MILL SELF-DISENGAGEMENT BARRING SYSTEMS

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AGENDA

Background

Principle and Operation

Cost Model

Instrumentation and Measurements

Measurement Results

Test Results

Conclusion

Other Benefits

Final word

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BACKGROUND

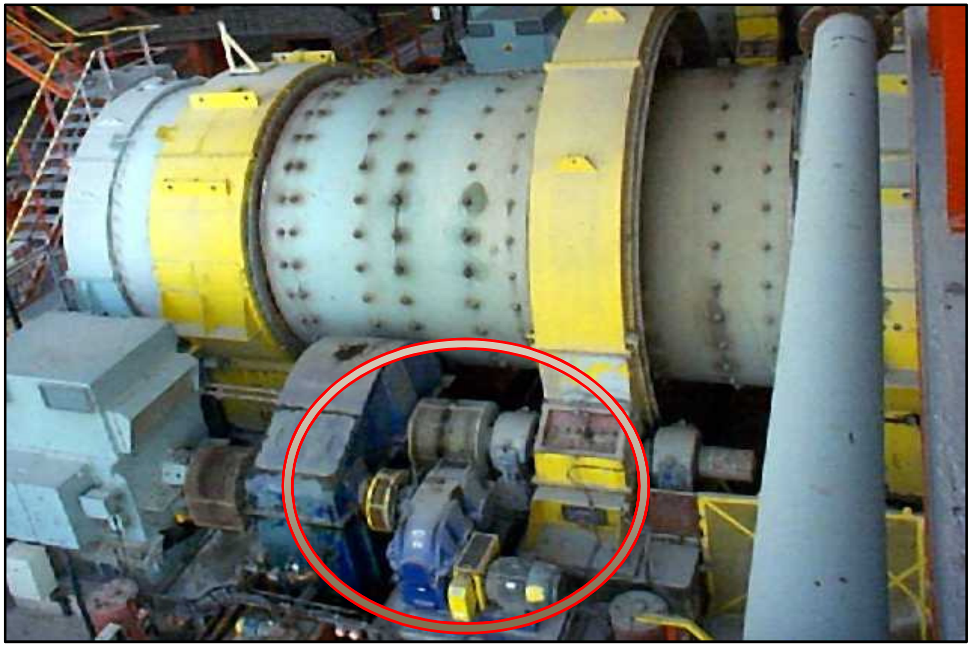
BACKGROUND-BARRING

- **The Barring drive, also known as Inching drive, "Sunday"- drive or auxiliary- drive, is an important component of any mill installation. It is used for maintenance and inspection purposes, as well as an emergency auxiliary drive to keep the mill rotating when the main motor fails and it is required for the mill to rotate at certain intervals. Re-lining as a maintenance function cannot be done without a barring drive.**

- **Probably the most important function of the Barring drive is to dislodge Frozen or Lock charge thus as frozen or lock charge protection**

The inching drive component include

- A prime mover and Speed reducer
- A connection - engaged by hand or automatically, between the inching reducer and the main drive.
- Included in the system, is a brake or backstop to hold the equipment when it is stopped in an unbalanced position
- Appropriate safety devices



PRINCIPLE and OPERATION

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PRINCIPLE and OPERATION

With the new barring gear coupling installed, the mill motor starts up whilst barring is taking place, and the mill load is in motion. The barring gear coupling slides back in a keyway and a limit switch simply stops the barring motor. The self-disengagement clutch is a <u>directionally actuated freewheel clutch.</u>

