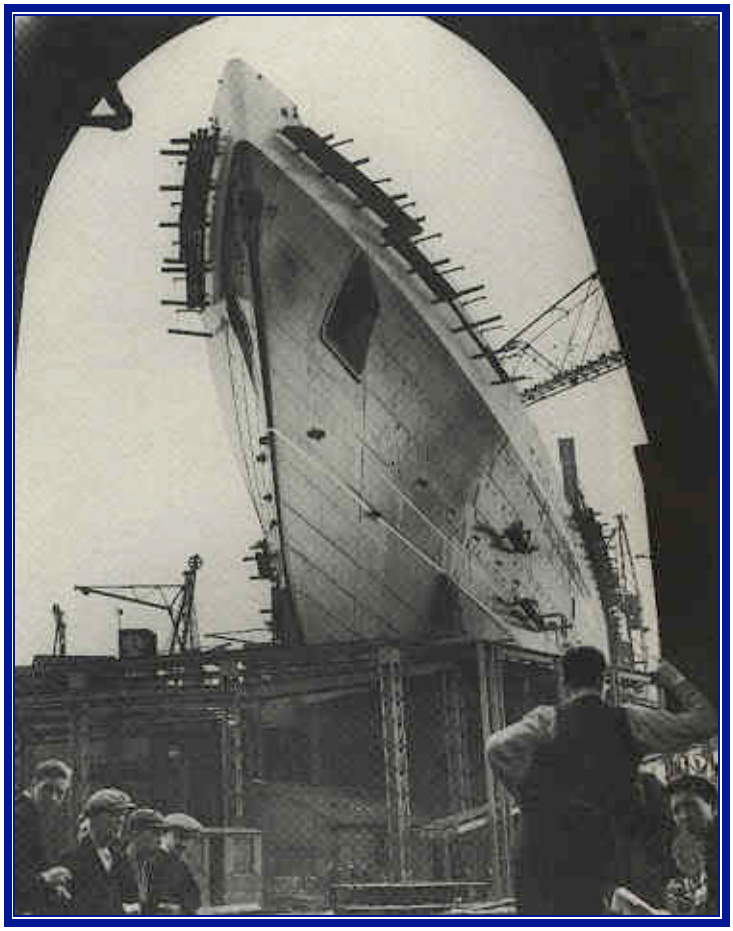
MARINE AIR CONDITIONING



R M S Queen Elizabeth

Tests on refrigeration plant, March 1939

Report by Carrier Engineering Company

00362

TEST DOPE (36)

2

WFS/HC
R.AC. 5806.

9th March 1939.

MARINE DEPARTMENT

S.S. "QUEEN ELIZABETH" - REFRIGERATION MACHINERY

TEST SET UP AT MIRRLEES WATSON

Further to my report of the 3rd instant, I again visited Mirrlees Watson on the 7th and 8th instant.

7th MARCH.

TEST PROGRESS.

Their suggested remedy for the failure of the plant to perform the specified duty outlined in my previous report was not ready for trial.

DISCUSSION.

Our suggested method for obtaining the specified duty in so far as water surface in the flash chamber is concerned, was explained to Mr. Dexter, Mr. Nicholl and Mr. McNaught.

As these gentlemen were still of the opinion that the amendments they had introduced would overcome the trouble, I tried to get an understanding that should this not be so, then they would be agreeable to adopt at once our suggestion and in the meantime make all possible preparations.

I obtained a somewhat unwilling admission that they had no alternative. (Cost is the reason for their attitude.)

WATER NOZZLES.

I obtained possession of the nozzles by Korting Bros. in the afternoon, by which time I had ready made up the fittings for taking observations of the form of spray obtained.

Whilst waiting for the Korting nozzles, I made tests of nozzles which Mirrlees Watson had in stock, one of which looked promising but in spite of alteration could not be made to deliver a reasonable amount of water.

Observation of the Korting nozzles :-
(they supplied one each of 6, 7 and 8 mm.) at 7 lb/water pressure

6 mm.	nozzle passed	1.7 g.p.m.
7 mm.	" "	2.4 "
8 mm.	" "	3.95 "

I had the 8 mm. nozzle opened out to 8.75 mm. when 4.2 g.p.m. water was obtained without altering the type of spray appreciably.

Having in mind a discharge of 5 g.p.m. per nozzle as being reasonable (100 nozzles per section of flash chamber) the above figures are not conclusive. They also do not confirm the information given us by the makers.

