Sample report
Dynamic Audit / Performance Test
XYZ Colliery

Reference	Description	Compiled by	Date
Sample	Performance Test	Engineer ID	11-10-2017

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1. Introduction

Continuous monitoring of the XYZ Conveyor was undertaken for 11 days, from April 23 to May 4, 2017, to investigate the performance of the conveyor under all operating conditions.

The focus of the test was to quantify the peak belt tensions and investigate / comment on the possibility of reducing the take-up tensions to achieve lower belt running tensions.

Regular splice failures were being reported.

The operating conditions and recommendations for improving the availability of the overall system were also to be included.

2. Conclusions and Recommendations

2.1 The current performance of the conveyor is good, although the belt safety factors are lower than the minimum value normally recommended.
The recommended minimum is 6.7 : 1. Compare to 5.8 : 1 and 4.1 : 1 for the St1400 and St1000 sections respectively.

2.2 The take-up tension could be reduced by 30% to improve the safety factor, but the saving is not significant: The safety factor would only increase by 6%. From 5.8 : 1 to 6.15 : 1 for the design rating of St1400.

2.3 There are no undesirable tension build-ups in the system during normal starts, aborted starts or stops. The capstan system in the take-up is working well.

2.4 The issue of different gearbox ratios on the drives needs to be addressed, particularly of the conveyor is to be split in the future.

2.5 The pulling / failure of splices is compounded by the severe impact damage being caused by the poor loading of the conveyor. There is also evidence of moisture and rust present.

This poor loading / impact damage issue needs to be addressed urgently on the entire conveying system.

2.6 Some of the belting inspected seems near the end of its lifespan: cracking, rust and wear are evident.
A scan should be carried out, before the belt is split, to identify the good belting to be salvaged and the bad belting sections.

3. Summary of findings

3.1 Normal running conditions

Conveyor power and drive torque
The peak power draw of the conveyor during the 11 days was 1 273 kW. This equates to 67% of the total installed power: 1 890 kW.

The tonnage on the belt at the time was approximately, on average, 1 800 tph along the entire carry length.

The power load sharing between the 3 drives is good, but the torque load sharing is bad. One of the drives has a different gearbox ratio and is transmitting more torque at less speed.

Belt tensions and safety factors
The peak running tension during the 11 days of monitoring was 290 kN.

Given the design belt rating of 1400 kN/m and width of 1200 mm, the resulting safety factor is 5.8 : 1.
This is lower than the 6.67 : 1 minimum normally recommended for this type of installation. (13% lower).

3.2 Stopping and starting conditions

The stopping behaviour is satisfactory with no excessive dynamic tension transients evident. The conveyor stopping times range from 26 seconds loaded to 29 seconds empty.

The starting behaviour is good with only minor dynamic tension transients evident. The conveyor starting times range from 3.5 minutes loaded to 4.5 minutes empty.

The peak start factor is good: It does not exceed 120%.

3.3 XYZ Overland conveyor specification sheet – relevant details

- Conveyor length: Approx. 5 400 m centres.
- Operating tonnage: 1800 tph ROM (Design 3 000 – 3 500 tph)
- Belting: St 1400 kN/m, as per original spec, 1 200 mm wide, 5x5, 6x4 covers.
- Belt speed: 5.26 m/s.
  At motor speed of 1 425 rpm. (5.5 m/s max. at 4 pole speed)
- Flight time, tail to head: Approx. 16 minutes.
- Motors: 3 Siemens 630 kW (525 V, 850 A, 1 485 rpm)
- Speed reducers:
  - Top master and bottom slave: 2 x Flender B2 SH14E, Ratio 14.74 : 1, 557.2 kW rating.
  - Top Slave: 1 x Fender B2 SH12E, Ratio11.05 : 1, 438.3 kW rating.
- Drive pulleys: Pulley diameter 1 000 mm w/o lagging. Ceramic lagging, estimated at 20 mm thick, coming apart on front pulley, good condition on back pulley.
- Take-up type: Gravity at head, 4 falls of belt to 4 falls of rope, with capstan brake. Take-up mass: 21.6 tonnes, based on the given cable rope tension of 5.4 tonnes on 7 May 2017. I.e. T2 = 53 kN.
  Original Design Spec: T2 = 69 kN (7 tonne take-up rope tension)

As per ceramic/belt friction factor of 0.5 and 180 degree wrap angle, drive motor absorbed power of 430 kW, and 118% start factor, T2 should be a minimum of 36 kN.
(Including 80% take-up efficiency and 10% power increase possibility with reduced T2)

- Tail Brake: 0 – full force in 15 seconds.

4. Observations and Discussion

The following measurement were taken during the period of monitoring:

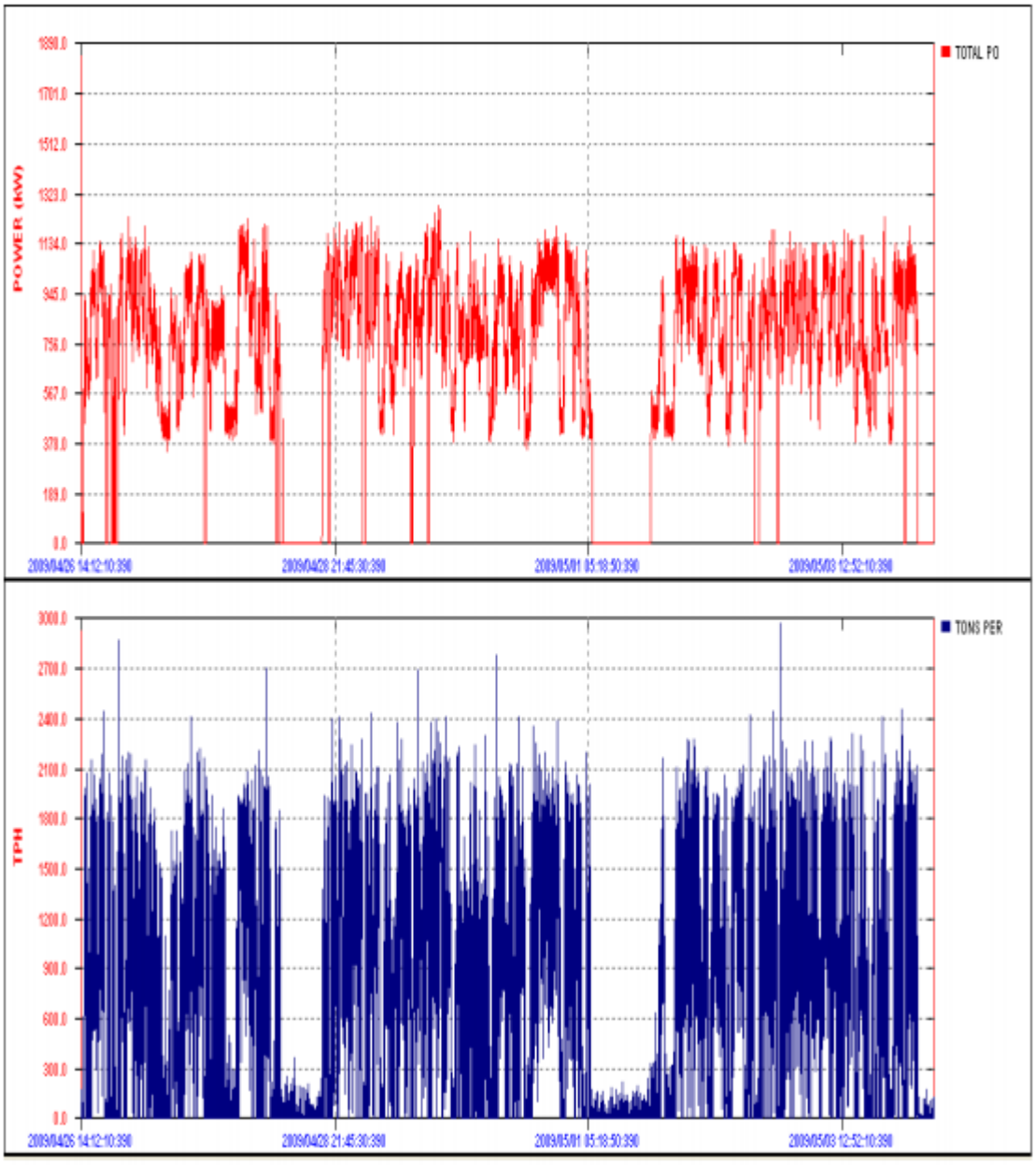
- Torques and speeds of all the drive motors
- Belt speed
- Take-up rope tension
- Tonnage
- Tail brake signal, voltage signal only, conversion factor and function logic unknown.

The pertinent results are presented and discussed in the following graphs:
(Note: All values are shown plotted against time in seconds)

CONTINOUS MONITORING – TRENDS
Graph 1 to 7: 6 days of typical trending showing peak power, torques, belt tensions, tonnages and load sharing for the conveyor system and other events of interest.

