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MADRAS RECORD OFFICE.

Government of Madras.

Public Works DEPARTMENT.

G.O. No.	747	Press
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Dated	21-11-18	

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GOVERNMENT OF MADRAS.

PUBLIC WORKS DEPARTMENT.

21st November 1877, No. 1,749 W.

Buildings and Roads.

Civil Works.

Read the following paper :—

No. 194. From the Government of India, Public Works Department, (Civil Works—Miscellaneous,) dated Simla, 7th November 1877, Circular No. 66, P. W.

In continuation of Circular No. 73 P. W., dated 30th October 1876, the undersigned is directed to forward for information the papers marginally noted on the subject of lightning conductors in connection with lighthouses.

(Signed) G. T. SKIPWITH, Captain, R.E.,
Assist. Secy. to the Govt. of India.

To the Secretary to the Government of Madras, Public Works Department, General Branch.

Despatch from the Secretary of State for India, to the Secretary to the Government of India, dated 13th September 1877, No. 42.

I ENCLOSE for Your Excellency's information copies of a letter and of a report that I have received from the Engineer to the Commissioners of Northern Lighthouses, on the subject of the systems of lightning conductors for lighthouses in use in this country.

2. The question is one of considerable importance, and the suggestions made by Messrs. Stevenson may be useful to the officers charged with the construction and the custody of lighthouses in India.

From Messrs. D. and T. STEVENSON, to the Director-General of Stores, dated 21st August 1877.

In consequence of Skerryvore Lighthouse having suffered damage by being struck by lightning, the Commissioners of Northern Lighthouses have caused inquiry to be made as to the means of protection used at their several stations. They also, at our suggestion, consulted Professor Tait who made a joint report along with us on the subject of protecting lighthouse buildings generally. That report has been communicated to the English and Irish Lighthouse authorities, and the result has been that various alterations are being introduced for the better protection of some of the lighthouse towers.

In these circumstances, it occurs to us to suggest that possibly some inquiry ought to be made as to the means of protection employed at the lighthouses under the care of the Indian Government, and we enclose for your information a copy of the joint report of Professor Tait and ourselves made to the Northern Lighthouse Board which we hope may prove useful.

Report by Messrs. D. and T. STEVENSON, Engineers to the Board, on the lightning conductors at the Northern Lighthouse stations.

In consequence of the severe lightning stroke with which Skerryvore Lighthouse was visited on 2nd February 1876, occasioning considerable damage to the internal fittings of the lighthouse and the destruction of the entrance door, we suggested to the Commissioners in our letter of 12th February 1876 the propriety of consulting Professor Tait on the general question of protecting the lighthouse towers against the effects of lightning.

We accordingly put ourselves in communication with Professor Tait, and, in order that he might judge of the precautions hitherto employed, it was considered necessary that he should inspect some of the stations on the west coast. In making that inspection we had the

advantage of Professor Tait's verbal suggestions, and, although the weather did not admit of a "landing" being made at Skerryvore, Professor Tait had the opportunity of examining for himself the lightning protections adopted to suit the varied circumstances of land and rock stations.

We think we shall best bring the subject before the Commissioners by giving—

First.—The documents submitted to Professor Tait for his consideration with his replies.

Second.—Our recommendations as to what we consider the Commissioners ought to do in carrying Professor Tait's views into practice.

I.—Documents submitted to Professor Tait and his replies.

No. 1.

Memorandum dated 14th March 1876, by Messrs. D. and T. STEVENSON, of points on which Professor Tait's opinion is requested in connection with the lightning conductors in the Northern Lighthouses.

Land Stations.

In land stations where there is no necessity for having smoke-tubes in the towers, the construction generally adopted is to have a pointed conductor rising above the dome of the lantern passing down the outside of the lantern and metallically connected with it, and thereafter passing down the outside of the tower to which it is fixed by short copper bats and terminating in plates of copper buried in the earth at a convenient place, not far from the base of the tower. See specimen sent herewith.

Does Professor Tait consider that a satisfactory arrangement, if properly carried out?

2. In some of the towers the lightning rod is not carried up to the top of the dome, but, in accordance with Professor Faraday's recommendation, terminates at the sole-plates of the lantern. The joinings of the several pieces of which the lantern is composed must, in order to prevent leakage, be bedded with a thin coating of putty or other similar cement, so that metallic connection of the parts is in some degree broken.

In such a case would Professor Tait consider attaching the rod to the sole-plate a sufficient protection? And in all cases where there is such an arrangement, would it be better to carry the rod to the top of the dome as in the manner described in No. 1?

