INCREMENTAL CHANGE Release Notification Date: 05/23/2023

SPM 70-42-02 REPAIR PRACTICES FOR HOLE REWORK

DISCLAIMER

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HIGHLIGHTS

HIGHLIGHT REFERENCE	DESCRIPTION OF CHANGE
tk70-42-02-320-001	Technical Change: Changed repair practices for hole rework.

TASK 70-42-02-320-001

1. General.

CAUTION: DO NOT USE ABRASIVES THAT INCLUDE A VITRIFIED BOND MATRIX ON TITANIUM ROTATING PARTS OR DAMAGE TO THE PART CAN OCCUR.

CAUTION: FOR ALL ABRASIVES USED, CONFIRM WITH SUPPLIER IF THE PRODUCTS HAVE "VITRIFIED BOND MATRIX". THE ABRASIVES WITH "VITRIFIED BOND MATRIX" ARE EXCLUDED FROM TITANIUM ALLOYS.

A. This procedure defines the process to be used for the rework of holes in rotor components and critical static parts. It will be used when specified by the process document. This rework includes the removal of damaged material, nicks, dents, gouges, etc., as well as enlargement of the hole for life extension purposes. This procedure may also be used to make new holes with a length (L) to diameter (D) ratio (L/D) of less than 1. For holes with L/D ratio greater than or equal to 1, specific Source Substantiation requirements will be issued. This procedure incorporates steps to ensure that the rework of a hole does not result in damage to the substrate and subsequent loss in design life for that component.

B. Refer to TASK 70-30-00-200-001 (70-30-00, Inspection Methods) for terms and definition.

2. Equipment.

Subtask 70-42-02-320-051

A. Hones and honing supplies can be obtained from the following manufacturers:
Micromatic Textron, refer to the List of Suppliers in Step 4 of 70-80-00.
Sunnen Products Co., refer to the List of Suppliers in Step 4 of 70-80-00.

3. Materials.

Subtask 70-42-02-320-052

A. For machining operations, any water-soluble cutting fluid is acceptable provided the part is subsequently cleaned using a process suitable to remove any residue such as TASK 70-21-22-110-042, Cleaning Method No. 22 Light Duty Aqueous Cleaning - Method No. 1, or equivalent.

B. For honing operations, any honing oil is acceptable provided the part is subsequently cleaned using a process suitable to remove any residue such as TASK 70-21-22-110-042, Cleaning Method No. 22 Light Duty Aqueous Cleaning - Method No. 1, or equivalent.

4. Procedure.

Subtask 70-42-02-320-053

A. Documented annual operator awareness training is required for those operators who will perform this process. The following is an outline of the subjects that must be addressed by the operator training program.
(1) Awareness of the effect on the part life of this Standard Practice.
(2) Significance of speed, coolant application, and tool wear controls.
(3) Significance of edgebreak requirements.
(4) Methods of recording unusual events or part defects.

NOTE: Deleted.

B. Tool Definition and Control. A Tool Control System must be in place to control the tooling used for this process. This system must address the following at a minimum:
(1) Detailed tool drawings.
(2) Supplier control.
(3) Method of issuing tools.
(4) Regrind control.
(5) Method of handling tool geometry variations.

C. Equipment Speed and Feed Verification.
(1) Measure machine tool spindle speeds under no load conditions to verify that actual speeds are within ± 10 percent of programmed speeds.
(2) Perform spindle speed measurements across the applicable range of spindle speeds for the operations performed on a specific machine.
(3) Measure machine tool feedrates under no load conditions to verify that actual feedrates are within ± 15 percent of programmed feedrates.
(4) Perform a feedrate measurement for each axis used in holemaking using a single feedrate that is typical of the operations performed on the machine.

NOTE: These measurements must be taken at regular intervals. Initially, it is recommended that these checks be performed and documented every six months, and annually thereafter.

(5) Keep records of the inspections in accordance with the repair shop's calibration system requirements.

