TRIPPER DRIVE - FIRST IN SOUTH AFRICA

1. INTRODUCTION:

The purpose of this presentation is to provide the audience with an overview of the technical aspects pertaining to the first tripper installation in South Africa. The two main topics that will be focused on are the basic design considerations and the control philosophy.

For ease of reading the presentation is structured as follows:

1. INTRODUCTION: (This section)

2. ASSUMPTIONS:

3. DISCUSSION:

   The reader will be guided through the discussion section by means of a series of questions outlining the topics with specific reference to:

   3.1 What are the components comprising the existing key elements?
   3.2 What is the constraint on the pulleys?
   3.3 What is the constraint on the belting?
   3.4 What is the constraint on the power?
   3.5 What is the control philosophy?
   3.6 How was this achieved with a fluid coupling?
   3.7 Where does all this fit into the bigger picture?
   3.8 How is the system performing?
   3.9 What are the operational experiences?

4. CONCLUSIONS:

5. RECOMMENDATIONS:

6. REFERENCES:

7. ACKNOWLEDGEMENTS:

8. APPENDICES

9. CV OF AUTHOR

2. ASSUMPTIONS:

It is assumed that the reader is familiar with physical layout of the mechanical components (refer appendix 1), electrical equipment used (refer appendix 2) and the programmable logic controller (PLC) system employed.

3. DISCUSSION:

The immediate requirement was to increase the main gate roadway length for a shortwall face from 2000 metres to 3000 metres hence the same requirement applied to the main gate conveyor. The capacity of the conveyor was to remain at 1800 tons per hour with a 3,5 metres per second belt speed.

The directive was to utilise as much as possible of the existing equipment available on the mine and to use these in such a manner to enable the main gate roadway length to be extended. The main elements falling into this category were the conveyor belting, conveyor pulleys and the powerpacks. Full details of the relevant items are:

3.1 What are the components comprising the existing key elements?

CONVEYOR BELTING:	1200 belt width class 1250S PVC with 0,8 thick standard covers.
DRIVE PULLEYS:	830 dia x 1350 face width c/w SD3148 bearings at 1830 housing crs.
H/T SNUB PULLEYS:	730 dia x 1350 face width c/w SD3148 bearings at 1830 housing crs.
240 kW POWER PACKS:	comprising: 240 kW FLP 1000 v 4 pole electric motors. 562 drain type traction high speed couplings. triple stage 20:1 right angle spiral bevel helical speed reducers. rigid flange low speed couplings with external locking elements.

3.2 What is the constraint on the pulleys?

From the attached calculations it became evident that at least three 240 kW power units would be required to meet the duty requirements. Please note that there are two sets of calculations. The first calculation is the design of the tripper unit and compares a standard 3000 metre installation with a 3000 metre tripper type conveyor (refer appendix 5 & 6). The second calculation reflects a standard 2000 metre conveyor (refer appendix 7). The tripper T1, T2 and Ttail values must be compared with that of the 2000 metre installation.

Tripper tensions	T1 =	137 kN	T2 =	22 kN	Ttail =	32 kN
2000 metre conveyor	T1 =	139 kN	T2 =	22 kN	Ttail =	29 kN
Tension variance	T1 =	2 kN	T2 =	0 kN	Ttail =	3 kN

The design of a pulley is governed by the tension it will be subjected to under starting, operating and stopping conditions. As can be seen from the above the only increase in tension that can be seen is on the tail pulley. After technical discussions with the pulley manufacturer it was confirmed that the existing units would be acceptable for this application. Should a fourth power unit become a requirement, the situation will have to be reviewed.

3.3 What is the constraint on the belting?

Having already determined the overall power requirement, next was to establish whether the standard class belting utilised on the mine would be suitable for the application. The following calculations were made:

The 1200 belt width class 1250S belting can be subjected to the following maximum tension:

Factor of safety = 10
Belt strength = 1250 kN per metre width.

Maximum working belt strength = belt width (m) x belt strength (kN/m) / FOS
= 1,2 m x 1250 kN/m / 10
= 150 kN

From the maximum tension the belt slope tension component must be subtracted to calculate the maximum T1 tension that can be present in the system.

BELT SLOPE TENSION:

Linear mass of class 1250S PVC belting = 15,6 kg/m
Maximum difference in elevation = 30 m

Belt slope tension component = Belt mass (kg/m) x difference in elevation (m) x gravity (m/s^2)
= 15,6 kg/m x 30 m x 9,81 m/s^2
= 4 591 N
say = 5 kN

MAXIMUM T1 TENSION:

Maximum T1 tension = Maximum working belt tension (kN) - belt slope tension (kN)
= 150 kN - 5 kN
= 145 kN

3.4 **What is the constraint on the power?**

The standard 240 kW power pack can produce the following effective tension:

Belt speed = 3,5 m/s
System design efficiency = 85 %

Effective tension produced by one 240 kW power unit = Installed power (kW) x efficiency / belt speed (m/s)
= 240 kW x 0,85 / 3,5 m/s
Te = 58,3 kN

Friction factor for single drive pulley with 210 degree wrap angle = 1,35 One power unit

Friction factor for dual drive pulleys with 420 degree wrap angle = 1,19 Two power units 1:1

Friction factor for dual drive pulleys with 420 degree wrap angle = 1,12 Two power units 2:1

T1 requirement for one power unit = Effective tension (kN) x friction factor
= 58,3 kN x 1,35
= 78,7 kN < 145 kN thus OK for class 1250 belting

T1 requirement for two power units = Effective tension (kN) x friction factor
= 2 x 58,3 kN x 1,19
= 138,8 kN < 145 kN thus OK for class 1250 belting

T1 requirement for three power units= Effective tension (kN) x friction factor
= 3 x 58,3 kN x 1,12
= 195,9 kN > 145 kN thus NOT OK for class 1250 belting

A maximum of two 240 kW power units can be used at any point on the 1200 wide class 1250 belting.

From the above calculations it can be seen that an additional drive had to be installed along the length of the conveyor and positioned such that the maximum belt class will not be exceeded at that specific point. Calculations proved that the tripper required to be positioned 1795 metres from the head of the conveyor.

With specific reference to the position where the tripper has been installed it was critical to ensure that there was always sufficient tension available in the system that will prevent the tripper drive pulley from slipping. The following control philosophy was then developed:

3.5 **What is the control philosophy?**

In principle the main drives at the head must operate continuously with the tripper only providing the extra power when required. When the situation arises where the head units are operating at peak power and more power is required, the tripper drive starts contributing by inserting additional power into the system. It must be clearly understood that there is no load sharing taking place between the head drive and the tripper station. The only position where load sharing occurs is between the two power units fitted to the head section.

From first principles in the design of a conveyor belt installation it is an accepted fact that the effective tension component progressively increases along the length of a belt for both the empty and the loaded condition. The fundamental principle applied here is that the empty belt condition is constant while the loaded belt condition varies from zero for the empty belt to absolute maximum for the fully loaded belt. There is a direct relationship between the increase in the tension and the power requirements. The higher the tension, the higher the absorbed power component. By measuring the tension in the belt at a known point and comparing it to design values the absorbed power can effectively be ascertained.

