cents out of \$10,000.
- 300 PPM** - The minimum concentration known to produce death. Time span not given. That would be equivalent to three (\$3.00) out of \$10,000.
- 3000 PPM** - Fatal in a very short period. That would only be thirty (\$30.00) out of \$10,000!

In low concentrations hydrogen sulfide smells like rotten eggs. As the concentration increases, it will deaden your olfactory senses (ability to smell). Consequently, if you enter an atmosphere wherein you detect a "rotten egg" smell and the area is not ventilated, an increase in the concentration of H₂S could quite easily be undetected by you until it is too late.

Because of the possible formation of these gasses, underground stations should be ventilated on a continuous basis. Never enter an underground station if the ventilation system is not operating. **Contact your supervisor!** He/she will take the necessary steps to ventilate the station and test the atmosphere **BEFORE** anyone enters the station. Wetwells and valve manholes are also to be ventilated and tested before anyone enters them.

OXYGEN (O₂) LEVELS

Ventilation and testing are to be continuous while personnel are working in areas that are not equipped with continuous ventilation. The atmosphere is tested not only for the presence of hazardous gasses, but also for the proper oxygen content.

An atmosphere having less than 19.5% oxygen is insufficient for a person to breathe for any period of time. The big problem with a low oxygen atmosphere is that instead of your body reacting in a negative way to alert you, you will become light headed and giddy, not realizing that there is a problem until it may be too late.

An atmosphere showing levels of 21.9% oxygen also poses a risk to a worker. While the enriched atmosphere is fine to breathe, it creates a situation more conducive to explosion by a spark or open flame, as oxygen is highly flammable. The simple act of an electric motor starting could trigger an explosion.

Every year there are numerous incidents reported across the country wherein employees are hurt or killed due to a lack of knowledge about atmospheric hazards, or simply a disregard for the danger that exists. Knowledge and awareness are the key ingredients to prevention of these incidents and to the safety of the lives of you and your co-workers.

There are also numerous accidents each year where there are multiple deaths or injuries caused by employees attempting to "rescue" fellow employees who have fallen victim to the unseen enemy.

If an employee is affected by an unseen reason, **NEVER** attempt to rescue that employee unless you have the proper rescue equipment. If proper precautions are taken and common sense prevails, you should never be in a situation wherein a co-worker needs to be rescued from an unseen cause.

Wastewater workers are exposed to many job related hazards. It is your responsibility to become familiar with these hazards and strive to be alert in regards to following established safety procedures in all aspects of your job.

In light of the hazardous nature of our environment, no employee is to be left alone at any of the automatic stations. While this practice was acceptable in the past, it is no longer condoned, nor will it be tolerated. The individual in charge of the route and his/her assistants are a team. Should one or the other get injured, the other party can summon help. There is an old saying that holds true, "there is safety in numbers!"

Remember, safety is no accident! Accidents don't just happen, they are caused. Behind every accident there is a chain of events that lead up to an unsafe act, unsafe condition, or a combination of both.

Don't Become Another Statistic in This Industry !!!

Always THINK
Before You Act !!!



Phase III - 28

GLOSSARY

ELECTRICAL TERMS

Listed below are definitions of many of the electrical terms which a Utility Plant Worker II will encounter during his/her training program:

Alternating Current Generator: A generator that produces an alternating current or alternating voltage.

Alternating Current or voltage (AC): Current or voltage which constantly fluctuates in value. As alternating current or voltage goes through one cycle, its value fluctuates from zero to maximum, to zero, to maximum in the opposite polarity, and back to zero. It is generally shown by a wave form.

Ammeter: A meter used for measuring current. In general, an ammeter measures amperes, a milliammeter measures milliamperes, and a micrometer measures microamperes.

Ampere: A unit of electric current flow.

Armature: The moving part of a relay or the part of a generator in which the voltage is induced.

Battery: A combination of cells used for producing voltage.

Brush: A conducting material, usually carbon, which is used to remove the voltage from the rotating part of a generator.

Bustie: Electrical switchgear used to connect one section (or bus) of an electrical distribution system to another section (or bus) of an electrical distribution system.

Cell: A voltage source that is capable of generating electricity by chemical means. It consists of the dissimilar conductors immersed in a chemical solution. A number of cells in combination make a battery.

Celsius: A system of measuring temperatures in which the temperature of freezing water is zero "0" (equivalent to 32 degrees F), and that of boiling water is 100 (equivalent to 212 degrees F). This system is called "centigrade."

Circuit Breaker: A device that automatically opens a circuit when the circuit current is excessive or when the circuit voltage is excessive. It serves the same purpose as a fuse. However, the circuit breaker is not destroyed when it opens a circuit. It can

be reset manually or electrically after the overload is removed.

Closed Circuit: A circuit in which there is a complete current path from the voltage source, through the circuit, and back to the voltage source.

Commutator: A number of conductors, insulated from each other, which are connected to the rotating part of a generator. The generator voltage is taken from the commutator by brushes.

Conductor: A material that will pass an electrical current with very little opposition or resistance.

Continuity: A word used to describe the completeness of a circuit. A circuit in which current can flow is said to have continuity.

Current: The flow of electrons through a circuit. Current flow is measured in amperes, but this unit may be too large for some applications, so milliamperes (thousandths of an ampere) and microamperes (millionths of an ampere) are also used for measurement.

Diode: A component that will conduct electricity in only one direction.

Direct Current or Voltage (DC): Current or voltage which does not fluctuate but remains at a constant direction.

Electrolyte: A solution that conducts an electrical current (used in batteries).

Electromagnet: A magnet that is produced by causing a current to flow through a coil.

Energy: The capacity to do work.

Feeder: A set of conductors in an electrical distribution system extending from the power generating plant to the facilities served by that distribution system. Feeders may be located underground or overhead (aerial).

Frequency: A measurement of how rapidly an alternating current changes direction. It is measured in hertz / cycle.

Fuse: A circuit protective device. When the circuit voltage or current becomes excessive, the fuse burns out and opens the circuit path.

Ground: A return path to the voltage source through the earth, or through a common connection.

Insulator: A material that will not readily conduct electricity.

Kilo: A prefix meaning thousand. Thus, a kilohertz is one thousand hertz.

Load: Technically, the "load" of a circuit refers to the amount of current delivered to that circuit. A circuit with a light load is one in which very little current flows. Also, the term "load" is sometimes used to mean load resistance.

Mega: A prefix meaning million. Thus a megohm is a million ohms.

Milli: A prefix meaning one-thousandth. Thus, a milliamperere is a thousandth of an ampere.

Motor: An electrical component that converts electricity to rotation. Motors are used to run our pumping equipment.

Rheostat: A variable resistor connected in such a way that varying the resistance changes the amount of circuit current.

Schematic Drawing: A one line drawing using symbols to represent components.

Switch: A component that opens or closes a circuit.

Power: A measure of the rate at which energy is expended or at which work is performed. In electrical circuits, power is measured in watts.

Power Factor: A measure of how nearly in phase the voltage and current are in an AC circuit. A power factor of 1.0, or 100%, means that the current and voltage are in phase. A power factor of 0, or 0% means that the current and voltage are 90 degrees out of phase.

Rectifier: A component that allows current to flow through it in only one direction. It is used for converting alternating current to direct current.

Relay: An electrically operated switch.

Transformer: A component that will pass AC, but will not pass DC. It can be used to step an AC voltage up or down, or to step an AC current up or down.

Volt: A unit of measurement for the voltage rise or drop in a circuit, also called Electrical Pressure.

Voltmeter: An instrument used for measuring voltages.

Watt: The unit of measurement for electric power.

Electrical Shock Can Kill !!!

Each year, water utility workers receive unexpected electrical shocks while at work. Electricity can kill you if the current passes through a vital organ, such as the heart or brain. For example, if you touch a source of electricity with your hand while standing on an electrical ground or holding an electrical ground with your other hand, the current can pass through your heart and cause severe rhythm problems in the heart muscle. Your heart can stop pumping blood through your body.

Many people ground electrical appliances to water pipes in their homes or businesses. A defective appliance can cause current to flow along the plumbing. If you remove the water meter without knowing about this current flow, you can absorb a lethal jolt of electricity.

If you find a person being shocked, first try to cut off the power. Do not touch the person being shocked with your bare hands or you, too, may get shocked. If you cannot turn the power off, use a dry piece of wood to knock the power source away from the individual or push his or her body partially away from the source of the electrical shock.

When you find someone who is unconscious from electrical shock, the current has probably disrupted the rhythm of the person's heart. The person may not be breathing. Prompt cardiopulmonary resuscitation (CPR) is the best response. Check for breathing and heart rhythm first. Be sure to have someone call the paramedics.

If the person responds, keep him or her lying down and resting. Make sure that the person is transported to the hospital even if he or she objects. Cardiac arrest can occur later.

*** * * END OF PHASE III * * ***

PHASE IV

(FIFTH MONTH)

PHASE IV OUTLINE

The following duties are required to be performed by Utility Plant Worker II in this phase of the Training Program:

Phase IV - 5th Month (Duration two months)

- A. Troubleshooting of low voltage electrical equipment
 - 1. Checking fuses
 - a. Continuity
 - b. Voltage
 - c. Sizing
 - 2. Relays and resets
 - 3. Circuit breakers
- B. Metering of electrical circuits
 - 1. Amperes
 - 2. Volts
 - 3. Watts or kilowatts
 - 4. Power factor
- C. Theory and servicing of motors and generators
 - 1. Parts of motors
 - 2. Parts of generators
 - 3. Cleaning of brushes, and brush rigging
 - 4. Cleaning of collector rings, and commutators
- D. Use of telephone and radio communications equipment
- E. Operational maintenance of valves and small pumps
 - 1. Proper exercise procedure
 - 2. Lubrication
 - 3. Repacking
- F. Interpretation of metering divisions and values
 - 1. Voltmeter
 - 2. Ammeter
 - 3. Kilowatt meter
 - 4. Temperature gauges
 - 5. RPM gauges
- G. Basic Electricity II (AC)

Training Classes: The following classes will be held 2nd Thursday every month
for this phase of training as scheduled below:

Basic Electricity II	7:00 - 9:00
Theory and servicing of motors and generators	9:00 - 11:00
Pump Packing	11:00 - 1:00
Bearing Maintenance; Lubrication	1:00 - 3:00

Phase IV - 2

Basic Electricity II

Transformers

A transformer does just what its name suggests - it transforms, or changes. What does it transform? The voltage and amperage of electricity passing through it. It contains no moving parts, just coils of wire, and in some cases a piece of iron in its' core. The transformer is a device that can only work with alternating current (AC) because of the relationship between electricity and magnetism.

When current moves through a wire, the wire produces a magnetic force. And conversely, when a magnetic force is moved near a wire, a current is produced in the wire. This principle is used in generators to produce power and in motors to produce mechanical motion.

In the transformer, it is applied to two separate coils of wire, one coil connected to the power source, the other coil connected to the power using device(s). A current flowing through the first (primary) coil generates a magnetic field in the space nearby. If the current changes, as alternating current does rapidly reversing its direction, the magnetism will change similarly, reversing the direction of its north and south poles. The result is a moving magnetic force which causes a current to flow in the other (secondary) coil, since current is induced in any wire that is subjected to a moving magnetic force.

The new current that is induced in the secondary coil does not need to be the same as the power supply current in the primary coil. Its voltage and amperage depend on the number of windings (turns of wire) in each coil. If the secondary coil has more turns of wire than the primary coil, the voltage of the secondary coil will be greater than the primary; however, the amperage will be lower than that of the primary. This type of transformer is called a "step-up" transformer and is used at the generating stations to create very high voltages and relatively low amperages for transmission. The combination of high voltage-low amperage reduces inevitable loss of power along the transmission lines.

Whenever electricity passes along a wire, some power is wasted in heat that is generated by electrons moving against the wire's resistance. At a high amperage, a large number of electrons passing through the wire would create a lot of heat loss, making long distance transmission impractical. By reducing the amperage, the transformer cuts the transmission loss, but does not change the total power, which remains constant because the voltage is simultaneously increased.

Between the power station and the homes and businesses, a number of transformers trade volts and amps, stepping voltage up at the generating end, then down in successive stages as the distribution network divides and subdivides to deliver power

to the end-user. The end of this network is visible on a nearby pole: a metal container about the size of a garbage can, that houses a "step-down" transformer, to reduce the local distribution down to what is required at the end-user site.

As you may have figured out, the secondary coil of a step-down transformer will have fewer windings than the primary coil. This means the output voltage will be lower than the primary, but the amperage will be increased.

Current Distribution

Regardless of the voltage, the power lines from the source are connected to some type of "service panel" at the end-user site, usually a metal box that is equipped with safety devices (fuses, circuit breakers, etc.) to shut off the electricity automatically if something goes wrong. The incoming electricity is then divided up into separate circuits. A circuit is a closed (complete) path along which current may pass.

These circuits are generally out of site, consisting of heavy cables that snake through walls and ceilings and terminate at outlet boxes that may be either plastic or metal. These outlet boxes may be simple junction boxes where wires are connected together, circuit breaker panels, switches, or receptacles. At some end-user sites, the incoming power may be fed to additional transformers on site which may be either step-up or step-down transformers. So, you may have a variety of available voltages on site, while there is only one incoming voltage from the power source.

The differences in available voltages call for somewhat different wiring arrangements, which become visible when you open an electrical outlet box. Since we use both 120 and 240 volts at the stations as well as at our homes, we'll give a brief discussion of these two wiring circuits, as you would more likely have a need to check and/or repair something within this range. Note that our heavy machineries such as drainage pumps, Generators, use up to 6,600 volts and the maintenance on these equipment are done by the Board's Facility Maintenance Department ONLY.

120 Volt AC Circuits

The 120 volt circuits are the simpler of the two types. Their cables generally consist of several layers of insulation surrounding three (3) wires: one bare, one coated with white plastic, and one coated with black plastic. The black wire in the cable provides the electric current when a circuit is switched on. It is often called the "hot" wire because it carries electrons "under pressure" at 120 volts, and is therefore ready to perform work. Using the analogy of a plumbing system, the black wire would be the equivalent of the supply pipe carrying water under pressure.

The white wire in the 120 volt system has an opposite function. Because an electrical system must have a complete path, or circuit, the white wire serves as the return path

for the electrons to travel from the using device back to the power plant. It runs continuously through each circuit, bypassing all switches to ensure an uninterrupted return flow. In the plumbing analogy, the white wire is the equivalent of the drain pipe. Just as water flows through the drain under extremely low gravity pressure, so the electrons flowing through the white wire are close to zero volts. The electrons have given up virtually all of their energy in operating whatever device they have passed through.

Because the black wire in a 120 volt circuit is always "hot" unless power is shut off at the service panel, it is dangerous. Touching the black wire while it is hot can shock you, and may even kill you. By contrast, the white wire is neutral. By the time the current reaches this wire, the energy of the 120 volts has been expended, and the wire is then at the same voltage as the earth. It cannot force a current to flow through your body or anything else. Thus, theoretically, it is safe to touch; **BUT DO NOT!!**

Sometimes people make mistakes, or simply take shortcuts and use the white wire as a hot wire. In a few cases, such as a switch loop this is perfectly permissible. So never, under any circumstances, consider any wire, or other part of a circuit safe to work on until you have disconnected it from the power supply and tested it for voltage.

240 Volt AC Circuits

Most of the elements of the 120 volt circuit - safety shutoff devices as well as ground and hot wires within the cables - are also present in a 240 volt circuit. The difference is in the cable and the design of the plugs and receptacles (to prevent anyone from plugging 120 volt devices into 240 volt circuits and vice-versa).

The 240 volt cable usually contains three (3) wires coded in one of two ways:

1. Bare for grounding, black and white for hot.
2. White for grounding, black and red for hot.

When the current is at 120 volts in one "hot" wire, it is also at 120 volts in the other "hot" wire - but flowing in the opposite direction. The total voltage carried by the two wires is thus 240 volts. To deliver 7,240 volts both "hot" wires are hooked up to the terminals of a receptacle. There is no neutral wire in such a circuit; the return to the power source is over one of the "hot" wires. The bare or white wire provides grounding for the entire circuit.

SERVICING MOTORS AND GENERATORS

I. What is a motor?

A motor is a machine that converts electrical energy into mechanical work. All motors are composed of a field winding and an armature winding. In some motors the field is stationary and the armature rotates. In other motors the armature is stationary and the field rotates. The torque, or turning force of a motor result from the interaction between the magnetic field of the field windings with the magnetic field of the armature windings.

Most motors also have brushes and metal rings which transfer electricity to the moving component of the motor. In D.C. motors the metal ring is referred to as either the "Commutator" or the "Collector Rings." In A.C. motors the metal rings are called "Slip Rings."

While there are many different types of motors, we use only four (4) types in sewerage and drainage operations:

- 1) D.C. motors
- 2) Synchronous motors
- 3) Squirrel Cage motors
- 4) Wound-Rotor Induction Motors

1) D.C. Motors: These motors use direct-current electricity in their field windings as well as in their armature winding. Current to the armature windings (rotating winding) is transferred through brushes to commutator. The Commutator is then connected to reverse the direction of the current flow through the armature, always enforcing the turning effort of the machine. D.C. motors are used to operate rheostats and to drive some water booster pumps.

2) Synchronous Motors: A motor which is in unison or in step with the phase of alternating current which operates it. The armature or stator winding is supplied with alternating three-phase electricity, while the field or rotor winding is supplied with direct current. The rotor of this motor must be brought up to the synchronous speed, the speed at which the magnetic field of the stator rotates around the stator. The D.C. supplied to field windings originates outside of the motor. Synchronous motors are used to operate the 12 ft. and 14 ft. diameter pumps in the Drainage facilities. They are also used for some of the constant duty pumps in Drainage Operations. The vertical pumps at Sewer Station "A" also use synchronous motors.