D. Multi-step Process Requirements.

NOTE: For shaped holes, use minor diameter to calculate Length/Diameter (L/D) ratio.

NOTE: Stock removal is given for each side (radially). Measured total stock removal for each diameter is two times of radial values.

NOTE: Finish machining process includes reaming, the bore portion of drill-bore, peripheral mill, hole sizing end mill, and single point bore.

(1) Multi-step machining of RENE alloy holes.
(a) New holes.
1 Use a multi-step process such as drilling followed by finish processes. A minimum of 0.006 inch (0.16 mm) radially must be removed by the finish process(es).
2 Alternative Procedure Available. The last 0.002 inch (0.05 mm) radially must be removed by post-finish machining. Refer to Subtask 70-42-02-320-053 (paragraph 4.H.).
2 A. Alternative Procedure. Remove a minimum of 0.004 inch (0.1 mm) radially, with a helical ramp milling. Finish with flex honing.
(b) Reworked holes.
1 Use finish processes if necessary. The depth of cut (measured radially) must be no more than 0.015 inch (0.38 mm) for each pass.
2 Alternative Procedure Available. The last 0.002 inch (0.05 mm) radially must be removed by post-finish machining. Refer to Subtask 70-42-02-320-053 (paragraph 4.H.). If the total of the material that you will remove is less than 0.002 inch (0.05 mm) radially, remove all material by post processing.
2 A. Alternative Procedure. Remove minimum of 0.004 inch (0.1 mm) radially, with a helical ramp milling. If the material that you will remove is less than 0.004 inch (0.1 mm) radially, remove all the material necessary by helical ramp milling. Finish with flex honing.

(2) Multi-step machining of non-RENE alloy holes with L/D ratio more than 1.
(a) New holes.
1 Use a multi-step process such as drilling followed by finish processes. A minimum of 0.006 inch (0.16 mm) must be removed by the finish process(es).
2 Alternative Procedure Available. The last 0.002 inch (0.05 mm) must be removed by post-finish machining. Refer to Subtask 70-42-02-320-053 (paragraph 4.H.).
2 A. Alternative Procedure. Remove minimum of 0.004 inch (0.1 mm) radially, with a single point boring or helical ramp milling. Finish with flex honing.
(b) Reworked holes.
1 Use finish processes if necessary. The depth of cut (measured radially) must be no more than 0.015 inch (0.38 mm) for each pass.
2 Alternative Procedure Available. The last 0.002 inch (0.05 mm) radially must be removed by post-finish machining. Refer to Subtask 70-42-02-320-053 (paragraph 4.H.). If the total of the material that you will remove is less than 0.002 (0.05

mm) inch radially, remove all material by post processing.

2 A. Alternative Procedure. Remove a minimum of 0.004 inch (0.1 mm) radially, with a single point boring or helical ramp milling. If the material that you will remove is less than 0.004 inch (0.1 mm) radially, remove all the material necessary by single point boring or helical ramp milling. Finish with flex honing.

(3) Multi-step machining of non-RENE alloy holes with L/D ratio equal to 1 or less.

(a) New holes.

1 Use a multi-step process such as drilling followed by finish processes. A minimum of 0.006 inch (0.16 mm) must be removed by the finish process(es).

(b) Reworked holes.

1 Use finish processes. The depth of cut (measured radially) must be no more than 0.015 inch (0.38 mm) for each pass.

E. Maximum Cutting Speeds and Feedrates.

Machining Process	**Length/Diameter**	**Diameter**	**Max Cutting Speed (SFM)**			**Max Chip Load**
			Powder Alloys	**Titanium Alloys**	**Inco and Others**	
Drill	3		35	70	45	0.0015
Drill	> 3	> 0.15	30	65	40	0.0015
Drill	> 3	0.15	30	55	35	0.0015
Coolant Fed Drill			60	120	80	0.0015
Gun Drill			60	120	80	0.0006
Drill-bore			30	65	45	0.0015
Ream or End Mill Size			20	45	30	0.001
Peripheral Mill			40	75	50	0.001
Single Point Bore			100	150	120	0.003
Chamfer Mill, Plunge Radius, or Countersink			60	100	60	0.001
Hand Feed Chamfer Mill, Plunge Radius, Countersink			30	50	30	0.001
Counterbore / Spotface			30	65	45	0.0015
Helical Ramp Milling			80	120	80	0.003

