PART II
GUIDELINES FOR WATER WORKS DEVELOPMENT

§7151. Mission of Plans. (a) **General**. For any water works contemplated or proposed, all reports, final plans and specifications should be submitted at least 30 days prior to the date on which action by the Guam Environmental Protection Agency is desired. Preliminary plans and the engineer's report should be submitted for review prior to the preparation of final plans. Approval for construction will not be issued until complete, detailed plans and specifications have been submitted to the Guam Environmental Protection Agency and found to be satisfactory. Documents submitted for consideration of formal approval shall include but not limited to:

(1) General layout, including location plan;

(2) Detailed plans and specifications;

(3) Basis of design, including a summary;

(4) Special operation requirements, where they differ from ordinary operational procedures;

(5) A list of any design deviations to these standards and the reason for a request for approval of said deviation.

(b) **Engineer's Report**. The engineer's report for any water works improvements shall present the following information. However, as basis of design is always required.

(1) General Information to include:

(A) Name and mailing address of the owner or utility agency;

(B) Identification of the area to be served;

(C) General description of any existing water works and sewerage facilities, including age, general condition and adequacy.

(2) Extent of water works system to include:

(A) Description of the nature and extent of the area to be served by this project;

(B) Provisions for extending the water works system to include areas beyond limits of intended construction;

(C) Appraisal of the future requirements or service, including existing and potential industrial commercial, institutional, and other water supply needs, where applicable.

(3) **Alternate plans**. Where two or more solutions exist for providing public water supply facilities, each of which is feasible and practicable, discuss the alternate plans. Give reasons for selecting the one recommended, including a comparison of the minimum classification of water works Operator required for Operation of each alternative facility.

(4) Soil and groundwater conditions should include a description of:

(A) The character of the soil through which water mains are to be laid;

(B) Soil conditions prevailing at sites of proposed structures;

(C) The elevation of highest groundwater in relation to subsurface structures.

(5) Water use data to include:

(A) A description of the population trends as indicated by available records, and the estimated population which will be served by the proposed water supply system or extended system,

(B) Present water consumption and the protected average and maximum daily demands, including fire flow demand (see §7151(b)(6)),

(C) Present and/or estimated yield of the source of supply, commercial uses, especially any uses during the day.

(6) Fire flow requirements to include:

(A) Requirements of the Guam Fire Department as to fire flow required or recommended in the service area involved;

(B) Fire flows which will be made available by the proposed or enlarge system.

(7) **Sewerage system available.** Describe the existing sewerage system and indicate location of existing and known future sewage treatment works, with special reference to their relationship to existing or proposed waster works structures which may affect the operation of the water supply system, or which may affect the quality of the supply.

(8) **Source of water supply**. Describe the proposed source or sources of water supply to be developed, the reasons for their selection and provide information as follows.

(A) Surface water sources to include:

(i) Hydrological data, stream flow and weather records;

(ii) Safe yield including factors that may affect it, and the minimum flows,

(iii) Maximum flood flow, together with approval for safety features of the spillway and dam from the appropriate reviewing authority both federal and local.

(iv) Description of the watershed, noting any existing or potential sources of contamination (such as highways, treated

wastewater discharges, drainage outfalls, chemical facilities etc.), which may affect water quality,

(v) Summarized quality of the raw water with special reference to existing or anticipated fluctuations in quality, changing meteorological conditions and known and predicted conditions.

(B) Groundwater sources to include:

(i) Refer to applicable requirements of the Water Resource Development and Operating Regulations.

(9) **Proposed treatment processes.** Summarize and establish the adequacy of proposed processes and unit parameters for the treatment of the specific water under consideration. Alternative methods of water treatment and chemical use should be considered as a means of reducing water handling when the proposed treatment devices from the conventional complete treatment involving coagulation, flocculation, sedimentation and filtrating with standard rates.

(10) **Waste disposal.** Discuss the various wastes from the water treatment plant, their volume, proposed treatment and points of discharge. Discharges of waste to rivers, streams or any territorial waters permit may be required from applicable local and federal reviewing and approving authority.

(11) **Automation.** Provide supporting data justifying automatic equipment, including the servicing and operator training to be provided. Manual override must be provided for any automatic controls. Highly sophisticated automation may put proper maintenance beyond the capability of the plant operator, leading to equipment breakdowns or expensive servicing.

(12) Project sites to include:

(A) Discussion of the various sites considered and advantages of the recommended ones.

(B) The proximity of residences, industries, and other important establishments and land uses

(C) Any potential sources of pollution that may influence the quality of the supply or interfere with effective operation of the water works system, such as septic tanks and leached fields, privies, cesspools, sink holes, sanitary landfills, solid waste disposal sites, etc.

(13) Future extensions. Summarizes planning for future needs and services.

(c) **Plans for Construction**. Plans for waterworks improvements shall, where pertinent, provide the following:

(1) General layout to include:

(A) Title

(B) Name of purveyor or other entity or person responsible for the water supply

(C) Service area

(D) Scale, in feet

(E) Direction of magnetic north

(F) Base elevation datum used

(G) Boundaries of the area to be served

(H) Date, name, and address of the design engineer

(I) Inclusion of professional engineer's seal or certification of conformance with engineering registration requirements

(J) Legible prints

(K) location of existing water mains

(L) Location and nature of existing water

works structures and appurtenances affecting the proposed improvements, noted on one sheet and location plan showing project location(s)

(M) Revision dates of all plan changes placed in the title block.

(2) Detailed plans, to include:

(A) Stream crossings, providing profiles with elevations of the stream bed and the normal and extreme high and low water levels;

(B) Profiles having a horizontal scale of not more than 100 feet to the inch and a vertical scale of not more than 10 feet to the inch with both scales clearly indicated;

(C) Location and size of the property to be used for the water source development with respect to known references such as roads, streams section lines, or streets

(D) Topography and arrangement of present or planned structures, with contour interval not greater than two feet;

(E) Elevations of the highest known flood level floor of the structure, upper terminal of protective casings and outside surrounding grade, using Flood Hazard Maps established by the Army Corps of Engineers and the Bureau of Planning, Government of Guam.

(F) Plant and profile drawings of well construction, showing diameter and depth of drill holes, casing and liner diameters and depths, grouting depths, elevations and designations of geological formations, water levels and other details to describe the proposed well completely in conformance wit] the requirements of the Water Resource Development and Operating Regulations.

(G) Location of all existing and potential sources of pollution within 1,000 feet of the

surface source and with Groundwater Management Protection Zone or 1,000 feet of the underground treated water storage facilities.

(H) Size, length and identity of sewers, drain and water mains and their locations relative to plant structures, also preferred type of pipe shall be indicated on the plan.

(I) Schematic flow diagrams and hydraulic profiles showing the flow through various plant units;

(J) Piping in sufficient detail to show flow through the plant, including waste lines;

(K) Locations of all chemical storage areas feeding equipment and points or chemical application (see Part 5 of this criteria);

(L) All appurtenances, specific structures, equipment, water treatment plant waste disposal units and points of discharge having any relationship to the plans for water mains and/or water works structures;

(M) Locations of sanitary or other potentially contaminating facilities, such as lavatories showers, toilets, and lockers, when applicable or required by the reviewing authority:

(N) Locations, dimensions, and elevations of all proposed plant facilities;

(O) Locations of all sampling taps;

(P) Adequate description of any features not otherwise covered by the specifications.

(d) **Specifications**. Complete, detailed, technical specifications shall be supplied for the proposed project, including:

(1) A program for keeping existing water works facilities in operation during construction of additional facilities so as to minimize interruption of service;

(2) Laboratory facilities and equipment;

(3) The number and design of chemical feeding equipment (see §7155);

(4) Materials or proprietary equipment for sanitary or other facilities including any necessary backflow or back-siphonage protection and coating and linings in contact with raw partially updated or finished water.

(e) **Design Criteria.** A summary of complete design criteria shall be submitted for the proposed project, containing but not limited to the following:

(1) Long-term dependable yield of the source of supply;

(2) Reservoir surface area and volume;

(3) Area of watershed, if applicable;

(4) Estimates average and maximum day water demands for the design period;

(5) Number of proposed services (including existing);

(6) Fire fighting requirements;

(7) Flash mix, flocculation and settling basin capacities;

(8) Retention times

(9) Unit loadings

(10) Filter area and the proposed filtration rate

(11) Backwash rate

(12) Feeder capacities and ranges

(f) **Revisions to Approved Plans.** Any deviations from approved plans or specifications affecting capacity, hydraulic conditions, operating units, the functioning of

water treatment processes, or the quality of water to be delivered, must be approved by the Guam Environmental Protection Agency before such changes are made. Revised plans or review and approval by the Guam Environmental Protection Agency of such plans or specifications before any construction works, which will be affected by such changes, is begun.

(g) **Additional Information Required.** The Guam Environmental Protection Agency may require additional information which is not part of the construction drawings, such as head loss calculations, proprietary technical data, or other pertinent information on the proposed project.

§7152. General Design Considerations. (a) **General.** The design of a water supply system or treatment process encompasses a broad area. Application of this part is dependent upon the type of system or process involved.

(b) **Design Basis.** For public water works, water treatment plant, wells and pump stations shall be designed for maximum day demand at the design year, 20 years hence. Water mains shall be designed for 50 years protected growth. Public water systems such as will serve condominiums or subdivisions need only plan for known projected demand. Latest approved guidelines of the Public Utility Agency of Guam Standards and/or latest 10 States Standards may be used in establishing design criteria.

(c) Plant Layout.

(1) Functional aspects of the plant layout;

(2) Provisions for future plant expansion;

(3) Provisions for expansion of the plant waste treatment and disposal facilities;

(4) Access roads;

(5) Site grading;

(6) Site drainage;

(7) Walks, driveways and ramps;

(8) Chemical delivery;

(d) Building Layout. Design shall provide for

(1) Adequate ventilation;

(2) Adequate lighting;

(3) Adequate drainage

(4) Dehumidification equipment, if considered necessary

(5) Accessibility of equipment for operation, servicing and removal

(6) Flexibility of operation

(7) Operator safety

(8) Convenience of Operation

(9) Chemical storage and feed equipment in a separate room to reduce hazards and dust problems.

(e) **Location of Structures.** The Guam Environmental Protection Agency and the Bureau of Planning and other appropriate agencies and departments both local and federal must be consulted regarding any structures which is so located that normal or flood stream flows may be impeded.

(f) **Electrical Controls**. Main switch near electrical controls shall be located above grade, in areas not subject to flooding.

(g) **Standby Power**. Standby power may be required so that water may be treated and/or pumped to the distribution Systems during power outages. If not proposed as the project, the engineer shall provide reasons for not including standby power.

(h) **Shop Space and Storage**. Adequate facilities should be included for shop space and storage consistent with the needs of the designed.

(i) **Laboratory Equipment**. Each public water supply shall have minimum equipment and facilities for laboratory testing necessary to assure proper operation. Laboratory equipment shall be based on the characteristics of the raw water source and the complexity of the treatment process involved.

(1) **Testing equipment.** As a minimum, the following laboratory equipment shall be provided:

(A) Surface water supplies shall have a nephelometric turbidimeter meeting the requirements of the latest Standard Methods for the Examination of Water and Wastewater.

(B) Each surface water treatment plant utilizing flocculation and sedimentation shall have a pH meter and jar test equipment.

(C) Each ion-exchange softening plant treating only groundwater shall have a pH meter and filtration equipment for both hardness and alkalinity.

(D) Each iron and/or manganese removal plant shall have test equipment capable of accurately measuring iron to a minimum of 0.1 mg/I and/or test equipment capable of accurately measuring manganese to minimum of 0.05 mg/1.

(E) Public water supplies which chlorinate, shall have test equipment for determining both free and total chlorine residual utilizing the latest Standard Methods for the Examination of Water and Wastewater.

(F) Public water supplies which fluoridate should have test equipment for determining fluoride by methods in the latest Standard Methods for the Examination of Water and Wastewater.

(G) Public water supplies which feed polyphosphates should have test equipment capable of accurately measuring phosphates from 0.1 to 20 mg/1.

(2) **Physical facilities**. Sufficient bench space, ventilation, lighting, storage and a laboratory sink shall be provided.

