

Allied-Signal Aerospace Company  
Airesearch Los Angeles Division

TO: DISTRIBUTION  
FROM: SYED SHAH 11-2-88  
SUBJECT: SUMMARY REPORT OF THE RELIABILITY OF THE WELD COMPUTER.

COPIES TO: G. WOELKI, R. WAMBOLT, M. JUMPS, R. KOENKE, C. KLAPROTH, P. VIDANO, G. GRIFFITH, G. BYER, A. MacKNIGHT, A. TRIVEDI, N. TRIVEDI, J. WEBSTER, J. VOLLMER, D. NICHOLS.

PURPOSE: OBTAIN APPROVALS TO SUBSTITUTE NONDESTRUCTIVE EVALUATION FOR ROUTINE LOT TESTING AT SPOT WELDING.

REQUIREMENTS:

MIL-W-6858D PARA 4.3.3.3 " CONTRACTOR MAY SUBSTITUTE NONDESTRUCTIVE EVALUATION FOR ROUTINE LOT TESTS UPON APPROVAL OF THE PROCUREMENT ACTIVITY PROVIDED HE CAN DEMONSTRATE THAT THE EVALUATION SYSTEM WILL IDENTIFY WELDS COMPLYING WITH SIZE OR STRENGTH REQUIREMENTS WITH A 99.5% RELIABILITY "

BACKGROUND:

OUR CURRENT SYSTEM REQUIRED FREQUENT DESTRUCTIVE TESTS, CONTROLLING OUR PROCESS THROUGH S.P.C. WOULD PROVIDE US HIGHER RELIABILITY. ~~A TEAM WAS SELECTED TO ASSESS OUR RELIABILITY (A PLUS AND MINUS THREE STANDARD DEVIATION PROVIDES A 99.7% RELIABILITY)~~ AND A WELD COMPUTER WAS INSTALLED TO PROVIDE THE NONDESTRUCTIVE S.P.C. CONTROL MECHANISM.

RESULTS:

OUR INITIAL CAPABILITY STUDY ON A HUNDRED WELDS YIELDED A GOOD PROCESS WITH A Cpk OF 1.19 (A 1.0 Cpk YIELDS 99.7% WHERE THE HIGHER THE NUMBER THE MORE RELIABLE). THIS INITIAL CAPABILITY (ATTACHMENT 1) IS ONLY ONE SNAPSHOT IN THE WELDING PROCESS AND THE TEAM WANTED THE ASSURANCE THAT FACTORS ARE IDENTIFIED THAT MAY SHIFT THE SPOT WELDING CAPABILITY. A BRAINSTORMING SESSION WAS HENCE SET UP TO IDENTIFY ALL FACTORS FOR A TAGUCHI EXPERIMENT - CAPTAIN ALSTOTT FROM D.C.A.S AND GEORGE WOELKI FROM Q.A. ATTENDED AS TEAM MEMBERS.

THE FOUR FACTORS SET UP ON THE TAGUCHI L-8 ARRAY WERE:

- 1) NIGHT AND DAY CHANGE IN VOLTAGE
- 2) HEAT SETTING (TWO LEVELS)
- 3) WELD PRESSURE (TWO LEVELS)
- 4) SQUEEZE TIME (TWO LEVELS)

RESULTS SHOWED THAT THE MAIN CONTROLLING FACTOR ARE THE HEAT SETTING AND WELDING PRESSURE, WHERE ANY TIME A HEAT SETTING IS SET AT LOW THE PRESSURE MUST ALSO BE SET AT LOW OR A HIGH HEAT SETTING NEEDS A HIGH PRESSURE (ATTACHMENT 2 - FOR DETAILED ANALYSIS PLEASE SEE Dr. OPFELL'S MEMO TO SYED SHAH 10-27-88)

A CAPABILITY ANALYSIS WAS REDONE WITH THE ABOVE KNOWLEDGE USING TEST NUMBER 6 (MOST ROBUST AND LESS BURDEN ON THE MACHINE). THIS STUDY SHOWED A C<sub>pk</sub> OF 2.7 (ATTACHMENT 3) THE NONDESTRUCTIVE DATA OF EXPANSIONS YIELDED THE FOLLOWING STATISTICAL CONTROL LIMITS:

<u>CYCLE</u>	<u>LOW LIMIT</u>	<u>HIGH LIMIT</u>
1	1.6	2.4
2	5.0	6.5
3	3.4	5.1
4	1.7	3.2
5	1.2	2.7

NOTE EACH WELD FOR THIS MATERIAL HAS FIVE CYCLES PER WELD. EXCEEDING THE LIMITS ESTABLISHED BY THE TAGUCHI EXPERIMENT WILL RESULT IN THE OPERATOR EVALUATING SPECIAL CAUSES. IN ADDITION THE OPERATOR WILL ALSO BE GIVEN SECOND LIMITS THAT CORRESPOND TO THE 99.5% RELIABILITY AND GOING OUT OF THESE SECOND LIMITS CONSTITUTE EVALUATION OF THE WELD ITSELF.


A FURTHER PERFECTION STEP WAS TAKEN TO ASSURE CONSISTENT CLEANING OF THE WELD TIP WITH AN IMPROVED TOOL, THIS WAS DONE ON 30 WELDS WHICH WERE WITNESSED BY DAN CASSIDY OF D.C.A.S. THIS STEP IMPROVED OUR C<sub>pk</sub> TO 3.06.


#### CONCLUSION

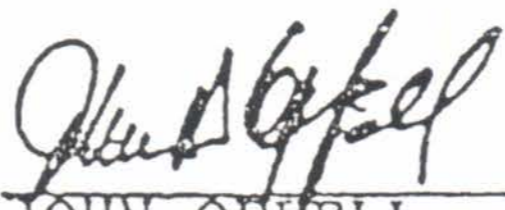
OUR CAPABILITY OF THE TESTED MATERIAL FAR EXCEEDS THE REQUIRED 99.5% LEVEL AND USING S.P.C TO CONTROL IT THROUGH THE WELD COMPUTER WILL ASSURE CONSISTENT HIGH QUALITY WELDS. THIS METHOD OF TAGUCHI AUGMENTED S.P.C PERFECTED THE PROCESS WHERE CONTROL LIMITS CAN BE DEVELOPED FOR EACH WELD SCHEDULE. APPROVALS WOULD MEAN THAT THE CONCEPTS IS APPROVED WHERE DETAILS OF CONTROL LIMITS OF ALL ALLOYS WILL BE DEVELOPED PER THE WELD SCHEDULE

#### APPROVALS

  
SYED SHAH  
PROCESS SPECIALIST SENIOR  
INDUSTRIAL ENGINEERING

  
GRAHAM MONTGOMERY  
QUALITY ENGINEER  
SPACE AND HEAT TRANSFER  
SYSTEMS

  
TONY GASPAROVIC  
MANUFACTURING ENGINEER  
WELDING

  
JOHN OPPELL  
SENIOR ENGINEER  
ADVANCED APPLICATIONS

#### CONCURRENCE

  
DAN CASSIDY  
D.C.A.S. QAS M&P