CHALLENGING MACHINE OBSOLESCENCE TO SUPPORT UNIT LEVEL TRACEABILITY FOR BGA PACKAGES

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ABSTRACT

This paper presents the comprehensive framework in employing the use of Internet of Things technology (IoT) to implement Unit Level Traceability for fingertip products. The product involved in this project is a new brick of BGA device supplied to one of our key customers for LCD touch controller application on mobile phones. This product is one of ST Calamba's high volume product that will support business ramp-up and the company's continued growth. Unit Level Traceability requirements were assessed in the process and gaps/constraints are identified. Driven with smart thinking, engaged people and team collaboration, assessment of the processes was done and identified that there are qualified machines which are not capable of supporting the system for Unit Level Traceability (ULT). This is one of the key focus or challenges the team met.

1. 0 INTRODUCTION

In today's technology, semiconductors and electronics have become part of our everyday activities. Internet of Things (IoT) are everywhere and part of our daily life. As technology keeps on changing, we too must adapt to these changes, and this is one of the biggest challenges for any semiconductor company to maintain its competitive market position, share and value. Always meeting the customer requirements and making our process robust in terms of process control, product traceability is the main goal of every company. Supporting this objective, ST introduced the Unit Level Traceability for its products, and we call this system STULT

The ST Unit Level Traceability (STULT) is a FW2 integrated system that serves as a central mapping repository for wafers, strips, devices and dice traceability information. The objective is to be able to do backward traceability for each device historical information at applicable process step.

During the introduction of our BGA product, unit level traceability is not included/considered during the qualification process. It just followed the standard lot traceability from input to end of the process. However, during the actual engineering runs, problems/issues arise related to defect escapees and will only be detected once lots are completed final testing step. Tracing backward the lot history at assembly process is a tedious activity which causes delays on the root cause analysis and manual validation of rejects. This is where the problem occurs and is highlighted by our customer, which needs to be acted upon immediately by the team.

1.1 Product Overview

The device is a substrate-based package where CMOSE40ULP wafer/die is mounted using die attach film (DAF) and wire bonded with a 0.70 mil Cu wire to form the interconnection. The product is molded through compression process, solder ball attached to each ball grid patterns, marked and then sawn into a single unit. This product application si for LCD touch controller on mobile phones.
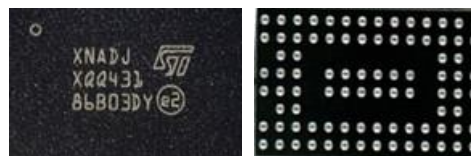
Figure 1: Sample photo of BGAXX product

2. 0 REVIEW OF RELATED WORK

Traceability is a key factor for process improvement, quality monitoring and analysis. In today's time, products become more complex and challenging and add dependencies to reduce engineering work. There is certain applicability that require connecting one system to another and one machine to other software/ applications to communicate and supply desired output. Unit level traceability allows the equipment to download and upload substrate, wafer x/y coordinates, and

lot information from different process via an Interface solution to provide full unit level backward and forward traceability from Assembly to Test & Finishing. Currently, STULT as a process control is supporting 60% of the products and the remaining percentage has some constraints/limitations on the process which is being addressed to achieve 100 % implementation.

3.0 METHODOLOGY

3.1 Problem Definition

The problem was triggered by high open/short rejects at Final test occurring on BGAXX qualification lots. After subjecting those FT rejects at Failure Analysis, it reveals assembly defects from wire bond like missing wire, non-stick on pad and others. These rejects escaped manual inspection/segregation at Assembly and have reached Final Testing process. Shown below are the occurrence of FT fails on BGA XX qual lots.
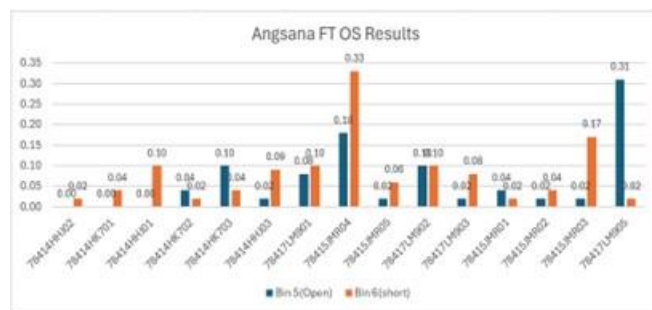

Figure 2: FT O/S data

Subjecting the affected sample with high O/S failure to FA, Assy related contributes 65% of the failures.
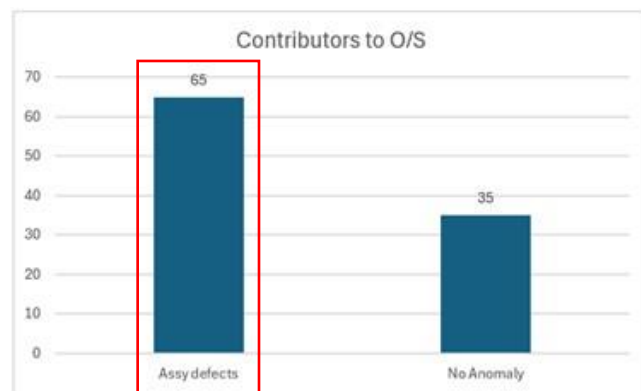

Figure 3: O/S contributors.

Assy defects contribution to O/S failures were further validated using 2 Proportion test.

Test and CI for Two Proportions

Method

p_1: proportion where Sample 1 = Event
p_2: proportion where Sample 2 = Event
Difference: $p_1 - p_2$

Descriptive Statistics

Sample	N	Event	Sample p
Sample 1	100	65	0.650000
Sample 2	100	35	0.350000

Estimation for Difference

Difference	95% CI for Difference
0.3	(0.167793, 0.432207)

CI based on normal approximation

Test

Null hypothesis H_0: $p_1 - p_2 = 0$
Alternative hypothesis H_1: $p_1 - p_2 \neq 0$

Method	Z-Value	P-Value
Normal approximation	4.45	0.000
Fisher's exact		0.000

Remarks :

Since p-value obtained (0.00) is less than the set alpha 0.05, we can dismiss the null hypothesis and conclude that there is statistically significant difference on the proportion of assy related defects compared to the no anomaly/non assy related in terms of its contribution to O/S failures. Assy defects has higher contribution to OS failures.

Details of the Assy related rejects were analyzed / subjected to FA and come up with below results. Based on the pareto, top defects are wire bond related like missing wire, lifted ball, lifted stitch, broken wire and club bonding.
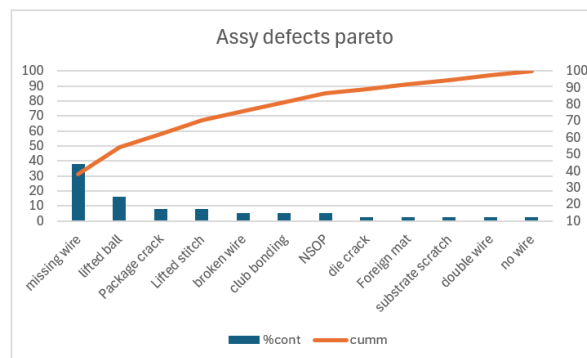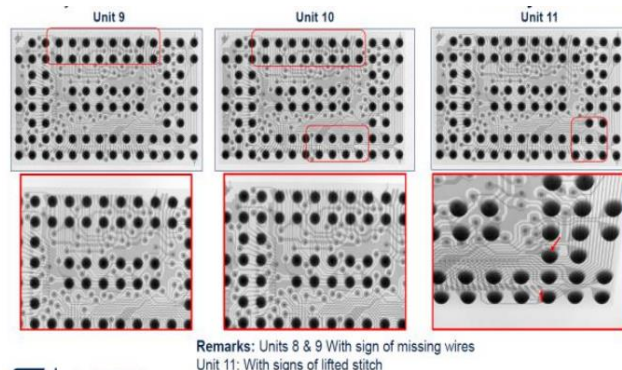

Figure 4: Assy defect pareto

Remarks: Units 8 & 9 With sign of missing wires
Unit 11: With signs of lifted stitch

Figure 5: Sample images of defects seen on Xray

3.2 VOC (Voice of the Customer)

The project is supported by Calamba Top Management and driven by customer needs to enhance product traceability up to unit level and for fast and easier lot disposition at Final Test when an SBL/SYL is encountered.

3.3 Problem Statement

Based on the collected data and information, Assembly rejects contribute 65% on the over-all Bin 5/bin 6 rejects detected at Final test for BGAXX products processed from Q1-Q2 2024.

3.4. Measure Phase
3.4.1 Assembly Process Flow
To have the full overview of the project, Figure 6 shows the macro map of BGA products and highlighted are the focused process (source and detection step)
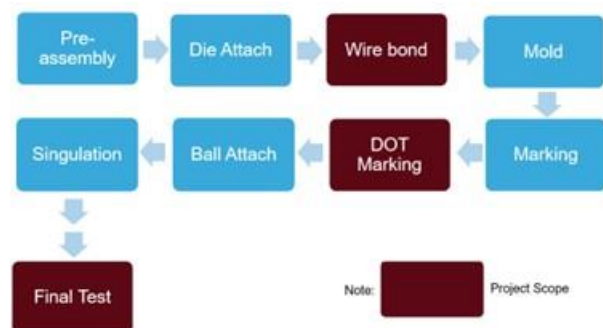
Figure 6. BGA XX process flow

It is followed by the details of the Wire bond process step and how each step is performed and impacts the problem.
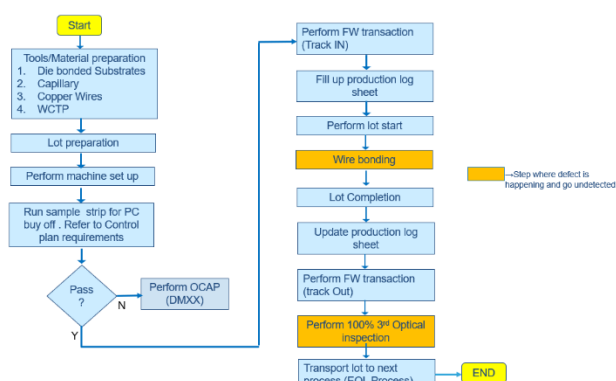
Figure7. Micro Map View of Wire bond process

3.4.2 Process Overview
3.4.2.1 Wire bond Process
Wire bonding is the process of providing electrical interconnections between external leads of semiconductor device (or other integrated circuits) and silicon chips using bonding wires, which are fine wires made of materials such as Gold, Copper, Silver or Aluminum. During wire bonding, defects incurred are detected by machine and giving signal/errors making it to stop the process. These errors are being attended by operator/technicians and necessary action plan on the machine and actual strip are needed /executed to resume the process.