(j) **Monitoring Equipment**. Water treatment plants with a capacity of 0.5 mgd or more should be provided with continuous monitoring equipment including recorders) to monitor water being discharged to the distribution system as follows:

(1) Plants treating surface water should have the capability of continuously monitoring and recording turbidity, free chlorine must be tested at least daily.

(2) Plants treating groundwater using iron removal and/or ion-exchange softening should have the capability to monitor and record free chlorine residual.

(k) **Sample Taps**. Sample taps shall be provided so that water samples can be obtained from each water source and from appropriate locations in each unit operation of treatment. Taps shall be consistent with sampling needs and shall not be of petcock type. Taps used for obtaining samples for bacteriological analysis shall be of the smooth-nosed type without interior or exterior threads, shall not be of the mixing type, and shall have a screen, aerator, or other such appurtenance. Provision shall be made for sampling untreated well water suing a sampling tap.

(l) **Facility Water Supply**. The facility water supply service line and the plant finished water sample tap shall be supplied from a source or finished water at a. point where all chemicals have been thoroughly mixed, and the required disinfectant contact time has been achieved. There shall be no cross-connections between the facility water supply service line and any piping, troughs, tanks, or other treatment units containing wastewater, treatment chemicals, raw or partially treated water.

(m) **Wall Castings**. Consideration shall be given to providing extra wall castings built into the structure to facilitate future uses whenever pipes pass through walls of concrete structures.

(n) **Meters.** All water supplies shall have an acceptable

means of metering the finished water.

(o) **Disinfection Prior to Use**. All walls, pipes, tanks, and equipment can convey or store potable water shall be disinfected in accordance with AWWA Standards Procedures (C651-86, C652-86, & C653-87). Plans or specifications shall outline the procedure and include the disinfectant contact time, and method of testing the results of the procedure.

(p) **Manuals and Parts Lists.** An operation and maintenance manual including equipment and a parts list and parts order forms shall be supplied to the water works as part of any proprietary unit installed in the facility.

(q) **Operator Instruction.** Provisions shall be made for operator instruction at the start up of a water system. water treatment plant or pumping station.

(r) **Other Considerations.** In the designing, consideration must be given for items such as safety requirements, special designs for the handicapped, latest plumbing and electrical codes and construction in or near wetland or flood plain areas.

§7153. Source Development. (a) **General** In selecting the source of water to be developed, the consulting engineer, hydrologist, or hydrogeologist must show, to the satisfaction of the Guam Environmental Protection Agency that an adequate quantity of water will be available, and that the water which is to be delivered to the consumers will meet the current requirements of the Guam Primary Safe Drinking Water Regulations with respect to microbiological, physical, chemical and radiological qualities. Each water supply should take its raw water from the best available source which is economically reasonable and technically possible. Each source must receive site, design and construction, quality, quantity, wellhead protection area, and interference approval prior to serving as public water system.

(b) **Water Demand.** Source yields will be compared against the demands of the water Systems to determine the adequacy of the source(s) to meet the expected demand. Surface water sources having detailed hydrologic studies must supply average day demands. All groundwater

sources must meet maximum day demands.

(1) Average day demands.

(A) Average day demands will be based on the average day flow quantities. The source must be shown to meet the average day demand in 12 hours of pumped or gravity flow.

(B) A 10 percent leakage/aging factor should be added to empirically derived average day demands. Two types of analyses may be presented to determine reductions in the average day demands.

(2) Maximum day demands. Maximum day demands are determined as follows:

Average day demands x peaking factor = maximum day demands.

(3) Peaking factor

(A) The peaking factor on new projects should be based on PUAG Standards or latest 10 States Standards.

(c) **Surface Water.** A surface water source includes all tributary streams and drainage basins, natural and artificial or natural impoundments above the point of water supply intake. Surface water includes all waters directly exposed to the atmosphere.

(1) Quantity.

(A) The quantity of water at the source shall:

(i) Be shown to supply the projected average day demands in the design year given either on design year low flow condition for intakes without raw water impoundments or 20-50 year drought condition using a mass diagram for systems with raw water impoundment, and

(ii) Must consider other withdrawals in

the stream, including minimum stream flow.

(B) Quantity testing

(i) Hydrology studies used to determine low flow conditions outlined in §7153(c) must utilize existing hydrology information available and surrounding watersheds. Hydrology models used to predict low flow conditions must in part be based on information obtained from the watershed in question. The proposed watershed should be gauged on a daily basis including the year's low flow conditions may be present in late summer depending on the watershed.

(ii) All proposed hydrology studies should be present to the Guam Environmental Protection Agency for review prior to their commencement.

(2) Quality

(A) Site approval. Site approval will be based on existing threats to the water sources and the ability of the water supplier to control the water quality. A sanitary survey and study shall be made of the factors, both natural and man made, which affect quality. The results of the sanitary survey must be presented to the Guam Environmental Protection Agency in report form and shall include but not limited to:

(i) An outline of the watershed on a U.S.G.S. topographic map, or Guam's latest topographic map, prepared by the Government of Guam, and

(ii) Description of the degree of control of the watershed by the owner, showing the area on the U.S.G.S. topographic map or Guam's latest topographic map prepared by the Government of Guam.

(iii) Location of existing sources of contamination in the watershed including

homes, leach fields, chemical storage facilities, landfills, agricultural areas and other activities which might impair water quality, and

(iv) Assessment of the degree of hazard to supply by accidental spillage of materials that may be toxic, harmful or detrimental to treatment processes, and

(v) Determination of the possible future uses of impoundments or reservoirs.

(3) Structures.

(A) Design of intake structures shall provide for:

(i) Withdrawal of water from more than one level if quality varies with depth;

(ii) Separate facilities for release of less desirable water held in storage.

(iii) Where debris may be a problem, holding the velocity of flow into the intake structure to a minimum, generally not to exceed 0.5 feet per second;

(iv) Inspection manholes every 1,000 feet for pipe sizes large enough to permit visual inspection;

(v) Occasional cleaning of the inlet line;

(vi) Adequate protection against rupture by dragging anchors, etc.,

(vii) Where shore wells are not provided, a diversion device capable of keeping large quantities of fish or debris from entering an intake structure.

(B) Shore wells shall:

(i) Have motors and electrical controls

located above grade, and protected from flooding as required by the Guam Environmental Protection Agency.

(ii) Be accessible;

(iii) Be designed against flotation;

(iv) Be equipped with removable or traveling screens before the pump suction well;

(v) Provide for introduction of chlorine or other chemicals in the raw water transmission main if necessary for quality control;

(vi) Have provisions for with surges where necessary.

(4) Natural and Artificial Impoundments.

(A) Site preparation shall provide where applicable.

(i) Removal of brush and trees to high water elevation;

(ii) Protection from floods during construction; and

(iii) Abandonment of all wells which will be inundated, in accordance with the requirements of the Water Resource Development and Operating Regulations (WRDOR).

d) **Infiltration Galleries.**

(1) Infiltration galleries may be considered only where geological conditions preclude the possibility of developing good quality potable drinking water.

(2) Infiltration galleries shall be regarded in the same manner as wells as far as isolation distance and land uses are concerned.

(3) Flow in the galleries shall be by gravity to the collecting well.

The type of infiltration galleries which may be considered by the agency is as follows:

(A) Surface water induced infiltration galleries located so as to intercept surface water or groundwater and surface water. Infiltration galleries are considered surface water induced infiltration galleries.

(4) **Review Process**. Infiltration galleries are viewed as a last resort and will only be considered when other sources are shown not to be technically viable.

(A) Surface water infiltration galleries will be reviewed on a case-by-case basis and may be considered surface water intakes (see §7153(c)).

(e) Surface Water Source Protection Programs.

(1) **General.** A source protection program (SPP) must be developed prior to Guam Environmental Program Agency issuance of permit- to operate. Source protection programs are intended to serve as a guide for water system owners, which define steps to be taken to assure maintenance of drinking water quality of surface water and ground water sources.

(2) **Source Protection Program - Approval Process.** After approval of a public community water supply source and receipt of either a wellhead protection area or surface water drainage area, applicants for permits to Operate shall submit a proposed SPP for review and approval by the Guam Environmental Protection Agency.

(3) Source Protection Program Scope

(A) **Description** - The description shall include a map showing the location of the wellhead protection area or surface water drainage area, and the rational and/or calculation for the boundary definitions.

(B) **Inventory** - The inventory shall include map, locations and descriptions of existing and future potential sources of contamination to the water supply. Existing potential sources of contamination are facilities, or past or present land uses, which may contaminate surface water or ground water. Map locations should identify both point and non-point sources and land areas. Descriptions should include type of source of contamination, owner, and age and duration of activity as appropriate. An evaluation of the threat to the water supply should be noted.

(C) **Proposed Action and Timetable** - A proposed action and timetable should be drafted for all areas and activities within the well protection zone and surface water drainage areas. The degree of action should be related to the likelihood of an area or activity impacting water quality and quantity. Actions to be taken may range from yearly inventory to be taken may range from yearly inventory to. land purchase by the water purveyors. Public information should be made available to residents living in the wellhead protection area and surface water drainage basins.

(4) **Contingency Plan**. A contingency plan for the location and provision of alternate drinking water supplies for each public water system in the event of well or well field contamination shall be developed. Said maintenance manual and identify backup water sources considered surface water intakes (see §7153(c)).

§7154. Treatment (General and Clarification.) (a) **General.** The design of treatment processes and devices shall depend on evaluation of the nature and quality of the particular water to be treated and the desired quality of the finished water.

(1) All filtration facilities must be capable of producing finished water turbidity of at least 0.2 NTU and meet the maximum contaminant levels established by the Guam Primary and Secondary Safe Drinking Water Regulations.

(2) Pilot studies are required on all non-conventional water treatment systems.

(3) Pilot studies must address water qualities expected throughout the year including peak storm runoff and dry season over flows.

(4) Pilot studies will not be required for conventional flocculation filtration facilities.

(b) **Clarification**. Plants designed for processing surface water shall:

(i) Provide a minimum of two units each of rapid mix flocculation and sedimentation;

(ii) Be constructed to permit units to be taken out of service without disrupting operations, and with drains or pumps sized to allow dewatering in a reasonable period of time,

(iii) Be started manually following shutdown; and

(iv) Minimize hydraulic head losses between units to allow future changes in processes without the need for repumping.

(1) **Rapid Mix.** *Rapid mix* shall mean the rapid dispersion of chemicals throughout the water to be treated, usually by violent agitation.

(A) **Equipment** - Basins should be equipped with mechanical mixing devices, or in line static mixers.

(B) **Location** - The rapid mix and flocculation basin shall be as close together as possible.

(2) **Flocculation**. Flocculation shall mean the agitation of water at low velocities for long periods of time.

(A) **Basin Design** - Inlet and outlet design shall prevent short circuiting and destruction of floc. A drain and/or pumps shall be provided to

handle dewatering and sludge removal.

(B) **Detention** - The flow through velocity shall be not less than *0.5* nor greater than *1.5* feet per second with a detention time for floc formation of at least 30 minutes.

(C) **Equipment** - Agitators shall be driven by variable speed drives with a peripheral speed of paddles ranging from 0.5 to 30 feet per second.

(D) **Piping** - Flocculation and sedimentation basins shall be as close together as possible. The velocity of flocculated water through pipes or conduits to settling basins shall be not less than 0.5 nor greater than 1.5 feet per second. Allowances must be made to minimize turbulence at bends and chances in direction.

(E) **Other designs** - Baffling may be used to provide for flocculation in small plants only after consultation with the Guam Environmental Protection Agency. The design should be such that the velocities and flows noted above will be maintained.

(F) **Accessibility** - Flocculation basin should be designed for easy access and observation of floc.

(3) **Sedimentation.** Sedimentation shall follow flocculation. The detention time for effective clarification is dependent upon a number of factors related to basin dependent upon a number of factors related to basin design and the nature of the raw water. The following criteria apply to convention sedimentation units.

(A) **Detention time** - Shall provide a minimum of four hours of settling time. Reduced sedimentation time may also be approved when equivalent effective settling is demonstrated.

(B) **Inlet devices** - Inlets shall be designed to distribute the water equally and at uniform velocities, and similar entrance arrangements are

required. A baffle should be constructed across the basin close to the inlet end and should project several feet below the water surface to dissipate inlet velocities and provide uniform flows across the basin.

