SAE INTERNATIONAL

# AEROSPACE RECOMMENDED PRACTICE

ARP1923™ REV. B

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Superseding ARP1923A

## Qualification and Certification of Etch Inspectors

RATIONALE

ARP1923B results from a Five Year Review and update of this specification.

ARP1923B has been reaffirmed to comply with the SAE Five-Year Review policy.

1. SCOPE

This specification covers the requirements for qualification, requalification, and certification of etch inspectors.

2. REFERENCES

There are no referenced publications specified herein.

3. QUALIFICATION REQUIREMENTS

Before performing etch inspection on production parts, inspection personnel shall be qualified in accordance with this recommended practice. At qualification and each year thereafter, inspection personnel shall pass physical, written, and practical examinations.

3.1 Physical Examination

The inspection applicant shall pass a vision test administered by medically qualified personnel with a requirement of reading Ortho-Rater 8, J2 or 20/30 Snellen near vision, at 12 to 16 inches (305 to 406 mm) in at least one eye, natural or corrected.

3.2 Written Examination

At least twenty written questions shall be administered to the inspection applicant. Questions shall include cleaning, operating procedures, and inspection techniques that the applicant would encounter during inspection. A minimum grade of 80% is required for acceptance. The questions of Appendix A are recommended for this written examination.

3.3 Practical Examination

At least three selected specimens representative of actual products shall be tested by the inspection applicant. During these tests, at least ten different check points shall be graded showing an understanding of test variables and an ability to perform etch inspection and correctly interpret its results. During these tests all rejectable parts shall be so rejected and a minimum grade of 80% is required for acceptance. The Appendix B table is a recommended checklist for this practical examination.



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3.4 Reexamination for Qualification

Personnel examined and not meeting qualification standards shall wait 30 days and show evidence of having taken suitable corrective action and additional training or self-study before reexamination.

4. CERTIFICATION REQUIREMENTS

Records for all qualified personnel shall be maintained and include date of qualification, results of physical, written, and practical examinations, and experience as a etch inspector.

5. NOTES

5.1 A change bar (l) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this document. An (R) symbol to the left of the document title indicates a complete revision of the document, including technical revisions. Change bars and (R) are not used in original publications, nor in documents that contain editorial changes only.

PREPARED BY AMS COMMITTEE "B"

## APPENDIX A - PROPOSED WRITTEN EXAMINATION QUESTIONS AND ANSWERS FOR QUALIFYING ETCH INSPECTORS

To examine a prospective inspector, select at least 20 questions as directed below. Have the selected questions, and only those questions, placed on a separate form. Administer the examination to the prospective inspector without aid of written or printed manner (closed book) with a time limit of 90 minutes. Score the test with partial score for each question permitted. Divide points scored by the maximum possible to obtain percentage. A percentage of 80 is necessary for acceptance. Personnel examined but not qualifying must wait 30 days and must take suitable corrective action, such as additional training or self-study, before reexamination.

**Points** **Topic: Inspector qualification, select no more than two**

2 1. What military standard must be met for near vision requirements to qualify as an etch inspector?

Write out answer

2 2. What are the minimum vision requirements for etch inspectors?

Write out answer

2 3. At what frequency must etch inspectors be recertified?

Write out answer

**Points** **Topic: Reason for etch inspection, select not more than one**

4 4. What is the etch inspection process attempting to accomplish?

Write out answer

3 5. Etch inspection can assist in detecting localized areas of martensitic steel parts that are hardened, softened, or both, due to overheating during metal removal?

Circle correct answer

A. True

B. False

3 6. Parts can be locally overheated during fabrication. Which of the following fabrication steps can locally overheat martensitic steel parts, the presence of which may be detected by etch inspection?

Circle correct answer(s)

A. Radiographic inspection

B. Drilling

C. Grinding

D. Magnetic inspection

E. Stress relieving

**Points** **Topic: Materials, select not more than one**

3 7. Which of the following alloys cannot be effectively etch inspected?

Circle correct answers

A. H-11

B. 440C

C. 4340

D. A286

E. PH13-8Mo

F. 300M

G. D6Ac

H. MP35

4 8. Which of the following alloys can be effectively etch inspected?

Circle correct answers

A. 4340 (200 to 220 ksi) (1379 to 1517 MPa)

B. 4330M (220 to 240 ksi) (1517 to 1655 MPa)

C. Inconel 718 (220 to 240 ksi) (1520 to 1655 MPa)

D. 301 Annealed

**Points** **Topic: Solution makeup, select not more than two**

6 9. The hydrochloric acid solution used during etch inspection is to be made up from technical grade hydrochloric acid (20° Baumé). It has been determined that the material on hand meets the specification requirements. If this material is to be used to make up a hydrochloric acid tank of 4 to 6% by volume of technical grade hydrochloric acid and water, how would this be done? Assume a 200 gallon (755 L) tank to be filled about one-half full.

Write out answer

6 10. The nitric acid solution used during etch inspection is to be made up from technical grade nitric acid (40° Baumé). It has been determined that the material on hand meets the specification requirements. If this material is to be used to make up a nitric acid tank of 2.5 to 3.5% by volume of technical grade nitric acid and water, how would this be done? Assume a 200 gallon (755 L) tank to be filled about one half full.

