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# What a Passing Nondestructive Test Report Really Promises

A flaw detection report with no rejectable indications is a measurement against a sensitivity, not a guarantee of soundness. The tables below give the acceptance criteria classes, the flat bottom hole yardstick, the demonstration statistics and the 90/95 capability demonstrated in service.

**Reference only.** This is a reference summary of published practice and it is not a specification of ours. The values are reproduced from the source tables, and tool material, machine rigidity, cutting fluid and workpiece condition will all move them. Final conditions are set on the job.

## An inspection is quoted against a sensitivity, not a guarantee

| Quality class | Single discontinuity, flat bottom hole number | Multiple discontinuities, flat bottom hole number | Maximum linear discontinuity, in. | Maximum loss of back reflection, % |
|---|---|---|---|---|
| AA | 3 | 1 | A No. 1 response for 0.12 in. | 50 |
| A1 | 3 | 2 | A No. 2 response for 1.00 in. | 50 |
| A | 5 | 3 | A No. 3 response for 1.00 in. | 50 |
| B | 8 | 5 | A No. 5 response for 1.00 in. | 50 |
| C | As established by purchaser and vendor for the specific part | | | |

Typical NDI acceptance criteria for longitudinal wave inspection of product over 13 mm thick, reproduced from Table 1 of Introduction to Quantitative Nondestructive Evaluation in ASM Handbook, Volume 17. The five quality classes are defined for inspection with flat bottom reflectors in ultrasonic references, and a response is rejected against a loss of back reflection as well as against a hole size. Class C is left to the purchaser and the vendor to agree for the specific part.

## The flat bottom hole is the yardstick

| Flat bottom hole number | Nominal diameter, mm | Nominal diameter, in. |
|---|---|---|
| No. 1 | 0.4 | 1/64 |
| No. 2 | 0.8 | 2/64, or 1/32 |
| No. 3 | 1.2 | 3/64 |
| No. 5 | 2.0 | 5/64 |
| No. 8 | 3.2 | 8/64, or 1/8 |

Flat bottom hole numbers converted to diameter, from the footing of Table 1 of Introduction to Quantitative Nondestructive Evaluation in ASM Handbook, Volume 17, which states that flat bottom hole numbers indicate diameter in multiples of 0.4 mm, or 1/64 in. A class AA part therefore turns on a single indication no larger than about 1.2 mm across and on multiple indications no larger than about 0.4 mm.

## Detection is a probability, not a yes or a no

## The demonstration decides the answer

| Number of observations | Misses allowed to hold 90 percent detection at the 95 percent confidence level |
|---|---|
| 29 | 0 |
| 46 | 1 |
| 61 | 2 |
| 75 | 3 |
| 89 | 4 |
| 103 | 5 |

Detection requirements used to meet a 90 percent probability of detection at the 95 percent confidence level in the B-1 program, reproduced from the reliability data analysis in ASM Handbook, Volume 17. For every flawed specimen presented to an inspector, at least two unflawed specimens were also included in the set.

## What the measurement programs actually found

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| Inspection | Demonstrated 90/95 capability |
|---|---|
| **Depot eddy current facility for critical engine parts** | 0.13 mm (0.005 in.) deep flaws at 90 percent probability of detection and 95 percent confidence |
| **Automated retirement-for-cause inspection station, rivet holes** | A 100 micrometre (4 mil) crack depth at 90 percent probability of detection and 95 percent confidence |
| **Same station, bolt holes and flat surfaces** | Reliable detection in the 125 to 250 micrometre (5 to 10 mil) depth range |
| **B-1 program production inspection of corner cracks** | A 1.3 mm (0.050 in.) depth requirement was not met until the processes were refined and the documentation rewritten |

Reliability demonstrated at a 90 percent probability of detection and a 95 percent confidence level in published aircraft engine and depot inspection programs, reproduced from the NDE reliability and applications articles in ASM Handbook, Volume 17. In the B-1 program the original production processes could not meet a 1.3 mm depth requirement for corner cracks, not all inspection personnel could reach the required reliability even after the procedures were refined, and etching was needed ahead of penetrant inspection before the requirement was met for any of the materials tested.

## Grades and stock

## Aobo Steel, tool steel supplier

Aobo Steel supplies tool steel to distributors and mold, tool and die shops, including D2, D3, DC53, A2, O1, H13, H11, H10, H21, S7, M2, M42, L6, P20 and 420 and 440C stainless. Forged or hot rolled, annealed or pre-hardened, cut to your sizes, with test certificates.
Source, ASM Handbook, Volume 17, Nondestructive Evaluation and Quality Control, ASM International, 1989.

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