- 3) Squirrel-Cage Motors: These types of motors use three-phase A.C. electricity in its stator windings. The rotor consists of bars of copper, insulated from one another and then joined together at both ends by copper rings to form short circuits. There is no external supply of electricity to this type of rotor. The current that flows in the squirrel-cage rotor is induced by the magnetic field of the stator winding. The rotor of the squirrel-cage motor must revolve slower than the rotating field of the stator, or the motor will not operate. The difference between the rotating speed of the stator-magnetic field and the rotor is called the "slip" of the motors. We use this type of motor to operate motor-generators, vacuum pumps, underpass station pumps, and some water booster pumps. Some constant duty pumps also use squirrel-cage motors. Most of the unmanned sewer stations use this type of motor.
- 4) Wound-Rotor Induction Motors: These motors use three-phase A.C. electricity in their stator windings. The rotors consist of more windings. No external electricity is supplied to the rotor. Current flow is induced in the rotor winding by the rotating magnetic field of the stator winding. The ends of the rotor winding are connected to collector rings. From the collector rings the current passes through the brushes to resistors. By varying the amount of resistance in the rotor circuit the speed of the motor is also varied. Wound-rotor induction motors are used wherever variable speed is desired. The resistance in the rotor circuit may be in the form of grid resistors or liquid rheostats. We use this type of motor in some of the automatic sewer stations. They are also used for the 60 hz horizontal pumps at Sewer Station "A." Drainage Station No. 1 uses this type of motor for the constant duty pump. Station "D" uses this type of motor for all of its pumps.

II. What is a Motor-Generator?

A motor-generator set consists of an A.C. induction motor driving a D.C. generator. A generator is a machine that converts mechanical energy into electrical energy. A D.C. generator produces direct-current electricity.

A D.C. generator, like a D.C. motor, consists basically of:

1. A field winding (stator winding)
2. An armature (rotor winding)
3. A commutator
4. Carbon brushes

These components perform the following functions in the D.C. generator:

1. Field windings - an electro-magnet. This provides the magnetic field through which the conductors of the armature rotate to produce voltage and current.
2. Armature - the coils of wire conductors mounted on the shaft. Their moving through the magnetic field results in the induced voltage and current.
3. Commutator - serves as a switch to periodically reverse the connections of the armature, resulting in an output voltage that maintains the same polarity, and thus the output current remains the same in direction.
4. Brushes - they are usually made of carbon-type material. They transfer the current from the commutator to the external circuitry.

in drainage and sewerage operations we use motor-generator sets for two (2) purposes:

1. As a source of control voltage for some of our closing circuitry.
2. As a source of field excitation for many of our synchronous motors.

MAINTENANCE TO BE PERFORMED ON MOTORS AND GENERATORS

The following services are performed on motors and generators:

Lubrication of Bearings, Cleaning of Commutators and Collector Rings, and Inspection of Carbon Brushes.

1. Lubrication: Procedures for bearings lubrication are outlined in Phase III of this Training Manual.
2. Commutators and Collector Rings: These rings are to be cleaned once a week in the manned stations. This cleaning should be done with a clean dry rag only. The equipment must be taken out of service when this is done. Equipment must be taken out of service properly when brushes are being serviced.
3. Brushes: Brushes must be inspected in all manned drainage stations and at Station "A" on a weekly basis. They are changed by the Facility Maintenance Department when necessary. A brush should be replaced when it measures 1/2 inch in length from the base of the pigtail connection to the face of the brush. Brushes on the automatic sewer stations are inspected three (3) times a week during the regular station check.

Some of Motor Problems and Maintenance:

AC Motors are much like transformers in that heat is the major cause of failure. Heat buildup in a motor, like a transformer, is usually due to overloading or restricted cooling.

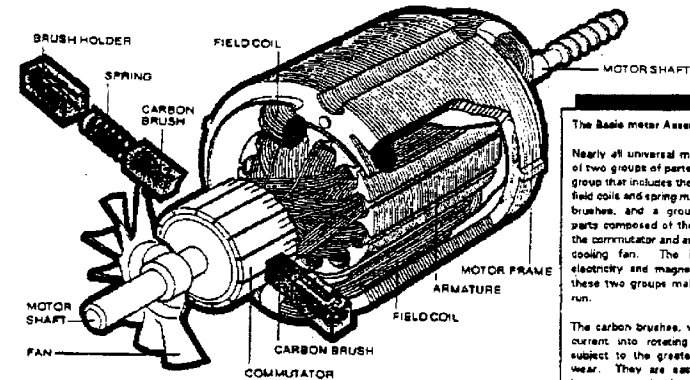
Most motors are air cooled. Many have built-in fans that blow air over the outside of the sealed motor housing, or actually through the motor. If the fan cannot do its job because of dirt restricting airflow or insulating surfaces, the motor will run hot.

Keep motors, fans and vents clean!

Motors also get hot when they are:

- ✦ Started, braked, or reversed too frequently in too short of a time
- ✦ Expected to produce more than their rated power
- ✦ Defective, either mechanically or electrically
- ✦ Operated on low voltage
- ✦ Operated with unbalanced phase voltages
- ✦ Operated in a hot environment

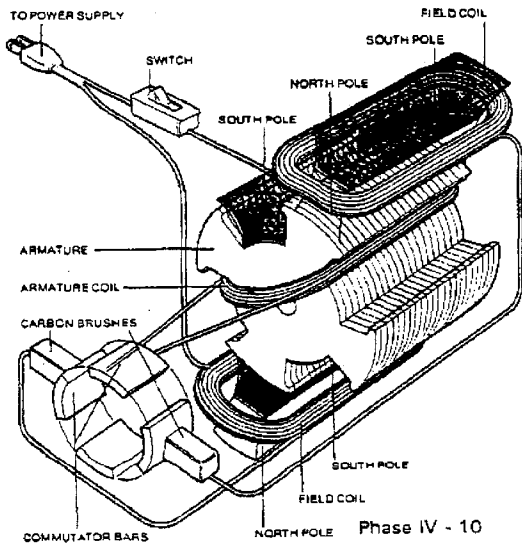
HOW MOTORS WORK



The Basic Motor Assembly

Nearly all universal motors consist of two groups of parts: a stationary group that includes the motor frame, field coils and spring-mounted carbon brushes, and a group of rotating parts composed of the motor shaft, the commutator and armature, and a cooling fan. The interaction of electricity and magnetism between these two groups makes the motor run.

The carbon brushes, which transfer current into rotating system, are subject to the greatest amount of wear. They are easy to replace, however, and they should be checked as part of the motor's maintenance.



The Electrical Circuit

Operation of the motor involves two stationary, or field coils, wired so that they carry current in opposite directions. One end of each field coil is connected to the power supply, the other to a carbon brush. Between the brushes, the circuit continues on into the rotating, or armature, coils through a number of commutator bars.

The wire ends of each armature coil are connected to two adjacent commutator bars as shown (for clarity, only one armature coil has been drawn). When the motor is switched on, the current flows from the power source through the first field coil and on to the first carbon brush. Contact between the brush and one of the commutator bars sends the current simultaneously through the two armature coils that are wired to that bar, then consecutively through each remaining armature coil on both sides of the brush. The second brush, with a bar on the opposite side of the commutator, picks up the current and sends it through the second field coil and back to the power source. The magnetism created by the passage of current through the various coils makes the motor turn.

Bearing Maintenance; Oil Changing

When storing lubricants such as grease or oil, cleanliness is of utmost importance. A grease pail or oil drum which has become contaminated with dirt, water, or other material should be discarded in the proper manner, and the lubricant should not be used. Contaminated lubricants will ruin the equipment you are trying to protect. Always keep containers closed when not using.

- 1) Check the equipment to see that the oil level indicator sight glass, dip stick, etc. is properly marked to show oil level before proceeding to drain the unit. If not properly marked, notify your supervisor. **DO NOT** proceed with changing of oil.
- 2) Shut off unit being serviced at motor control panel, making sure you follow all required safety and operating procedures for working on or repairing equipment.
- 3) Check the lubrication chart for the facility, if one is available, get the proper oil for the equipment making sure that it is free of dirt and other contaminants.
- 4) Wipe area around fill and drain plugs, or valves, with clean rag. Also, wipe off the funnel, top of oil drum, and bucket.
- 5) Place container under drain plug or valve. Remove the drain plug, or open valve, and remove fill plug, or open fill valve.
- 6) After oil has drained out of unit, using a clean funnel with screen, flush the bearing with the proper oil until the oil comes out clean.
- 7) Put used oil in a waste oil drum, making sure that the drum is properly marked. When the waste oil drum is filled, notify your supervisor to have the waste oil picked up.
- 8) Clean out all sight glasses, or flow indicators on units oil system.
- 9) Install drain plug, or close valve. Pour in new, clean oil, through a clean funnel with a screen in it. Fill to proper level. This can be determined by the dip stick, ring or sight glass. Different pieces of equipment use different methods to show proper oil level.
- 10) Install filler plug, or close fill valve. Wipe off any oil that has been spilled on or around equipment.
- 11) Put unit back in service, making sure that you follow all safety and operating procedures.

- 12) Run the unit long enough to bring the bearings up to normal operating temperature. While the unit is running, frequently monitor the temperature gauge, or feel for heat by placing your hand on the bearing and slowly counting to ten. Check for leaks on the unit, and if applicable, check the oil level while the unit is running.

CAUTION: Oil levels on some equipment should only be checked with the unit STOPPED, otherwise you may overfill the unit and possibly create more problems.

- 13) Record this maintenance in the log book and/or route report if applicable.
- 14) Monitor the unit for unusually high temperature or noises during the next several hours of operation or next several daily checks. If anything unusual is observed, stop the unit, record it in your log book and notify your supervisor.

Bearing Maintenance; Grease Lubrication

When storing lubricants such as grease or oil, cleanliness is of utmost importance. A grease pail or oil drum which has become contaminated with dirt, water, or other material should be discarded. Contaminated lubricants will ruin the equipment you are trying to protect. Always keep containers closed when not using.

- 1) Run the pump for a few minutes to warm up any stiff grease in the bearing. This is especially important during the colder months.
- 2) Identify the proper type of grease to be used in the equipment. Make sure the grease you are using is clean and has not been left in an open container.
- 3) Pump one or two shots of grease from your grease gun into a clean rag, and wipe off the end of the hose.
- 4) Turn off the equipment and pull disconnects or fuses. In the manned stations, sign on the unit and log in log book. Follow all safety and operating procedures.
- 5) Clean the grease fitting on the equipment to be greased with a clean rag, and wipe off the end of the hose.
- 6) Pump in the new grease until all the old, discolored grease no longer comes out the relief opening. Watch around the bearing seals while doing this, so as not to possibly blow out a seal due to hardened grease not exiting the relief hole, and causing the fresh grease to be forced through the seal. If there is no relief plug, pump in three (3) shots of grease.
- 7) Put unit back in service. Follow all safety and operating procedures.
- 8) Turn on pump and allow to run for a few minutes so that any excess grease can exit the relief hole. Too much grease can damage a bearing by allowing excessive heat buildup. Allow the unit to run long enough to get the bearing up to normal operating temperature. In manned stations, the unit should be run for four continuous (4) hours.
- 9) While the unit is running, monitor the bearing temperature either with a temperature gauge, or by placing your hand on the bearing and slowly counting to ten. If the bearing seems to be running hotter than normal, stop the unit and notify your supervisor.

- 10) If bearing checks out satisfactorily, stop unit, shut it off, and if in a manned station, sign on the equipment and log it in the log book.
- 11) Wipe area around grease relief hole and replace plug. Wipe off area around grease fitting. Clean around grease seals if necessary.
- 12) Put unit back in service. In the manned stations you will have to sign off the equipment.
- 13) Record this maintenance in the station log and/or daily route report.
- 14) Monitor the unit for the next few days for unusually high temperatures or noises. If anything unusual is observed, record it and report it to your supervisor.
- 15) Whenever equipment is checked, wipe off any grease that may seep out from the seal area. Also clean the wall close to the pump if grease has been flung on it after seeping out of the seal. Your equipment is only as clean as YOU keep it.

Pump Packing Procedure

(Excluding Major Drainage and Sewerage Units)

As part of your job it is required that the pump packing to be replaced periodically. Note that this section applies to ALL unmanned Sewerage Pumping Stations, Underpass Drainage Pumping Stations, and small pumping units throughout our system.

I. Preparation of Pump for Packing

- 1) Take unit out of service following all required safety and operating procedures.
- 2) Close discharge valve, and if pump is a positive suction type close the suction valve.
- 3) If pump uses water for lubrication, turn off water supply to packing.
- 4) If pump is positive suction type, open bleed valve on volute or loosen inspection cover to determine if you have good closure on the valves. If you cannot get good closure, **DO NOT PROCEED WITH STEP 5!** Contact your route supervisor.
- 5) Remove packing gland nuts and/or bolts and remove gland. The packing gland is a two-piece device usually held together with 2 screws. Separate the halves and place the two pieces out of your work area, being careful not to lose the screws.
- 6) Each level of packing in the **packing box** (also called **stuffing box**) is called a "turn" or "row". Remove the rows of packing by screwing a packing hook into the packing and pulling up with a slow steady motion. Do not attempt to jerk the packing out, as this will cause the packing hook to pull out of the packing, tearing it and making it more difficult to remove. Care should be taken when using the packing hooks to prevent scoring or nicking the pump shaft.
- 7) After the top rows of packing (usually 2 or 3 turns) have been removed, the **lantern ring** (or **water ring**), must be removed. This can usually be fished out using a heavy piece of wire with a hook bent on the end. The hooks are inserted into two holes which are directly opposite of each other. Some rings have threaded holes that a screw of appropriate length may be screwed into, and then pulling evenly on the screws will pull the lantern ring out. It is important that the ring be pulled up from

both sides together to prevent the ring from cocking sideways in the stuffing box and possibly jamming.

NOTE: It may be necessary to clean around the shaft and/or stuffing box in order to get the ring out. If the pump has been in service for a while, you may find that it helps to tap on the ring with a small wooden stick or dowel to loosen it. If still unable to remove the ring, notify your supervisor.

Once the ring is pulled out of the stuffing box, they can usually be split apart like the packing gland to be moved out the way. If there is no lantern ring in the stuffing box, notify your route supervisor immediately...Do not repack pump without installing a lantern ring!

- 8) Next, remove the remaining rows of packing. In some older pumps there will be rubber packing under the lantern ring. This is not to be removed by operations personnel. If rubber packing is found under the lantern ring, notify your route supervisor.
- 9) Clean out the stuffing box and the shaft as best you can. It will make repacking the pump easier, and will help to prevent debris from damaging the shaft and the new packing.
- 10) If the pump uses water to seal and lubricate the packing, open the water line to flush it out. If the pump uses a grease cup, remove the grease cup and clean out the line entering the packing box, and clean out the grease cup.
- 11) During the repacking process it is very important that all rows of packing as well as the lantern ring to be installed in their proper positions. The lantern ring must be reinstalled in the exact location otherwise the lubricating liquid (water) will not enter the packing box properly; therefore, major damage to the pump can occur.

II. Determining Packing Requirements

- 1) To determine the correct packing size, measure from the shaft to the inside wall of the stuffing box with a scale or rule. Whatever the measurement is, will be the size of the packing needed. In the case of our illustration, shown on page (18), let us assume the measurement is 1/2", thus we will need 1/2" packing.
- 2) Next we measure from the top of the packing box to the bottom of the inside of the box. In our illustration this measurement is 3 1/2". We will

call this measurement "A".

- 3) Using a small rod with a hook bent at a 90° angle, insert the rod into the stuffing box and set the hooked end into the water or grease seal inlet. Grasp the rod firmly at the top of the stuffing box, remove it and measure the length from where the top of the stuffing box was, to the hook. In our illustration the length is 1 1/2". We'll call this measurement "B".
- 4) Subtract this length, (B), from the length of the packing box, (A), to determine the length from the bottom of the seal inlet to the neck ring. We'll call the difference "C".

$$3 \frac{1}{2}"(A) - 1 \frac{1}{2}"(B) = 2"(C)$$

We then divide 2" (C) by the size of the packing, in this case 1/2":

$$2 / (1/2) = 4$$

We will need 4 rows of packing below the seal inlet.

- 5) Since the lantern ring is to be in line with the seal inlet, it will go in after the 4th row of packing. To find out how many rows of packing will be needed above the lantern ring, measure the thickness of the lantern ring (3/8" for our illustration). We'll call this measurement "D". We then add "C" to "D" and subtract from "A".

