THE BOEING COMPANY
AERO-SPACE DIVISION
LAUNCH SYSTEMS BRANCH

DOCUMENT NO. T5-6539-97

VOLUME ____ OF ____

TITLE EVALUATION OF RETENTION METHODS ON MBC 455 CONNECTOR CONTACTS

MODEL NO. SAT V/S-IC CONTRACT NO. NAS8-5608

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PREPARED BY	C. A. Guidry	10-16-67
SUPERVISED BY	E. L. Clark	10-16-67
APPROVED BY	W. W. Davis	10-17-67
APPROVED BY		
APPROVED BY		
APPROVED BY		

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ABSTRACT

An unwired contact was found dislodged from an MBC 455-1 connector in a S-1C-5 vehicle distributor and was reported on UER 235513. An investigation revealed that some contacts could be pushed out of the connector with a force lower than that which might be experienced during distributor assembly operations.

KEY WORDS

Contact Retention

Connector

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1.0 OBJECT

To evaluate:

a) heat shrinkable sleeving as a supplementary contact retention device for connectors installed on the S-1C-5 vehicle.

b) connectors with modified contact retention.

c) contact retention degradation due to contact retention test

2.0 BACKGROUND

The S-1C-5 was the first vehicle on which the MBC455 connectors were used. After manufacture of the distributors an unwired contact was found dislodged from an MBC455-1 connector. This condition appeared to be caused by an abrasive de-flashing operation by the connector manufacturer which partially removed the contact retention shoulder from the connector body. Although the connector contacts are captivated when printed circuit (P/C) boards are installed in the distributors, a method to retain unwired contacts when P/C boards are removed was considered necessary. The fix on the S-1C-5 vehicle was the installation of RNF100 sleeving on the wire termination ends of unwired MBC455-1 connector contacts. This fix avoided the hazzard of additional re-work on the distributors.

As the test results of this evaluation became available the following actions were implemented:

1. The contact retention requirement was added to the MBC455 specification by revision "B" and MBC455-3 was the designated part number.

2. The remaining -1 connectors in Receiving-Inspection were tested to the new specification and connectors meeting the new requirement were part-numbered MBC455-3.

3. The vendor was requested to perform the secondary crimp operation to enhance meeting the contact retention requirement.

4. The part number call out for all vehicles from the S-1C-3 on, except S-1C-5 was changed from MBC455-1 to MBC455-3.

3.0 CONCLUSIONS

a) The heat shrinkable sleeving adds to contact retention and is considered adequate for the S-1C-5 vehicle.

b) Contact retention is much higher on connectors on which the secondary crimp operation was performed.

c) Contact retention is not degraded by contact retention test, to any measurable amount.

d) Contact retention is reduced on contacts replaced by manufacturer.

4.0 RECOMMENDATIONS

The secondary crimp operation should be performed on contacts, at time of connector manufacture.

5.0 PROCEDURES AND RESULTS

5.1 Heat Shrinkable Sleeving

Test specimens were prepared with heat shrinkable sleeving on wire end of contacts. The retention tabs were depressed so that only sleeving retained contact. Contacts were pulled from the mating end, and the values for dislodging were recorded. See Tables Ia through Id. The heat shrinkable sleeving exceeded the MBC455, Rev. B specification requirement of 2.0 pounds minmum when tested at lab ambient temperature (80°F). Since at 180°F the distributor is in a static condition, the drop to a minmum of one pound retention is not considered significant. After return to Lab ambient temperature, the 2.0 pounds minimum is again exceeded.

5.2 Modified Contact Retention

A total of 50 connectors were tested to evaluate the effect of the secondary crimp operation , de-flashing, and body color. See Tables IIa through IIg. Contact retention is supplemented by a secondary crimp operation on the retention tab which is performed after the contact is in the body. The secondary crimp operation on the contact greatly increases contact retention. Abrasive de-flashing does have a detremental effect when not used in conjunction with the secondary crimp operation. Connector body color, where a difference of material strength was suspected, has no effect on contact retention.