F. Coolant Application Instructions.

(1) Use a continuous flow of coolant throughout the machining process except for manual edgebreak operations. Coolant delivery must be controlled by a system that detects the interruption of the flow to the tool and stops the machining operation. The capability of the flow monitors to detect interruption of coolant flow and to stop the machining process must be demonstrated. If such a system is not available, cutting speeds may not exceed the flood coolant limits for that tool type (See E. Maximum Cutting Speeds and Feedrates).

(2) Direct the coolant toward the tool cutting edge along the tool shank or submerge the part in coolant.

G. Tool Wear Limits. See Figure 1.

(1) Tool wear must be measured using an optical device that provides at least 7X magnification and a reference scale marked in 0.005 inch (0.13 mm) increments or finer. Refer to Figure 2 for the examples of abnormal wear on the tool.

(2) Tool Change Points (the maximum number of holes by which the cutting tool must be changed) are determined based on the maximum tool flank wear values listed in the following table. Tool change points are established using the highest wear measurement from a minimum of three tools used on a specific application. If the tooling or process parameters are later changed, a new Tool Change Point must be established.

Cutting Tool Type	**Maximum Flank Wear**	
	inch	**mm**
Drills & Drill Portion of a Drill-bore	0.008	0.20
Gun Drill	0.006	0.15
Bore Portion of a Drill-bore	0.010	0.25
Reamer	0.006	0.15
Endmill	0.008	0.20
Peripheral Mill	0.005	0.13
Single Point Bore	0.004	0.10
Chamfermill, Plunge Radius, or Countersink	0.005	0.13
Counterbore / Spotface	0.008	0.20
Helical Ramp Milling	0.008	0.20

H. Post-finish Machining Requirements.

(1) Post-finish holes by honing, jig-grinding, or abrasive flow processes to remove 0.002 inch (0.05 mm) minimum of material. Measure this 0.002 inch (0.05 mm) of material radially, equivalent to 0.004 inch (0.10 mm) on the diameter.

(2) The following requirements apply to the processes used for post-finishing:

(a) Abrasive Flow.
1 Maximum grit size shall be 710 micron (36 grit ANSI).
2 Grit type shall be silicon carbide or aluminum oxide.
(b) Honing.
1 Maximum grit size shall be 122 micron (150 grit ANSI).
2 Maximum tool expansion rate shall be 90 microns/minute.
3 Minimum stroke rate shall be 120/minute.
4 Grit type shall be silicon carbide or cubic boron nitride (CBN).
(c) Jig Grinding.
1 Maximum grit size shall be 122 micron (150 grit ANSI).
2 Maximum tool speed shall be 3500 SFM.
3 Maximum feed rate shall be 0.0059 inch/minute (150 microns/minute).

I. Edgebreak, Handbenching Definition.
(1) Edgebreak:
(a) Edgebreaks/Radii are to be milled unless otherwise specified in the process document. Edgebreaks and corners are to be free of burrs and high metal.
(b) Perform chamfer corner rounding (slightly breaking the two edges formed by a chamfer) as the last metal removal operation in making the holes and prior to a shot peen.
NOTE: Chamfer corner rounding must be done with soft tools such as Cratex C10-043 or Flex-Hone C10-164 , C10-165 , C10-166 , C10-167 , C10-168 , or equivalent.
(2) Handbenching:
(a) Use soft tools such as Cratex C10-043 or Flex-Hone C10-164 , C10-165 , C10-166 , C10-167 , or C10-168 to remove surface imperfections in holes.
NOTE: The use of hard tools (such as abrasive stones) is allowed only when specified in the process document.

