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YUKON QUALITY CONTROL TECH REPORT

Yukon Gear & Axle

Measuring & Dimensions

August 2010

Our dedication to providing our customers with the highest quality automotive differential parts requires Quality Control inspections of all parts.

Our Coordinate Measuring Machine (CMM) (Figure 1.1) is utilized to inspect parts with programs designed to measure dimensions that otherwise would be very difficult to measure. The accuracy of the CMM is within 5 microns. A human hair is 60 microns.

The CMM is composed of three axes, X, Y, and Z. These are relative to each other in a typical three dimensional coordinate system. Each axis has a very accurate scale system which relays information to the computer control and is displayed on a digital readout. The probe (Figure 1.2) is used to touch various features of a part, checking them against the program and the Solid Model to determine if a part is within the allowable manufacturing tolerances.

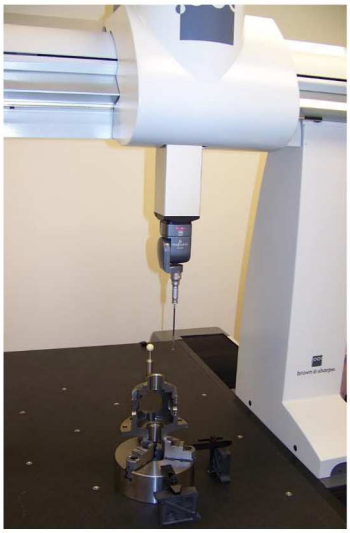


Figure 1.1

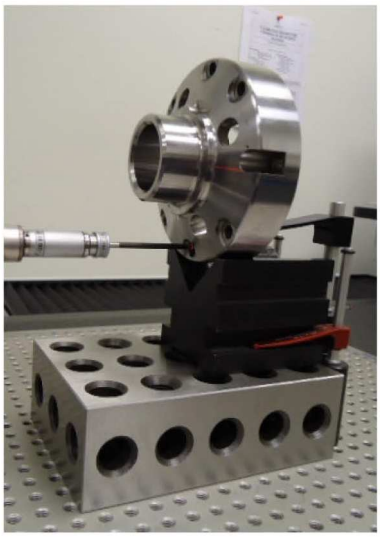


Figure 1.2

Solid Models are generated using a Solidworks platform (Figure 1.3). These models are imported directly into our CMM software (Figure 1.4) where accurate programming can be performed directly from the engineered features of the part. Many product manufacturers use Solidworks models for direct machining and production, allowing high quality parts to be made and checked to insure the quality is the highest available.

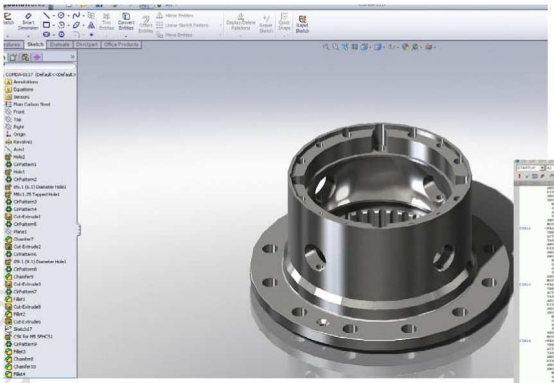


Figure 1.3

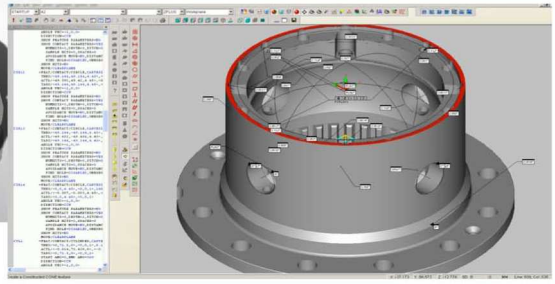


Figure 1.4

Measuring & Dimensions

In addition to utilizing a CMM for checking dimensions, a percentage of each shipment of product received into Randy's Ring & Pinion's warehouse is inspected by our highly qualified inspectors (Figure 2.1). A variety of accurate measuring devices are used, ranging from Bore Gages (Figure 2.2) to Surface Finish devices (Figure 2.3).