The 6 and 7 mm. nozzles are as shewn on thiir Sk. No. 4310 and are exactly the same as each other except for the size of hole.

The 8 mm. nozzle is larger throughout and has not got the cup formation at the outlet shewn on their sketch.

The spray from the 6 and 7 mm. nozzles is very fine - part of it so fine that it floats off with the appearance of a vapour.

The spray from the 8 mm. nozzle is much coarser, consisting of drops of an estimated dia. of 1/32".

From all the nozzles, the first part of the spray is a cone of water film which breaks up into a whirling spray of fine drops at about 4" from the outlet of the nozzle.

I attach a sketch of the spray from the 8 mm. (opened out to 8.75 mm.) nozzle at varying pressures. The dimensions given can duly be regarded as approximate.

I formed the opinion finally that the nozzle nearest to our requirements would be one combining the characteristics of the two types of nozzles.

8th March

TEST PROGRESS.

Mirrlees Watson's amendments to the spray arrangements proved on test to show no ascertainable improvement, and I at once brought this to Mr. Dexter's attention.

DISCUSSION.

Mr. Dexter still did not show enthusiasm for our suggestion. He desired to have the holes in spray headers fitted with copper strips in the form of helices.

I got one made at once and demonstrated it on the spray "hook-up" and in my opinion the result was hopeless. This was finally agreed to by Mr. McNaught.

It was now late in the afternoon and I could not get hold of Mr. Dexter again.

After further talk with Mr. Nicholl, however, he gave me his assurance that they would at once proceed on the lines suggested by us and in detail as follows :-

(1) They will immediately get in touch with Korting Bros. and obtain from them 100 nozzles to pass each 5 g.p.m. at a pressure of 7 lb/sq. inch, the resulting spray being between that obtained by the 8 mm. size and the smaller ones.

(2) They will at once design the necessary internal headers to accommodate the nozzles.

(3) Avoiding all delays they will have the test re-erected on these lines and inform us immediately they are ready.

(4) It is estimated that they will again be ready for test in a week's time.

CHILLED WATER QUANTITY.

As mentioned in my previous report, this is measured by an Electroflo meter. I attach some of the maker's details for record, and would observe that the mercury column has considerable movement making accurate observation difficult.

URGENCY.

By all means I could use, I urged in and out of season the necessity for early completion of test.

All their material with the exception of the two air bends and the extraction pump was being shipped to J.B that day.

GENERALLY.

Upon enquiry I obtained the following figures for the capacity test on the compressor :-

Steam to flash chamber, 1300 lb/hour
Total heat of steam, 1200 B.T.U's/lb.
Pressure maintained in chamber, 6 mm.

I have asked that a mercury gauge be fitted to the chilled water inlet to the flash chamber.

I got Mr. Nicholl to check my calculation of the pressure of chilled water which will obtain on the ship, with which he agreed.

I made it clear in conversations with them that, although we think they would do well to try out our suggestions, the responsibility remains entirely with them to fulfil the specified duty of the plant.

When it was pointed out to them that they might at any time now be called upon to deliver to the Yard the material they are using for the test (which would entail still further expense to them and delay) the suggestion was made that the test could be completed on site. I told them this was entirely out of the question and I think this and other points should be confirmed to them in writing today.

W.F. SCOTT.

00363

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WFS/HC
R.AC. 5806.

3rd March 1939.

MARINE DEPARTMENT

S.S. "QUEEN ELIZABETH" - REFRIGERATION MACHINERY.

TEST SET-UP AT MIRRLEES WATSON
REPORT OF PRELIMINARY INSPECTION

I visited Mirrlees Watson's Works on the 2nd March 1939.

On arrival, I met Mr. Nicholl and Mr. McNaught.

TEST PROGRESS.

Mr. Nicholl explained the position as it stood at that moment :-

They were unable to obtain the specified results under the specified conditions.

Their most successful recorded trial was, water in to flash tank 49° F. Water out from flash tank 46° F. (See copy of their log attached to this report for other details)

CONCLUSIONS REACHED.

On the basis of the following test figures :-

Water in to flash tank 51.5° F Water out 48.5° F.
Pressure in flash tank 4 mm. Hg. = 30.5° F. (approx.)
Temperature difference between water out and vacuum = 18° F.(approx)
and
Water in to flash tank 49°F. Water out 46° F.
Pressure in flash tank 4 mm. Hg.= 30.5° F. (approx.)
Temperature difference between water out & vacuum = 15.5° F. (approx.)

and, the ejector was shown to be capable of dealing with the full volume of flash vapour evolved under specified conditions by the admission to the flash tank of steam when the pressure of 4 mm. Hg. was maintained, it was concluded that the cause of failure lay in the manner the water to be chilled passed through the flash chamber.

