Republic of the Philippines
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
OFFICE OF THE SECRETARY
Manila

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DEPARTMENT ORDER)
)
No. 123)
Series of 2017. 10.03.17)

SUBJECT : DPWH Standard Specification for Item 1604 – Water Treatment Plant

In order to provide specification for water treatment plant stated in Department Order No. 05, Series of 2017 (*Revised Standardized Pay Items of Works for Civil Works Construction for Infrastructure Projects*), and in line with the mandate of the Department to provide Standard Specifications in the implementation of various infrastructure projects, the attached **DPWH Standard Specification for Item 1604 – Water Treatment Plant** is hereby prescribed, for the guidance and compliance of all concerned.

This specification shall form part of the ongoing revision of the DPWH Standard Specifications for Public Works Structures – Buildings, Ports and Harbors, Flood Control and Drainage Structure and Water Supply Systems, Volume III, 1995 Edition.

This Order shall take effect immediately.

MARK A. VILLAR
Secretary

RAFAEL C. YABUT
Senior Undersecretary
Officer-In-Charge

14.1.2 FET/RGT

Department of Public Works and Highways
Office of the Secretary
WIN7U01517

DPWH Standard Specification for
ITEM 1604 – Water Treatment Plant (WTP)

1604.1 Description

This Item covers the provision and installation of a complete modular/skid-type Water Treatment Plant (WTP). This shall be capable of treating actual water quality of surface water source based on the results of water analyses conducted and whose output water quality shall comply with Philippine National Standards (PNS) for Drinking Water. The entire treatment system may comprise of, but not limited to, Pre-Filtration Treatment System, Activated Carbon Filtration, Water Softener System and Ultra-Filtration System or other approved treatment processes that are applicable to deliver the required water quality for drinking water.

1604.2 Material Requirements

1604.2.1 Pre - Filtration Treatment System

The Pre-Filtration Treatment System shall be composed of a Fiberglass or Composite Media Tank, Bronze or Plastic Control Valve (top-mount), PVC Control Valves (front-mount) and timer motor/controls. The system must use an Activated Filter Media (AFM) from pure green and brown glass and manufactured under ISO 9001:2008 quality system. It must exhibit a self-sterilizing property. It must be compliant with the international standard NSF/ANSI 61 (NSF-61), and must bear a Water Quality Association (WQA) Gold Seal Certification for Drinking Water System Components.

1604.2.2 Activated Carbon Filtration

The Filter Tanks shall be made of Fiber Glass Reinforced Plastic (FRP or GRP) and the Activated Carbon Filters shall be Certified Food Grade compliant. It shall be equipped with an automated valve of approved rated capacity based on the actual need and conditions, flow meter and pressure gauges. Its control system shall be soft start Human Machine Interface (HMI), Programmable Logic Controller (PLC), and its backwash pump shall have a rated capacity based on actual design requirements.

1604.2.3 Water Softener System

The Raw Water Pump shall have a rated capacity adequate enough to deliver the required volume of water. The bag filter shall also have a rated capacity that is consistent with the requirement of the entire system. The resin shall be certified by the WQA to NSF/ANSI-61 Standard. Its particle range shall be 300 to 1,600 µm and its specific gravity shall be 1.17.

1604.2.4 Ultra-Filtration System

The ultra-filtration system shall be capable of processing feed water with up to 500 parts per million (ppm) total suspended solids (TSS) at 25 °C and Turbidity of < 15 nephelometric turbidity unit (NTU). It must be equipped or must have the following features: Hollow-Fiber or Ceramic Ultra-Filtration (UF) Membranes, Stainless Steel Pumps, Valves, Pressure Gauges, Corrosion-Resistant Piping, 3-Phase Totally Enclosed Fan Cooled (TEFC) Motor, Automatic Backwash System (Hollow-Fiber Only), Filtrate and Concentrate Flowmeters, Total Automatic Operation with PLC Control, Self-Backwashing Sediment Strainer and Turbidity Meter.

1604.3 Installation Requirements

All components of the water treatment system such as tanks, pumps, valves, motors/controls and other similar equipment and appurtenances shall be located and so installed to 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. In this case, all equipment shall be elevated at least 16 cm above finished grade and all floors shall drain in such manner that the quality of the potable water will not be endangered. Electrical controls shall be located above grade.