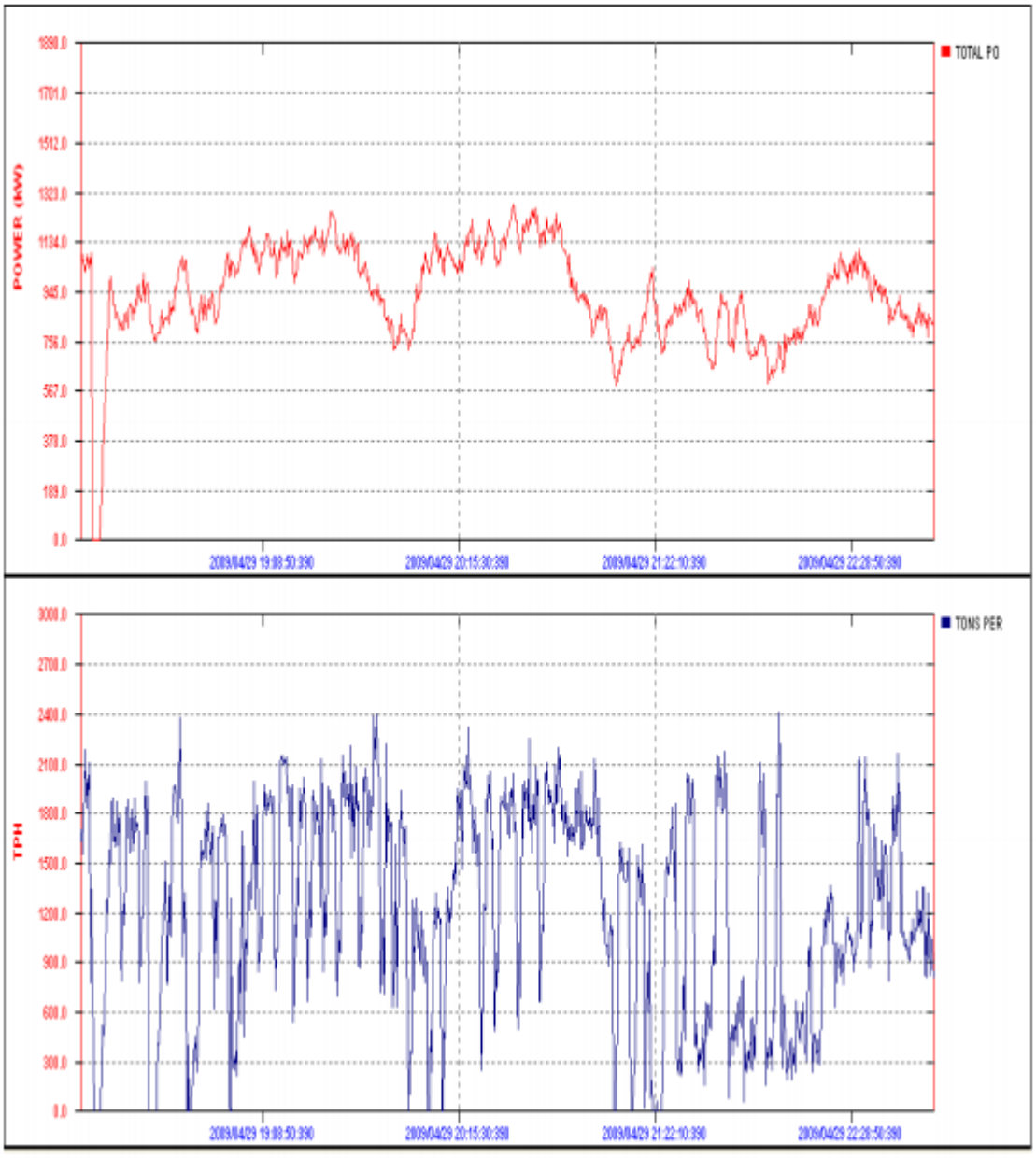
DYNAMIC EVENTS
Graph 8: Peak loaded stop
Graph 9: Zoom on peak loaded stop tensions
Graph 10: Peak loaded start – first half
Graph 11: Zoom on peak loaded start tensions – first half
Graph 12: Peak loaded start – second half
Graph 13: Zoom on peak loaded start tensions – second half
Graph 14: Empty stop
Graph 15: Zoom on empty stop tensions
Graph 16: Empty start – first half

Graph 17: Empty start – second half
Graph 18: Abnormal event – 5 aborted starts
Graph 19: Zoom on aborted start tensions



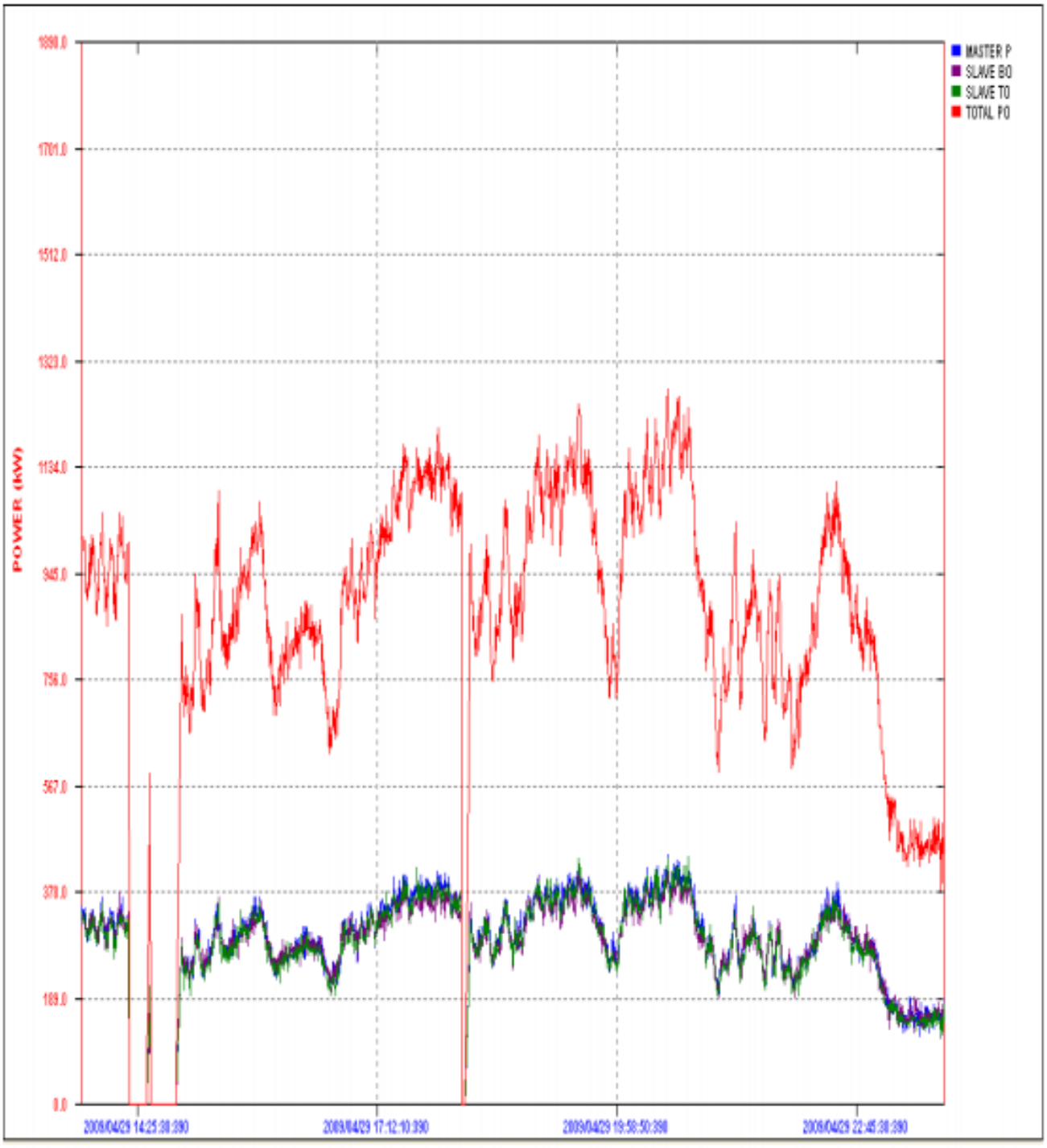
Graph 1: 3 Days of typical trending in conveyor power demand showing the peak running powers, associated tonnages and other events of interest.

The peak total conveyor running power was 1 273 kW. This equates to 67% of total installed power 1 890 kW. The empty running power was around 420 kW.



Graph 2: Zoom on 3 days of typical trending in conveyor power demand showing the peak running powers, associated tonnages and other events of interest.

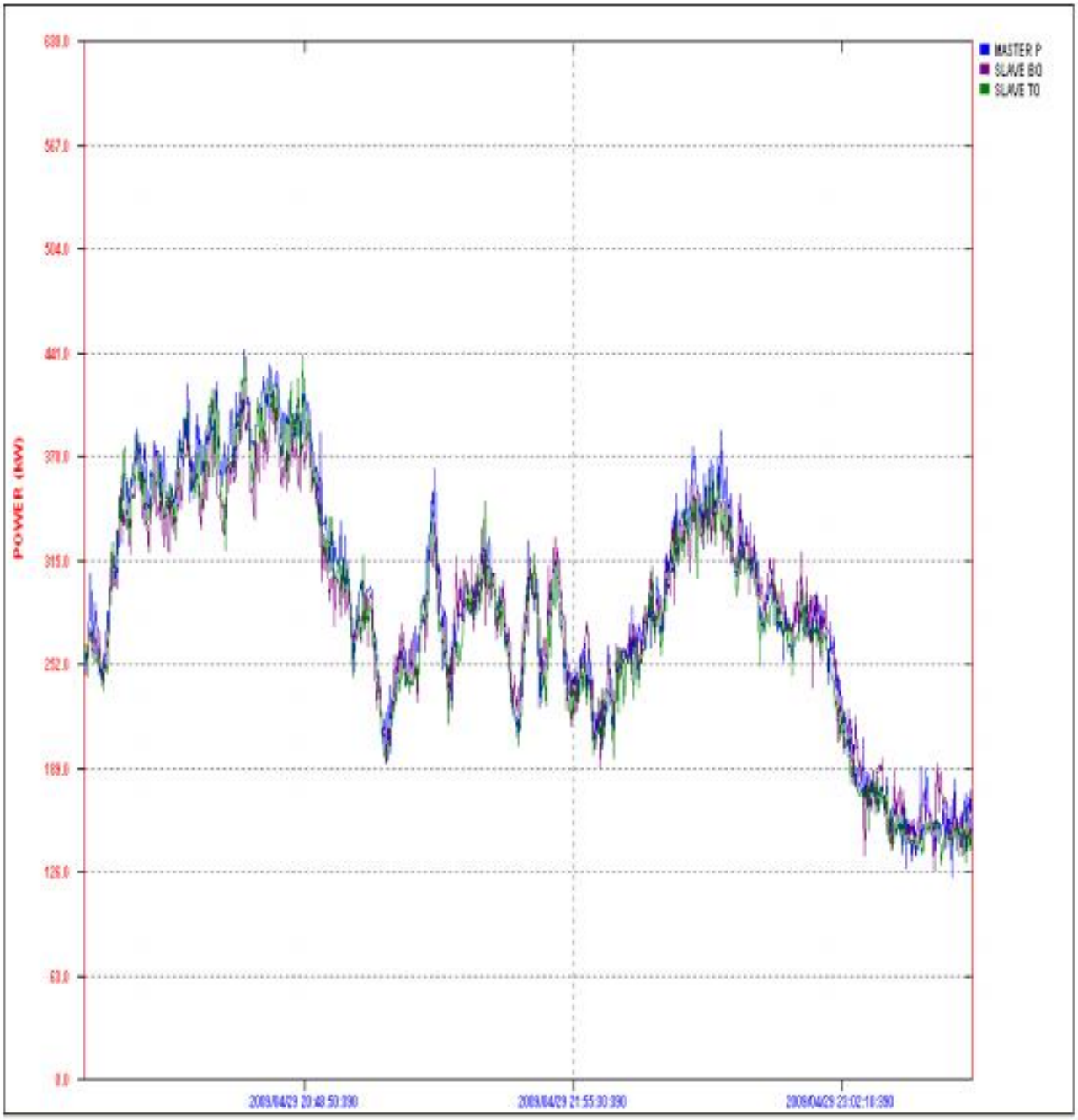
The peak conveyor running power was 1 273 kW, at an estimated average tonnage of 1800 tph along the entire carry belt length.