The most reliable control link that exists between the driving station at the head and the driving station at the tripper is the relative tension in the conveyor belt. The tripper principle taps into this link by measuring the tension in the top carrying belt by means of load cells. These tensions in the belt indirectly reflect the power requirements and thus by monitoring the actual tension values, indirectly the actual powers are ascertained. Being able to monitor the tensions allows access to information that is used for controlling powers.

The control tension levels are predetermined by the belt conveyor designer dependent on the geometry and the duty requirements of the installation at hand. At the design stage the minimum and maximum tension levels that will be experienced at the tripper station are determined. These tension levels form the basis of the input and output signals required for control purposes. These signals are processed by the electronics to establish and control the power requirements at any particular point in time.

This installation is equipped with block type load cells fitted between the base of the bearing housings and the snub pulley supporting steel work. These load or tension sensing units measure the tension in the belt out-bye of the tripper. It was decided to place the tripper at the position where the tension in the system will be in the region of 40 kN. Should the tension in the belt drop below this value, the tripper will reduce the work effort, while if the tension exceeded or tended to exceed 40 kN the tractive power from the tripper will increase to reduce the tension component back down to the selected value.

3.6 **How was this achieved with a fluid coupling?**

Again it is common knowledge that the volume of oil in a fluid coupling is directly proportional to the power it can transmit. Thus by controlling the volume of oil in the fluid coupling the transmittable power can be controlled.

Standard high speed couplings used on the mine are the drain type. The flow of oil starts from a suction pipe situated in the sump which forms part of the power unit base plate, through a flexible hose into the gear pump, through the gear pump to the oil cooler, through the oil cooler into a flexible hose and then finally into the catchment ring of the coupling (refer appendix 3) This catchment ring acts as delay fill chamber for filling the working circuit of the fluid coupling. It may have been be more descriptive to describe the catchment ring as a delay fill chamber of sorts. The oil passes from the catchment ring into the working circuit from where it finally drains back into the sump for the cycle to be repeated again. The existing units and the units on the head section operate on a constant flow system while the flow of the unit at the tripper must be variable and controlled.

Initial thoughts on the project were that the volume could effectively be controlled by means of a three way valve system. Tests and graphs generated dispelled this option during the early stages as repeatability was a problem. It was found that for this application the preferred way to ensure repeatability was by means of a variable speed motor being fitted to the oil supply pump (refer appendix 4). The controls of the tripper station must effectively monitor and control the speed of the variable speed drive to satisfy the power requirement.

The characteristics of the fluid coupling is very complex. The performance of the coupling is a combination of the following variables at any point in time:

the rate at which the oil is draining from the coupling
and
the level of the oil in the coupling
and
the rate at which the oil is entering the coupling and
and
the rate at which the coupling is slipping.

All of this is PLC controlled by means of a simple algorithm which will ensure one of three things:

maintain the oil level in the coupling constant if the tension reading remains at 40 kN
or
add oil to the coupling if the tension increases above 40 kN
or
drain oil from the coupling if the tension value drops below 40 kN.

Expressed in terms of the variable speed drive the control algorithm is only dependent on the tensions present in the system at any specific point in time. Should these tensions be higher than the set values, the variable speed drive will speed up and should the reverse be true, the variable speed drive will slow down. Provided that the tensions remain within the tolerance band the speed will remain constant. The maximum speed that the unit will go up to is 1500 rpm which is the normal condition for a fully loaded belt. Minimum speed is in the region of 500 rpm which is equivalent to the lubrication requirement.

In addition the algorithm allows for relative slow response to the change in tension fluctuations as any rapid response will result in transients being generated. The controls are programmed not to respond to fluctuations that take place over a very short period of time outside the control parameters in order to make the system impervious to hunting.

The system described above is considered as the minimum required to perform the duty. As is the case with any mechanical / electrical unit there are improvements that can be made up and fitted to enhance the effectiveness, efficiency and performance of the equipment described but this is considered to be outside the scope of this discussion.

3.7 **Where does all this fit into the bigger picture?**

The main drive at the head of the conveyor and the tripper drive operate completely independent. There is a transformer complete with motor control centre at the head plus a separate transformer complete with motor control centre at the tripper station. Similarly there is a PLC at the head and a PLC at the tripper. Both systems operate completely independent apart from the sequencing interlocks and system healthy signal. This means that the head drive is controlled by the PLC at the head while the tripper drive is controlled by the PLC installed at the tripper. The only connection between the two PLC's is the 4 core cable between them for system healthy signals. (refer Appendix 5 for electrical schematic)

The signals received and generated by the PLC's are relayed via a SCADA system to the control room on surface. The data acquisition system has no control function over the PLC's. From the control room a signal can be sent to both stations of the tripper conveyor to initiate starting and stopping of the belt. Local starting of the belt can also take place. The status of the drive and fault conditions in the belt are monitored by the PLC's and displayed via the L2 protocol on the monitors in the control room.

3.8 **How is the system performing?**

The tripper drive was delivered early 1996 and commissioned in September 1996 being the first in the country. Since then it was re-commissioned during the earlier part of this year on the second panel and final preparations are currently underway to install it on a third panel. The mechanical principle of the tripper concept is believed to be 100% proven.

With the aforementioned statement the impression may have been created that there is no room for improvement and that the ultimate solution was reached. This is far from the truth. The existing equipment reused in this installation limited the dimension and scope available to the designers.

Latest technology available in the world make use of the "extended S" curve principle for starting conveyor belts, specially on faster belts. This installation is a borderline case at 3,5 m/s belt speed. It is the opinion of the author that fast belts can be defined as being 4,5 m/s while slow belts operate at 2,5 m/s. Slower belts can achieve perfect starts with a linear increase in the rate of power application. Faster belts perform better if the power is applied to a pre-set value, held there for a short period of time to allow for the redistribution of the tensions around the system before it is finally accelerated to the required belt speed. The specific rate of power application must still be maintained to levels as dictated by the "Funke" line. (refer appendix 11) From the graphs generated during testing and recording the starting characteristics of this installation, the rise in the tension at the tripper can be clearly seen. (refer appendix 10) The reason for this is that the drain type couplings at the head drive are operating on a straight line principle. Although the fixed rate of filling the fluid couplings at the head section during starting cycle falls below the "Funke" line, there is not sufficient time delay between progressive belt breakaway and movement taking place in-bye of the tripper. It is recommended that the couplings at the head section should now also be of the variable speed oil pump motor type to facilitate full control of these couplings during the staring cycle.

With these controls it will be possible to ramp the system up to approximately 50 kW power in each power pack, hold it there for a period of 20 to 30 seconds to allow for full tension redistribution around the entire conveyor belt, and then only continue to accelerate the installation to full speed. Maintaining and holding the power for the 20 to 30 second period allows the tensions in the belting to effectively redistribute which will alleviate the tension rise currently being experienced local to the tripper drive.

This will make it comparable with other equipment available in the market place with the only exception being a transmission system where the low speed coupling is disconnected during the starting cycle. This particular equipment gets rid of the inherent flywheel inertia problem associated with any high speed coupling control equipment with a solid or uninterrupted connection on the output shaft.