Write out answer

3 11. An ammonium persulfate in water solution may be used as an etching solution. However, this solution will vaporize losing its effectiveness with time. The ammonium persulfate etching solution must be used within how many hours after mixing?

Write out answer. _____ hours

3 12. A surfactant is a chemical that is added to a solution to minimize the formation of dark smut on steel when the steel is etched. To what solution must the surfactant be added and in what concentration?

Write out answer

**Points** **Topic: General process sequencing of steel parts, select not more than two**

4 13. Roll burnishing should be performed before etch inspection?

Circle correct answer

A. True

B. False

Why? Write out reason

4 14. Thread rolling should be performed after etch inspection?

Circle correct answer

A. True

B. False

Why? Write out reason

3 15. Certain steel processing steps can alter the part surface to such an extent as to make etch inspection ineffective. These steps must be performed after etch inspection, some of which are:

Circle correct answer(s).

A. Chromium plating

B. Milling

C. Shot peening

D. Supplementary phosphate treat

2 16. Which are more likely to cause overheating?

Circle correct answer

A. Machining before heat treatment

B. Machining after heat treatment

2 17. When an engineering approved surfactant is used in the etch solution it is not necessary to immerse the parts in a hydrochloric solution.

Circle correct answer

A. True

B. False

**Points** **Topic: Tolerances, select not more than one**

3 18. Approximately how much material is removed from a surface by etch inspection?

Circle correct answer

A. 0.00001 to 0.00005 inch (0.0002 to 0.0013 mm)

B. 0.0001 to 0.0005 inch (0.002 to 0.013 mm)

C. 0.001 to 0.005 inch (0.02 to 0.13 mm)

D. It does not remove metal

E. None of the above

3 19. When must very close tolerance parts (less than ±0.001 inch (±0.02 mm) be dimensionally inspected?

Circle single most correct answer

A. Before plating

B. After final machining

C. After etch inspection baking prior to plating

3 20. Why must very close tolerance parts (less than ±0.001 inch (±0.02 mm) be dimensionally inspected after being etch inspected?

Write out answer

**Points** **Topic: Etch inspection sequencing, select not more than one**

8 21. During etch processing, without using a surfactant, the sequencing of steps must of course be followed. List the following steps in the correct sequence.

Step

A. Rinse

B. Clean

C. Hydrochloric Acid (muriatic) Dip

D. Nitric Acid (Nital) Dip

E. Rinse

F. Rinse

G. Inspect

H. Ink Stamp (acceptable parts)

I. Dry

J. Rack Parts (not touching)

K. Bake

L. Oil

M. Immerse in Neutralizing Solution

N. Rinse

10 22. Sixty 4340 steel belleville springs 0.25 inch (6.4 mm) thick with a 4 inch (102 mm) OD and 2 inch (51 mm) ID were ground after heat treatment to 260 to 280 ksi (1793 to 1931 MPa). List in sequence all steps that are required for etch inspection of these parts; assume no surfactant and that all parts are found acceptable.

**Points** **Topic: Etching Process, select not more than two**

6 23. Care must be taken during etching to ensure even etching of all surfaces to be inspected. This can be provided by the following: Give at least two answers

A.

B.

4 24. Heavy smutting can mask etch indications and requires removal and reprocessing prior to inspecting. Excessive smutting is evident by _____. Complete sentence.

4 25. For what reason are parts immersed in hydrochloric acid during acid etch processing?

Write out answer

4 26. What causes heavy smutting during etch inspection?

Write out answer

**Points** **Topic: Actual visual inspection, select not more than three**

6 27. Localized overheating of martensitic steel parts results in these areas being overtempered and softened. This condition, if detected during etch inspection, must be rejected and is evident as _____. Complete the sentence.

6 28. Localized overheating of martensitic steel parts can result in rehardening of these areas without subsequent adequate tempering. This condition, if detected during etch inspection, must be rejected and is evident as _____. Complete the above sentence.

5 29. To assist in the interpretation of etch results, which of the following may be used?

Circle the correct answer(s)

A. Comparison with examples

B. Visually examine with magnifying glass

C. Discuss indication with other certified inspectors or metallurgist.

D. Comparison with photographs of rejected parts.

E. Have a metallurgical laboratory section a representative part in a questionable area and evaluate or unacceptable condition.

F. Perform a superficial hardness test on the area in question.

3 30. Acceptable areas during etch inspection appear as uniform _____ in color.

What word would correctly complete the above sentence?

3 31. Etch indications tend to run perpendicular (opposite) to the direction of metal removal from the part.

Circle the correct answer

A. True

B. False

**Points** **Topic: Baking, select not more than two**

3 32. Why is it required to bake parts that have passed etch inspection without the use of an approved surfactant?

Circle correct answer(s)

A. Relieve residual surface tensile stresses

B. Drive off embrittling hydrogen

C. Ensure complete transformation of retained austenite to martensite

D. Temper martensite

2 33. It is not necessary to bake parts that were etch inspected using an engineering approved surfactant in the etch solution and no desmut acid immersion.