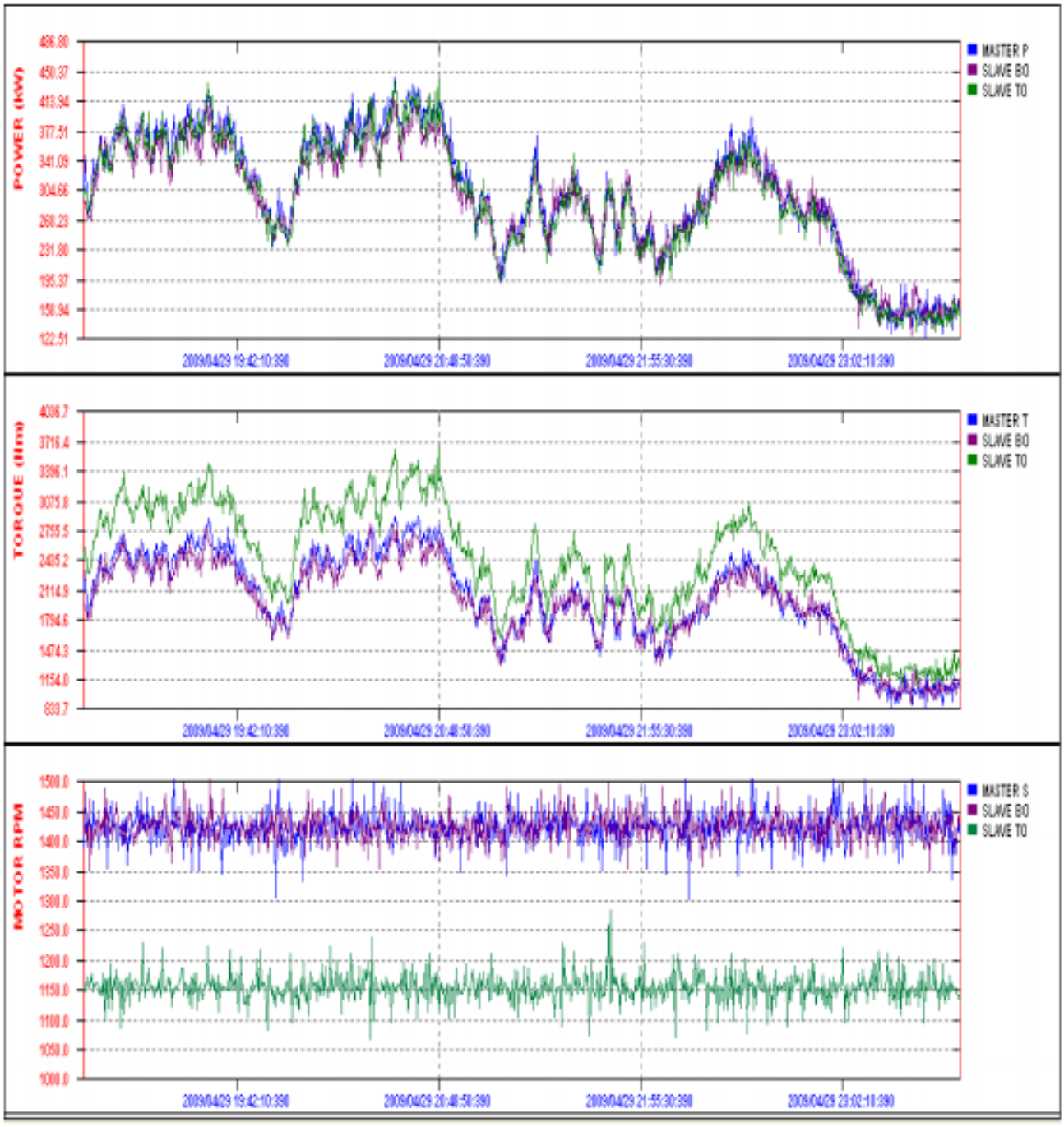
Graph 3: Loading diagram.

The peak total conveyor running power was 1 273 kW. This equates to 67% of total installed power of 1 890 kW. (3 x 630 kW)

Note: Y max = total installed power.



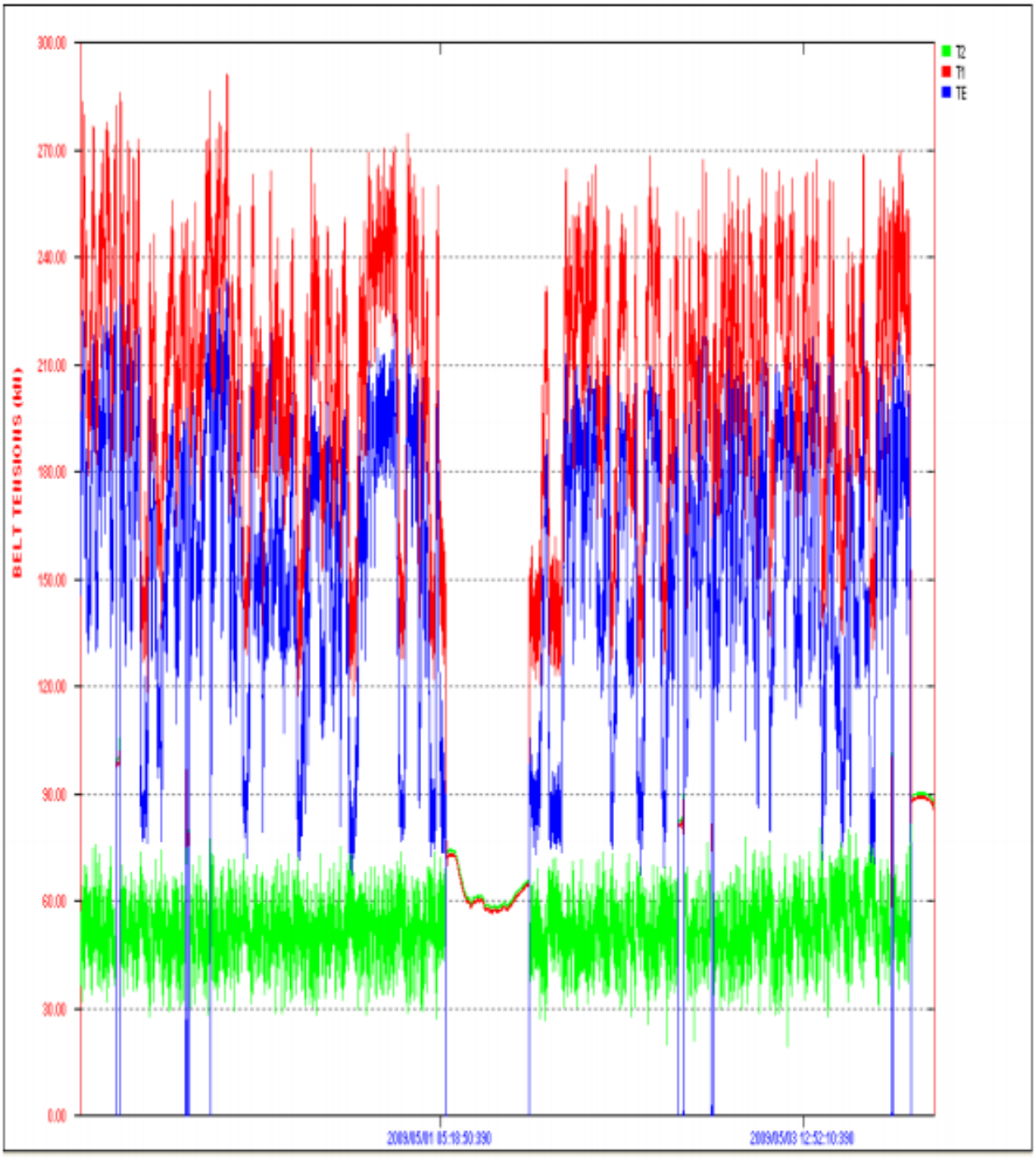
Graph 4: Zoom on load sharing.
Load sharing is good under all load conditions, from peak to empty.
Note: Y max = individual motor installed power – 630 kW.