3.9 **What are the operational experiences?**

Installing and removing of the tripper station under operating conditions present no problems. Typically the unit was disconnected and taken out on the retreating tail end application within one shift. This included taking out the in-bye grading and replacing it with standard garland structure.

Degradation of the material was negligible at the tripper discharge point and did not impact on the quality of the product being supplied to the end user.

4. CONCLUSION:

The tripper concept in its current form is mechanically sound and practical.

There is scope for improvement on the existing equipment.

5. RECOMMENDATIONS:

With the increasing demand from industry for higher production volumes it is inevitable that conveyors will become bigger, faster and longer. For very high belt capacities and faster belt applications the existing equipment has its limitations. The only recommendation is that serious consideration must be given to using other equipment specifically designed for starting high inertia systems. This equipment is being very effectively used by most of the world's biggest coal producing mines in America and Australia.

The use of tripper drives in main gate conveyor systems has revolutionised single flight conveying. As is evident from the contents of this paper our design of tripper was based on specific requirements being the utilisation of standard componentry. Should however the necessity arise where multiple trippers are required then alternative types of equipment would be installed.

A recent single flight installation in America utilised a main drive, two tripper drives and features two separate retarding trippers over a distance of 5490 metres. This conveyor is controlled by a combination of computer software and a series of controlled start transmissions. This 1800 mm wide main gate conveyor is said to be the longest of its type in the world.

This technology is now locally available in South Africa. It is recommended that the Southern African market take cognisance of this fact and make full use of the potential advantages and benefits.

6. REFERENCES:

ISO 5048 - Calculation of operating power and tensile forces in belt conveyors with carrying idlers on continuous mechanical handling equipment.

Handbook of conveyor and elevator belting Metric edition - Goodyear.

BELTCON 7 - Refining conveyor specifications and operating procedures to cut running costs and downtime. - A. Surtees and S. Curry

7. ACKNOWLEDGEMENTS:

Doug Rome	For editing the paper.
Stan Fouche	For preparing all the drawings and schematics.
Meco Conveyors	For affording the writer the time and the resources for compiling this presentation.

8. APPENDICES:

APPENDIX 1 - Schematic arrangement of the tripper drive.
APPENDIX 2 - Schematic of the electrical equipment.
APPENDIX 3 - Schematic of head drive drain coupling.
APPENDIX 4 - Schematic of tripper drive drain coupling.
APPENDIX 5 - 3000 metre Tripper conveyor design calculation.
APPENDIX 6 - 3000 metre Tripper conveyor graph.
APPENDIX 7 - 2000 metre Standard conveyor design calculation.
APPENDIX 8 - Standard 240 kW Power pack arrangement.
APPENDIX 9 - Elevation on 1200 belt width tripper.
APPENDIX 10 - Starting graph.
APPENDIX 11 - Starting graph extended S-curve and Funke line

9. CV OF THE AUTHOR:

Before the author joined his present employer he was head of the mechanical team that developed, patented, built, tested and certified the first 11 kV indoor vacuum circuit breaker in South Africa.

The author has now been involved in the belt conveyor industry for 21 years.

Since joining his present employer 16 years ago he has registered a patent on behalf of this company for the building of taper roller idlers.
Other firsts in his career include the following:
Part of the engineering team that designed the first shiftable gantry type surface mining conveyor in the country.
Part of the engineering team that designed the first six lap belt storage in the country.
Part of the engineering team that designed and built the first booster conveyor in the country.
Headed the team that ultimately developed the longest 1200 belt width class 1000 booster conveyor in the world at the length of 7100 metres.
Headed the team that has now designed the first tripper conveyor in the country.

