Zille

FILE COPY

O T T A W A June 1st, 1943.

REPORT

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1421.

Examination of a Failed Bolingbroke
Aircraft Fuel Tank.

(Copy No. 10.)

Bureau of Mines
Division of Metallic
Minerals
-
Ore Dressing
and Metallurgical
Laboratories

CANADA

DEPARTMENT
OF
MINES AND RESOURCES

Mines and Geology Branch

O T T A W A   June 1st, 1943.

REPORT

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1421.

Examination of a Failed Bolingbroke Aircraft Fuel Tank.

==========

Origin of Problem and Object of Investigation:

In a letter dated May 13th, 1943 (File No. 938AC-1-5-AMAE DAI), A/C A. L. Johnson, for Chief of the Air Staff, Department of National Defence for Air, Ottawa, Ontario, requested the investigation of the probable cause of failure of a Bolingbroke aircraft fuel tank skin.

A fuel tank from a Bolingbroke aircraft which had proved defective was dismantled and a corner including the section which failed was submitted for examination. See Figure 1.

The nature of the defect was the development of fine cracks along the line of bolts securing the baffles

(Origin of Problem and Object of Investigation, cont'd) -

which run parallel to the lateral axis. Inner tanks were said to be more subject to failure than outer tanks, and it was reported that the skin material of a tank which had failed was excessively hard.

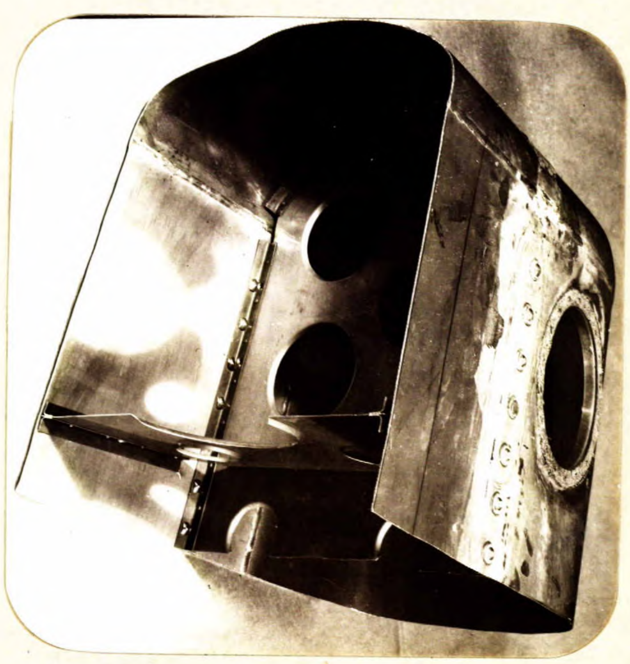
It was further stated, in the letter, that the tank material specified was Aluminium Alloy 3S-¾H but that it was understood that the skin was fully annealed before forming and naturally became somewhat work-hardened during manufacture. In the event that failure might have been due to brittleness, it was thought desirable to determine whether work-hardening was taking place in service or in manufacture. It was therefore requested that the relative hardness be determined for the above-mentioned tank skin and for a sample of the original material which was attached.

Description of Material:

Figures 1 and 2 show the failed part of the fuel tank, as received.

Figure 1.

Figure 2.



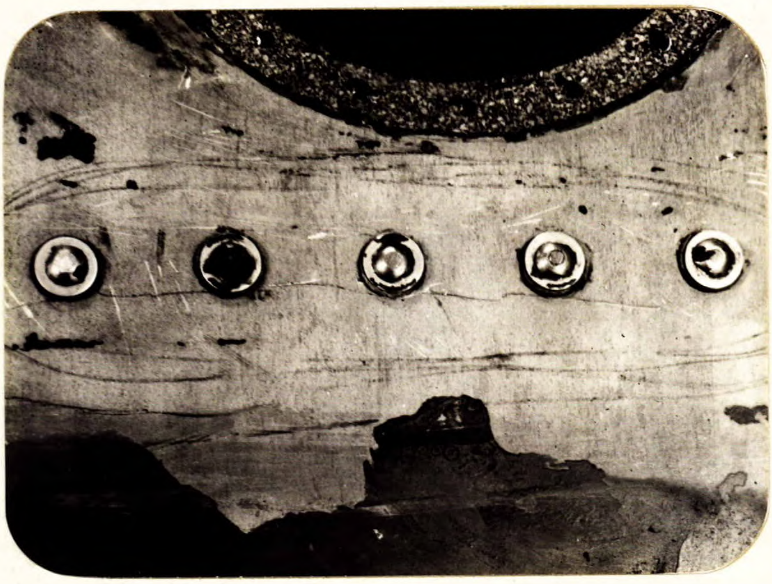
FUEL TANK CORNER - AS RECEIVED.
(Approximately 1/6 size).

(Continued on next page)

(Description of Material, cont'd) -

Figure 3 shows the character of the failure, cracks along the line of bolts.