5.3 Degradation Effect of Contact Retention Test

Two connectors were used as test specimens. See Tables IIIa and IIIb. A pulling force was repeatedly applied to contacts to simulate the testing performed by Receiving - Inspection. Contact retention is not degraded due to contact retention test.

TABLE Ia

CRN and RNF Sleeving

Force in Pounds

Specimen	J21		J22		J23	
Sleeve	RNF 100	CRN	RNF 100	CRN	RNF 100	CRN
	3.3	4.5	3.1	5.1	4.9	3.85
	4.0	5.1	3.8	4.8	4.95	5.3
	3.6	6.8	3.8	6.1	3.9	4.0
	4.2	6.15	3.45	5.9	4.85	8.4
	4.3	6.5	4.2	5.5	3.6	7.95
	4.65	5.85	4.25	4.15	5.1	7.0
	4.75	5.7	4.2	4.5	4.75	3.85
	7.0	5.75	4.45	5.4	4.7	5.2
	4.2	5.5	4.5	5.8	4.9	4.6
	4.35	5.8	3.9	6.1	4.7	4.6
					4.9	5.1
Average	4.4	5.8	4.0	5.3	4.7	5.4
High	7.0	6.8	4.5	6.1	5.1	7.95
Low	3.3	4.5	3.1	4.15	3.6	3.85

TABLE Ib

CRN and RNF Sleeving - Averages

Force in Pounds

Sleeve	RNF	CRN
Average	4.4	5.5
High	7.0	7.95
Low	3.1	3.85

TABLE Ic

Sleeving at 180°F

Force in Pounds

Contact Number	Specimen J21 RNF 100 Sleeve Force in Pounds	Specimen J28 CRN Sleeve Force in Pounds
BEFORE TEMPERATURE		
1	3.5	3.5
2	3.7	5.5
3	3.9	4.1
4	3.65	4.9
5	3.6	4.0
6	3.8	5.2
7	3.5	4.5
8	3.4	4.1
9	3.2	5.2
10	3.4	4.25
11	3.5	5.0
AT TEMPERATURE, 180°F		
A	1.15	2.2
B	1.5	3.5
C	1.65	2.1
D	1.4	2.45
E	1.4	3.0
F	1.6	1.2
H	1.7	1.6
J	1.3	1.2
K	1.65	1.4
L	1.6	2.7
M	1.65	2.05
N	1.1	1.5
P	1.3	1.7
R	1.4	1.75
S	1.4	2.35
T	1.0	1.6
U	1.6	1.7
V	1.4	1.65
W	1.0	2.2
X	1.55	2.75
Y	1.5	2.45
Z	1.4	2.55

TABLE Ic - Con't.

Contact Number	Specimen J21 RNF 100 Sleeve Force in Pounds	Specimen J28 CRN Sleeve Force in Pounds
AFTER TEMPERATURE		
12	3.25	3.1
13	3.65	4.8
14	3.3	3.55
15	3.35	4.5
16	3.2	3.8
17	3.4	4.05
18	3.1	4.4
19	3.15	4.35
20	3.65	3.7
21	3.0	4.35
22	4.6	4.25

TABLE Id

Sleeving at 180°F - Averages

Force in Pounds

Sleeve	RNF	CRN
BEFORE TEMPERATURE		
Low	3.2	3.5
High	3.9	5.5
Average	3.6	4.5
AT TEMPERATURE		
Low	1.0	1.2
High	1.7	3.5
Average	1.42	2.07
AFTER TEMPERATURE		
Low	3.0	3.1
High	4.6	4.8
Average	3.4	4.07

Room temperature 81°F

TABLE IIa

Connector Types

Specimen Type	De-Flashing Operation	Secondary Crimp Operation	Body Color
1	Hand	No	Black
2	Hand	No	Green
3	Hand	Yes	Black
4	Hand	Yes	Green
5	Sand Blasted	Yes	Black

TABLE IIb

Type - Averages

Force in Pounds

Type	High	Low	Average
1	5.5	3.1	4.0
2	6.8+	2.9	4.9
3	6.8+	5.8	6.8+
4	6.8+	6.8+	6.8+
5	6.8+	6.8+	6.8+

NOTE: A mechanical stop on gauge was positioned at 6.8

⬭ Indicates contact replaced by manufacturer These values not in averages.