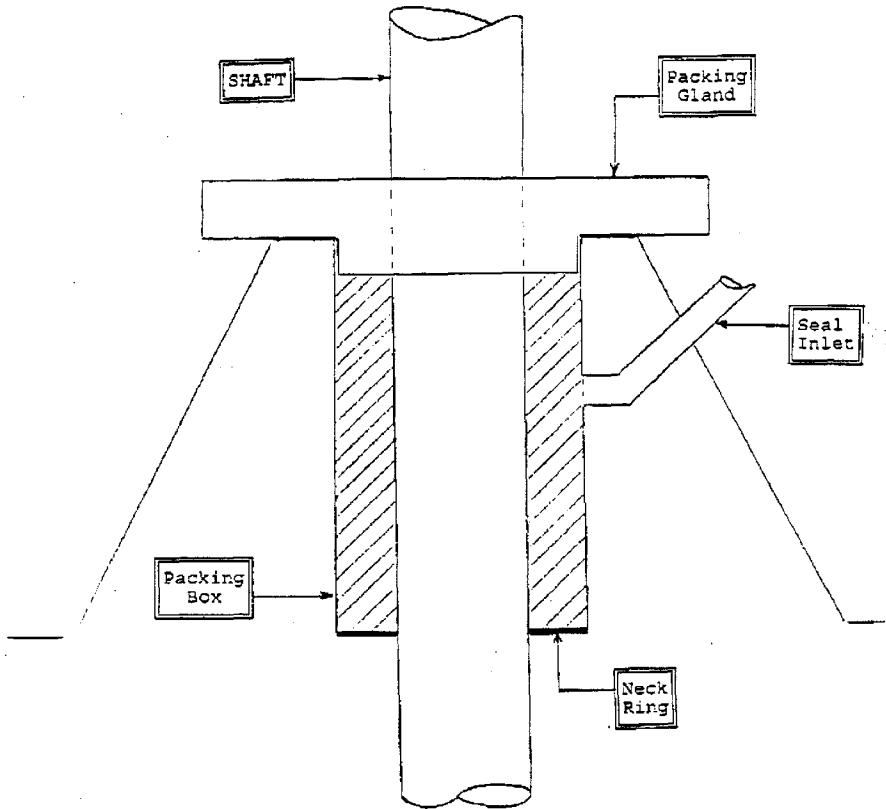
$$\begin{aligned} A &= 3 \frac{1}{2}" , \quad C = 2" , \quad D = \frac{3}{8}" \\ C + D &= 2 + \frac{3}{8} = 2 \frac{3}{8}" \\ A - (C + D) &= 3 \frac{1}{2}" - 2 \frac{3}{8}" = 1 \frac{1}{8}" \end{aligned}$$

We now know that we have 1 1/8" remaining above the lantern ring to the top of the stuffing box. We then divide that measurement by the packing size to determine how many turns are needed above the lantern ring. 1 1/8" divided by 1/2" = 2 with 1/8" left over. This 1/8" will allow for the packing gland to set inside the stuffing box. These measurements should be recorded on the inside of the front or rear cover of the station log book for future reference.

- 6) Now that we know what size packing we need and how many rows are required above and below the lantern ring, let's get some clean packing and pack the pump.

PUMP PACKING BOX

(The Lantern ring for this packing box is 3/8")
(Drawing is to scale)



Phase IV - 18

III. Packing the Pump

- 1) Having prepared the pump and obtaining the correct packing, lay out a clean plastic bag, or clean rags, on which to work with the packing. You should NEVER lay the packing directly on the floor. Packing that has been contaminated with dirt, sand, grit, or other foreign matter should be discarded. Using packing that has dirt in it will eventually cause the pump shaft to wear excessively, creating an expensive repair job.
- 2) To determine the correct length for each row of packing, wrap the packing around the shaft making sure the packing does not twist. Pull firmly together and mark the packing where the end meets. Lay the packing on a clean surface and with a sharp knife, or packing cutter, make a clean, even cut.
- 3) Check the turn for proper fit by wrapping it around the shaft. The ends should meet with no overlap and no gap between the ends. If the turn is a good fit, cut the remaining rows needed to the same size.
- 4) Wrap the packing around the shaft and insert it into the stuffing box, keeping the ends together. Working around the shaft evenly, push the packing down as far as possible. If necessary, use short pieces of wood to tap the packing down in place. It is very important that the ends stay together and that the packing lays flat. If the packing is not flat, successive rows will become a greater problem, as they will not lay flat either.
- 5) As the rows are placed in the stuffing box, stagger the ends at least 1/4 turn from the previous row that was inserted.
- 6) After installing the first 4 rows in our pump illustration, we would then install the lantern ring. Remember, the lantern ring must be in line with the water or grease seal inlet.
- 7) Install the remaining rows of packing, alternating the ends as described in #5. The last row may have to be left out until the packing has been seated inside the stuffing box by pushing down with the packing gland.
- 8) Place the packing gland around the shaft and re-assemble it. Install the gland inside the stuffing box. Tighten the gland down, hand tight only at first, to prevent excessive leakage. The gland should be square with the pump shaft to prevent it from rubbing on the shaft.

IV. Starting the Re-packed Pump

- 1) Make a visual inspection of the area, making sure that the area around the pump is clear of tools, rags, etc.
- 2) Open seal water, or refill grease cup and install grease cup on seal inlet.
- 3) Open discharge and suction valves.
- 4) Make sure all personnel are clear of pump.
- 5) Put pump back in service following all safety and operating procedures. Start unit and observe its' operation. If there are any unusual noises, or if packing begins to get hot, shut the unit off and investigate the problem. If no problems are observed, proceed.
- 6) A good packing job can be easily ruined by improper gland adjustment. While the pump is running, carefully tighten the gland (a little at a time), to prevent excess leakage. A little leakage is necessary to ensure cooling and lubrication of the packing.

Tighten the gland evenly, so as not to cock the gland. This is done by tightening up 1/4 to 1/2 turn on each gland bolt alternately. Tightening up too much on one side can cause the gland to jamb against the shaft and cause damage.

Allow the pump to run for a few minutes, as you monitor the gland temperature by feeling it with your hand. The gland should remain cool. If it begins to get hot, stop the unit and allow the gland to cool down. Back off the gland bolts a turn or two, then restart the pump and observe again. Readjust as necessary.

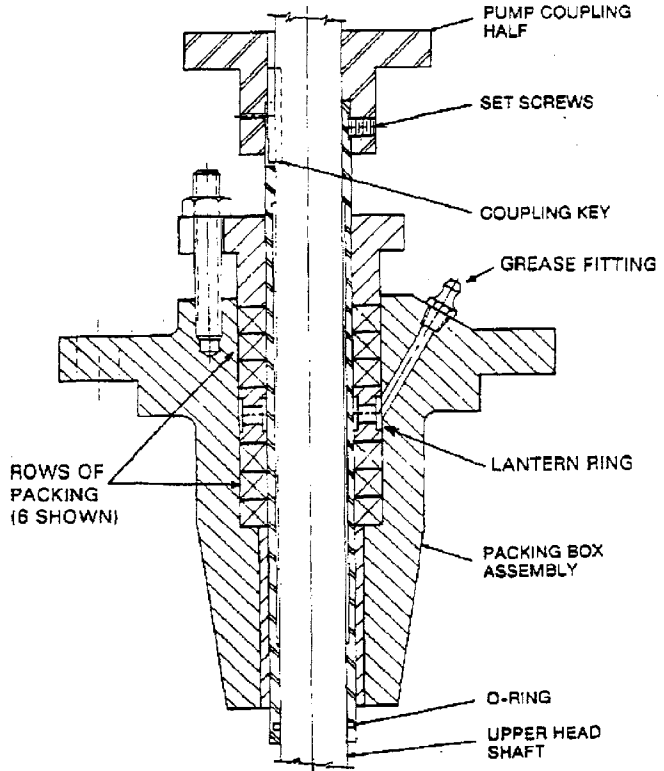
- 7) Once you have finished with the packing, place it back in the box and/or a clean plastic bag. **DO NOT LEAVE PACKING MATERIALS EXPOSED!** Contaminated packing can ruin a pump shaft. Packing is also a very expensive item. Show your responsibility in your job performance and handle packing in a proper manner.
- 8) Record this maintenance in your station log book as well as on your daily route report. Note all measurements taken, size of packing used, and the number of turns placed before the lantern ring and after the lantern ring.
- 9) Thereafter, inspect the packing gland during each station inspection. As the packing wears, it will be necessary to adjust the gland. Eventually

the gland will be seated all the way down, allowing for no further adjustment. At this point the pump must be repacked. Under no circumstances should a pump be left to run over the weekend if the gland is fully seated. The pump is to be repacked at that time!

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TYPICAL PUMP PACKING BOX

(Picture depicts a typical grease lubricated shaft)



Phase IV - 22

RADIO and TELEPHONE COMMUNICATIONS GUIDELINES

Radio Communications

The radio equipment are provided to help in the operations of the Board and shall not be used for any other reasons but work related situations. Personnel who abuse the equipment will be dealt with accordingly. Channel 11 AND 31 are high priority channels which are monitored 24 hours a day.

Eastbank Drainage Operations operate on radio Channel 11.
Eastbank Sewerage Operations operate on radio Channel 31.
Westbank Drainage and Sewerage Operations operate on Channel 11.

In order to have a proficient radio communications throughout the Board the following guidelines are established:

- Only qualified personnel are authorized to use the radio communication device. The supervisory personnel will determine who has the proper qualifications depending on training progress.
- When transmitting a radio message speak loudly and clearly into the microphone. The microphone should be close to your mouth as possible.
- If initiating the radio call hit the "Transmit" button on the radio, wait for transmit signal (usually a loud beep) then hold "Transmit" button and proceed with your message.
- Always identify yourself first; either name and title, truck number, or facility name.
- If you are receiving a radio call wait till the message is complete then hold "Transmit" button and respond by identifying yourself first.
- The following are some typical verbiage for initiating a radio call:

SENDING MESSAGE

"Truck 123 to Drainage Station 5"
"John Doe of Maintenance to Drainage Office"
"Machine Shop to Central Control"

RECEIVING MESSAGE

"This is DPS 5 Operator"
"Drainage Office"
"Central Control"

- Once you have established who you are talking to state your message. Please note that your communications must be short, accurate, and to the point.

- The person receiving the message must repeat the message to assure that the message has been properly received and understood.
- After the message is gone through, the ending to the communication should be by identifying yourself and the word "Clear".
- The following are the typical verbiage for ending a radio communication:

SENDING MESSAGE

"Truck 123 Clear"
 "John Doe Clear"
 "Machine Shop Clear"

RECEIVING MESSAGE

"Drainage Station 5 Clear"
 "Drainage Office Clear"
 "Central Control Clear"

The following Radio Checks are currently performed by Central Control and Facility's Operator:

A. 7:00 a.m., and 7:00 p.m. Radio Checks:

Board setup-feeders, opened or closed, voltage or no voltage on feeders, buss ties opened or closed, equipment out of service and for who, suction and discharge elevations. Central Control should be notified if U.P.W. II in training is authorized to answer radio.

Typical response from Drainage Pumping Station No. 2:

Feeders 24, 224, 204, 304, 404, and 406 are closed with voltage;
 Feeders 46, and 18 are open with no voltage;
 Bustle 1 is closed, bustles 2 and 3 are open;
 Suction is 10 feet, and discharge is 16.2 feet.

B. Random Radio Check:

Station should identify itself, only the operator in charge should answer the radio and identify himself/herself as the operator and should give his/her last name. If the operator is going to be away from the radio for any length of time Central Control should be notified. Remember the operator is the prime responsible person for the facility.

C. Rainload Rundown:

Stations must identify themselves as stated previously and give the following additional information:

- What pumps are loaded,
- What pumps are running (light (no load),
- Rain intensity,

- Rain gauge reading (stick or recorder), and
- Suction and discharge elevations (drainage and Sewerage Operations).

Station "D", and Carrollton Frequency Changer should give load (25 cycle kilowatts or megawatts) information.

ii. Telephone Communications



All telephone lines should be answered by:

Good morning or Good afternoon, _____ † Pumping Station _____ †,
" _____ ‡" Operator

† (Identify facility's name OR number, where applicable)

‡ (Identify the name of the individual answering the telephone)

Messages shall be taken and forwarded to proper personnel as soon as possible.

No long distance calls or operator assisted calls shall be made and/or accepted. Personal telephone calls shall be limited to three (3) minutes.

Lockout-Tagout Procedures Saves Lives

John Doe was changing a blade on his table saw in his garage when he accidentally caught his pants pocket on the on/off switch. The motor turned on and John lost three fingers.

You might think this was a freak accident, but every year hundreds of people are injured or killed when power is inadvertently turned on while they are working on a machine. Freak accidents don't exist.

Both at home and at work, it is important to disconnect tools from their power sources when servicing them. At work, disconnection often means turning off the power at a master switch. Even if you have turned the power off at the master switch it is a good practice to use proper instrument to check for voltage.

Even if you are going to be in continuous sight of the master switch, lock out the power by proper means. This way, another worker cannot turn on the power while you are away from the machine or while you turn your back momentarily. Also, you should place a tag on the switch indicating the reason the machine is locked out, the period of time it will be locked out, and your name. If more than one person is working on the machine, each person should place his or her lock individually onto the switch and tag it. Special multilocking devices are available for such purposes.

Lockout-Tagout procedures are covered by Occupational Safety and Health Administration (OSHA) Regulation (Sept. 1, 1989) 29CFR 1910.147.

* * * END OF PHASE IV * * *

NOTE

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NOTE

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PHASE V

(SEVENTH MONTH)

PHASE V OUTLINE

The following duties are required to be performed by Utility Plant Worker II in this phase of the Training Program:

Phase V - 7th Month (Duration two months)

- A. Operation of electrical switchgear
 - 1. Low voltage equipment
 - 2. High voltage equipment
 - 3. Control voltage

- B. Potable water system
 - 1. Water meter locations
 - 2. Shutoff valves
 - 3. Backflow prevention
 - 4. Pressure switches
 - 5. Seal water and adjustment
 - 6. Water solenoids and bypasses
 - 7. Float tube flushing
 - 8. Hydraulic gates
 - 9. Drawing of water system diagram

- C. Vacuum priming system
 - 1. Vacuum pumps
 - 2. Locations of valves
 - 3. Purposes of valves
 - 4. Pressurization of vacuum system
 - 5. Drawing of vacuum system diagram

- D. Suction lift
 - 1. Vacuum reading and analysis
 - 2. Atmospheric pressure
 - 3. Conversion of inches of Mercury (Hg) to feet of head
 - 4. Conversion of feet of head to inches Hg
 - 5. Methods of determining if a pump is loaded

- E. Recorder systems
 - 1. Cairo Datum elevation system
 - 2. Air compressors
 - 3. Regulators
 - 4. Flow meters
 - 5. Bias relays

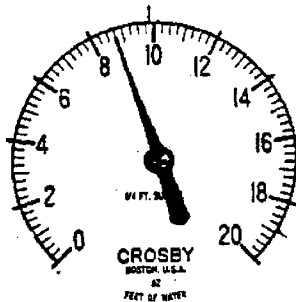
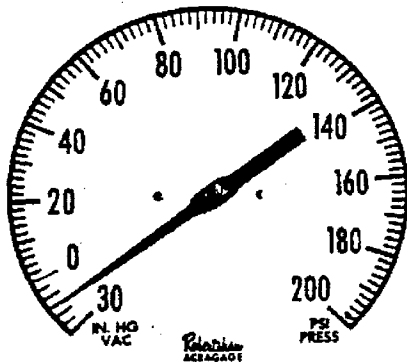
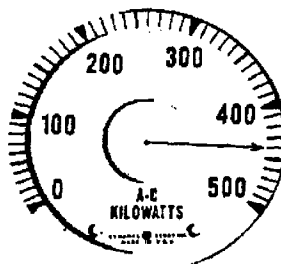
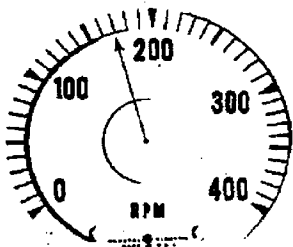
Phase V - 1

6. Suction recorders
7. Discharge recorders
8. Pump recorders

Phase 5 Training Classes: The following classes will be held 3rd Tuesday every month for this phase of training as scheduled below:

Recorder Systems' Automation
 Suction Lift, Elevation
 Water and Vacuum Systems

8:00 - 10:00
 10:00 - 12:00
 12:00 - 2:00



Typical Gauges Used in Our Operations

Phase V - 2

SUCTION LIFT... VACUUM AND FEET OF WATER

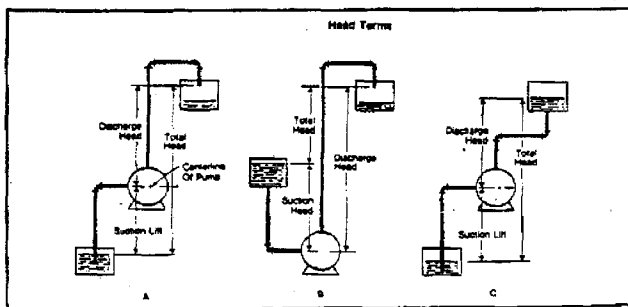
In order for a liquid (drainage AND/OR sewerage) to be pumped it must be able to reach the impeller of the pump, either by gravity or some other means (See Phase VI for discussion about pumps).

In majority of our facilities the pumping unit is installed above flood level so the water, either drainage or sewerage, must somehow find its way to the pump impeller. For this reason we use Vacuum Pumps throughout our system. Vacuum pumps basically suck the air from the suction pipe; therefore, allowing the atmospheric pressure to push the water to the impeller and from there the drainage OR sewerage pumping unit will take over. There are certain terminologies that we use when we talk about pumps and the purpose of this section is to make you understand these terms.

The following definitions are quoted from the Hydraulic Institute Standards and are illustrated in figure shown below:

- Suction Head:** Suction head exists when the suction head is above atmospheric pressure.
Suction Lift: Suction lift exists when the suction head is below atmospheric pressure.
Discharge Head: Discharge head is the reading of a pressure gauge at the discharge of the pump, converted to feet of liquid and referred to datum plus the velocity head at the point of gauge attachment.
Total Head: Total head is the measure of work increase per pound of the liquid, imparted to the liquid by the pump, and is therefore the algebraic difference between the discharge head and the suction head.

It must be admitted that the above formal definitions are not too clear or edifying for anyone not already well versed in pump fundamentals. As we proceed with discussion on pumps, however, the definitions should become clearer and more easily understood.