Rock Stations.

3. In rock stations it is necessary to have smoke-tubes passing through the dome. In the most recently erected rock lighthouse towers, the conductor has been carried above the dome terminating in a point raised above the smoke-tube as shown in the tracing.

Does Professor Tait consider this a proper arrangement?

4. In the case of Skerryvore the accident at which place has led to this inquiry, the conductor terminates at the sole-plate of the lantern, and is not carried up to the dome.

Would Professor Tait regard it as a satisfactory protection, if the conductor at Skerryvore were now carried up in the manner referred to in No. 3?

5. The idea acted on has been that in all rock stations the conductor should, where practicable, be connected with plates similar to those noted in No. 1, immersed in the sea.

If this can be done and maintained, does Professor Tait think it a satisfactory arrangement?

6. It has been found at some stations difficult, and at others impossible, to maintain these low-water connections in consequence of the violence of the sea. In short at exposed situations it cannot reliably or satisfactorily be done.

Could Professor Tait suggest any other design to overcome this difficulty?

7. Does Professor Tait think the platinum point, as described in the drawings, is a satisfactory manner of terminating the conductor?

No. 2.

Opinion of Professor P. G. Tait, dated 10th March 1876, on points of memorandum.

In almost all respects—

I would observe however that the copper plates buried in the ground appear to be rather small.

Also that wherever a rod is jointed it should be thickly soldered as well as screwed together: unless there be special reasons against this, in which case it should occasionally be taken to pieces and carefully cleaned at the junction.

2. It would be advantageous to connect by stout copper straps the several pieces of the dome which are separated by layers of putty.

I think you have misapprehended Dr. Faraday's directions in so far as you do not speak of having points projecting from the dome (when the copper rod does not project above it), while it seems to me that he expressly provides for such a point in the words: "That if the point on the vane be terminated as the lightning rods usually are, and then the metal of the lantern be strongly attached to, and connected with, the upper end of the copper rod such a system will be an effectual lightning conductor."

(N.B.—I cannot quite understand some parts of Dr. Faraday's report; because certain terms are employed in it which describe some (evidently nonsensical) adjuncts which he ordered to be removed; and, as these are not fully described, it does not appear quite clear what would be left when they were removed.)

There can be no doubt, however, that as the object of a lightning rod is not merely to prevent injury to a building, but even to prevent its being "struck by lightning" at all, a point or points projecting from the metallic dome are necessary when the rod does not rise above it.

To carry the copper rod itself up the side of the dome is quite superfluous if the precautions just described are taken.

3. Certainly.

But the smoke-tubes must, like the metal of the dome and all large metallic masses in the building, be put in good electric connection with the copper rod. A point at the top of the smoke-tube may also be useful.

4. I would call it "necessary" unless points be attached to the metallic dome as suggested in (2) above; but I would not call it "satisfactory" until precautions (to be described in (5) and (6) below) are taken.

5. Again I would call it "necessary," but it cannot be "satisfactory" unless the plates are of sufficient size. Somewhat smaller plates will do in the sea than those required in earth. Even a 3 or 4-inch cast-iron pipe, of which 20 feet or so are always under water, will do.

6. This is the most difficult part of the inquiry. I do not see how the damage described could possibly have occurred at Skerryvore if the attachments were made as you have described them, and if the copper rod had been continuous and properly connected with the sea. For even though there may not have been direct metallic connection between the flue and the dome, they must have been in very close contiguity at their intersection.

Unless (5) be carried out (and the doing so is purely an Engineer's problem on which I offer no opinion), only very inadequate substitutes can be devised: except such as involve great expense, viz., making the whole erection of metal, or coating it with sheet metal, or at least surrounding it with a sort of cage of stout copper rods. Such devices would not prevent the buildings being "struck by lightning," but they would ensure its safety.

7. This is a matter of comparative indifference. The platinum is of little use except to prevent oxidation of the copper point. But a two or three-pronged fork might be better than a single point, inasmuch as if it were struck by a flash, it is improbable that all the points would be melted. Thus while a single point might be impaired in efficiency, a multiple point is very unlikely to be so impaired.

From Messrs. D. and T. STEVENSON, to the Secretary of the Board of Northern Lighthouses, dated 17th July 1876, No. 3.

DURING our late visit to the lighthouses with Professor Tait on the subject of thunder rods, we made certain suggestions which we think we should get authority to carry out at Skerryvore at once, and we have to request the Commissioners to give us authority to have this done by sending some one to Skerryvore with the necessary copper rod to form the connections suggested.