(C) **Outlet devices** - Outlet devices shall be designed to maintain velocities suitable for settling in the basin arid to minimize short circuiting. The use of submerged orifices is recommended in order to provide a volume above the orifices for storage where there are fluctuations in flow.

(D) **Overflow rate** - The rate of flow over the outlet weir shall not exceed 20,000 gpd per foot of weir length. Where submerged orifices are used as an alternate for overflow weirs, they should be not lower than three feet below the flow line with flow rates equivalent to weir loadings.

(E) **Velocity** - The velocity through settling basins shall not exceed 0.5 feet per minute. The basins must be designed to minimize short circuiting. Fixed or adjustable baffles must be provided as necessary to achieve the maximum potential for clarification.

(F) **Overflow** - An overflow weir (or pipe) should be installed which will establish the maximum water level desired on top of the filters. It shall discharge by gravity with a free fall at a location where the discharge will be noted.

(G) **Superstructure** - A superstructure over the sedimentation basin is required.

(H) **Sludge collection** - Mechanical sludge collection equipment should be provided.

(I) **Drainage** - Basins must be provided with a means for dewatering. Basins bottoms should slope toward the drain not less than one foot in twelve feet where mechanical sludge collection equipment is not required.

(J) **Flushing lines** - Flushing lines or hydrants shall be provided and must be equipped with backflow prevention devices acceptable to the Guam Environmental Protection Agency.

(K) **Safety** - Permanent ladders or handhold should be provided on the inside wall at basins above the water level. Guard rails should be included.

(L) **Sludge removal** - Sludge removal design shall provide that:

(1) Sludge pipes shall be not less than three inches in diameter and so arranged as to facilitate cleaning.

(2) Entrance to sludge withdrawal piping shall prevent clogging,

(3) Valves shall be located outside the tank for accessibility, and

(4) The operator may observe and sample sludge being withdrawn from the unit.

(M) **Sludge disposal** - Sludge disposal facilities shall meet the requirements of the Guam Environmental Protection Agency and the U.S. Environmental Protection Agency.

(4) **Solids Contact Unit.** Units are acceptable for clarification where water characteristics are not variable and flow rates are uniform. Clarifiers should be designed for the maximum uniform rate and should be adjustable to changes in flow which are less than the design rate and for changes in water characteristics. A minimum of two units are required for surface water treatment.

(A) **Chemical Feed.** Chemicals shall be applied at such points and by such means as to insure satisfactory mixing of the chemicals with the water.

(B) **Mixing.** A rapid mix device or chamber

ahead of solids contact units may be required by the Guam Environmental Protection Agency to assure proper mixing of the chemicals applied. Mixing devices employed shall be so constructed as to:

(1) Provide good mixing of raw water with previously formed sludge particles, and

(2) Prevent deposition of solids in the mixing zones.

(C) **Sludge Concentrators.** The equipment should provide either internal or external concentrators in order to obtain a concentrated sludge with a minimum of waste water.

(D) **Sludge Removal.** Sludge removal design shall provide that:

(1) Sludge pipes shall be not less than three inches in diameter and so arranged as to facilitate cleaning,

(2) Entrance to sludge withdrawal piping shall prevent clogging,

(3) Valves shall be located outside the tank for accessibility. arid

(4) The operator may observe and sample sludge being withdrawn from the unit.

(E) **Detention time.** As approved by the Guam Environmental Protection Agency on the individual units used, and the raw water characteristics.

(F) **Weirs or Orifices.** The units should be equipped with overflow weirs or orifices constructed so that water at the surface of the unit does not travel over 10 feet horizontally to the collection trough.

(1) Weirs shall be adjustable, and at least equivalent in length to the perimeter of the

tank.

(2) Weir loading shall not exceed:

(i) 10 gpm per foot of weir length for units used for clarifiers. and

(ii) 20 gpm per foot of weir length for units used for softeners.

(3) Where orifices are used the loading per foot of launder rates should be equivalent to weir loadings. Either shall produce uniform rising rates over the entire area of the tank.

(G) **Upflow rates.** Unless supporting data is submitted to the Guam Environmental Protection Agency to justify flow rates increase. the rate of flow shall not exceed 1.0 gpm per square foot of area at the sludge separation line.

(5) **Tube Settlers**. Although recognized as an alternate method of clarification. sufficient experience is not yet available to establish design standards. Therefore, proposals for tube settler clarification will be reviewed on a case by case basis.

(c) **Filtration**. Acceptable filters shall include, upon the discretion of the agency, the following types.:

(i) Rapid rate gravity filters;

(ii) Rapid rate pressure filters;

(iii) Slow sand filtration;

(iv) Direct filtration.

The application of any one type must be supporting by water quality data representing a reasonable period of time to characterize the variation in water quality. Experimental treatment studies may be required to demonstrate the applicability of the method of filtration proposed.

(1) Rapid Rate Gravity Filters

(A) **Pretreatment.** The use of rapid rate gravity filters shall require pretreatment.

(B) **Rate of Filtration**. The rate of filtration shall be determined through consideration of such factors as raw water quality, degree of pretreatment provided, filter media, water quality control parameters, competency of operating personnel, and other factors as required by the Guam Environmental Protection Agency. In any case, the filter rate must be proposed and justified by the designing engineer to the satisfaction of the Agency prior to the preparation of final plans and specifications.

(C) **Number**. At least two units shall be provided. Where only two units are provided each shall be capable of meeting the plant design capacity (normally the projected average daily demand) at the approved filtration rate. Where more than two filter units are provided, the filters shall be capable of meeting the plant design capacity at the approved filtration rate with one filter removed from service. Where declining rate filtration is provided, the variable aspect of filtration rates, and the number of filters must be considered when determining the design capacity for the filters.

(D) **Structural details and hydraulics**. The filter structure shall be so designed as to provide for:

(1) Vertical wells within the filter.

(2) No protrusion of the filter walls into the filter media;

(3) Head room to permit normal inspection and operation.

(4) Trapped effluent to prevent backflow of air to the bottom of the filters;

(5) Prevention of floor drainage to the filter with a minimum of 4 inch curb around

the filters;

(6) Prevention of flooding by providing overflow;

(7) Maximum velocity of treated water in pipe and conduits to filters of two feet per second;

(8) Cleanouts and straight alignment for influent pipes of conduits where solids loading is heavy;

(9) Washwater grain capacity to carry maximum flow;

(10) Safety handrails or walls around filter areas adjacent to normal walkways;

(11) Construction to prevent cross-connections and common walls between potable and non-potable water.

(E) **Washwater troughs**. Washwater troughs should be constructed to have:

(1) The bottom elevation above the maximum level of expanded media during washing;

(2) A two inch freeboard at the maximum rate of wash;

(3) The top edge level and all at the same elevation;

(4) Spacing so that each trough serves the same number of square feet of filter area;

(5) Maximum horizontal travel of suspended particles to reach the trough not to exceed three feet.

(F) **Filter material**. The media shall be clean silica sand or other natural or synthetic media approved by the Guam EPA and having the

following characteristics:

(1) A total depth of not less than 24 inches and generally not more than 30 inches;

(2) An effective size range of the smallest material no greater than 0.45 to 0.55 mm.

(3) A uniformity coefficient of the smallest material not greater than 1.65.

(4) A minimum of 12 inches of media with an effective size range no greater than 0.45 mm to 0.55 mm, and a specific gravity greater than other filtering material within the filter.

(5) Types of filter media

(i) Anthracite - Clean crushed anthracites, or a combination of anthracite and other media may be considered on the basis of experimental data specific to the project, and shall have:

(a) Effective size of 0.45-0.55 mm with uniformity coefficient not greater than 1.65 when used alone.

(b) Effective size of 0.5 - 1.2 mm with a uniformity coefficient not greater than 1.85 when used as a cap.

(ii) Sand - Sand shall

(a) Effective size of 0.45 - 0.55 mm.

(b) Uniformity coefficient of not greater than 1.65.

(iii) Granular activated carbon (GAC) -Granular activated carbon media may be considered only with approval of

the Guam EPA and must meet the basic specifications for filter material as given in §713154(c)(1); and

(a) There must be provision for a free chlorine residual in the water following the filters and prior to distribution.

(b) There must be means for periodic - treatment of filter material for control of bacterial and other growth,

(c) Provisions must be made for frequent replacement or regeneration if GAC is used for filtration.

(iv) Other media - Other media will be considered based on experimental data and operating experience.

(v) Gravel - Gravel, when used as the supporting media shall consist of hard. rounded particles and shall not include flat or elongated particles. The coarsest gravel shall be 2-1/2 inches in size when the strainer system rest directly on the strainer system. and must extend above the top of the perforated laterals. Not less than four layers of gravel shall be provided in accordance with the following size with perforated laterals.

SIZE	DEPTH
2-1/2 to 1-1/2 inches	5 to 8 inches
1-1/2 to 3/4 inches	3 to 5 inches
3/4 to 1/2 inches	3 to 5 inches
1/2 to 3/16 inches	2 to 3 inches

3/16 to 3/32 inches	2 to 3 inches

(G) Filter bottoms and strainer systems. Departures from these standards may be acceptable for higher rate filters. Porous plate bottoms shall not be used where iron or manganese may clog them or with waters softened by lime. The design of manifold-type collection Systems shall be such as to:

(1) Minimize loss of head in the manifold materials;

(2) Assure even distribution of wash water and even rate of filtration over the entire area of the filter.

(H) Surface wash or subsurface wash. Surface Wash or subsurface wash facilities are recommended and may be accomplished by a system of fixed nozzles or a revolving type apparatus. All devices shall be designed with:

(1) Provision for water pressure of at least 45 psi;

(2) A properly installed vacuum breaker or siphonage if connected to the treated water system,

(3) Rate of flow of 2.0 gallons per minute per square foot of filter area with fixed nozzles or *0.5* gallons per minute per square foot with revolving arms,

(4) Air wash can be considered based on experimental data and operating experiences.

(I) Appurtenances

(1) The following shall be provided for every filter:

(i) Influent and effluent sampling taps;

(ii) Means for measuring headloss;

(iii) A flow meter. A modified rate controller which limits the rate of filtration to a maximum rate may be used. However, equipment that simply maintains a constant water acceptable, unless the rate of flow onto the filter is properly controlled. A pump or a flow meter is used as the limiting device for the rate of filtration only after consultation with the Guam Environmental Protection Agency and other appropriate reviewing authority.

(2) It is recommended the following be provided for every filter:

(i) A continuous or rotating cycle turbidity recording device for surface water treatment plants,

(ii) A 1 to 1 - 1/2 inch pressure hose and storage rack at the operating floor for washing filter walls;

(iii) Provisions for draining the filter to waste with appropriate measures for backflow prevention (see §7154(1)).

(J) **Backwash.** Provisions shall be made for washing filters as follows:

(1) A minimum rate of 15 gallons per minute per square foot, consistent with water temperatures and specific gravity of the filter media. A rate of 20 gallons per minute per square or a rate necessary to provide for a 50 percent expansion of the filter bed is recommended. A reduced rate of 10 gallons per minute per square foot may be acceptable for full depth anthracite or granular activated carbon filters.

(2) Filtered water provided at the required rate by washwater tanks, a

washwater pump, from the high service main, or a combination of these.

(3) Washwater pumps in duplicate unless an alternate means of obtaining washwater is available.

(4) Not less than 15 minutes wash of filter at the design rate of wash.

(5) A washwater regulator or valve on the main washwater line to obtain the desired rate of filter wash with the washwater valves on the individual filters open wide.

(6) A rate-of-flow indicator, preferably with a totalizer. on the main washwater line, located so that is can be easily read by the operator during the washing process.

(7) Design to prevent rapid changes in back-wash water flow.

(2) Rapid rate pressure filters.

(A) **General.** Minimum criteria relative to number. rate of filtration. structural details and hydraulics, filter media. etc., provided for rapid rate gravity filters also apply to pressure filters where appropriate.

(B) **Rate of filtration.** The rate shall not exceed three gallons per minute per square foot of filter area; except where pilot study or in plant testing as approved by the Agency has demonstrated satisfactory results in higher rates.

(C) **Details of design**. The filters shall be designed to provide for:

(1) A minimum of two site ports (except for iron and manganese removal filters);

(2) A differential headloss gauge;

(3) An easily readable meter or flow

indicator on each battery of filters. A flow indicator is recommended for each filtering unit;

(4) Filtration and backwashing of each filter individually with an arrangement of piping as simple as possible to accomplish these purposes;

(5) Filter and backwashing of each filter individually with an arrangement of piping as simple as possible to accomplish these purposes;

(6) The top of the washwater collectors to be at least 18 inches above the surface of the media.