Plug-and-play of individual parts shall be done in good workmanship. Installation shall be watertight.

Supervision by a representative of the manufacturer shall be provided as to the assembly of all mechanical equipment/ appurtenances at the time of installation and initial operation.

1604.4 Water Quality Output Testing Requirements

The water treatment system shall deliver the required water quality based on the standard parameters set forth in the Philippine National Standards (PNS) for Drinking Water and shall therefore pass the permissible level of parameters or elements for microbiological, chemical, physical and radiological quality as shown on the succeeding tables.

The Water Quality Test or Water Analyses shall be conducted duly by a Department of Health (DOH) Accredited Testing Laboratory, if not by a World Health Organization (WHO) Accredited Laboratory, to verify compliance to PNS.

Table 1604.4.1 - Standard Methods of Detection and Values for Microbiological Quality

Parameters	*Method of Determination*	*Value**	*Units of Measurement*	*Point of Compliance*
Total coliform	Multiple Tube Fermentation Technique (MTFT)	< 1.1	Most Probable Number (MPN)100 mL	Service reservoirs Water treatment works Consumer's Taps Refilling Stations Water Haulers Water Vending Machines
	Chromogenic substrate test (Presence-Absence)*	Absent <1.1	MPN/100 mL	
	Membrane Filter (MF) Technique	< 1	Total coliform colonies / 100 mL	
	Compliance to Total coliform			
	(a) For water systems analyzing at least 40 samples per month, no more than 5% of the monthly sample may be positive for total			Consumer's Taps

	coliform;			
	(b) For water systems analyzing fewer than 40 samples per month, no more than one (1) sample per month may be positive for total coliform			Consumer's Taps
	At least 95% of standard samples taken in each year from each reservoir are total coliform negative			Service reservoirs
	No standard sample taken each month should exceed maximum allowable value specified in the above.			Water treatment works Refilling stations Water haulers Water vending machines
Fecal coliform	Multiple Tube Fermentation Technique (MTFT)	< 1.1	MPN/ 100 mL	Service reservoirs Water treatment works Consumer's Taps Refilling Stations Point Sources (Level I) Water Haulers Water Vending Machines
	Membrane Filter Technique (MFT)	< 1	Fecal coliform colonies / 100 mL	
	Chromogenic substrate test (Presence-Absence)*	< 1.1	MPN/100mL	
Heterotrophic Plate Count	Pour Plate Spread Plate Membrane Filter Technique	<500	Coliform Forming Units (CFU) / mL	Service reservoirs Water treatment works Consumer's taps nearest the meter Refilling Station Water Vending Machines

* Should be validated and approved by the Department of Health

Table 1604.4.2 - Standard Values for Inorganic Chemical Constituents with Health Significance

Constituent	**Maximum Level (mg/L)**	**Remarks (Sources/Occurrence)**	**Method of Analysis**
Antimony	0.02	Antimony is a contaminant from pipe and fitting materials. It is not a raw water contaminant.	FAAS; EAAS; ICP/MS;
Arsenic	0.05	For existing water supply systems. Arsenic may be naturally occurring in water sources. Where maximum level of arsenic is unachievable, concentration in water supply must be kept as low as possible.	ICP/MS; hydride generation AAS; Silver Diethyldithiocarbamate Method, EAAS (Graphite furnace

			AAS)
Barium	0.7	Barium occurs naturally as trace elements in both igneous and sedimentary rocks.	ICP/MS; FAAS; EAAS, ICP
Boron	0.5	Present in surface water due to discharge of treated sewage effluent, which still contains detergents; could be naturally occurring in certain areas. Maximum level has been elevated from 0.3 mg/L (PNSDW 1993) to 0.5 mg/L (PNSDW 2007) because it is difficult to achieve in areas with high natural levels and limited access to treatment technology.	ICP/MS; ICP/AES
Cadmium	0.003	Cadmium is used in manufacture of steel, plastics and battery and released to the environment through wastewater or fumes. Cadmium is released in water supply as impurity of the zinc coating of galvanized pipes and solders and metal fittings.	ICP/MS; FAAS
Chromium (Total)	0.05	Chromium is widely distributed in the Earth's crust. Occurs in wastewater in certain industries such as chromium plating of bumpers, grills and ornaments.	FAAS; EAAS, ICP, ICP/MS
Cyanide (Total)	0.07	Cyanides are occasionally found in drinking water primarily as a consequence of industrial contamination.	Titrimetric; Colorimetric; Cyanide Selective Electrode
Fluoride	1.0	In areas where high natural fluoride levels occur, the maximum level may be difficult to achieve due to limited access to treatment technology.	Ion chromatography, Ion-selective electrodes; SPADNS (a reagent used to measure flouride) colorimetric; Complexone Method