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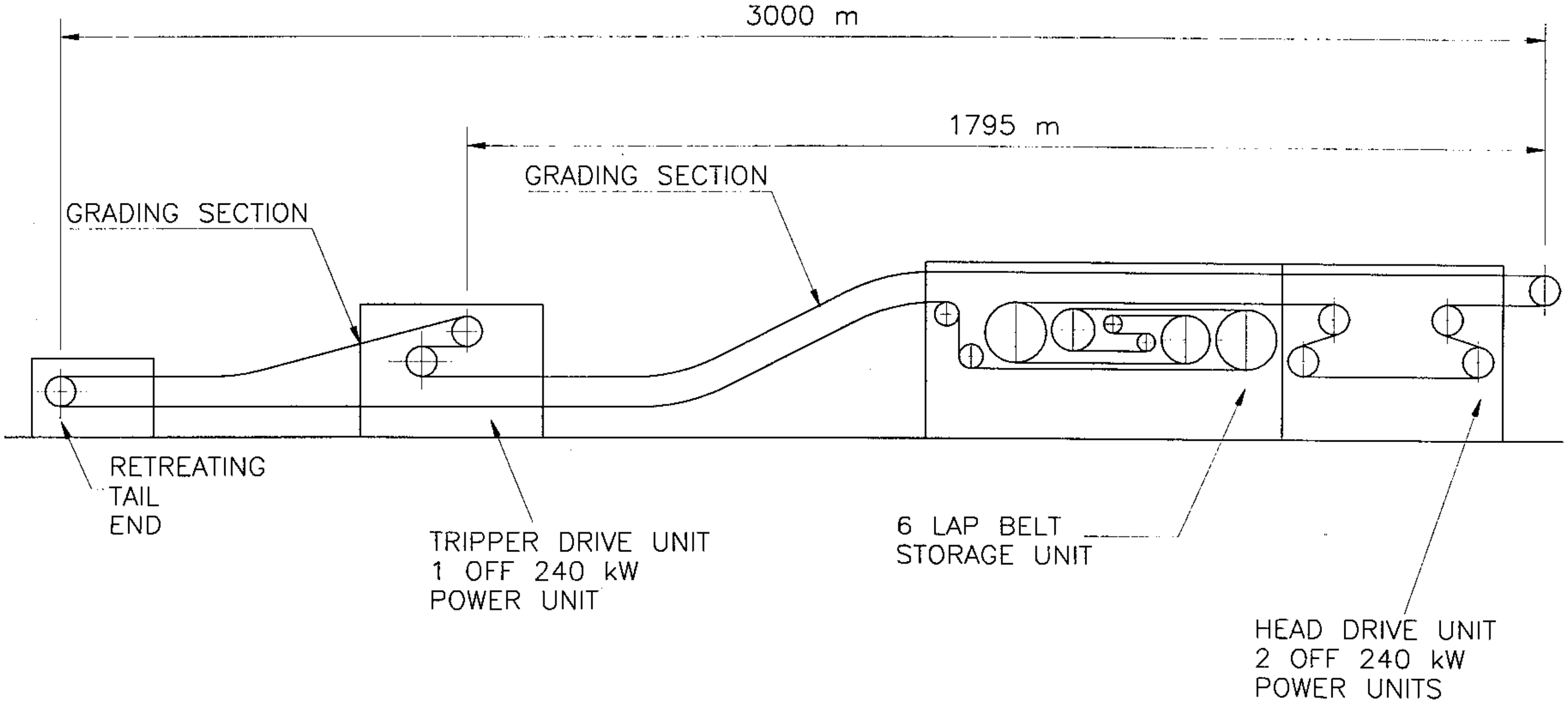
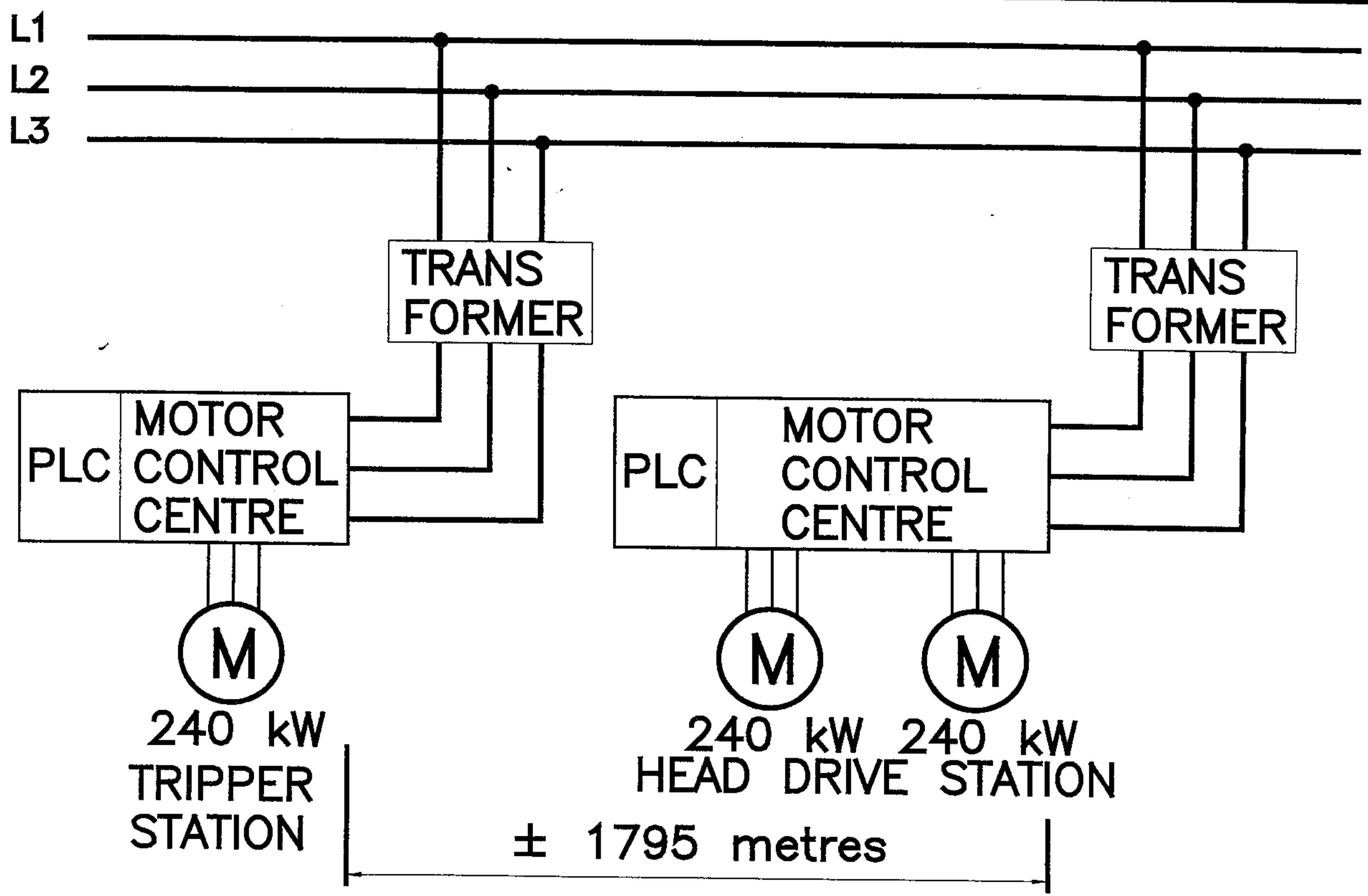
APPENDIX 1



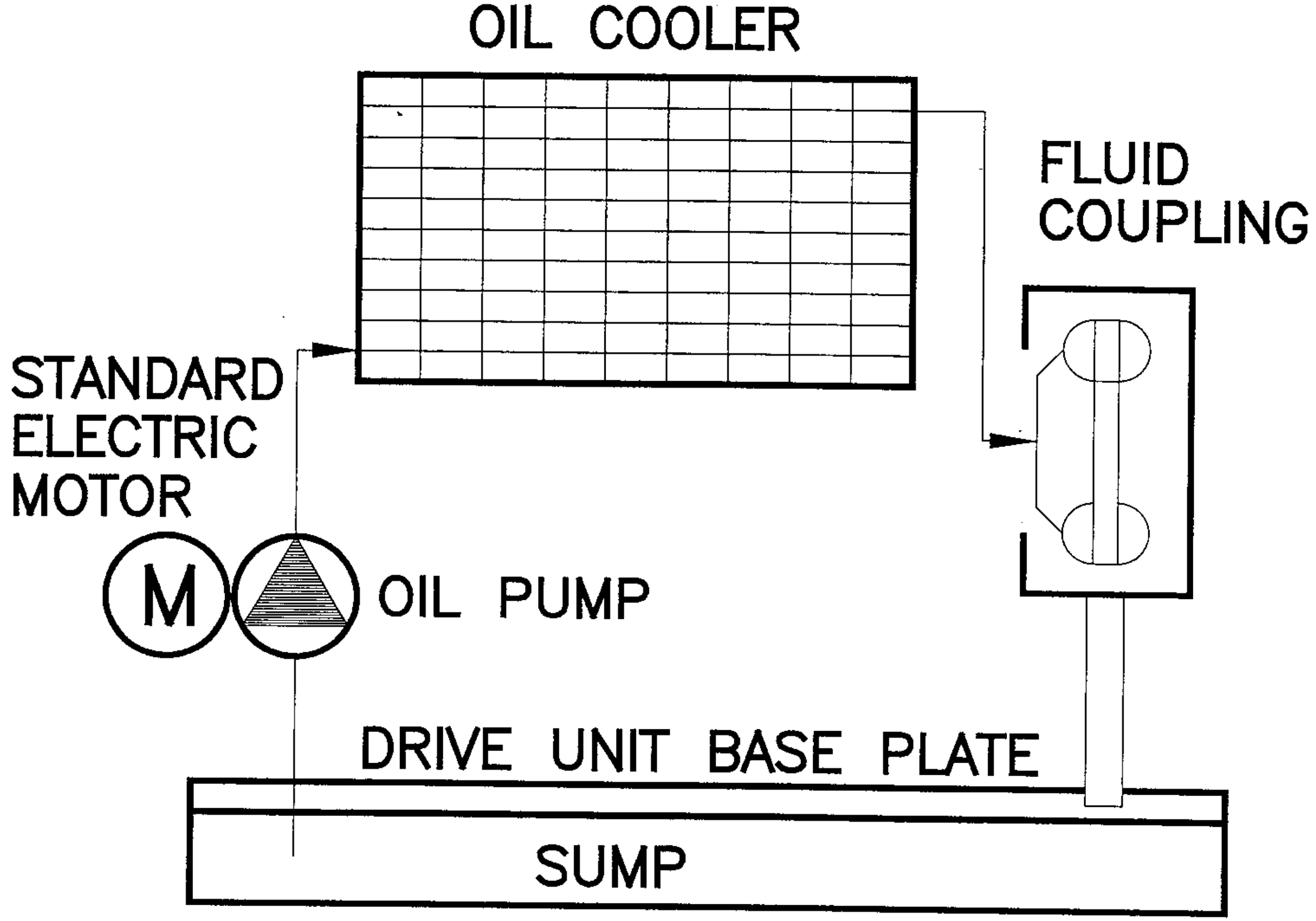
SCHEMATIC ARRANGEMENT OF THE TRIPPER DRIVE