J. Shotpeen Requirements.
(1) Follow the instructions specified in the repair document to shotpeen holes. Shotpeen all new and reworked holes, unless repair document advises against shot-peening.

K. Process Approval Responsibility.
(1) Internal approval is required for this section of the Standard Practice Manual. The internal approval must be based upon the following:
(a) Documentation of the Operator Training Program.
(b) Definition of Tooling Control System.
(c) Results of calibration of the machine tool as defined in the procedure.
(d) Documentation of the speeds and feeds used for the rework of the hole(s).

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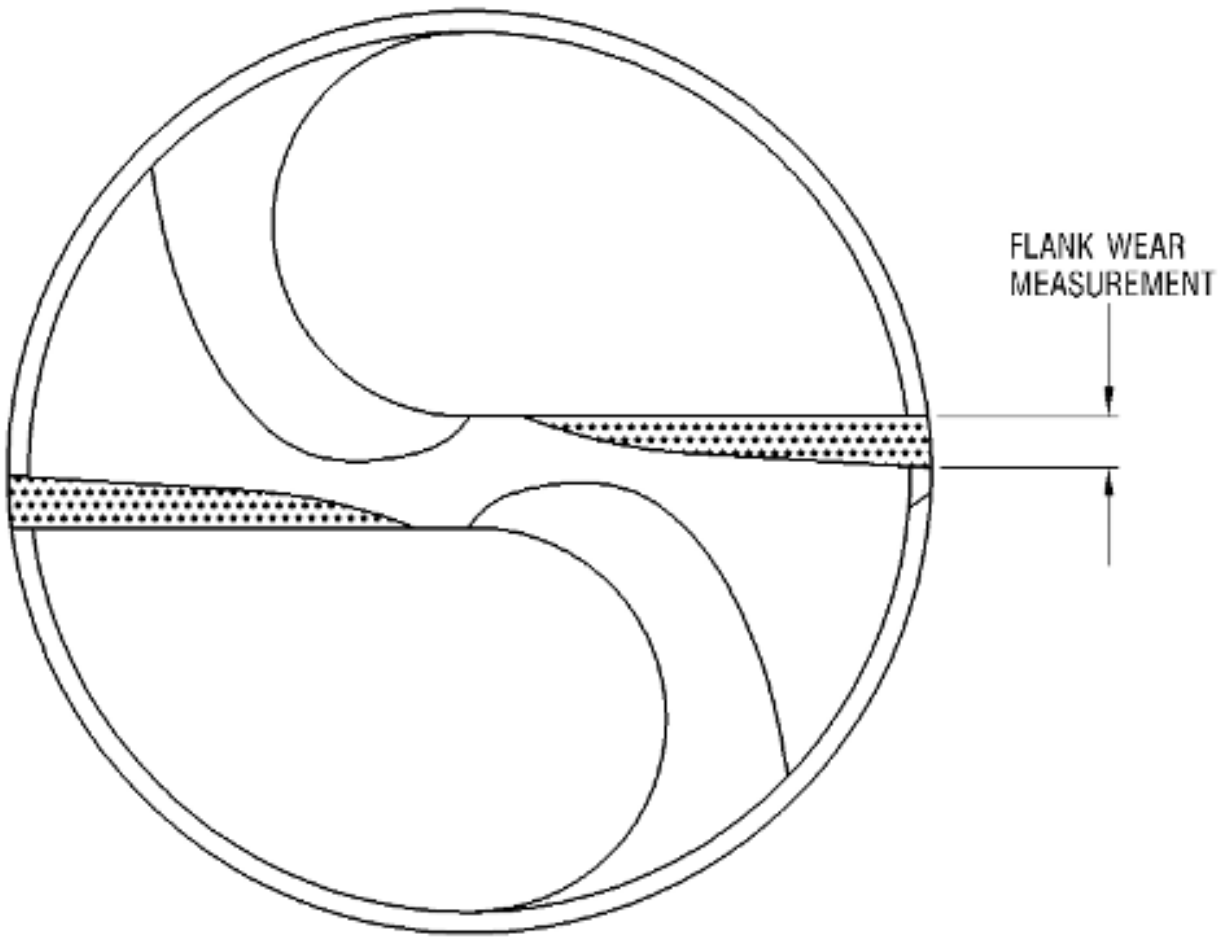