Lead	0.01	Lead may be present in water primarily from plumbing systems containing lead pipes, solder, fittings or the service connections to the homes. Although it may be found naturally occurring in certain areas, rarely is it present in water supply as a result of its dissolution from natural sources.	FAAS; EAAS; ICP/MS; Anodic Stripping Voltammetry; Dithizone
Mercury (Total)	0.001	Mercury is used in industries such as in the electrolytic production of chlorine, in electrical appliances, in dental amalgams and as a raw material for various mercury compounds. Mercury occurs naturally in freshwater and groundwater in the inorganic form. Methylation of inorganic mercury occurs in freshwater and seawater.	Cold vapor AAS; ICP/MS
Nickel	0.02	Nickel is very toxic and usually occurs in water supply as a result of nickel or nickelplated plumbing components. Although nickel could be naturally occurring in certain areas, it is not usually a raw water contaminant.	ICP/MS; EAAS; ICP; FAAS
Nitrate	50	Nitrate concentration in groundwater and surface water can reach high levels as a result of leaching or run-off from agricultural land or contamination from human or animal wastes. Anaerobic conditions may result in the formation and persistence of nitrite.	Cd Reduction Method; IC; Capillary Ion electrophoresis Colorimetric (Diazotization); IC; Flow Injection Analysis
Nitrite	3		
Selenium	0.01	Selenium occurs naturally in groundwater sources.	AAS with hydride generation; Colorimetric, Fluorometric, EAAS, ICP, ICP/MS

Table 1604.4.3 - Organic Chemical Constituents from Industrial Pollution (with health significance)

Constituent	**Maximum Level (mg/L)**	**Sources**	**Method of Analysis**
Benzene	0.01	Benzene may be introduced into water by industrial effluents and atmospheric pollution due to vehicular emissions.	GC/PID; GC/MS

Carbon Tetrachloride	0.004	From industrial discharges, carbon tetrachloride levels in anaerobic groundwater may remain elevated for months or even years.	GC/PID; GC/ELCD; GC/MS
1,2-Dichlorobenzene	1.0	Dichlorobenzenes are widely used in industry and in domestic products such as odor-masking agents, chemical dyestuffs and pesticides	GC/PID; GC/ELCD; GC/MS
1,4-Dichlorobenzene	0.30		
1,2-Dichloroethane	0.03	Used as an intermediate in the production of vinyl chloride and other chemicals and as a solvent.	GC/PID; GC/ELCD; GC/MS
1,1-Dichloroethene	0.03	Used as monomer in the production of polyvinylidene chloride co-polymers and as an intermediate in synthesis of other organic chemicals.	GC/PID; GC/ELCD; GC/MS
1,2-Dichloroethene	0.05	Its presence appears as metabolites of other unsaturated halogenated hydrocarbons in wastewater and anaerobic groundwater, which may indicate the simultaneous presence of more toxic organochlorine chemicals such as vinyl chloride.	GC/PID; GC/ELCD; GC/MS
Dichloromethane	0.02	Dichloromethane or methylene chloride is widely used as a solvent for many purposes including coffee decaffeination and paint stripping.	GC/MS
Di(2-ethylhexyl) phthalate	0.008	Used mainly as a plasticizer.	GC/MS
Edetic Acid (EDTA)	0.6	Maximum value of 0.6 mg/L for EDTA as the free acid. Human exposure to EDTA arises directly from its use in food additives, medicines, and personal care and hygienic products.	Potentionmetric stripping analysis
Ethylbenzene	0.3	Primary sources are petroleum industry and use of petroleum products.	GC/PID; GC/MS
Nitrilotriacetic acid (NTA)	0.2	Used primarily in laundry detergents as a replacement for phosphates and in the treatment of boiler water to prevent accumulation of mineral scale.	GC with nitrogenspecific detector
Polynuclear aromatic hydrocarbons (PAHs)	0.0007	Used as coal-tar coating in drinking-water distribution pipes	GC/MS; reversephase HPLC with a fluorescence detector