Figure 2.1

Figure 2.2

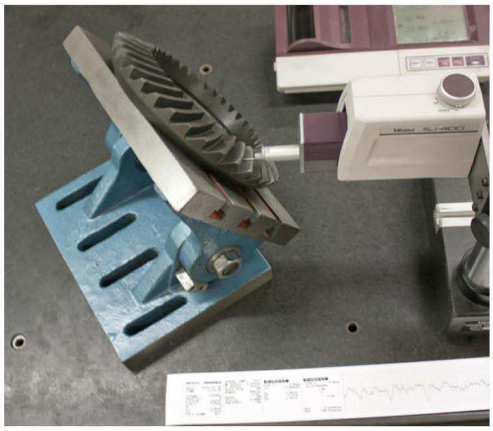


Figure 2.3

The Yukon Gear and Axle Quality department insures that every critical dimension to the function of the part is checked. Inspection Plans (Figure 2.4) are utilized to check each part against the Solidworks drawing (Figure 2.5).

RRP INSPECTION FORM

PART/ DWG. NO.		REV	PART DESCRIPTION			SUPPLIER		PO NUMBER	INVOICE NUMBER		LOT SIZE		SAMPLE SIZE	DATE
COMDA-0117		A	DIFFERENTIAL CASE-D60HD											8/23/10
ID	NOMINAL VALUE	TOLERANCE +	TOLERANCE -	SPECIFICATION MIN	SPECIFICATION MAX	TOOL	PROCESS	SAMPLE 1	2	3	4	5	6	7	8	9	10
1	SURFACE FINISH 3.2 UNLESS SPECIFIED OTHERWISE				3.20												
2	⏥ Ø0.04			0.00	0.04												
3	⊥ Ø0.05 A			0.00	0.05												
4	57.92	0.10	-0.10	57.72	57.92												
5	22.50	0.25	-0.25	22.25	22.75												
6	10.82	0.05	-0.05	10.77	10.87												
7.1	1.00	0.25	-0.25	0.75	1.25												
7.2	45.00	0.00	0.00	45.00	45.00												
8.1	Ø 25.40 THRU ALL	0.05	-0.05	25.35	25.45												
8.2	90°±0.15 APART	0.15	-0.15	89.85	90.15												
9	⌖ Ø0.10 A B			0.00	0.10												
10	Ø 150.99	0.00	-0.04	150.95	150.99												
11	Ø 218.47	0.05	0.00	218.42	218.47												
12	MAXIMUM ROUGHNESS 1.6				1.60												
13	MAXIMUM ROUGHNESS 1.6				1.60												
14	R 2.25	0.25	-0.25	1.75	2.25												
15	MAXIMUM ROUGHNESS 1.6				1.60												
16.1	0.50	0.25	-0.25	0.25	0.75												
16.2	45.00	0.00	0.00	45.00	45.00												
17	⌖ Ø0.05 B			0.00	0.05												

Figure 2.4

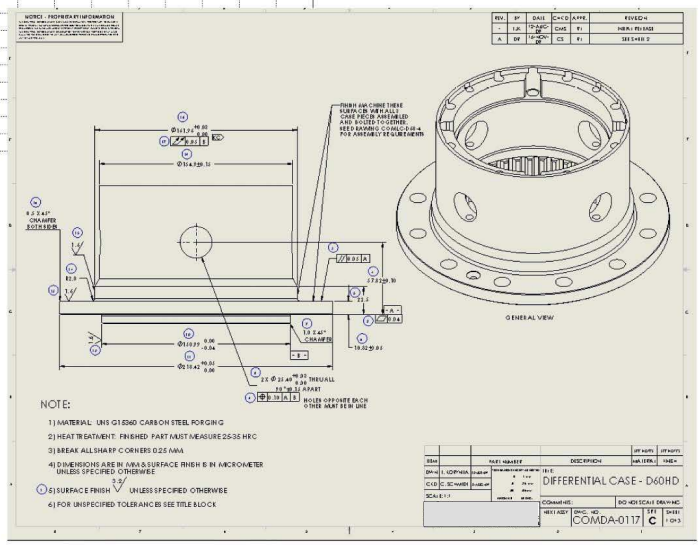


Figure 2.5

In addition to insuring that all critical measurements are met, the Metallurgy side of the product is equally important. The correct material and heat treat requirements must be met by each manufacturer in order for each part to provide the life expectancy and performance expectations of every part.