Instructions by Messrs. D. and T. STEVENSON, to Inspector, as to what is required at Skerryvore, dated 20th July 1876, No. 4.

TWENTY feet 5th inch rod wanted from sole of lantern to top of cowl, and about two feet above it to terminate in two points. This piece of rod to be metallically connected with astragals and cornice plate of lantern also with dome, and with top of lightning conductor.

Kitchen smoke-pipe to be metallically connected with copper dome by a copper strap, about 1½ inch broad and ¼ inch thick.

The store pipe and kitchen grate to be connected with conductor by a piece of copper wire-rope taken down inside of tower with top of ladder, and another piece connected with bottom of ladder and led round turret in the rock for this part of the rope which must be covered with cement.

The lightning rod terminates at present in a pool above low-water level. The end of it must be found and a piece of rod attached to it and led into the sea at nearest point, or into a pool in constant connection with it.

The stove on landing and its pipe to be removed entirely from the tower.

The iron tramways to be connected with rod by $\frac{1}{4}$ th inch rod: about 10 feet may be needed for this.

A piece of copper $\frac{1}{4}$ th inch rod, say 9 inches long with two points to be fixed to top of kitchen vent outside of dome.

The iron tanks inside of tower to be connected by copper clips to each other, and to wire-ropes inside of tower.

The bottom of machine case to be connected by $\frac{1}{4}$ th inch copper rod with the smoke pipe: about 6 feet will be needed for this. About 20 lbs. solder to be taken and say 6 screwed ends 4 inches long of $\frac{1}{4}$ th inch diameter for coupling wire rope, right and left screws, also coupling boxes for ditto; some copper rod for rivets and $\frac{1}{4}$ th inch screws for fixing rod, &c., to lantern and dome; sheet copper to close hole of stove-pipe in dome.

From Messrs. D. and T. STEVENSON, to Professor P. G. TAIT, dated 23th September 1876, No. 5.

ACTING on your verbal recommendations as conveyed during our cruise, we advised the Commissioners at once to give us authority to make the several protective arrangements at Skerryvore, which we described in the enclosed directions given to the Inspector who was entrusted with carrying them out. These have been done, and the same arrangements so far as applicable are now being done at Dhu Heartach, and we hope you will find that they carry out your views.

Now that the working season has commenced, we shall be glad to get (quite at your leisure) a report under the remit made by the Commissioners as to the precautions they should endeavour to carry out at their land and rock stations so far as the peculiarities of situation render it reasonably practicable to do so. We see Clerk Maxwell has had the subject before the British Association.

From Professor P. G. TAIT, to Messrs. D. and T. STEVENSON, dated 16th January 1877, No. 6.

IN accordance with the wish expressed in your letter of 23th September 1876, I now make the following remarks in addition to the "opinion and points of memorandum" sent you 16th March 1876:—

First.—The arrangements you describe as having been carried out at Skerryvore seem to me to be in all respects but one amply sufficient, in some respects even excessive.

The defect I allude to has reference to the lower end of the lightning rod, where it is led to "earth." You say merely "a piece of rod attached to it and led into the sea," without saying what is to be the diameter of the rod, or what length of it is to be immersed. In my report in answer to your query 5, I said "even a 3 or 4-inch cast-iron pipe, of which 20 feet or so are always under water, will do." So long as a good "earth" like this is not provided, the tower is liable to be "struck by lightning" as it is called: and, though the precautions already taken will prevent damage, they will not necessarily prevent the occurrence of phenomena which may alarm the lightkeepers. As I said before, however the mode of making a lasting sea-connection (which is all that remains to be done) is entirely an Engineer's problem.

As we were unable to land at Skerryvore last summer, I cannot assign from personal observation, the probable cause of the accident: but from what I saw at Dhu Heartach, and from what you tell me as to the detached pool in which the conductor at Skerryvore formerly terminated, I think it certain that the copper stove-pipe and the ladder (though not metallurgically connected) formed parts of a path from the top of the tower to the sea in which the resistance was less than in that of which the lightning rod formed part. Had the ladder and stove-pipe been properly connected (as they now are), if of the tower to the sea in which the would have been done inside the building; though the rod formed part. Had the ladder and been a disruptive one. Until there is proper connection, it is probable that no damage whatever discharges will be always possible. But, in its present condition, the tower is virtually protected by a process resembling that alluded to in my report on made with the sea, such disruptive suggested by Dr. Faraday's investigations which was under query 6. It is this process, Maxwell at the recent meeting of the British Association.