PRINCIPLE and OPERATION

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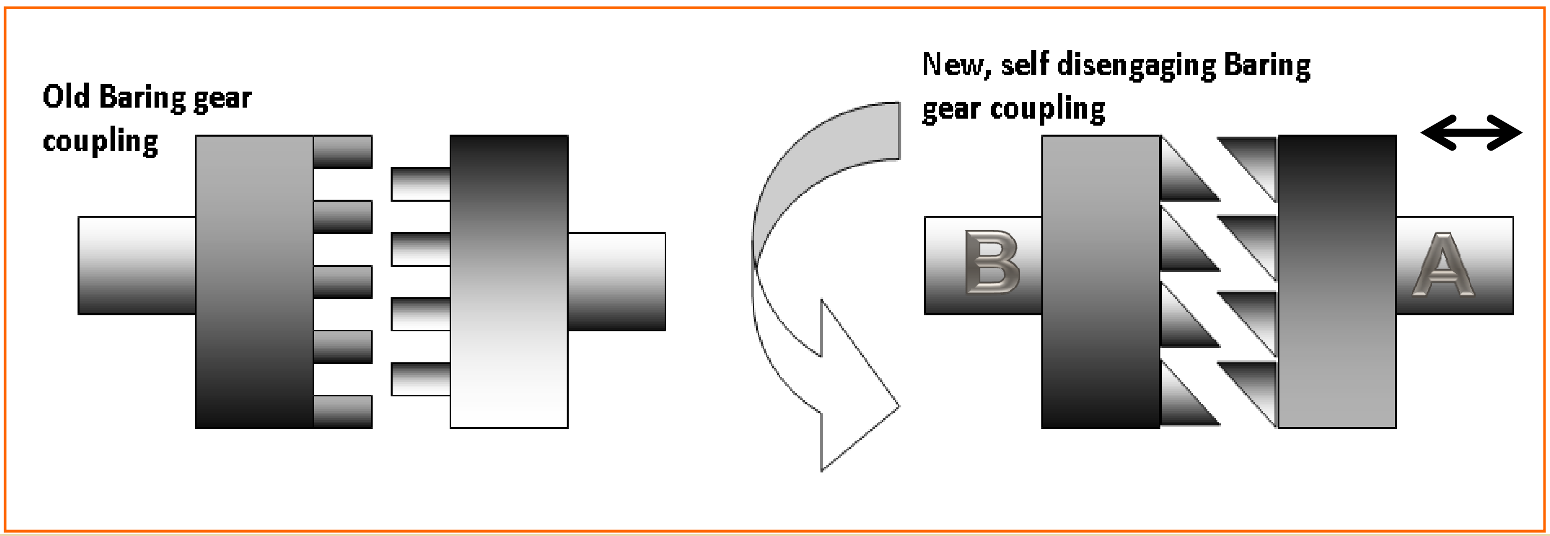
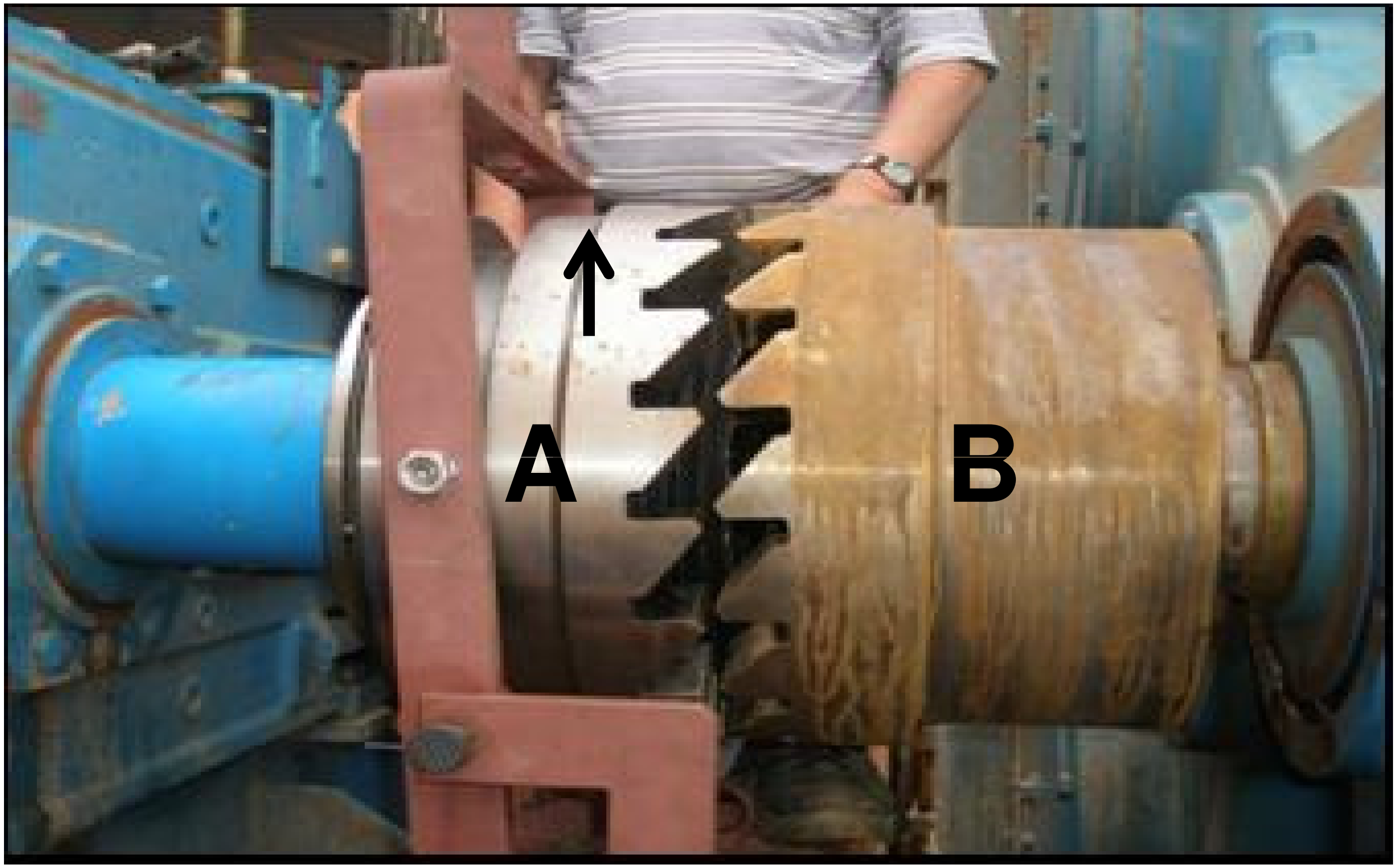
- Part A is mounted on the driver gear unit shaft with axial movement by means of a key and part B on unit to be driven and is fixed.
- This imply that A is driving B in the Barring mode.
- The overrunning clutch is engaged in the stationary condition by shifting part A axially to engage with B.
- Once the speed of clutch part B is higher than that of clutch part A (Starting point of main motor), independent dis-engagement caused by the angled faces of the engaging dogs on clutch part A and clutch part B takes place. Motor and driven machine unit are then dis-engaged mechanically. A is then locked in the dis-engaged position.

