Key PMR's

Girth Gear Axial Runout measurement Procedure

1. **PURPOSE**

The axial run out on girth gears has to be kept within the acceptable values in order to avoid an uneven contact between pinion and girth gear, which might damage their running surfaces.

The Holcim preferred method uses non-contact **inductive sensors** connected to an Analog/Digital (A/D) converter. The data is then transferred via USB port to a laptop. This set up allows immediate results in the field and, more importantly, the measurement is performed **while the equipment is running** (see picture above)

HGRS/MER Department can assist plants on buying their own measurement instruments.

Additional methods **(cumulative** and **traditional**) will be also described, but they require the equipment (kiln or mill) to be down.

2. **SAFETY**

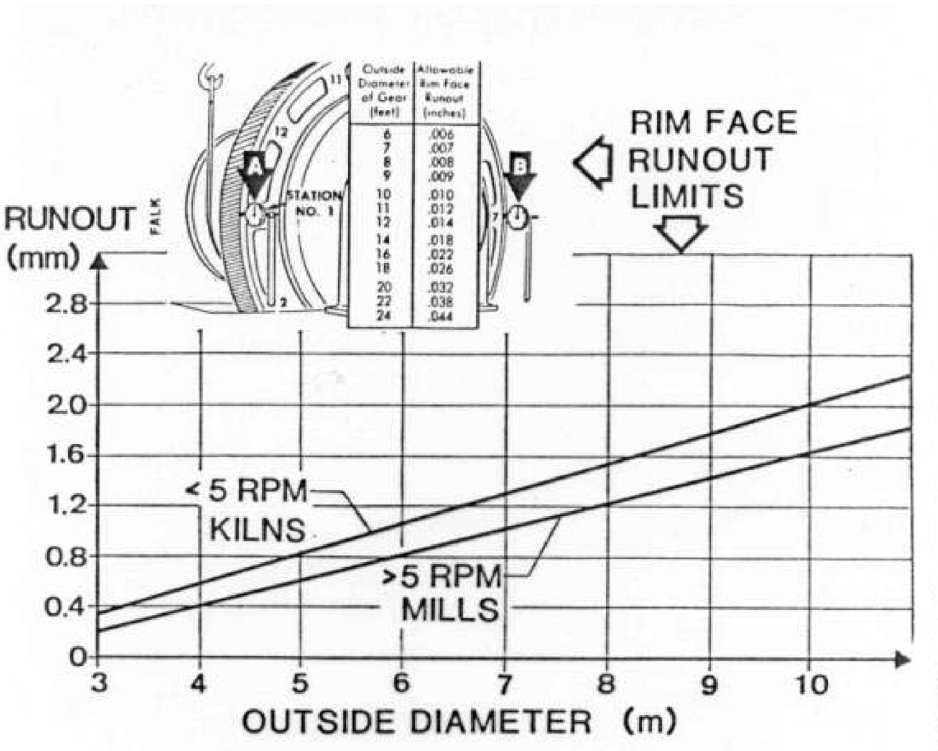
As mentioned before, the inductive sensor method is performed with the equipment running. Therefore, care has to be taken that neither instruments nor personnel come in contact with running surfaces of the gear.

Especially for mills, it is recommended to install the sensors during a planned stop of the equipment and to let them in place until the measurement is done.

For the **cumulative** and **traditional methods** the equipment (kiln, mill) must be properly de-energized. Use the local lock-out/tag-out/try-out procedure on the main drive.
Since the equipment has to be turned with the auxiliary drive (spotting), a perfect coordination among all personnel involved in the measurement must be assured.

3. <u>RESULTS AND ACCEPTABLE VALUES</u>

The result from this measurement is a numerical value, the axial runout. The allowable axial (rim face) runout is a function of the gear diameter and is presented in Figure # 1. It is rare when a flange-mounted gear will not be within the limit indicated on Figure # 1.



