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CONSULTANCY REPORT

**EVALUATION OF THE MICROBIOLOGICAL
QUALITY OF WATER FOR CONSUMPTION
AT THE OCEAN SKY GARMENT
MANUFACTURING FACILITIES**

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For: FAIR LABOR ASSOCIATION

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EVALUATION OF THE MICROBIOLOGICAL QUALITY OF WATER FOR CONSUMPTION AT THE OCEAN SKY GARMENT MANUFACTURING FACILITIES

GENERAL OBJECTIVE

To evaluate the microbiological quality of water intended for human consumption through the systems for intake, distribution and purification of water within the facilities at OCEAN SKY located in Olocuilta.

SPECIFIC OBJECTIVES

- ◆ Evaluate the water supply system at OCEAN SKY.
- ◆ Determine a sampling plan to evaluate water quality.
- ◆ Based on the results, provide recommendations to improve the water supply system.

METHODOLOGY

The work methodology consisted of the following:

- ◆ Visits to the facilities for planning and taking samples.
- ◆ Evaluation of the results of the analysis.
- ◆ Presentation of reports containing results and recommendations.

DESCRIPTION OF THE WATER SUPPLY SYSTEM AT THE OCEAN SKY FACILITIES

Following is a description of the water supply system based on a visual inspection and information provided by the person responsible for maintenance at the facility.

Ocean Sky occupies 3 plants within the International Free Zone. Building #1 houses the main production lines and the packing department. Building #2 houses the cutting department, two small production lines which produce samples and a warehouse. Building #3 (Screen printing) houses the screen printing and embroidery departments, as shown in figure 1.