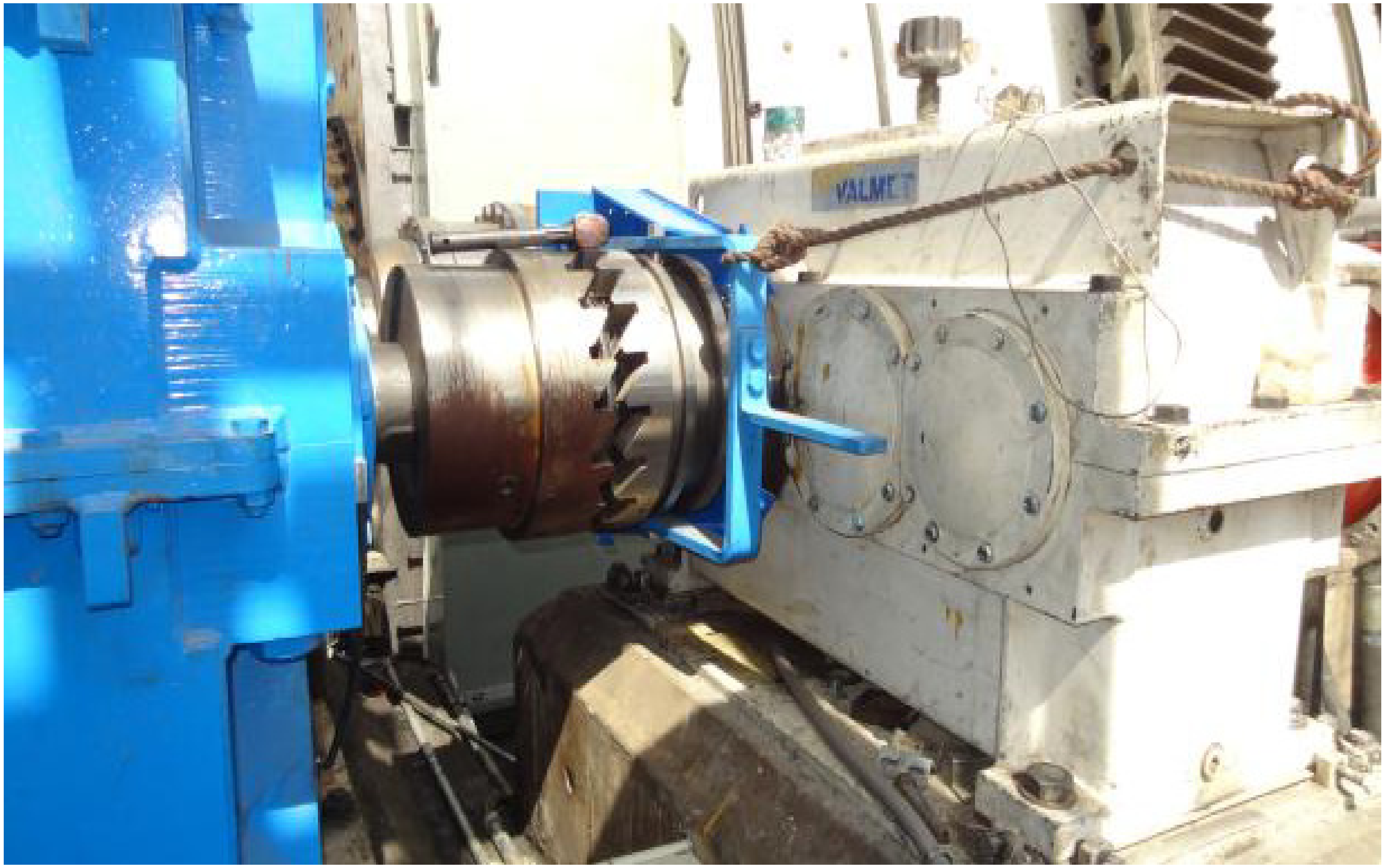


BPRINCIPLE and OPERATION



OPERATION

BPRINCIPLE and OPERATION



BPRINCIPLE and OPERATION - Geita

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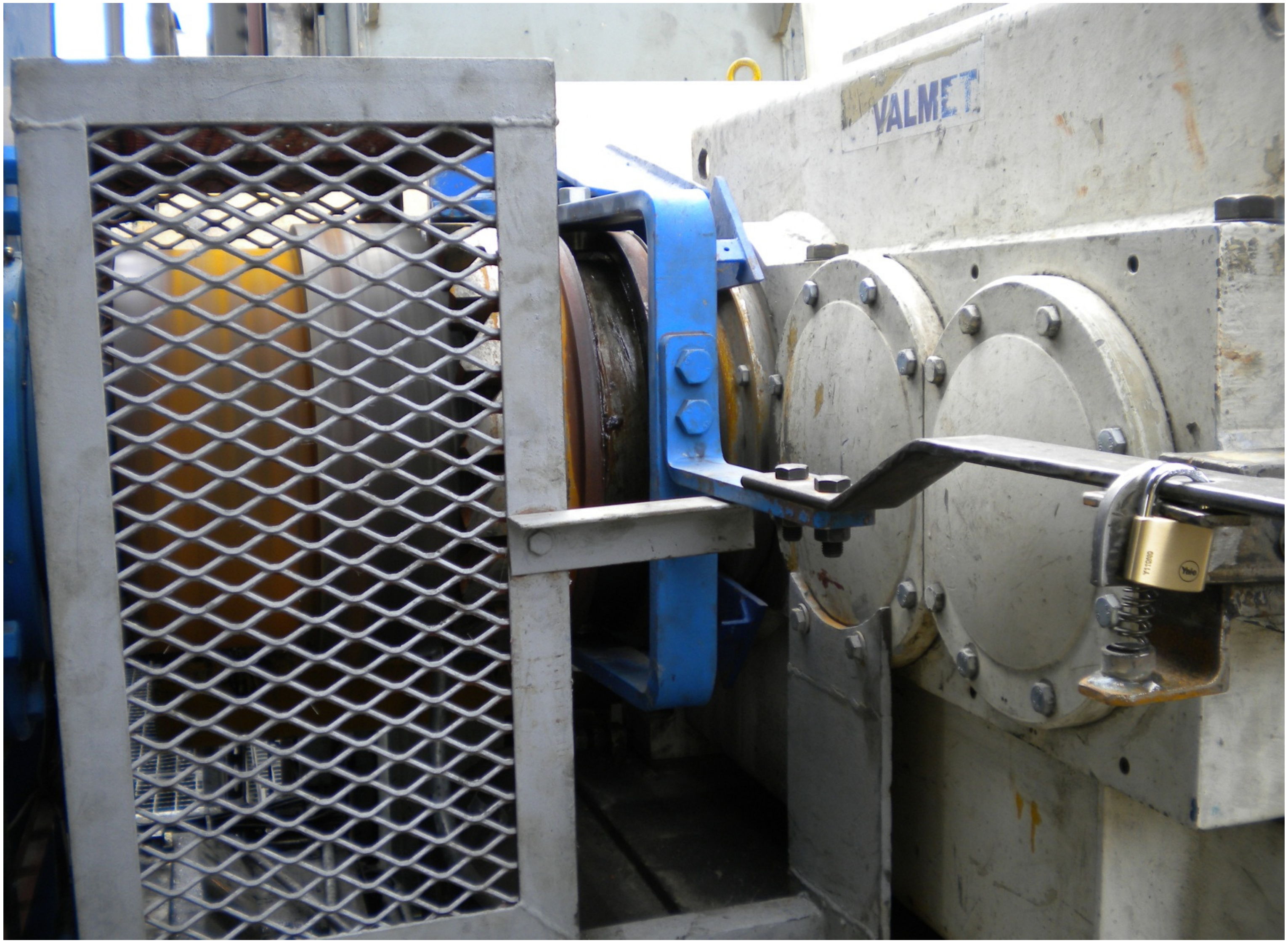