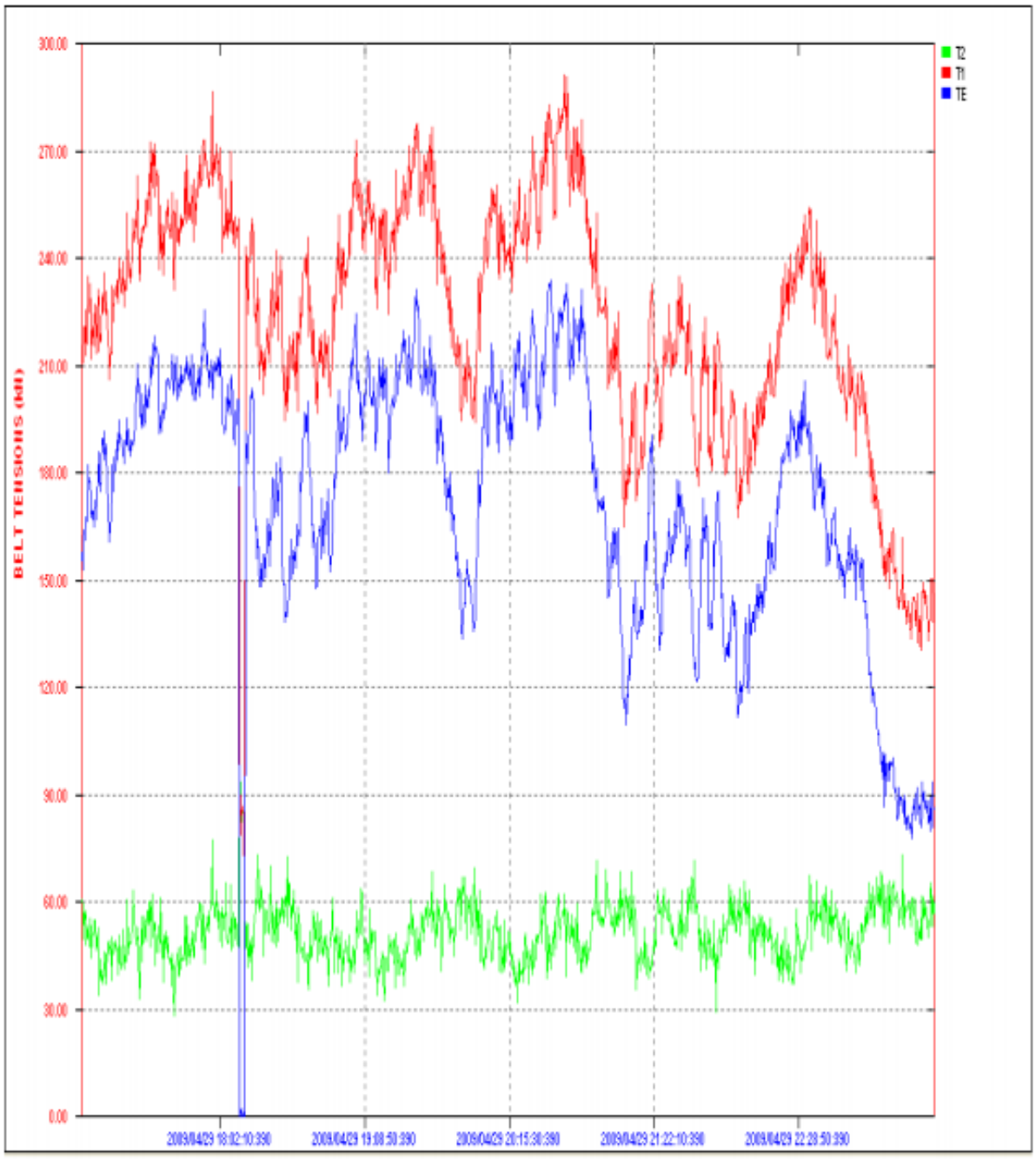
Graph 5: Motor powers, torques and speeds.

While the power load sharing is good under all load conditions, the torques and speeds are different for the top slave drive because its gearbox ratio is higher than that of the other two drives.

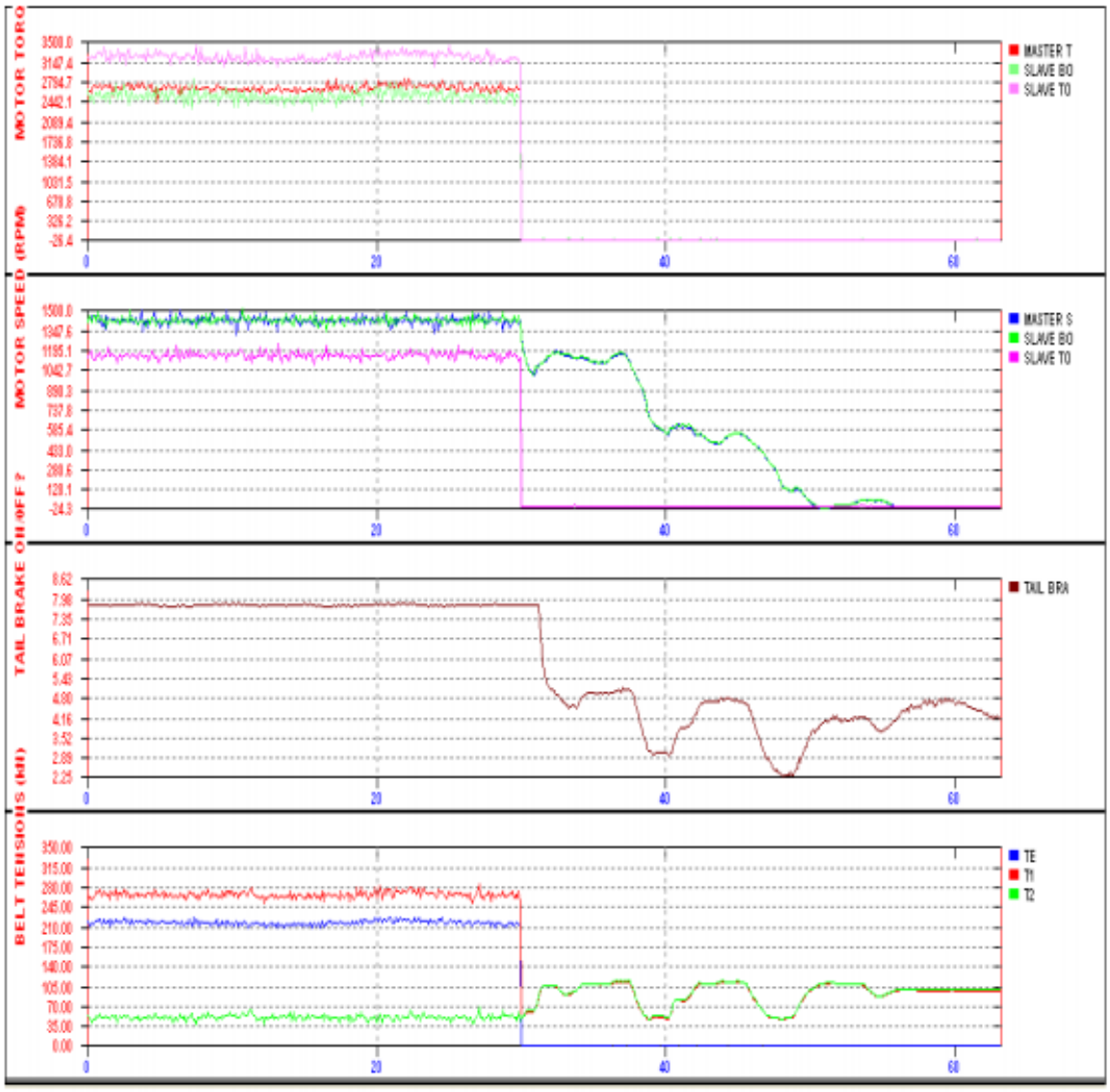
This implies that higher torques are being experienced on the top slave reducer.



Graph 6: Typical belt tension trending during 3 days of monitoring.
Green is the T2 take=up tension.
Blue is the TE effective total drive tension.
Red is the T1 peak tension in the belt at the head station.



Graph 7: Zoom on belt tension trending to show peak values measured during the 6 days monitoring.
Green is the T2 take-up tension
Blue is the TE effective total drive tension
Red is the T1 peak tension in the belt at the head station. The peak T1 value is 290 kN, which for a ST1400 belt, 1 200 mm wide implies a belt safety factor of 5.8 : 1.

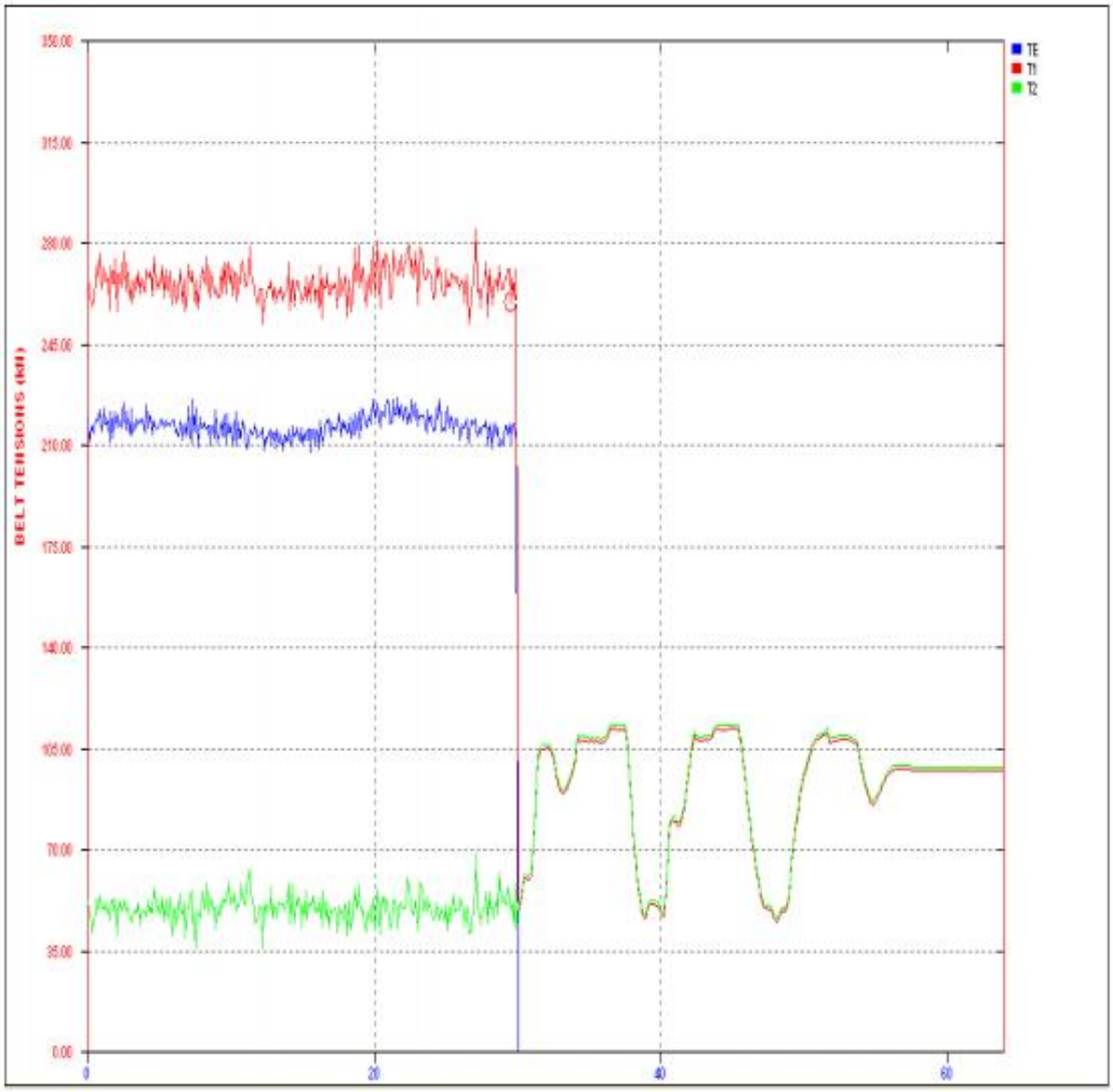


Graph 8: Peak loaded stop; 8 350 Nm total torque at trip, 1 120 kW total power draw. (88% pf peak running load, TE = 213 kN)

