

# Preventive Measures against smear from seabird droppings on PV panels

Japan Coast Guard

## 1. Introduction

A number of aids to navigation have been using solar power as a power source in recent years, and smear from seabird droppings on PV panels not only reduces the effectiveness during the daytime but influences nighttime signaling functions caused by insufficient charge from PV panels.

We came out with various countermeasures in order to establish preventive methods against smear from seabird droppings, and conducted on site test analysis for a year and a half.

## 2. Analysis methods and evaluations

The countermeasures described in Material 1. were tested for 239 aids to navigation (mainly buoys and Resident buoys), which were heavily smeared by seabird droppings.

And the comparison of the smear before and after the tests is as follows:



Lighted buoy



Resident buoy

### (1) The countermeasures against smear caused by seabirds perching on PV panels.

“(a) Pyramidal metal attachments“ and “(c) Standard bird control metal attachments” are effective as countermeasures against smear caused by seabirds perching on PV panels. And the combination of these two, “A-3 pyramidal type and standard bird control (20W model) type” is the most effective countermeasure.

The pyramidal metal attachments for both 20W and 50W are expensive, but considering that they are durable, reusable and easy to install, they are the most effective countermeasures.

“(b) Standard bird control metal attachments with strings of wire or synthetic fiber, etc.” have reasonable prices, since they are only for the cost of standard bird control metal attachments plus wire. But many incidents are reported of the devices being knocked down by seabirds, which indicates insufficient effectiveness against large seabirds, etc. The installation method for wires needs to be fully and sufficiently planned out.

## **(2) The countermeasures against smear caused by birds perching on nearby PV panels.**

### ① Countermeasures to take for topmarks

“(f) Metal strings such as wires, etc.” are installed mainly as a countermeasure to protect topmarks, and it is proved to be effective.

But some seabirds were observed to perch between metal spikes on the topmarks despite installed metal attachments, thus these metal spikes need to be modified, or other measures, such as commercially available plastic attachments, should be considered.

### ② Countermeasures to take for topmark spars and handrails/protection frames

“(d) Commercially available plastic attachments” is the most effective countermeasure to take for topmark spars and handrails/protection frames. This is the most effective countermeasure considering ease of installation and a durability of 5 years.

“(e) Fastening attachments” is an effective countermeasure for protecting handrails and frames against birds perching on nearby PV panels. It is cheaper than commercially available plastic attachments and some of them have a durability and weather resistance of 10 years.

But they need to be installed in large amounts without big gaps in between to be effective, which requires extensive labor. Thus “(d) Commercially available plastic attachments” is the way to go.

## **(3) Countermeasures to take using installation methods for PV panels**

### ① Resident buoys

Perpendicular installation of PV panels for resident buoys is the most effective countermeasure for preventing smear caused by bird droppings and dust, etc. Resident buoys are exposed to enough solar radiation because of a small amount of rotational motion and pitching/rolling of the Resident buoys. But reduction of power generations from perpendicular installation of PV panels is not avoidable compared to level installation due to the change of angle of sun light incidence. Installation of extra panels and battery capacity needs to be considered for each mark in order to obtain necessary power generations.

Some Resident buoys do not have enough space for extra PV panels, depending on the shape. Countermeasures (1) or (2) will be implemented to prevent smear in such cases.

### ② Lighthouses and Offshore fixed lights

Perpendicular installation of PV panels for lighthouses and Offshore fixed lights, as well as Resident buoys, are considered to be the most effective countermeasures for preventing smear. Perpendicular installation of PV panels for lighthouses and Offshore fixed lights will be considered, but if that is difficult, countermeasure (1) or countermeasure (2) will be taken.

### ③ Lighted buoys

Lighted buoys are exposed to a large amount of rotational motion and pitching/rolling, which causes variability of the necessary insolation to generate sufficient electricity. Perpendicular installation of PV panels is not a choice in this case. The countermeasure of (1) or (2) will be implemented to prevent smear.