TABLE IIc

Type 1 through Type 5 - Group A

Force in Pounds

Contact Number	Type 1	Type 2	Type 3	Type 4	Type 5
1	3.0	4.9	6.8+	6.8+	6.8+
2	3.95	4.85	6.8+	6.8+	6.8+
3	3.75	4.8	6.8+	6.8+	6.8+
4	3.95	4.15	6.8+	6.8+	6.8+
5	3.1	3.85	6.8+	6.8+	6.8+
6	4.5	4.45	6.8+	6.8+	6.8+
7	3.9	4.6	6.8+	6.8+	6.8+
8	3.4	3.85	6.8+	6.8+	6.8+
9	4.05	4.8	6.8+	6.8+	6.8+
10	3.25	5.5	6.8+	6.8+	6.8+
11	4.65	5.15	6.8+	6.8+	6.8+
12	3.65	5.4	6.8+	6.8+	6.8+
13	3.55	4.1	6.8+	6.8+	(5.7)
14	3.85	5.3	6.8+	6.8+	6.8+
15	3.95	4.9	6.8+	6.8+	6.8+
16	4.15	4.65	6.8+	6.8+	6.8+
17	4.7	4.95	6.8+	6.8+	6.8+
18	4.05	6.8	6.8+	6.8+	6.8+
19	4.9	5.3	6.8+	6.8+	6.8+
20	4.05	4.75	6.8+	6.8+	6.8+
21	4.45	5.6	6.8+	6.8+	(5.2)
22	4.35	5.1	6.8+	6.8+	6.8+
A	4.70	5.9	6.8+	6.8+	6.8+
B	4.95	5.9	6.8+	6.8+	6.8+
C	4.35	5.1	6.8+	6.8+	6.8+
D	3.7	6.0	6.8+	6.8+	6.8+
E	3.4	3.6	6.8+	6.8+	6.8+
F	4.15	4.2	6.8+	6.8+	6.8+
H	5.15	6.7	6.8+	6.8+	6.8+
K	4.2	5.05	6.8+	6.8+	6.8+
L	3.4	4.5	6.8+	6.8+	6.8+
M	4.95	4.1	6.8+	6.8+	6.8+
N	4.05	4.9	6.8+	6.8+	6.8+
P	4.3	5.0	6.8+	6.8+	6.8+
R	4.9	4.8	6.8+	6.8+	6.8+
S	3.6	5.1	6.8+	6.8+	6.8+
T	3.75	4.0	(4.35)	6.8+	6.8+
U	4.0	4.8	6.8+	6.8+	6.8+
V	5.2	4.3	6.8+	6.8+	6.8+
W	4.5	4.6	6.8+	6.8+	6.8+
X	4.3	5.4	6.8+	6.8+	6.8+
Y	4.8	5.25	6.8+	6.8+	6.8+
Z	3.85	4.55	6.8+	6.8+	6.8+
Average	4.11	4.90			

