1.0 SCOPE

This specification covers gas nitriding of suitably quenched and tempered alloy steels by either the single stage or double stage dissociation process.

2.0 APPLICATION

This heat treatment provides wear and fatigue resistance with a minimum of distortion.

3.0 QUALIFYING SPECIFICATIONS

1E2261 Stock Removal After Heat Treat
1E2349 Materials Application – Alternate
1E2617 General Requirements – Heat Treat

4.0 PROCESSING SEQUENCE

4.1 Prior heat treatment provides a tempered martensitic structure and the specified core hardness for proper nitride response.

4.2 Complete all machining operations before nitriding except for processing allowed after nitriding by 1E2261 stock removal control or special processing notes on the part number drawing. CBN grinding after nitriding is not permitted.

4.3 Clean with approved process.

Note: Contamination of any type, such as oil, grease, dirt, oxide, scale, or passive films, inhibits the nitriding process. Cleaned parts shall be nitrided as soon as possible after drying and all contaminated parts shall be recleaned prior to nitriding.

4.4 Unless otherwise qualified on the part number drawing, nitride in an atmosphere of raw ammonia gas with either dissociated ammonia or nitrogen carrier gas at a temperature of 525 ±5ºC.

5.0 QUALITY REQUIREMENTS

5.1 Control of Heat Treat Special Process Characteristics

5.1.1 These requirements apply **only** when tighter control of heat treat process parameters beyond normal heat treat process controls are required by a 1E2966 Special Characteristics note ▽P on the part drawing.

5.1.2 Special Process Requirements

5.1.2.1 Temperature control throughout the furnace workspace shall be checked when furnace is placed in service, after major overhauls, or at a frequency specifically requested by the customer. Temperature uniformity throughout the furnace part workspace shall be within ±5°C at the normal operating temperatures.

5.1.2.2 Prior to placing new equipment into production, heat up test shall be conducted on loads representing the minimum and maximum load size to ensure that no temperature overshoot greater than 2°C occurs above the nitriding temperature setpoint.

5.1.2.3 Thermocouples and temperature controllers shall be checked, managed, and results recorded in accordance with ME1004 and MQ1010-90.

5.1.2.4 Furnaces shall be equipped with either manual or automatic means of 1) measuring ammonia dissociation and calculating nitride potential, 2) adjusting the nitride potential to meet a specific setpoint, and 3) recording the temperature and nitride potential data.

5.1.2.5 A test piece shall be run with each load on batch type furnaces or with each production lot on continuous furnace. The test piece shall be evaluated for conformance to all metallurgical requirements.

5.1.2.6 When a new furnace is placed in service, after major overhauls, or at a frequency specifically requested by the customer, the atmosphere uniformity shall be determined by 1) running either testpieces or piece parts throughout furnace workspace, and 2) analyzing for proper white layer levels and case depth.

6.0 METALLURGICAL REQUIREMENTS

6.1 Unless otherwise qualified, nitriding applies to all surfaces on the part.

6.1.1 The specified surface hardness and the nitrided depth are required on all surfaces that have been finished machined prior to heat treatment.

6.1.2 Surfaces allowed to be machined after nitriding as indicated by a 1E2261 stock removal control or by rough and finish process dimensions, will have hardness and a nitrided depth commensurate with the amount of stock removal allowed.

6.1.3 Cast, forged, wrought and/or extruded surfaces will have surface hardness and nitrided depth different than specified.

6.1.4 The metallurgical requirements on gear and spline teeth shall be measured at an x-location as described in the 1E2617 specification for carburized and hardened gears.

6.1.5 The nitrided depth specified for 1E2584A, Class III, friction clutch discs shall be measured in the spline root fillet.

6.2 The nitrided depth is obtained by a hardness traverse on a metallographic section by a tukon tester (Knoop indenter with a 500 g load) or equivalent. The minimum Knoop hardness for the appropriate case depth and material is specified in Figure 1.