Figure 8. Wire bonder Machine

3.4.2.2 100% 3ʳᵈ Optical Inspection
This is the process of inspecting the wire bonded strips to separate out any wire bond related defects. This is being performed by operator where rejects detected are inked on the strip and recorded on a strip map. Below is the sample strip map used for BGAXX. This is the replica of the actual substrate inspected as shown in Figure9.
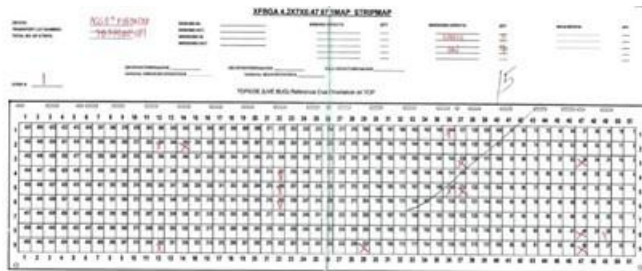
Figure 9: Rejects detected are x marked on the strip map

3.4.2.3 Dot Marking

Dot Marking is the process step wherein all identified rejects on strip are marked using a silver marking pen. During this process, operator used the dot marking jig and actual paper strip map as reference. The dot marking jig is the representation of the strip map and actual strip where the unit location is properly identified. Rejects on strip map are manually marked in actual strip using the dot marking pen by the operator. These rejects are then bin out during singulation and segregated on separate reject trays

Figure 10. Actual DOT marking by operator

Remarks : Reject identified on strip map are locate on the actual strip through the dot marking jig
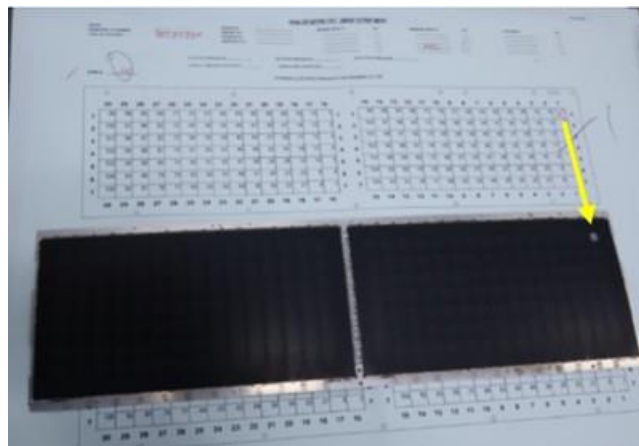
Figure 12: Paper Strip map vs actual strip with rejects

Remarks : Reject identified on strip map are marked on actual strip on the same location

3.4.3 Measurement System Analysis (MSA)

To assess the accuracy of the operators performing the visual inspection of the strips after wire bond process, attribute MSA was conducted. All operators were assigned to perform inspection on 50 samples and compare results with standards. Shown below are the results.

Operators	Effectiveness: 95% Lower CI (≥90%)	P (False Alarm) (≤5%)	P (Miss) (≤2%)	Kappa (≥0.75)	Result (Passed/ Failed)
144122	96.3207%	1.45%	0.00%	0.9866	Passed
144205	96.3207%	1.45%	0.00%	0.9866	Passed
144207	96.3207%	1.45%	0.00%	0.9866	Passed
253088	96.3207%	1.45%	0.00%	0.9866	Passed
144229	96.3207%	1.45%	0.00%	0.9866	Passed
145117	97.5030%	0.00%	0.00%	1.0000	Passed
297973	97.5030%	0.00%	0.00%	1.0000	Passed
144939	97.5030%	0.00%	0.00%	1.0000	Passed
144326	97.5030%	0.00%	0.00%	1.0000	Passed
144336	97.5030%	0.00%	0.00%	1.0000	Passed
144451	97.5030%	0.00%	0.00%	1.0000	Passed
144632	97.5030%	0.00%	0.00%	1.0000	Passed
144220	96.3207%	0.00%	1.23%	0.9866	Passed
144739	96.3207%	0.00%	1.23%	0.9866	Passed
262022	97.5030%	0.00%	0.00%	1.0000	Passed
144788	97.5030%	0.00%	0.00%	1.0000	Passed
253077	97.5030%	0.00%	0.00%	1.0000	Passed
144477	97.5030%	0.00%	0.00%	1.0000	Passed
144137	97.5030%	0.00%	0.00%	1.0000	Passed
144797	97.5030%	0.00%	0.00%	1.0000	Passed
144127	97.5030%	0.00%	0.00%	1.0000	Passed
144761	97.5030%	0.00%	0.00%	1.0000	Passed

261772	97.5030%	0.00%	0.00%	1.0000	Passed
143420	97.5030%	0.00%	0.00%	1.0000	Passed
145054	97.5030%	0.00%	0.00%	1.0000	Passed
252114	97.5030%	0.00%	0.00%	1.0000	Passed
272009	97.5030%	0.00%	0.00%	1.0000	Passed
253089	97.5030%	0.00%	0.00%	1.0000	Passed
243181	96.3207%	0.00%	1.23%	0.9866	Passed
253854	96.3207%	0.00%	1.23%	0.9866	Passed
291420	96.3207%	0.00%	1.23%	0.9866	Passed
144174	97.5030%	0.00%	0.00%	1.0000	Passed
144859	97.5030%	0.00%	0.00%	1.0000	Passed
144791	97.5030%	0.00%	0.00%	1.0000	Passed
262037	97.5030%	0.00%	0.00%	1.0000	Passed
253090	97.5030%	0.00%	0.00%	1.0000	Passed
307030	96.3207%	0.00%	1.23%	0.9866	Passed
253847	96.3207%	0.00%	1.23%	0.9866	Passed
308729	97.5030%	0.00%	0.00%	1.0000	Passed
253857	96.3207%	0.00%	1.23%	0.9866	Passed
300724	97.5030%	0.00%	0.00%	1.0000	Passed
144562	97.5030%	0.00%	0.00%	1.0000	Passed
144778	97.5030%	0.00%	0.00%	1.0000	Passed
248213	97.5030%	0.00%	0.00%	1.0000	Passed
277531	97.5030%	0.00%	0.00%	1.0000	Passed
145913	97.5030%	0.00%	0.00%	1.0000	Passed
144601	97.5030%	0.00%	0.00%	1.0000	Passed
275723	97.5030%	0.00%	0.00%	1.0000	Passed
272020	97.5030%	0.00%	0.00%	1.0000	Passed
144397	97.5030%	0.00%	0.00%	1.0000	Passed
145041	97.5030%	0.00%	0.00%	1.0000	Passed

Table 1: Operators Attribute MSA Study

Summary :

Parameter	E (95% LCI)	P (FA)	P (MISS)
Acceptable for the appraiser	≥ 90%	≤ 5%	≤ 2%
Actual	96.3207%	1.45%	1.23%

Conclusion :
Attribute MSA study of all the operators/inspectors passed the specs with 96.32% effectiveness, 1.45% False alarm and 1.23% miss.

Refer to Appendix 1 for the detaisl of the MSA study.

3.5 Analyze Phase
Potential root causes of the Assy defects detected at Final test are identified/summarized on the Fishbone Diagram shown below in Figure 13. Results are the collective data during brainstorming performed by the team.
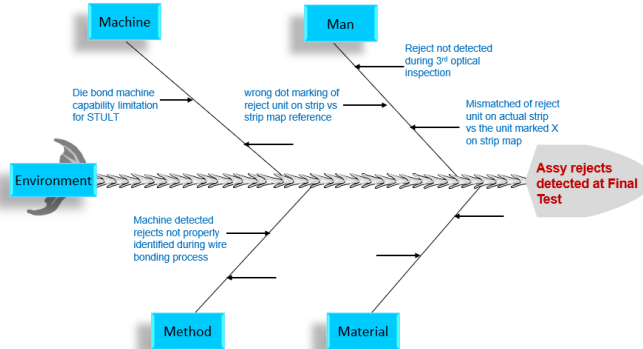
Figure 13 : Fishbone Diagram

3.5.1 Root Cause Validation

Potential Root Causes identified on the Fishbone are then validated and come up with below valid root causes:

Factors	Potential Root Cause	Method of Validation	Results	Remarks
MAN	Reject not detected during 3rd optical inspection	Perform sampling verification on inspected strip	Reject still detected during inspection . Said unit not inked as reject	VALID
MAN	wrong dot marking of reject unit on strip vs strip map reference	Verification on actual unit with dot mark vs X marked unit in strip map if tally		VALID
MAN	Mismatch of the actual reject unit on strip vs the unit marked "X" on strip map	Verification of actual strip with reject and compare it to its equivalent strip map if tally	Observed 1x unit with inked mark not tally with the unit that is marked X on strip map	VALID
METHOD	Machine detected rejects not properly identified during wire bonding process		Machine detected rejects are validated during 3rd optical inspection which could escapee also during inspection	VALID
MATERIAL	none			
MACHINE	Die bond machine capability limitation for STULT	Check current qualified die bonder if capable for ULT	Current machine platform/model is not capable to support STULT	VALID
ENVIRONMENT	none			

Table 2: Validation Matrix

4.0 RESULTS AND DISCUSSION

Results of the detailed analysis and investigations lead to the identification of the root causes/factors affecting Final test yield and come up with below action plan.