(7) The underdrain system to efficiently collect the filtered water and to uniformly distribute the backwash water at a rate not less than is gallons per minute per square foot of filter area;

(8) Backwash flow indicators and controls that are easily readable while operating the control valves;

(9) An air release valve on the highest point of each filter;

(10) An accessible manhole to facilitate inspection and repairs;

(11) Means to observe the wastewater during backwashing;

(12) Construction to prevent cross connection;

(13) A pressure relief valve shall be installed for each filter.

(3) **Slow Rate Gravity Filters**. The use of these filters shall require prior engineering studies to demonstrate the adequacy and suitability of this

method of filtration for the specific raw water supply.

(A) **Quality of raw water.** Slow rate gravity filtration shall be limited to waters having maximum turbidities of 50 units and maximum color of 30 units; such turbidity must not be attributable to colloidal clay. Raw water quality data must include examinations for algae.

(B). **Number**. At least two units shall be provided. Where only two units are provided. each shall be capable of meeting the plant design capacity (normally the projected maximum daily demand) at the approved filtration rate.

Where more than two units are provided, the filters shall be capable of meeting the plant design capacity at the approved filtration rate with one filter removed from service.

(C) **Structural details and hydraulics.** Slow rate gravity filters shall be so designed as to provide:

(1) A cover, and insulation to protect from contamination and vandalism;

(2) Headroom to permit normal movement by operating personnel for scraping and sand removal operations;

(3) Adequate manholes and access ports for handling of sand;

(4) Filtration to waste;

(5) An overflow at the maximum filter water level;

(6) Provisions for graining the filter to waste with appropriate measures for backflow prevention (see §7154(l)).

(D) **Rates of filtration**. The permissible rates of filtration shall be determined by the quality of the raw water and shall be on the basis of

experimental data derived from the water to be treated. The nominal rate may be 45 to 150 gallons per day per square foot of sand area. with somewhat higher rates acceptable when demonstrated to the satisfaction of the Guam Environmental Protection Agency.

(E) **Underdrains.** Each filter unit shall be equipped with a main drain and an adequate number of lateral underdrains to collect the filtered water. The underdrains shall be so spaced that the maximum velocity of the water flow in the lateral underdrain will not exceed 0.75 feet per second. The maximum spacing of the laterals shall not exceed 12 feet.

(F) Filtering material

(1) Filter sand shall be placed on graded gravel layers for a minimum depth of 30 inches;

(2) The effective size shall be between 0.40 rum and 0.45 mm;

(3) The uniformity coefficient shall not exceed 2.5;

(4) The sand shall be clean and free from foreign matter.

(G) **Filter gravel**. The supporting gravel shall conform to the size and depth distribution provided for rapid rate gravity filters (see §7154(c) - Filter materials).

(H) **Depth of water on filter beds**. Design shall provide a depth of at least three feet of water over the sand. Influent water shall not scour the sand surface.

(I) **Control appurtenances.** Each filter shall be equipped with:

(1) Loss of head gauge;

(2) An orifice, venturi meter, or other suitable metering device installed on each filter to control the rate of filtration.

(3) An effluent pipe designed to maintain the water level above the top of the filter sand.

(4) **Direct Filtration.** Direct filtration. as used herein, refers to the filtration of a surface water without prior settling. The nature of the treatment process will depend upon the raw water quality. A full scale direct filtration plant shall not be constructed without prior pilot studies which are acceptable to the Guam Environmental Protection Agency. In-plant demonstration studies may be appropriate where conventional treatment plants are converted to direct filtration. Where direct filtration is proposed, an engineering report shall be submitted prior to conducting pilot plant or in-plant demonstration studies. In cases where a direct filtration plant is effectively treating the same source, pilot plant studies may be eliminated.

(A) **Engineering report.** In addition to the items considered in §7151(b), "Engineering Report,"the report should include a historical summary of meteorological conditions and of raw water quality with special reference to fluctuations in quality, and possible sources of contamination. The following raw water parameters should be evaluated in the report:

(1) Color

(2) Turbidity

(3) Bacterial concentration

(4) Microscopic biological organisms

(5) Temperature

(6) Total solids

(7) General inorganic and organic

chemical characteristics

(8) Additional parameters as required by the Guam Environmental Protection Agency.

The report should also include a description of methods and work to be done during a pilot plant study or where appropriate, an in-plant demonstration study.

(B) **Pilot plant studies.** After approval of the engineering report, a pilot study or in-plant demonstration study shall be conducted. This study shall be conducted under average and adverse water quality conditions and shall emphasize but not be limited to the following items:

(1) Chemical mixing conditions including shear gradients and detention periods;

(2) Chemical feed rates;

(3) Use of various coagulant aids including polymers;

(4) Flocculation conditions;

(5) Filtration rates;

(6) Filter gradation. types of media and depth of media;

(7) Filter breakthrough conditions.

Prior to the initiation of design plans and specifications. a final report including the engineer's design recommendations shall be submitted to the Guam Environmental Protection Agency.

(C) **Pretreatment - Rapid mix and flocculation**. The final rapid mix and flocculation basin design should be based on the pilot plant or in-plant demonstration studies augmented with applicable portions of §7154(b)(l) "Rapid Mix" and

§7154(1,)(2) "Flocculation".

(4) Filtration

(a) Filters should be rapid rate gravity filters with dual or mixed media. The final filter design should be based on the pilot plant or in-plant demonstration studies augmented by applicable portions of §7154(c)(l) "Rapid Rate Gravity Filters." Pressure filters or single media sand filters shall not be used.

(2) Surface wash shall be provided for the rapid rate gravity filters in accordance with §7154(c)(l)(H).

(E) Control and Operation.

(1) A continuous recording turbidimeter should be installed on each filter effluent line and on the composite filter effluent line.

(2) Additional continuous monitoring equipment may be required by the Guam Environmental Protection Agency.

(d) **Disinfection**. Chlorine is the preferred disinfecting agent. Chlorination may be accomplished with liquid chlorine, calcium or sodium hypochlorites or chlorine dioxide. Other disinfecting agents will be considered, providing reliable application equipment is available and testing procedures for residual are recognized in "Standard Methods for the Examination of Water and Wastewater." latest edition. Disinfection is required at all surface water supplies and at any groundwater supply of questionable sanitary quality or where other treatment is provided. Capability for continuous disinfection is required for all water supplies.

(1) Chlorination equipment

(A) **Type**. Solution feed gas chlorinators or hypochlorite feeders of the positive displacement type must be provided (see §7155).

(B) **Capacity.** The chlorinator capacity shall be such that a free chlorine residual of at least 2 mg/1 can be maintained in the water after contact time of at least 30 minutes when maximum flow rate coincides with anticipated maximum chlorine demand. The equipment shall be of such design that it will operate accurately over the desired feeding range.

(C) **Standby equipment**. Where chlorination is required for protection of the supply, standby equipment of sufficient capacity shall be available to replace the largest unit. Spare parts shall be made available to replace parts subject to wear and breakage.

(D) **Automatic switchover.** Automatic switchover of chlorine cylinders should be provided, where necessary. to assure continuous disinfection.

(E) **Automatic proportioning**. Automatic proportioning chlorinators will be required where the rate of flow or chlorine demand is not reasonably constant.

(F) **Eductor**. Each eductor must be selected for the point of application with particular attention given to the quantity of chlorine to be added! the maximum injector waterflow, the total discharge back pressure, the injector operating pressure, and the size of the chlorine solution line. Gauges for measuring water pressure and vacuum at the inlet and outlet of each eductor should be provided.

(G) **Injector/diffuser**. The chlorine solution injector/diffuser must be compatible with the point of application to provide a rapid and thorough mix with all the water being treated. The center of a pipeline is the preferred application point.

(2) Contact time and point of application.

(A) Due consideration shall be given to the

contact time of the chlorine in water with relation to pH, ammonia, taste-producing substances, temperature, bacterial quality, trihalomethane formation potential and other pertinent factors. Chlorine should be applied at a point which will provide adequate contact time. All basins used for disinfection must be designed to minimize short circuiting.

(B) At planning treating surface water, provisions should be made for applying chlorine to the raw water, filtered water, and water entering the distribution system.

The contact time as required in §7154(d)(2) must be provided after filtration unless other wise approved by the Guam Environmental Protection Agency.

(C) Free residual chlorination is the preferred practice; 30 minutes contact time must be provided for all finished water from groundwater systems and 120 minutes from surface water systems.

(3) **Residual chlorine.** Minimum free chlorine residual at distant points in a water distribution system should be 0.3 milligram per liter. Higher residuals may be required depending on pH, temperature and other characteristics of the water.

(4) **Testing equipment.** Chlorine residual test equipment utilizing other method recognized in the latest edition of "Standard Methods for the Disinfection of Water and Wastewater," shall be provided and should be capable of measuring residuals to the nearest 0.1 milligrams per liter in the range below 0.5 milligrams per liter and to the nearest 0.3 milligrams per liter between 0.5 milligrams per liter and 1.0 milligrams per liter and to the nearest 0.5 milligrams per liter between 1.0 milligrams per liter and 2.0 milligrams per liter.

(5) Chlorinator piping

(A) **Cross connection protection**. The

chlorinator water supply piping shall be designed to prevent contamination of the treated water supply by sources of questionable quality. At all facilities treating surface water, pre-and post-chlorination systems must be independent to prevent possible siphoning of partially treated water into the clear well. The water supply to each eductor shall have a separate shut-off valve. No master shut-off valve will be allowed.

(B) **Pipe material.** The pipes carrying elemental liquid or dry gaseous chlorine under pressure and liquid chlorine must be schedule 80 seamless steel tubing or equal. Nylon products are not acceptable for any part of the chlorine solution piping system.

(6) **Housing**. Adequate housing must be provided for the chlorination equipments and for storing the chlorine (see §7155).

(7) **Other disinfecting agents**. Although disinfecting agents other than chlorine are available., each has usually demonstrated shortcomings when applied to a public water supply. Proposals for use of disinfecting agents other than chlorine must be approved by the Guam Environmental Protection Agency prior to preparation of final plans and specifications.

(e) **Softening**. The softening process selected must be based upon the mineral qualities of the raw water and the desired finished water quality in conjunction with requirements for disposal of brine waste, cost of plant, cost of chemicals and plant location. Applicability of the process chosen shall be demonstrated.

(1) **Cation exchange process**. Alternative methods of hardness reduction should be investigated when the sodium content and dissolved solids concentration is of concern.

(A) Iron, manganese, or a combination of the two. should not exceed 0.3 mg/l in the water as applied to the ion exchange resin. Pre-treatment is required when the content of iron., manganese. or

a combination of the two. is one mg/l or more. (see §7154(g)). Water having 5 units or more turbidity should not be applied directly to the cation exchange softener. Nor should chlorination precede softening by ion exchange.

(B) **Design**. The units may be of pressure or gravity type. of either an upflow or downflow design. Automatic regeneration based on volume of water softened should be used unless manual regeneration is justified and is approved by the Guam Environmental Protection Agency. A manual override shall be provided on all automatic controls.

(C) **Flow rates**. The rate of softening is recommended to be to 4 gallons per minute per square foot and should not exceed 7 gallons per minute per square foot of bed area and the backwash rate should be 6 to 8 gallons per minute per square foot of bed area. Rate of flow controllers or the equivalent must be installed for the above purposes.

(D) **Freeboard**. The freeboard will depend upon the specific gravity of the resin and the direction of water flow. Generally, the wash water collector should be 24 inches above the top of the resin and the direction of water flow.

(E) **Underdrains and supporting gravel.** The bottoms, strainer and support for the exchange resin shall conform to criteria provided for rapid rate gravity filters. (see §7153(c)(F) and (G)

(F) **Brine distribution.** Facilities should be included for even distribution of the brine over the entire surface of both upflow and downflow units.

(G) **Cross-connection control.** Backwash. rinse and air relief discharge pipes should be installed in such a manner as to prevent any possibility of back-siphon-age.