## 3. Conclusions

According to the results (see Material 2) based on the effectiveness proved by onsite test analysis and factors such as cost and durability, etc., We decided to implement the following countermeasures for aids to navigation that are heavily smeared with seabird droppings:

### (1) Lighted buoys

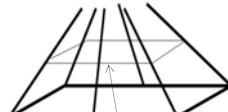
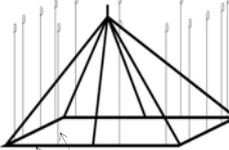
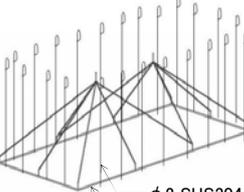
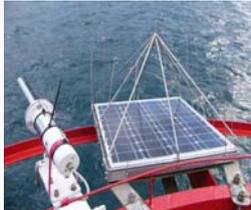
- (a) Combination of “Pyramidal metal attachments “ and “Standard bird control metal attachments” for PV panels.
- (b) “Metal strings such as wires, etc.” for topmarks.
- (c) “Commercially available plastic attachments” for topmark spars and handrails/protection frames.

### (2) Resident buoys, lighthouses and Offshore fixed lights

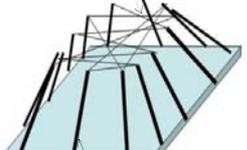
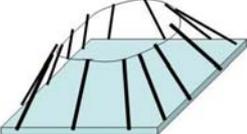
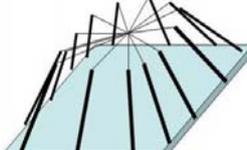
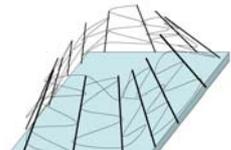
- (a) Perpendicular installation of PV panels. If it is difficult to do so because of insufficient space for additional PV panels, etc., the above mentioned countermeasure “(a)” will be implemented.
- (b) “Metal strings such as wires, etc.” for topmarks.
- (c) “Commercially available plastic attachments” for prop of topmark and handrails/protection frames.

(1) The countermeasures against smear caused by birds perching on PV panels

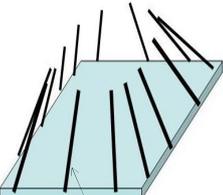
(a) Pyramidal metal attachments

A-1	A-2	A-3 (20W model)	A-4 (50W model)
 <p>— <math>\phi 5</math> SUS304</p>	 <p>— <math>\phi 1.6</math> SUS304 — <math>\phi 5</math> SUS304</p>	 <p>— <math>\phi 2</math> SUS304 — <math>\phi 5</math> SUS304</p>	 <p>— <math>\phi 2</math> SUS304 — <math>\phi 5</math> SUS304</p>
			

(b) Standard bird control metal attachments with strings of wire or synthetic fiber, etc

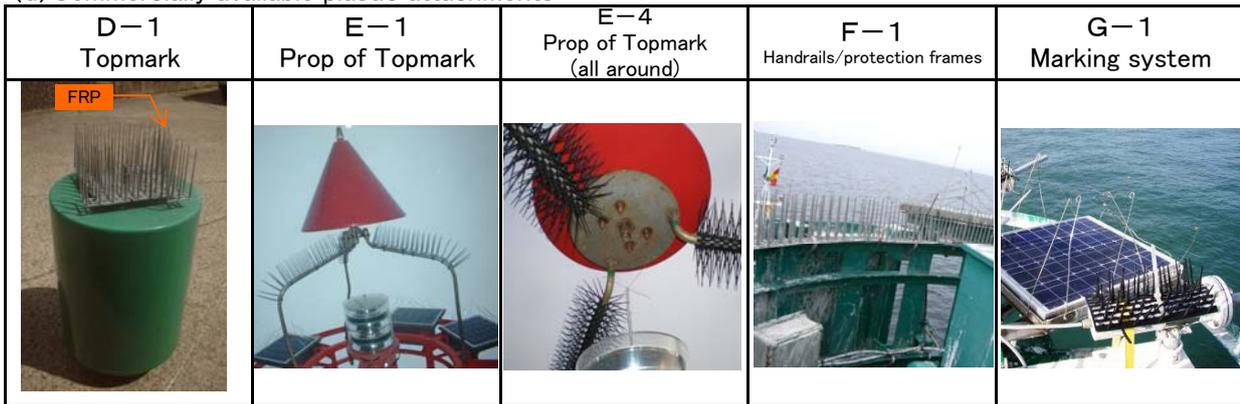
B-1	B-2	B-3	B-4
<p>wire, synthetic fiber</p>  <p>— <math>\phi 2</math> SUS304</p>			
			