Circle correct answer

A. True

B. False

4. 34. What is the correct post etch inspection baking temperature and time?

Write out answer

_____

_____

_____

_____

4 35. After passing etch inspection, parts to be baked at 375 °F ± 25 (191 °C ± 14) for 4 hours would be which of the following:

Circle correct answer.

A. Placed in a furnace set and recording at 350 to 400 °F (175 to 205 °C) and held at heat for not less than 4 hours.

B. Placed in a furnace with a ±25 °F (±14 °C) degrees tolerance that is recording a temperature of 375 °F (191 °C) and held at that temperature for not less than 4 hours.

C. Held in furnace for 4 hours after setting temperature at 375 °F (191 °C).

D. None of the above.

2 36. To ensure adequate process verification records, it is necessary to note on the bake furnace record chart, the part traveler, or shop order number and the date and time placed in the furnace.

A. True

B. False

**Points** **Topic: Inaccessible areas, select not more than one**

2 37. Adequate etch inspection of some areas sometimes cannot be performed due to geometric restrictions in these areas. Other steps must be taken if assurance is needed that these areas are acceptable.

Circle correct answer

A. True

B. False

2 38. Some areas of parts cannot be adequately etch inspected due to geometric restrictions, such as in small or deep holes machined after heat treatment. For this reason, alternative methods must be used to ensure these areas are acceptable. Which of the following may be used to ensure that these inaccessible areas are acceptable?

Circle the correct answer(s)

A. Machine preproduction part or samples recording the production parameters such as tool type, speed, feed, number of holes, etc. Cross section this sample and perform a superficial hardness traverse on the sectioned surface. If the section is acceptable, machine the production parts using the same production parameters.

B. Machine preproduction part or samples recording the production parameters such as tool type, speed, feed, number of holes, etc. Cross section this sample and perform etch inspection. If section is acceptable, machine the production parts using the same production parameters.

C. For open ended holes, ream and hone a minimum from each diameter after drilling.

| Points | Topic: General (rework, identification, etc), select not more than six |
|---|---|
| 2 | 39. Inspection of etched parts should take place in what type of lighting conditions?<br><br>Write out answer. |
| 3 | 40. Etch inspection is also referred to as:<br><br>Circle correct answer(s)<br><br>A. Temper etch inspection<br><br>B. Anodic etch inspection<br><br>C. Acid etch inspection<br><br>D. Nital etch inspection<br><br>E. All of the above<br><br>F. None of the above |
| 2 | 41. Sample etch inspection is acceptable for large lots of parts only with prior specific written approval.<br><br>A. True<br><br>B. False |
| 3 | 42. Electric arcing may occur during fabrication of heat treated martensitic steel parts which may be detected during etch inspection.<br><br>Circle correct answer<br><br>A. True<br><br>B. False |
| 4 | 43. Which of the following processes are acceptable means for removing etch indications?<br><br>Circle correct answer(s)<br><br>A. Grit blasting<br><br>B. Sanding<br><br>C. Shot Peening<br><br>D. Remachining |
| 4 | 44. Steel parts that are etch inspected are highly active and will corrode. How is this avoided?<br><br>Write out answer. |
| 3 | 45. How are parts that have passed nital inspection so identified?<br><br>Write out answer. |

2 46. If a localized area is questionable during nital etch inspection, it is acceptable to lightly polish this area and reinspect it by hand swabbing the solutions on the area in question.

A. True

B. False

ANSWERS TO ETCH INSPECTION QUESTIONS
GRADING CODE

4-P Partial credit possible

3-1X One point for each correct answer, minus one point each incorrect answer

4-2X Two points for each correct answer, minus two points each incorrect answer

Total number of possible points

**Points**

2 1. MIL-STD-410.

2 2. Read Ortho-Rater 8, J2 or 20/30 Snellen near vision, at 12 to 16 inches (305 to 406 mm) in at least one eye, natural or corrected.

2 3. Yearly.

4-P 4. To detect and reject localized overheated surfaces on martensitic steel parts.

3 5. A. True

3-1X 6. B. Drilling

C. Grinding

D. Magnetic Inspection - Electric Arcing

3-1X 7. D. A286

E. PH 13-8Mo

H. MP 35

4-2X 8. A. 4340

B. 4330M

6 9. Add 4 gallons (15 L) of technical grade hydrochloric acid (20° Baume) to 96 gallons (363 L) of water or add 6 gallons (23 L) hydrochloric acid to 94 gallons (356 L) of water. Answers between these ranges acceptable such as 5 gallons (19 L) hydrochloric acid to 94 gallons (356 L) water.

6 10. Add 2.5 gallons (9.5 L) of technical grade nitric acid (40° Baume) to 97.5 gallons (369 L) of water or add 3.5 gallons (13 L) of O-N-350 to 96.5 gallons (365 L) of water. Answers between these ranges of concentration are also acceptable such as 3 gallons (11 L) of nitric acid to 97 gallons (367 L) of water.

3 11. 72 hours.

3 12. The surfactant shall be mixed with the nitric acid solution per the surfactant manufacturer's recommendation.