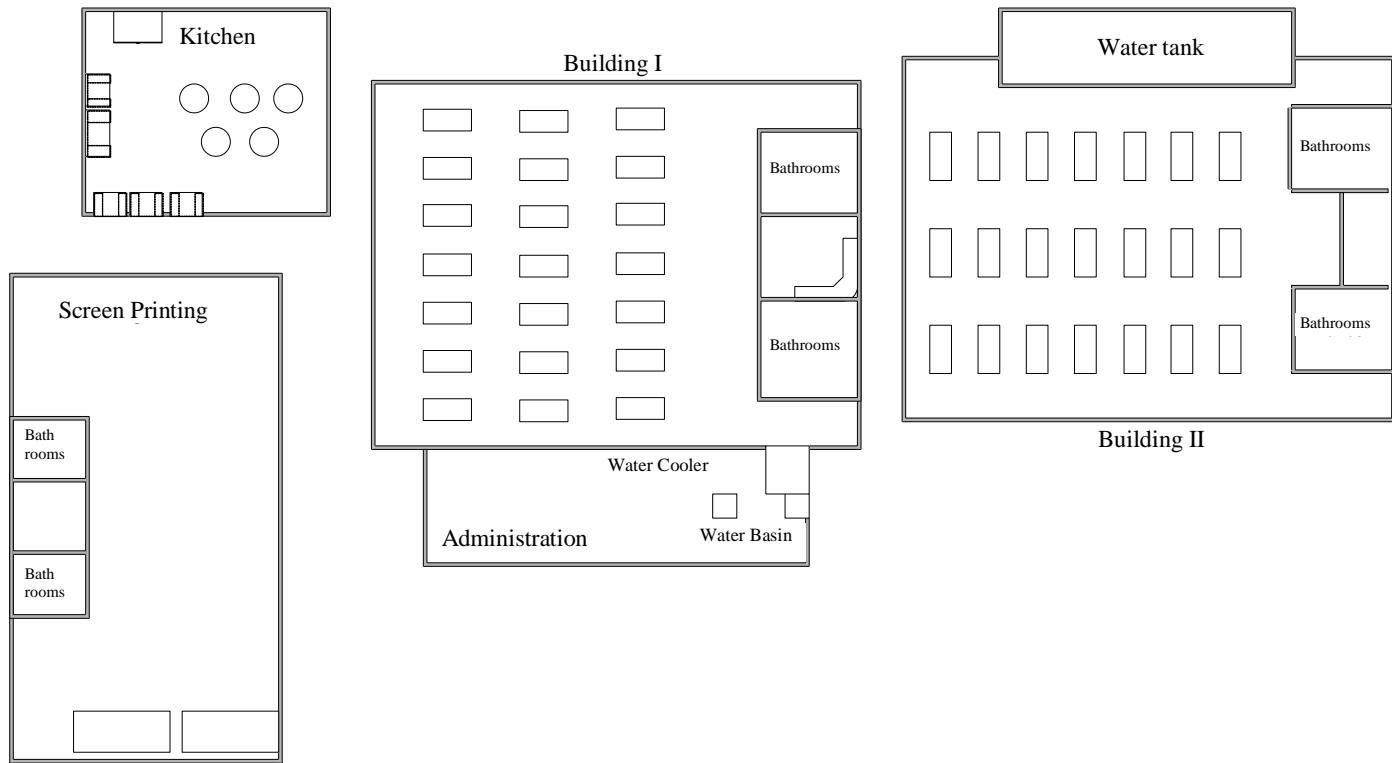


Figure 1. Floor plan for Ocean Sky plant

The water supply for the plant comes from a central well in the industrial park. The contract between the owner of the park and Ocean Sky establishes that each company is responsible for the purification and potabilization of their water.

Ocean Sky receives water from the industrial park well into two water tanks and directly into the area known as Screen Printing.

Water Tank 1: located at the rear of building 2. The water in this tank receives a weekly chlorine treatment. This water tank feeds the filtration system for water destined for the consumption of operators. This water tank also supplies the bathrooms in Building 2.

Water Tank 2: located in the Kitchen-Cafeteria area. The water collected here does not receive treatment, because it is used for laundry and the bathrooms in Building 1 and the Administration Building. The Kitchen area is also supplied from this water tank.

Screen Printing: water from the park's well supplies the bathrooms in this area.

The supply of drinking water for workers is provided in the following manner:

- 1- Building 1 y Building 2: Two areas for water filtration are found, according to the system shown in Figure 2.
- 2- In the Screen Printing and Administration areas, drinking water is supplied by commercial bottled water (*Alpina* brand) and distributed through water coolers.
- 3- The Kitchen area is supplied by Water Tank 2, and distributed through sinks. There is a single kitchen, in which meals are prepared. It has a water filter, which supplies the water used for the preparation of meals and a water basin used for washing utensils. The food service concessionaires do not prepare meals on site; they bring prepared meals and lack water systems of their own.