Phase V - 3

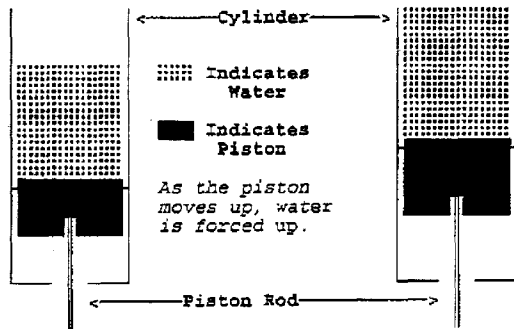
If a piece of steel is laid on the floor it retains its shape and form. It can be picked up and moved. There are very strong cohesive forces holding the piece of steel together. Water lacks these cohesive forces.

The lack of these cohesive forces prevents a pump from grabbing the water from above and lifting it. Therefore, no actual lifting of the water is done by the pump.

Water will take the shape of the container it is in. A cup of water is in the shape of the cup; however, if the same water is poured into a bucket it takes the shape of the bucket.

If you fill a vertical cylinder that has a piston at the bottom of the cylinder with water, the water will take the shape of the cylinder. The water can be raised by forcing the piston upward. So water can be pushed up from below, but cannot be pulled up from above.

The illustration below shows water being forced upward with a piston. Note that the water always takes the shape of the container, it has no fixed shape:



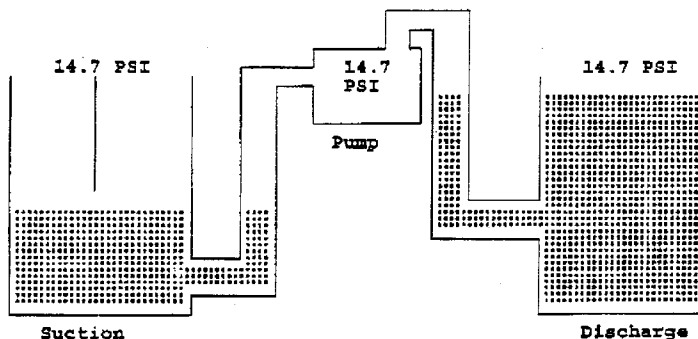
In the case of negative suction lift pumps, a vacuum must be created to push the water up and into the pump. A vacuum is any space without matter. In practice, a perfect vacuum is unattainable, but it is common to refer to a region of space with a very low density of matter as a vacuum, or more correctly as a partial vacuum.

As the air (matter) is removed from the inside of the pump, the density of the gas (air) is reduced. This reduction of density causes the outer atmospheric pressure to force the water upward to fill the void space, or area of lower pressure.

Atmospheric pressure at sea level is 14.7 P.S.I. (pounds per square inch). As the density of the gas (air) inside the pump is reduced the pressure inside the pump is reduced. When this occurs, the outside pressure, being greater than the inside pressure, forces the water into the pump.

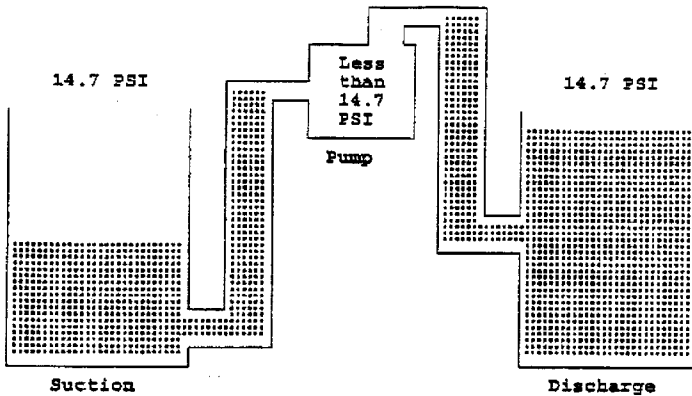
The air inside the suction pipe and/or pump casing is removed, either by the pump impeller (to some degree) or by some external means such as vacuum pumps. Atmospheric pressure pushes down on the surface of the water in the wet well and forces the water into the suction pipe and/or pump to replace the air being removed. The work done on the suction side of a pump is always limited by atmospheric pressure, as atmospheric pressure acts as the piston to force the water into the suction pipe and/or pump.

Atmospheric Pressure Inside and Outside of the Pump



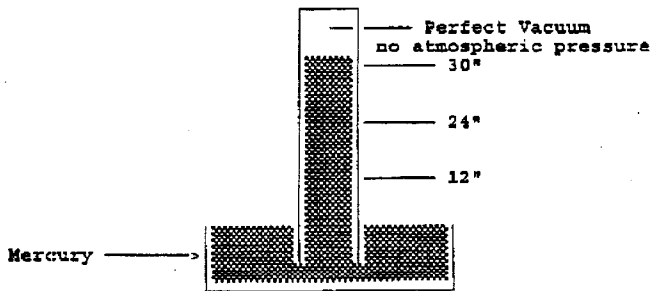
As you can see in the above illustration, the water inside the suction and discharge pipes are the same height as the water in the suction and discharge bays while the pressure inside the pump is matched to the pressure outside the pump.

**Atmospheric Pressure Outside of the Pump
Reduced Pressure Inside of the Pump (Partial Vacuum)**



Illustrations show that as the pressure inside the pump is reduced the force of atmospheric pressure exerted on the surface of the water outside the pump forces the water up the suction and discharge pipes. The height of the water inside the pipes is now higher than the water in the suction and discharge bays.

A vacuum or partial vacuum is normally measured in inches of mercury (inches Hg). (The symbol "Hg" stands for mercury) A perfect vacuum is equivalent to approximately 30" Hg. This means that if all matter is removed, mercury will rise 30".



Because water is lighter than mercury, water will rise to 33.95 feet in a perfect vacuum. This can be computed by converting atmospheric pressure to feet as follows:

$$14.7 \text{ PSI} / 0.433 = 33.95 \text{ feet of water}$$

Therefore the maximum suction lift a pump can obtain is limited by the available atmospheric pressure. In practical use, the maximum suction lift a pump can achieve is about 25 feet of water. This lift is limited by the ability to create as near a perfect vacuum as possible in field applications.

In most cases the actual suction lift will be less than 25 feet. To compute the actual vacuum required to make any given lift, use the following:

$$\text{Feet of Lift} / 1.133 = \text{Inches of Mercury (Hg)}$$

Example: If we know that a pump is 10 feet above the surface of the suction water, and we want to know what vacuum is required to load the pump (fill the pump with liquid), using the above formula:

$$\begin{aligned} \text{Feet of Lift} / 1.133 &= \text{Inches of Hg} \\ 10 \text{ feet of lift} / 1.133 &= 8.83 \text{ Inches of Hg} \end{aligned}$$

If we have a vacuum gauge attached to the pump, and can measure the vacuum, the gauge reading can be converted to show the actual feet of lift.

The vacuum gauge shown elsewhere in this section shows a reading of 15" Hg. To find the actual feet of lift, use the following formula:

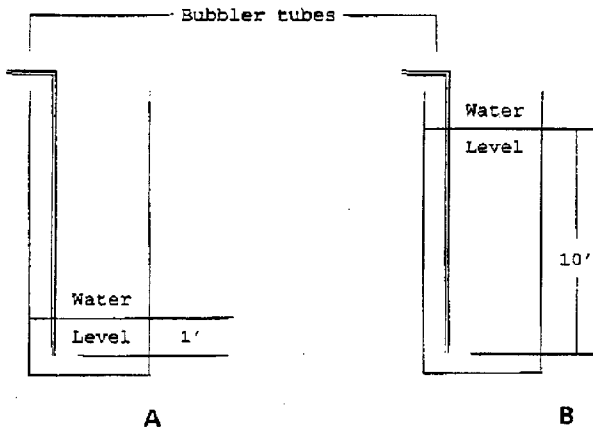
$$\begin{aligned} \text{Inches Hg} \times 1.133 &= \text{Lift of water in feet} \\ 15" \text{ inches Hg} \times 1.133 &= 16.995 \text{ feet of lift} \end{aligned}$$

Another type of gauge used to measure a vacuum is a compound gauge. A compound gauge measures pressure in PSI and Vacuum in inches Hg. Normally the numbers on the right side of "0" (zero) indicate pressure in PSI and numbers on the left side of the "0" indicate vacuum in inches of Hg. A typical compound gauge is shown elsewhere in this section.

Bubbler Tube Automation Systems

In addition to "Staff Gauges" Bubbler Automation is also used throughout our facilities in order for the station's operators to know the elevation of the water; either drainage or sewerage. The bubbler tube automation system is based on the principle of air pressure in a tube or pipe, that is set in a liquid (such as water) displacing the liquid and forcing air out of the bottom of the tube. It requires a specific amount of air pressure to displace a given amount of liquid.

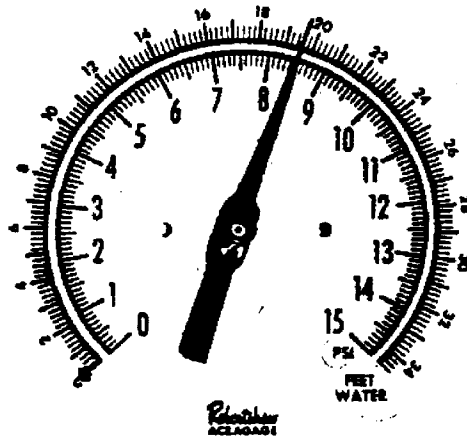
Since we are working with water (drainage and sewerage), it takes 0.433 pounds per square inch (P.S.I.) to displace one foot (1') of water. For every additional foot of water above the open end of the bubbler tube, it will require an additional 0.433 P.S.I. of air pressure to get air bubbles out of the bottom of the tube.



In illustration A, the water is one foot (1') above the open end of the bubbler tube. It will require 0.433 P.S.I. of pressure to get bubbles coming out of the bottom of the tube.

In illustration B, the water is ten feet (10') above the open end of the bubbler tube. If we multiply 10×0.433 , we find that we need 4.33 P.S.I. of pressure to get bubbles coming out of the tube.

The gauge shown below illustrates the relationship between the elevation of the water and the corresponding amount of air pressure required to read the elevation.



Looking at the above gauge you'll notice that there are two (2) sets of numbers on the gauge face. The inner set of numbers range from "0" to "15" and is read in PSI (pounds per square inch). The outer set of numbers read from "0" to "34.6" and is read in Feet of Water. Notice that both number scales increase as you read from left to right. To be able to "read" or sense a particular level of water with this gauge, the amount of air pressure on the inner scale must be available in the system.

If you look at the "10" mark on the outer scale you'll see that the PSI scale is at 4.33, or 1 foot of water is equivalent to .433 PSI. The indicator in this example is showing approximately 19.6' of water. In order to read this elevation, the system must have a minimum of 8.48 PSI of air pressure going into it ($19.6 \times 0.433 = 8.48$ PSI).

If we know the maximum amount of air pressure that a system is working on, we can determine the highest elevation that we will be able to read.

Example:

We have our bubbler systems operating with 10 PSI. Looking at the gauge, we will be able to read from "0" to approximately 23' of water. (This is the deepest of any of our wet wells.)

If the pressure were set at 5 PSI, we would only read elevations up to 11.55', which would not be sufficient at many of the stations.

CONVERSIONS:

Feet of water X 0.433 = PSI

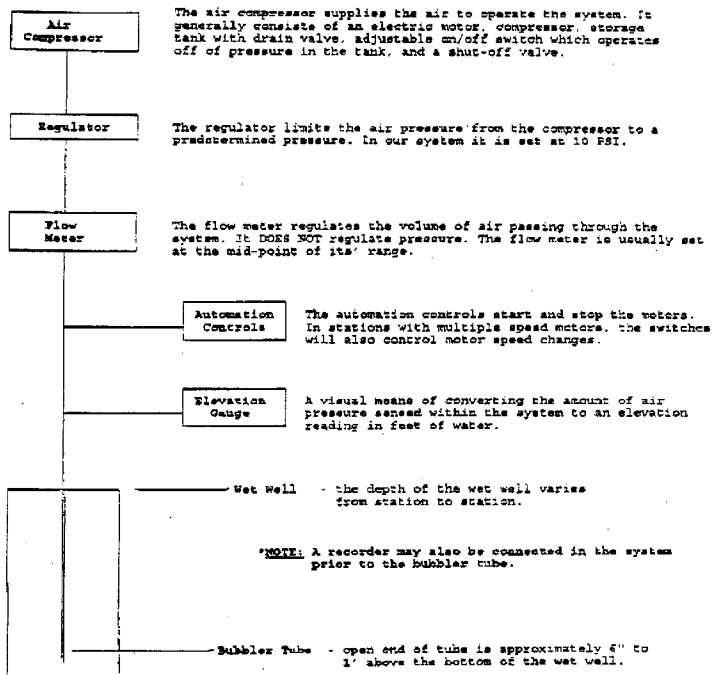
PSI / 0.433 = Feet of water

Feet of water / 1.133 = Inches of Hg

Inches Hg X 1.133 = Lift of water in feet

Bubbler System Components

Now that you know the basic principle of how our bubbler tube automation systems operate, let's look at a one-line diagram of the system to better understand the relationship of each of the components within the system. While the physical layout and type of components may vary at the different facilities, the basic principle of how the system works remains the same:



Next, we'll look at the system from the bottom up, and explain some more of the details of how the components relate to one another.

1. **Wet Well OR Suction Basin**

The wet well (in the sewerage system) OR Suction Basin (in the drainage system) is the terminal point of the collection system at the site of the station. It can be of any size, shape or depth. In the sewerage system, at most stations, the suction lines of the pumps are connected into the wet well. At a few stations the pump, and in one case the pump/motor units are submerged in the wet well. The depths of the wet wells in our system range from approximately 10' to 23'. In the drainage system the water will flow toward the stations in the suction basin. There are bubbler systems both for suction and discharge of most drainage pumping stations.

2. **Bubbler Tube**

The bubbler tube is usually made of 3/4" schedule 40, type 316 stainless steel. Stainless steel is used because it is highly resistant to corrosion. The bubbler tube is kept from 6" to 1' above the bottom of the wet well. This is done to help prevent blockages in the tube from siltation. Since the water that enters the wet well or suction basin will sit there for a while, some of the suspended solids will settle down to the bottom. Over a period of time the siltation will build up. If the open end of the bubbler tube was located at the very bottom of the well, the siltation would build up around the open end causing the system to feel more pressure as the air tries to bubble out through the siltation. The system would not be able to tell the difference of the cause of the increase of pressure and would trigger the automation controls as though the water elevation was rising.

3. **Elevation Gauge**

The elevation gauge is nothing more than a pressure gauge that has a scale which equates the pressure in the system to its' corresponding water elevation. Some of the elevation gauges we use have both the PSI (pressure) and Feet of Water (head) scales on the gauge face, some will have only the feet of water scale. Since we know that the maximum depth of our wet wells is 23' (which requires $23 \times 0.433 = 9.96$ PSI) we need to use gauges that will read up to that elevation at the least.

4. **Automation Controls**

The automation controls regulate the starting and stopping of the motors, as well as changing motor speeds if applicable. While we have many types of automation controls in use throughout our system, they all have one thing in common - each has a rubber diaphragm which moves up and down with the increase and decrease in pressure within the air system. This diaphragm in turn

moves some type of mechanical device to operate a mercury switch, or contact points which open and close to "make" or "break" the electrical signal sent to the motor starters. At some stations a single switch is used to control both the "on" and "off" signals. At other stations one switch controls the "on" signal, while another controls the "off" signal. The diaphragms in these switches are usually rated at a maximum working pressure of 15 PSI. Any pressure in the system greater than 15 PSI can rupture the diaphragm, causing the switch to operate erratically, or not at all.

5. Flow Meter

The flow meter controls the volume (amount) of air flowing through the system. A large volume of air shortens the response time in the system, while a low volume of air decreases the response time. The flow meter is usually set at its mid-point. The flow meter does not regulate the air pressure.

6. Regulator

The regulator is a device located between the compressor and the rest of the system. It is used to limit the pressure being fed into the bubbler system. The regulator must have a working pressure that exceeds the amount of air pressure coming from the compressor, otherwise it would be damaged, and would not work properly. It must have a pressure gauge on it in order to be able to set it. The gauge should read from "0" to "30" PSI. Since we know that the diaphragms on the automation controls have a maximum working pressure of 15 PSI, the regulator is set at 10 PSI as a means of protecting the automation controls. The 10 PSI of pressure still enables us to read the entire depth of our deepest wet well.

7. Air Compressor

The air compressor supplies the air to operate the bubbler tube system. The compressor pumps air into a storage tank where it builds up pressure. The pressure switch on the compressor will automatically start and stop the compressor. The "on" and "off" points are adjustable, although you will usually not make any adjustments to it. The "on" point is set above the 10 PSI output of the regulator, between 20 and 25 PSI, to ensure that there is a constant working pressure in the bubbler tube system. The "off" point should be between 40 and 45 PSI. This is well below the working pressure of the regulator. The unit should have a pressure gauge on it that reads from "0" to "60" PSI.

Automation system operation

It is extremely important that you have a thorough working knowledge of the basic system, so that you can properly troubleshoot problems with bubbler tube systems at any of the stations, rather than making haphazard guesses if a problem arises.

With the bubbler tube system set up as explained above, and no water in the wet well, we will have a "0" (zero) reading on the elevation gauge. While we do have 10 PSI of air pressure flowing through the bubbler tube, since there is no water in the well, there is no resistance at the open end of the bubbler tube. The air flow passes out of the tube unrestricted.

As the water in the well rises above the open end of the bubbler tube, it creates a resistance that the air flow must overcome in order to flow out of the tube. That resistance is felt in the system as pressure. Each one foot (1') rise of water above the open end of the tube will require 0.433 PSI of air pressure to push the air out of the tube.

The automation controls are set to a predetermined level for motor "start" and "stop", and/or speed changes. These controls are connected into the low voltage (110 volts ac) electrical system and in turn operate relays that open and close the motor starters which are high voltage (220 volts or greater). When the elevation increases enough, the pressure within the system will cause the activation of the "start" control switch. This sends an electrical signal to the motor starter which then closes, making an electrical connection from the high voltage system to the motor that drives the pump.