APPENDIX 2



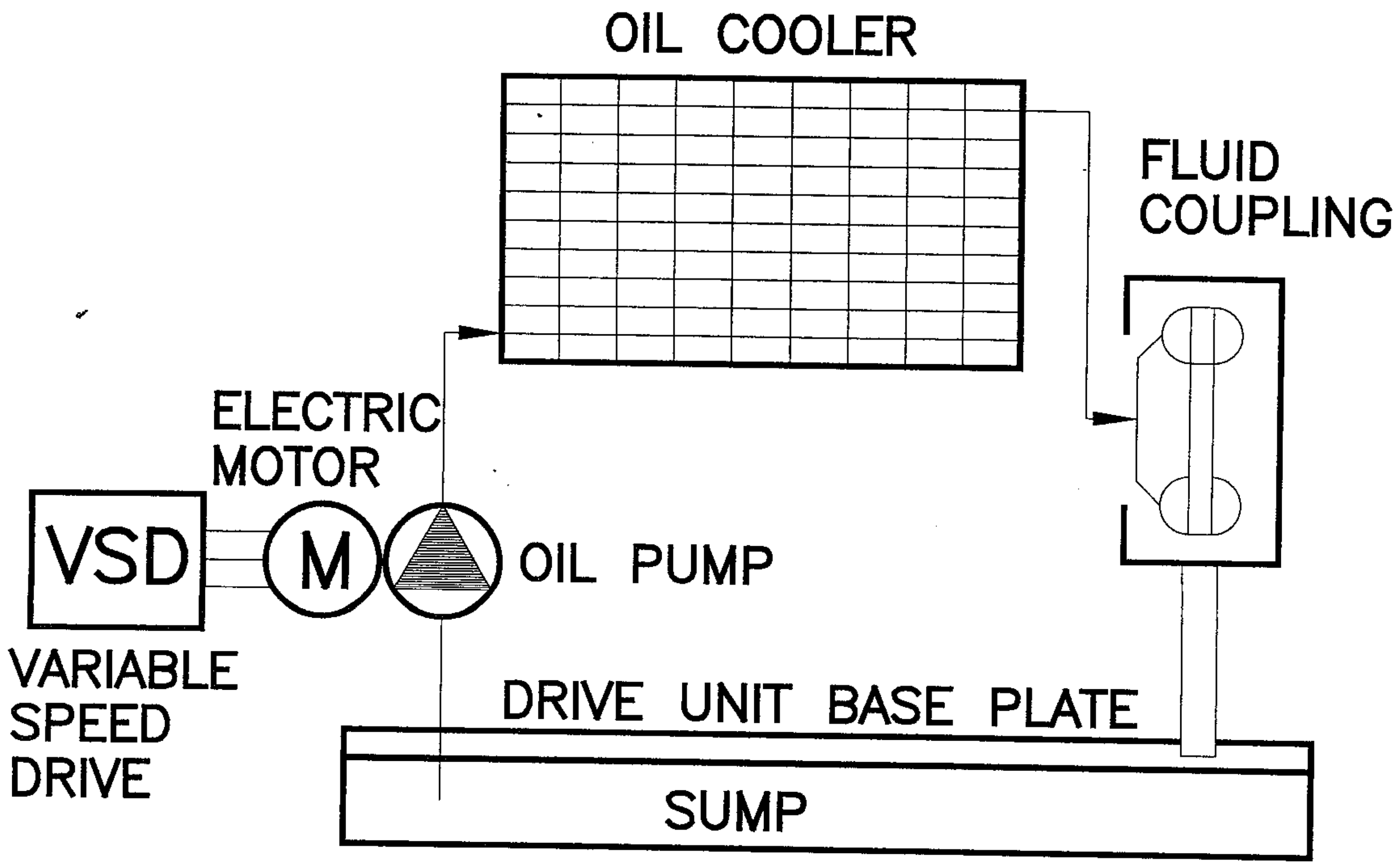
SCHEMATIC OF THE ELECTRICAL EQUIPMENT

APPENDIX 3



SCHEMATIC OF HEAD DRIVE DRAIN COUPLING

APPENDIX 4



SCHEMATIC OF TRIPPER DRIVE DRAIN COUPLING

18-Sep-97 ** *MECO CONVEYORS* ** **Belt Conveyor Calculations**

Customer: BELTCON 9
Ref No: TRIPPER DRIVE
Engineer: Simon Curry

*** CONVEYOR PROFILE AND LOADING ***

		TOTAL	Sect. 1	Sect. 2	Sect. 3	Sect. 4	Sect. 5
Length:	(m)	3000	1200	5	1795		
Lift:	(m)	30	12.0	0.1	18.0		
Design cap:	(TPH)	1800	1800				

Normal cap:	1893 (TPH)	Trough angle:	35 (deg)	
Flooded cap:	2690 (TPH)	Surcharge angle:	15 (deg)	
No of rolls:	3 (3/5)	Material density:	1.00 (t/m^3)	
Belt Width:	1200 (mm)	Trough idler crs:	1.37 (m)	
Belt Speed:	3.50 (m/s)	Transmission eff:	85 (%)	
T/Idler wt:	16.0 (kg/m)	Installed Power:	720 (kW)	
Ret Roll wt:	6.0 (kg/m)	H/S Coupling ref:	5 (1/2/3/4/5)	
Belt mass:	15.6 (kg/m)	Friction factor:	0.022	1="T"
Percent sag:	2 (%)	Drive factor:	1.19	2="TV"
				3="TVV"

LOADING CONDITION:		**EMPTY**	**FULL**	**MAX +ve**	**MAX -ve**	4="TSS"
eff Tension:	req(kN)	35.4	172.6	172.6	35.4	5="TPE"
absorbd pwr:	req(kW)	124.0	604.0	604.0	124.0	
motor power:	req(kW)	145.9	710.6	710.6	145.9	

***** STANDARD TENSION CONDITIONS (kN) *****

	NORMAL	NORMAL	BOOSTER	BOOSTER
LOADING CONDITION:	**EMPTY**	**FULL**	**EMPTY**	**FULL**
T1:	42	205	28	137
T2:	7	33	4	22
Ttail:	17	43	23	32
T start:	23	94	26	39
T ave:	20	81	24	26