Styrene	0.02	Used in the production of plastics and resins	GC/PID; GC/MS
Tetrachloroethene	0.04	Used as solvent in dry cleaning industries and as a metal degreasing solvent.	GC with ECD; GC/MS
Toluene	0.7	Used in the blending of petrol, as a solvent and as a raw material in chemical production. It may penetrate plastic pipes from contaminated soil.	GC/ FID; GC/MS
Trichloroethene	0.07	Used in dry cleaning and metal degreasing processes. Trichloroethene in anaerobic groundwater may degrade to more toxic compounds, including vinyl chloride.	GC/ ECD; GC/MS
Vinyl chloride	0.0003	Used primarily for production of PVC. Migration of vinyl chloride monomer from unplasticized PVC is possible source of vinyl chloride in drinking water. Degradation product of the chlorinated solvents trichloroethene and tetrachloroethene in groundwater.	GC / ECD; FID ; with MS for confirmation
Xylene	0.5	Used in blending petrol, as a solvent and as a chemical intermediate.	GC/MS; GC/ FID

Table 1604.4.4 - Standard Value for Organic Chemical Constituents (Pesticides)

Constituent	**Maximum Level (µg/L)**	**Status in the Philippines §**	**Remarks (Persistence)**	**Method of Analysis**
Aldrin and Dieldrin (combined)	0.03	Banned	Highly persistent organochlorine compounds	GC with ECD
Atrazine	2.0	Registered	Relatively stable in soil and aquatic environments; half-life measured in months, but is degraded by phytolysis and microbial action in soil	GC/MS
Carbofuran	7.0	Registered	0.007 mg/L is based on the 1998 amendment to the 1993	GC with nitrogenphosphorus detector; reverse-phase

			WHO GV	HPLC with fluorescence detector
Chlordane	0.2	Banned	Chlordane is highly persistent and has a high bioaccumulation potential.	GC /ECD, GC/MS
DDT	1.0	Banned*	DDT is highly persistent.	GC /ECD, GC/MS
1,2-Dibromo-3chloropropane (DBCP)	1.0	Banned	Highly soluble in water	GC /ECD, GC/MS
2,4-Dichlorophenoxyacetic acid (2,4-D)	30.0	Registered	2,4 D is rapidly biodegraded in the environment	GC/ECD, GC/MS
Endrin	0.6	Banned	Endrin is highly persistent	GC / ECD, GC/MS
1,2-Dibromoethane (Ethylene dibromide)	0.4	Banned	Used also in industry as solvent WHO GV is provisional value due to serious limitations of the critical studies. PNSDW adapts precautionary approach.	GC/MS; GC/ELCD; GC/PID
Heptachlor and Heptachlor epoxide (combined)	0.03	Banned	Heptachlor is quite persistent in soil where it is transformed into its epoxide. Heptachlor epoxide is resistant to further degradation.	GC/MS;/GC/ECD
Lindane	2.0	Restricted		GC/MS; GC/ECD
MCPA [4-(2methyl-4-chlorophenoxy)acetic acid]	2.0	Registered	Very soluble, highly mobile and can leach from soil. It has limited persistence in water.	GC/MS; GC/ECD
Pendimethalin	20.0	Registered	Fairly immobile and persistent in soil	GC/MS
Pentachlorophenol (PCP)	9.0	Banned	WHO GV is provisional value due to serious limitations of the critical studies.	GC/ ECD, GC/FID, GC/MS

Table 1604.4.5 - Standard Values for Physical and Chemical Quality for Acceptability Aspects