Material	Core		Case			
	Heat Treatment	Hardness	Case Depth		Surface Rockwell Hardness	
		Brinell Hdns, mm or HRC	mm	Knoop Hdns, 500 g Load MIN	MIN	Typical
1E0681, 1E0509, 1E1286A	1E0106 or 1E0107 Q & T 565°C MIN	3.7–3.9 mm	0.13	395	81 HR15N	83 HR15N
			0.20	395	82 HR15N	84 HR15N
		3.5-3.7 mm	0.13	395	82 HR15N	84 HR15N
			0.20	440	85 HR15N & 40 HRC**	86-87 HR15N & 42 HRC**
			0.30	440	70 HR30N & 42 HRC**	72 HR30N & 44 HRC**
1E1286B	1E0106 or 1E0107 Q & T 565°C MIN	3.5-3.7 mm	0.13	440	87 HR15N	15N88
			0.20	440	88 HR15N & 42 HRC**	90 HR15N & 44 HRC**
			0.30	440	75 HR30N & 44 HRC**	78 HR30N & 46 HRC**
SAE 4142	1E0106 or 1E0107 Q & T 565°C MIN	3.4-3.6 mm	0.20	452	86 HR15N	87-88 HR15N
1E1005	1E0106 or 1E0107 Q & T 565°C MIN	23-28 HRC	0.30	395	85 HR15N	87 HR15N
1E0684 (ASTM A355 Alloy Steel Class C)	*Solution Heat Treat	3.5-3.7 mm	0.20	542	78 HR30N & 50 HRC**	81 HR30N & 52 HRC**
	Nitride & Age Harden Simultaneously	40 MIN HRC				
1E1371	1E0106 or 1E0107 Q &T 530°C MIN	42-47 HRC	0.13	542	90 HR15N	92-94 HR15N
			0.2	542	78 HR30N & 50 HRC**	81 HR30N & 52 HRC**

Figure 1

Note*: Oil quench from 900°C and temper 675°C, followed by a rapid cool to below 450°C. Precipitation hardening occurs between 510°C and 650°C.

Note:** Surface hardness obtained by Rockwell HRC testing reflects the combination of case and core hardness. Parts meeting nitride case depth and both Rockwell superficial hardness and HRC minimum surface hardness will have acceptable core hardness. For parts which do not meet the HRC minimum surface hardness in Figure 1, the core hardness and microstructure shall be evaluated to determine if the prior direct hardening heat treatment is acceptable in accordance with Paragraph 6.3.1.

6.3 In addition to all of the requirements specified on the detail drawing, the following requirements shall apply to all parts processed to this specification.

6.3.1 With the exception of 1E0684, the core hardness after nitriding, measured at a point adjacent (below) to the transition zone, shall be the same as specified for the quench and temper treatment on the detail drawing. For 1E0684 steel core hardness at any location below the nitride case shall be Rockwell 40 HRC minimum.

6.3.2 The white layer shall be sound, adherent, and free of blisters, cracks, or spalled areas. Unless otherwise specified, white layer depth is limited to 0.020 mm maximum.

7.0 INSPECTION AND TESTS

7.1 Inspection of piece parts shall include assurance of core hardness, Rockwell hardness of nitrided surface, examination of surface for cracking and spalling, assurance of minimum case depth, and control of the white layer.

7.2 Examination of Case - A Rockwell “C” indentation shall be made on a noncritical area of the finished surface and shall be examined with a Brinell glass. Cracking or spalling indicates a brittle form of white layer and is cause for rejection.

8.0 ALTERNATE PROCESSING

1E4186 - Ion Nitride may be used to fulfill 1E0548. Process parameters shall be controlled to meet all print and specification requirements. However, for gears and splines, 1E2349C approval is required for each part number.

9.0 REFERENCES

Caterpillar Specifications	1E0106, 1E0107, 1E0509, 1E0548, 1E0681, 1E0684, 1E1005, 1E1286A, 1E1286B, 1E1371, 1E2349C, 1E2584A, 1E2966, 1E4186
Caterpillar Manufacturing Practices	ME1004, MQ1010-90
ASTM	A355
SAE	4142