As the unit pumps out the water in the wet well, the elevation decreases, creating less resistance at the open end of the bubbler tube. As the pressure within the system decreases, the automation controls will open the circuit to the motor starter when the water reaches a predetermined level. This, in turn, will disconnect the electric power from the motor causing it to stop, completing the cycle.

The automation controls are usually labeled "Low Level" and "High Level". There is a selector switch that enables us to alternate which motor/pump unit will operate on which level automation control. The selector switch does not change which automation controls are operating on which level. It changes which motor is controlled by the "low" level or "high" level automation control.

Prior to setting automation controls and periodically thereafter, the air system should be checked for proper operation. This should be done systematically as described below:

- 1) Close the shut-off valve at the compressor.

- 2) To check the gauge, disconnect the air line at the point where it exits the station and observe the elevation gauge. The needle on the gauge should read "0". If not, replace the gauge.
- 3) To check the air system within the station for leaks, plug the air line that you disconnected on the end coming from the control board. This can be done by having someone hold their fingertip tightly against it.
- 4) Open the shut-off valve on the compressor and allow the system to fill with air. Check the gauge on the regulator to see that it is set at 10 PSI, adjust if necessary. The regulator should never be set above 10 PSI, as the higher pressure will damage other components in the system. The elevation gauge should come up to 23'.
- 5) With the end of the air tube still blocked, shut off the flow meter. You now have 10 PSI of air pressure trapped between the flow meter and the blocked end of the bubbler tube. If there are no leaks within this section, the 23' reading on the gauge will hold steady. If the needle begins to drop, you have one or more leaks within this section. The faster the needle drops, the bigger the leak (which may be many small leaks). Before proceeding any further, the leaks must be detected and corrected. This is done by applying liquid leak detector around all air line connections. If leaks are detected at the fittings, you may be able to simply tighten the nut a bit. **DO NOT OVER TIGHTEN!** It may be necessary to replace the plastic ferrule inside the nut. If the source of the leaks is not at the connections, you must visually check the air tubing, especially any areas that may rub against the control board when opening and closing the control board door. If no leaks are found in the tubing, you may have a diaphragm leaking on one of the control switches. If this is suspected, contact your route supervisor.
- 6) Once you have determined that there are no leaks within the station, reconnect the air tubing at the point where you disconnected it.
- 7) To check for leaks between the exit point of the station and the wet well, open the wet well and disconnect the air line from the bubbler tube. Once again, have someone block the end of the air line with their finger. Open the flow meter and allow the system to fill with air. Once the gauge reads 23', shut off the flow meter. The gauge should hold steady. If it begins to drop, check for leaks at the exit point of the station, and at the connection in the wet well where the tubing is connected to the pipe coming from the station. When the system shows no leaks, reconnect the air line to the bubbler tube. Open the flow meter to its' normal setting. Once your gauge is showing a reading, use leak detector

on the fitting from the air line to the bubbler tube. If no leaks are found, close the wet well cover.

- 8) Now that the air system is known to be free of leaks, we want to determine that there are no blockages or restriction in the bubbler tube. To do so, we must "purge" the bubbler tube. Purging the bubbler tube is accomplished by feeding the full pressure of the compressor to it, rather than the normal 10 PSI. To properly do this, you must make a direct connection from the compressor to the air line to the bubbler tube bypassing the entire control board, so as not to damage any of the components. Close the shut-off valve on the compressor and make the direct connection to the air line to the bubbler tube. Open the drain valve on the compressor tank long enough to kick the compressor on. Close the drain valve and allow the compressor to run until it shuts off automatically. You should have 40 to 45 PSI in the tank. Open the shut-off valve on the compressor and allow this higher pressure to feed out to the bubbler tube. When the blockage has been cleared, the tank should empty rather quickly. It may be necessary to repeat this procedure a couple of times if the blockage is heavy. If you are unable to clear the blockage in this manner, notify your supervisor.
- 9) Once the above procedures have been followed, settings, or adjustments to the automation controls can be made if need be.

Troubleshooting the Air System

There are only two basic problems that you will encounter with the air system, exclusive of electrical problems:

- 1) Low air pressure
- 2) Blocked or restricted air line

These two problems bring about a very different set of symptoms. Become familiar with the symptoms and what to do about them.

- 1) Low air pressure

Low air pressure will create a false reading in the system that indicates lower water elevation than what actually exists. Consequently, the pumps will not cycle when they should. This can cause the wet well to fill and sewage to overflow from manholes in the street. Check the air compressor, regulator and flow meter for proper operation and settings. If these components are set and working properly, you have a leak in the system. Detect and correct as described earlier.

- 2) Blocked or restricted line

This will also create a false reading in the system, as a restriction causes resistance which is felt as pressure in the air system. This is seen as high water elevation, and can cause the pump to pump too far down, causing it to suck air into the suction line. Since the pump cannot pump air it becomes "airbound". This simply means that the pump is running with no load. Since most of the pumps must have the air bled from the volute by opening a valve, most will continue to run with no load even though the wet well may again fill with water. Anytime you find a pump that has become air bound, you must contact your route supervisor and inform him of same. The bubbler tube must be purged, or if necessary, manually rodded out.

Once the blockage has been cleared, reconnect the compressor and air line to the control board. Allow the pump to go through a normal cycle, or check back later in the day to assure that the pump is now cycling properly.



When we talk about operation of pumping equipment one must know what the level of water is, both in the suction and discharge. So far we have discussed the equipment that obtain these readings for us and how to change these readings from feet of water to pound per square inch and vice versa.

The term elevation is used throughout the operations constantly and it refers to the height OR depth of liquid based on the "sea level". "Sea level" or "Mean Sea Level" is a base line and it is set at elevation "0". However, here at the Sewerage and Water Board there is another base line OR datum that is being used in lieu of Mean Sea Level and that is "Cairo Datum". The relationship between the two is as follows:

$$\text{Cairo Datum} = 20.43' + \text{Mean Sea Level}$$

Example: Most of our pumping station's floors are built at elevation 24.0; or:

$$24 - 20.43 = 3.57'$$

(That means our facilities are only 3.57' above sea level !!!)

So if someone says the water in the suction bay is at elevation 8.0', it simply means that the water is at elevation 8.0' and not 8.00 feet of water in the suction bay. In order to know exactly the depth of water in the basin, then you need to know the elevation of the bottom of the basin slab and that is not necessary for our operators to know.

By means of the bubbler system, the station operator would know the water elevations at any given time, and the operator would know when a pump can operate. Remember that we always need to know the water elevation and not so much the depth.

Illustrations on the next two pages and on page V-27 show typical Sewerage and Water Board facilities with the pumping equipment and their relation with its surrounding.

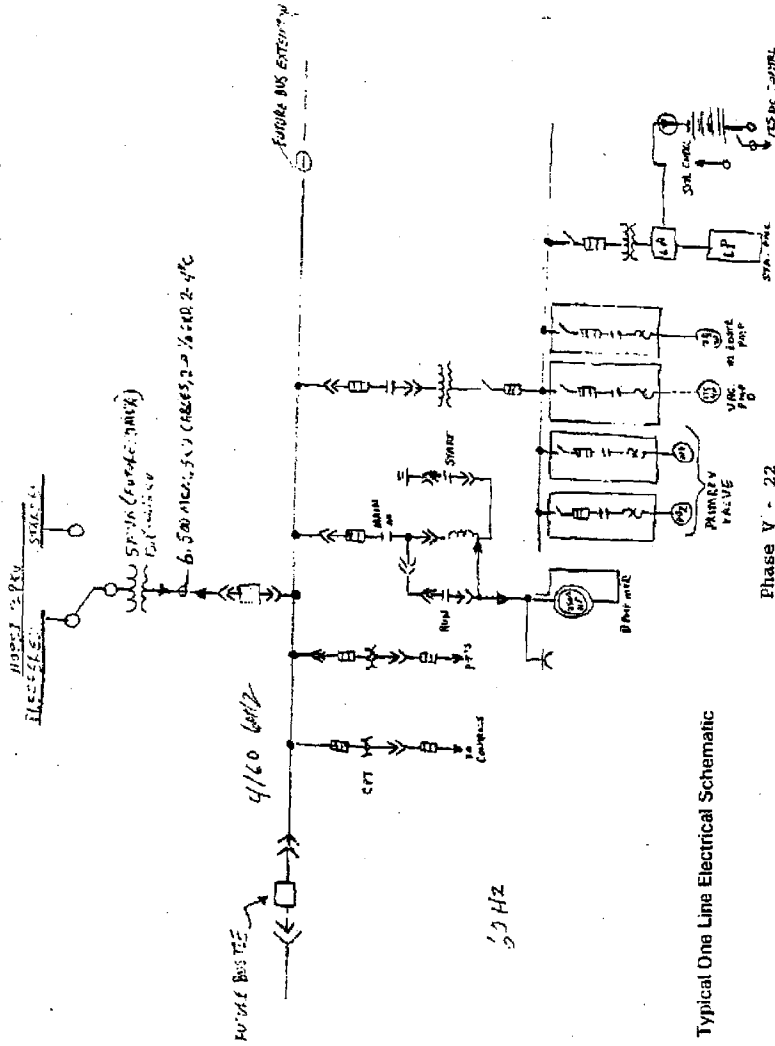
10 Common Rules to Prevent Fire in Your Workplace

Over the past 10 years, the number of people killed by fires has fallen slightly each year. But still, more than 4000 people die from fire-related causes each year.

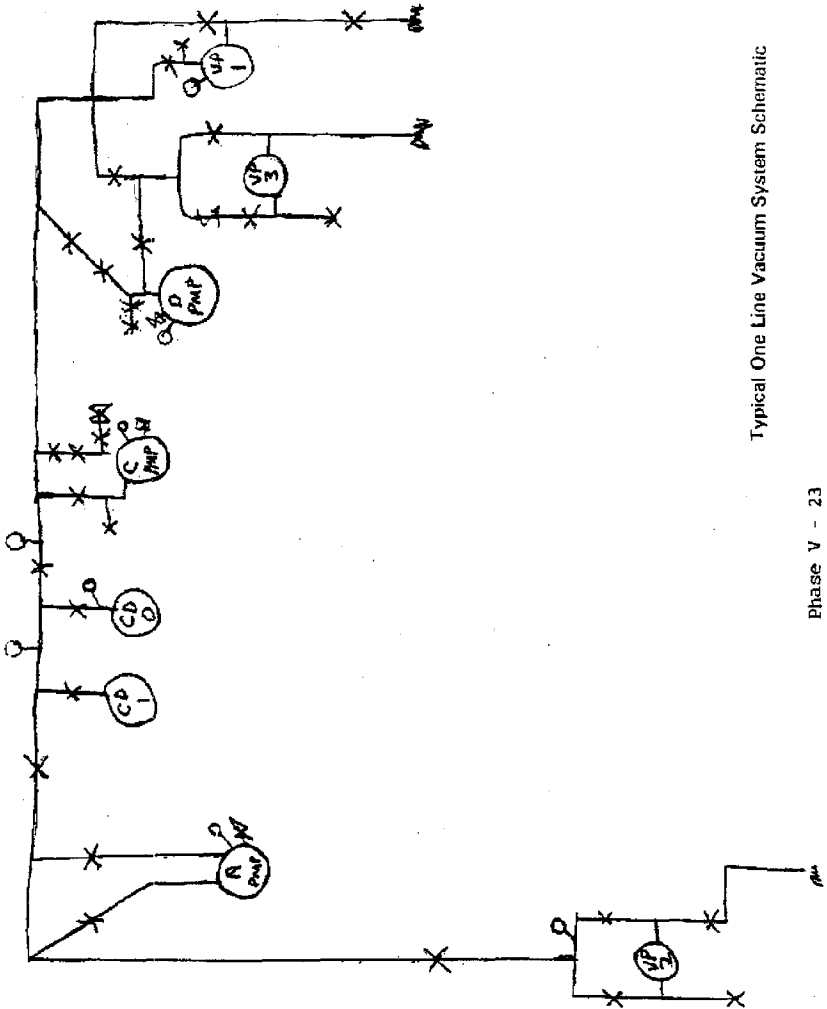
Every year, people are injured or die in fires at work because they did not follow some simple rules. Unfortunately, some employees assume that their Workplace cannot burn because it is constructed of concrete and steel. The contents of most buildings, however, are rarely fire-resistant. Carpeting, ceiling tile, insulation, desks, upholstered chairs and combustible items, such as papers and books, all can burn. When overstuffed furniture and carpeting burn, they give off toxic fumes.

To avoid being a fire victim at work, follow these rules:

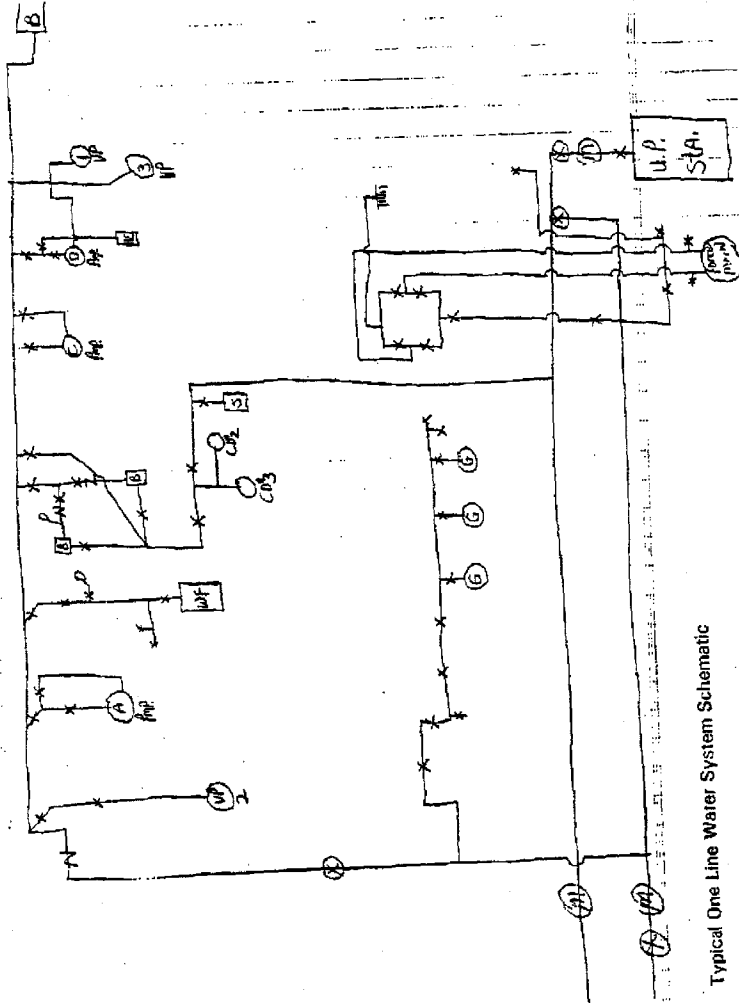
1. Know at least two ways to escape from your building. If one way is blocked, you will need to find an alternate route.
2. If caught in a fire, stay low to the floor. Most of the hazardous fumes and gases are lighter than air. There is often a safe zone near the floor.
3. If you see a fire, sound the fire alarm and call the fire department before you attempt to fight the fire. In that way, if you are not successful in extinguishing the fire, at least you have given the fire fighter a head start.
4. Know how to use your fire fighting equipment, such as extinguishers and standpipe hoses. Remember, never use a standpipe hose (water) to try to extinguish an electrical or chemical (grease, oil, or gasoline) fire.
5. Participate in fire drills. Drills help make safe procedures become good habits.
6. Don't store flammable chemicals, even in small quantities, outside of approved storage areas.
7. Don't smoke in the vicinity of flammable materials.
8. If you smoke in designated areas, use a large ashtray that will contain your cigarette if you forget about it.
9. Practice good housekeeping. Clean up your work area frequently, at least at the end of each workday or shift.
10. Be alert to the potential causes of fire in your work area: do what you can to eliminate or control them.



