PANAIR LABORATORY, INC.

QUALITY CONTROL

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DATE: May 19, 1981

REPORT NO.: 291M

CLIENT: Mr. Svenn Dahl, Vice-President Operations
Norwegian Caribbean Cruise Line

SUBJECT: Boiler failure. Panair Lab. No. 7241W through 7250W
SHIP: S.S. Norway
LOCATION: Port of Miami

INTRODUCTION: Four one-quart samples of water were delivered to Panair Laboratory by Mr. Svein Kruse of NCCL at approximately 10 A.M. on May 6, 1981. A three-foot section of boiler tubing was delivered at the same time. Mr. Kruse stated that at the time of boiler failure a strong odor of ammonia prevailed.

Two of the boiler water samples showed the presence of acid. Mr. Kruse stated that sulfamic acid had been used to clean the evaporators. Sulfamic acid can give off ammonia gas when decomposed by heat, consequently this would account for the ammonia odor that prevailed when the boiler tubes failed.

Mr. Kruse phoned Mr. Svenn Dahl of NCCL and reported the information he had obtained from Panair Lab up to that time. A visit to the ship by a Panair chemist for consultation and conference was scheduled by Mr. Dahl and Mr. Kruse for later in the day.

The boiler tube was cut into sections at Panair. Preliminary visual examination of the sections showed need for a thorough examination by a qualified metallurgical laboratory. The sections were taken by Mr. Kruse and Mr. Ray Williams of Panair Laboratory to Q. C. Metallurgical Laboratory in Hollywood, Florida. Their report will be issued separately.

Mr. Kruse and Mr. Williams, Chief Chemist, Panair, arrived at the Port of Miami at approximately 2 PM. Four more samples of water were taken on board ship between approximately 2:30 PM and 6 PM May 6. The samples were tested and reported verbally at 9:15 AM May 7. Two additional samples were delivered to Panair by Mr. Kruse later in the morning of May 7. The results were reported verbally a short time after receipt of the samples.

Possible corrosion of non-ferrous components by the acid was investigated by determining copper and zinc on the first boiler water samples to arrive at Panair Laboratory. The copper and zinc found is shown in the table of results. The values are low and indicate very little acid attack on any copper and/or brass surfaces in contact with the acid.

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CONCLUSION: A chemical compound known as SAFE made by Drew Chemical Corporation was reported by Mr. Kruse to have been used as a solution in water to clean scale off of the evaporator tubes. The main ingredient in SAFE is understood to be sulfamic acid. It is believed that sufficient heat was available to cause the following chemical reactions:

NH_2SO_3H	+	H_2O	=	NH_3	+	H_2SO_4
Sulfamic Acid		Water		Ammonia Gas		Sulfuric Acid
H_2SO_4	+	Fe	=	H_2	+	$FeSO_4$
Sulfuric Acid		Iron (boiler tube)		Hydrogen Gas		Iron Sulfate

Theoretically, the sulfamic acid split or broke down giving off gaseous ammonia. The sulfuric acid as well as any unsplit sulfamic acid which may have been present was carried into the boiler where it acted upon the boiler tubes. The presence of the acids in the water circulating through the tubes accounts for the low pH values reported below:

TABLE OF RESULTS

Panair Lab No.	Date Sampled	Date Rec'd. at Panair	Date Tested	Identification of Source	Copper PPM	Zinc PPM	pH
7241W	5/6/81	5/6/81	5/6/81	Ameret tank (1)	-	-	Hold for future
7242W	"	"	"	Boiler No. 21	0.02	0.01	9.6
7243W	"	"	"	Boiler No. 22	0.21	0.57	5.1
7244W	"	"	"	Boiler No. 24	0.04	0.60	4.3
7245W	"	5/7/81	5/7/81	Evap. 8, 18	-	-	6.2
7246W	"	"	"	Evap. 11	-	-	5.8
7247W	"	"	"	Evap. 12	-	-	5.6
7248W	"	"	"	Boiler No. 23	-	-	4.8
7249W	5/7/81	"	"	" " "	-	-	5.0
7250W	"	"	"	Feed water drain tank	-	-	6.2

(1) Aft evaporator

By Raymond N. Williams
Raymond N. Williams, Chief Chemist

Approved Carl E. Johnson
Carl E. Johnson, President

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S/S NORWAY

Files

Copy to file for "Boiler Average"

MAIN BOILER REPORT

Work performed on main boilers from May 5, 1981 after tube failure and Black out:

Tubes identified by original DRWG.