(H) **Bypass piping and equipment**. A bypass

must be provided around softening units to produce a blended water of desirable hardness. Totalizing meters must be installed on the bypass line and on each softener unit. An automatic proportioning or regulating device and shut off valve should be provided on the bypass line. In some installation. It may be necessary to treat the bypassed water to obtain acceptable levels of iron and/or manganese in the finished water.

(I) **Additional limitations.** Silica gel resins should not be used for waters having a pH above 8.4 or containing less than six milligram per liter silica and should not be used when iron is present. When the applied water contains a chlorine residual, the cation exchange resin shall be a type that is not damaged by residual chlorine. Phenolic resin should not be used.

(J) **Sampling taps.** Taps shall be located to provide for sampling of the softener influent, effluent and blended water. The sampling taps for the blended water shall be at least 20 feet downstream from the point of blending. Sampling taps should be provided on the brine tank discharge piping.

(K) Brine and salt storage tanks.

(1) Salt dissolving or brine tanks and wet salt storage tanks must be covered and must be corrosion resistant.

(2) The make-up water inlet must be protected from back-siphonage. The tanks should be provided with an automatic declining level control system on the make-up water line.

(3) Overflow, where provided, must be turned down, have a proper free fall discharge and be protected with corrosion resistant screens or self-closing flap valve.

(L) **Waste disposal**. Suitable disposal must be provided for brine waste. (See §7154(t)).

(M) **Construction materials.** Pipes and contact materials must be resistant to the aggressiveness of salt. Plastic and red brass are acceptable piping materials. Steel and concrete must be coated with a non-leaching protective coating which is compatible with salt and brine.

(f) **Aeration.** Aeration may be used to help remove offensive tastes and odors due to dissolved gases from decomposing organic matter, or to reduce or remove objectionable amounts of carbon dioxide, hydrogen sulfide, etc., and to introduce oxygen to assist in iron and/or manganese removal. Proposals will be considered on an individual basis.

Groundwater supplies exposed to the atmosphere by aeration must receive chlorination as a minimum additional treatment.

(g) **Iron and Manganese Control.** Iron and manganese control, as used herein, refers solely to treatment processes designed specifically for this purpose. The treatment process used will depend upon the character of the raw water. The selection of one or more treatment processes must meet specific local conditions as determined by engineering investigations, including chemical analyses of representative samples of water to be treated, and receive the approval of the Guam Environmental Protection Agency. It may be necessary to operate a pilot plant in order to gather all information pertinent to the design. Consideration should be given to adjusting pH of the raw water optimize reaction.

(1) Removal by oxidation, detention and filtration.

(A) **Oxidation**. Oxidation may be by aeration, as indication in §7154(f) or by chemical oxidation with chlorine, potassium permanganate, ozone or chlorine.

(B) **Detention**

(1) **Reaction** - A minimum detention time of 20 minutes shall be provided following aeration to insure that the oxidation reactions are as complete as possible. This minimum

detention may be omitted only where a pilot plant study indicates no need for detention. The detention basin should be designed as a holding tank with no provisions for sludge collection but with sufficient baffling to prevent short circuiting.

(2) **Sedimentation** - Sedimentation basins are recommended when treating water with high iron and/or manganese content, or where chemical coagulation is used to reduce the load on the filters. Provisions for sludge removal shall be made.

(C) **Filtration.** Filters shall be provided and shall conform to §7154(c).

(2) **Removal by manganese greensand filtration**. This process. consists of either a continuous feed of potassium permanganate to the influent of a manganese greens and filter or regeneration of filter media permanganate.

(A) Provisions should be made to apply the permanganate as far ahead of the filter as practical and to a point immediately before the filter.

(B) Other oxidizing agents or processes such as chlorination or aeration may be used prior to the permanganate feed to reduce the cost of the chemical.

(C) Anthracite media cap of at least six inches over the manganese greensand is recommended.

(D) Normal filtration rate is three to give gallons per minute per square foot.

(E) Normal wash rate is 6 to 10 gallons per minute per square foot.

(F) Air washing should be provided.

(G) Sample taps should be provided

(1) Prior to application of permanganate;

(2) Immediately ahead of filtration;

(3) At the filter effluent.

(3) **Removal by ion exchange**. This process of iron and manganese removal should not be used for water containing more than 0.5 milligrams per liter of iron, manganese or combination thereof. This process is not acceptable where either the raw water or wash water contains dissolved oxygen.

(4) **Sampling equipment.** Taps shall be located on each raw water source, each treatment unit influent and each treatment unit effluent.

(5) **Testing equipment.** Testing equipment should be provided for all plants. The equipment should have the capacity to accurately measure the iron content to a mini-mum of 0.1 milligrams per liter and the manganese content to a minimum of 0.05 milligrams per liter.

(h) **Fluoridation**. Fluoridation of public water supplies is encouraged by the Guam Environmental Protection Agency. Proposed fluoridation facilities shall be approved by the Guam Environmental Protection Agency prior to construction.

(i) **Stabilization**. Water that is unstable due either to natural causes or to subsequent treatment should be stabilized.

(1) **Polyphosphates**. The feeding of polyphosphate for corrosion control and in conjunction with alkali fed following ion exchange softening.

(A) Feed equipment shall conform to Part 5.

(B) Phosphate must meet latest AWWA standards.

(C) Stock phosphate solution must be kept covered and disinfected by carrying approximately 10 milligrams per liter free chlorine residual.

(D) Satisfactory chlorine residuals shall be maintained in the distribution system when phosphates are used.

(2) **Other treatment**. Other treatment for controlling corrosive waters by the use of sodium silicate and sodium bicarbonate may be used where necessary. Any proprietary compound must receive the specific approval of the Guam Environmental Protection Agency before use. Chemical feeders shall be as required in Part 5.

(3) **Water unstable due to biochemical action in distribution system.** Unstable water resulting from the bacterial decomposition of organic matter in water (especially in dead end mains), the biochemical action within tubercles, and the reduction of sulfates to sulfides should be prevented by the maintenance of a free chlorine residual throughout the distribution system.

(j) **Taste and Odor Control**. Provision shall be made for the control of taste and odor as required by the Guam Environmental Protection Agency. Chemicals shall be added sufficiently ahead of other treatment processes to assure adequate contact time for an effective and economical use of the chemicals. Where severe taste and odor problems are encountered in-plant and/or pilot plant studies are required.

(1) **Flexibility**. Plants treating water that is known to have taste and odor problems should be provided with equipment that makes several of the control processes available so that the operator will have flexibility in operation.

(2) **Chlorination**. Chlorination can be used for the removal of some objectionable odors. Adequate contact time must be provided to complete the chemical reactions involved. Excessive potential trihalomethane production through this process should be avoided by adequate bench-scale testing prior to design. The breakpoint technique of chlorinating is recommended.

(3) **Chlorine dioxide.** Chlorine dioxide has been

generally recognized as a treatment for tastes caused by industrial wastes, such as phenols. However, chlorine dioxide can be used in the treatment of any taste and odor that is treatable by an oxidizing compound. Provisions shall be made for proper storing and handling of the sodium chlorite, so as to eliminate any danger of explosion.

(4) Powdered activated carbon.

(A) Powdered activated carbon when prescribed should be added as nearly as possible in 'the treatment process to provide maximum contact time. Flexibility to allow the addition of carbon at several points is preferred. Activated carbon should not be applied near the point of chlorine application.

(B) The carbon can be added as a premixed slurry or by means of a dry-feed machine as long as the carbon is properly wetted.

(C) Continuous agitation or resuspension equipment is necessary to keep the carbon from depositing in the slurry storage tank.

(D) Provision shall be made for adequate dust and explosion control.

(E) The required rate of feed of carbon in the water treatment plant depends upon the tastes and/or odors involved, but provision should be made for adding from 0.1 milligrams per liter to at least 40 milligrams per liter.

(F) Powdered activated carbon shall be handled as a potentially combustible material. It should be stored in a building or compartment as nearly fireproof as possible. Other chemicals should not be stored in the same compartment. Carbon feeder rooms should be equipped with explosion-proof electrical outlets, lights and meters.

(5) Granular activated carbon absorption units See §7154(c) (F).

(6) **Copper sulfate and other copper compounds**. It is recommended that continuous or periodic treatment of water with copper compounds to kill algae or other growths shall be controlled to prevent copper in excess of 1.0 milligrams per liter as copper in the plant effluent or distribution system.

(7) Aeration. See §7154(f).

(8) **Potassium permanganate**. Application 0+potassium permanganate may be considered, providing the treatment shall be designed so that the products of the reaction are not visible in the finished water.

(9) **Ozone**. Ozonation can be used as a means of taste and odor control. Adequate contact time must be provided to complete the chemical reactions involved. Ozone is generally more desirable for treating water with high threshold odors.

(10) **Other methods.** The decision to use any other methods of taste and odor control should be made only after careful laboratory and for pilot plant tests and on consultation with the Guam Environmental Protection Agency.

(k) **Microscreening**. A microscreen is a mechanical supplement of treatment capable of removing some of the suspended matter from the water by straining. It may be used to reduce nuisance organisms. leaves, weeds and organic matter. It shall not be used in place of:

(i) Filtration. When filtration is necessary to provide satisfactory water, or

(ii) Coagulation, in the preparation of water for filtration.

(1) Design

(A) Shall give due consideration to

(1) Nature of the suspended matter to be removed;

(2) Corrosiveness of the water;

(3) Effect of chlorination, when required as a pre-treatment;

(4) Duplication of units for continuous operation during equipment maintenance.

(B) Shall provide

(1) A durable, corrosion-resistant screen;

(2) By-pass arrangements;

(3) Protection against back-siphonage when potable water is used for washing;

(4) Proper disposal of wash waters (see §7154(1)).

(l) **Waste Handling and Disposal**. Provisions must be made for proper disposal of water treatment plant waste such as sanitary, laboratory, clarification sludge, softening sludge, iron sludge, filter backwash water, and brine. All waste discharges shall be the United States Environmental Protection Agency and the Guam Environmental Protection Agency. In locating waste disposal facilities. due consideration shall be given to preventing potential contamination of the water supply.

Alternative methods of water treatment and chemical use should be considered as a means of reducing waste handling and disposal problems.

(1) **Sanitary waste.** The sanitary waste from waster treatment plants, pumping stations, etc., must receive treatment. Waste from these facilities must be discharge directly to a sanitary sewer system, provided approved the Public Utility Agency of Guam (PUAG), when feasible or to an on-site waste treatment facility approved by the United States Environmental Protection Agency and the Guam Environmental Protection Agency.

(2) **Alum sludge.** Lagooning may be used as a method of handling alum sludge. Lagoon size can be

calculated using total chemicals used plus a factor for turbidity. Mechanical concentration may be considered. A pilot plant study is required before the design of a mechanical dewatering installation. Alum sludge can be discharged to a sanitary sewer. However, approval of this method will depend on obtaining approval from the owner of the sewerage system as well as from the Guam Environmental Protection Agency before final designs are made.

Lagoons should be designed to produce an effluent satisfactory to the Guam Environmental Protection Agency and should provide for

(A) Location from flooding;

(B) Where necessary dikes. deflecting gutters or other means of diverting surface water so that it does not flow into the lagoon;

(C) A minimum usable depth of five feet;

(D) Adequate freeboard;

(E) Adjustable decanting device;

(F) Effluent sampling point; and

(G) Adequate safety provisions.

(3) **"Red water" waste.** Waste filter wash water from iron and manganese removal plants must be disposed of according to the Guam Environmental Protection Agency and United States Environmental Protection Agency requirements.

(4) **Waste filter wash water**. Waste filter wash water from surface water treatment plants should have suspended solids reduced to a level acceptable to the Guam Environmental Protection Agency and the United States Environmental Protection Agency before being discharged. Many plants have constructed holding tanks and returned this water to the inlet and of the plant. The holding tank should be of such a size that it will contain the anticipated volume of waste wash water produced by the plant when operating at

design capacity. A plant that has two filters should have a holding tank that will contain the total waste wash water from both filters calculated by using a 15 minute wash at 20 gallons per minute per square foot. In plants with more filters, the size of the holding tank will depend on the anticipated hours of operation. It is recommended that waste filter wash water be returned at a rate or less than 10 percent of the raw water entering the plant.

§7155. Chemical Application. (a) **General.** No chemicals shall be applied to treat drinking waters unless specifically permitted by the Guam Environmental Protection Agency.