Typical One Line Electrical Schematic



Typical One Line Vacuum System Schematic



Typical One Line Water System Schematic

Phase V - 24

PHASE (V) PRACTICE PROBLEMS

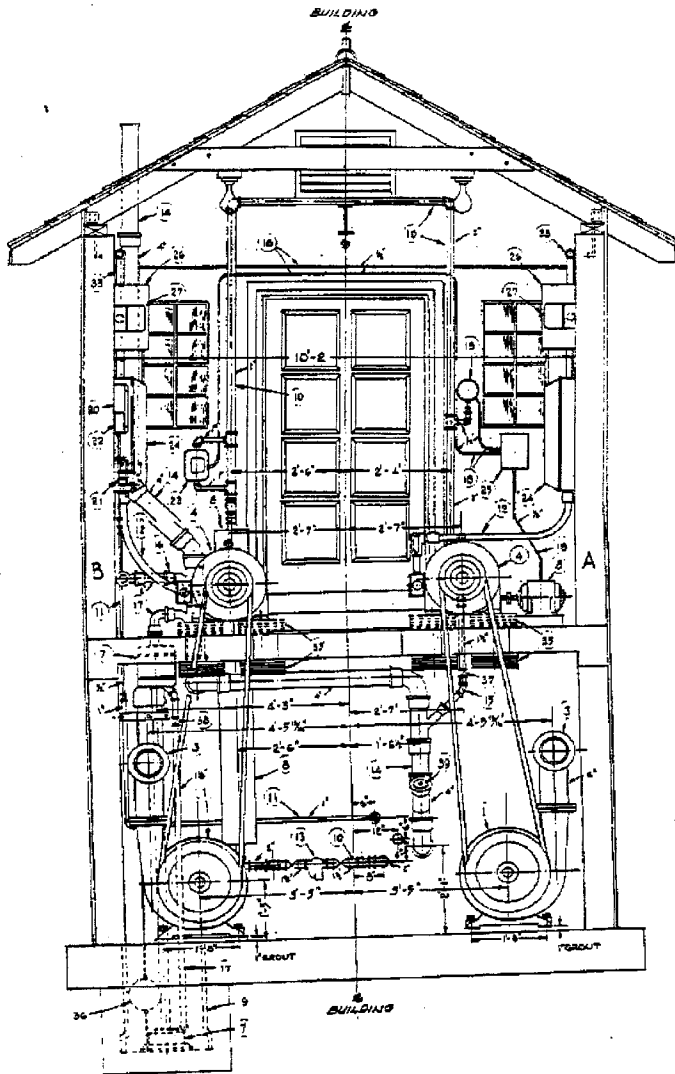
1. An elevation gauge is reading 21' of water. How much air pressure is required to obtain the reading?
A) 48.5 psi B) 23.79 psi C) 9.09 psi D) 18.53 psi
2. A vacuum gauge reading of 17.5" shows how many feet of lift?
A) 7.6 B) 15.44 C) 19.83 D) 40.41
3. A bubbler tube 34 feet long is used in an automation system using 10 psi of air pressure. The bubbler tube is in a wet well 45 feet deep. What is the highest reading that could be seen on your elevation gauge?
A) 23' B) 45' C) 34' D) More than 23' but less than 45'
4. What is atmospheric pressure equal to?
A) 1.133 ft B) 17.4 psi C) 8.34 lbs D) 14.7 psi
5. The maximum lift of a pump under perfect condition would be?
A) 23 ft B) 33.95 ft C) 14.7 ft D) Depends on the discharge pressure
6. How much vacuum is required to load a pump that is 26 feet above the water?
A) 29.5" Hg B) 24.92" Hg C) 22.95" Hg D) 2.94" Hg
7. How much vacuum is required to load a 30" pump rated at 350 GPM?
A) 1.58" B) Unknown C) 17.9" Hg D) 14.02" Hg
8. The regulator in the air system of our pumping station's is set at?
A) 14.7 psi B) 7.48 psi C) 10 psi D) 34 psi
9. A gauge reading of 5.5' requires how much air pressure?
A) 6.23 psi B) 2.38 psi C) 12.7 psi D) 4.85 psi
10. What is the maximum reading a vacuum gauge could show when loading a pump?
A) 34" Hg B) 14.7" Hg C) 18.6" Hg D) 30" Hg

ANSWERS TO PHASE 5 PRACTICE PROBLEMS

1. $21' \times 0.433 = 9.09$ psi
2. $17.5'' \text{ Hg} \times 1.133 = 19.83'$
3. The maximum water elevation that could be read depends first on the air pressure supplied to the system, which is in this case 10 psi or $10 \text{ psi} / 0.433 = 23'$.
4. 14.7 psi (known fact)
5. $14.7 / 0.433 = 33.95$ feet
6. $26' / 1.133 = 22.93'' \text{ Hg}$
7. This problem cannot be solved with the information given. (30" given is the size of the pumping unit)
8. 10 psi to protect the downstream components
9. $5.5' \times 0.433 = 2.38$ psi
10. Since we know the maximum lift of a pump is 33.95 feet: $(14.7 / .433 = 33.95)$ divide this number by 1.133:

$$33.95 / 1.133 = 29.96 \text{ or } 30'' \text{ Hg}$$

* * * END OF PHASE V * * *



(Typical Sewerage Pumping Station)

Phase V - 27

NOTE

Phase V - 28

**PHASE
VI**

(NINTH MONTH)

PHASE VI OUTLINE

The following duties are required to be performed by Utility Plant Worker II in this phase of the Training Program:

Phase VI - 9th Month (duration two months)

- A. Record keeping
 - 1. Station logbooks
 - 2. Reporting and logging of defects and problems
 - 3. Departmental requisitions
 - 4. Safety meeting reports
 - 5. Training reports
 - 6. Work order forms
 - 7. Vacation requests
 - 8. Overtime request

- B. Operation of equipment
 - 1. Daily test runs of large pump units
 - 2. Operation of auxiliary equipment

- C. Drawing of electrical system diagram

- D. Types of valves
 - 1. Gate
 - 2. Ball
 - 3. Butterfly

- E. Operation of electrical circuits
 - 1. Feeders
 - 2. Bus ties
 - 3. Transformers
 - 4. D.C. switches
 - 5. Control voltage

- F. Types of Pumps
 - 1. Positive displacement
 - a. Rotary
 - b. Reciprocating

 - 2. Kinetic energy (centrifugal)
 - a. Radial flow
 - b. Axial flow
 - c. Mixed flow

G. **Phase VI Training Classes:** The following classes will be held 3rd Thursday every month for this phase of training as scheduled below:

Record Keeping	7:00 - 9:00
Pump Classifications	9:00 - 11:00
Valve Classifications, Maintenance	11:00 - 1:00
Electrical Systems	1:00 - 3:00

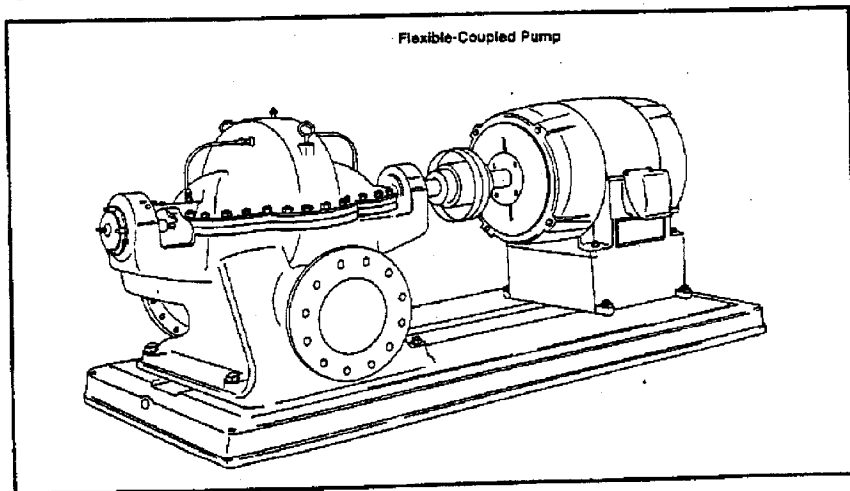
Phase VI - 2

PUMPS

As part of your daily job in the Department of Operations, you are responsible for proper maintenance and operation of pumping units, both in drainage and sewerage operations. A pumping unit consists of many parts such as pump, motor, and coupling. In this section we briefly discuss the types of pumps and their purpose in our operations.

There are two (2) major classification of pumps; kinetic energy, and positive displacement. The following chart shows each type of pump and its relation to one of the two major classes:

Pumps										
Positive Displacement		Kinetic Energy								
Reciprocating	Rotary	Centrifugal			Peripheral		Special			
		Radial Flow	Mixed Flow	Axial Flow	Single Stage	Multi Stage	Jet Pump	Gas Lift	Hydraulic Ram	Electromagnetic



Phase VI - 3

Positive Displacement Pumps

A positive displacement pump operates by forcing a fixed volume of liquid from the suction inlet to the discharge side of the pump under pressure. The flow from a positive displacement pump is constant in quantity but pulsating in flow. Positive displacement pumps are normally used for pumping raw sludge or slurries and other high density liquids. These pumps produce a constant capacity of pulsating flow at a lower speed and develop higher shut-off heads than other pump types. Positive displacement pumps are suitable for use as chemical feed pumps where a high degree of accuracy of flow is required.

Kinetic Energy Pumps

A kinetic energy pump operates by transmitting energy from the rotating unit to the liquid in the form of spinning or rotational action causing the liquid to increase in velocity. The high velocity is then changed to static pressure when the liquid contacts the diffuser section of the pump. A kinetic energy pump will produce a constant flow of liquid at varying capacities. Capacities will change as the head conditions that the pump is required to meet change.

The most commonly used kinetic energy pumps for our operation is the centrifugal pump. The basic centrifugal pump has two (2) main parts: the rotating element which consists of the shaft and the impeller; and the stationary element which consists of a pump casing or volute, and the bearing frame.

The rotating impeller transmits rotating energy to the fluid and the vanes of the impeller discharge the fluid at a high velocity at the periphery (outer edge) of the impeller. The velocity of the fluid is converted to static pressure by the volute (diffusion vanes) located at the impeller discharge. This static pressure forces the fluid out the discharge passage of the pump. The following is an explanation of each type of centrifugal pump:

Axial Flow Pumps

The fluid in an axial flow pump is lifted or propelled by the impeller (more commonly called a propeller in this type of pump) in an axial direction (in the same direction as the pump axis or shaft), and diffusion vanes are used to change the lifting velocity to static pressure. The fluid enters the pump in an axial direction, and there is no basic change in the flow direction through the pump. Therefore, the fluid is discharged (by the pump) in the same direction as it enters, which is along the pump's axis.

Radial Flow Pumps

A radial flow pump uses centrifugal force as the principal means of developing head or discharge pressure. The fluid enters the pump in an axial direction and is turned at a 90 degree angle by the spinning motion of the impeller. The fluid leaves the outer edge of the impeller at a high velocity and contacts the inner wall of the pump volute where the velocity is changed to static pressure and forces the fluid out of the discharge. The fluid enters the impeller axially and leaves at a 90 degree angle to the axis.

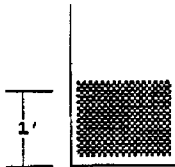
Mixed Flow Pumps

A mixed flow pump employees the principles of both the axial flow pump and the radial flow pump. The liquid enters the pump axial and is lifted and turned by the spinning motion of the impeller. Discharge pressure is developed in a mixed flow pump by the centrifugal force as well as the lifting of the impeller. The fluid enters the axial pump and leaves the impeller at some angle less than 90 degrees.

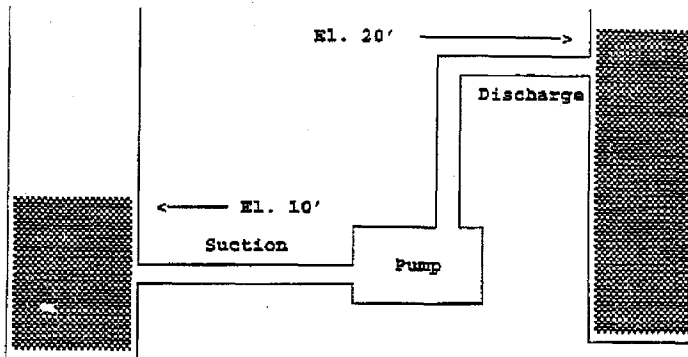
In order to understand the basic operation of a pump it is necessary to understand the basic theory used in pump design and the changes of the liquid through the pump. Pumps are used to take liquids and liquid/solid mixtures from a lower level and move these liquids to a higher level through the transmission of energy.

Terms Used in Pump Operation

Pressure and head are different ways of expressing the energy parameter. Pressure is usually expressed in PSI (pounds per square inch) and head is usually expressed in feet. One (1) foot of head is equal to 0.433 PSI (See Phase V).



One (1) foot of head exerts a downward force of 0.433 PSI on the bottom of the container



In the above illustration the suction water level is at elevation 10', and the discharge elevation is 20'; therefore, the static head is: $20' - 10' = 10'$. The static pressure can be determined by multiplying the static head by 0.433 PSI per one (1) foot of head:

$$10' \text{ static head} \times 0.433 = 4.33 \text{ PSI}$$

In addition to static head the pump must also overcome the friction losses in the piping and pump, and the velocity losses in the pump. Friction losses are caused by the liquid rubbing on the inside walls of the pipe and pump, and energy being lost due to this friction. Velocity losses are losses where the velocity of the liquid is never changed to static pressure. The sum or combination of all the head losses, the static head, and the suction lift are known as the Total Dynamic Head (TDH).

A pump's discharge pressure can be measured with a pressure gauge or a compound gauge. The illustrations on pages V-2, and V-8 show a 0 to 15 PSI (pressure) gauge, a 0 - 200 PSI / 30" - 0" Hg vacuum compound gauge. Note that a compound gauge measures vacuum and pressure, not pressure and feet of water or altitude.

A PSI gauge can be used to measure pressure in pounds per square inch only. PSI gauges can be made in a wide variety of sizes (face diameter) and a wide variety of range (minimum to maximum scale).

A compound gauge can be used to measure vacuum in inches of mercury (inches Hg) and pressure in PSI. Compound gauges can also be made in a variety of sizes and ranges.

The TDH (Total Dynamic Head) is very complicated to calculate; however, for pumps that are already in service the TDH can be determined by measuring the discharge pressure. If a pressure gauge or compound gauge were installed on the discharge side of the pump in the previous page, with the pump running the gauge would read higher than the 4.33 PSI calculated for the static head because the gauge would show the static head plus the head losses.

Conversions

From PSI to TDH ----- PSI / 0.433
From TDH to PSI ----- TDH X 0.433

Examples

If a pump is rated for a maximum discharge head of 73 feet, what would the maximum discharge pressure be?

$$\begin{aligned} \text{TDH} \times 0.433 &= \text{PSI} \\ 73' \times 0.433 &= 31.61 \text{ PSI} \end{aligned}$$

Quantity

The term quantity, when used in reference to the operation of a pump, means the amount that the pump will discharge at a given head condition in a specified time period. The specified time period can be varied to fit the particular situation, e.g. seconds, minutes, hours, days, etc. Likewise the volume measurement can be varied to fit the particular situation; e.g. cubic feet, gallons, million gallons, etc.

A 12' Wood Screw Pump, such as "A" pump at DPS 1, is rated for 550 CFS (Cubic Feet per Second). This means that this pump will discharge enough water to fill 550 cubes measuring one (1) foot wide, by one (1) foot high, by one (1) foot deep in one second! This quantity can be converted as follows:

$$550 \text{ CFS} \times 7.48 = 4,114 \text{ GPS (gallons per second)}$$

$$4,114 \text{ GPS} \times 60 = 246,840 \text{ GPM (gallons per minute)}$$

$$246,840 \text{ GPM} \times 60 = 14,810,400 \text{ GPH (gallons per hour)}$$

$$14,810,400 \times 24 = 355,450,000 \text{ GPD (gallons per day)}$$

$$14,810,400 \text{ GPD} / 1,000,000 = 355.45 \text{ MGD (million gallons per day) !!!}$$

Use of Pumps

Axial-flow pumps

Axial flow pumps deliver very large quantities of water at low head conditions. An example of the requirements for an axial flow pump would be a 14' Wood Screw Pump in our drainage pumping system. The 14' Wood Screw Pump (like "H" pump at DPS No. 6) is rated for 1,000 CFS at a 12' head:

$$1,000 \text{ CFS} \times 7.48 = 7,480 \text{ GPS}$$

$$7,480 \text{ GPS} \times 60 = 448,800 \text{ GPM}$$

$$448,800 \text{ GPM} \times 60 = 26,928,000 \text{ GPH}$$

$$26,928,000 \text{ GPH} \times 24 = 646,272,000 \text{ GPD}$$

$$646,272,000 \text{ GPD} / 1,000,000 = 646.3 \text{ MGD (Million Gallons per Day) !!!}$$

As you can see, the quantity pumped is extremely large. However, the total head is very low, only 12'.

$$12' \text{ TH} \times 0.433 = 5.196 \text{ PSI}$$

This pump reaches "shut off" head at about 22 feet. Shut off head is the point at which the pump pressure and the head pressure are equal, and therefore no liquid can be displaced even though the pump is running:

$$22' \text{ shut off head} \times 0.433 = 9.526 \text{ PSI}$$

At all points between the 12' and the shut off head the quantity pumped is less than 1,000 CFS. The higher the TH, the less the pump can actually pump until shut off head is reached where no water is pumped.

Radial flow pumps

Radial flow pumps deliver smaller quantities of water at high head conditions. An example of the requirements for a radial flow pump would be a 30" Wood Trash Pump in our Sewage Pumping System. The 30" Wood Trash Pump is rated for 150 CFS at 44' head.

$$150 \text{ CFS} \times 7.48 = 1,122 \text{ GPS}$$

$$1,122 \text{ GPS} \times 60 = 67,320 \text{ GPM}$$

$$67,320 \text{ GPM} \times 60 = 4,039,200 \text{ GPH}$$

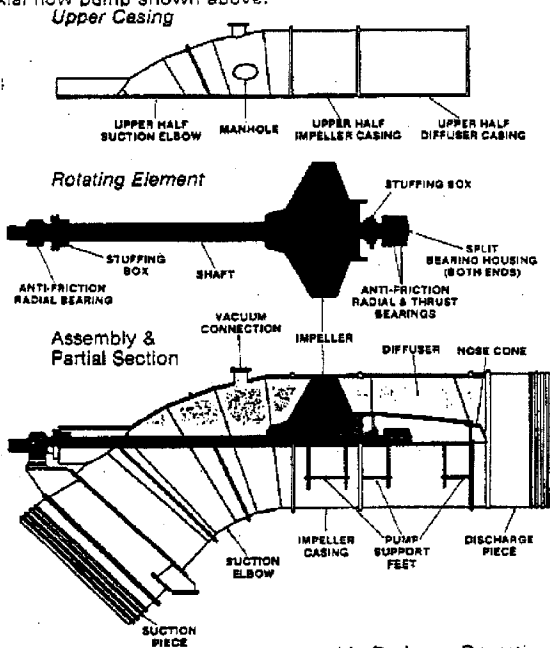
As you can see, the quantity pumped is much less than that pumped with the 14' Wood Screw Pump (axial flow pump). The quantity is about 15% of the axial flow pump; however, the total head is much higher.

$$44' \times 0.433 = 19.052 \text{ PSI}$$

This pump reaches shut off head at approximately 130'.