Boiler #24:

Following pipes in row no. 3, has been cut and new pipe pieces of approximate one meter length has been welded in on pipe no. 7, 8, 9, 10, 11, 12 and 14.

Window openings rewelded on outer tube wall on pipe no 14 - 18 and 20.

The boiler cleaned internaly on water side and inspected and found in good condition related to earlier inspections made, some pipes had spots of lacking Magnetitt layer.

Flame chamber brickwork repaired.

Boiler closed up and filled with water and added 240l. Drew GC for neutralization. Pressure tested hydraulicaly with 30 BAR/cm^2 - light with diesel oil for tow and a half hours.

Drums emptied and filled again - treated with normal dosage Drew boiler chemicals and lighted May 9. Steam pressure slowly rised and the boiler was taken in service May 9, 1981 at 2040hrs.

Boiler #22:

The following pipes in row no. 3, have been cut and new pipe pieces of approximately one meter length welded in on pipes no. 7, 8, 9, 10, 11 and 12.

The Boiler cleaned internaly on water side, inspected and found in good order. Some spots showed that the Magnetitt layer was disappeared.

The flame chamber brickwork repaired as found necessary.

The Boiler closed up and pressuretested hydraulicaly with 30 BAR/cm^2 - than light with diesel oil for two and a half hours to circulate water for neutralization of tubes and drums.

Drums emptied and flushed, filled up to normal water level and light.

Pressure slowly rised until the boiler was taken into service May 10, at 0300hrs.

.....cont'd/2.

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Boiler #21:

Following pipes in boiler #21, row three, have been cut and new pipe pieces of approximately 1.5meters welded in on pipe no. 8, 10, 12 and 16.

Window openings made and rewelded again on outer tube wall pipes no. 24 and 25.

Pipe No. 7 and 8, row No. 5, plugged.

One old plug was replaced due to leakage from upper drum.

The boiler cleaned internaly on the water side and inspected and found in good order compared to earlier inspection made.

Brickwork in the flame chamber repaired.

The boiler closed up and filled up, pressuretested with 30 BAR/cm^2.

Lighted with diesel oil and neutralized with 2401. Drew GC.

Drums emptied and flused and filled with water to normal level and light May 11, and put into service on May 11, 1981 at 2145hrs.

Boiler #23:

This boiler was stopped May 12 and cooled slowly down.

May 14, was the boiler inspected and there was a few places on the pipes that loocked suspicious.

Pipe No. 1 in row No. 4, was plugged. Windows were cut and rewelded in pipes two in No. 19 - and one in 20 - 21 and 24.

Two handhole covers on Penhoit economizer renewed and valve for boiler water tusted on lower water drum, fully overhauled and repacked. Put in place.

Brickwork repaired both in superheater area and flame chamber.

Boiler closed up and filled with water and pressuretested hydraulicaly to 30 BAR/cm^2 and found tight.

Boiler light for 2½ hours with diesel oil for making circulation of the water while neutralizing the water side.

Drums emptied and flushed, filled to normal water level and light May 16 and taken into service May 17 at 0450hrs.

Egil Fossen

E. Fossen
Chief Engineer
S/S Norway

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Norwegian Caribbean Lines®

NCL

INTER OFFICE MEMO

6/19-81: Gill Knopted

From Chief Engineer Southward Date May 19, 1981

To S.Dahl, Ships Operations, NCL,Miami

Extra Fuel Expences due to S/S NORWAY,s "Black OUT" May 1, 1981.

Friday may 1 was the M/S Southward ordered by Miami Office to be ST BY in case help was needed. We stopped the ship from 1555 pm to 1905 and was then beeing released to go back to our shedule.

Due to increased speed to go back to Miami our extra Fuel Consumtion was 15 tons.

Chief Engineer

M/S Starward M/S Skyward M/S Southward M/S Sunward II

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