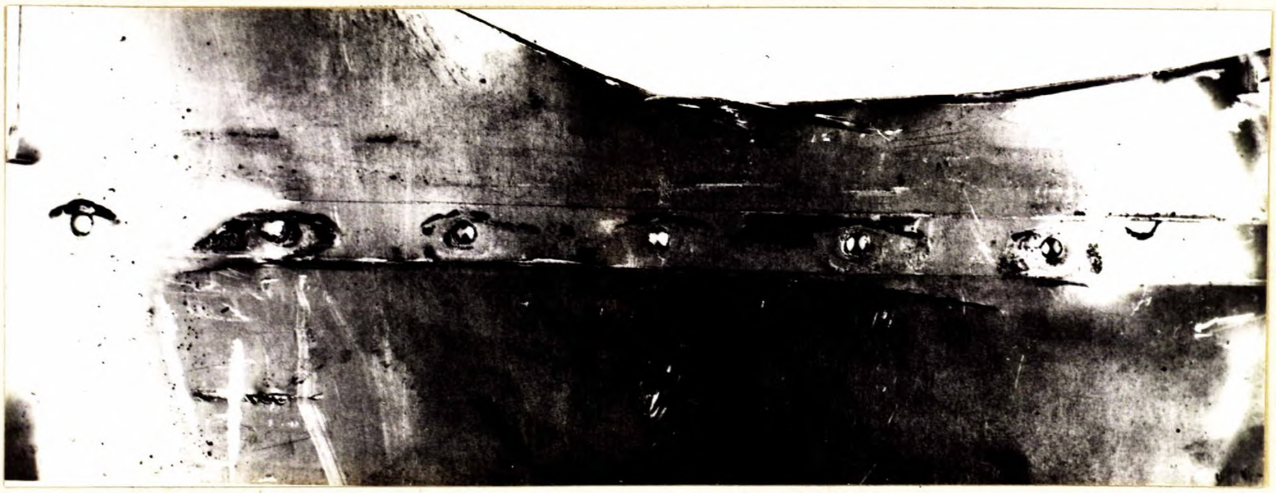
Figure 3.



CRACKS ON FUEL TANK SKIN.
(Approximately 2/3 size).

Figure 4 shows the inside of the cracked tank skin after dismounting and dismantling of the baffles. During this operation the cracks originally present developed into one continuous, long crack.

Figure 4.



INSIDE VIEW OF THE CRACKS.
(Approximately 2/3 actual size).

As shown in Figure 4, the cracks occurred in the

(Description of Material, cont'd) -

sheet along the line where the inner edge of the angle supporting the baffle was attached.

For comparison of properties, a sample of an AC.3S-½H sheet, 0.049-inch thick, was received.

Chemical Composition:

		Fuel Tank Skin	AC.3S-½H Sheet
		- Per cent -	
Manganese	-	0.06	1.09
Iron	-	0.33	0.45
Silicon	-	0.22	0.32
Copper	-	0.12	0.09
Titanium	-	0.008	0.015
Magnesium	-	None detected.	None detected.

Mechanical Properties:

Tensile Tests:

		0.1 per cent proof stress, p.s.i.	Ultimate tensile strength, p.s.i.	Elongation, per cent in 2 inches
Fuel Tank Skin -				
Longitudinal specimen	-	16,300	18,300	4.5
Transverse specimen	-	16,200	17,900	6.0
AC.3S-½H Sheet -				
Longitudinal specimen	-	20,400	22,000	6.5
Transverse specimen	-	18,800	21,000	5.5

Hardness Tests:

Hardness was determined by the Vickers method, using a 5-kilogram load.

Fuel tank skin - 23 V.H.N.
AC.3S-½H sheet - 25 V.H.N.

-

Specifications:

Chemical Composition:

		A.S.T.M. Spec.	
		B25-42T (Alloy 2S)	B79-42T (Alloy 3S)
		- Per cent -	
Manganese	-	0.05 max.	1.0 - 1.5
Copper	-	0.2 max.	0.2 max.
Iron	- (Fe)	1.0 max.	0.7 max.
Silicon	- (+Si)		0.6 max.
Zinc	-	0.10 max.	0.10 max.
Other elements, each	-	0.05 max.	0.05 max.
Other elements, total	-	0.15 max.	0.15 max.
Aluminium	-	Remainder.	Remainder.

Mechanical Properties:

ASTM Spec. B25-42T (Alloy 2S)	Ultimate tensile strength, p.s.i.	Elongation, per cent in 2 inches
0.032 - 0.050 inch sheet, soft	- 15,500 max.	25 min.
½ hard	- 16,000 min.	5 min.
¾ hard	- 19,000 min.	3 min.
hard	- 22,000 min.	3 min.

ASTM SPEC. B79-42T (Alloy 3S)	Ultimate tensile strength, p.s.i.	Elongation, per cent in 2 inches
0.032 - 0.050 inch sheet, soft	- 19,000 max.	23 min.
½ hard	- 19,500 max.	5 min.
¾ hard	- 23,500 max.	3 min.
hard	- 27,000 max.	3 min.

Discussion of Results:

Chemical analysis and mechanical tests show definitely that the examined fuel tank skin was made from commercially pure aluminium sheet (2S) instead of the somewhat stronger 3S - aluminium alloy.

The difference in the mechanical properties obtained is 20 to 25 per cent. This difference would be still greater if the 3S - alloy sheet were "¾ hard" (as should be used in actual production, as stated in the letter dated May 13th, 1943) and had received additional work-hardening during manufacture

(Discussion of Results, cont'd) -

of the tank.

It seems that the use of a weaker sheet metal was only partly responsible for the failure, which was caused, probably, by the design or manufacture of the supporting members. Clearly visible scoring of the sheet (see Figure 4) at the outer edge of the angle in the baffle mounting would indicate either that too great a pressure was used in the tightening of the bolts or that the angle was originally distorted and extra force was required during the joining operation in order to obtain a tight joint.

CONCLUSIONS:

It was found that the fuel tank skin was made from a weaker material (2S) than recommended.

It is, however, probable that the failure occurred as a result of overstressing of the material during the assembling of the baffles.

OOOOOOOOOOO
OOOOO
O

JWM:GHB.