Material types are carefully selected by our Engineering department for each application, driven by the requirements that will allow each product to last its expected lifetime. Material selection is an important factor that directly relates to the strength and durability of the product.

In order to insure that each part that we distribute has the correct metallurgic properties, our Quality Control department utilizes the most sophisticated means of testing. A spark Spectrometer (Figure 3.1) is used to determine the actual material type the part was made with. The Spectrometer creates a spark on a cut metal sample in an ultra-high purity argon environment (Figure 3.2). The clean spark is optically analyzed (Figure 3.3 and 3.4) by the Spectrometer, breaking down and reporting each element percentage that makes up particular metals.

Figure 3.1

Figure 3.2

Figure 3.3

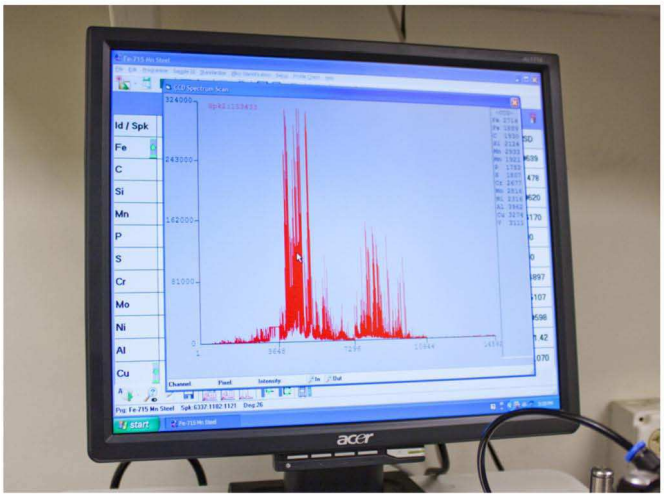


Figure 3.4

Hardness

In addition to material type, material hardness specifications are just as critical. Areas designed for wear or strength typically require a case hardness, meaning a specific hardness requirement on the surface, an effective case depth, meaning how far the depth of the effective case hardness reaches, and the core hardness. The core hardness is the softer area that allows the product to not simply break but endure shock loads that are very common in automotive differential parts.

Parts are evaluated for hardness requirements by utilizing our Micro-hardness test device (Figure 4.1).

By definition, hardness is the resistance to permanent penetration of the material by another one that is harder.

Figure 4.1

The Micro Hardness Test device allows us to test hardness at micro intervals from the exterior portion of a sample to the core. (Figures 4.2 & 4.3) The testing device measures the indentation and takes an average of the diagonal measurements to obtain a hardness value. You can see between figure 4.4 and 4.5 the different diamond indent, showing the material is softer in the core as designed. The smaller diamond is different in size only due to the hardness and resistance of the part to the indenter. Several measurements are taken beginning at the edge of a sample with incremental steps towards the center. These measurements can then be plotted into a chart (Figure 4.6)

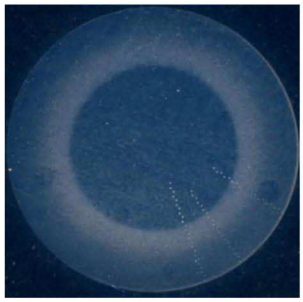


Figure 4.2

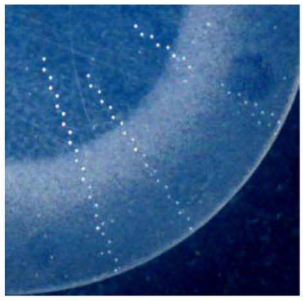


Figure 4.3

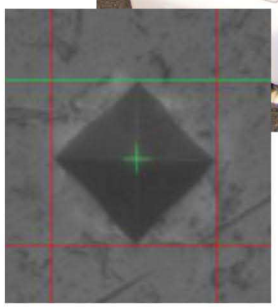


Figure 4.4

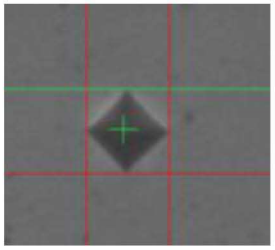


Figure 4.5

RRP INSPECTION FORM

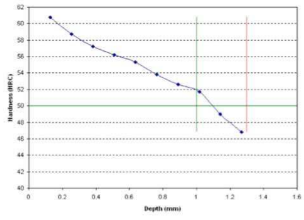
PART/ DWG. NO.	REV	PART DESCRIPTION	SUPPLIER	PO NUMBER	INVOICE NUMBER	LOT SIZE	SAMPLE #	DATE
COMSLG000	X	Driver		58933		99	5	4/5/2010