4.1 Action Plan
To address the root cause identified for the assy rejects reaching Final Test, STULT was implemented to improve reject detection and avoid mixing of units. Shown below is the current STULT architecture.
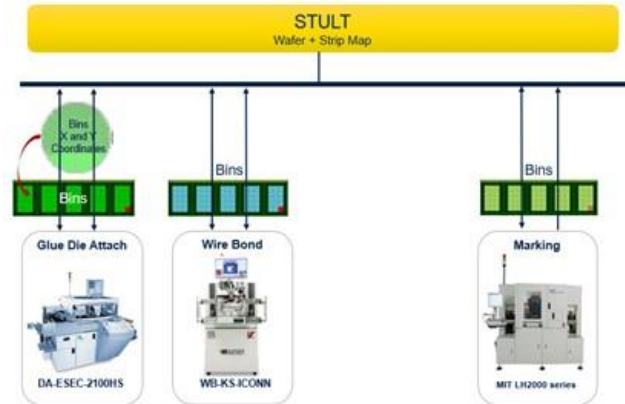
Figure 14. STULT Architecture

STULT by default will provide a higher level of process control such as: Diffusion Check, Product Check, Duplicate Die Pick Check, Strip Part Number Check, Anti Mix Check, 2D Read Off Check, Dummy Strips checks, Production Strips checks, Bin Code Check and Strip ID Format Check.

Communication between the Equipment controllers and the Equipment is done through SECS-GEM protocol.

STULT will help trace die coordinates pick from wafer level down to strip level unit location and rejects are traceable in the electronic strip map that will be generated from Die

Attach to Wire bond. Rejects identified will not be marked during marking process and therefore defect segregation is easy and accurate.
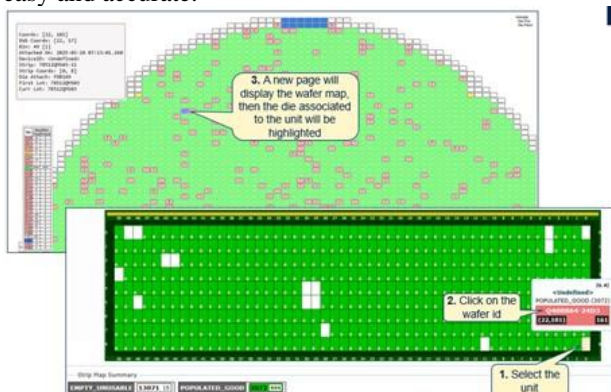
Figure 15. Strip to wafer map Traceability

Currently, STULT as a process control is supporting 79% of our products and the remaining percentage which is using a different system has some constraints/limitations on the process which is being addressed to achieve 100 % implementation.
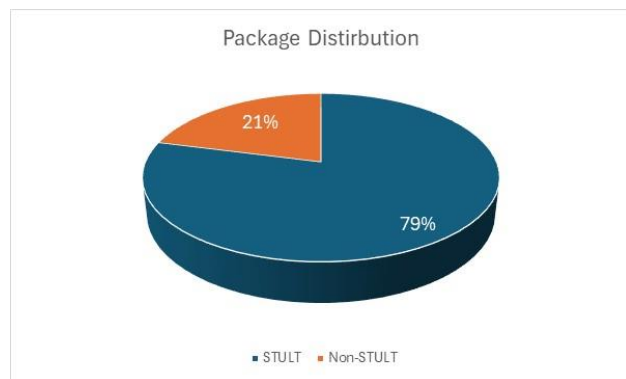
Figure 16 : STULT Distribution

4.2 **STULT Process Validation and Capability Assessment**

Prior implementing STULT on the current process, risk assessment was done to ensure no limitations or hindrances will be encountered during implementation. Below is the assessment done on the qualified machines used by the product.

Process/Machine	STULT Assessment	Remarks
Die Attach / ESEC2008	Not capable for STULT	Needs action
Wire bond / KNS ICONN	Capable	OK
Laer marking / MIT L2000HI	Capable	OK

Table 3: Machine Assessment
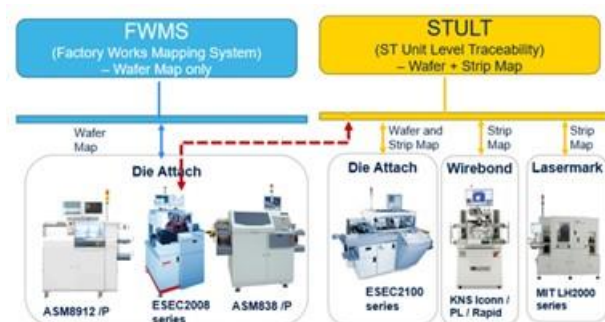
Remarks :ESEC2008 (old machine) is not capable for STULT. It can only support FWMS(Wafer mapping only)

4.3 Addressing the Gap for the Die Attach Machine
ESEC2008 series was tagged by the OEM as obsolete machines and no longer supported in terms of SW upgrade. To support the STULT requirement, 3rd party supplier was invited for the needed software or application. The MONOID Solution was introduced on the machine to support the requirements. Below are the features of this MONOID solution .

- HSMS connection
- SECS/GEM connection to machine
- Machine control and process state events
- Machine alarms to HOST
- Dynamic configurations of events
- Recipe upload / download to host
- Wafer mapping
- Strip mapping (E142 format)
- External wafer ID reading
- Log history of ACQYR-SM operations

MONOID Architecture:
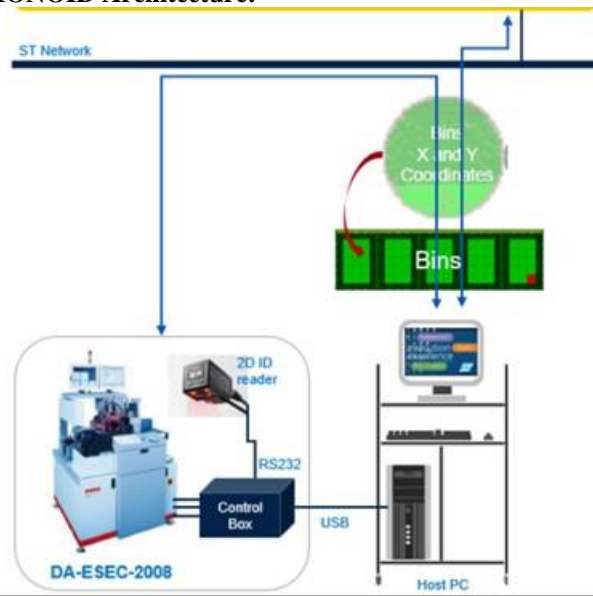
Figure 17. MONOID Interface with the ESEC2008

4.4 Results Validation
4.4.1 New Process Flow

After completing the needed upgrade on Die Attach machine, STULT was fully deployed/integrated on the affected processes (Die attach, Wire bond and marking). Below is the macro map of the process monitored during implementation.
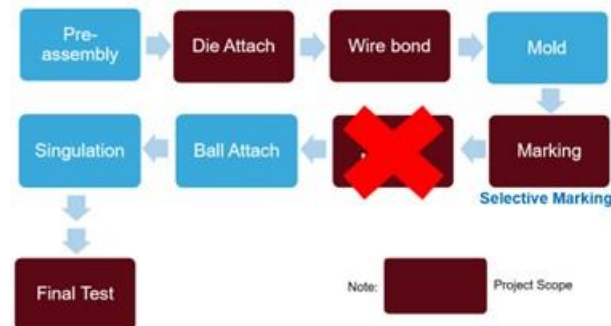
Figure 18. New Process Flow

Remarks : Dot marking step was eliminated after the STULT implementation. Rejects on actual strips are no longer dot mark, instead during laser marking, it will be skipped/not marked (selective marking) and only good units will be marked

4.4.2 Electronic Strip Map Creation
Starting at Die Attach step, electronic strip map are generated per strip. Good units are identified and differentiated with the bad/rejects.

4.4.2.1 Die Attach
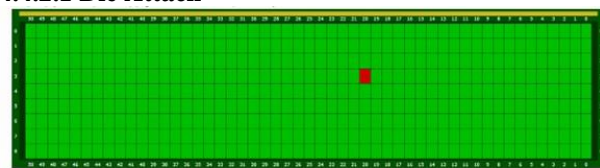
Remarks: At this step, machine rejects are updated in STULT including the bonded good dice.

4.4.2.2 Wire bond
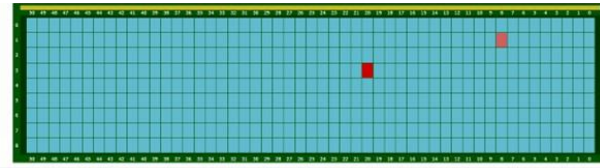
Remarks : During Wire bond step, the electronic strip map are updated real time . Rejects detected by the machine are automatically updated on the e-strip map. Detailed

breakdown of rejects and good units are visible in the electronic strip map.
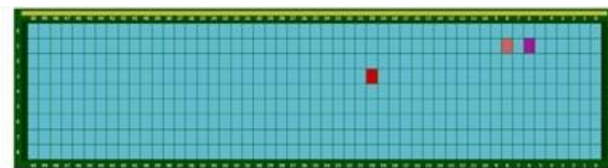
Remarks : During visual inspection, if there are rejects, user/operator will update the electronic strip map in STULT.

4.4.2.3 Laser marking
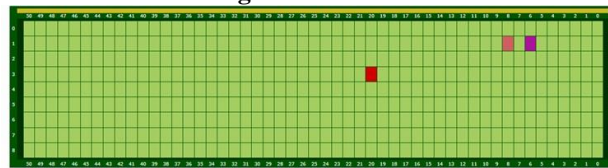
Remarks : During laser marking step, only good units are marked (selective marking) in the actual strips. Detailed breakdown of rejects and good units are also visible in the electronic strip map
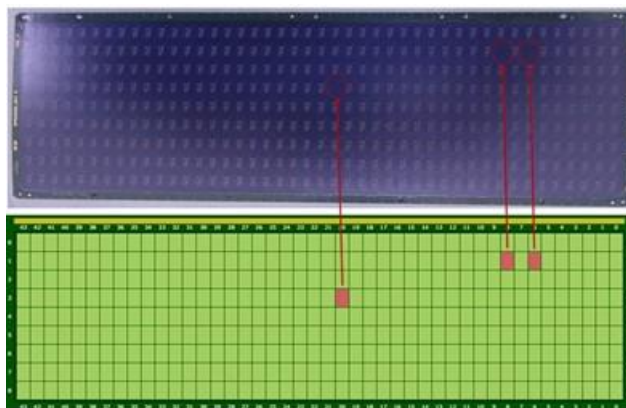
Remarks : Only **good units** are marked. Rejects units have NO marking as shown on the 3x units highlighted.