(c) Standard bird control metal attachments

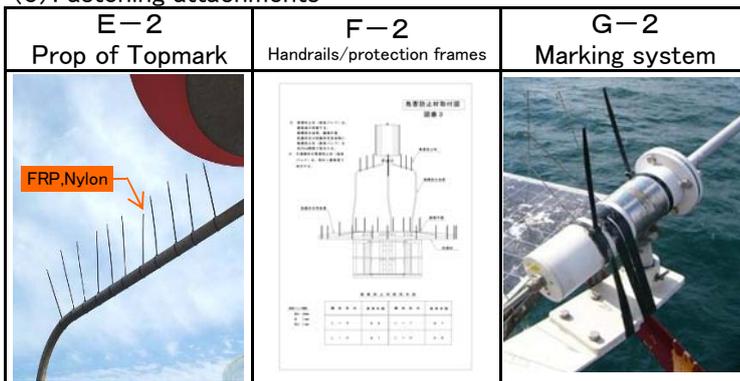
C-1 (10W model)	C-2	C-3
<p><math>\phi 1</math> SUS304</p> 	 <p>— <math>\phi 2</math> SUS304</p>	
		

(2) The countermeasures against smear caused by birds perching on nearby PV panels.

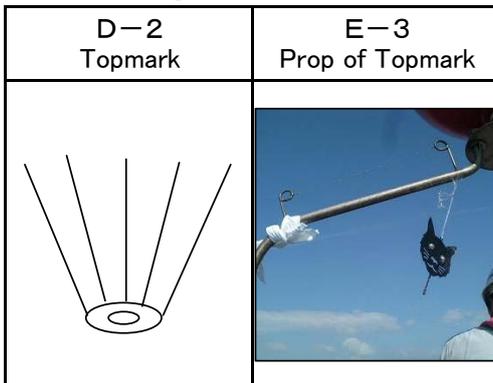
(d) Commercially available plastic attachments



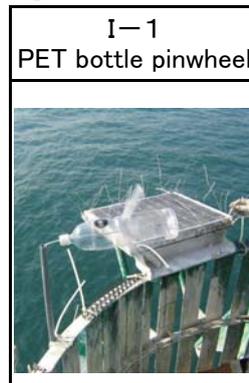
(e) Fastening attachments



(f) Metal strings such as wires

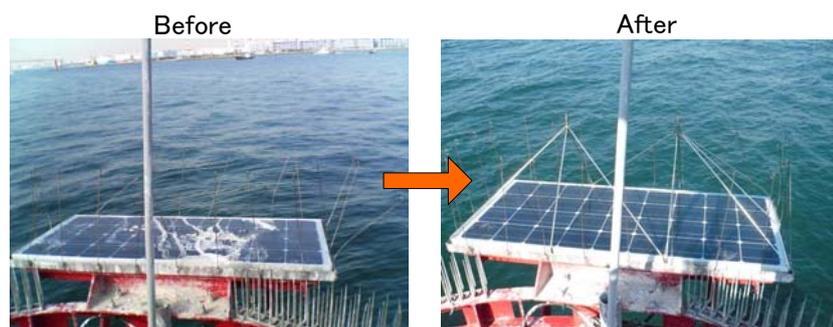
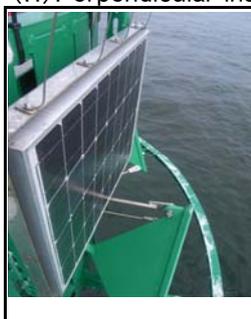


(g) etc.