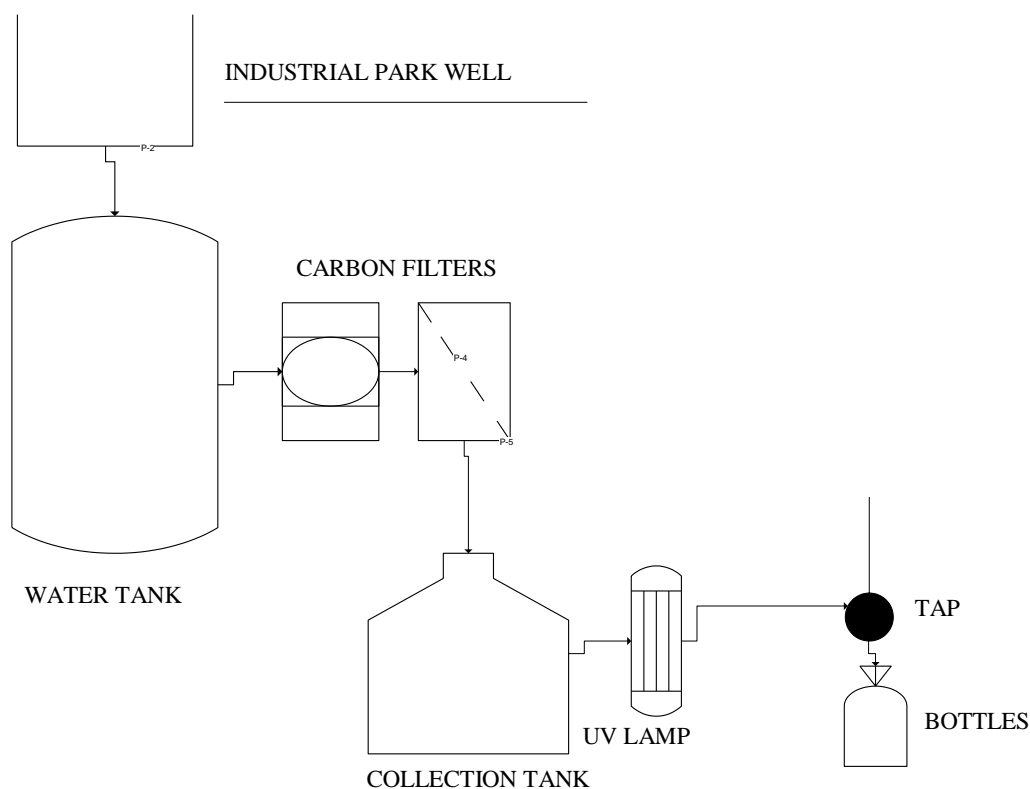


Figure 2. Water Filtration System

SAMPLING PLAN

In order to establish a plan for taking samples a first visit to the facilities was conducted to recognize and identify possible sampling points, this visit was completed on February 10.

The sampling was performed Wednesday, February 23, between 10:00 and 11:00 am. This day was defined as being in the middle of the work week and the selected time was three hours after the work shift started.

The Plan for taking samples is described below:

- a) Water Tank 1: This is the zone for collection of water from the well, without any previous treatment.
- b) Bathrooms: these zones are supplied with water from the water tank without previous treatment, used for washing hands and water containers. Of the bathroom areas, samples were taken from those corresponding to Building 1, in the women's bathrooms as well as the men's bathrooms.

- c) Filtration and water treatment zones: this is the zone where workers refill their water bottles. Samples were taken from two different taps from the two treatment zones, in Building 1 and in Building 2.
- d) Kitchen Area. There are 5 sinks available that also serve as input for the food service concessionaires. A sample was taken from one sink and in the big kitchen, the filter and water basin were sampled.
- e) Screen Printing area: This area is supplied with bottled water distributed using water coolers, having three in the production area and two in more restricted areas. One water cooler in the production area and the bathroom area were sampled.
- f) Administrative area: this zone is supplied with bottled water for drinking and from the water tank for the bathrooms and sink. A sample was taken from the dishwashing sink and one from the water cooler.

LABORATORY ANALYSIS

The analyses were performed based on the Salvadorian Mandatory Norm (Norma Obligatoria Salvadoreña) NSO 13.07.01:04 Water. Potable Water (Second Update), within which it is defined as a *Type of Complete Analysis*, with the following microbiological parameters (1):

- 1- Total Count of Mesophilic Bacteria (Heterotrophic): considers the microorganisms that required organic carbon to grow (2)
- 2- Total coliforms and fecals: Microorganism indicators (bacteria) associated with fecal contamination from human beings or other warm-blooded animals (3)
- 3- *Escherichia coli*: Enterobacteria specific indicator of fecal contamination. (3)

The methods for analysis were performed using BAM methods. Analysis method: APHA-AWWWA-WEF

RESULTS

Following, the results are presented corresponding to the supply source.

Water Tank 1: Water from this tank is distributed as shown in figure 3, and the results are presented below, which include the temperature of the sample at the time of collection:

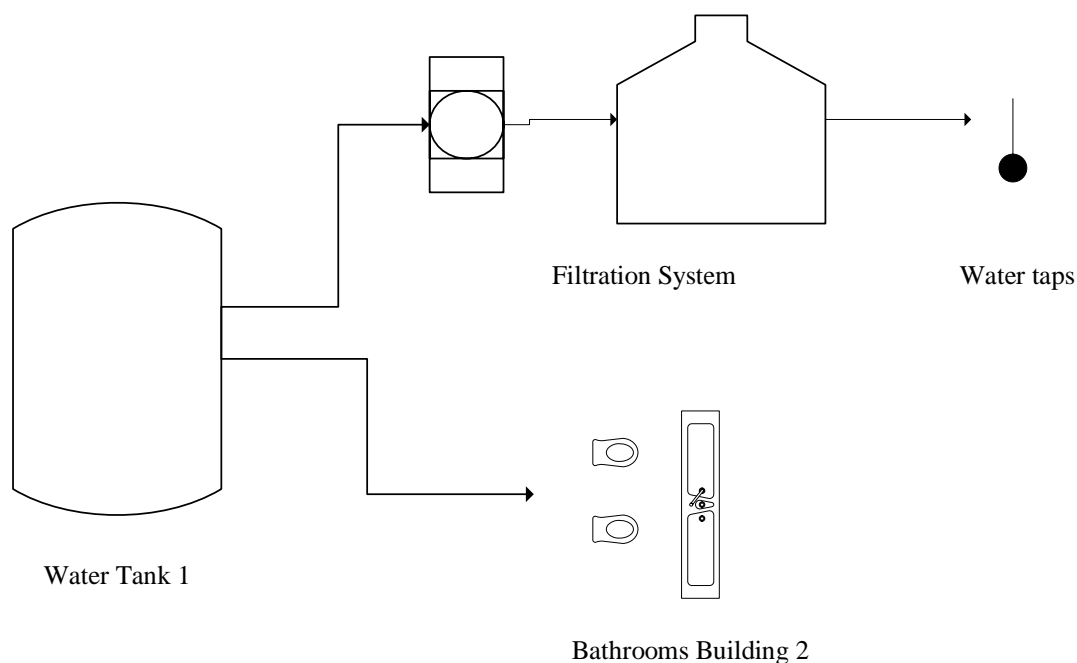


Figure 3. Distribution of water from Water Tank 1

ANALYSIS	Total Bacteria Count (CFU /mL)	Total Coliforms (MPN /100mL)	Fecal Coliforms (MPN /100mL)	<i>Escherichia coli</i> (CFU /mL)
Water Tank 1 (29.5°C)	135 x 10 ²	Less than 1.1	Less than 1.1	Less than 1
Filtration System: Building 1 Tap 1 (29.5°C)	365 x 10 ²	Less than 1.1	Less than 1.1	Less than 1
Filtration System: Building 1 Tap 2 (29.0°C)	210 x 10 ²	Less than 1.1	Less than 1.1	Less than 1
Filtration System: Building 2 Tap 1 (28.5°C)	Greater than 300	Less than 1.1	Less than 1.11	Less than 1
Filtration System: Building 2 Tap 2 (28.5°C)	Greater than 300	Less than 1.1	Less than 1.1	Less than 1
NORMA SALVADOREÑA OBLIGATORIA (Salvadorian Mandatory Norm) NSO13.07.01:08	Less than 100	Less than 1.1	Less than 1.1	Less than 1

Water Tank 2:

Water in this tank is distributed as shown in figure 4, and the results are presented below:

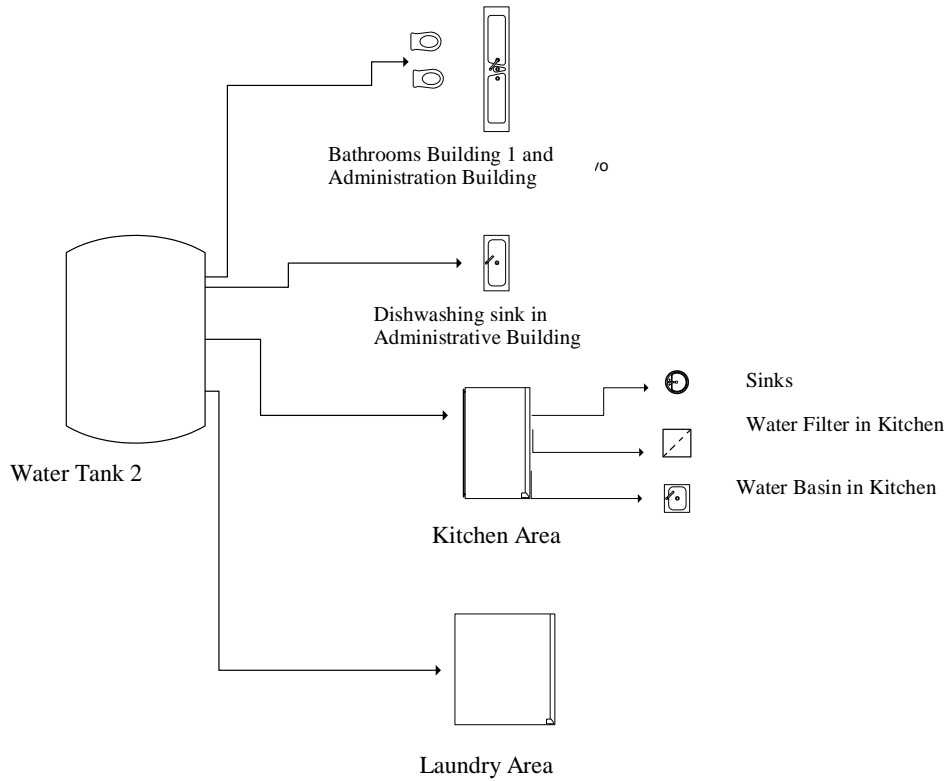


Figure 4. Distribution of water from Water Tank 2

ANALYSIS	Total Bacterial Count (CFU /mL)	Total Coliforms (MPN /100mL)	Fecal Coliforms (MPN /100mL)	<i>Escherichia coli</i> (CFU /mL)
Men's Bathroom Building 1 (30.0°C)	558 x 10 ²	20	20	Less than 1
Women's Bathroom Building 1 (29.0°C)	Greater than 300	20	20	Less than 1
Dishwashing sink Administration Building (29.0°C)	Less than 100	Less than 1.1	Less than 1.1	Less than 1
Kitchen area: sinks (31.0°C)	Greater than 300	20	Less than 1.1	Less than 1
Kitchen area: water filter (31.0°C)	154 x 10 ²	40	20	Less than 1
Kitchen area: water basin (32.5°C)	Greater than 300	300 x 10 ²	Less than 1.1	Less than 1
NORMA SALVADOREÑA OBLIGATORIA (Salvadorian Mandatory Norm) NSO13.07.01:08	Less than 100	Less than 1.1	Less than 1.1	Less than 1

The water coolers in Screen Printing and the Administration Building are supplied with commercial bottled water, *Alpina* Brand. Following are the results for these water coolers:

ANALYSIS	Total bacterial count (CFU /mL)	Total Coliforms (MPN /100mL)	Fecal Coliforms (MPN /100mL)	<i>Escherichia coli</i> (CFU /mL)
Screen printing Water Cooler (27.5°C)	193 x 10 ²	Less than 1.1	Less than 1.1	Less than 1
Administration Building Water Cooler (19.0°C)	Greater than 300	300 x 10 ²	Less than 1.1	Less than 1
NORMA SALVADOREÑA OBLIGATORIA (Salvadorian Mandatory Norm) NSO13.07.01:08	Less than 100	Less than 1.1	Less than 1.1	Less than 1

A sample from the bathrooms in screen printing was taken, because they are supplied directly from the well and the results were the following:

ANALYSIS	Total bacterial count (CFU /mL)	Total Coliforms (MPN /100mL)	Fecal Coliforms (MPN /100mL)	<i>Escherichia coli</i> (CFU /mL)
Women's Bathrooms Screen printing (28.0°C)	150 x 10 ²	40	20	Less than 1
NORMA SALVADOREÑA OBLIGATORIA (Salvadorian Mandatory Norm) NSO13.07.01:08	Less than 100	Less than 1.1	Less than 1.1	Less than 1

DISCUSSION OF RESULTS

The results indicate the situation at a specific moment of operation at the facilities, and the following discussion of results is conducted stemming from this data, and does not imply a systematic evaluation of the process. In summary:

- 1- In general terms, no samples showed a presence of *Escherichia coli*, implying an absence of this pathogenic bacterium, which causes gastrointestinal diseases.
- 2- Of the total samples, all those showing the presence of fecal coliforms, except for the water filter in the kitchen, were in the bathrooms in all areas. In addition fecal coliforms were found in the samples from the kitchen sinks, the water filter and the water basin in the kitchen.
- 3- The presence of total coliforms, not necessarily implying fecals, was also found in all samples taken from the bathrooms.

- 4- All of the samples taken presented mesophilic bacterial count (Heterotrophic) above the 100 CFU/ml set in the Salvadorian Norm.

Following are a few considerations regarding the causes of the elevated total heterotrophic bacterial count.