COST MODEL

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COST MODEL

The methodology was to develop a Cost model and quantify the effect of Self-disengagement barring systems on key performance indicators of a mill with special attention to life time reliability

- **Capital costs.**
- **Operating costs.**
- **Product costs.**
- **Repair and maintenance costs.**
- **Lost production due to unplanned failures**

Repair and Maintenance Cost

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Maintenance

Siguiri Mill

Expected maintenance cost:

Monthly Artisan inspections:	R -25 000.00	per mill
Monthly Vibration and oil sampling:	R -7 500.00	per mill
Bi-Annual trip testing:	R -	per mill
Annual Tan/Delta & Partial discharge:	R -5 000.00	per motor

Main Menu

Restore default formulas

Nominal cash flow 7% per annum (0.57% per month)

		1	1	1	1	1	1	1
	No	1	2	3	4	5	6	7
No		2010	2011	2012	2013	2014	2015	2016
1	January	R -32 683.76	R -34 971.62	R -37 419.64	R -40 039.01	R -42 841.74	R -45 840.66	R -49 049.51
2	February	R -32 868.56	R -35 169.36	R -37 631.21	R -40 265.40	R -43 083.98	R -46 099.85	R -49 326.84
3	March	R -33 054.40	R -35 368.21	R -37 843.98	R -40 493.06	R -43 327.58	R -46 360.51	R -49 605.74
4	April	R -33 241.30	R -35 568.19	R -38 057.96	R -40 722.02	R -43 572.56	R -46 622.64	R -49 886.22
5	May	R -33 429.25	R -35 769.29	R -38 273.15	R -40 952.27	R -43 818.92	R -46 886.25	R -50 168.29
6	June	R -33 618.26	R -35 971.54	R -38 489.55	R -41 183.82	R -44 066.68	R -47 151.35	R -50 451.95
7	July	R -33 808.34	R -36 174.93	R -38 707.17	R -41 416.68	R -44 315.84	R -47 417.95	R -50 737.21

INSTRUMENTATION and MEASUREMENTS

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INSTRUMENTATION and MEASUREMENTS

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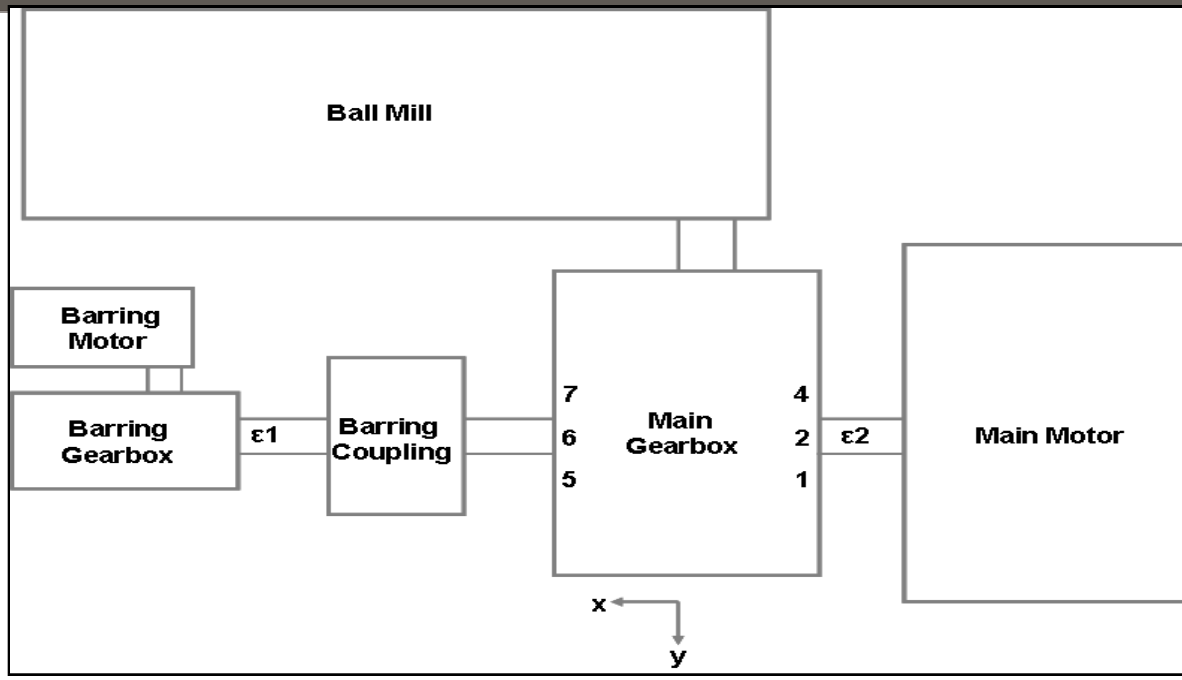

- Two 90° degree bi-axial shear strain gauges on the barring gearbox output shaft. Wired to measure torque output – One full-bridge channel (position ε1)
- Two 90° degree bi-axial shear strain gauges on the main gearbox's input shaft. Wired to measure torque output – One full-bridge channel (position ε2)
- Three accelerometers on the main gearbox housing on the input shaft end measuring tri-axial acceleration of the main gearbox.
- Three accelerometers on the main gearbox housing on the barring coupling end measuring tri-axial acceleration of the main gearbox.