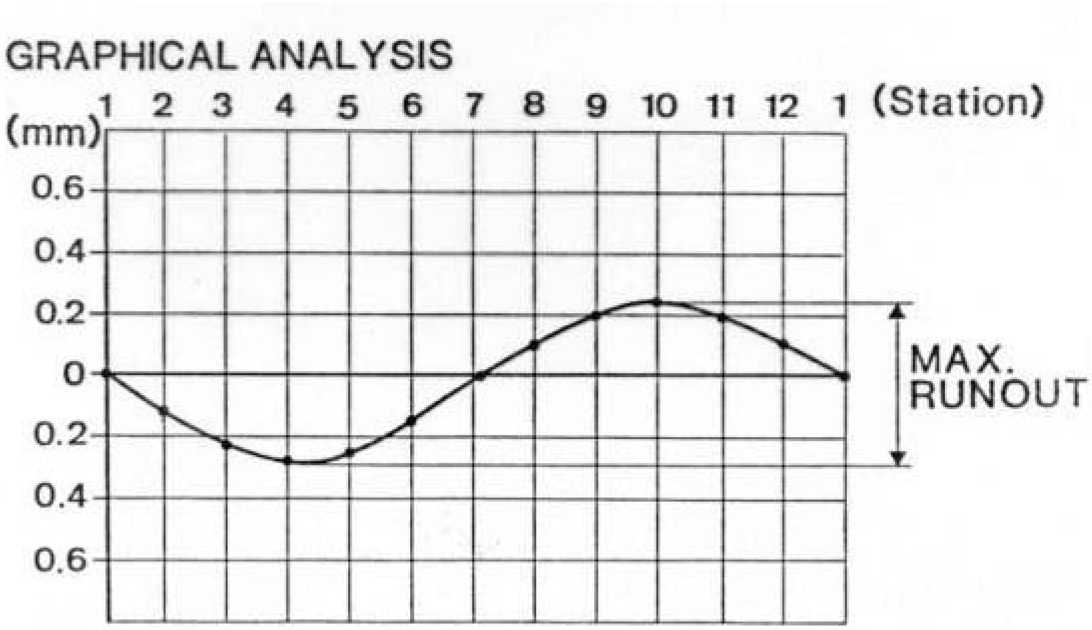


Figure #1. Maximum allowable axial run out for girth gears

4. FREQUENCY OF REALIZATION

The axial runout should be measured on a yearly basis.

5. STEP BY STEP PROCEDURE

5.1 Steps: Inductive sensor method (equipment running)

1. Take the required instrumentation to the field. The following picture shows the different components:

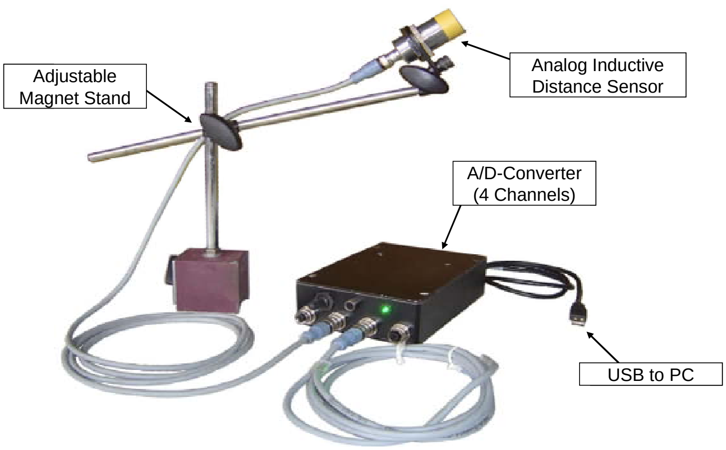


Figure #2. Measurement device required for the inductive sensor method

2. Place the smaller inductive sensor as close as possible to a machined edge of the rim, on the axial direction (see Figure #3). Plug the inductive sensor to the converter and connect the converter to the laptop.

Figure #3. Measurement device placed for axial run out measurement.

Note: look for a stable support for the magnetic stand; otherwise equipment vibration will distort the measurement!