(1) **Plans and specifications.** Plans and specifications shall be submitted for review and approval, as provided for in Part 2, and shall include:

(A) Descriptions of feed equipment, including maximum and minimum feed ranges;

(B) Location of feeders, piping layout and points of application,

(C) Storage and handling facilities;

(D) Specifications for chemicals to be used;

(E) Operation and control procedures including proposed application rates;

(F) Descriptions of testing equipment and procedures.

(2) **Chemical application**. Chemicals shall be applied to the water at such points and by such means as to:

(A) Assure maximum efficiency of treatment;

(B) Assure maximum safety to consumer;

(C) Provide maximum safety to operators;

(D) Assure satisfactory mixing of the

chemicals with the water;

(E) Provide maximum flexibility of operation through various points of application, when appropriate;

(F) Prevent backflow or back-siphonage between multiple points of feed through common manifolds.

(3) **General equipment design**. General equipment design shall be such that:

(A) Feeders will be able to supply, at all times, the necessary amounts of chemicals at an accurate rate, throughout the range of feed;

(B) Chemical feed pumps shall be installed so they can be easily calibrated;

(C) Chemical contact materials and surfaces are resistant to the aggressiveness of the chemical solution;

(D) Corrosive chemicals are introduced in such a manner as to minimize potential for corrosion;

(E) Chemicals that are incompatible are not stored or handled together;

(F) All chemicals are conducted from the feeder to the point of application in separate conduits;

(G) Chemical feeders are as near as practical to the feed point;

(H) Chemical feeders and pumps operate at no lower than 20 percent of the feed range.

(b) Facility Design.

(1) Number of feeders.

(A) Where chemical feed is necessary for the

protection of the supply such as chlorination, coagulation, or other essential processes:

(1) A minimum of two feeders shall be provided;

(2) The standby unit or a combination of units of sufficient capacity should be available to replace any unit during shut-downs;

(3) Where a booster pump is required, duplicate equipment should be provided and, when necessary, standby power.

(B) A separate feeder shall be used for each chemical applied.

(C) Spare parts shall be available for all feeders to replace parts which are subject to wear and damage.

(2) **Control**

(A) Feeders may be manually or automatically controlled, with automatic controls being designed so as to allow override by manual controls.

(B) Chemical feed rates shall be proportional to flow.

(C) A means to measure water flow must be provided in order to determine chemical feed rates.

(D) Provisions shall be made for measuring the quantities of chemicals used.

(E) Weighing scales

(1) Shall be provided for weighing cylinders, at all plants utilizing chlorine gas;

(2) May be required for fluoride solution feed;

(3) Should be provided for volumetric dry chemical feeders; and

(4) Should be accurate to measure increments of 0.5 percent of load.

(3) **Dry chemical feeders.** Dry chemical feeders shall:

(A) Measure chemicals volumetrically or gravimetrically;

(B) Provide adequate solution water and agitation of the chemical in the solution pot,

(C) Provide gravity feed from solution pots; and

(D) Completely enclose chemicals to prevent emission of dust to the operation room.

(4) **Positive displacement solution pumps.** Positive displacement type solution feed pumps should be used to feed liquid chemicals, but shall not be used to feed chemical slurries. Pumps must be sized to match or exceed maximum need conditions found at the point of injection.

(5) **Liquid chemical feeders - Siphon control.** Liquid chemical feeders shall be such that chemical solutions cannot be siphoned into the water supply by:

(A) Assuring discharge at a point of positive pressure, or

(B) Providing vacuum relief; or

(C) Providing a suitable air gap; or

(D) Other suitable means or combinations as necessary.

(6) **Cross-connection control**. Cross-connection control must be provided to assure that:

(A) The service water lines discharging to

solution tanks shall be properly protected from backflow,

(B) Liquid chemical solutions cannot be siphoned through solution feeders into the water supply as required in §7155(b)(5) and

(C) No direct connection exists between any sewer and a drain or overflow from the feeder., solution chamber or tank by providing that all drains terminate at least six inches or two pipe diameters, whichever is greater, above the overflow rim of a receiving sump, conduit or waste receptacle.

(7) **Chemical feed equipment location.** Chemical feed equipment shall:

(A) Be located in a separate room to reduce hazards and dust problems;

(B) Be conveniently located near points of application to minimize length of feed lines; and

(C) Be readily accessible for servicing, repair and observation of operation.

(8) **In-Plant water supply**. In-plant water supply shall be:

(A) Ample in quantity and adequate in pressure;

(B) Provided with means for measurement when preparing specific solution concentrations by dilution;

(C) Properly treated for hardness, when necessary;

(D) Properly protected against backflow; and

(E) Obtained from a location sufficiently downstream of any chemical feed point to assure adequate mixing and contact time if necessary.

(9) Storage of chemicals.

(A) Space should be provided for:

(1) At least 30 days of chemical supply;

(2) Convenient and efficient handling of chemical;

(3) Dry storage conditions; and

(4) A minimum storage volume of 1-1/2 truck loads where purchase is by truck load lots.

(B) Storage tank sand pipelines for liquid chemicals shall be specific to the chemicals and not alternates.

(C) Chemicals shall be stored in covered or unopened shipping containers , unless the chemical is transferred into an approved storage unit.

(D) Liquid chemical storage tanks must:

(1) Have a liquid level indicator, and

(2) Have an overflow and a receiving basin or drain capable of receiving accidental spills or overflows.

(10) Solution tanks

(A) A means which is consistent with the nature of the chemical solution shall be provided in a solution tank to maintain a uniform strength of solution. Continuous agitation shall be provided to maintain slurries in suspension.

(B) Means shall be provided to measure the solution level in the tank.

(C) Chemical solutions shall be kept covered. Large tanks with access openings shall have such openings curbed and fitted with overhanging

covers,

(D) Subsurface-locations for solution tanks shall

(1) Be free from sources of possible contamination; and

(2) Assure positive drainage for groundwater, accumulated water, chemical spills and overflows.

(E) Overflow pipes. when provided should

(1) Be turned downward, with the end screened;

(2) Have a free fall discharge, and

(3) Be located where noticeable.

(F) Acid storage tanks must be vented to the outside atmosphere, but not through vents in common with day tanks.

(G) Each tank shall be provided with a valved drain. protected against backflow in accordance with §7155(b) and (c).

(H) Solution tanks shall be located and protective curbing provided so that chemicals from equipment failure, spillage or accidental drainage shall not enter the eater in conduits, treatment or storage basins.

(11) **Day tanks**

(A) Day tanks should be provided where bulk storage of liquid chemical is provided.

(B) Day tanks shall meet all the requirements of §7155(b).

(C) Day tanks should be scale-mounted. or have a calibrated gauge painted or mounted on the side if liquid level can be observed in a gauge

tube or through translucent sidewalls of the tank. In opaque tanks, a gauge rod extending above a reference point at the top of the tank, attached to a float may be used. The ratio of the area of the tank to its height must be such that unit readings are meaningful in relation to the total amount of chemical fed during the day.

(D) Hand pumps may be provided for transfer from a drum. A tip rack may be used to permit withdrawal into a bucket from a spigot. Where motor-driven transfer pumps are provided a liquid level limit with and an overflow from the day tank. must be provided.

(E) A means which is consistent with the nature of the chemical solution shall be provided to maintain uniform strength of solution in a day tank. Continuous agitation shall be provided to maintain chemical slurries in suspension.

(F) Tanks shall be properly labeled to designate the chemical contained.

(12) **Feed lines**

(A) Should be as short as possible; and

(1) Of durable, corrosion resistant material.

(2) Easily accessible throughout the entire length;

(3) Protected against freezing; and

(4) Readily cleanable;

(B) Should slope upward from the chemical source to the feeder when conveying gases;

(C) Shall be designed consistent with forming or solids depositing properties of the chemical. solution or mixtures conveyed; and

(D) Should be color coded.

(13) **Handling**.

(A) Carts, elevators and other appropriate means shall be provided for lifting chemical containers to minimize lifting by operators.

(B) Provision must be made for the proper transfer of dry chemicals from shipping containers to storage bins or hoppers, in such a way as to minimize the quantity of dust which may enter the room in which the equipment is installed.

(C) Provision shall be made for measuring quantities of chemical used to prepare feed solutions.

(14) **Housing**

(A) Floor surfaces shall be smooth and impervious, slip-proof and well drained with 2.5 percent minimum slope.

(B) Vents from feeders, storage facilities and equipment exhaust shall discharge to the outside atmosphere above grade and remote from air intakes.

(c) **Chemicals.**

(1) **Shipping containers**. Chemical shipping containers shall be fully labeled to include:

(A) Chemical name, purity and concentration, and

(B) Supplier name and address.

(2) **Specifications**. Chemicals shall meet the latest edition of AWWA specifications, where applicable.

(3) **Assay**. Provisions may be required for assay of chemicals delivered.

(d) **Operator Safety.**

(1) **Ventilation.** Special provisions shall be made for ventilation of chlorine feed and storage rooms.

(2) **Respiratory protection equipment**. Respiratory protection equipment, meeting the requirements of the Guam Department of Labor for Occupational Safety and Health shall be available where chlorine gas is handled, and shall be stored at a convenient location. but not inside any room where chlorine is used or stored. The units shall use compressed air, have at least a 30 minute capacity, and be compatible with or exactly the same as units used by the Guam Fire Department.

(3) **Chlorine leak detection**. A bottle of ammonium hydroxide, 56 percent ammonia solution, shall be available for chlorine leak detection: where ton containers are used, a leak repair kit shall be provided. Continuous chlorine leak detection equipment is recommended.

(4) Protective equipment.

(A) At least one pair of rubber gloves, dust respirator of a type certified for toxic dusts, an apron or other protective clothing and goggles or face mask shall be provided for each operator.

A deluxe shower and/or eye washing device should be installed where strong acids and alkalis are used or stored.

(B) Other protective equipment should be provided as necessary.

(e) Specific Chemicals.

(1) Chlorine gas.

(A) Chlorine gas feed and storage shall be enclosed and separated from other operating areas. The chlorine room shall be:

(1) Provided with a shatter resistant inspection window installed in an interior wall;

(2) Constructed in such a manner that all openings between the chlorine room and the remainder of the plant are sealed; and

(3) Provided with doors equipped with panic hardware, assuring ready means of exit and opening outward only to the building exterior.

(B) Full and empty cylinders of chlorine gas should be:

(1) Isolated from operating areas;

(2) Restrained in position to prevent upset;

(3) Stored in rooms separate from ammonia storage, and

(4) Stored in areas not in direct sunlight or exposed to excessive heat.

(C) Were chlorine gas is used. the room shall be constructed to provide the following:

(1) Each room shall have a ventilating with a capacity which provides one complete air change per minute when the room is occupied;

(2) The ventilating fan shall take suction near the floor as far as practical from the door and air inlet, with the point of discharge so located as not to contaminate air inlets to any rooms or structure;

(3) Air inlets should be through louvers near the ceiling;

(4) Louvers for chlorine room air intake and exhaust shall facilitate airtight closure;

(5) Separate switches for the fan and lights shall be located outside of the chlorine room and at the inspection window. Outside

switches shall be protected from vandalism. A signal light indicating fan operation shall be provided at each entrance when the fan can be controlled from more than one point;

(6) Vents from feeders and storage shall discharge to the outside atmosphere, above grade;

(7) The room location shallowed be on the prevailing downwind side of the building and shall not be connected to the internal or external drainage systems.

(D) Chlorinator rooms should be protected from excessive heat. Cylinders and gas lines should be protected from temperatures above that of the feed equipment.

(E) Pressurized chlorine feed lines shall not carry chlorine gas beyond room.

(2) Acids and caustics

(A) Acids and caustics shall be kept in closed corrosion-resistant shipping containers or storage units.

(B) Acids and caustics shall not be handled in open vessels, but should be pumped in undiluted form from original containers through suitable hose, to the point of treatment or to a covered day tank.

(3) **Sodium chlorite**. Provisions shall be made for proper storage and handling of sodium chlorite to eliminate any danger of explosion.

§7156. Pumping Facilities. (a) **General.** Pumping facilities and other high voltage electrical equipment are not to be located below grade. Low voltage controls or sensors may be located in vaults. Pumps, electrical panels., etc. must be housed in above grade structures.