MICRO HARDNESS EVALUATION FOR EFFECTIVE CASE DEPTH (ECD)

ECD Specification

Depth (mm) min	Depth (mm) max	Hardness (HRC)	TEST LOAD
1.0	1.3	50	1000

Distance in	Distance metric	Test Results Test 1	Test 2	Test 3
0.005	0.127	60.8		
0.010	0.254	58.7		
0.015	0.381	57.2		
0.020	0.508	56.2		
0.025	0.635	55.3		
0.030	0.762	53.8		
0.035	0.889	52.6		
0.040	1.016	51.7		
0.045	1.143	49		
0.050	1.27	46.8		
0.055	1.397			



MICRO HARDNESS TEST DESCRIPTION

TEST 1:
TEST 2:
TEST 3:

CORE HARDNESS (HRC) TEST TYPE	TEST LOAD	SPECIFICATION MIN	SPECIFICATION MAX	RESULTS
Rockwell	500	35	45	40.4

INSPECTION TYPE: ☐ FAI ☐ SAMPLE ☑ PROD

NOTES: Case, Core, & ECD Correct

☑ PASSED ☐ FAILED ☐ SUBMIT FOR ENG REVIEW

APPROVAL: ☐ ACCEPT ☐ REJECT

INSPECTED BY | DATE | APPROVED BY | DATE

Figure 4.6

Metal Grain Structure

Cast products (such as products that are ductile iron used in Drop-out Housings), require a different means of testing to insure that material specifications are met. In order to insure that the correct ductile iron is provided in the finished product, a sample is cut and prepared to look at microscopically. In order to see the grain structure, the sample is prepared and etched with a 4% diluted Nitric Acid solution.

Ductile iron will contain nodular graphite in a matrix of ferrite and pearlite. The pearlite / ferrite structure provides higher wear resistance and strength. The amount of pearlite and ferrite determines the tensile strength (in PSI), yield strength (in PSI), and elongation. Figure 6.1 shows the different areas of an 80-55-06 specified ductile iron sample as compared to a 65-45-12 sample (Figure 6.2).

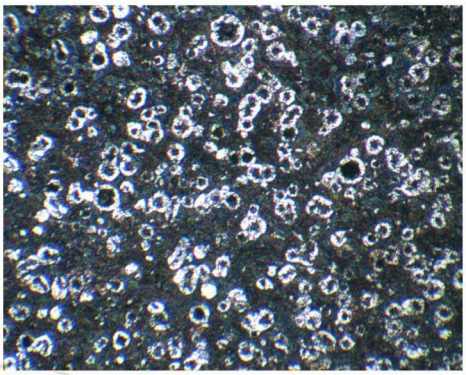
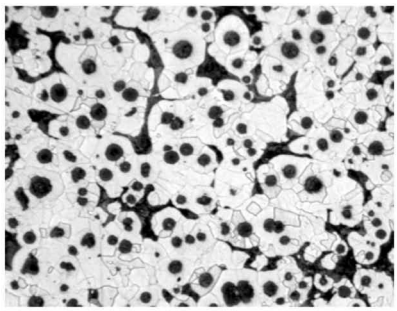


Figure 6.1
Properties:
Tensile Strength psi (min) = 80,000
Yield Strength psi (min) = 55,000
Elongation (min) = 6%



Properties:
Tensile Strength psi (min) = 65,000
Yield Strength psi (min) = 45,000
Elongation (min) = 12%

Figure 6.2

Axle Strength

Yukon parts are produced with state-of-the-art equipment and manufacturing techniques by the some of the world's foremost leaders in OEM manufacturing. We visit the factories. We know the people. And we constantly strive to improve the processes. Without a doubt, we stand behind the quality of the Yukon name.