According to the WHO (4), the microorganisms normally grow in water and the surfaces that are in contact with it in the form of biofilms. Bacterial growth following a water purification treatment is known as “regrowth”. The most important determining factors of “regrowth” are temperature, availability of nutrients and inefficient residual disinfection. The nutrients can be derived from the bodies of water and/or materials in contact with the water. The use of instruments at the Point of Use (PU) such as carbon filters and water softeners present an opportunity for the new growth of bacteria in the water.

A biofilm is a collection on the surface of organic and inorganic material, of dead and living material. In the plumbing system for potable water it can be found as a complete film or small focused patches on the surfaces of the pipes. The biofilms on the potable water pipes are responsible for a wide array of problems with the operation and quality. The Biofilms contribute to a loss of the residual effect of the disinfection system, increasing bacterial levels, reducing dissolved oxygen, changing the odor and taste, causing reddish or blackish colors due to bacteria reducing iron and sulfates, bacterial influence on corrosion among others.

The multiplication of bacteria in the distribution system results primarily on the exposed surfaces of pipes and in the sediments, even in the presence of residual disinfectant.

A Total Count of Heterotrophic Bacteria produces the following interpretations:

- It indicates the effectiveness of a water treatment process, as an indirect indicator of the removal of pathogens.
- As a measure of the number of organisms from regrowth, that could or could not have a sanitary meaning.
- Provides information and could be utilized to control and optimize the treatment process, procedures and good engineering practices related to water treatment and its distribution. (4)

As expressed before and considering the values obtained for the Total Count of Heterotrophic Bacteria and the temperature of the water at the time of sampling, these elevated values may be produced by the formation of biofilms in the water distribution system, causing the chlorination and filtration systems to become inefficient.

Regrowth of coliform bacteria is produced in the accumulation of sediments in the distribution systems, due to the temperatures and type of coating of the distribution system. The conditions of growth of coliform bacteria depend on the availability of substrate, water temperature, corrosion, presence of sediments and residual disinfectant. (4)

It is noteworthy to mention, that in spite of the absence of total coliforms, fecals and *E. coli* in the water filtration systems, the elevated Total Bacterial Count may imply the presence

of “opportunistic infections” such as *Pseudomona spp.*, primarily *Pseudomona aeruginosa*, *Acinetobacter spp.*, *Aeromonas spp.*, *Klebsiella pneumoniae*, etc. There is no evidence of a link between these bacteria and gastrointestinal infections through water. (2)

For this reason, further evaluation of the water purification and distribution system is necessary, after taking some actions such as the following:

- 1- Verification and standardization of the procedure for cleaning Water Tank 1 and Water Tank 2: documentation and standardization, in order for it to be performed under the same conditions.
- 2- Normalize the chlorination procedure for the water tank, including the concentration of added chlorine, application method and verification of the effectiveness of the chlorination. Physicochemical controls such as residual chlorine, pH and turbidity can be established.
- 3- It is necessary to evaluate the filtration system at each point of input and output of water: before and after the carbon filter, in the water reservoir, before and after the ultraviolet lamp. In order to evaluate if the filtration system is operating adequately.
- 4- Evaluate and normalize the useful life of the filters and UV lamp used in the purification system. Likewise, it is necessary to establish the procedures for cleaning the storage tanks located after the carbon filters.
- 5- Water entering the meal preparation area must be purified prior to entry. In addition, an industrial filter must be customized and not filters for home use such as the ones currently used.
- 6- Kitchen and food service providers must be trained in Good Manufacturing Practices, since food and water are the primary vehicles for pathogens, and kitchen personnel may be the main source of contamination.
- 7- If the water used for the bathrooms is not treated and is used to wash the worker’s bottles, it is a source of contamination for bottles and water containers, making it necessary to consider purified water for washing bottles.
- 8- The water coolers show contamination due to lack of adequate cleaning, making it necessary to normalize the cleaning of water coolers, as well as the periodicity and type of water used for cleaning.

In potable water that complies with established standards, there is no absolute guarantee of the absence of pathogens; it only confirms that its presence is unlikely. Therefore, the probability of disease transmitted through water is diminished. (3)

Regarding posterior evaluations, that might consider:

- 1- Evaluation of water quality before and after the water tanks are cleaned
- 2- Evaluation of water quality after chlorine treatment
- 3- Evaluation of water quality at each point of the filtration system
- 4- Evaluation of water quality of commercial bottled water (*Alpina*)

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