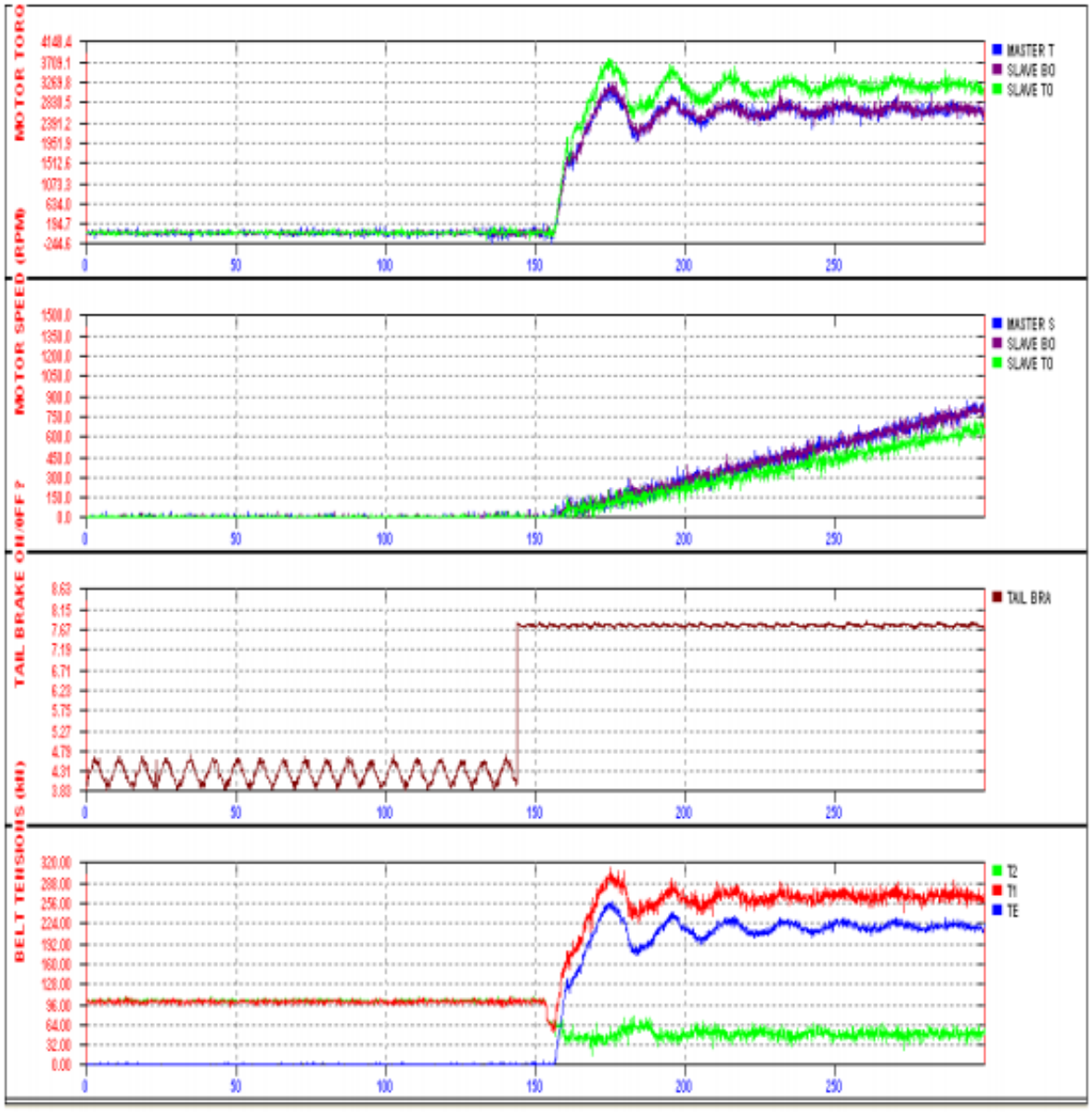
The conveyor comes to rest 26 seconds after de-energising the drives, in a nonlinear function. There is minor run back before finally stopping – 1.5%.

Significant belt tension transients are evident – up to 2 times in the take-up area. (Period of oscillation: Approx. 8 seconds)

The tail brake function is not clear – according to the mine the function is a 15 second ramp, but the measurement shows some sort of control function.



Graph 9: Zoom on peak loaded stop, 1 120 kW.
(88% of peak running load, TE = 213 kN)
As the conveyor trips, the drive tension drops to zero, and the take-up tension rises rapidly up to 105 kN. Over this value, the capstan slips and grips during the rundown, as the tension transients rise and fall.
(Period of oscillation: Approx. 8 seconds)
The final T2 tension is 100 kN.
The peak belt tensions during the stop do not exceed those prior to the trip.
(113 kN compared to 260 kN respectively)



Graph 10: Peak loaded start – first half.

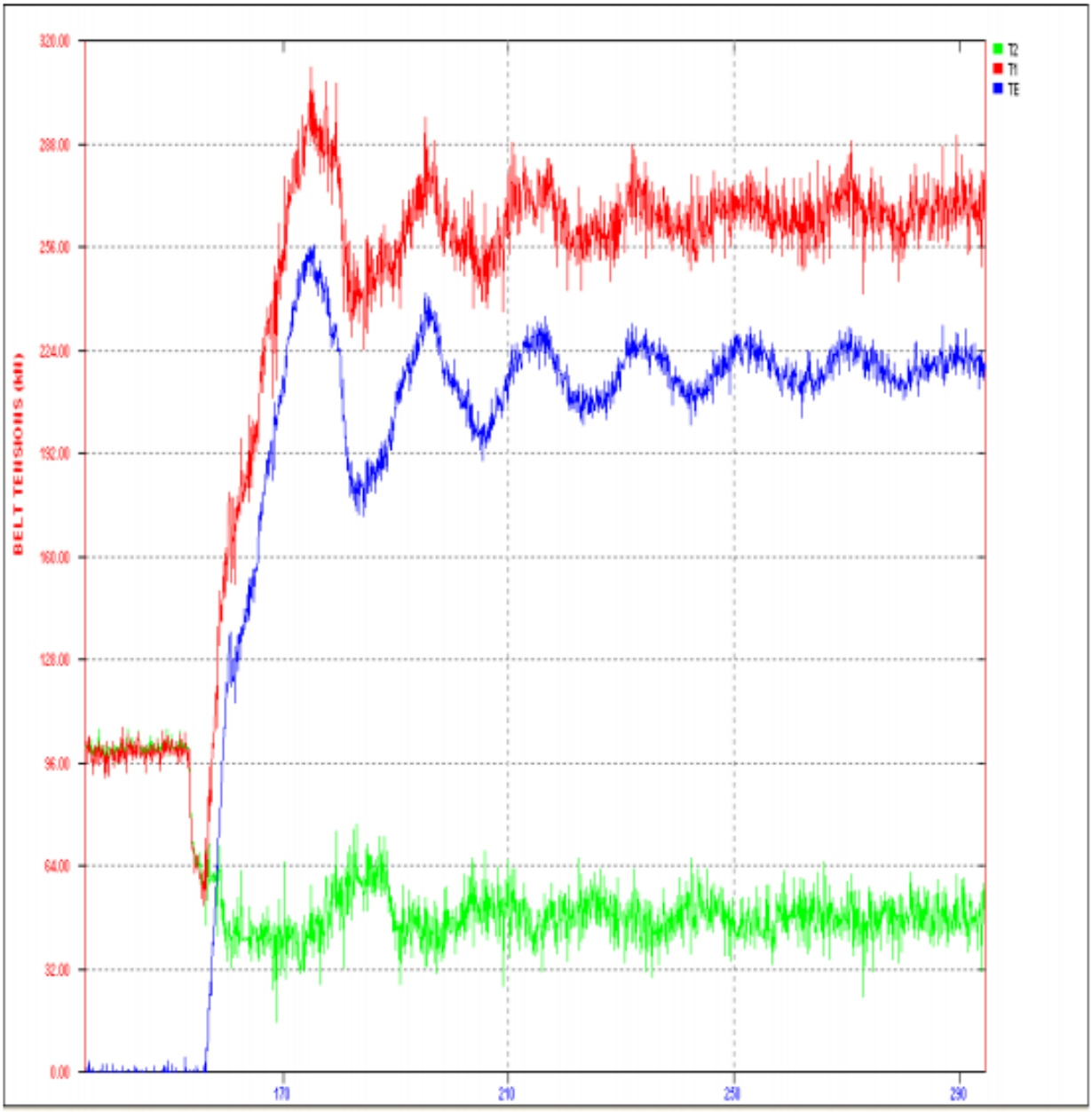
The tail brake is released and the T2 tension starts to drop after 10 seconds. The drives are energised 4 seconds later.

The start-up behaviour is good. The belt comes up to speed linearly, 210 seconds after break-away.

Minor transients are evident in the TE and T2 measurements because of the starting torque control function to achieve a linear speed ramp.

The peak start-up factor is good – 120%.