MEASUREMENT RESULTS

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MEASUREMENT RESULTS

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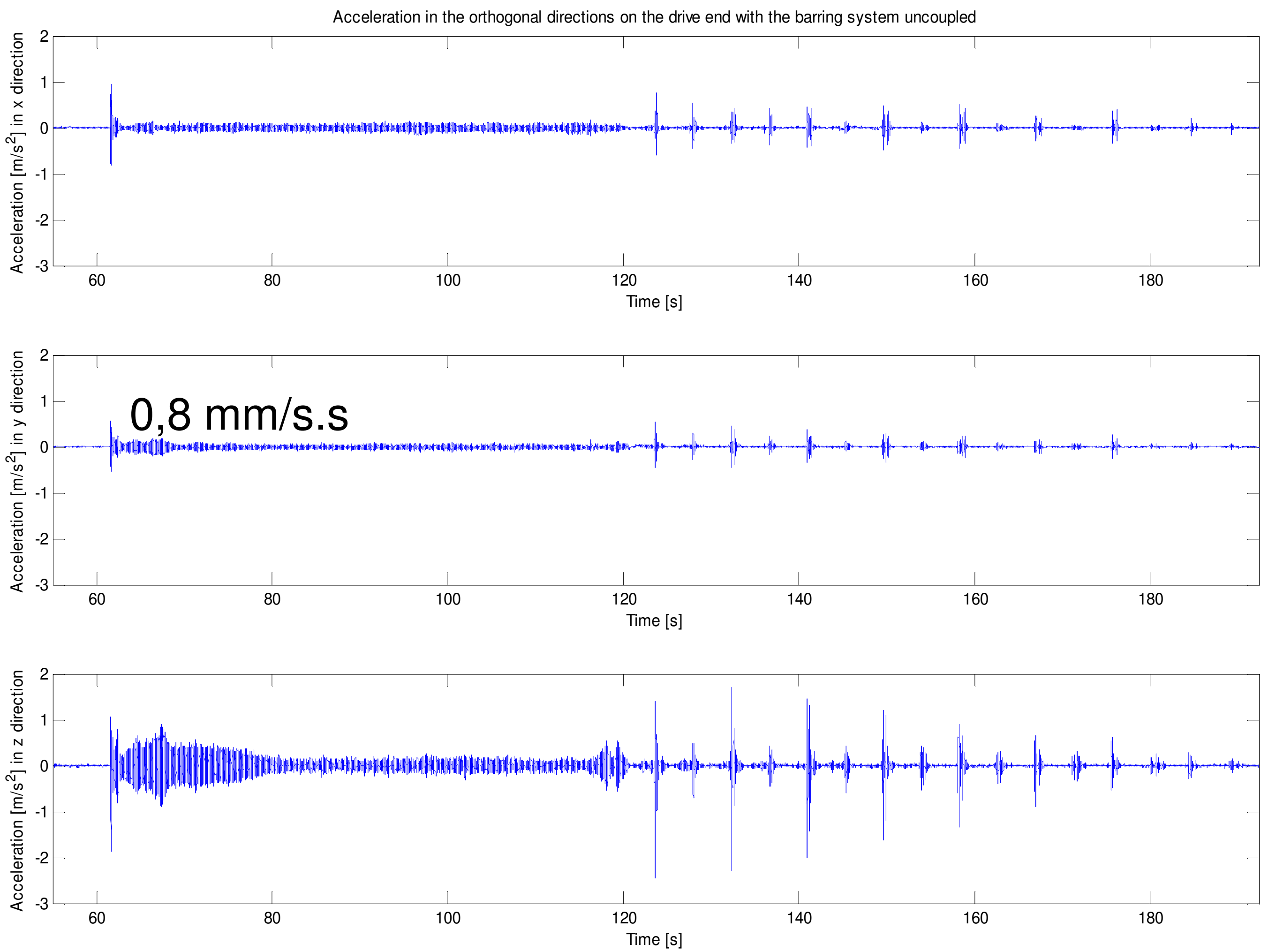
- **ACCELERATION:** **GEARBOX CASING MAINDRIVE UNCOUPLED (y)**