TABLE IId

Type 1 - 5, Group B

Force in Pounds

Contact Number	Type 1	Type 2	Type 3	Type 4	Type 5
1	3.55	5.5	(2.3)	6.8+	6.8+
2	4.5	5.1	6.8+	6.8+	6.8+
3	4.1	4.6	6.8+	6.8+	6.8+
4	3.85	5.8	6.8+	6.8+	6.8+
5	4.45	5.9	6.8+	6.8+	6.8+
6	4.0	4.3	6.8+	6.8+	6.8+
7	4.5	4.2	6.8+	6.8+	6.8+
8	4.4	6.5	6.8+	6.8+	6.8+
9	4.1	5.2	6.8+	6.8+	6.8+
10	4.15	6.1	6.8+	6.8+	6.8+
11	4.5	4.75	6.8+	6.8+	6.8+
12	4.3	6.3	6.8+	6.8+	6.8+
13	3.7	6.7	6.8+	6.8+	6.8+
14	3.4	4.2	6.8+	6.8+	6.8+
15	3.55	4.9	6.8+	6.8+	6.8+
16	4.4	4.7	6.8+	6.8+	6.8+
17	4.3	5.2	6.8+	6.8+	6.8+
18	3.85	5.3	6.8+	6.8+	6.8+
19	4.15	4.5	6.8+	6.8+	6.8+
20	4.3	5.2	6.8+	6.8+	6.8+
21	3.65	5.3	6.8+	6.8+	6.8+
22	3.55	4.5	6.8+	6.8+	6.8+
A	3.8	4.85	6.8+	6.8+	6.8+
B	4.7	4.7	6.8+	6.8+	6.8+
C	3.95	6.0	6.8+	6.8+	6.8+
D	3.85	4.8	6.8+	6.8+	6.8+
E	3.0	3.9	6.8+	6.8+	6.8+
F	4.5	6.4	6.8+	6.8+	6.8+
H	3.75	4.6	6.8+	6.8+	6.8+
J	3.95	4.7	6.8+	6.8+	6.8+
K	3.75	4.4	6.8+	6.8+	6.8+
L	4.0	4.8	6.8+	6.8+	6.8+
M	4.1	4.2	6.8+	6.8+	6.8+
N	4.0	6.0	6.8+	6.8+	6.8+
P	4.15	4.5	6.8+	6.8+	6.8+
R	3.85	3.7	6.8+	6.8+	6.8+
S	3.4	4.4	6.8+	6.8+	6.8+
T	3.8	6.2	6.8+	6.8+	6.8+
U	4.0	4.2	6.8+	6.8+	6.8+
V	4.25	4.0	6.8+	6.8+	6.8+
W	3.95	5.0	6.8+	6.8+	6.8+
X	3.7	4.6	6.8+	6.8+	6.8+
Y	4.0	6.05	6.8+	6.8+	6.8+
Z	3.5	3.9	6.8+	6.8+	6.8+
Average	3.98	5.01			

TABLE IIe

Types 1 - 5, Group C

Contact Number	Type 1	Type 2	Type 3	Type 4	Type 5
1	3.75	6.8+	6.5	6.4	6.8+
2	3.80	5.0	6.8+	6.8+	6.8+
3	3.65	5.95	6.8+	6.8+	6.8+
4	3.75	3.75	6.8+	6.8+	6.8+
5	3.50	4.6	6.8+	6.8+	6.8+
6	3.95	5.25	6.8+	6.8+	6.8+
7	3.60	3.75	6.8+	6.8+	6.8+
8	4.05	4.8	6.8+	6.8+	6.8+
9	4.15	5.0	6.8+	6.8+	6.8+
10	3.60	4.75	6.8+	6.8+	6.8+
11	3.65	5.4	6.8+	6.8+	6.8+
12	3.75	5.25	6.8+	6.8+	6.8+
13	3.10	5.25	6.8+	6.8+	6.8+
14	3.20	5.65	6.8+	6.8+	6.8+
15	3.95	5.35	6.8+	6.8+	6.8+
16	4.60	4.0	6.8+	6.8+	6.8+
17	3.80	5.3	6.8+	6.8+	6.8+
18	4.30	5.3	6.8+	6.8+	6.8+
19	3.25	5.0	6.8+	6.8+	6.8+
20	3.40	4.25	6.8+	6.8+	6.8+
21	3.90	5.4	6.8+	6.8+	6.8+
22	3.75	6.8	6.8+	6.8+	6.8+
A	4.5	4.85	6.8+	6.8+	6.8+
B	5.0	6.8+	6.8+	6.8+	6.8+
C	3.9	5.4	6.8+	6.8+	6.8+
D	4.4	4.2	6.8+	6.8+	6.8+
E	3.3	2.9	6.8+	6.	6.8+
F	4.4	5.2	6.8+	6.8+	6.8+
H	3.9	4.3	6.8+	6.8+	6.8+
J	4.4	5.5	6.8+	6.8+	6.8+
K	3.8	4.1	6.8+	6.8+	6.8+
L	3.25	4.5	6.8+	6.8+	6.8+
M	3.65	5.85	6.8+	6.8+	6.8+
N	3.55	4.5	6.8+	6.8+	6.8+
P	3.5	4.0	6.8+	6.8+	6.8+
R	3.85	4.25	6.8+	6.8+	6.8+
S	4.35	5.3	6.8+	6.8+	6.8+
T	3.45	3.7	6.8+	6.8+	6.8+
U	3.7	3.35	6.8+	6.8+	6.8+
V	3.3	5.4	6.8+	6.8+	6.8+
W	4.05	4.7	6.8+	6.8+	6.8+
X	3.75	3.5	6.8+	6.8+	6.8+
Y	3.45	4.05	6.8+	6.8+	6.8+
Z	4.15	4.55	6.8+	6.8+	6.8+
Average	3.79	4.85			