3. In order to graph the gear revolutions, a second inductive sensor is required. The sensitivity of this sensor does not need to be as high as the one used for the actual runout measurement. A small magnet must be attached to the gear, preferably close to the joint and this will act as a trigger to register the gear revolutions. See an example on Figure #4 on a kiln tire (used for the same purpose on a kiln roller shaft bending measurement)

   If this is not possible, the gear revolutions can be determined from the axial run out graph (see Figure #5)

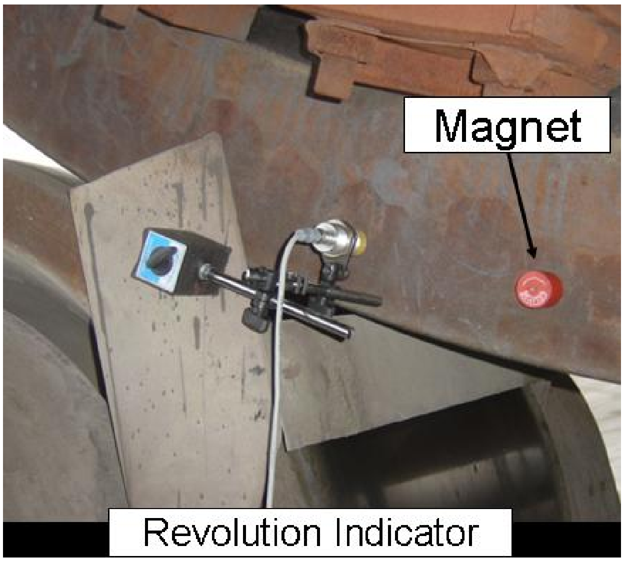


Figure #4. Set up of a second inductive sensor to measure the gear (in this case a kiln tire) revolutions

4. Double check on the laptop software that the signals from both sensors are being read
5. Let the equipment run for several revolutions and determine the runout value from the signal peaks (see an example on Figure #5)

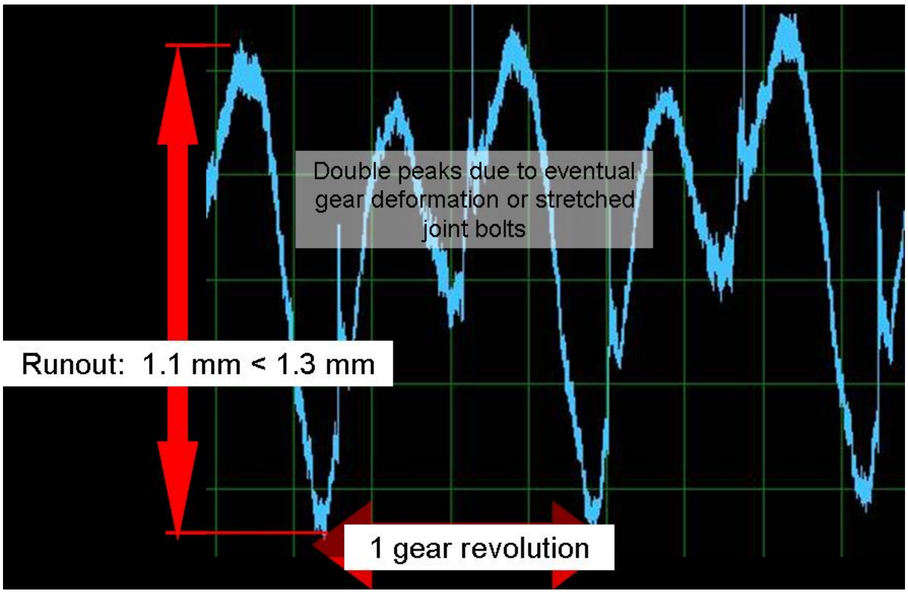
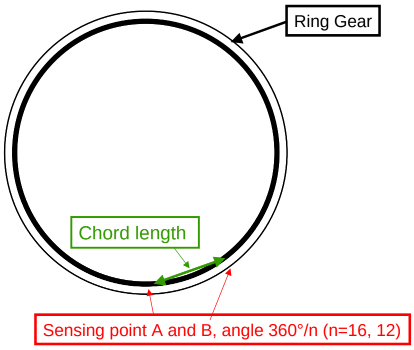