MEASUREMENT RESULTS

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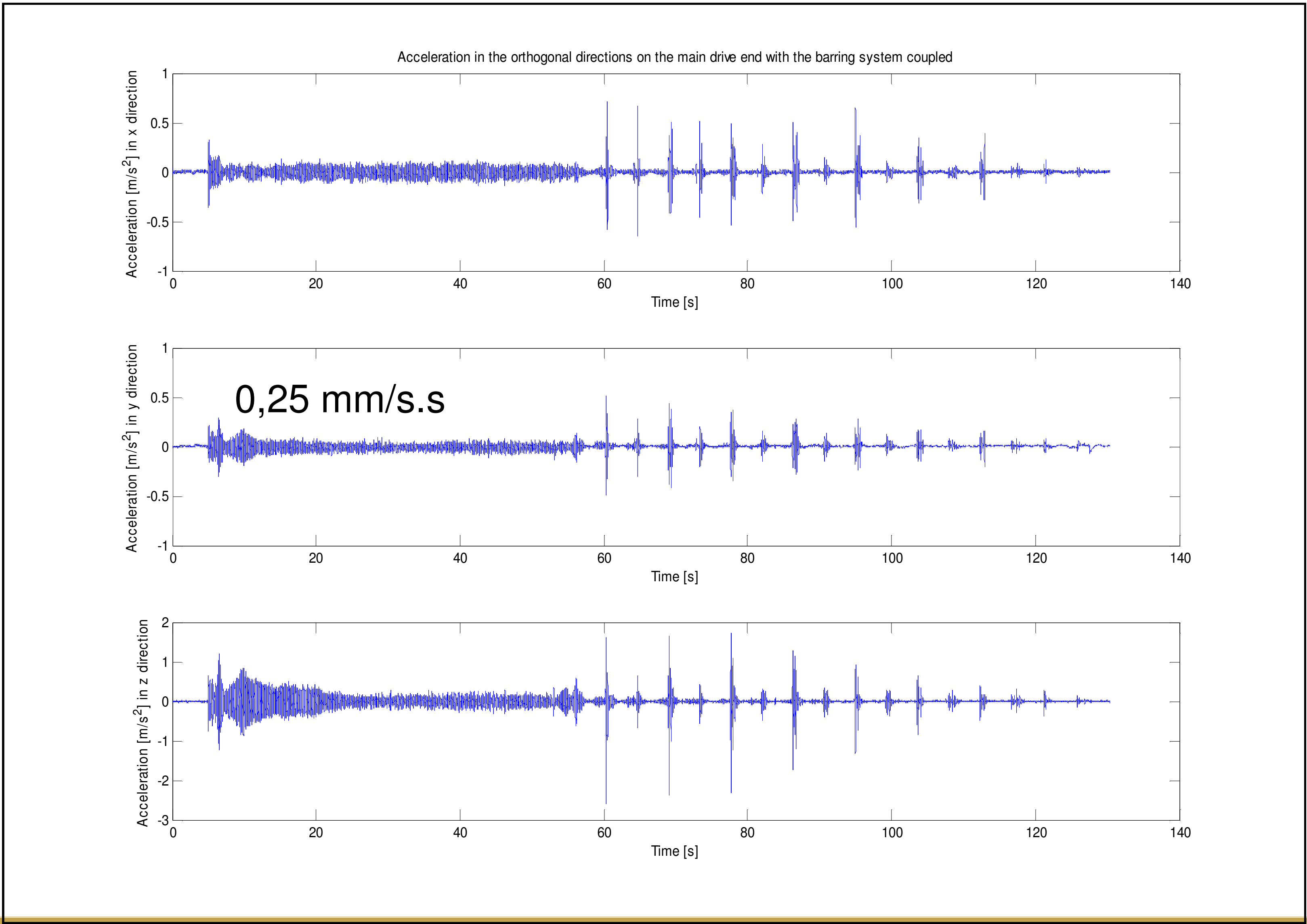
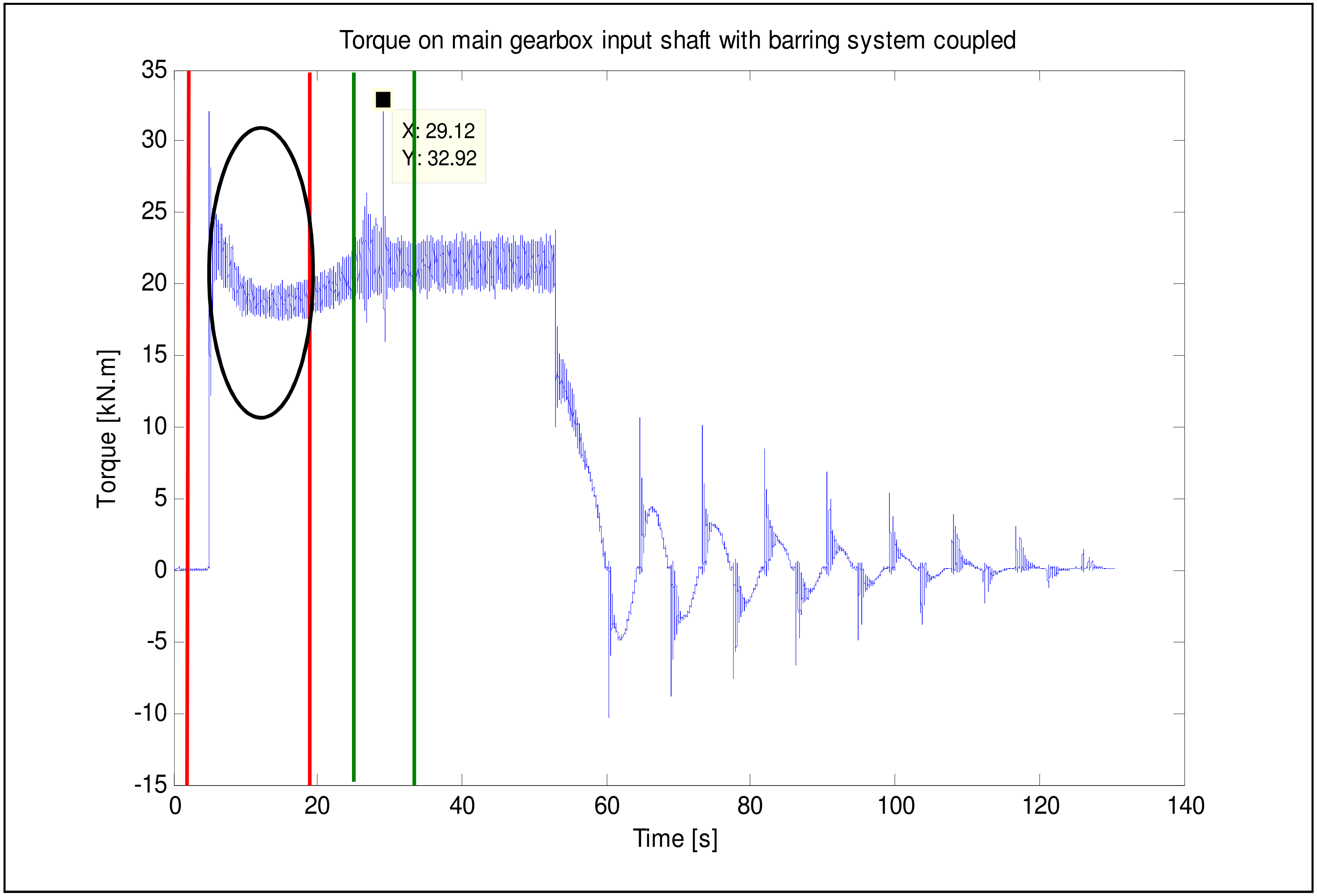
- **ACCELERATION : GEARBOX CASING MAINDRIVE COUPLED (y)**



