YADA Technologies S.L.

FAQs

For customers' support

Monday, 16 November 2020

Index

Yada technologies S.L. Avenida Gasteiz, 72, 2D. 01012- Spain info@yadatech.com Phone: +34 628724984 / +34 644671050

1 Will the water be compliant for human consumption?

We test the material of our floaters, HDPE, which will be in touch with the water for many years. The most commonly used standard is the BS 6290:2000 (British Standard). In the US, the most suitable standard is the "NSF-61: Drinking Water System Components – Health Effects". Anyway, each State has its own right to require or not this standard, according to the map below.

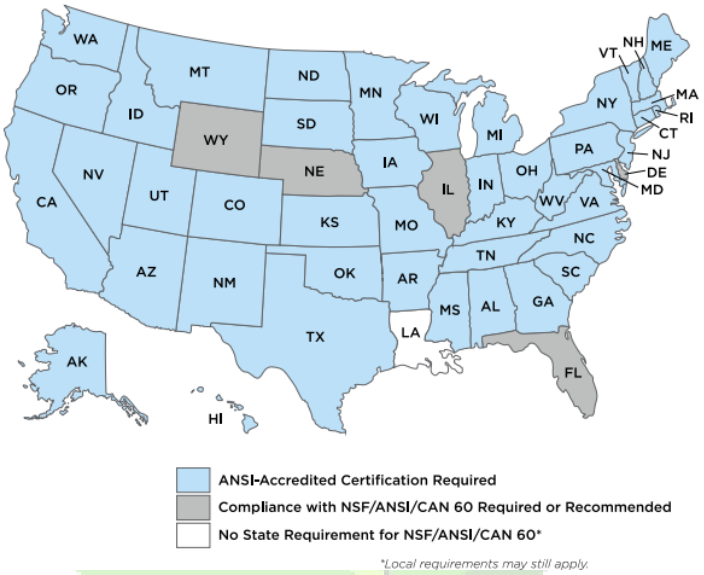

Figure 1- Compliance with NSF map

Talking about potable water, HDPE was initially limited to cold water service applications. This is because early formulations were not too strong for the high temperatures of hot water systems. This has changed with the years and nowadays many formulations of HPDE are stronger at higher temperatures. Its use is common in radiant floor heating applications and, increasingly, in domestic hot/cold water systems.

Every plastic contains some residual of the chemicals required for its manufacture. These may include certain catalysts that had assisted the polymerization reaction or traces of unreacted raw material. A number of additives are typically compounded along with polymer resin prior to forming the final product. These could include stabilizers, UV-blockers, plasticizers, antioxidants, colorants, etc., to enhance both processing and performance features.

Under the Safe Drinking Water Act, the United States Environmental Protection Agency (USEPA) establishes regulations for contaminant levels in drinking water distribution systems. These standards mainly address water quality where it enters the distribution system and do not address changes in quality from contamination downstream, such as in building plumbing. Drinking water standards include a long list of contaminants and their maximum allowable level for drinking water.

2 Is the NSF-372 necessary?

No, the components in contact with the water have no Lead content. Hence, and otherwise stated, this standard is not mandatory.

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3 Is it safe for recreational areas such as big lakes?

Yada's Floating Photovoltaic system fulfils electrical regulations in order to avoid any electrical failures. Our systems are reviewed and certified by independent third parties and are compliant with electrical regulations and standards in the EU and the country where the installation takes part. The cables and electrical components are certified to be used in water what ensures long life of the construction and optimizes maintenance cost. Moreover, depending on the project, the inverters are located in the reservoir or in land.

However, is the State's solely responsibility to admit recreational purposes near any industrial plant, such as this.

4 What is the algae reduction procedure?

4.1 The theory

Algae are a diverse group of aquatic organisms that can conduct photosynthesis. The term "algae" covers many different organisms capable of producing oxygen through photosynthesis (the process of harvesting light energy from the sun to generate carbohydrates).

Generally, algae are capable of photosynthesis and produce their own nourishment by using light energy from the sun and carbon dioxide in order to generate carbohydrates and oxygen.