Figure #5. Run out signal as seen on the software. According to the set scale, the run out value can be calculated as the peak-to-peak value of the sinus wave and the gear revolution as the frequency

6. Compare measured value against the recommended ones. In the case shown in Figure #5, the allowable axial run out for this particular gear was of 1.3 mm and since the actual value is of 1.1 mm, no actions need to be taken (other than yearly run out measurements).
7. Once the measurement is finished, retrieve all the instruments. Be extra careful when handling the inductive sensor, to avoid injuries and/or material damages.

5.2 Steps: Cumulative method

1. Two dial indicators are mounted (360°/n) one from each other; n is typically 16 (12). On the gear all 16 (12) sectors have to be labeled. The corresponding chord length can be calculated with the attached excel sheet.



2. The cumulative method cumulates the axial displacement stepwise over the circumference in 16 (12) steps.
3. Readings are taken simultaneously on both dial indicators 16 (12) times per revolution.
4. The accumulation of differences of readings taken simultaneously gives the actual face profile.
5. A correction has to be applied because the position of the dial indicators at the start is unknown (see excel sheet).

Axial run out - Cumulative Method

fill in	
Date:	25. Okt 02
Plant	Holcim
Equipment	Kiln
No of meas. Pt. n	16
Meas. Diam [mm]	7619
Chord length	1486.393163

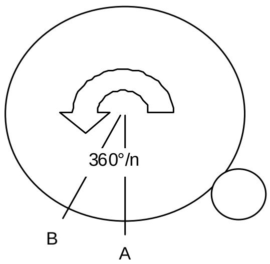
"G3 Axial RO cumulative method m

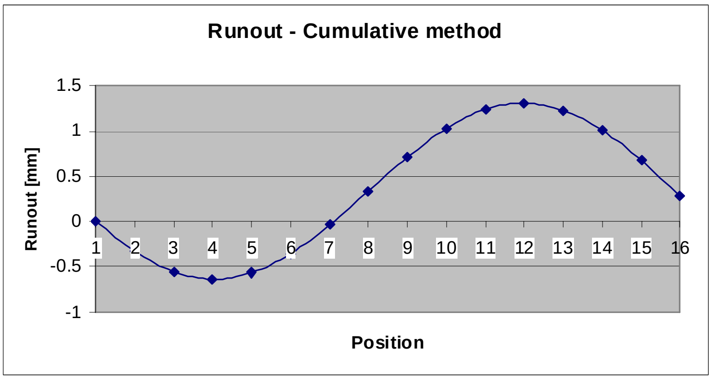
Pos at A	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
A [mm]	0.707	0.924	1	0.924	0.707	0.383	0	-0.383	-0.707	-0.924	-1	-0.924	-0.707	-0.383	0	0.283
B [mm]	0.3827	0.7071	0.9239	1	0.9239	0.7071	0.3827	1E-16	-0.383	-0.707	-0.924	-1	-0.924	-0.707	-0.383	-2E-16
A-B [mm]	0.3243	0.2169	0.0761	-0.076	-0.217	-0.324	-0.383	-0.383	-0.324	-0.217	-0.076	0.076	0.2169	0.3241	0.3827	0.283

Sum A-B	-0.100
Sum/n	-0.006

Runout [mm]	0	-0.331	-0.554	-0.636	-0.566	-0.356	-0.038	0.3386	0.7153	1.0334	1.244	1.3139	1.2317	1.0085	0.6782	0.2892

max. value	1.3139
min. value	-0.636
axial run out peak to peak	**1.95**





5.3 Steps: Traditional method

1. Select a number of at least 8 or better 12 points, which are equally spaced around the rim of the gear and mark them.
2. Place two dial indicators fitted with button shoes against and perpendicular to the rim reference surface at two points 180' apart on the gear rim surface as shown in Figure # 1. Start point for the first indicator will be Position 1 and for the second indicator, Position 7 (when using 12 points)
3. Set both dial readings at zero. Write down values indicators in column # 1 and # 2 of the table on the Holcim Work Sheet (See attached file PW Girth gear axial runout measurement; a filled-in example is provided in the file PW Girth gear axial runout measurements E Annex-2).