4.4.3 Final Test Validation
Results of the lots processed at Assy with STULT shows acceptable FT yield and no Assy related rejects are reported that had cause high bin 5/6 failures.

Lot	78432YDN01	78430X4S05
Diffusion	VQ408744	VQ408864
Qty In	5637	5555
Sbin SbinName		
1 GOOD	96.65%	99.71%
5 ContOPEN	0.04%	0.05%
6 ContSHORT	0.04%	0.02%
Sbin5 Quantity	2	3
Sbin6 Quantity	2	1

Table 4 : Final Test OS data

Statistical comparison using 2 proportion tests for lots with STULT and w/o STULT was performed.

Test and CI for Two Proportions

Method

p_1: proportion where Sample 1 = Event
p_2: proportion where Sample 2 = Event
Difference: $p_1 - p_2$

Descriptive Statistics

Sample	N	Event	Sample p
Sample 1	13122	37	0.002820
Sample 2	11192	0	0.000000

Estimation for Difference

Difference	95% CI for Difference
0.0028197	(0.001912, 0.003727)

CI based on normal approximation

Note : Sample 1: Lots without STULT
Sample 2: Lots with STULT

Test

Null hypothesis H_0: $p_1 - p_2 = 0$
Alternative hypothesis H_1: $p_1 - p_2 \neq 0$

Method	Z-Value	P-Value
Normal approximation	6.09	0.000
Fisher's exact		0.000

The normal approximation may be inaccurate for small samples.

Figure 19: 2- Proportion test

Remarks :
Since p-value obtained (0.00) is less than the set alpha 0.05, we can dismiss the null hypothesis and conclude that there is statistically significant difference on the number of Assy rejects detected on lots without STULT and lots with STULT. Lots with STULT shows better results and low/zero

occurrence of Assy rejects that may reached Final test and high chance of passing the SYL/SBL limit.

Further validation/monitoring was performed on production lots and shows good results. No lots failed the SBL limit for O/S (Open/Short) .
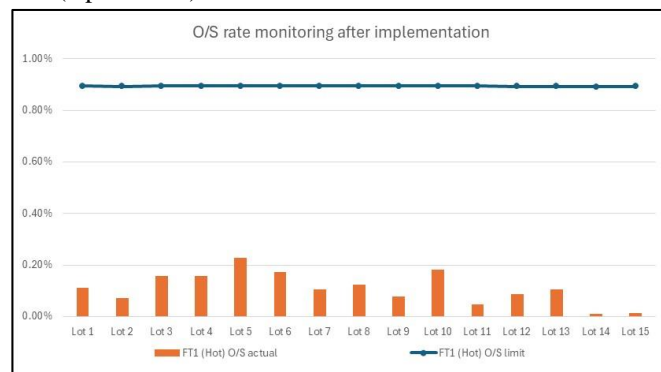
Figure 20 : O/S Performance of Production lots after STULT implementation

5.0 CONCLUSION

Machine obsolescence poses significant challenges to maintaining unit level traceability. As machine age or become obsolete, ensuring compatibility becomes increasingly difficult. Through team's collaboration, teamwork and partnership with manufacturers and third-party providers, we were able to overcome these challenges and ensures the continues use of STULT in our manufacturing process. Unit level traceability as an effective process control has enable us to guarantee quality products reached Final test and therefore minimizing time consume during failure analysis whenever low yield limit was triggered. Furthermore, our process becomes more efficient by minimizing the time consume on non-value add activities like dot marking of rejects.

6.0 RECOMMENDATIONS

The authors would like to recommend the fan out of STULT system implementation on all fingertip/BGA products using the legacy machine at Die Attach and to other products during NPI phase . In addition, assess and qualify STULT on lead frame-based packages for continuous improvement in the system. This fan out will help for the 100% full deployment of STULT in our manufacturing process.

7.0 ACKNOWLEDGMENT

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8.0 REFERENCES

1. STULT, a guideline in implementing ULT in ST sites
2. Unit Level Traceability (ULT) Development and Implementation for High Level Traceability in Semiconductor Assembly & Test Manufacturing, Oct 2022, Conf paper

9.0 ABOUT THE AUTHORS

Marichu S. AMALIN received her B.S degree in Electrical Engineering at Batangas State University in Batangas City. She has 25 years of solid experience in a semiconductor company focusing on Operations Process Engineering, Project Management and New Product Introduction. She is Currently the NPI Manager leading products/projects from Imaging/Analog Division. She is a certified SIX Sigma Black Belt , Subject matter Expert trainer for AIAG-VDA PFMEA, 7 QC tools and 8D problem Solving Methodology and a technical writer of various papers presented /published on ASEMEP National Technical Symposium.

Cheryl JALLORINA received her B.S degree in Electronics and Communication Engineering at Mapua Institute of Technology in Intramuros Manila. She has 22 years of solid experience in semiconductor company focusing on application / system used in equipment. She is a senior Equipment Engineer under Assembly Equipment Engineering Focused Improvement and Automation - System handling various application used in the production shopfloor.

Corazon R. LLAMAS received her B.S Degree from Technological University of the Philippines with major in Chemical Technology & Manufacturing Engineering and has an MBA unit from University of Batangas.
She has more than 25 years' experience in the Semiconductors Industry focusing on Back End Plating Process Engineering, Technical Training, Customer Support, Back End Quality, QMS/Audits, Process Control and NPI-QA. She is a Certified SME for AIAG-VDA PFMEA, a Trainer, a QMS Lead Auditor and proud Manager Coach of "InSTrippers team Manufacturing Cell" and published/presented technical project which focused on ESDFOS / Surface ESD at IEEE Singapore.

10.0 APPENDIX

APPENDIX A: Wire bond Operator's Attribute MSA Study

Operators	Effectiveness: 95% Lower CI (≥90%)	P (False Alarm) (≤5%)	P (Miss) (≤2%)	Kappa (≥0.75)	Result (Passed/ Failed)
144122	96.3207%	1.45%	0.00%	0.9866	Passed
144205	96.3207%	1.45%	0.00%	0.9866	Passed
144207	96.3207%	1.45%	0.00%	0.9866	Passed
253088	96.3207%	1.45%	0.00%	0.9866	Passed
144229	96.3207%	1.45%	0.00%	0.9866	Passed
145117	97.5030%	0.00%	0.00%	1.0000	Passed
297973	97.5030%	0.00%	0.00%	1.0000	Passed
144939	97.5030%	0.00%	0.00%	1.0000	Passed
144326	97.5030%	0.00%	0.00%	1.0000	Passed
144336	97.5030%	0.00%	0.00%	1.0000	Passed
144451	97.5030%	0.00%	0.00%	1.0000	Passed
144632	97.5030%	0.00%	0.00%	1.0000	Passed
144220	96.3207%	0.00%	1.23%	0.9866	Passed
144739	96.3207%	0.00%	1.23%	0.9866	Passed
262022	97.5030%	0.00%	0.00%	1.0000	Passed
144788	97.5030%	0.00%	0.00%	1.0000	Passed
253077	97.5030%	0.00%	0.00%	1.0000	Passed
144477	97.5030%	0.00%	0.00%	1.0000	Passed
144137	97.5030%	0.00%	0.00%	1.0000	Passed
144797	97.5030%	0.00%	0.00%	1.0000	Passed
144127	97.5030%	0.00%	0.00%	1.0000	Passed
144761	97.5030%	0.00%	0.00%	1.0000	Passed

Operators	Effectiveness: 95% Lower CI (≥90%)	P (False Alarm) (≤5%)	P (Miss) (≤2%)	Kappa (≥0.75)	Result (Passed/ Failed)
268306	97.5030%	0.00%	0.00%	1.0000	Passed
144903	96.3207%	0.00%	1.23%	0.9866	Passed
144580	97.5030%	0.00%	0.00%	1.0000	Passed
276549	97.5030%	0.00%	0.00%	1.0000	Passed
253109	97.5030%	0.00%	0.00%	1.0000	Passed
243161	97.5030%	0.00%	0.00%	1.0000	Passed
145158	96.3207%	1.45%	0.00%	0.9866	Passed
303632	97.5030%	0.00%	0.00%	1.0000	Passed
144756	97.5030%	0.00%	0.00%	1.0000	Passed
144146	97.5030%	0.00%	0.00%	1.0000	Passed
243787	97.5030%	0.00%	0.00%	1.0000	Passed
298046	97.5030%	0.00%	0.00%	1.0000	Passed
294231	97.5030%	0.00%	0.00%	1.0000	Passed
301615	97.5030%	0.00%	0.00%	1.0000	Passed
144641	97.5030%	0.00%	0.00%	1.0000	Passed
303633	97.5030%	0.00%	0.00%	1.0000	Passed
262004	97.5030%	0.00%	0.00%	1.0000	Passed
307612	97.5030%	0.00%	0.00%	1.0000	Passed
253078	97.5030%	0.00%	0.00%	1.0000	Passed
144887	97.5030%	0.00%	0.00%	1.0000	Passed
143608	97.5030%	0.00%	0.00%	1.0000	Passed
143417	97.5030%	0.00%	0.00%	1.0000	Passed
145169	97.5030%	0.00%	0.00%	1.0000	Passed
252752	97.5030%	0.00%	0.00%	1.0000	Passed
144212	97.5030%	0.00%	0.00%	1.0000	Passed
275730	97.5030%	0.00%	0.00%	1.0000	Passed
145208	97.5030%	0.00%	0.00%	1.0000	Passed
144946	97.5030%	0.00%	0.00%	1.0000	Passed
299626	97.5030%	0.00%	0.00%	1.0000	Passed
272006	97.5030%	0.00%	0.00%	1.0000	Passed
144271	97.5030%	0.00%	0.00%	1.0000	Passed
145079	97.5030%	0.00%	0.00%	1.0000	Passed
143453	97.5030%	0.00%	0.00%	1.0000	Passed
144461	97.5030%	0.00%	0.00%	1.0000	Passed
304756	97.5030%	0.00%	0.00%	1.0000	Passed