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Figure 1 Flank Wear Measurement

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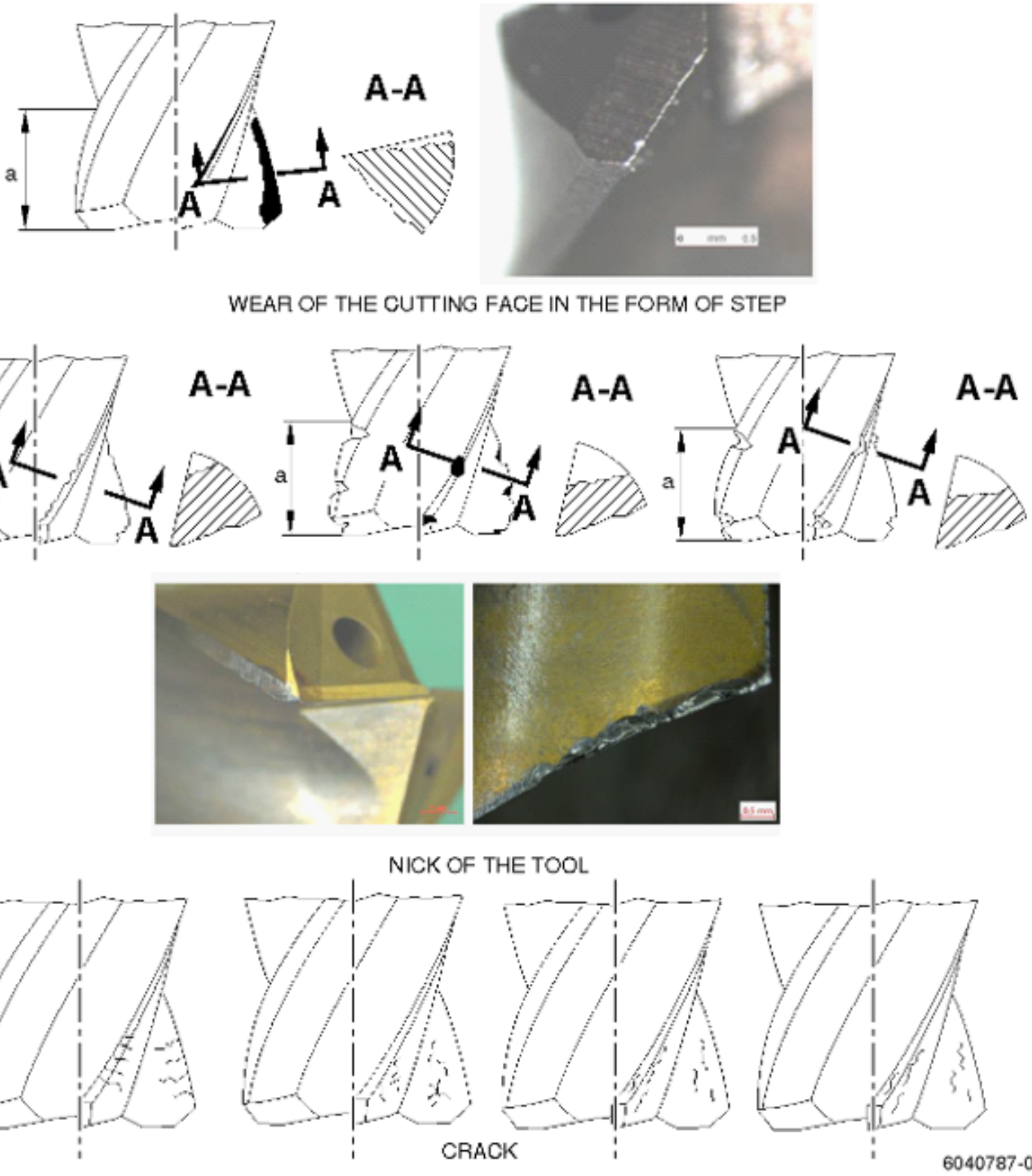