Algae growing in a drinking water reservoir will increase both the TSS and the CBOD5 of the effluent, deteriorate water taste, plug filtration systems and increase chemical treatment cost. Since algae diminishes water quality and play no beneficial role in drinking water and wastewater, preventing algae growth is important to those responsible for the design and operation of these systems. Some algae are toxic to humans and dogs. Water can also become unsuitable for fish, swimming, and other animals.

The construction of a FPV system will prevent light from entering the water column and will prevent the algae growth and other noxious weeds. Chlorophyll-a max absorption rate is in the range 465-665nm of light wavelength. Thus, if we can shade the water surface, we could avoid this range, reducing its significant weighted values.

4.2 The proof

A research published in the American Geophysical Union in 2018 found that installing FPV, such that the lake is shaded has the following effects:

FPV coverage ratio (%)	Ecological effect
0-20	**No effect**
20-40	**Little effect**
40-60	**Algae blooms avoided**
60-80	**Loss of natural food**
80-100	**Harm to the ecosystem**

This is a very interesting article but, unfortunately, they assumed as a constraint that a minimum water level is needed for the FPV, which makes the economical part of the research invalid for our design. Anyway, although our product would be more profitable than that of the

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study because we do not need a minimum water level, it is absolutely valid for the ecological part.

The plot below shows that a coverage ratio of 40% is suitable for algae avoidance.

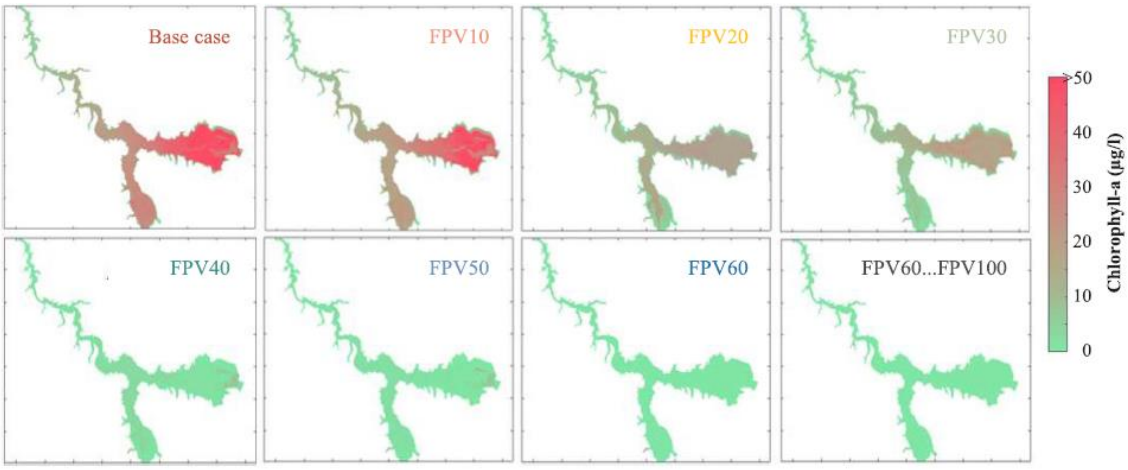

Figure 2- Concentration of Chlorophyll-a vs FPV coverage ratio (%). Source: Energy Conversion and Management 206 (2020) 112414