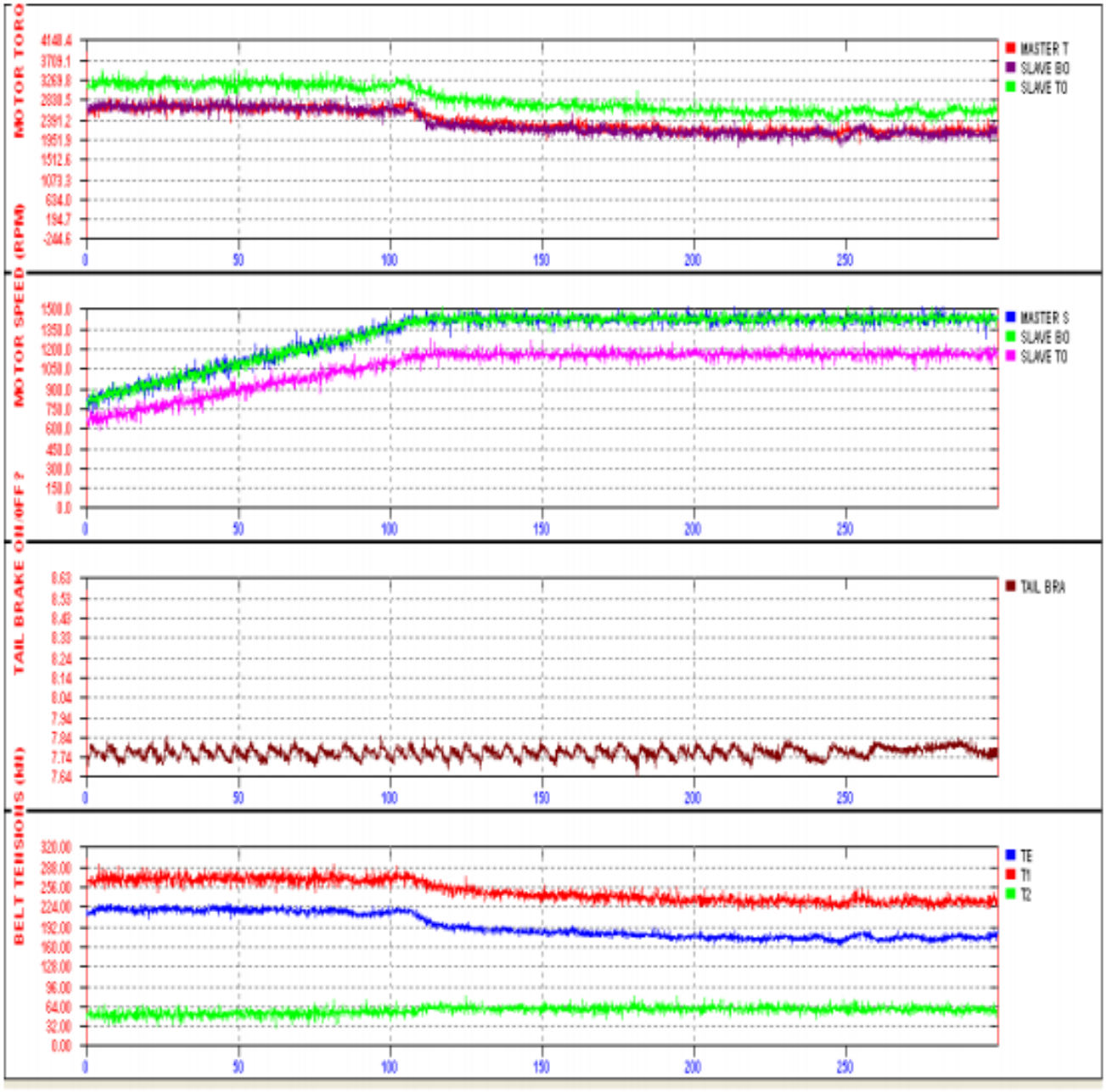
(256 kN start peak / 213 kN trip)



Graph 11: Zoom on peak loaded start tensions – first half.

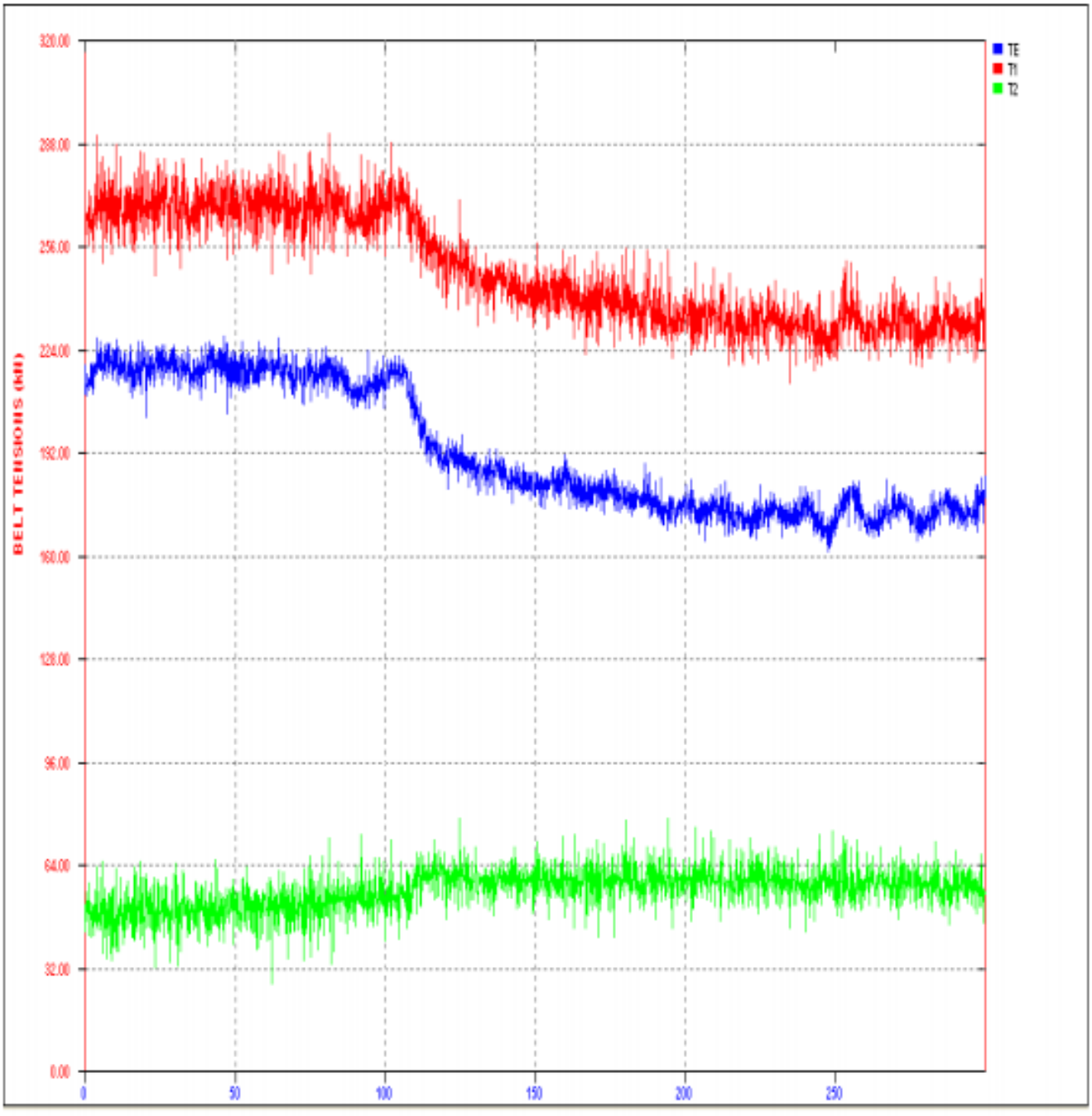
The tail brake is released and the T2 tension starts to drop after 10 seconds. The drives are energised 4 seconds later.

Minor transients are evident in the TE and T2 measurements because of the starting torque control function to achieve a linear speed ramp.
(256 kN start peak / 213 kN trip)



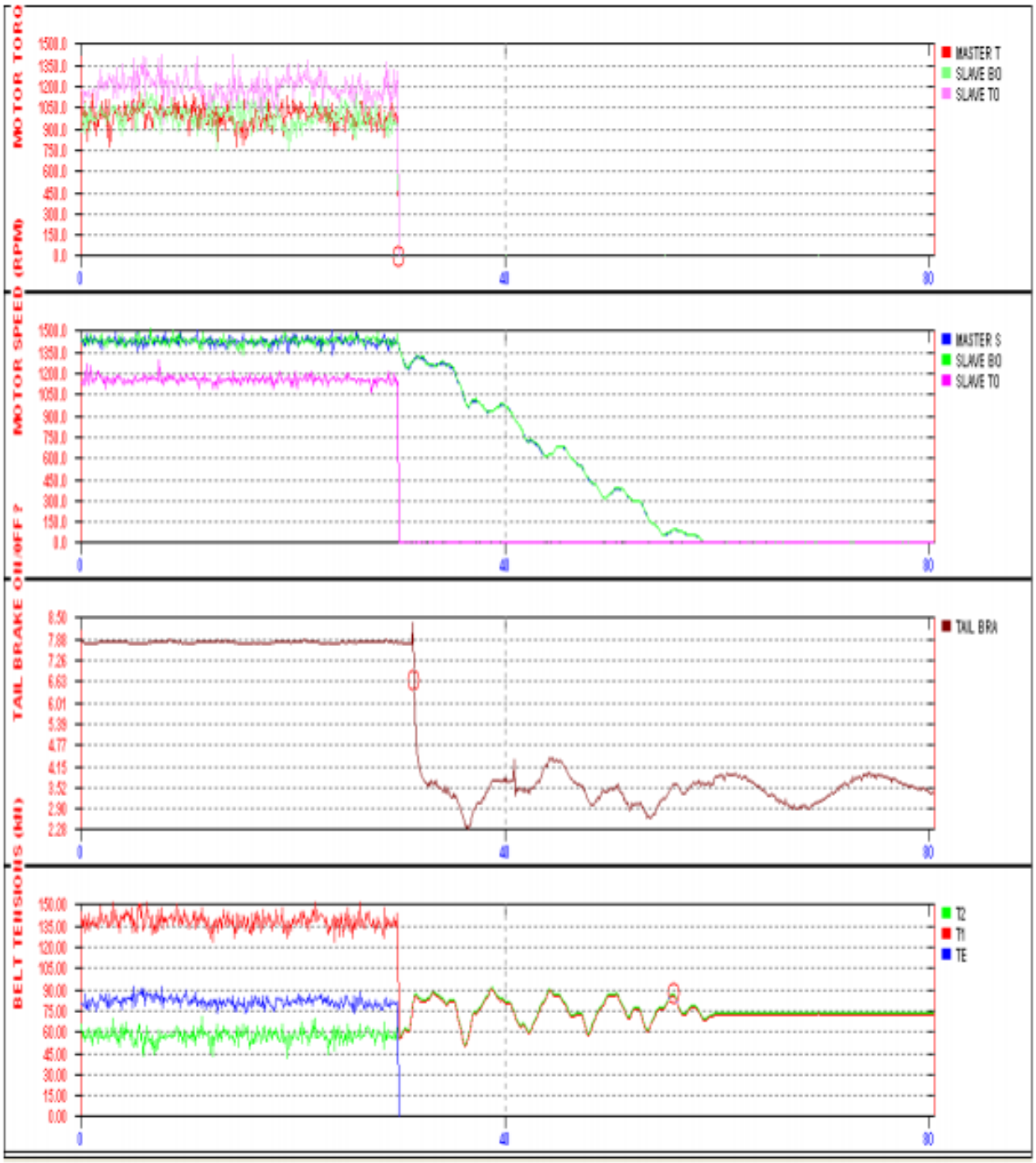
Graph 12: Peak loaded start – second half

The start-up behaviour is good
The belt comes to speed linearly, 210 seconds after break-away.