Figure 2 (Sheet 1) Example of abnormal wear (wear of the cutting face in the form of step, nick of the tool, crack)

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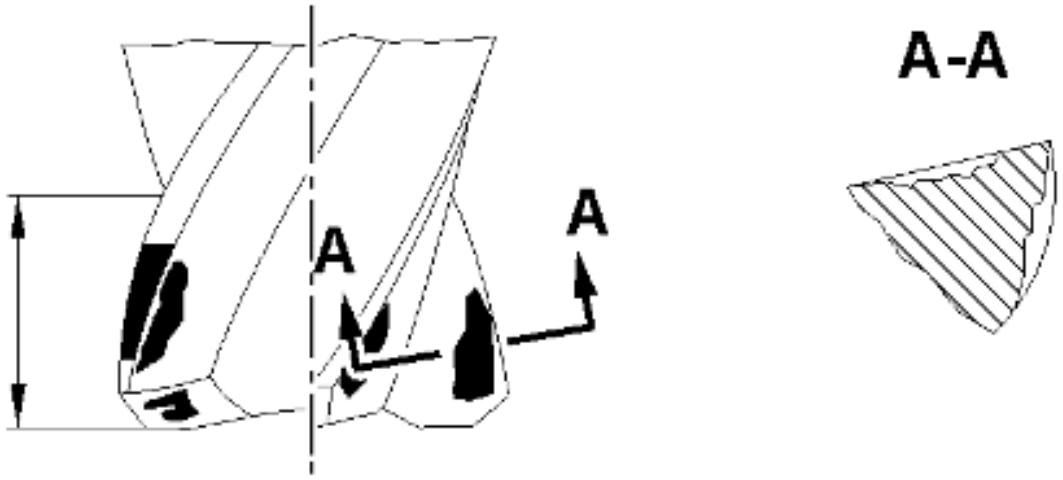