Constituent		**Maximum Level (mg/L) Or Characteristic**	**Remarks**	**Method of Analysis**
Taste		No objectionable Taste	The cause of taste must be determined.	Sensory Evaluation Technique
Odor		No objectionable odor	The cause of odor must be determined.	Sensory Evaluation Technique
Color	Apparent	10 Color Units	Decomposition of organic materials such as leaves or woods usually yield coloring substances to water; Tannins, humic acid, and humates from the decomposition of lignin; Insoluble form of iron and manganese; colored suspended matters	Visual Comparison Colorimetric
	True	5 Color Units		
Turbidity		5 NTU	Turbidity increases with the quantity of suspended matters in water.	Turbidimetry
Aluminum		0.2	Aluminum sulfate is used in water treatment as coagulants	FAAS, EAAS, ICP, Colorimetry Method
Chloride		250.0	Chloride in drinking water originates from natural sources, sewage and industrial effluents, urban runoff, and seawater intrusion.	Argentometric Method, IC
Copper		1.0	Copper in drinking water occurs primarily as corrosion of interior of copper plumbing especially with acid pH or high-carbonate waters with alkaline pH.	FAAS, EAAS, ICP, Neocuproine Method, Bathocuproine Method
Hardness		300 as $CaCO_3$	Hardness is due to the presence of naturally occurring divalent cations, such as calcium, magnesium, and strontium resulting from contact of acidic groundwater with rocks such as limestone and dolomites. Hardness beyond the standard value maybe acceptable for drinking by the consumers in certain areas.	FAAS, EAAS, ICP, Colorimetry Method
Hydrogen sulfide		0.05	Hydrogen sulfide may be generated by microorganisms under anaerobic conditions in bottom of swamps, marshes, eutrophic lakes and	Methylene Blue Method, Iodometric Method

		groundwater.	
Iron	1.0	Applicable for existing and new water supply systems. Iron is found in natural fresh waters. It may be present in drinking water as a result of the use or iron coagulants or the corrosion of steel and cast iron pipes during water distribution.	Phenanthroline, AAS, ICP, Colorimetric Method
Manganese	0.4	Applicable for existing and new water supply systems. Manganese is naturally occurring in many surface and groundwater sources, particularly in anaerobic or low oxidation conditions.	Persulfate Method, AAS, ICP, ICP/MS
pH	6.5 – 8.5 5 – 7 for product water that undergone reverse osmosis or distillation process	The pH range is based on aesthetic consideration only. The acceptable range may be broader in the absence of a distribution system. pH is important as operational water quality parameter	Electrometric method
Sodium	200	Sodium is usually associated with chloride, thus, it may have the same sources in drinking water as chloride. Water softeners can add significantly to the sodium content in drinking water especially from water refilling stations.	AAS (Flame absorption mode) , ICP/MS, Flame photometry
Sulfate	250	High levels of sulfate occur naturally in groundwater.	Turbidimetric Method, Ion Chromatography, Gravimetric Method
Total Dissolved Solids (TDS)	500 <10 for product water that undergone reverse	TDS in drinking water originate from natural sources, sewage, urban runoff and industrial wastewater.	Gravimetric, dried at 180°C

	osmosis or distillation process		
Zinc	5.0	Zinc may occur naturally in groundwater. Concentration in tap water can be much higher as a result of dissolution of zinc from pipes.	FAAS, ICP, ICP/MS

Table 1604.4.6 Standard Values for Chemicals Used in Treatment and Disinfection and Disinfection by-products

Constituent	**Maximum Level (mg/L)**	**Occurrence**	**Method of Analysis**
a. Contaminants from Treatment Chemicals			
Acrylamide	0.0005	Residual acrylamide monomer occurs in the use of anionic, cationic and non-ionic polyacrylamide coagulant aids;	GC/ELCD; HPLC with UV Detection
Epichlorohydrin	0.0004	Epichlorohydrin is used for the manufacture of glycerol, unmodified epoxy resins and water treatment resins.	GC /ECD, GC/MS, GC/FID
b. Disinfection Chemicals			
Chlorine Residual	0.3 min	Detected at the farthest point of the distribution system	Iodometric; Amperometric Titration; DPD Colorimetric Method
	1.5 max	Detected at any point in the distribution system	
Iodine	Not recommended for long term disinfection		Leuco Crystal Violet/ Amperometric Method
c. Disinfection by-products			
Bromate	0.01	As DBP, bromate is formed during ozonation when bromide ion is found in water or in concentrated hypochlorite solutions used to disinfect drinking water. The maximum level is based on the recent (2003) risk assessment as reported in WHO Guidelines (2004).	IC