By being able to work directly with the factories we are able to review and implement controls at the factories that minimize their product defects. Manufacturing plans are implemented in conjunction with our inspection plans to insure that checks are made not only on finished products, but during the entire manufacturing process.

At Yukon Gear and Axle we go beyond dimensional and metallurgical checks by performing various destructive tests to determine the ultimate yield of products. A great example of this is our Axle Break test device (Figure 7.1, 7.2, 7.3, 7.4). This device allows us to test an axles' ultimate yield point and allows us to plot data to measure angular deflection against the amount of torque that was required to break the axle (Figure 7.5).

Figure 7.1

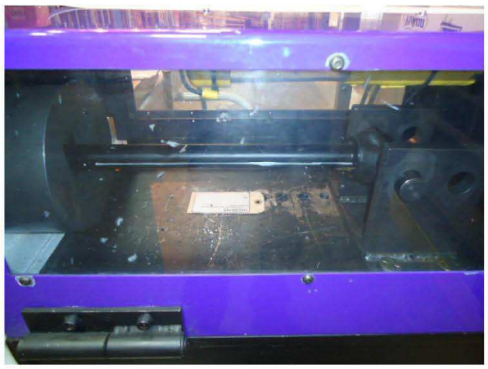


Figure 7.2

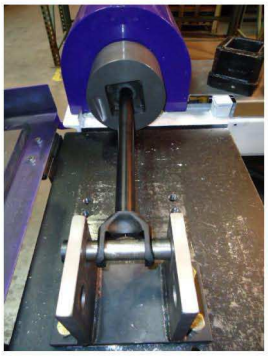


Figure 7.3

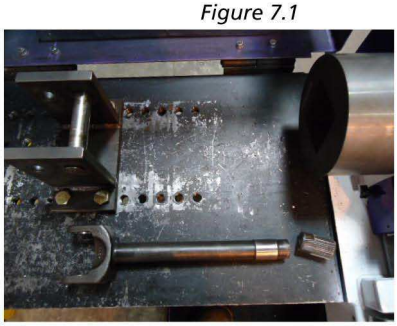


Figure 7.4

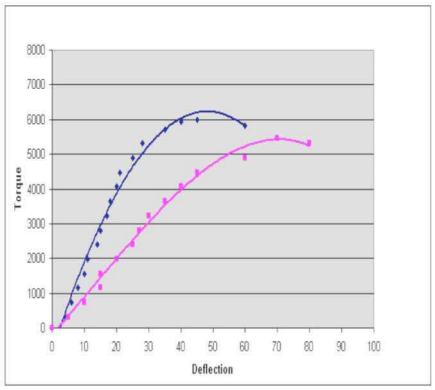


Figure 7.5

Assembly Inspections

With the database that we have compiled on axle break tests, we are able to not only provide the best product to our customers, but in addition give us the confidence that we will see a very minimal amount of warranties and field failures.

At Yukon Gear and Axle every warranty claim is thoroughly evaluated to determine the root cause of the failure and to prevent re-occurrence.

Complete assembly inspections are routinely checked using custom tooling to check proper performance. A couple of examples are our engagement and disengagement test device (Figure 9.1) for assembled posi-traction cases and an air activation test device used to test Zip Locker activation with the correct air powered seal housing (Figure 9.2).

Figure 9.1

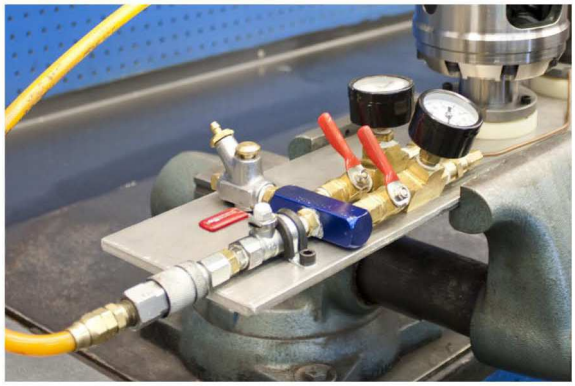


Figure 9.2