"PW Girth Gear Axial Runout Measurements E Annex-2.x

"PW Girth Gear Axial Runout Measurement

4. Rotate the gear with the auxiliary drive until the first indicator is in contact with the second point (Position 2) and the second indicator with the eighth point (Position 8). Write down results.
5. Repeat step 4 until the gear has turned a full revolution.
6. Measure again with the indicators on their starting positions (1 and 7) and compare against values from the first reading.

Note: The indicators will rarely indicate zero when the gear returns to the starting points. If their indications are within 0.10mm (0.004 inch) of each other the readings are acceptable, but if they exceed this amount, repeat the procedure. Occasionally an indicator slips, resulting in an erroneous set of readings.

The attached example file illustrates the recording of a set of measurements and the calculation of runout on a machine with end-float. The indicator readings are first recorded in column # 1 and # 2. Entries are then made successively in columns # 3 and # 4 by following the instructions in the column headings.

Runout Measurements

Readings must be taken on two points 180' apart on gear rim surface

	1		2	3	4
Pos	Dial Gauge Berg (mm)	Pos	Dial Gauge Donau (mm)	Difference of both readings (mm)	Difference divided by 2 (mm)
1	**0.461**	7	**0.314**	**0.147**	**0.074**
2	**0.549**	8	**0.286**	**0.263**	**0.132**
3	**0.683**	9	**0.589**	**0.094**	**0.047**
4	**1.224**	10	**0.832**	**0.392**	**0.196**
5	**1.613**	11	**1.078**	**0.535**	**0.268**
6	**1.489**	12	**1.132**	**0.357**	**0.179**
7	**1.235**	1	**1.049**	**0.186**	**0.093**
8	**0.929**	2	**0.817**	**0.112**	**0.056**
9	**0.696**	3	**0.782**	**-0.086**	**-0.043**
10	**0.716**	4	**0.626**	**0.09**	**0.045**
11	**0.648**	5	**0.409**	**0.239**	**0.120**
12	**0.489**	6	**0.305**	**0.184**	**0.092**
1	**0.479**	7	**0.319**	**0.16**	**0.080**
	1.152		**0.846**	**0.621**	**0.311**

Maximum Value

Minimum Value

Difference between min and max

max. Runout

(max. difference of column 4)

Site: ____________________

Responsible: ____________________

End-Float = 0.005 mm

End-Float = 0.018 mm

The runout is determined from column 4 and is an algebraic difference between the maximum and the minimum values.

6. Repeat the whole procedure to obtain a second result . This should not deviate more than 0.5 mm from the first run out result obtained.

7. Compare the obtained run out values against the recommended one (see Figure #1)

6. OTHER ADVICE

In case the plant lacks the instrumentation required for the inductive sensor method, it is recommended to perform the traditional method. The cumulative method was devised for rare cases and it is more complicated than the traditional one.

For the inductive sensors method: if the run out reading 'drifts' (i.e. the peak value diminishes or increases steadily), this is a sign of strong axial movement of the kiln (or mill). In this case, a traditional method might be required (two dial gauges eliminate the influence from the axial movement)

For the **traditional method:**

A separate dial gauge installed on the trunnion bearing flange is a great help to indicate the axial movement (swimming) of mill during the runout measurements.

The shell temperature of the machine must be uniform while performing runout measurements. The proximity of other heat-producing elements may have to be considered.

To ensure a stable measurement procedure the mill should be rotated several times before starting the measurement campaign.

Additional information on inductive sensors can be found here: Axial Runout-Inductive ser

7. CORRECTIVE ACTIONS IN CASE OF DEVIATIONS

If the allowable run out is exceeded, the mating faces of the flange and the gear should be rechecked for burrs or other protrusions. If there are none, shims should be placed between the mill flange and the gear at appropriate locations and the run out measurement repeated.