Second.—The "repeller" which I have lately seen (understand) recommended by Clerk Maxwell at the recent meeting of the British Association, and which you inform me was taken from a lighthouse in the Isle of Man, which was transferred to the custody of the Commissioners

of Northern Lighthouses in 1859, fully deserves the epithet which I conjectured to be applicable to it, and which I gave to it in my answer to query 2.

Third.—My visits to several land and rock stations last summer have not led me to alter in any respect the statements made in my report; but the inspection of the localities has suggested one or two additions, which I now give in order.

Query 1.—Where the lighthouse though called a land station is (like that at Sanna off Cantyre) built on the top of a rock, and especially when part of the building is led down the side of the rock in the ground. I do not consider that a sufficient "earth" is afforded by copper plates buried in the scanty soil on the top of the rock. These should be removed, and the copper rod or rope led down to the ground and properly connected with it, or (still better) with the sea.

Query 2.—I noticed the almost entire absence of points on the domes of the lighthouses I examined. On this point I strongly press my former answer. Such points can be easily screwed into the metal, they cannot possibly do harm, and they may be of great use.

Queries 3—7.—I have nothing to add to my former answers, except what has been given incidentally at the beginning of this letter.

II.—Recommendations in consequence of foregoing opinions by Professor Tait.

Acting on the recommendations of Professor Tait as set forth in the foregoing opinions and as more fully explained verbally in the interviews we have had with him, we have, by the directions of the Commissioners, carried out the connections requisite for protecting Skerryvore tower against such a visitation as that which occurred on 2nd February 1876, and as circumstances admitted of the same appliances being conveniently introduced at Dhu Heartach, the Commissioners considered it proper to order them to be carried out at that station also. The towers at the Bell Rock, Chickens, Whalsey, North Vast, Skerryvore, and Sanna will require special consideration, and will be afterwards reported on.

The invaluable services rendered by lighthouse towers, and the almost invariably isolated rocks, or islets, or prominent headlands, which they occupy, renders the best means of protecting them from lightning stroke a question of paramount importance in lighthouse management, and therefore we consider it unnecessary to add a single remark to enforce the importance of the subject of this report.

One point remains to be noticed, the difficulty of maintaining a "sea-connection" at exposed rock stations, having sufficient surface always under water, involves an engineering difficulty that has not been overcome. But as the precautions that have been taken at Skerryvore are such as will, in Professor Tait's opinion, "prevent damage," the consideration of a more perfectly satisfactory and lasting sea-connection may safely be delayed for the present, and will be dealt with in the report on rock towers to be afterwards submitted to the Commissioners.

EDINBURGH,
23rd January 1877.

D. and T. STEVENSON.

No. 195.

ORDER THEREON, 21st November 1877, No. 1,749 W.

COMMUNICATED to District Engineers for information and to the Marine Department.

(True Extract.)

Colonel, R.E.,
Secretary to Government, P.W.D.

To District Engineers.
To the Consulting Architect.
,, Marine Department.

Exd. E. C. Shunker.
Spare Copies

Enclosure to Circular No. 66 Public Works of 1877.

No. 42, dated 13th September 1877.

From—The Secretary of State for India,

To—The Government of India.

I enclose for Your Excellency's information copies of a letter and of a report that I have received from the Engineer to the Commissioners of Northern Lighthouses, on the subject of the systems of lightning conductors for lighthouses in use in this country.

2. The question is one of considerable importance, and the suggestions made by Messrs. Stevenson may be useful to the officers charged with the construction and the custody of lighthouses in India.

19-2-77 No 544

GOVERNMENT OF INDIA.

PUBLIC WORKS DEPARTMENT.

CIVIL WORKS.

Miscellaneous.

To

The Governments of Madras, Bombay, Bengal,
North-Western Provinces and Oudh, and
Punjab, in the Public Works Department,
General Branch.

The Chief Commissioners of Central Pro-
vinces, British Burmah, Mysore and Coorg,
and Assam.

The Resident at Hyderabad.

The Agents to the Governor General for Central
India and Rajpootana.

The Superintendent of Port Blair.

The Inspector General of Military Works.

The Principal, Thomason College.

The Revenue, Agriculture and Commerce De-
partment.

Circular No. 66 Public Works.

Dated SIMLA, November 7, 1877.

Received

13th Nov 1877
By Mr. B. K. ...
... 13th Nov 1877

For information
and to the Marine
Dept.
20.11.77

Forwards for information papers on the subject
of lightning conductors in connection with light-
houses.

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To *Master Engineers*

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G. O., 21st Nov 1877, No. 17396

Nos. 194-195

Lightning Conductors in
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