Chlorite	0.7	The maximum values for chlorite and chlorate are provisional values. When chlorine dioxide is used as a disinfectant, chlorite or chlorate levels may be allowed to exceed the maximum level. Difficulty in meeting the maximum level is not a reason for compromising adequate disinfection.	IC with suppressed conductivity detection for chlorate
Chlorate	0.7		
Chloral hydrate (trichloroacetaldehyde)	0.01	Chloral hydrate is formed as a by-product of chlorination when chlorine reacts with humic acids.	GC /ECD; GC/MS
Dibromoacetonitrile	0.07	Dibromoacetonitrile is produced during water chlorination from naturally occurring substances including algae, fulvic acid and proteinaceous material.	GC/ ECD
Dichloroacetic acid	0.05	Chlorinated acetic acids are formed from organic material during water chlorination.	GC/ECD; GC/MS
Dichloroacetonitrile	0.02	Dichloroacetonitrile is produced during water chlorination from naturally occurring substances including algae, fulvic acid and proteinaceous material.	GC/ECD
Formaldehyde	0.9	Formaldehyde in drinking water results primarily from oxidation of natural organic matter during ozonation and chlorination.	GC/ECD
Monochloroacetate	0.02	Chlorinated acetic acids are formed from organic material during water chlorination.	GC/ ECD; GC/MS
Trichloroacetate	0.20	Chlorinated acetic acids are formed from organic material during water chlorination.	GC /ECD; GC/MS
2,4,6trichlorophenol	0.2	Chlorophenols are present in drinking water as a result of the chlorination of phenols, as by-products of hypochlorite with phenolic acid, as biocides or as degradation products of phenoxy herbicides.	GC/ ECD;GC/MS

Trihalomethanes			
Bromoform	0.1	Trihalomethanes are generated principally as by-products of chlorination of drinking water, being formed from naturally occurring organic compounds.	GC /ECD; GC/MS
Dibromochloromethane	0.1		
Bromodichloromethane	0.06		
Chloroform	0.2		

AAS - Atomic Absorption Spectrometry
DPD -N,N-diethyl-p-phenylenediamine (under residual chlorine method)
EAAS - Electrothermal Atomic Absorption Spectrometry
ELISA - Enzyme-linked Immunosorbent Assay
FAAS - Flame Atomic Absorption Spectrometry (FAAS)
FID – Flame Ionization Detector
GC - Gas Chromatography
GC/ECD - Gas Chromatography/Electron Capture Detector
GC/ELCD - Gas Chromatograph/Electrolytic Conductivity Detector
GC/FID -Gas Chromatograph/Flame Ionization Detector
GC/MS - Gas Chromatography / Mass Spectrometry
GC/PID - Gas Chromatograph/Photoionization Detector
HPLC - High-performance Liquid Chromatography
ICP/AES - Inductively Coupled Plasma / Atomic Emission Spectrometry
ICP/MS - Inductively Couple Plasma / Mass Spectrometry (ICP/MS)

Table 1604.4.7 - Standard Values for Radiological Constituents

Constituents	Activity Level (Bq/liter)
gross alpha activity	0.1 (excluding radon)
gross beta	1.0
radon	11(MCL)

1604.5 Method of Measurement

The quantity to be paid for will be measured by lump-sum for the complete WTP as furnished on site, in accordance with these specifications and as accepted by the Engineer.

1604.6 Basis of Payment

The accepted quantity, measured as prescribed in Section 1604.5, shall be paid for at the Contract Unit Price for Water Treatment Plant which price and payment shall be full compensation for furnishing all materials, including all labor, equipment, tools and incidentals necessary to complete the work prescribed in this item.

Payment shall be made under:

Pay Item Number	Description	Unit of Measurement
1604 (1)	Water Treatment Plant (WTP), Modular/Skid Type	Lump-sum

References:

1. *Philippine National Standards for Drinking Water 2007*
2. *ISO 9001:2008 Quality Management System*
3. *NSF International Standard/American National Standard; NSF/ANSI 61 – 2013 Drinking Water System Components – Health Effects; USA, 2013*
4. *Water Quality Association; Gold Seal Certification Program's Gold Seal Logo Policy*
5. *European Standard AFNOR NF X 15-211:2009 Standard*
6. *British Standard BS 7989:2001*