SUGGESTED REMEDY.

After discussion it was agreed that their suggested remedy should first be tried out.

The suggestion is that the chilled water inlet pipe should be taken down to a lower level in the flash tank (but not lower than 2' 0" from the bottom) and lead into two horizontal branch pipes.

These horizontal branch pipes to be cut so that the top part is open and this open part be covered with perforated steel sheet (1/8" dia. holes).

The object of this arrangement is to endeavour to obtain rising jets of water which by their rise and fall will offer a greater surface for evaporation, and by decreasing the size of the holes (1/8" dia. against 3/16" dia. at present in the spray headers) it is hoped to break up the jets into a finer spray than is supposed to obtain in the present arrangement.

It is further proposed that two similar perforated steel sheet longitudinal shelves shall be fitted horizontally to the sides of the tank in an endeavour to catch the jets and thus increase the surface offered.

All the above is subject to our approval.

(It was pointed out to them that this further unlooked for delay is bound to prove most disappointing to us and I got them started on the work of alteration immediately. They promise to write or wire us immediately they have tried the amendment and in any case not later than Wednesday next).

TEST SET UP.

This is substantially as shewn on their drawing No. P.D. 9118.C.

Variations are :-

1. Load steam tank is separate.
2. Flash tank is a shell 8' 0" inside dia. x 8' 6" long between plates.

3. Chilled water quantity is measured by an orifice device manufactured by Electroflo Meter Co. Ltd. Abbey Road, Park Royal and stated to be correct to within 0.1%.

4. Condensate measurement is by an orifice device which they use as a standard. (I obtained a print of this giving details of construction and calculation. It is attached).

It will not be difficult to use calibrated tanks for condensate measurement if confidence cannot be placed in their apparatus.

5. A dry air pump is used for the condenser. The reason given is that they have no ejector air pump of suitable capacity.

6. A condensate level gauge has been added to the condenser.

The thermometers for which we asked are all supplied together with the special fittings for which we also asked.

I took with me our own test thermometers and they have been left in their care to await the final tests.

The condenser circulating water is cooled by sprays in conjunction with galvanised corrugated flooring. It is not fully capable of the duty and is augmented by mains water.

Generally, although "rough and ready" in parts, I do not think objection will be taken to the way they have made up and assembled the test.

EJECTOR NOZZLES.

They have carried out a considerable number of tests involving some five different designs of nozzles (Muntz metal) and these combined with varying positions, both circumferentially and radially in the steam chest and vertically in the vapour inlet box and in varying numbers undoubtedly account for much time.

They have reached their final design, however, and I obtained a drawing of it which is attached. (Their Drg. No. C 20403.) The nozzle to be used is marked (1) on the drawing and its position in the air inlet box is central and 15" from the joint face of the nozzle plate to the nozzle exit. (One nozzle only will be used).

The nozzle plate will be altered in design having a circular depression on the steam inlet side presumably to give a better steam approach to the nozzle. (The 15" dimension given above includes for this circular chamber).

The drawing referred to will give some idea of the tests they have carried out in connection with the nozzles.

GENERALLY.

Mirrlees Watson are most anxious to complete the tests, as apart from cost, the gear occupies almost the whole of their pump test bed.

I saw Mr. Dexter and discussed some of the matters outlined above.

As it was obvious that no further progress could be made with the test, and also I considered it advisable to report the failure of the test as soon as possible, I returned from Glasgow the same night.

COPY OF MIRRLEES WATSON LOG.

VACUUM REFRIGERATING PLANT

VAPOUR COMPRESSOR.

Pressure in flash chamber	4 mm. =	29.843" Hg.
" " condenser	48 mm. =	28.11" Hg.
" at Steam nozzle	185 lb/sq. in. gauge.	Dry saturated.

CONDENSER.

Circulating Water	445 g.p.m.
" " inlet temp.	71° F.
" " outlet "	89.9° F.
Condensate Quantity	4810 lb/hour
" outlet temp.	87° F.
Vapour inlet temperature from diffuser	130° F.

LOAD TANK.

Quantity	470 g.p.m.
Flash chamber outlet	46° F.
" " inlet	49° F.
Load steam pressure	130 lb/sq. in.
Load steam	942 lb/hour.