261772	97.5030%	0.00%	0.00%	1.0000	Passed
143420	97.5030%	0.00%	0.00%	1.0000	Passed
145054	97.5030%	0.00%	0.00%	1.0000	Passed
252114	97.5030%	0.00%	0.00%	1.0000	Passed
272009	97.5030%	0.00%	0.00%	1.0000	Passed
253089	97.5030%	0.00%	0.00%	1.0000	Passed
243181	96.3207%	0.00%	1.23%	0.9866	Passed
253854	96.3207%	0.00%	1.23%	0.9866	Passed
291420	96.3207%	0.00%	1.23%	0.9866	Passed
144174	97.5030%	0.00%	0.00%	1.0000	Passed
144859	97.5030%	0.00%	0.00%	1.0000	Passed
144791	97.5030%	0.00%	0.00%	1.0000	Passed
262037	97.5030%	0.00%	0.00%	1.0000	Passed
253090	97.5030%	0.00%	0.00%	1.0000	Passed
307030	96.3207%	0.00%	1.23%	0.9866	Passed
253847	96.3207%	0.00%	1.23%	0.9866	Passed
308729	97.5030%	0.00%	0.00%	1.0000	Passed
253857	96.3207%	0.00%	1.23%	0.9866	Passed
300724	97.5030%	0.00%	0.00%	1.0000	Passed
144562	97.5030%	0.00%	0.00%	1.0000	Passed
144778	97.5030%	0.00%	0.00%	1.0000	Passed
248213	97.5030%	0.00%	0.00%	1.0000	Passed
277531	97.5030%	0.00%	0.00%	1.0000	Passed
145913	97.5030%	0.00%	0.00%	1.0000	Passed
144601	97.5030%	0.00%	0.00%	1.0000	Passed
275723	97.5030%	0.00%	0.00%	1.0000	Passed
272020	97.5030%	0.00%	0.00%	1.0000	Passed
144397	97.5030%	0.00%	0.00%	1.0000	Passed
145041	97.5030%	0.00%	0.00%	1.0000	Passed

Gauge Attribute Chart

10

Agreement Report

Rater	% Agreement	95% Lower CI	95% Upper CI
144122	99.2448	91.5250	99.9375
144205	99.2448	91.5250	99.9375
144207	99.2448	91.5250	99.9375
253088	99.2448	91.5250	99.9375
144229	99.2448	91.5250	99.9375
145117	99.8881	92.6590	99.9984
297973	99.8881	92.6590	99.9984
144939	99.8881	92.6590	99.9984
144326	99.8881	92.6590	99.9984
144336	99.8881	92.6590	99.9984
144451	99.8881	92.6590	99.9984
144632	99.8881	92.6590	99.9984
144220	99.2308	91.5012	99.9353
144739	99.2308	91.5012	99.9353
262022	99.8881	92.6590	99.9984
144788	99.8881	92.6590	99.9984
253077	99.8881	92.6590	99.9984
144477	99.8881	92.6590	99.9984
144137	99.8881	92.6590	99.9984
144797	99.8881	92.6590	99.9984
144127	99.8881	92.6590	99.9984
144761	99.8881	92.6590	99.9984
268306	99.8881	92.6590	99.9984
144903	99.2261	91.4933	99.9346
144580	99.8881	92.6590	99.9984
276549	99.8881	92.6590	99.9984
253109	99.8881	92.6590	99.9984
243161	99.8881	92.6590	99.9984
145158	99.2261	91.4933	99.9346
303632	99.8881	92.6590	99.9984
144756	99.8881	92.6590	99.9984
144146	99.8881	92.6590	99.9984
243787	99.8881	92.6590	99.9984
298046	99.8881	92.6590	99.9984
294231	99.8881	92.6590	99.9984
301615	99.8881	92.6590	99.9984
144641	99.8881	92.6590	99.9984
303633	99.8881	92.6590	99.9984
262004	99.8881	92.6590	99.9984
307612	99.8881	92.6590	99.9984
253078	99.8881	92.6590	99.9984
144887	99.8881	92.6590	99.9984
143608	99.8881	92.6590	99.9984
143417	99.8881	92.6590	99.9984
145169	99.8881	92.6590	99.9984
252752	99.8881	92.6590	99.9984
144212	99.8881	92.6590	99.9984
275730	99.8881	92.6590	99.9984

Rater	% Agreement	95% Lower CI	95% Upper CI
145208	99.8881	92.6590	99.9984
144946	99.8881	92.6590	99.9984
299626	99.8881	92.6590	99.9984
272006	99.8881	92.6590	99.9984
144271	99.8881	92.6590	99.9984
145079	99.8881	92.6590	99.9984
143453	99.8881	92.6590	99.9984
144461	99.8881	92.6590	99.9984
304756	99.8881	92.6590	99.9984
253068	99.2261	91.4933	99.9346
144695	99.8881	92.6590	99.9984
311448	99.8881	92.6590	99.9984
253811	99.8881	92.6590	99.9984
253835	99.8881	92.6590	99.9984
306522	99.8881	92.6590	99.9984
145214	99.8881	92.6590	99.9984
144825	99.8881	92.6590	99.9984
144766	99.8881	92.6590	99.9984
144534	99.8881	92.6590	99.9984
261772	99.8881	92.6590	99.9984
143420	99.8881	92.6590	99.9984
145054	99.8881	92.6590	99.9984
252114	99.8881	92.6590	99.9984
272009	99.8881	92.6590	99.9984
253089	99.8881	92.6590	99.9984
243181	99.2261	91.4933	99.9346
253854	99.2448	91.5250	99.9375
291420	99.2448	91.5250	99.9375
144174	99.8881	92.6590	99.9984
144859	99.8881	92.6590	99.9984
144791	99.8881	92.6590	99.9984
262037	99.8881	92.6590	99.9984
253090	99.8881	92.6590	99.9984
307030	99.2448	91.5250	99.9375
253847	99.2448	91.5250	99.9375
308729	99.8881	92.6590	99.9984
253857	99.2448	91.5250	99.9375
300724	99.8881	92.6590	99.9984
144562	99.8881	92.6590	99.9984
144778	99.8881	92.6590	99.9984
248213	99.8881	92.6590	99.9984
277531	99.8881	92.6590	99.9984
145913	99.8881	92.6590	99.9984
144601	99.8881	92.6590	99.9984
275723	99.8881	92.6590	99.9984
272020	99.8881	92.6590	99.9984
144397	99.8881	92.6590	99.9984
145041	99.8881	92.6590	99.9984

Number Inspected	Number Matched	% Agreement	95% Lower CI	95% Upper CI
50	43	86.000	73.814	93.049

Agreement Comparisons

Rater	Compared with Rater	Kappa	Plot Kappa	Standard Error
144122	144205	1.0000		0.0000
144122	144207	1.0000		0.0000
144122	253088	1.0000		0.0000
144122	144229	1.0000		0.0000
144122	145117	0.9866		0.0134
144122	297973	0.9866		0.0134
144122	144939	0.9866		0.0134
144122	144326	0.9866		0.0134
144122	144336	0.9866		0.0134
144122	144451	0.9866		0.0134

Rater	Compared with Rater	Kappa	Plot Kappa	Standard Error
144122	144632	0.9866		0.0134
144122	144220	0.9732		0.0188
144122	144739	0.9732		0.0188
144122	262022	0.9866		0.0134
144122	144788	0.9866		0.0134
144122	253077	0.9866		0.0134
144122	144477	0.9866		0.0134
144122	144137	0.9866		0.0134
144122	144797	0.9866		0.0134
144122	144127	0.9866		0.0134
144122	144761	0.9866		0.0134
144122	268306	0.9866		0.0134
144122	144903	0.9732		0.0188
144122	144580	0.9866		0.0134
144122	276549	0.9866		0.0134
144122	253109	0.9866		0.0134
144122	243161	0.9866		0.0134
144122	145158	0.9731		0.0189
144122	303632	0.9866		0.0134
144122	144756	0.9866		0.0134
144122	144146	0.9866		0.0134
144122	243787	0.9866		0.0134
144122	298046	0.9866		0.0134
144122	294231	0.9866		0.0134
144122	301615	0.9866		0.0134
144122	144641	0.9866		0.0134
144122	303633	0.9866		0.0134
144122	262004	0.9866		0.0134
144122	307612	0.9866		0.0134
144122	253078	0.9866		0.0134
144122	144887	0.9866		0.0134
144122	143608	0.9866		0.0134
144122	143417	0.9866		0.0134
144122	145169	0.9866		0.0134
144122	252752	0.9866		0.0134
144122	144212	0.9866		0.0134
144122	275730	0.9866		0.0134
144122	145208	0.9866		0.0134
144122	144946	0.9866		0.0134
144122	299626	0.9866		0.0134
144122	272006	0.9866		0.0134
144122	144271	0.9866		0.0134
144122	145079	0.9866		0.0134
144122	143453	0.9866		0.0134
144122	144461	0.9866		0.0134
144122	304756	0.9866		0.0134
144122	253068	0.9731		0.0189
144122	144695	0.9866		0.0134
144122	311448	0.9866		0.0134
144122	253811	0.9866		0.0134
144122	253835	0.9866		0.0134
144122	306522	0.9866		0.0134
144122	145214	0.9866		0.0134
144122	144825	0.9866		0.0134
144122	144766	0.9866		0.0134
144122	144534	0.9866		0.0134
144122	261772	0.9866		0.0134
144122	143420	0.9866		0.0134
144122	145054	0.9866		0.0134
144122	252114	0.9866		0.0134
144122	272009	0.9866		0.0134
144122	253089	0.9866		0.0134
144122	243181	0.9732		0.0188
144122	253854	0.9732		0.0188
144122	291420	0.9732		0.0188