MEASUREMENT RESULTS

- ## INPUT SHAFT TORQUE : COUPLED



MEASUREMENT RESULTS

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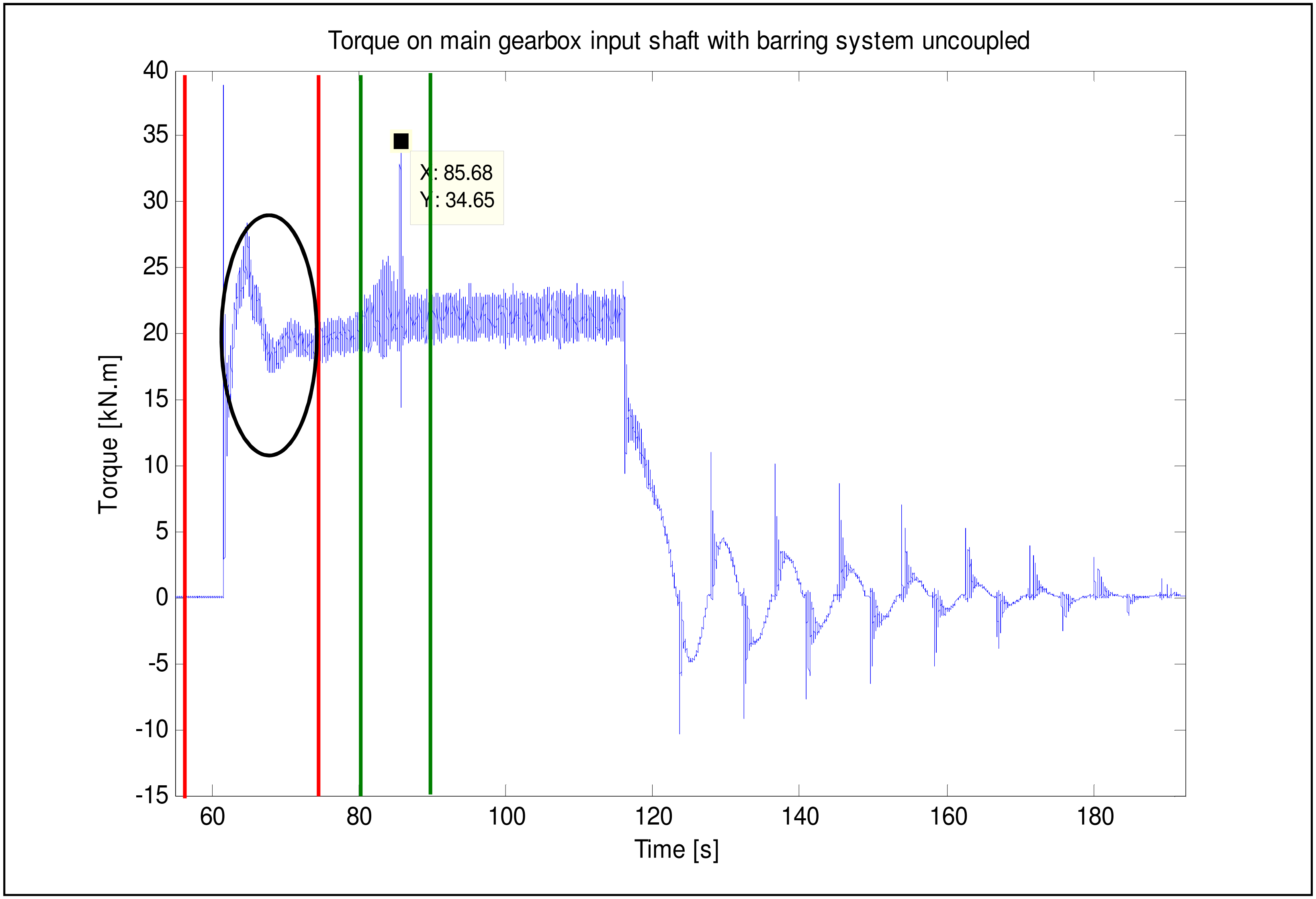
- **INPUT SHAFT TORQUE : UNCOUPLED**