(3) Countermeasures to take using installation methods for PV panels

(h) Perpendicular installation of PV panels



# Results based on the effectiveness proved by onsite experiment analysis and factors

Countermeasures	Installation place	Type	Number of installations	Effectiveness(※)			Cost	Durability	Recycling	Difficulty	Evaluation	備考	
				Effective	A little Effective	Ineffective	○ : cheap × : Expensive	◎ : Best ○ : Good △ : Normal	○ : Possible △ : A little possible × :	○ : Easy △ : Normal × : Difficult	○ : Adoption × : No adoption		
Countermeasures against smear caused by birds perching on PV panels	Pyramidal metal attachments	A 1	7	86%	0%	14%	×	◎	○	○	×		
		A 2	5	100%	0%	0%	×	◎	○	○	×		
		A 3	51	100%	0%	0%	×	◎	○	○	○	* This result has reliability because the execution part is more than A-1 and A-2. * the initial cost is expensive. But it will be recycle because the durability is high.	
		A 4	3	0%	67%	33%	×	◎	○	○	○	* It was not effective in each execution part. * Some birds may stays easily because the panel for 50W is wide * It seems that the effect can be expected by simultaneous using the steps Torjo disregarding of A-2.	
	Standard bird control metal attachments with strings of wire	PV panels	B 1	41	54%	2%	44%	○	△	△	△	×	
			B 2	14	100%	-	-	○	△	△	△	×	The standard bird control metal attachments seems to be ineffective for large seabird because there were a lot of cases that the standard bird control metal attachments is knocked down.
			B 3	5	100%	-	-	○	△	△	△	×	The type of B-2, B-4 was more effective than the type of B-1, B-3.
			B 4	13	84%	8%	8%	○	△	△	△	×	
	Standard bird control metal attachments	C 1	1	100%	-	-	○	△	△	○	×	The standard bird control metal attachments seems to be ineffective for large seabird because there were a lot of cases that the standard bird control metal attachments is knocked down.	
		C 2	43	90%	5%	5%	○	△	△	○	×		
C 3		1	100%	-	-	○	△	△	○	×			
Countermeasures against smear caused by birds perching on nearby PV panels	Commercially available plastic attachments	Prop of Topmark	E 1	19	100%	-	-	△	○	×	○	The life of the commercially available plastic attachments are about five years.	
		Prop of Topmark (all around)	E 4	13	92%	-	8%	△	○	×	○	×	The type of E-1is very effective without all surroundings.
		Handrails/protection frames	F 1	10	60%	20%	20%	△	○	×	○		
	Fastening attachments	Marking system	G 1	1	100%	-	-	△	○	×	○	×	
		Prop of Topmark	E 2	8	100%	-	-	○	○	×	×	×	This type was effective equal with the standard bird control metal attachments. It is necessary to narrow the installation interval to achieve an effect and time is required though some is cheap compared with the the commercially available plastic attachments.
		Handrails/protection frames	F 2	25	96%	-	4%	○	○	×	×	×	
	Metal strings such as wires	Marking system	G 2	9	67%	33%	-	○	○	×	○	×	
		Topmark	D 2	139	76%	7%	17%	○	△	△	○	○	
etc.	Prop of Topmark	E 3	35	91%	9%	-	○	△	△	○	○		
	PET bottle pinwheel	I 1	3	67%	-	33%	○	△	×	×	×	A lot of work	
Countermeasures to take using installation methods for PV panels	Perpendicular installation of PV panels	Landing	-	5	100%	-	-	○	-	○	○	This is limited when there is space that can increase the amount of power generation and the PV	

※ Effective :No dropping  
A little Effective :Reduction in comparison with the past  
Ineffective :No change in comparison with the past