Rater	Compared with Rater	Kappa	Plot Kappa	Standard Error
144122	144174	0.9866		0.0134
144122	144859	0.9866		0.0134
144122	144791	0.9866		0.0134
144122	262037	0.9866		0.0134
144122	253090	0.9866		0.0134
144122	307030	0.9732		0.0188
144122	253847	0.9732		0.0188
144122	308729	0.9866		0.0134
144122	253857	0.9732		0.0188
144122	300724	0.9866		0.0134
144122	144562	0.9866		0.0134
144122	144778	0.9866		0.0134
144122	248213	0.9866		0.0134
144122	277531	0.9866		0.0134
144122	145913	0.9866		0.0134
144122	144601	0.9866		0.0134
144122	275723	0.9866		0.0134
144122	272020	0.9866		0.0134
144122	144397	0.9866		0.0134
144122	145041	0.9866		0.0134
144205	144207	1.0000		0.0000
144205	253088	1.0000		0.0000
144205	144229	1.0000		0.0000
144205	145117	0.9866		0.0134
144205	297973	0.9866		0.0134
144205	144939	0.9866		0.0134
144205	144326	0.9866		0.0134
144205	144336	0.9866		0.0134
144205	144451	0.9866		0.0134
144205	144632	0.9866		0.0134
144205	144220	0.9732		0.0188
144205	144739	0.9732		0.0188
144205	262022	0.9866		0.0134
144205	144788	0.9866		0.0134
144205	253077	0.9866		0.0134
144205	144477	0.9866		0.0134
144205	144137	0.9866		0.0134
144205	144797	0.9866		0.0134
144205	144127	0.9866		0.0134
144205	144761	0.9866		0.0134
144205	268306	0.9866		0.0134
144205	144903	0.9732		0.0188
144205	144580	0.9866		0.0134
144205	276549	0.9866		0.0134
144205	253109	0.9866		0.0134
144205	243161	0.9866		0.0134
144205	145158	0.9731		0.0189
144205	303632	0.9866		0.0134
144205	144756	0.9866		0.0134
144205	144146	0.9866		0.0134
144205	243787	0.9866		0.0134
144205	298046	0.9866		0.0134
144205	294231	0.9866		0.0134
144205	301615	0.9866		0.0134
144205	144641	0.9866		0.0134
144205	303633	0.9866		0.0134
144205	262004	0.9866		0.0134
144205	307612	0.9866		0.0134
144205	253078	0.9866		0.0134
144205	144887	0.9866		0.0134
144205	143608	0.9866		0.0134
144205	143417	0.9866		0.0134
144205	145169	0.9866		0.0134
144205	252752	0.9866		0.0134
144205	144212	0.9866		0.0134

Rater	Compared with Rater	Kappa	Plot Kappa	Standard Error
144205	275730	0.9866		0.0134
144205	145208	0.9866		0.0134
144205	144946	0.9866		0.0134
144205	299626	0.9866		0.0134
144205	272006	0.9866		0.0134
144205	144271	0.9866		0.0134
144205	145079	0.9866		0.0134
144205	143453	0.9866		0.0134
144205	144461	0.9866		0.0134
144205	304756	0.9866		0.0134
144205	253068	0.9731		0.0189
144205	144695	0.9866		0.0134
144205	311448	0.9866		0.0134
144205	253811	0.9866		0.0134
144205	253835	0.9866		0.0134
144205	306522	0.9866		0.0134
144205	145214	0.9866		0.0134
144205	144825	0.9866		0.0134
144205	144766	0.9866		0.0134
144205	144534	0.9866		0.0134
144205	261772	0.9866		0.0134
144205	143420	0.9866		0.0134
144205	145054	0.9866		0.0134
144205	252114	0.9866		0.0134
144205	272009	0.9866		0.0134
144205	253089	0.9866		0.0134
144205	243181	0.9732		0.0188
144205	253854	0.9732		0.0188
144205	291420	0.9732		0.0188
144205	144174	0.9866		0.0134
144205	144859	0.9866		0.0134
144205	144791	0.9866		0.0134
144205	262037	0.9866		0.0134
144205	253090	0.9866		0.0134
144205	307030	0.9732		0.0188
144205	253847	0.9732		0.0188
144205	308729	0.9866		0.0134
144205	253857	0.9732		0.0188
144205	300724	0.9866		0.0134
144205	144562	0.9866		0.0134
144205	144778	0.9866		0.0134
144205	248213	0.9866		0.0134
144205	277531	0.9866		0.0134
144205	145913	0.9866		0.0134
144205	144601	0.9866		0.0134
144205	275723	0.9866		0.0134
144205	272020	0.9866		0.0134
144205	144397	0.9866		0.0134
144205	145041	0.9866		0.0134
144207	253088	1.0000		0.0000
144207	144229	1.0000		0.0000
144207	145117	0.9866		0.0134
144207	297973	0.9866		0.0134
144207	144939	0.9866		0.0134
144207	144326	0.9866		0.0134
144207	144336	0.9866		0.0134
144207	144451	0.9866		0.0134
144207	144632	0.9866		0.0134
144207	144220	0.9732		0.0188
144207	144739	0.9732		0.0188
144207	262022	0.9866		0.0134
144207	144788	0.9866		0.0134
144207	253077	0.9866		0.0134
144207	144477	0.9866		0.0134
144207	144137	0.9866		0.0134

Rater	Compared with Rater	Kappa	Plot Kappa	Standard Error
144207	144797	0.9866		0.0134
144207	144127	0.9866		0.0134
144207	144761	0.9866		0.0134
144207	268306	0.9866		0.0134
144207	144903	0.9732		0.0188
144207	144580	0.9866		0.0134
144207	276549	0.9866		0.0134
144207	253109	0.9866		0.0134
144207	243161	0.9866		0.0134
144207	145158	0.9731		0.0189
144207	303632	0.9866		0.0134
144207	144756	0.9866		0.0134
144207	144146	0.9866		0.0134
144207	243787	0.9866		0.0134
144207	298046	0.9866		0.0134
144207	294231	0.9866		0.0134
144207	301615	0.9866		0.0134
144207	144641	0.9866		0.0134
144207	303633	0.9866		0.0134
144207	262004	0.9866		0.0134
144207	307612	0.9866		0.0134
144207	253078	0.9866		0.0134
144207	144887	0.9866		0.0134
144207	143608	0.9866		0.0134
144207	143417	0.9866		0.0134
144207	145169	0.9866		0.0134
144207	252752	0.9866		0.0134
144207	144212	0.9866		0.0134
144207	275730	0.9866		0.0134
144207	145208	0.9866		0.0134
144207	144946	0.9866		0.0134
144207	299626	0.9866		0.0134
144207	272006	0.9866		0.0134
144207	144271	0.9866		0.0134
144207	145079	0.9866		0.0134
144207	143453	0.9866		0.0134
144207	144461	0.9866		0.0134
144207	304756	0.9866		0.0134
144207	253068	0.9731		0.0189
144207	144695	0.9866		0.0134
144207	311448	0.9866		0.0134
144207	253811	0.9866		0.0134
144207	253835	0.9866		0.0134
144207	306522	0.9866		0.0134
144207	145214	0.9866		0.0134
144207	144825	0.9866		0.0134
144207	144766	0.9866		0.0134
144207	144534	0.9866		0.0134
144207	261772	0.9866		0.0134
144207	143420	0.9866		0.0134
144207	145054	0.9866		0.0134
144207	252114	0.9866		0.0134
144207	272009	0.9866		0.0134
144207	253089	0.9866		0.0134
144207	243181	0.9732		0.0188
144207	253854	0.9732		0.0188
144207	291420	0.9732		0.0188
144207	144174	0.9866		0.0134
144207	144859	0.9866		0.0134
144207	144791	0.9866		0.0134
144207	262037	0.9866		0.0134
144207	253090	0.9866		0.0134
144207	307030	0.9732		0.0188
144207	253847	0.9732		0.0188
144207	308729	0.9866		0.0134

Rater	Compared with Standard	Kappa	Plot Kappa	Standard Error
144122	STANDARD	0.9866		0.0134
144205	STANDARD	0.9866		0.0134
144207	STANDARD	0.9866		0.0134
253088	STANDARD	0.9866		0.0134
144229	STANDARD	0.9866		0.0134
145117	STANDARD	1.0000		0.0000
297973	STANDARD	1.0000		0.0000
144939	STANDARD	1.0000		0.0000
144326	STANDARD	1.0000		0.0000
144336	STANDARD	1.0000		0.0000
144451	STANDARD	1.0000		0.0000
144632	STANDARD	1.0000		0.0000
144220	STANDARD	0.9866		0.0134
144739	STANDARD	0.9866		0.0134
262022	STANDARD	1.0000		0.0000
144788	STANDARD	1.0000		0.0000
253077	STANDARD	1.0000		0.0000
144477	STANDARD	1.0000		0.0000
144137	STANDARD	1.0000		0.0000
144797	STANDARD	1.0000		0.0000
144127	STANDARD	1.0000		0.0000
144761	STANDARD	1.0000		0.0000
268306	STANDARD	1.0000		0.0000
144903	STANDARD	0.9866		0.0134
144580	STANDARD	1.0000		0.0000
276549	STANDARD	1.0000		0.0000
253109	STANDARD	1.0000		0.0000
243161	STANDARD	1.0000		0.0000
145158	STANDARD	0.9866		0.0134
303632	STANDARD	1.0000		0.0000
144756	STANDARD	1.0000		0.0000
144146	STANDARD	1.0000		0.0000
243787	STANDARD	1.0000		0.0000
298046	STANDARD	1.0000		0.0000
294231	STANDARD	1.0000		0.0000
301615	STANDARD	1.0000		0.0000
144641	STANDARD	1.0000		0.0000
303633	STANDARD	1.0000		0.0000
262004	STANDARD	1.0000		0.0000
307612	STANDARD	1.0000		0.0000
253078	STANDARD	1.0000		0.0000
144887	STANDARD	1.0000		0.0000
143608	STANDARD	1.0000		0.0000
143417	STANDARD	1.0000		0.0000
145169	STANDARD	1.0000		0.0000
252752	STANDARD	1.0000		0.0000
144212	STANDARD	1.0000		0.0000
275730	STANDARD	1.0000		0.0000
145208	STANDARD	1.0000		0.0000
144946	STANDARD	1.0000		0.0000
299626	STANDARD	1.0000		0.0000
272006	STANDARD	1.0000		0.0000
144271	STANDARD	1.0000		0.0000
145079	STANDARD	1.0000		0.0000
143453	STANDARD	1.0000		0.0000
144461	STANDARD	1.0000		0.0000
304756	STANDARD	1.0000		0.0000
253068	STANDARD	0.9866		0.0134
144695	STANDARD	1.0000		0.0000
311448	STANDARD	1.0000		0.0000
253811	STANDARD	1.0000		0.0000
253835	STANDARD	1.0000		0.0000
306522	STANDARD	1.0000		0.0000
145214	STANDARD	1.0000		0.0000