Graph 13: Zoom on peak start tensions – second half.

Minor transients are evident at the end of the acceleration.

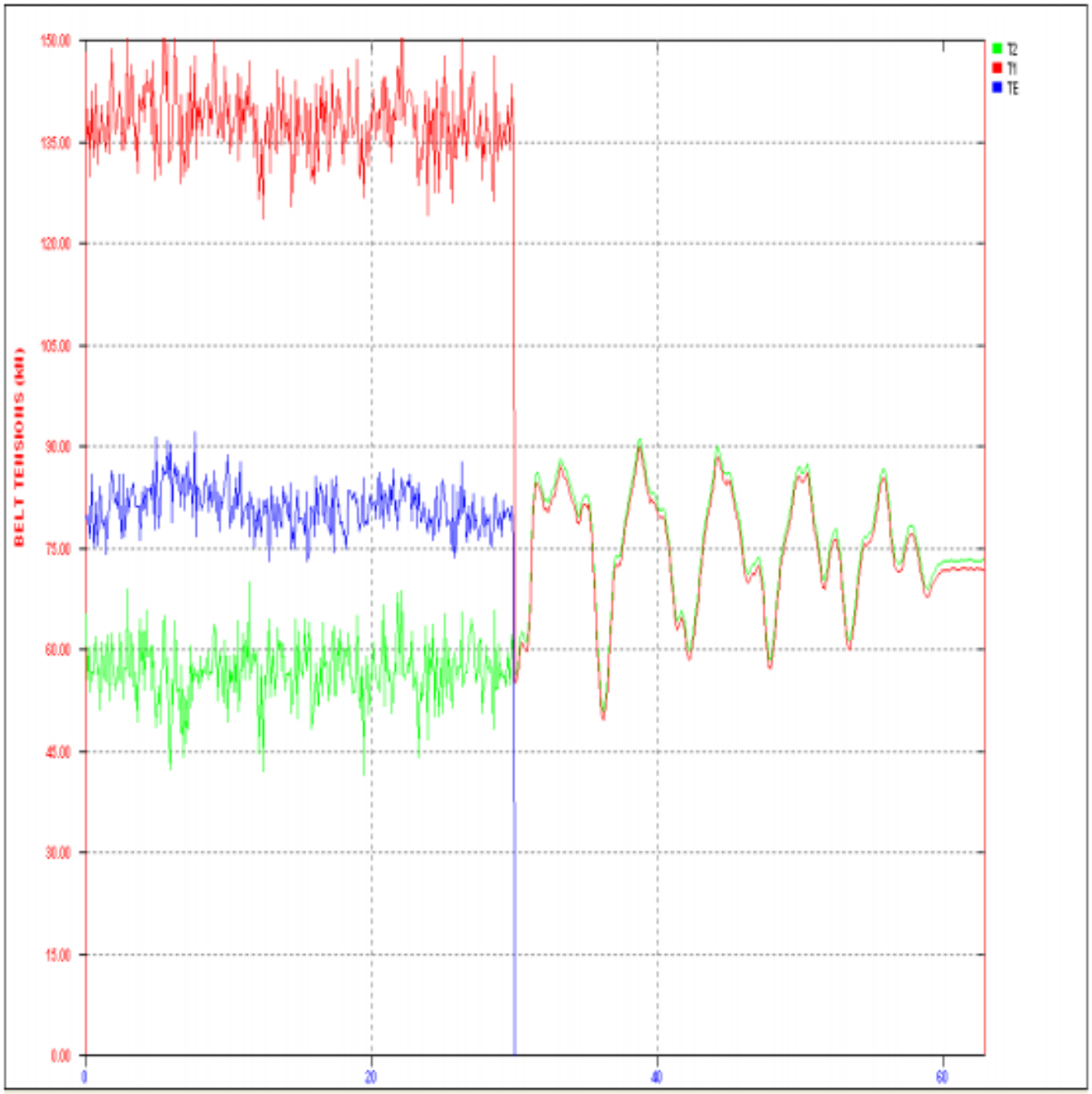


Graph 14: Empty stop

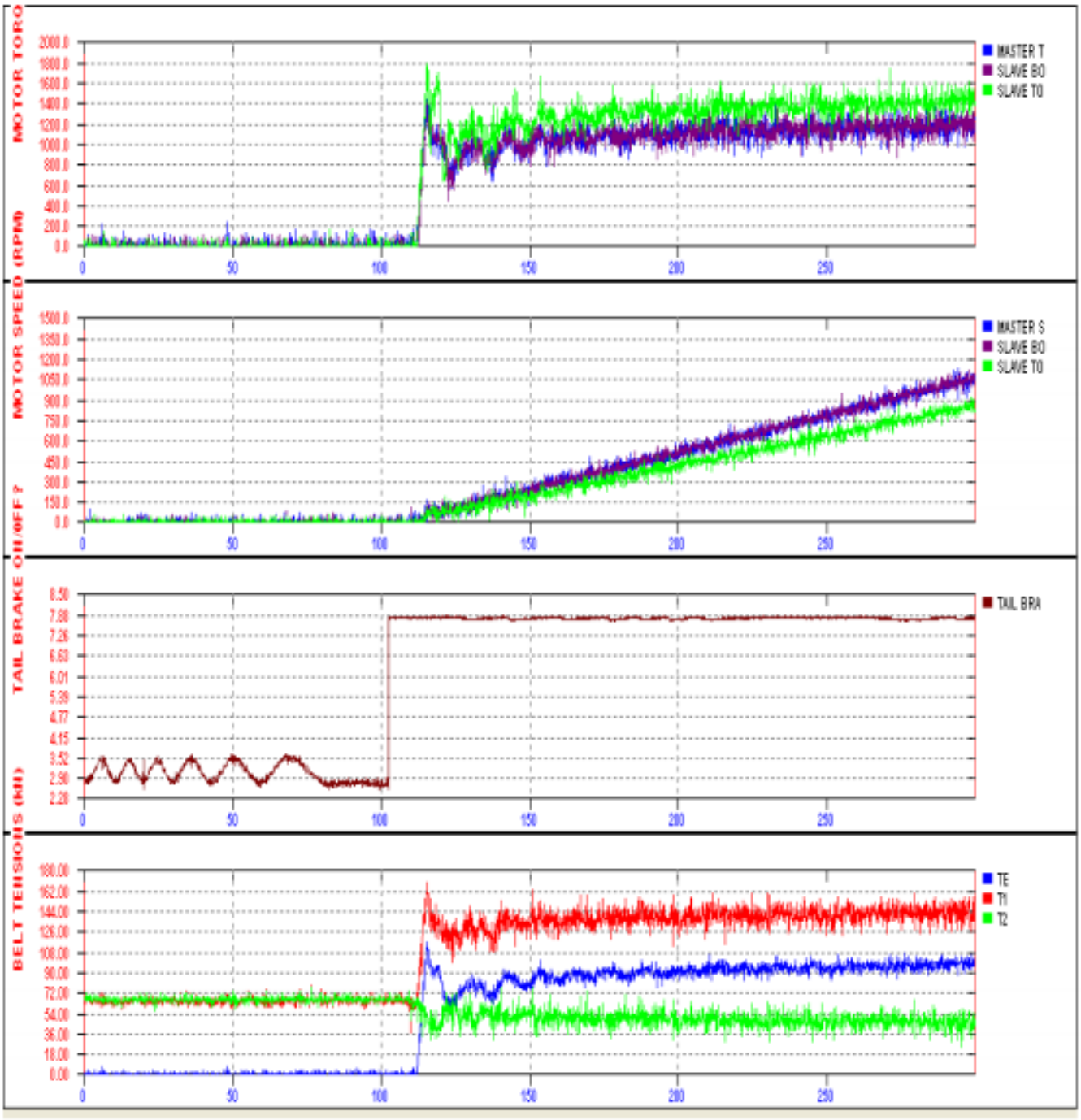
The conveyor comes to rest 29 seconds after de-energising the drives, in a fairly linear way.

Some tension transients are evident – period of approx. 6 seconds.

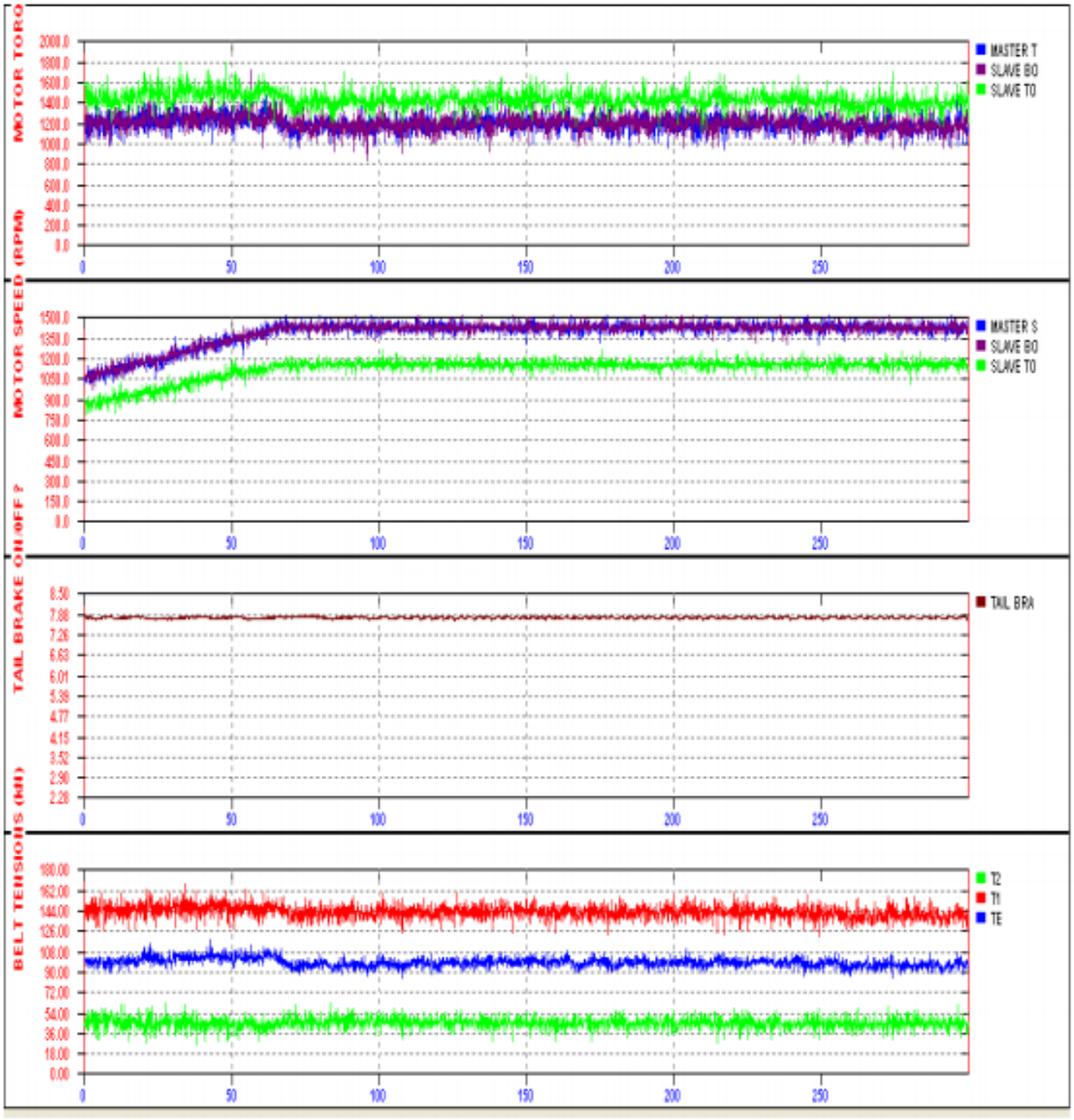
The capstan does not slip.