(b) **Location**. The pumping station shall be so located that the proposed site will meet the requirements for

sanitary protection of water quality, hydraulics of the system and protection against interruption of service by fire, flood or any other hazard.

(1) **Site protection.** The station shall be:

(A) Elevated to a minimum of one foot above the 100 year flood elevation, or three feet above the highest recorded flood elevation, whichever is higher, or protected for such elevations;

(B) Readily accessible at all times unless permitted to be out of service for the period of inaccessibility;

(C) Graded around the station so as to land surface drainage away from the station; and

(D) Protection to prevent vandalism and entrance by unauthorized persons or animals.

(c) **Pumping Stations**. Both raw and finished water pumping stations shall:

(i) Have adequate space for the safe servicing of all equipment;

(ii) Be of durable construction and insulated;

(iii) Have floor elevation of at least six inches above finished grade;

(iv) Have underground structure waterproofed; and

(v) Have all floors drained in such a manner that the quality of the potable water will not be endangered. All floors shall slope to a suitable drain.

(1) **Suction well.** Suction well shall:

(A) Be watertight;

(B) Have floors sloped to permit removal of water and entrained solids; and

(C) Be covered or otherwise protected against contamination.

(2) **Equipment servicing.** Pump stations shall be provided with:

(A) opening in floors, roofs or wherever else needed for removal of heavy or bulky equipment, and other adequate facilities for servicing heavy equipment;

(B) A convenient tool board, or other facilities as needed. for proper maintenance of the equipment.

(3) **Stairways and ladders.** Stairways and ladders shall:

(A) Be provided between all floors, and in pits or compartments which must be entered, and

(B) Have handrails on both sides, and treads of non-slip material. Stairs are preferred in areas where there is frequent traffic or where supplies are transported by hand.

(4) **Ventilation.** Ventilation shall conform to current Guam codes requirements. Adequate ventilation shall be provided for all pumping stations. Forced ventilation of at least six changes of air per hour shall be provided for:

(A) All rooms. compartments. pits and other enclosures below ground floor; and

(B) Any areas where unsafe atmosphere may develop or where excessive heat may be built up.

(5) **Dehumidification.** In areas where excess moisture could cause hazards to safety or damage to equipment, means for dehumidification should be provided.

(6) **Lighting.** Pump stations shall be adequately lighted throughout. All electrical work shall conform to the requirements of the latest edition of the

National Electrical Code.

(7) **Sanitary and other convenience.** All pumping stations that are manned for extended periods should be provided with potable water, lavatory and toilet facilities. Plumbing must be so installed as to prevent contamination of a public water supply. Wastes shall be discharged in accordance with §7153(l).

(d) **Pumps.** At least two pumping units shall be provided. With any pump out of service, the remaining pump or pumps shall be capable of providing the maximum daily pumping demand of the system. The pumping units shall:

(i) Have ample capacity to supply the peak demand without dangerous overloading. The calculated peak demand should be no less than the total gpm obtaining by using fixture methods outlines in the latest AWWA Manual "Sizing Service Lines and Meters" and the latest National Plumbing Code, or the required fire flows if fire hydrants are provided for the system;

(ii) Be driven by a prime mover able to operate against the maximum head;

(iii) Have spare parts and tools readily available; and

(iv) Be served by control equipment that has overload protection for air temperature encountered.

(1) **Suction lift.** Suction lift shall:

(A) Be avoided, if possible; and

(B) Be within allowable limits, preferably less than 15 feet;

If suction lift is necessary, provision shall be made for priming the pumps.

(2) **Priming.** Prime water must not be of lesser sanitary quality than that of the water being pumped.

Means shall be provided to prevent back siphonage. When an air operated ejector is used, the screened intake shall draw clean air from a point at least 10 feet above the ground or other source of possible contamination. Vacuum priming may be used.

(e) **Booster Pumps (Main Lines).** Booster pumps shall be located or controlled so that:

(i) They will not produce negative pressure in their suction lines;

(ii) The intake pressure shall be at least 20 psi when the pump is in normal operation;

(iii) Automatic or remote control devices shall have a range between the start and cut-off pressure which will prevent excessive cycling;

(iv) Automatic cut-off pressure shall be at least 20 psi in the suction line; and

(v) A bypass is available.

(1) **Duplicate pumps**. Each booster pumping station should contain not less than two pumps with capacities such that peak demand can be satisfied with the largest pump out of service.

(2) **Metering.** All booster pumping stations should contain a totalizer meter.

(3) **Inline booster pumps.** In addition to the other requirements of this section, inline booster pumps shall be accessible for servicing and repairs.

(4) **Individual home booster pump.** Individual home booster pumps shall not be allowed for any individual service from the public water supply main.

(5) **Automatic and Remote Controlled Stations.** All automatic stations should be provided with automatic signaling apparatus which will report when the station is out of service. All remote controlled stations- shall be electrically operated and controlled and shall have signaling apparatus of proven

performance. Installation of electrical equipment shall conform with the requirements of the latest edition of the National Electrical Code and other applicable requirements of the latest Guam codes.

(6) **Appurtenances.**

(A) Pumps shall be adequately valved to permit satisfactory operation, maintenance and repair of the equipment. If foot valves are necessary, they shall have a net valve area of at least 2-1/2 times the area of the suction pipe and they shall be screened. Each pump shall have a positive-acting check valve on the discharge side between the pump and the shut-off valve. A pressure relief valve should be located between the pump and an electric check valve.

(B) **Piping.** In general, piping shall:

(1) Be designed so that the friction losses will be minimized;

(2) Not be subject to contamination;

(3) Have watertight joints;

(4) Be protected against surge or water hammer; and

(5) Be such that each pump has an individual suction line or that the lines shall be so manifolded that they will insure similar hydraulic and operating conditions.

(C) **Water seals.** Water seals shall not be supplied with water of a lesser sanitary quality than that of the water being pumped. Where pumps are sealed with potable water and are pumping water of lesser sanitary quality the seal shall:

(1) be provided with a break tank open to atmospheric pressure. and

(2) Have an air gap of at least six inches

or two pipe diameters, whichever is greater. between the feeder line and the spill line of the tank.

(D) **Controls.** Pumps, their prime movers and accessories. shall be controlled in such a manner that they will operate at rated capacity without dangerous overload. Where two or more pumps are installed, provision shall be made for alteration. Provision shall be made to prevent energizing the motor in the event of a backwash cycle. Electrical controls shall be located above grade.

(E) **Water Pre-lubrication.** When automatic pre-lubrication of pump bearings is necessary and an auxiliary direct drive power supply is provided, the pre-lubrication line shall be provided with a valved bypass around the automatic control so that the bearings can, if necessary, be lubricated manually before the pump is started or the pre-lubrication controls shall be wired to the auxiliary power supply.

§7157 Finished Water Storage. (a) **General.** The materials and designs used for finished water storage structures shall provide stability and durability as well as protect the quality of the stored water. Steel structures shall follow the latest edition of AWWA standards concerning steel tanks. standpipes reservoirs, and elevated tanks wherever they are applicable. Other materials of construction are acceptable when properly designed to meet the requirements of Part 7.

(1) **Sizing.** Storage facilities should have sufficient capacity, as determined from engineering studies, to meet domestic demands, and where fire protection is provided, fire flow demands.

(A) Fire flow requirements established by the Guam Fire Department should be satisfied where fire protection is provided.

(B) The minimum storage capacity (or equivalent capacity) for systems not providing fire protection shall be equal to the average daily

consumption. This requirement may be reduced when the source. and treatment facilities have sufficient capacity with standby power to supplement peak demands of the system.

(2) **Location of ground level reservoirs.**

(A) The bottom of reservoirs and standpipe should be placed above 100 year flood level.

(B) When the bottom must be below normal ground surface, it shall be placed above the groundwater table. Sewers, drains, standing water, and similar sources of possible contamination must be kept at least fifty feet from the reservoir. Water main pipe, pressure tested in place to 50 psi without leakage, may be used for gravity sewers at distances greater than 20 feet and less than 50 feet.

(3) **Protection.** All finished water storage structures shall have suitable watertight roofs which exclude birds, animals, insects, and excessive dust.

(4) **Protection from trespassers.** Fencing, locks on access manholes, and other necessary precautions shall be provided to prevent trespassing, vandalism, and sabotage.

(5) **Drains.** No drain on a water storage structure may have a direct connection to a sewer or storm drain. The design shall allow draining the storage facility for pressure in the distribution system.

(6) **Overflow.** All water storage structures shall be provided with an overflow which should terminate at least 18 inches above the ground surface, and discharges over a drainage inlet structure or a splash plate. No overflow may be connected directly to a sewer or storm drain. All overflow pipes shall be located so that any discharges is visible.

(A) The overflow shall be constructed of metallic pipe open downward and be screened with 24 mesh noncorrodible screen installed within the pipe at a location least susceptible to

damage by vandalism.

(B) The overflow pipe shall be of sufficient diameter to permit waste of water in excess of the filling rate.

(7) **Access.** Finished water storage structures shall be designed with reasonably convenient access to the interior for cleaning and maintenance. Manholes above the waterline.

(A) shall be framed at least four inches. and preferably six inches, above the surface of the roof at the opening; on ground level structures, manholes should be elevated at least 18 inches above the top or covering sod.

(B) shall be fitted with a solid watertight cover which overlaps the framed opening and extends down around the frame at least two inches.

(C) should be hinged at one side.

(D) shall have a locking device.

(8) **Vents.** Finished water storage structures shall be vented. Overflows shall not be considered as vents. Open construction between the sidewall and roof is not permissible. Vents:

(A) shall be made of metallic pipe:

(B) shall prevent the entrance of surface water and rainwater;

(C) shall exclude birds and animals;

(D) should exclude insects and dust, as much as this function can be made compatible with effective venting. For elevated tanks and standpipes, four-mesh noncorrodible screen may be used;

(E) shall on ground level structure, terminate in an inverted U construction with the opening at

least 18 inches above the roof or sod and covered with 24 mesh noncorrodible screen installed within the pipe at a location least susceptible to vandalism.

(9) **Roof and sidewall.** The roof and sidewalls of all structures must be watertight with no openings except properly constructed vents, manholes, overflows, risers, drains, pump mountings, control ports, or piping inflow and outflow.

(A) Any pipes running through the roof or sidewall of a finished water storage structure must be welded, or properly casketed in metal tanks. In concrete tanks, these pipes shall be connected to standard wall castings which were poured in place during the forming of the concrete. These wall castings should have seepage rings imbedded in the concrete.

(B) Openings in a storage structures roof or top, designed to accommodate control apparatus or pump columns, shall be curbed and sleeved with proper additional shielding to prevent the access of surface or floor drainage water into the structure.

(C) Valves and controls should be located outside the storage structure so that the valve stems and similar projections will not pass through the roof or top of the reservoir.

(10) **Drainage of roof.** The roof of the storage structure shall be well drained. Downspout pipes shall not enter or pass through the reservoir. Parapets, or similar construction which would tend to hold water on the roof, will not be approved unless adequate waterproofing and drainage are provided.

(11) **Safety.** The safety of employees must be considered in the design of the storage structure. As a minimum, such regulations for the area where the reservoir is constructed.

(A) Ladders. ladder guards. balcony railings. and safely located entrance hatches shall be

provided where applicable.

(B) Elevated tanks with riser pipes over eight over eight inches in diameter shall have protective bars over the riser openings inside the tank.

(C) Railings or handholds shall be provided on elevated tanks where persons must transfer from the access tube to the water compartment.

(12) **Silt Stop.** The discharge pipes from all reservoirs shall be located in a manner that will prevent the flow of sediment into the distribution system. Removable silt stops should be provided.

(13) **Grading.** The area surrounding a ground level structure shall be graded in a manner that will prevent surface water from standing. within 50 feet of it.

(14) **Painting and/or cathodic protection.** Proper protection shall be given to metal surfaces by paints or other protective coatings, by cathodic protection devices, or by both.

(A) Only paints and coatings for contact with potable water approved by the U.S. EPA and/or GEPA can be applied to tank interior.

(B) Cathodic protection should be designed and installed by competent technical personnel.

(15) **Disinfection.** Finished water storage structures shall be disinfected in accordance with the latest AWWA Standard. Two or more successive sets of samples, taken at 24 hour intervals. shall indicate microbiologically satisfactory water before the facility is placed into operation.