Rater	Compared with Standard	Kappa	Plot Kappa	Standard Error
144825	STANDARD	1.0000		0.0000
144766	STANDARD	1.0000		0.0000
144534	STANDARD	1.0000		0.0000
261772	STANDARD	1.0000		0.0000
143420	STANDARD	1.0000		0.0000
145054	STANDARD	1.0000		0.0000
252114	STANDARD	1.0000		0.0000
272009	STANDARD	1.0000		0.0000
253089	STANDARD	1.0000		0.0000
243181	STANDARD	0.9866		0.0134
253854	STANDARD	0.9866		0.0134
291420	STANDARD	0.9866		0.0134
144174	STANDARD	1.0000		0.0000
144859	STANDARD	1.0000		0.0000
144791	STANDARD	1.0000		0.0000
262037	STANDARD	1.0000		0.0000
253090	STANDARD	1.0000		0.0000
307030	STANDARD	0.9866		0.0134
253847	STANDARD	0.9866		0.0134
308729	STANDARD	1.0000		0.0000
253857	STANDARD	0.9866		0.0134
300724	STANDARD	1.0000		0.0000
144562	STANDARD	1.0000		0.0000
144778	STANDARD	1.0000		0.0000
248213	STANDARD	1.0000		0.0000
277531	STANDARD	1.0000		0.0000
145913	STANDARD	1.0000		0.0000
144601	STANDARD	1.0000		0.0000
275723	STANDARD	1.0000		0.0000
272020	STANDARD	1.0000		0.0000
144397	STANDARD	1.0000		0.0000
145041	STANDARD	1.0000		0.0000

Agreement within Raters

Rater	Number Inspected	Number Matched	Rater Score	95% Lower CI	95% Upper CI
144122	50	49	98.0000	89.5046	99.6461
144205	50	49	98.0000	89.5046	99.6461
144207	50	49	98.0000	89.5046	99.6461
253088	50	49	98.0000	89.5046	99.6461
144229	50	49	98.0000	89.5046	99.6461
145117	50	50	100.000	92.8652	100.000
297973	50	50	100.000	92.8652	100.000
144939	50	50	100.000	92.8652	100.000
144326	50	50	100.000	92.8652	100.000
144336	50	50	100.000	92.8652	100.000
144451	50	50	100.000	92.8652	100.000
144632	50	50	100.000	92.8652	100.000
144220	50	49	98.0000	89.5046	99.6461
144739	50	49	98.0000	89.5046	99.6461
262022	50	50	100.000	92.8652	100.000
144788	50	50	100.000	92.8652	100.000
253077	50	50	100.000	92.8652	100.000
144477	50	50	100.000	92.8652	100.000
144137	50	50	100.000	92.8652	100.000
144797	50	50	100.000	92.8652	100.000
144127	50	50	100.000	92.8652	100.000
144761	50	50	100.000	92.8652	100.000
268306	50	50	100.000	92.8652	100.000
144903	50	49	98.0000	89.5046	99.6461
144580	50	50	100.000	92.8652	100.000
276549	50	50	100.000	92.8652	100.000
253109	50	50	100.000	92.8652	100.000
243161	50	50	100.000	92.8652	100.000
145158	50	49	98.0000	89.5046	99.6461

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Rater	Number Inspected	Number Matched	Rater Score	95% Lower CI	95% Upper CI
303632	50	50	100.000	92.8652	100.000
144756	50	50	100.000	92.8652	100.000
144146	50	50	100.000	92.8652	100.000
243787	50	50	100.000	92.8652	100.000
298046	50	50	100.000	92.8652	100.000
294231	50	50	100.000	92.8652	100.000
301615	50	50	100.000	92.8652	100.000
144641	50	50	100.000	92.8652	100.000
303633	50	50	100.000	92.8652	100.000
262004	50	50	100.000	92.8652	100.000
307612	50	50	100.000	92.8652	100.000
253078	50	50	100.000	92.8652	100.000
144887	50	50	100.000	92.8652	100.000
143608	50	50	100.000	92.8652	100.000
143417	50	50	100.000	92.8652	100.000
145169	50	50	100.000	92.8652	100.000
252752	50	50	100.000	92.8652	100.000
144212	50	50	100.000	92.8652	100.000
275730	50	50	100.000	92.8652	100.000
145208	50	50	100.000	92.8652	100.000
144946	50	50	100.000	92.8652	100.000
299626	50	50	100.000	92.8652	100.000
272006	50	50	100.000	92.8652	100.000
144271	50	50	100.000	92.8652	100.000
145079	50	50	100.000	92.8652	100.000
143453	50	50	100.000	92.8652	100.000
144461	50	50	100.000	92.8652	100.000
304756	50	50	100.000	92.8652	100.000
253068	50	49	98.0000	89.5046	99.6461
144695	50	50	100.000	92.8652	100.000
311448	50	50	100.000	92.8652	100.000
253811	50	50	100.000	92.8652	100.000
253835	50	50	100.000	92.8652	100.000
306522	50	50	100.000	92.8652	100.000
145214	50	50	100.000	92.8652	100.000
144825	50	50	100.000	92.8652	100.000
144766	50	50	100.000	92.8652	100.000
144534	50	50	100.000	92.8652	100.000
261772	50	50	100.000	92.8652	100.000
143420	50	50	100.000	92.8652	100.000
145054	50	50	100.000	92.8652	100.000
252114	50	50	100.000	92.8652	100.000
272009	50	50	100.000	92.8652	100.000
253089	50	50	100.000	92.8652	100.000
243181	50	49	98.0000	89.5046	99.6461
253854	50	49	98.0000	89.5046	99.6461
291420	50	49	98.0000	89.5046	99.6461
144174	50	50	100.000	92.8652	100.000
144859	50	50	100.000	92.8652	100.000
144791	50	50	100.000	92.8652	100.000
262037	50	50	100.000	92.8652	100.000
253090	50	50	100.000	92.8652	100.000
307030	50	49	98.0000	89.5046	99.6461
253847	50	49	98.0000	89.5046	99.6461
308729	50	50	100.000	92.8652	100.000
253857	50	49	98.0000	89.5046	99.6461
300724	50	50	100.000	92.8652	100.000
144562	50	50	100.000	92.8652	100.000
144778	50	50	100.000	92.8652	100.000
248213	50	50	100.000	92.8652	100.000
277531	50	50	100.000	92.8652	100.000
145913	50	50	100.000	92.8652	100.000
144601	50	50	100.000	92.8652	100.000
275723	50	50	100.000	92.8652	100.000
272020	50	50	100.000	92.8652	100.000

Rater	Number Inspected	Number Matched	Rater Score	95% Lower CI	95% Upper CI
144397	50	50	100.000	92.8652	100.000
145041	50	50	100.000	92.8652	100.000

Agreement across Categories

Category	Kappa	Plot Kappa	Standard Error
G	0.9956		0.0007
NG	0.9956		0.0007
Overall	0.9956		0.0007

Effectiveness Report

Agreement Counts

Rater	Correct(NG)	Correct(G)	Total Correct	Incorrect(NG)	Incorrect(G)	Grand Total
144122	81	68	149	0	1	150
144205	81	68	149	0	1	150
144207	81	68	149	0	1	150
253088	81	68	149	0	1	150
144229	81	68	149	0	1	150
145117	81	69	150	0	0	150
297973	81	69	150	0	0	150
144939	81	69	150	0	0	150
144326	81	69	150	0	0	150
144336	81	69	150	0	0	150
144451	81	69	150	0	0	150
144632	81	69	150	0	0	150
144220	80	69	149	1	0	150
144739	80	69	149	1	0	150
262022	81	69	150	0	0	150
147788	81	69	150	0	0	150
253077	81	69	150	0	0	150
144477	81	69	150	0	0	150
144137	81	69	150	0	0	150
144797	81	69	150	0	0	150
144127	81	69	150	0	0	150
144761	81	69	150	0	0	150
268306	81	69	150	0	0	150
144903	80	69	149	1	0	150
144580	81	69	150	0	0	150
276549	81	69	150	0	0	150
253109	81	69	150	0	0	150
243161	81	69	150	0	0	150
145158	81	68	149	0	1	150
303632	81	69	150	0	0	150
144756	81	69	150	0	0	150
144146	81	69	150	0	0	150
243787	81	69	150	0	0	150
298046	81	69	150	0	0	150
294231	81	69	150	0	0	150
301615	81	69	150	0	0	150
144641	81	69	150	0	0	150
303633	81	69	150	0	0	150
262004	81	69	150	0	0	150
307612	81	69	150	0	0	150
253078	81	69	150	0	0	150
144887	81	69	150	0	0	150
143608	81	69	150	0	0	150
143417	81	69	150	0	0	150
145169	81	69	150	0	0	150
252752	81	69	150	0	0	150
144212	81	69	150	0	0	150
275730	81	69	150	0	0	150
145208	81	69	150	0	0	150
144946	81	69	150	0	0	150