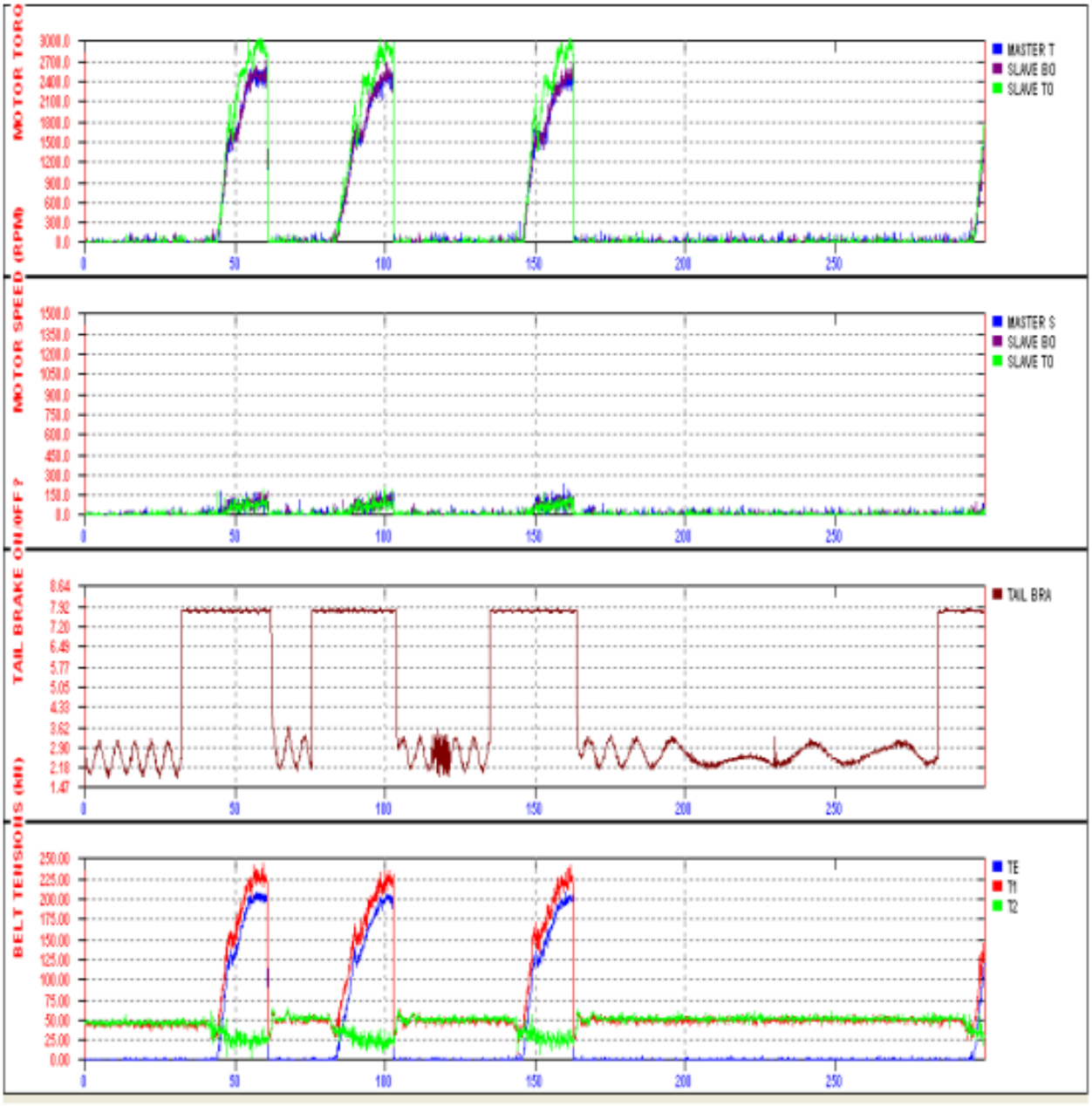
Graph 15: Zoom on the tensions of the empty stop.
Some tension transients are evident during the deceleration – period of approx. 6 seconds.
The capstan does not slip.
The final T2 tension is 72 kN.



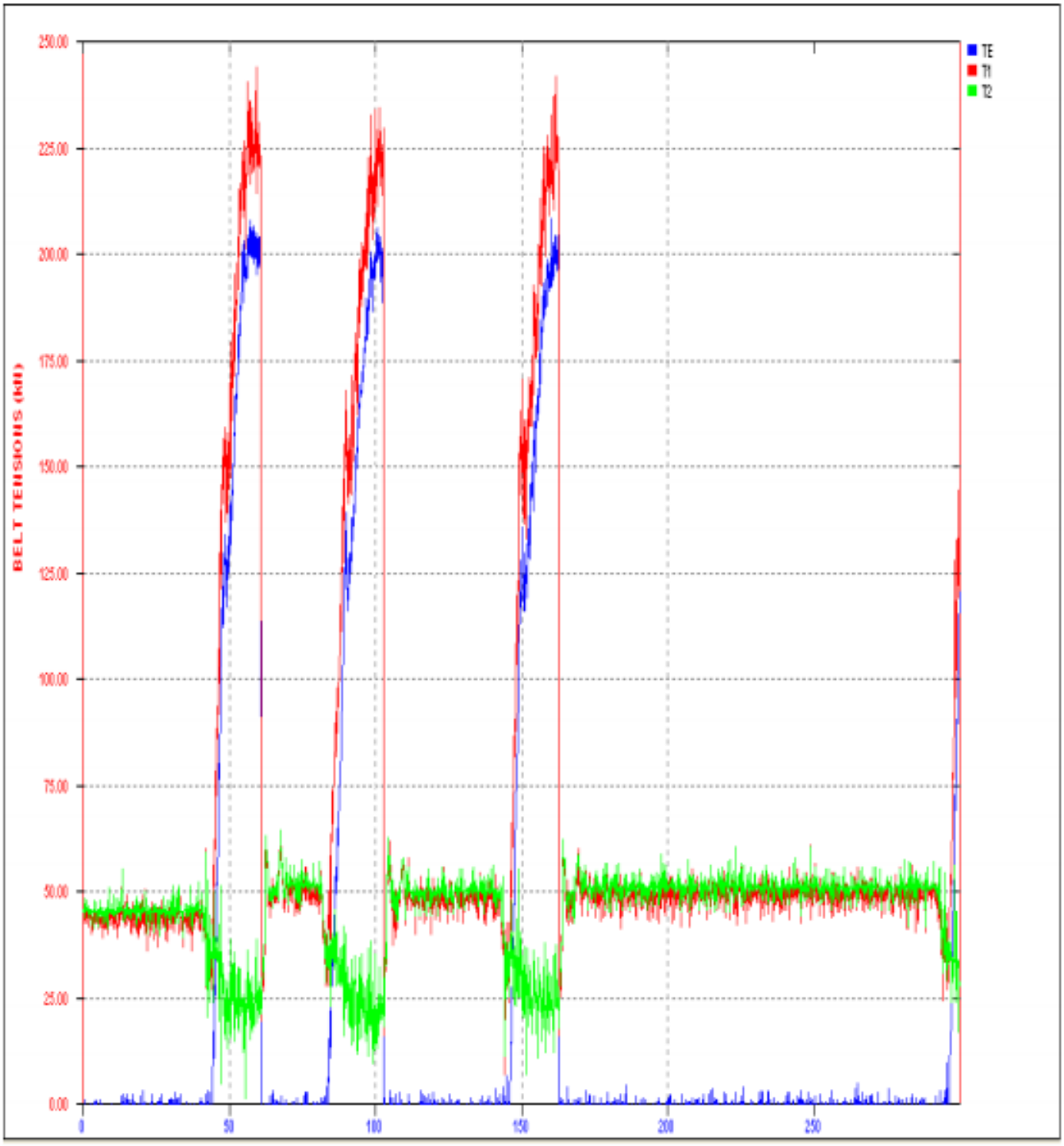
Graph 16: Empty start – first half.
The start-up behaviour is good.
The total starting time is 255 seconds.



Graph 17: Empty start – second half.
The star-up behaviour is good.
The total staring time is 255 seconds.



Graph 18: Abnormal event – First 4 of 5 aborted start attempts after the whole mine tripped.
Time delays between each start attempt: 23 seconds, 43 seconds, 133 seconds.
The 6th attempt to start was successful and good / normal.
At the instance of trip, the conveyor was drawing 986 kW, which is only 77% of the peak power measured. The conveyor started successfully before at 88%, so these aborts are not related to any starting problem.



Graph 19: 3 x Zoom in on belt tensions during the aborted start attempts. There is no accumulation of tension in the take-up during the aborted start attempts.