MEASUREMENT RESULTS

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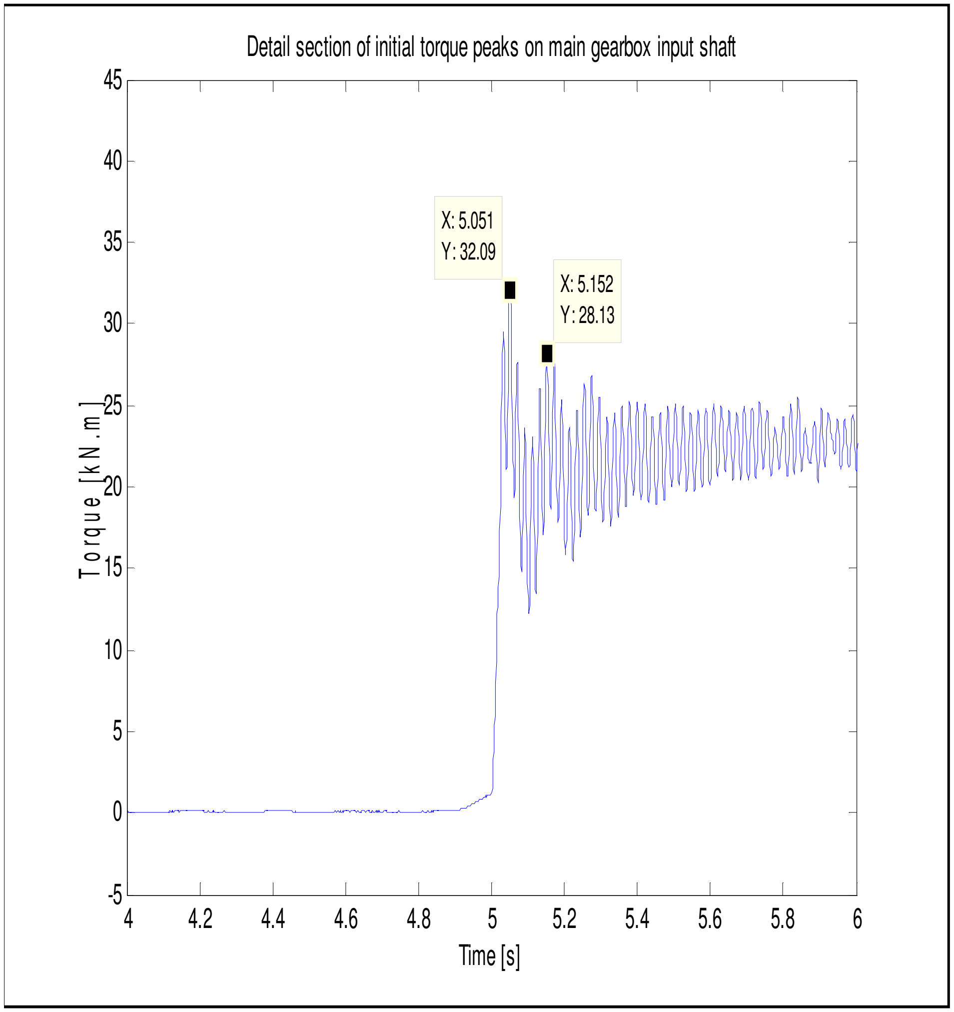
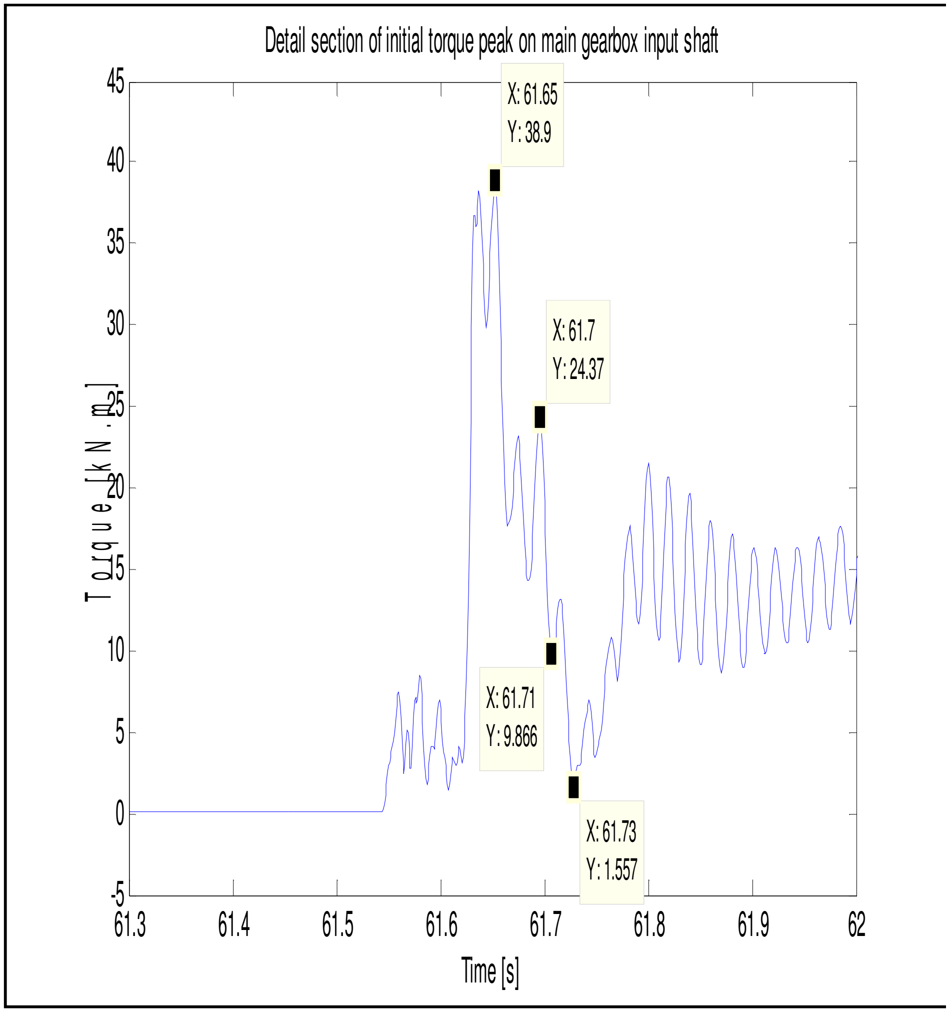
- **INPUT SHAFT TORQUE :**

COUPLED



UNCOUPLED



TEST RESULTS

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TEST RESULTS

Acceleration results

- Comparing Fig.2 with Fig.4 the acceleration measured on the main drive end on the y direction recuses from 0.8 mm/s.s uncoupled to 0.25 mm/s.s coupled.
- Reduction of 68 %.

Torque results

- The first torque (COUPLED) peak to be considered for the main gearbox input shaft was calculated as being 28.13kN.m. This is about a 32.6% increase from the average operational torque (21.2kN.m) calculated for the shaft and is 49% of the rated torque of the gearbox. (57kN.m).
- The first initial torque (UNCOUPLED) peak for the main gearbox input shaft was calculated as being 38.9kN.m. This is about a 83.4% increase from the average operational torque (21.2kN.m) calculated for the shaft and is 68% of the rated torque of the gearbox (57kN.m).
- The result that would have an effect on the operational life of the system is the difference in the first torque peak (38.9kN.m) in the system uncoupled and the second torque peak (28.13kN.m) in the system coupled. This difference equates to a 38% increase in torque experienced by the system compared to starting up from the barring speed.

CONCLUSION

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CONCLUSION

- **The acceleration peaks measured on the main drive end reduced by 68 %.**
- **The torque peaks on the input shaft were 38.9kN.m for the system with no barring and 28.13kN.m for the system with barring. 38% Reduction.**
- **The contact stresses in the pinions and gears increase by about 17% for no barring compared to barring.(Calculated)**
- **A reduction in operational life of 31.5% for the gearbox is calculated when the barring system is not used. (37% of rated torque).**

OTHER BENEFITS

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OTHER BENEFITS

- **Smooth torque transfer through the drive train because backlash is taken up by the barring drive.**
- **Angular momentum at point of start-up of the main drive. The system does not start from rest that could result in lower torques.**
- **Small and low cost motors and drive keeps the mill in rotation.**
- **Safe and non-complex system to operate and operator friendly**
- **Very low and basic maintenance intensive system**
- **Non-complex retrofit on current systems**
- **Time saving operation**
- **Relative small capital layout**
- **Eliminates the possibility of bridging out limit switches as it form part of the Control Philosophy.**

FINAL WORD

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FINAL WORD

- **From a safety perspective and with specific attention to Stored Energy this system is almost incomparable to the normal practice. Just the elimination of force by hammer or lever to engage the wheel speaks for itself. If you consider sometimes the physical condition of the engagement wheel you would prefer not to be present at this operation during specifically at night time.**

- **It is my absolute belief that this is a <u>Step Change in Mill starting procedures</u> with many other benefits and advantages not quantified in this paper. This does not eliminate other factors to be considered that will hinder this change but in no doubt I believe we can overcome that.**

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