(b) **Plant Storage.** The applicable design standards of §7157(a) shall be followed for plant storage.

(1) **Washwater tanks.** Washwater tanks shall be sized, in conjunction with available pumps units and finished water storage, to provide the backwash water required by §7154(c). Consideration must be given to

the backwashing of several filters in rapid succession.

(2) **Clearwell.** Clearwell storage should be sized, in conjunction with distribution system storage, to relieve the filters from having to follow fluctuations in waster use.

(A) When finished water storage is used to provide contact time for chlorine (see 73154(d)) special attention must be given to size and baffling.

(3) **Adjacent compartments.** Finished water must not be stored or conveyed in a compartment adjacent to unsafe water when the two compartments are separated by a single wall.

(4) **Basins and wet wells.** Receiving basins and pump wet wells for finished water shall be designed as finished water storage structures.

(c) **Hydropneumatic Tanks.**

(1) **Location.** The tank is recommended to be located above normal ground surface and be completely house. If the tank is partially buried underdrains must be provided.

(2) **Sizing** The gross volume of the hydropneumatic tank, in gallons, should be large enough to prevent the pumps from cycling more than 10 times an hour.

(3) **Piping.** The tank shall have bypass piping to permit operation of the system while it is being repaired or painted, unless more than one pressure tank is provided.

(4) **Appurtenances.** Each tank shall have an access manhole, a drain, and control equipment consisting of pressure gauge, water sight glass, automatic or manual air blow off, means for adding air, pressure operated start-stop controls for the pumps, and a pressure relief valve. Where practical the access manhole should be 24 inches in diameter. Bladder type pressure tanks are not requited to have an access

manhole or sight glass.

(d) **Distribution Storage**. The applicable design standards of §7157(a) shall be followed for distribution system storage.

(1) **Pressures.** The maximum variation between high and low levels in storage structures providing pressure to a distribution system should not exceed 30 feet. The minimum working pressure in the distribution system should be 35 psi and the normal working pressure should be approximately 60 psi. When static pressures exceed 100 psi, pressure reducing devices should be provided on mains in the distribution system.

(2) **Drainage.** Storage structures which provide pressure directly to the distribution system shall be designed so they can be isolated from the distribution system and drained for cleaning or maintenance without necessitating loss of pressure in the distribution system. The drain shall discharge to the ground surface with no direct connection to a sewer or storm drain.

(3) **Level controls.** Adequate controls shall be provided to maintain levels in distribution system storage structures. Level indicating devices should be provided at a central location.

(A) Pumps should be controlled from tank levels with the signal transmitted by telemetering equipment when any appreciable head loss occurs in the distribution system between the source and the storage structure.

(B) Altitude valves or equivalent controls may be required for a second and subsequent structures on the system.

(C) Overflow and low-level warnings or alarms should be located on places in the village where there will be under reasonable surveillance 24 hours a day.

§7158. Distribution Systems. (a) **Materials.**

(1) **Standards, materials selection.** Pipe. fittings, valves and fire hydrants shall latest AWWA Standards. Special attention shall be given to selecting pipe materials which will protect against both internal and external pipe corrosion.

(2) **Used materials.** Water mains which have been used previously for conveying potable water may be reused provided they meet the above standards and have been restored practically to their original condition.

(3) **Joints.** Packing and jointing materials used in the joints of pipe shall meet the latest AWWA Standards. Pipe having mechanical joints or slip-on joints with rubber caskets is preferred.

(b) Water Main Design.

(1) **Pressure.** All water mains, including those not designed to provide fire protection, shall be sized after a hydraulic analysis based on flow demands and pressure requirements. The system shall be designed to maintain a minimum pressure of 20 psi at ground level at all points in the distribution system under all conditions of flow. The normal working pressure in the distribution system should be approximately 60 psi and not less than 35 psi.

(2) **Diameter.** The minimum size of water main for providing fire protection and serving fire hydrants shall be eight inch diameter; six inch pipe can be used for a short dead-end line. Larger size mains will be required if necessary to allow the withdrawal of the required fire flow while maintaining the minimum residual pressure specified in §7158(b).

(3) **Fire Protection.** When fire protection is to be provided, system design should be such that fire flows and facilities are in accordance with the requirements of Guam Fire Department.

(4) **Small mains.** Any departure from minimum requirements shall be justified by hydraulic analysis and future water use, and can be considered only in special circumstances.

(5) **Hydrants.** Water mains not designed to carry fire flows shall not have fire hydrants with pumper connections connected to them.

(6) **Dead ends.** Dead ends shall be minimized by looping of all mains whenever practical.

(7) **Flushing.** Where dead end mains occur they shall be provided with a fire hydrant if flow and pressure are sufficient, or with an approved flushing hydrant or blow off for flushing purposes. Flushing devices should be sized to provide flows which will give a velocity of at least 25 feet per second in the water main being flushed. No flushing device shall be directly connected to any sewer, he open end of a blow of must be capped and terminate at least 18 inches above grade.

(c) **Valves.** Sufficient valves shall be provided on water mains so that inconvenience and sanitary hazards will be minimized during repairs. valves should be located at not more than 500 foot intervals in commercial areas, at not more than one block or 800 foot intervals in other residential areas, and not more than 1500 feet on the transmission lines.

(d) **Hydrants.**

(1) **Location and spacing.** Hydrants should be provided at each street intersection and at intermediate points between intersections as recommended by Guam Fire Department. Generally, hydrant spacing may range from 350 to 600 feet depending on the area being served.

(2) **Valves and nozzles.** Fire hydrants should have a bottom valve size of at least five inches, one 4-1/2 inch pumper nozzle and two 2-1/2 inch nozzles.

(3) **Hydrant leads.** The hydrant lead shall be a minimum of six inches in diameter. Auxiliary valves shall be installed in all hydrant leads.

(4) **Drainage.** Hydrant drains should be plugged. When the drains are plugged the barrels must be pumped dry after use during freezing weather. Where

hydrant drains are not plugged, a gravel pocket or dry well shall be provided unless the natural soils will provide adequate drainage. Hydrant drains shall not be connected to or located within 10 feet of sanitary sewer or storm drains.

(e) **Air Relief Valves: Valve, Meter and Blow-off Chambers.**

(1) **Air relief valves.** At high points in the water mains where air can accumulate provisions shall be made to remove the air by means of hydrant or air relief valves. Automatic air relief valves shall not be used in situations where the flooding of the manhole or chamber may occur.

(2) **Air relief valve piping.** The open end of an air relief pipe shall be extended to at least 18 inches above grade and provided with a screened, down-facing elbow.

(3) **Chamber drainage.** Chambers, pits and manholes containing valves, blow-offs, meters, or other such appurtenances to a distribution system, shall not be connected directly to any storm drain or sanitary sewer, nor shall blow-offs or air relief valves be connected directly to any sewer. Such chambers or pits shall be drained to the surface water, or to absorption pits underground.

(f) **Installation of Mains.**

(1) **Standards.** Job specifications shall incorporate applicable provisions of the latest AWWA standards. Manufacturer's recommended installation procedures may be specified when they are equal to or better than AWWA procedures.

(2) Piping, fittings and appurtenances which have been previously used for purposes other than for public water system use shall not be used in a public water system without the written approval of Guam Environmental Protection Agency.

(3) **Bedding.** A continuous and uniform bedding shall be provided in the trench for all buried pipe.

Backfill material shall be tamped in layers around the pipe and to sufficient height above the pipe to adequately support and protect the pipe. Stones found in the trench shall be removed for a depth of at least six inches below the bottom of the pipe.

(4) The open ends of exposed pipe shall be left plugged in excavations at the conclusion of the day's work. during periods of delay and at the conclusion of the day's work lengths of pipe with open ends shall be tightly closed with watertight plugs, special seals or by other suitable means to prevent the entry of animals, foreign matters and trench water. Trench water shall be pumped out before the seals, plugs or other closures are removed.

(5) **Cover.** All water mains shall be covered with at least 3 feet of earth. Insulation may be used in lieu of cover depth when approved in advance by Guam Environmental Protection Agency.

(6) **Thrust Blocks.** All tees, bends, plugs and hydrants shall be provided with reaction blocking, tie rods or joints designed to prevent movement. Specifications shall include requirement that all air be removed from the pipes before water at test pressure levels is added.

(7) **Pressure and leakage testing.** all types of installed pipe shall be pressure tested and leakage tested in accordance with the latest edition of AWWA Standard C600.

(8) All new, cleaned or repaired water mains shall be disinfected in accordance with the latest A Standard C601. The specifications shall include detailed procedures for the adequate flushing, disinfection, and microbiological tests show the treatment to be unsatisfactory, the disinfection procedures shall be repeated until satisfactory bacteriological sample results are obtained.

(g) **Separation of water mains. Sanitary sewers and storm sewers.**

(1) **General.** The following factors should be

considered in providing adequate separation:

(A) Materials and type of joints for water and sewer pipes;

(B) Soil conditions;

(C) Service and branch connections into the water main and sewer line;

(D) Compensating variations in the horizontal and vertical separations;

(E) Space for repair and alterations of water and sewer pipes; and

(F) Off-setting of pipes around manholes.

(2) **Parallel installation.** Water mains shall be laid at least 10 feet horizontally from any existing or proposed manhole or sanitary sewer. This distance shall be measured edge to edge. In cases where it is not practical to maintain a 10 foot separation, the Guam Environmental Protection Agency may allow deviation on a case-by-case basis if supported by data from the design engineer. Such deviation may allow installation of the water main closer to a sewer, provided that the water main is laid in separate trench or on an undisturbed earth shelf located on one side of the sewer at such an elevation that the bottom of the water main is at least 18 inches above the top of the sewer.

(3) **Crossings.** Water mains crossing sewers shall be laid to provide a minimum vertical distance of 18 inches between the outside of the water main and the outside of the sewer. This shall be the case where the watermain is either above or below the sewer. At crossings, one full length of water pipe shall be located so both joints will be as far from the sewer as possible. If the sewer main is over the water main, the first sewer pipe joints on each side of the water main must be concrete encased. Special structural support for the water and sewer pipes may be required. Public water system lines shall not pass through sewer manholes or be submerged in basins containing sewage or other

grossly contaminated or hazardous material.

(4) **Exception.** The Guam Environmental Protection Agency must specifically approve any variance from the requirements of §7158(g)(2) and (3) when it is impossible to obtain the specified separation distances.

(5) **Force mains.** There shall be at least 10 foot horizontal separation between water mains and sanitary sewer force mains. There shall be an 18 inch vertical separation at crossings as required in §7158(g)(3).

(h) **Surface Water Crossings.** Surface water crossings, whether over or under water, present special problems. The Guam Environmental Protection Agency and other appropriate reviewing authority should be consulted before final plans are prepared.

(1) **Above-water crossings.** The pipe shall be adequately supported and anchored, protected from damage, and accessible for repair or replacement.

(2) **Underwater crossings.** A minimum cover of three feet shall be provided over the pipe. When crossing water courses which are greater than 15 feet in width, the following shall be provided:

(A) The pipe shall be of special construction, having flexible water tight joints;

(B) Valves shall be provided at both ends of water crossings so that the section can be isolated for testing or repair; the valves shall be easily accessible, and not subject to flooding; and the valve closest to the supply source shall be in the manhole;

(C) Permanent taps shall be made on each side of the valve within the manhole to allow insertion of a small meter to determine leakage and for sampling purposes.

(i) **Cross-Connection and Interconnections.**

(1) **Cross-connections.** There shall be no connection between the distribution system and any pipes, pumps, hydrants, or tanks whereby unsafe water or other contaminating materials may be discharged or drawn into the system.

(2) **Cooling water.** Neither steam condensate nor cooling water from engine jackets or other heat exchange device shall be returned to the potable water supply.

(3) **Interconnections.** Drains from the fire hydrants, air relief pits and blow-off valve pits shall not connect directly to sewer lines or discharge at a point which will permit possible back-siphonage conditions. The approval of the Guam Environmental Protection Agency and other reviewing authority shall be obtained for interconnections between potable water supply.

(j) **Water Services and Plumbing.**

(1) Water services and plumbing shall conform to the latest edition of the National Plumbing Code, and other rules enforced by the Guam Department of Public Works.

(2) **Booster pumps.** Individual booster pumps shall not be allowed for any individual service from the public water supply mains.