TABLE III f

Types 1 - 5, Group D

Force in Pounds

Contact Number	Type 1	Type 2	Type 3	Type 4	Type 5
1	3.5	5.9	6.8+	6.8+	6.4
2	5.7	5.15	5.8	6.8+	6.8+
3	5.1	4.75	6.8+	6.8+	6.8+
4	3.9	4.1	6.8+	6.8+	6.8+
5	4.9	5.25	6.8+	6.8+	6.8+
6	4.75	5.9	6.8+	6.8+	6.8+
7	4.9	4.55	6.8+	6.8+	6.8+
8	4.05	5.7	6.8+	6.8+	6.8+
9	3.85	4.25	6.8+	6.8+	6.8+
10	4.0	4.3	6.8+	6.8+	6.8+
11	3.8	4.95	6.8+	6.8+	6.8+
12	3.8	4.7	6.8+	6.8+	6.8+
13	4.1	4.3	6.8+	6.8+	6.8+
14	4.3	6.3	6.8+	6.8+	6.8+
15	4.0	4.7	6.8+	6.8+	(3.3)
16	4.6	6.2	6.8+	6.8+	6.8+
17	3.6	4.5	6.8+	6.8+	6.8+
18	4.25	4.2	6.8+	6.8+	6.8+
19	3.6	6.0	6.8+	6.8+	6.8+
20	3.8	4.45	6.8+	6.8+	6.8+
21	3.6	4.9	6.8+	6.8+	(6.8+)
22	4.1	4.8	6.8+	6.8+	6.8+
A	5.5	6.9	6.8+	6.8+	6.8+
B	4.55	4.5	6.8+	6.8+	6.8+
C	4.65	4.4	6.8+	6.8+	6.8+
D	4.2	5.7	6.8+	6.8+	6.8+
E	3.3	5.55	6.8+	6.8+	6.8+
F	3.9	4.65	6.8+	6.8+	6.8+
H	4.4	4.5	6.8+	6.8+	6.8+
J	3.9	4.5	6.8+	6.8+	6.8+
K	4.5	5.8	6.3	6.8+	6.8+
L	3.75	6.9	6.8	6.8+	6.8+
M	4.2	4.75	6.4	6.8+	6.8+
N	4.2	4.25	6.8	6.8+	6.8+
P	3.7	3.7	6.5	6.8+	6.8+
R	4.7	4.0	6.6	6.8+	6.8+
S	3.5	5.5	6.8	6.8+	6.8+
T	3.45	4.6	6.8	6.8+	6.8+
U	3.2	4.5	6.8	6.8+	6.8+
V	3.25	6.1	6.5	6.8+	6.8+
W	4.25	5.35	6.8	6.8+	6.8+
X	4.5	6.05	6.8	6.8+	6.8+
Y	3.15	4.35	6.8	6.8+	6.8+
Z	4.55	4.1	6.8	6.8+	6.8+
Average	4.09	5.01			