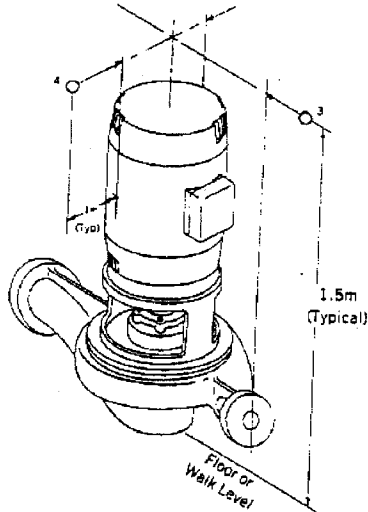
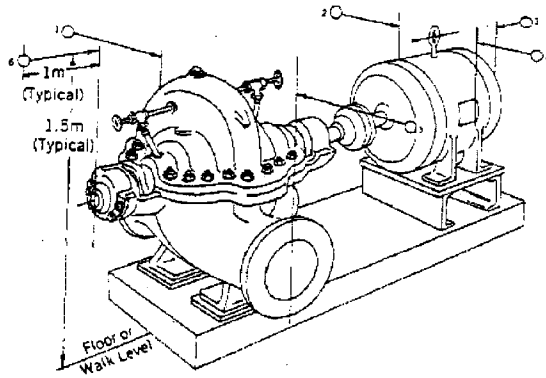
$$130' \text{ shut off head} \times 0.433 = 56.29 \text{ PSI}$$

The shut off head of this radial flow pump is 5.9 times greater than the shut off head of the axial flow pump shown above.



Typical Horizontal Pump used in Drainage Operations

Typical Horizontal Split Centrifugal Pump



Typical Vertical In-Line Centrifugal Pump

PHASE VI - 10

VALVES

A valve is a mechanical device with moveable parts which, by opening or closing, allows the control or regulation of the flow of liquids, gasses, or bulk materials. The moveable portion of the valve is used to partially or totally restrict flows by blocking an opening, port or passageway.

There are numerous types of valves used in the operation of drainage and sewerage stations. All perform the same function of controlling or regulating the flow of liquids or gasses.

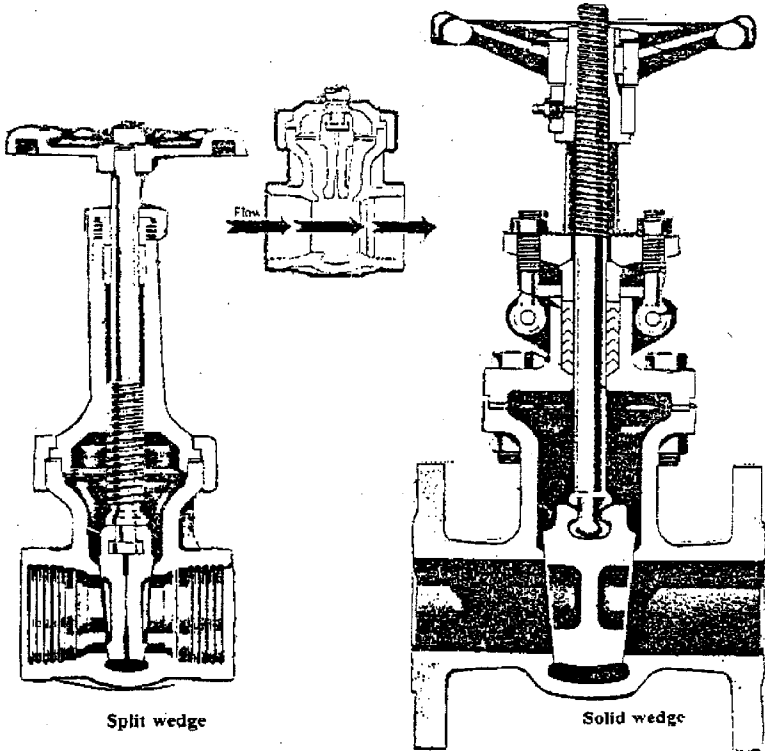
Refer to the appropriate pages as we look at some of the different valves most frequently used in the drainage and sewerage systems:

1. Gate Valves
2. Ball Valves
3. Butterfly Valve
4. Globe Valves
5. Sluice Gates
6. Corporation Cocks
7. Relief Valves
8. Air Release Valves
9. Y-strainer
10. Check Valves

Gate Valves

The gate valve is the most commonly used valve in the industry. It is intended for on/off flow control and should only be used in a fully open or fully closed position. Any attempt to use a gate valve in a partially opened position for throttling could result in chattering, excessive wear and rapid erosion of the seat and disc and impair its' ability to close tightly. When the valve is closed, the disc wedges between the seats to establish tight shut-off.

The gate valve may have either a rising or non-rising stem. The disc may be a solid wedge or a split wedge. The split wedge is made up of two parts, each of which is free to adjust to the seat angle, thereby improving the long term ability of tight shut-off.

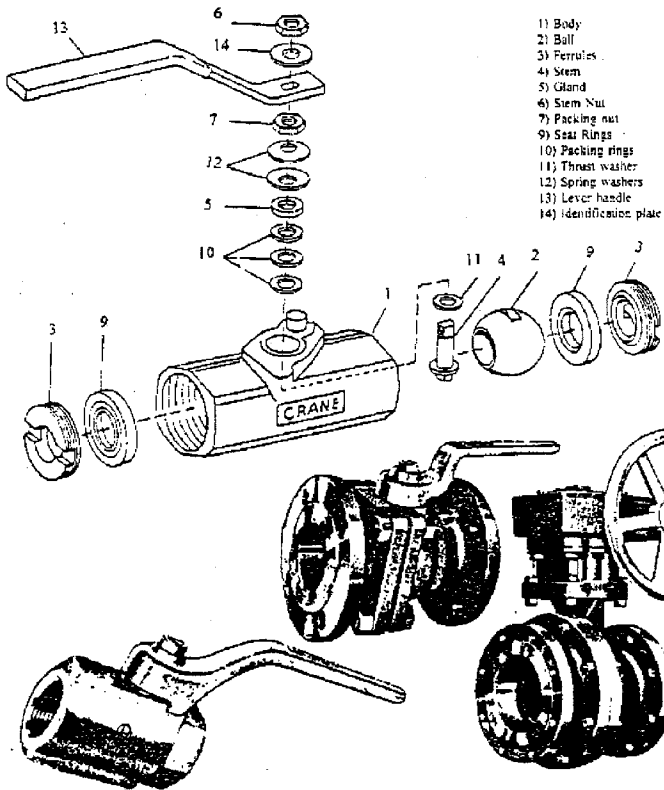


PHASE VI - 12

Ball Valves

The ball valve provides quick opening operation with minimum flow resistance. Going from full open to a full close position is accomplished with a quarter turn of the handle*. This valve uses a ball shape rather than a disc shape to perform its function.

*Larger valves may have a manual gear operator.

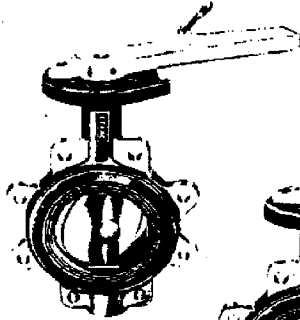


PHASE VI - 13

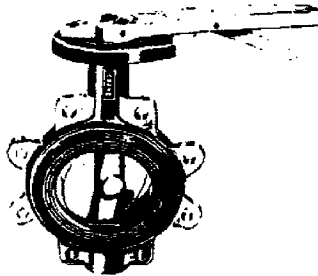
Butterfly Valves

Similar in some respects to the gate valve, the butterfly valve uses a disc to control flow. The disc operates by turning inside the valve body rather than rising. This type of valve is primarily used as a priming valve at some of the drainage stations.

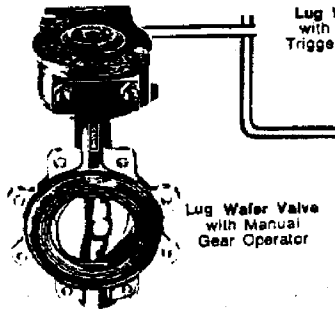
Butterfly valves may operate directly with a lever, or may operate with a gear reducer using a crank handle or wheel operator.



Lug Wafer Valve
with 10-Position
Thumbscrew Lock Lever



Lug Wafer Valve
with 10-Position
Trigger Lock Lever



Lug Wafer Valve
with Manual
Gear Operator

Plug or Globe Valves

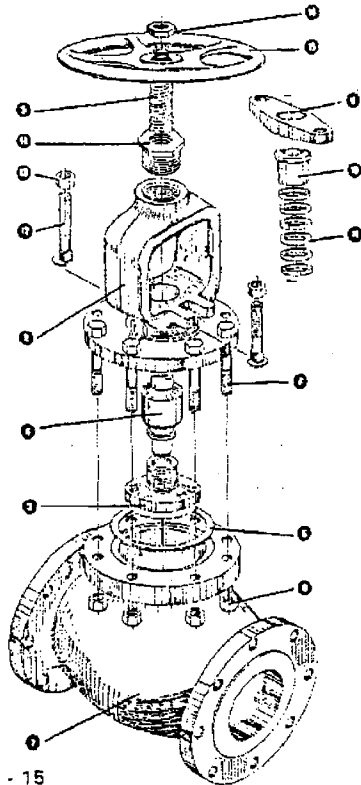
This type of valve is used to control flow rather than open/close control. Shut-off with this type of valve is accomplished by moving the disc (which resembles a plug), against the flow stream instead of across the stream as with a gate valve.

Typical Stainless Steel Globe Valve

Globe globe valves are highly efficient for services requiring frequent operation and throttling when pressure drop across the valve is about 50% of inlet pressure. Gas throttling, creating higher pressure drops may cause cavitation or excessive velocities which could cause high noise levels, vibration and possible damage to the valve or adjacent piping. Angle valves utilize the globe valve seating principle while providing for a 90° turn in piping. Because piping installations using angle valves require lower joints, make-up time and labor are saved. Both types of valves can be equipped with optional operators.

- 1 Body is cast with heavy sections reinforced at points subjected to greatest stress. A raised face flanged end is shown but Globe stainless steel globe and angle valves are also available with threaded and socket weld ends and flat face flanges.
- 2 Integral Bonnet and Yoke is cast and finished to the same exacting tolerances as the body for accurate alignment of stem and ease of sealing. Bonnet/body joints are male-female for all Classes.
- 3 Disc is plug-type (as illustrated) with metal-to-metal seating. Plug type is also available with metal-to-TFE seating. V-Port plug disc with metal-to-metal seating can be ordered. See page 2 for descriptions and following pages for Catalog Numbers of valves.
- 4 Disc Stem Ring connects the disc to the stem, permitting the disc to pivot and aid in securing tight sealing for trouble-free service.
- 5 Stem has long engagement with yoke bushing for accurate seating. Outside threads are free from damage by corrosion and sediment in line fluids.
- 6 Bonnet Gasket provides a positive seal against leakage.
- 7 Bonnet Bolts
- 8 Bonnet Bolt Nuts
- 9 Gland Flange
- 10 Gland is a two-piece, ball type which exerts even pressure on the packing without binding the stem if gland bolts should be pulled up unevenly.

- 11 Packing
- 12 Gland Bolts
- 13 Gland Bolt Nuts
- 14 Yoke Bushing
- 15 Handwheel
- 16 Handwheel Nut



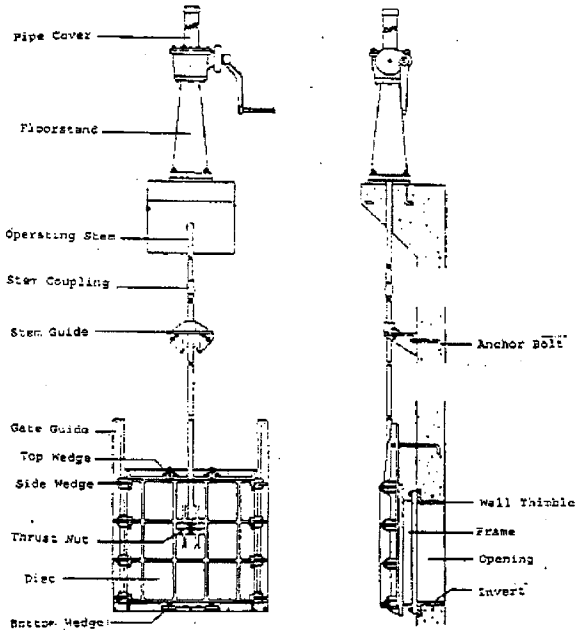
PHASE VI - 15

Sluice Gates

A sluice gate is a cast iron, vertically sliding valve having bronze seating surfaces and adjustable bronze wedges. It is used at the end of a pipe line, or to cover an opening in a wall, and is not an in-line valve.

Sluice gates are raised or lowered by means of a stem or rod using a manually operated screw stem hoist, an electrically driven screw or a hydraulic cylinder.

The Typical Sluice Gate



PHASE VI - 16

Cocks

Cocks are generally used in open/close situations more so than flow control. The operating mechanism is usually similar to a ball valve. One of the uses of a cock valve in the sewerage system is the corporation cocks that are installed on our force mains. They are usually placed at high point on the force main, so that air may be bled from the line. Shown below are some examples of the many types of cocks that are available.

Square Head
w/Stop
No. 250,
Threaded
1/2" to 2"



Square Head
w/Check
No. 254,
Threaded
1/2" to 2"

Flat Head
No. 252,
Threaded
1/4" to 2"



Flat Head
No. 266,
Male &
Female Ends
1/4" to 1"

Tee-Head
No. 256, Threaded
1/2" to 1/2"



3-Way
Square Head w/Stop
No. 268, Threaded
1/4" to 2"

4-Way
Square Head w/Stop
No. 269, Threaded
1/2" to 2"



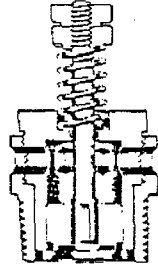
Square Head
No. 80E, Threaded
1/4" to 2"

Relief Valves

Relief valves are used to prevent excess pressure or vacuum from building up in a line or tank. These valves may be adjustable within certain limits, as defined by the manufacturer.



CRANE
VACUUM
RELIEF VALVE
CLASS 250
 $\frac{1}{2}$ " to $1\frac{1}{2}$ "
No. 1155V, Threaded



CRANE
POP
SAFETY VALVE
CLASS 250
 $\frac{3}{8}$ " to 1"

Top Discharge
No. 2550, Threaded

Side Outlet
No. 2551, Threaded

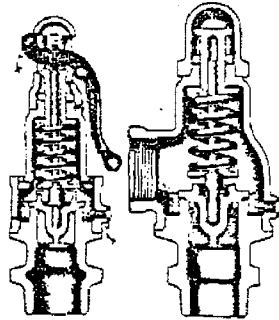
Side Outlet
No. 2551, Threaded



No. 2550



No. 2551



PHASE VI - 18

Air Release Valves

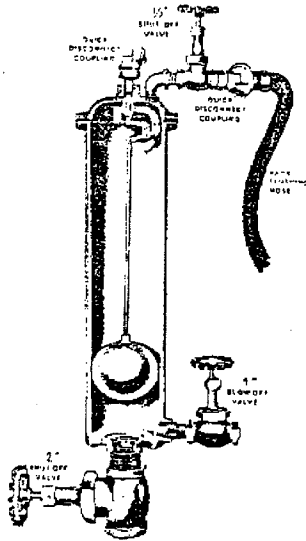
The illustration below shows an "APCO" brand air release valve especially adopted for use with sewage. The long stem and body keep the valve operating mechanism as free from contact with sewage as possible.

This is achieved as follows:

When sewage enters the valve, it rises forcing the air ahead of it. When the sewage reaches the float it raises the float and float stem approximately 1/2" which closes the venting mechanism in the cover and traps the remaining air in the valve body. The entrapped air is initially at atmospheric pressure, but it compresses as the sewage continues to rise in the valve body after the venting mechanism closes until both air and sewage are the same pressure. The sewage then stops rising and leaves the venting mechanism free from contamination with the e sewage.

Additional gasses given off by the sewage rise up into the valve body displacing the sewage which lowers until the float is exposed. The float will then also lower, opening the venting mechanism and allowing some gas to escape. This cycle will repeat itself as often as necessary.

The air release valves must be cleaned out periodically to ensure proper operation.

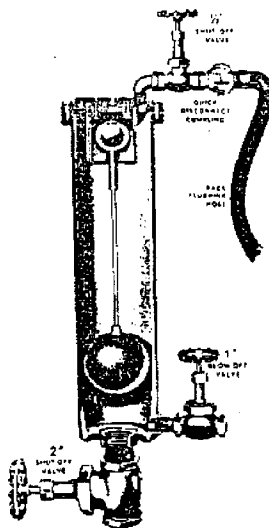


PHASE VI - 19

Shown here is an "APCO" brand air and vacuum valve specifically designed for operation on sewage and wastewater lines. These are used to vent large volumes of air when the line is filled, and allow air to re-enter when draining, to prevent vacuum or column separation from occurring.

Air will vent from the unit until the top float shuts off against the seat, due to the lifting force of the much larger bottom float, as sewage media enters the body. Once closed, and pressurized, the air and vacuum valve will not open to release air.

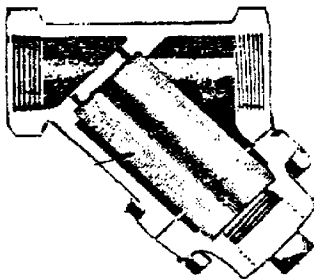
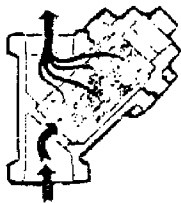
As with the air release valve, periodic cleaning must be performed on the valve to assure proper operation.