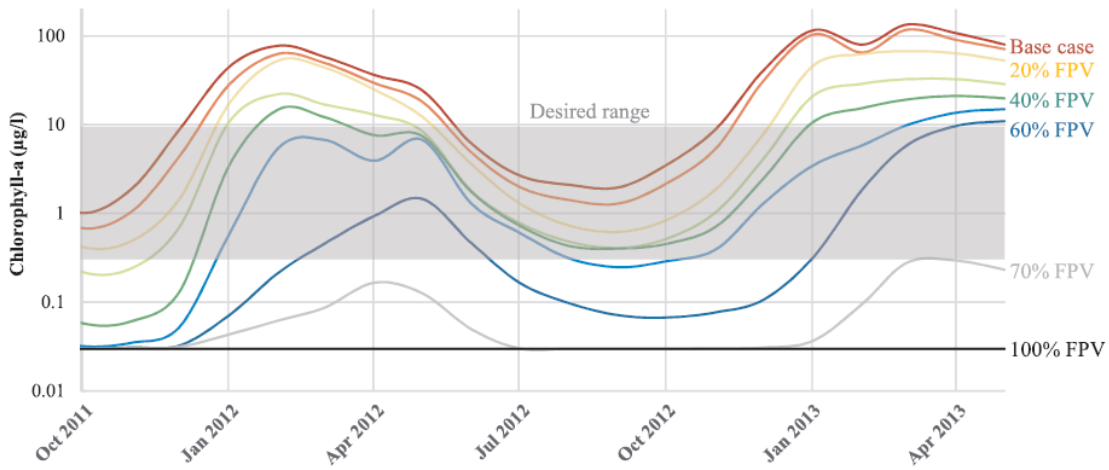

Figure 3- Chlorophyll-a evolution during the year with the FPV coverage.

According to the previous research, the use of the reservoir will define the FPV coverage ratio as shown below:

FPV coverage ratio (%)	Use of the reservoir
0-20	Agriculture, irrigation and related (those activities where algae does not impact the human health)
20-40	Those activities that has bigger maintenance cost due to algae, but there is no impact for human health)
40-60	Human consumption reservoirs and lakes
60-80	Big dams where there should not be a big animal ecosystem (damage of the propellers, high maintenance…). During

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	certain months, the nutrients of the water might decrease.
80-100	Industrial reservoirs where there must not be any natural environment (or is not necessary)

Table 1- FPV coverage ratio according to the use of the water

With Yada's current design, the **40,8%** of the surface is shadowed, while we only touch the 7% of the total water surface. This number can vary dependending on the string' size. This means that the pollution risk of the water is minimal while the quality of the water keeps optimum.

Figure 4- Algae bloom in Lake Eire (US)

Covering the reservoir protects the water from the dust, rain, birds, and algae growth. This technology has been used in several locations in US also diminishing the water evaporation in these reservoirs. But we find it almost useless compared with a solar system.

https://www.youtube.com/watch?v=52-MCHrqhRo

4.3 The solar alternatives

4.3.1 Ultrasonic treatments

We are in contact with a company who can avoid up to 90% of algae growth within 500m radius, so we can integrate this component in our structure, supplying it with our own energy.

4.3.2 Herbicide treatments

We can adapt the cleaning system control to add herbicide parameters. This way, whenever our sensors detect that Chlorophyll-a level is above certain value, the herbicide will be fed in the system during a pre-fixed time. A tube with drip foggers will be attached to the mooring line. This way, the herbicide will be dispensed straight in the most critical part or the reservoir: the coastal perimeter. The maintenance is very simple as the herbicide is replenished on each of the required tanks. Our electronic control will do the rest and will tell when to clean the sprinklers

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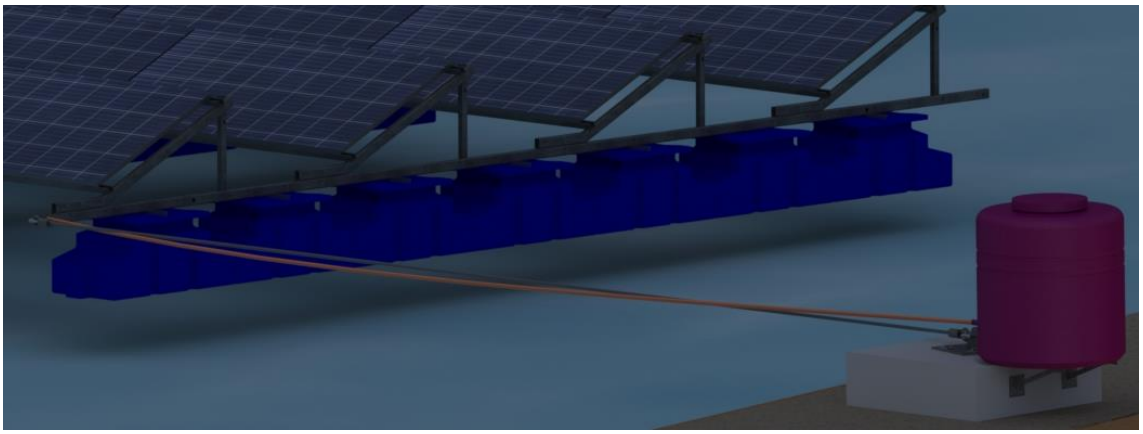