TABLE IIg

Types 1 - 5, Group E

Force in Pounds

Contact Number	Type 1	Type 2	Type 3	Type 4	Type 5
1	3.35	3.8	6.8+	6.8+	4.3*
2	4.9	6.2	6.8+	6.8+	4.4
3	3.4	4.6	6.8+	6.8+	4.3
4	3.65	4.9	6.8+	6.8+	3.7
5	4.05	5.2	6.8+	6.8+	4.0
6	4.0	5.2	6.8+	6.8+	3.7
7	3.65	5.3	6.8+	6.8+	4.1
8	3.95	4.6	6.8+	6.8+	4.0
9	3.9	4.8	6.8+	6.8+	3.9
10	3.65	4.7	6.8+	6.8+	4.0
11	4.9	4.5	6.8+	6.8+	4.5
12	3.2	5.2	6.8+	6.8+	4.1
13	3.7	3.8	6.8+	6.8+	4.05
14	3.8	4.5	6.8+	6.8+	3.9
15	3.8	4.8	6.8+	6.8+	3.75
16	4.35	4.5	6.8+	6.8+	3.5
17	3.5	4.3	6.8+	6.8+	3.65
18	3.95	5.3	6.8+	6.8+	4.0
19	3.9	5.0	6.8+	6.8+	4.9
20	4.25	5.0	6.8+	6.8+	4.5
21	4.25	5.25	6.8+	6.8+	4.2
22	3.5	6.0	6.8+	6.8+	3.8
A	4.95	4.8	6.8+	6.8+	6.8+
B	4.7	5.5	6.8+	6.8+	6.8+
C	5.0	4.8	6.8+	6.8+	6.8+
D	4.3	3.8	6.8+	6.8+	6.8+
E	3.6	5.0	6.8+	6.8+	6.8+
F	4.55	5.0	6.8+	6.8+	6.8+
H	4.0	3.5	6.8+	6.8+	6.8+
J	4.9	4.15	6.8+	6.8+	6.8+
K	5.0	4.9	6.8+	6.8+	6.8+
L	4.2	4.8	6.8+	6.8+	6.8+
M	4.5	4.8	6.8+	6.8+	6.8+
N	4.9	4.8	6.8+	6.8+	6.8+
P	4.35	4.35	6.8+	6.8+	6.8+
R	4.7	4.0	6.8+	6.8+	6.8+
S	4.4	4.5	6.8+	6.8+	6.8+
T	3.85	4.95	6.8+	6.8+	6.8+
U	4.5	4.9	6.8+	6.8+	6.8+
V	4.45	5.2	6.8+	6.8+	6.8+
W	4.45	4.4	6.8+	6.8+	6.8+
X	5.0	5.1	6.8+	6.8+	6.8+
Y	4.1	4.2	6.8+	6.8+	6.8+
Z	4.0	4.0	6.8+	6.8+	6.8+
Average	4.18	4.74			

TABLE IIIa

Load Cycling

Force in Pounds

Specimen	5J			5K	
Contact					
1	*	**	10.0	*	7.5
2	*	**	7.5	*	9
3	*	**	8.0	*	8
4	*	**	7.5	*	9.5
5	*	**	8.0	*	9
6	*	**	8.0	*	9
7	*	**	7.5	*	7.5
8	*	**	8.0	*	8.5
9	*	**	8.5	*	6.75
10	*	**	10.0	*	7.25
11	*	**		*	8.0
A			9		8.0
B			8.0		(2.0)
C			(5.0)		9.0
D			7.5		8.0
E			6.25		7.5
F			7.5		7.5
H			8.0		7.5
J			8.0		7.0
K			(3.5)		7.0
L			7.5		7.5
M			7.5		7.0

TABLE IIIb

Load Cycling - Averages

Force in Pounds

Specimen		Cycled	Not Cycled
5J	High	10	9.5
	Low	7.5	6.75
	Average	8.3	8.1
5K	High	9	9
	Low	6.25	7.5
	Average	7.7	7.6
Average		8.0	7.9

* Cycled to two pounds pull five times

** Cycled to 6.8 pounds pull one time

( ) Indicates contact replaced by manufacturer

Instruments: Chatillon MC3322 0-5 lbs.
Chatillon S/N31495 0-50 lbs.