PHASE VI - 20

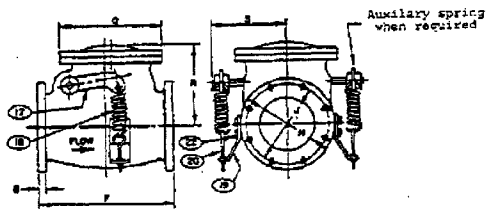
Y-Strainers

Although not a valve, the strainer is often seen in lines in close proximity to a valve. It is used to trap and collect foreign matter in a line, thus protecting equipment from damage. The strainer must be installed in proper relation to the flow in the line. Usually there will be an indicating arrow on the body of the strainer for flow direction. The strainer must be periodically removed and cleaned of debris.



Shown here are additional examples showing a plain check valve, a spring and lever check valve and a lever and weight check valve.

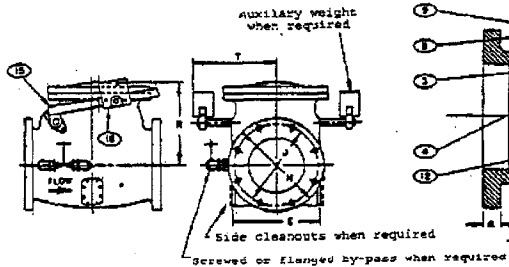
The lever and weight, as well as the lever and spring type serve the same purpose. These devices help to close the check valve as the pump comes to a stop. Without the extra downward force of these devices, the check valve could "chatter", or bounce to some extent. This causes unnecessary wear on the seat and the disc.



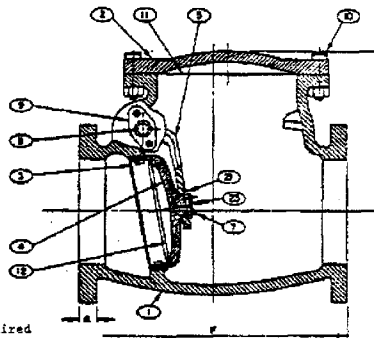
SPRING AND LEVER CHECK VALVE

Parts List

- 1) Body
- 2) Cover
- 3) Body ring (seat)
- 4) Clapper (disc)
- 5) Clapper arm
- 7) Capscrew
- 8) Hinge pin (shaft)
- 9) Gland
- 10) Cover bolts & nuts
- 11) Cover gasket
- 12) Clapper ring
- 15) Weight lever arm
- 16) Weight
- 17) Spring lever arm
- 18) Spring
- 19) Spring bracket
- 20) Spring eyebolt
- 21) Cap plate
- 22) Spring bracket cap screw
- 23) Lock wire



LEVER AND WEIGHT CHECK VALVE

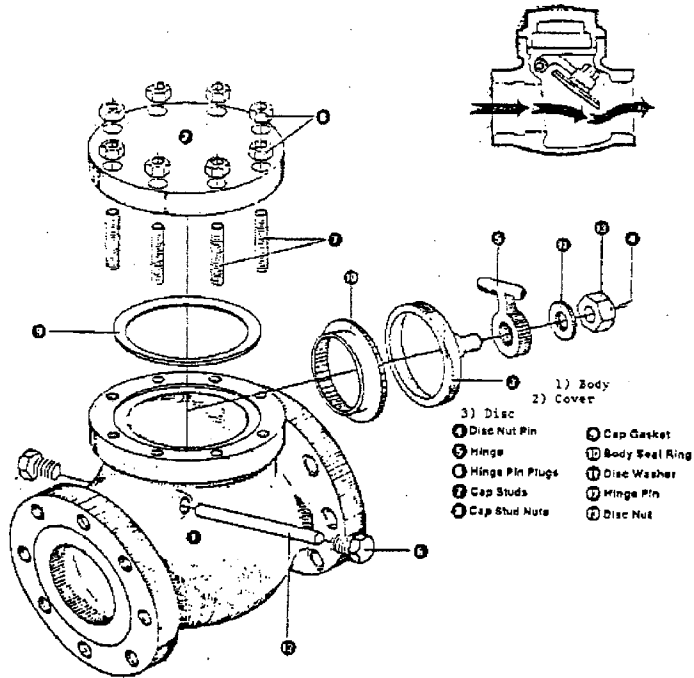


PLAIN CHECK VALVE

Check Valves

Check valves are used in lines to prevent liquids or gasses from flowing back through the line. They must be installed in proper relation to the flow of the media. You will find check valves on pump discharge lines, water lines, vacuum lines and there is even a check valve on the air compressor line where air is pumped into the tank.

Shown below is an illustration of a typical "swing" type check valve showing and identifying the various parts.



PHASE VI - 23

Check Valve Maintenance



(This section is intended specifically for Sewerage Operations)

Check valves such as those in the previous illustration are subject to wear on the moving parts such as the hinge pin (shaft), the clapper (disc), and the seat. You will also have situations wherein trash gets caught up around the disc which will not allow the disc to seat properly, causing water to pass back through the check valve. These problems require the check valve cover to be opened up to facilitate inspection and repairs.

In order to open the cover, it is necessary to take the respective pump unit out of service following all safety procedures, then you must isolate the check valve from line pressure by closing the discharge valve, and in the deep stations the suction valve must also be closed. Once the valves are closed, remove every other bolt holding the cover to the body. Then proceed by loosening the remaining bolts a turn or two each until all remaining bolts are loose.

At this point you need to separate the cover from the body. It may be necessary to drive a small wedge between the cover and body to break the seal of the gasket. There may be some water under pressure trapped inside the check valve, so be aware as you break the cover loose from the body. Should the water pressure not decrease, it may be necessary to tighten down on the suction and/or discharge valves.

Once you have determined that there is no pressure in the check valve, remove all but one bolt. The cover may be swung out of the way using the remaining bolt as a pivot. If there is trash in the body, remove it.

After the cover is open, loosen the set screws holding the clapper arm to the hinge pin. Remove the side plugs, or packing glands from the body and remove the hinge pin. The clapper arm and disc can then be removed from the body. The following items should be visually checked while the check valve is open:

1. Check the seat to see that it is in place, and check for excessive wear.
2. Check for excessive wear on the face of the disc.
3. Check for a tight fit between the disc and the arm.
4. Check for wear on the hinge pin that the arm pivots on.
5. Check to see that the hinge pin is secure and does not slide from side to side.
6. Check to see that the plugs, or glands that the hinge pin pivots on are not out of round (elongated). Parts that are out of round must be replaced.
7. If needed repack the packing for the hinge pin if it is used on that particular check valve.

Once all internal parts are re-assembled, make sure the gasket is in good shape and not torn up. It may be necessary to replace the gasket. Do not use any type of liquid gasket material to take the place of a new gasket unless you have been authorized to do so by a supervisor. Once the cover is in place, tighten all bolts hand tight only until all bolts are in place. Then proceed to tighten down each bolt using a wrench, alternating with every other bolt. When all bolts have been tightened down in this manner, go back a second time and check each bolt again.

After the cover is secured in place, open the valves and see that the check valve cover is not leaking. If no leaks are seen, put the pump unit back in service.

Confined Spaces

Confined spaces are dangerous because they are usually hard to enter and exit, and they may contain hazards that are not readily apparent to those entering. For example, lack of oxygen is one of the most serious hazards of confined spaces. Oxygen supply can be depleted when iron or steel parts rust, or organic matter decomposes.

Hazardous chemicals can seep into manholes from many sources. For example, a gasoline station developed a leak in a 10,000-gal gas tank. The leaking fuel found a way through the ground and filled several manholes in a 600-foot radius of the leaking tank with explosive gasoline vapors. Later, a utility worker opened one of the manholes and entered. On his way down the ladder, a tool struck a spark, causing a serious explosion, which killed him !

Many parts of the United States and Canada have naturally occurring methane and hydrogen sulfide in the ground. Methane is the chief component of natural gas. Methane is odorless, as are many other hazardous chemicals; hydrogen sulfide smells like rotten eggs. Hydrogen sulfide is deadly; very small doses can cause death.

To be safe around confined spaces, always follow safety rules.

If you are an attendant, never enter a confined space to rescue an entrant. Call for emergency backup, then try to remove the injured person using your rescue equipment. Many people have been killed in confined spaces, more than half of those killed have been would-be rescuers.

Record Keeping

Good record keeping is the most important aspect of the Drainage and Sewerage Operations Department. Good records can aid the operators and/or supervisor(s) by revealing problems before they become major and possibly cause extensive damage to equipment. The log book entries **MUST** be clear and legible and this requirement is strongly enforced. Log records and recorder charts are also considered legal records and are admissible as evidence in court proceedings, etc. These records are often used to verify the proper operation of a facility or system. All department records are to be kept a minimum of three (3) years.

The following is an outline of records and forms that may be required to be used in this department.

A sample of most COMMON forms used in this department are attached at the end of this section.

1) Station log books (Drainage and Sewerage Operations)

- A) Employees who are on watch
- B) Equipment status at start of each shift and every 1/2 hour for all equipment in operation
 - 1) volts
 - 2) amps (current)
 - 3) kilowatts
 - 4) power factor
 - 5) hour meter
 - 6) start counters
 - 7) position of discharge gates and/or valves (if applicable)
- C) Suction and discharge readings every 1/2 hour
- D) Remarks column
 - 1) person(s) in and out of station
 - 2) operational changes in equipment status
 - a) start, stop
 - b) speed changes
 - c) load, unload pumps
 - d) out of service
 - e) changes in discharge gates/valves position (if applicable)
 - 3) maintenance work performed at station by shift personnel
 - 4) information reported to Central Control
 - 5) U.P.W. II training duties
 - 6) work performed by others

- 7) employees calling in sick and time calls are received
- 8) any other information concerning unusual events pertaining to the facility or its operation

NOTE: The station log books for the unmanned stations are not set up in columns as are the manned stations. The same essential information should be recorded whenever making an inspection or performing work at the station.

2) Route sheets for Drainage and Sewerage Operations

NOTE: This form is filled out for the automatic sewerage stations and underpass drainage pumping stations only.

FRONT OF SHEET

- A) Date
- B) Name of operator
- C) Names of personnel assigned to assist on route
- D) Equipment out of service
 - 1) Reason equipment is out of service
 - 2) Other problems or defects at station
 - 3) To whom problems or defects have been reported
- E) Suction elevation
- F) Discharge pressure
- G) Lead/lag pump sequence

BACK OF SHEET

- A) Others working at the station site
- B) Work performed at station
- C) Reasons for leaving assigned route area (gas, central yard, supervisor's office, etc.)
- D) Training done with UPW II

3) Departmental Requisitions

- A) Requisition number (must be a consecutive 3 digit number)
- B) Date (date you fill out requisition)
- C) Ordered by (your name)
- D) Item no. (consecutively number each different item ordered)
- E) Quantity (how many you are ordering)
- F) Material description, (size, detail description, etc....no name brands)

NOTE: Check with your supervisor to see if you are permitted to fill out these requisitions in your department.

- 4) Sewerage and Water Board Absence Report (sick report)

NOTE: Only the "on-duty" operators at D.P.S. No. 1, D.P.S. No. 13, and S.P.S. "A" are authorized to accept sick calls. Information should be logged as required at the facility to which you are assigned.

- 5) Medical and Disability Certificate and/or Doctor's Certificate

NOTE: Whenever you are out sick and see a doctor, this form should be filled out and submitted to your supervisor upon your very first day return to work.

- 6) Vacation Request

- 7) Daily/weekly vehicle check list

NOTE: This report is filled out only by those employees who are assigned the use of a Board vehicle.

- 8) Rain Gauge Reports (For only facilities with Rain Gauge equipment)

- 9) Pump Operation Report

NOTE: This form is used only at manned pumping stations

- 10) Facility Maintenance Work Order

NOTE: This form will be filled out by assistant supervisor and is to be handled in accordance with assigned facility.

- 11) Safety Report

- 12) Weekly Training Report

* * * END OF PHASE VI! * * *

Conversion Chart for Military Time

<u>Regular time</u>	<u>Military time</u>	<u>Regular time</u>	<u>Military time</u>
Noon	12:00	Midnight	24:00
12:30 PM	12:30	12:30 AM	00:30
1:00 PM	13:00	1:00 AM	01:00
1:30 PM	13:30	1:30 AM	01:30
2:00 PM	14:00	2:00 AM	02:00
2:30 PM	14:30	2:30 AM	02:30
3:00 PM	15:00	3:00 AM	03:00
3:30 PM	15:30	3:30 AM	03:30
4:00 PM	16:00	4:00 AM	04:00
4:30 PM	16:30	4:30 AM	04:30
5:00 PM	17:00	5:00 AM	05:00
5:30 PM	17:30	5:30 AM	05:30
6:00 PM	18:00	6:00 AM	06:00
6:30 PM	18:30	6:30 AM	06:30
7:00 PM	19:00	7:00 AM	07:00
7:30 PM	19:30	7:30 AM	07:30
8:00 PM	20:00	8:00 AM	08:00
8:30 PM	20:30	8:30 AM	08:30
9:00 PM	21:00	9:00 AM	09:00
9:30 PM	21:30	9:30 AM	09:30
10:00 PM	22:00	10:00 AM	10:00
10:30 PM	22:30	10:30 AM	10:30
11:00 PM	23:00	11:00 AM	11:00
11:30 PM	23:30	11:30 AM	11:30
Midnight	24:00	Noon	12:00

OPERATOR'S DAILY INSPECTION GUIDE
AND TROUBLE REPORT VEHICLES

Vehicle No. _____
End Mileage _____
Start Mileage _____
Date: _____
Time In: _____

No. **557702**

Time Out _____

Start of Shift	<p>"X" to certify that the following items have been inspected. An "O" will denote a discrepancy in that area. Check and correct these items before starting vehicle:</p>	End of Shift
	1. Oil Check to see if at full mark.	
	2. Coolant-if applicable-check to see if full	
	3. Battery water level	
	4. Check tires	
	5. Drive belts check for 1/2" deflection	
	6. Windshield, mirrors, reflectors-if applicable	
	7. Damage to equipment, chassis or body (list on back)	
	8. Steering, power steering oil level	
	9. Clean interior and exterior as required	
	10. Auxiliary equipment-oil, water, belts	
	11. Instruments, gauges-gas, oil, air, amp., if applicable	
	Check these items after starting vehicle:	
	*12. Engine operation Miss Knock	
	*13. Brakes service - parking - drain air tanks *	
	14. Hydraulic oil level -if applicable	
	15. Transmission oil level & linkage, -if applicable	
	*16. Horn-Signal lights, headlights, tail lights, backup alarm	
	*17. Check equipment for unusual noise, stoppage, breakage or malfunction and record separately from other noted discrepancy.	
	18. Cyclic equipment one time - check chains, cylinders, belts and hoses if applicable.	
	19. Other specify (Air intake system)	
	20. Vehicle parked in spot number	
SIGNATURE OF DRIVER		
* If any of these items cannot be corrected, you must have your supervisor's signature prior to using vehicle.		
SIGNATURE OF SUPERVISOR		
<input type="checkbox"/> Dist. Yard <input type="checkbox"/> At garage for repair		

DATE _____

I would like to take my full vacation beginning _____

I would like to take my vacation in installments, as follows: _____

(Signed) _____

Recommended: _____

Approved for _____ working days from _____ to _____

**PHASE
VII**

(ELEVENTH MONTH)

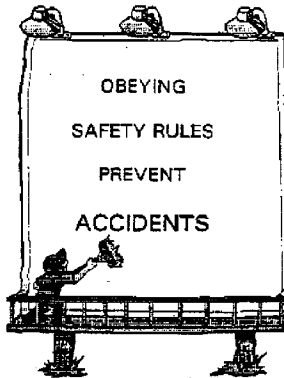
PHASE VII OUTLINE

The following duties are required to be performed by Utility Plant Worker II in this phase of the Training Program:

Phase VII - 11th Month

- A. Daily performance of operational duties under way
- B. Performance of routine maintenance under close supervision of P.P.O. and/or P.P.P.O.
- C. Troubleshooting of electrical system
 1. Low voltage A.C.
 2. High voltage A.C.
 3. D.C. circuits
- D. Troubleshooting of water system
- E. Troubleshooting of vacuum system

This phase of training is all hands-on work, and the required instructions will be given to UPWIIIs by their supervisor and/or station supervisor and/or operator. Individuals are encouraged to pay attention to the work description and its requirement, and use the blank pages provided at the end of this section for taking field notes. In this phase of the training the UPW II will learn how to operate all equipment in the assigned facility and/or route, trouble shoot, and perform all duties of PPO under close supervision of their assigned operator and/or supervisor.



According to the latest National Safety Council statistics, the number of accidents at work have decreased steadily over the past 20 years. The latest statistics show that 9,900 people were killed at work, and there were another 1,700,000 disabling injuries. About a third of the work-related deaths and disabling injuries resulted from auto accidents.

Accident rates have fallen over the past years because of improvements in work safety programs. The accident rate, however, is still far too high. Employees are still injured or killed because they disobey work safety rules. Safety regulations were formulated because people were injured on the job.

Even though we have many mandated safety rules, such as OSHA regulations and other regulations mandated by individual states and provinces, people get injured for other reasons. Many safe work practices are a matter of using common sense and are not necessarily covered by mandated regulations.

It is important to obey all safety rules whether they are regulated or simply common sense. It is important to wear personal protective equipment (PPE) and not to take chances. Even though employers are responsible for establishing safety rules and notifying employees of safety rules, employees must take these safety work rules seriously.

*** * * END OF PHASE VII * * ***

Phase VII - 2

NOTE

Phase VII - 3

NOTE

Phase VII - 4

NOTE

Phase VII - 5

NOTE

Phase VII - 6