Figure 5- Example of the proposed system

4.3.3 Hybrid shading

As has been discussed above, certain reservoirs in the U.S. have released plastic balls (very expensive tough) to avoid algae growth, evaporation and so one. As the solar plant will be in the centre as much as possible (the deeper it is, the cooler the water will be and, also, the panels), the surrounding area can be covered with a plastic cover, if the algae must be ideally zero.

5 Can the plant withstand any water level variation?

Not any. We design the mooring system according to certain previous parameters agreed with the customer. Our system can adapt to level variations thanks to an automatic pulling-system or to a manual one, depending on the customers' needs or budget. Anyway, while working in that agreed range, there is no problem with the speed of variation or similar.

6 Will the anchoring and mooring system damage my seabed plastic protection?

No. Small irrigation and human-consumption reservoirs often have a plastic cover in the seabed, every time they lay on terrain prone to water seeping or leakage. In these cases, we do not touch the seabed, but we anchor the mooring system to the coastal area of the lake. For us, it is the most reliable method and it avoids the need of divers for maintenance.

7 What is the maximum tilt angle of the PV modules?

Right now, our product can withstand up to 150km/h (around 93mph) at 20 degrees. It means that, depending on the wind zone, we can go further or not with the tilt angle, as that inclination will definitely affect the lift force and, hence, the floatability, the dynamic response, etc.

8 If the seabed is not plain, will the structure be damaged?

Each string (group of x panels, from 16 to 30) is attached to their neighbours through a series of joints (SJ1, SJ2…). These are the ones which allow every string to adapt to the seabed' shape. The maximum angle they allow is 15º North-South and East-West. Areas with double curvature are not recommended. Although small changes can be absorbed by the design, it is more

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convenient to avoid this area. Furthermore, those areas where any pipe or other submerged obstacle is located must be avoided.

9 How is the access to the floating plant by maintenance staff?

Normally the customer is given a small boat to reach the plant. Then, maintenance paths can be installed (permanent or temporary) between each panel row. Other customers ask for a custom deck. It really depends on the project, the coast or the weather conditions.

10 Will the birds be affected by the floating plant?

First, we need to protect the animal habitat. For that, we can supply the customer what we call "Front Decks" as it can be seen in the picture below. Up there, many clients place bees' houses, nests and other kind of accessories to help the animal environment to be developed in a safe place.

Moreover, by doing that we are able to locate the animals where it is better for both parts. We reduce the dirt of the panels and any random impact on them. Animals win a safe environment far from land predators where they can drink, generate honey or lay eggs in their nests.

This has opened us a new point of view about Floating PV Systems (FPV), as many rural areas are trying to welcome young people, and this would be a structure to support new business. We say it day and night: "this is a floating structure. We firstly place solar panels, but we can use it for much more".

Figure 6-View of the Front Deck

11 Will the structure suffer corrosion episodes?

Only the 7% of the structure is in direct contact with water. Moreover, this element is the HDPE floating component.

High-density polyethylene is widely used for alimentary purposes as it does not transmit any chemicals into foods or drinks, making this plastic a low health risk variety, according to Chemical Safety Facts. Moreover, HDPE material is effective for the large-scale transfer of liquids given that they can withstand high amounts of pressure and are unaffected by rust due to their thermoplastic quality. HDPE products do not rust, corrode or rot. They are also resistant to biological growth, eliminating the costly problems associated with corrosion and fouling.

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Regarding the rest of the structure is manufactured by hot deep galvanized steel profiles. These components are not in contact with the water and thanks to the surface treatment they resist the corrosion effect.