******** TIMING ********

LOADING CONDITION:	**EMPTY**	**FULL**
Starting time:	54.1	40.9
Stopping time:	16.2	12.3
Overrun (Ton):	n/a	3.1

EMPTY BELT CONDITION:- Max tens 42.2 (kN)

	Tail	Sect. 1	Sect. 2	Sect. 3	Sect. 4	Sect. 5
Top strand:	17	27	27	42		
Return strand:	17	13	13	7		

LOADED BELT CONDITION:- Max tens 205.4 (kN)

	Tail	Sect. 1	Sect. 2	Sect. 3	Sect. 4	Sect. 5
Top strand:	43	108	108	205		
Return strand:	43	39	39	33		

TRIPPER EMPTY CONDITION:- Max tens 36.9 (kN)

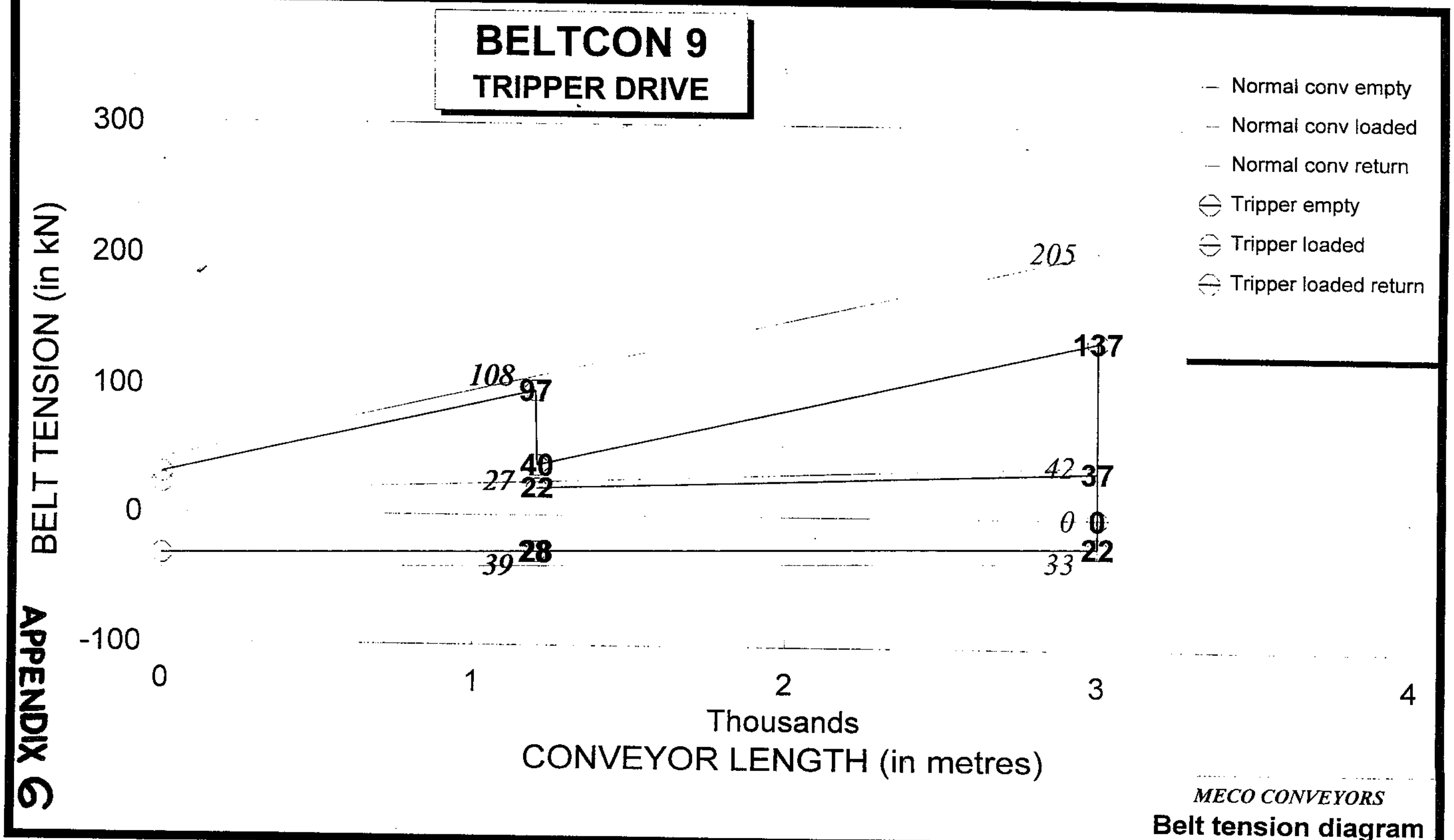
	Tail	Sect. 1	Sect. 2	Sect. 3	Sect. 4	Sect. 5
Top strand:	23	33	22	37		
Return strand:	23	19	19	13		

TRIPPER LOADED CONDITION:- Max tens 136.9 (kN)

	Tail	Sect. 1	Sect. 2	Sect. 3	Sect. 4	Sect. 5
Top strand:	32	97	40	137		
Return strand:	32	28	28	22		

APPENDIX 5

Meco Conveyors



BELTCON 9
TRIPPER DRIVE
BELT TENSION (in kN)
300
200
100
0
-100
0
1
2
3
4
Thousands
CONVEYOR LENGTH (in metres)
108
97
40
27
22
39
28
205
137
42
37
0
0
33
22
Normal conv empty
Normal conv loaded
Normal conv return
Tripper empty
Tripper loaded
Tripper loaded return
MECO CONVEYORS
Belt tension diagram

APPENDIX 6

18-Sep-97 * * * *Meco Conveyors* * * * Belt Conveyor Calculations

Customer:BELTCON 9 EL no: 2797

Ref No:2000 metre CONVEYOR 1200 belt width at 3.50 m/s

Engineer: Simon Curry * * * CONVEYOR PROFILE AND LOADING * * *

		TOTAL	Sect. 1	Sect. 2	Sect. 3	Sect. 4	Sect. 5
Length:	(m)	**2000.0**	2000				
Lift:	(m)	**20.0**	20.0				
Design cap:	(TPH)	**1800**	1800				
Skirt length:	(m)	**3.0**	3.0				

Belt Speed:	**3.50**	(m/s)	Skirt friction:	50	(N/m)
Belt Width:	1200	(mm)	Skirt matl depth:	100	(mm)
Trough angle:	35	(deg)	Material density:	1.00	(t/m^3)
Surcharge:	15	(deg)	Percent sag:	2	(%)
No of rolls:	3	(3/5)	Trough idler crs:	1.37	(m)
T/Idler wt:	16.00	(kg/m)	**Drive factor:**	**1.19**	
Ret Roll wt:	6.00	(kg/m)	Friction factor:	0.022	
Belt mass:	15.60	(kg/m)	Transmission eff:	85	(%)
Normal cap:	**1893**	**(TPH)**	**Installed Power:**	**480**	**(kW)**
Flooded cap:	2690	(TPH)	H/S Coupling ref:	5	(1/2/3/4/5)