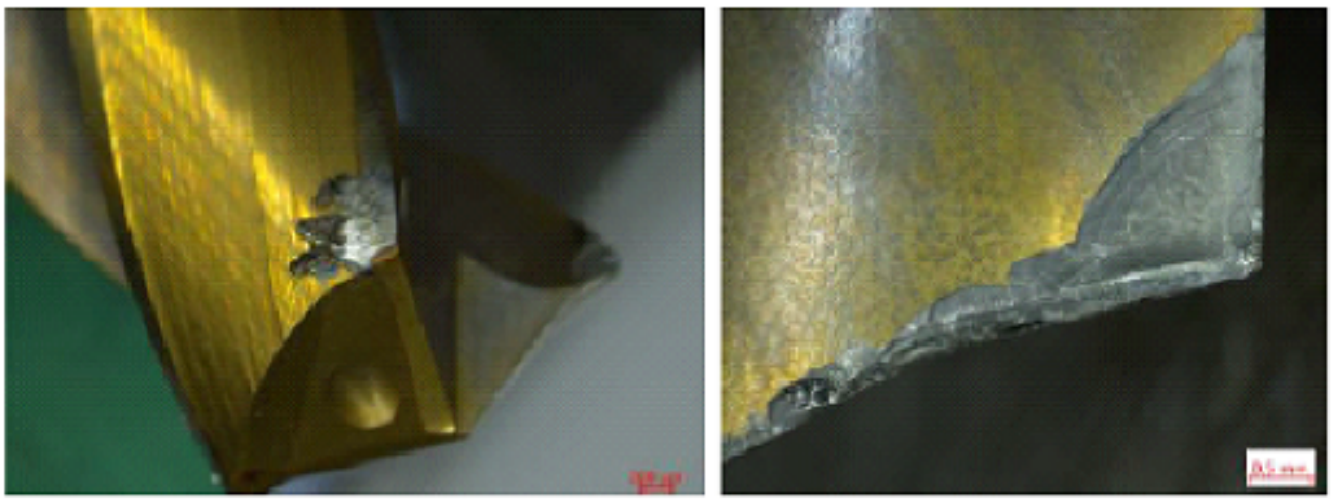

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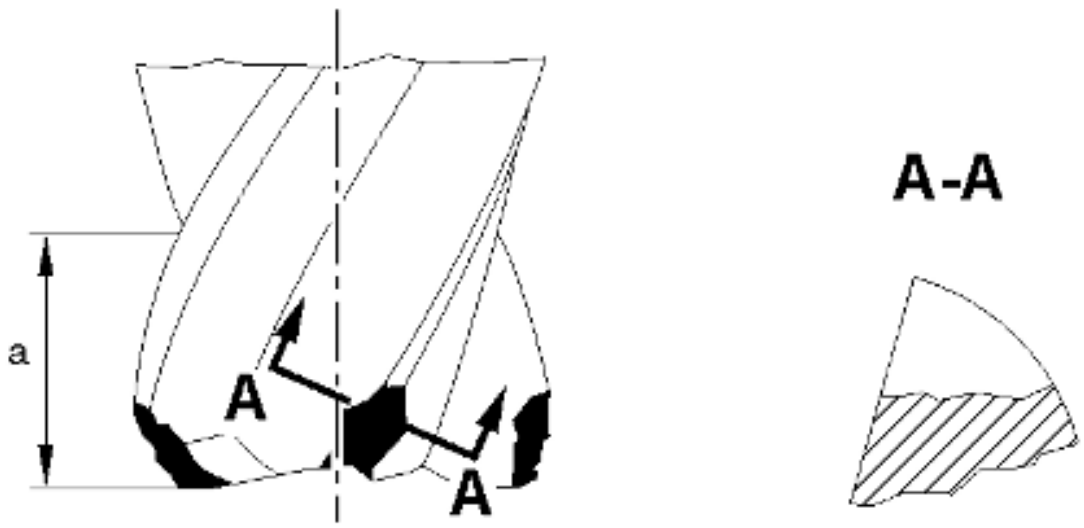

PLASTIC DEFORMATION OF THE CUTTING EDGE

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Figure 2 (Sheet 2) Example of abnormal wear (scales, plastic deformation of the cutting edge)

5. Quality Assurance

Subtask 70-42-02-220-002

A. Inspect the machined surface visually before shotpeening.

(1) The visual examination of the machined surface must be performed without etching with magnification equipment 5X to 10X and at minimum, 100 ft-candles (1000 lux) must be

achieved at the inspected surfaces. Areas inaccessible for direct or indirect visual examination must be inspected using a borescope, swiveling inspection mirror. The direction of lighting intensity must be optimized in function of:

(a) The surface condition of the part and its reflectivity (no stray reflections and no risk of glare).

(b) The indications to be searched (low-angle lighting can be favorable for detecting extremely fine linear indications).

(2) When some portion of a broken tool may remain in the hole after tool retraction the event must be recorded and the affected hole must be identified. The hole must be visually inspected and any noted tool material removed. The hole must be visually inspected again after all machining is complete but prior to shot peening if any. No surface imperfections including Visual Flaws, Rebonded Titanium Material, Discoloration, Material Grain Pullout, Micro-Burrs, Re-Deposited or Re-Bonded Material, Contamination, Broken Tools, Foreign or embedded tool material but not limited to, are acceptable at final inspection. For holes larger than 0.25 inch (6.35 mm) in diameter with a length-to-diameter ratio (L/D) greater than two, a borescope inspection must be performed in addition to the visual inspection. The hole must be inspected from both sides, unless one side is inaccessible to the borescope. Results of the final inspection must be recorded.