Taking under study a C_4 corrosive atmosphere due to the definition given in ISO 9223 and shown below:

C4	High	Spaces with high frequency of condensation and high pollution from production process, e.g. industrial processing plants, swimming pools	Temperate zone, atmospheric environment with high pollution (SO_2: 30 µg/m³ to 90 µg/m³) or substantial effect of chlorides, e.g. polluted urban areas, industrial areas, coastal areas without spray of salt water or, exposure to strong effect of de-icing salts Subtropical and tropical zone, atmosphere with medium pollution

Figure 7- Extract from ISO-9223:2012

The average microns of zinc lost per year would be between 2,1 / 4,2 microns. This means that, depending on the location and the requirements of the project an average of 10/15 years must be accomplished.

Table 2 — Corrosion rates, r_{corr}, for the first year of exposure for the different corrosivity categories

Corrosivity category	Corrosion rates of metals r_{corr}				
	Unit	Carbon steel	Zinc	Copper	Aluminium
C1	g/(m²·a)	$r_{corr} \leq 10$	$r_{corr} \leq 0,7$	$r_{corr} \leq 0,9$	negligible
	µm/a	$r_{corr} \leq 1,3$	$r_{corr} \leq 0,1$	$r_{corr} \leq 0,1$	—
C2	g/(m²·a)	$10 < r_{corr} \leq 200$	$0,7 < r_{corr} \leq 5$	$0,9 < r_{corr} \leq 5$	$r_{corr} \leq 0,6$
	µm/a	$1,3 < r_{corr} \leq 25$	$0,1 < r_{corr} \leq 0,7$	$0,1 < r_{corr} \leq 0,6$	—
C3	g/(m²·a)	$200 < r_{corr} \leq 400$	$5 < r_{corr} \leq 15$	$5 < r_{corr} \leq 12$	$0,6 < r_{corr} \leq 2$
	µm/a	$25 < r_{corr} \leq 50$	$0,7 < r_{corr} \leq 2,1$	$0,6 < r_{corr} \leq 1,3$	—
C4	g(m²·a)	$400 < r_{corr} \leq 650$	$15 < r_{corr} \leq 30$	$12 < r_{corr} \leq 25$	$2 < r_{corr} \leq 5$
	µm/a	$50 < r_{corr} \leq 80$	$2,1 < r_{corr} \leq 4,2$	$1,3 < r_{corr} \leq 2,8$	—
C5	g/(m²·a)	$650 < r_{corr} \leq 1\,500$	$30 < r_{corr} \leq 60$	$25 < r_{corr} \leq 50$	$5 < r_{corr} \leq 10$
	µm/a	$80 < r_{corr} \leq 200$	$4,2 < r_{corr} \leq 8,4$	$2,8 < r_{corr} \leq 5,6$	—
CX	g/(m²·a)	$1\,500 < r_{corr} \leq 5\,500$	$60 < r_{corr} \leq 180$	$50 < r_{corr} \leq 90$	$r_{corr} > 10$
	µm/a	$200 < r_{corr} \leq 700$	$8,4 < r_{corr} \leq 25$	$5,6 < r_{corr} \leq 10$	—

NOTE 1 The classification criterion is based on the methods of determination of corrosion rates of standard specimens for the evaluation of corrosivity (see ISO 9226).

NOTE 2 The corrosion rates, expressed in grams per square metre per year [g/(m²·a)], are recalculated in micrometres per year (µm/a) and rounded.

NOTE 3 The standard metallic materials are characterized in ISO 9226.

NOTE 4 Aluminium experiences uniform and localized corrosion. The corrosion rates shown in this table are calculated as uniform corrosion. Maximum pit depth or number of pits can be a better indicator of potential damage. It depends on the final application. Uniform corrosion and localized corrosion cannot be evaluated after the first year of exposure due to passivation effects and decreasing corrosion rates.

NOTE 5 Corrosion rates exceeding the upper limits in category C5 are considered extreme. Corrosivity category CX refers to specific marine and marine/industrial environments (see Annex C).

Figure 8- Extract from ISO-9223:2012

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12 Can I, as customer, supply with my own solar panels?

Of course. We just need to know the panel for the feasibility study (or at least a similar one). For the design stage we will sign a contract in which one of the most critical parts will be to determine the solar module.