Rater	Correct(NG)	Correct(G)	Total Correct	Incorrect(NG)	Incorrect(G)	Grand Total
299626	81	69	150	0	0	150
272006	81	69	150	0	0	150
144271	81	69	150	0	0	150
145079	81	69	150	0	0	150
143453	81	69	150	0	0	150
144461	81	69	150	0	0	150
304756	81	69	150	0	0	150
253068	81	68	149	0	1	150
144695	81	69	150	0	0	150
311448	81	69	150	0	0	150
253811	81	69	150	0	0	150
253835	81	69	150	0	0	150
306522	81	69	150	0	0	150
145214	81	69	150	0	0	150
144825	81	69	150	0	0	150
144766	81	69	150	0	0	150
144534	81	69	150	0	0	150
261772	81	69	150	0	0	150
143420	81	69	150	0	0	150
145054	81	69	150	0	0	150
252114	81	69	150	0	0	150
272009	81	69	150	0	0	150
253089	81	69	150	0	0	150
243181	80	69	149	1	0	150
253854	80	69	149	1	0	150
291420	80	69	149	1	0	150
144174	81	69	150	0	0	150
144859	81	69	150	0	0	150
144791	81	69	150	0	0	150
262037	81	69	150	0	0	150
253090	81	69	150	0	0	150
307030	80	69	149	1	0	150
253847	80	69	149	1	0	150
308729	81	69	150	0	0	150
253857	80	69	149	1	0	150
300724	81	69	150	0	0	150
144562	81	69	150	0	0	150
144778	81	69	150	0	0	150
248213	81	69	150	0	0	150
277531	81	69	150	0	0	150
145913	81	69	150	0	0	150
144601	81	69	150	0	0	150
275723	81	69	150	0	0	150
272020	81	69	150	0	0	150
144397	81	69	150	0	0	150
145041	81	69	150	0	0	150

Effectiveness

Rater	Effectiveness	95% Lower CI	95% Upper CI	Error rate
144122	99.3333	96.3207	99.8822	0.0067
144205	99.3333	96.3207	99.8822	0.0067
144207	99.3333	96.3207	99.8822	0.0067
253088	99.3333	96.3207	99.8822	0.0067
144229	99.3333	96.3207	99.8822	0.0067
145117	100.000	97.5030	100.000	0.0000
297973	100.000	97.5030	100.000	0.0000
144939	100.000	97.5030	100.000	0.0000
144326	100.000	97.5030	100.000	0.0000
144336	100.000	97.5030	100.000	0.0000
144451	100.000	97.5030	100.000	0.0000
144632	100.000	97.5030	100.000	0.0000
144220	99.3333	96.3207	99.8822	0.0067
144739	99.3333	96.3207	99.8822	0.0067
262022	100.000	97.5030	100.000	0.0000
144788	100.000	97.5030	100.000	0.0000

Rater	Effectiveness	95% Lower CI	95% Upper CI	Error rate
253077	100.000	97.5030	100.000	0.0000
144477	100.000	97.5030	100.000	0.0000
144137	100.000	97.5030	100.000	0.0000
144797	100.000	97.5030	100.000	0.0000
144127	100.000	97.5030	100.000	0.0000
144761	100.000	97.5030	100.000	0.0000
268306	100.000	97.5030	100.000	0.0000
144903	99.3333	96.3207	99.8822	0.0067
144580	100.000	97.5030	100.000	0.0000
276549	100.000	97.5030	100.000	0.0000
253109	100.000	97.5030	100.000	0.0000
243161	100.000	97.5030	100.000	0.0000
145158	99.3333	96.3207	99.8822	0.0067
303632	100.000	97.5030	100.000	0.0000
144756	100.000	97.5030	100.000	0.0000
144146	100.000	97.5030	100.000	0.0000
243787	100.000	97.5030	100.000	0.0000
298046	100.000	97.5030	100.000	0.0000
294231	100.000	97.5030	100.000	0.0000
301615	100.000	97.5030	100.000	0.0000
144641	100.000	97.5030	100.000	0.0000
303633	100.000	97.5030	100.000	0.0000
262004	100.000	97.5030	100.000	0.0000
307612	100.000	97.5030	100.000	0.0000
253078	100.000	97.5030	100.000	0.0000
144887	100.000	97.5030	100.000	0.0000
143608	100.000	97.5030	100.000	0.0000
143417	100.000	97.5030	100.000	0.0000
145169	100.000	97.5030	100.000	0.0000
252752	100.000	97.5030	100.000	0.0000
144212	100.000	97.5030	100.000	0.0000
275730	100.000	97.5030	100.000	0.0000
145208	100.000	97.5030	100.000	0.0000
144946	100.000	97.5030	100.000	0.0000
299626	100.000	97.5030	100.000	0.0000
272006	100.000	97.5030	100.000	0.0000
144271	100.000	97.5030	100.000	0.0000
145079	100.000	97.5030	100.000	0.0000
143453	100.000	97.5030	100.000	0.0000
144461	100.000	97.5030	100.000	0.0000
304756	100.000	97.5030	100.000	0.0000
253068	99.3333	96.3207	99.8822	0.0067
144695	100.000	97.5030	100.000	0.0000
311448	100.000	97.5030	100.000	0.0000
253811	100.000	97.5030	100.000	0.0000
253835	100.000	97.5030	100.000	0.0000
306522	100.000	97.5030	100.000	0.0000
145214	100.000	97.5030	100.000	0.0000
144825	100.000	97.5030	100.000	0.0000
144766	100.000	97.5030	100.000	0.0000
144534	100.000	97.5030	100.000	0.0000
261772	100.000	97.5030	100.000	0.0000
143420	100.000	97.5030	100.000	0.0000
145054	100.000	97.5030	100.000	0.0000
252114	100.000	97.5030	100.000	0.0000
272009	100.000	97.5030	100.000	0.0000
253089	100.000	97.5030	100.000	0.0000
243181	99.3333	96.3207	99.8822	0.0067
253854	99.3333	96.3207	99.8822	0.0067
291420	99.3333	96.3207	99.8822	0.0067
144174	100.000	97.5030	100.000	0.0000
144859	100.000	97.5030	100.000	0.0000
144791	100.000	97.5030	100.000	0.0000
262037	100.000	97.5030	100.000	0.0000
253090	100.000	97.5030	100.000	0.0000
307030	99.3333	96.3207	99.8822	0.0067

Rater	Effectiveness	95% Lower CI	95% Upper CI	Error rate
253847	99.3333	96.3207	99.8822	0.0067
308729	100.000	97.5030	100.000	0.0000
253857	99.3333	96.3207	99.8822	0.0067
300724	100.000	97.5030	100.000	0.0000
144562	100.000	97.5030	100.000	0.0000
144778	100.000	97.5030	100.000	0.0000
248213	100.000	97.5030	100.000	0.0000
277531	100.000	97.5030	100.000	0.0000
145913	100.000	97.5030	100.000	0.0000
144601	100.000	97.5030	100.000	0.0000
275723	100.000	97.5030	100.000	0.0000
272020	100.000	97.5030	100.000	0.0000
144397	100.000	97.5030	100.000	0.0000
145041	100.000	97.5030	100.000	0.0000

Misclassifications

Standard Level	NG	G
NG	.	7
G	9	.
Other	0	0

Conformance Report

Rater	P(False Alarms)	P(Misses)
144122	0.0145	0.0000
144205	0.0145	0.0000
144207	0.0145	0.0000
253088	0.0145	0.0000
144229	0.0145	0.0000
145117	0.0000	0.0000
297973	0.0000	0.0000
144939	0.0000	0.0000
144326	0.0000	0.0000
144336	0.0000	0.0000
144451	0.0000	0.0000
144632	0.0000	0.0000
144220	0.0000	0.0123
144739	0.0000	0.0123
262022	0.0000	0.0000
144788	0.0000	0.0000
253077	0.0000	0.0000
144477	0.0000	0.0000
144137	0.0000	0.0000
144797	0.0000	0.0000
144127	0.0000	0.0000
144761	0.0000	0.0000
268306	0.0000	0.0000
144903	0.0000	0.0123
144580	0.0000	0.0000
276549	0.0000	0.0000
253109	0.0000	0.0000
243161	0.0000	0.0000
145158	0.0145	0.0000
303632	0.0000	0.0000
144756	0.0000	0.0000
144146	0.0000	0.0000
243787	0.0000	0.0000
298046	0.0000	0.0000
294231	0.0000	0.0000
301615	0.0000	0.0000
144641	0.0000	0.0000
303633	0.0000	0.0000
262004	0.0000	0.0000
307612	0.0000	0.0000

Rater	P(False Alarms)	P(Misses)
253078	0.0000	0.0000
144887	0.0000	0.0000
143608	0.0000	0.0000
143417	0.0000	0.0000
145169	0.0000	0.0000
252752	0.0000	0.0000
144212	0.0000	0.0000
275730	0.0000	0.0000
145208	0.0000	0.0000
144946	0.0000	0.0000
299626	0.0000	0.0000
272006	0.0000	0.0000
144271	0.0000	0.0000
145079	0.0000	0.0000
143453	0.0000	0.0000
144461	0.0000	0.0000
304756	0.0000	0.0000
253068	0.0145	0.0000
144695	0.0000	0.0000
311448	0.0000	0.0000
253811	0.0000	0.0000
253835	0.0000	0.0000
306522	0.0000	0.0000
145214	0.0000	0.0000
144825	0.0000	0.0000
144766	0.0000	0.0000
144534	0.0000	0.0000
261772	0.0000	0.0000
143420	0.0000	0.0000
145054	0.0000	0.0000
252114	0.0000	0.0000
272009	0.0000	0.0000
253089	0.0000	0.0000
243181	0.0000	0.0123
253854	0.0000	0.0123
291420	0.0000	0.0123
144174	0.0000	0.0000
144859	0.0000	0.0000
144791	0.0000	0.0000
262037	0.0000	0.0000
253090	0.0000	0.0000
307030	0.0000	0.0123
253847	0.0000	0.0123
308729	0.0000	0.0000
253857	0.0000	0.0123
300724	0.0000	0.0000
144562	0.0000	0.0000
144778	0.0000	0.0000
248213	0.0000	0.0000
277531	0.0000	0.0000
145913	0.0000	0.0000
144601	0.0000	0.0000
275723	0.0000	0.0000
272020	0.0000	0.0000
144397	0.0000	0.0000
145041	0.0000	0.0000

SUMMARY:

Parameter	E (95% LCI)	P (FA)	P (MISS)
Acceptable for the appraiser	≥ 90%	≤ 5%	≤ 2%
Actual	96.3207%	1.45%	1.23%

CONCLUSION:

The MSA study passed the specs for effectiveness at 96.32%, False alarm of 1.45% and miss of 1.23%