LOADING CONDITION:		EMPTY	FULL	MAX +ve	MAX -ve	1="T"
						2="TV"
eff Tension:	req(kN)	23.9	116.4	116.4	23.9	3="TVV"
absorbd pwr:	req(kW)	83.8	407.4	407.4	83.8	4="TSS"
motor power:	req(kW)	98.6	**479.3**	**479.3**	98.6	5="TPE"

*** * * STANDARD TENSION CONDITIONS (kN) * * ***

LOADING CONDITION:	EMPTY	FULL	MAX +ve	MAX -ve
T1:	31	139	139	31
T2:	7	22	22	7
Ttail:	13	29	29	13
T start:	19.6	72.0	72.0	19.6
T ave:	16	55	55	16

*** * * * * * TIMING * * * * * ***

LOADING CONDITION:	EMPTY	FULL	MAX +ve	MAX -ve
Starting time:	54.1	41.0	41.0	54.1
Stopping time:	16.2	12.3	12.3	16.2
Overrun (Ton):	n/a	3.1	3.1	4.1

*** EMPTY BELT CONDITION:-** Max tens ***30.6*** (kN)

	Tail	Sect. 1
Top strand:	13	31
Return strand:	13	7

*** LOADED BELT CONDITION:-** Max tens ***138.5*** (kN)

	Tail	Sect. 1
Top strand:	29	139
Return strand:	29	22

*** MAX+ve BELT CONDITION:-** Max tens ***138.5*** (kN)

	Tail	Sect. 1
Top strand:	29	139
Return strand:	29	22

*** MAX-ve BELT CONDITION:-** Max tens ***30.6*** (kN)

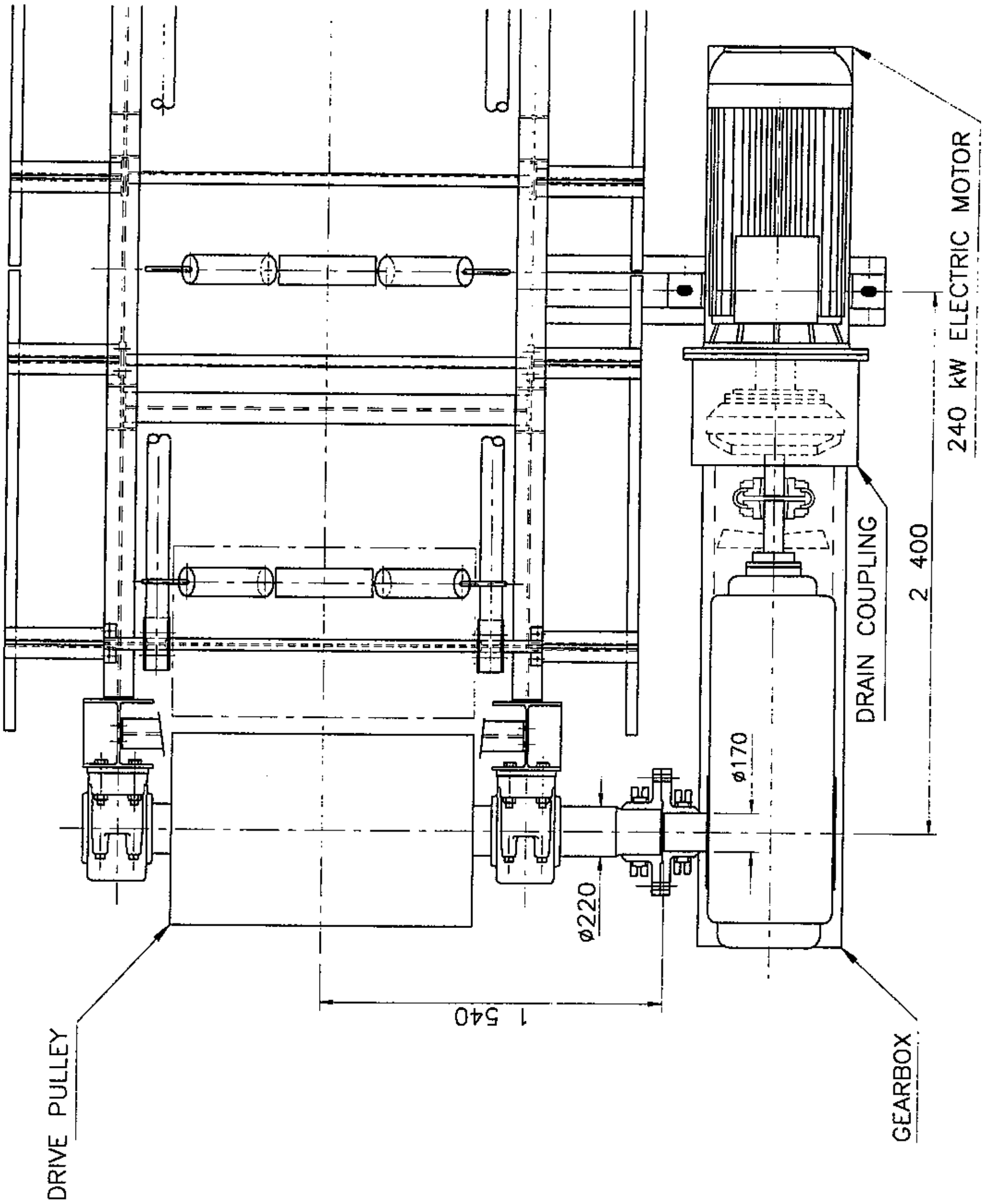
	Tail	Sect. 1
Top strand:	13	31
Return strand:	13	7