13 How can I follow the plant's performance?

You will be supplied with a very easy software to see the energy production, weather parameters related with the plant, such as wind or temperature, and maintenance updates. We just need a router near the plant (around 10km or 6miles) to which we will connect our transceiver from the plant by LoRa® communication procedures.

14 What is the maintenance about?

Maintenance can be made by Yada' staff or by customer, by written agreement in the contract. Below, a summary of the main actions during a year can be seen.

	Annual frequency	Inspection when critical whether
Fasteners inspection	**1**	**YES**
Mooring Inspection	**2**	**YES**
General cleaning	**2**	
Corrosion inspection	**1**	
Cables Status	**1**	
Modules Status	**1**	**YES**
Inverters and protective devices inspection	**1**	
Energy meters inspection	**1**	
Combiner boxes inspection (IP and functioning)	**1**	**YES**
Earthing system inspection	**1**	**YES**

Table 2- Maintenance summary

15 How much is the difference between a ground solar system and a floating one in terms of energy production?

Yada has made real tests to reach the following conclusion: floating systems can get, at least, 5% more energy than those in ground. Below a table with more tests claiming the same values or even better is shown.

Author	Title	MIN GAIN FPV(%)	MAX GAIN FPV(%)
Choi, Lee, et al. 2013	**Empirical research on the efficiency of floating PV systems compared with overland PV systems.**	**10,3**	**13,5**

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Liu, Wang, et al. 2017	**Power generation efficiency and prospects of floating photovoltaic systems.**	**1,58**	**2**
Azmi, Othman, et al. 2013	**Study on electrical power output of floating photovoltaic and conventional photovoltaic**	**2,82**	**14,58**
Majid, Ruslan, et al. 2014	**Study on performance of 80W floating panel**	**5,93**	**15,5**
Kamuyu, Lim, et al. 2018	**Prediction model of PV module temperature for power performance of FPV**	**14,69**	**-**
Rosa-clot, Tina, et al. 2017	**Submerged and floating photovoltaic systems: modelling, design and case studies.**	**10**	**-**
Trapani, Santafé et al. 2015	**A review of floating photovoltaic installations 2007-2013**	**20**	**25**
Yadav and Gupta. 2016	**Energy assessment of floating photovoltaic system.**	**0,79**	**-**
Lee, Joo, et al. 2014	**Design and installation of floating type photovoltaic energy generation system using frp members**	**0,6**	**1,8**

Table 3- Examples of studies on the differences between FPV & GPV in terms of energy production

Compared to ground-mounted parks, the big advantage is that no agricultural land is used, and the parks do not conflict with food production. Of course, the chance to cool-down the solar modules is definitive for their performance.

16 What is the auto-cleaning system about?

Many times, we see huge solar plants, called "renewable plants", being cleaned by a tractor (gasoil) with a water tank... in the desert! Is this renewable? Every time the tractor ends the task, they need to start again, if the plant is big.

What we offer is an integrated system with "tube pumps" and an irrigation system that will clean the panel using the water from the reservoir. Obviously, the dirt is going to the water. But it would have been the same if there were no solar plant, as the dust from the air will touch the water anyway. There are no new components going to the water. We have a sprinkler, patent pending, which forces the water to the panel with pressure enough to clean the main dirt. This procedure can be adjusted depending on the season, the climate and the customers' needs through the software.

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Some interesting bibliography

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http://www.epa.gov/ogwdw000/consumer/2ndstandards.html.

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http://www.epa.gov/SAFEWATER/disinfection/tcr/pdfs/whitepaper_tcr_permation-leaching.pdf.

- "Submerged and floating photovoltaic systems. Modelling, design and case studies". *Marco Rosa-Clot et al.*
- "Floating photovoltaic plants: Ecological impacts versus hydropower operation flexibility". Jannik Haas et al. Energy Conversion and Management. Volume 206, 15 February 2020, 112414.

https://www.sciencedirect.com/science/article/abs/pii/S0196890419314219?via%3Dihub

- National Sanitation Foundation. Standards 60 and 61.
- European Commision: study on ZincOxide.

http://ec.europa.eu/health/ph_risk/committees/sccp/documents/out222_en.pdf

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