* * * RECOMMENDED MINIMUM: PVC Belting class: 1250S

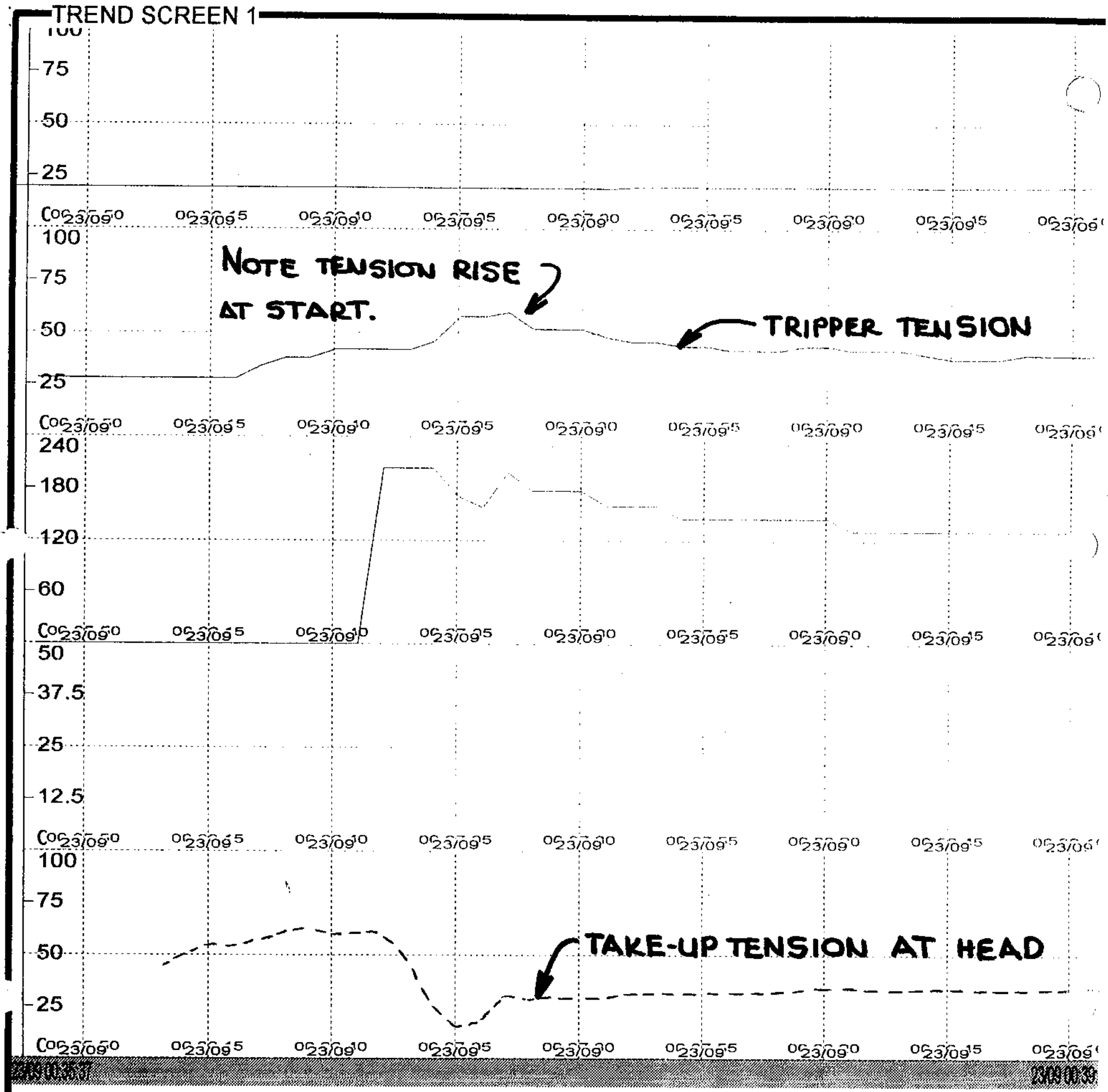
* * * BELTING SPECIFICATION:

APPENDIX 7

PLAN ON 240 kW POWER PACK



APPENDIX 8



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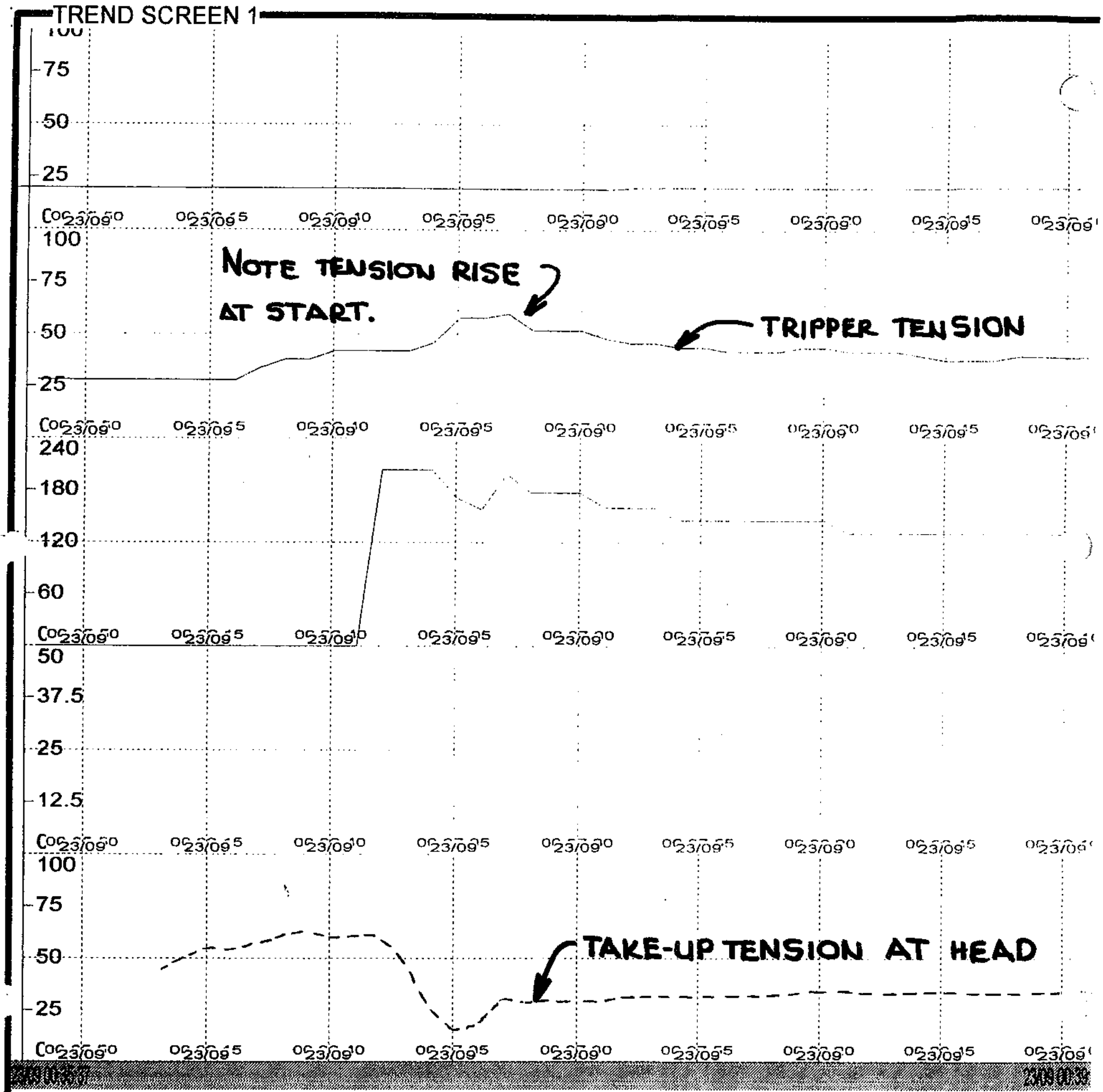
N2AIN000.value	TRIPPER TENSION	30.00
N2AIN003.VALUE	RADIATOR TEMP OUTLET	30.00

APPENDIX 10.



PULLKEY.value	PULL WIRE STATION	0.00
N2AIN004.value	TRIPPER KW	103.20
N2AIN000.value	TRIPPER TENSION	30.00
N2AIN003.VALUE	RADIATOR TEMP OUTLET	30.00

APPENDIX 10.