String Transport Systems Pty Ltd
ACN 129 604 351
Suite 124, 78 William Street,
Sydney, NSW 2011

Explanation for calendar implementation plan, technical characteristics and competitive analysis of automated STU Palembang Port commercial-demonstration mining transportation line (Coupler cable drive variant)

1. Components of automated STU demonstration-commercial mining transportation line (line):

- String-rail two way track structure for suspended rolling stock;
- Loading terminal;
- Unloading terminal;
- Rolling stock (highly aerodynamic suspended modules dump-cars);
- Drive system (coupler cable drive);
- Line's control system.

2. Line's technical characteristics:

Length, meters	8500
Carrying capacity, tons/hour minimum-maximum	**571 - 1998**
Carrying capacity per year, million tons minimum-maximum	5-17.5
Number of tracks	**2**
Gage, mm	1750
String tension at the assembly temperature of +30° C, kgs	**80000**
Projected temperatures of string-rail track structure's operation, ° C : • Minimal • Maximum • Maximum variation	 0 +80 80
Average height of supports, meters	**10**
Number of intermediate supports	41
Number of anchor supports	**3**
Spans between supports, meters	200
Deflection under the designed load in the middle of the span, meters	**3.1**
Number of loading terminals	1
Number of unloading terminals	**1**
Number of dump-cars minimum capacity (maximum capacity)	51(164)
Dump-car's carrying capacity, kgs	**6000**
Interval between dump-car movement, seconds minimum-maximum	37.8-10.8
Distance between dump-cars on the line, meters minimum-maximum	**378 - 108**
Dump-car's speed, m/s (km/h)	10 (36)
Power supply requirement KWT (without loading and unloading terminal requirements). Minimum-maximum	**135 - 472**
Control system	Semi-automatic

3. Cost (as per calendar implementation plan):

- Shown in thousands $ (USD);
- Does not account for customs duties and/or taxes;
- Does not account for electrical supply system;
- Payment terms with suppliers and sub-contractors may vary depending on conditions negotiated with them;

- Costs are for **demonstration**-commercial line and is higher then for a line in serial production will be;
- In serial production cost of an **automated STU mining transportation line will be** 250,000 USD/km for the capacity of 1 mln. ton per annum (MTA).
- When higher capacity is required each additional 1 MTA will increase cost per kilometer by 50,000 USD e.g. a line for 20 MTA will cost: 250,000 + 19x50,000 =1,200,000 USD /km.

4. **Delivery of system's components to the construction site will be gradual. It will depend on manufacturing dates and other factors.**

5. **Carrying capacity of the designed system with steel cable drive can be increased by scaling. Increase in size of dump-cars and their quantity (for example doubling of dump-car's volume, will increase system's capacity by 8 times), gage, string tension etc.**

6. **Preliminary list of supplier and sub-contractors:**
   - Consortium "Monorakurs" Belorussia, Russian Federation;
   - Consortium "Dorelectromach" Belorussia;
   - Public company «Souzprommechanizaciya» Russian Federation;

7. **STU mining transportation line with steel cable drive resembles cable conveyor. It is however based on different principals and apart from lower construction and maintenance costs has the following advantages:**

   - STU track structure is significantly more resistant to wear and tear. Maintenance free life expectancy of the track structure is 50 years. Rail head will have minimal wear due to STU being railed transport with all the corresponding advantages. Rail body will be manufactured from stainless steel which does not require painting or other maintenance. Life expectancy of the cable conveyor on the other hand is only 6-8 years. This is due to its main structural component - steel cable having to support the weight of the entire system as well as provide propulsion. This causes cable to experience very significant contact friction fatigue. Also it must be noted that unlike STU, cable in a cable conveyor is fully exposed to mechanical damage and aggressive impact of natural forces.
   - Main structural element of STU system – the tensioned strings located inside robust steel body which is also filled with a special hermetic. This ensures full protection from either mechanical damage or aggressive impact of natural forces. STU is therefore safe, reliable and all weather operational system.
   - Wires that form cable of a cable conveyor are thin (around 1 mm), twisted and experience shifting stress. This causes wires to experience damaging friction from other wires and other moving elements of the system. Such a cable is not operational when only 5% of wires have been damaged. Wires that form string of STU track structure are thicker (3-5 mm) and stationary tensioned inside the rail body parallel to each other, they do not contact with other wires and do not experience shifting stress (only shifting tension within operating parameters). STU track structure is operational even if 50% of wires break. Remaining 50% of wires ensure regular operating conditions of the system.
   - Strength reserve of a cable conveyor is five fold. Strength reserve of the STU system is twenty fold.
   - STU system's energy consumption is 4-6 times less; this is due to very low rolling resistance of steel wheel on steel rail as well as superb aerodynamic qualities of a dump-car. For example at the speed of 36 km/h a dump car with the carrying capacity of 350 kg will require power of 120 Wt against 1 KWT in cable conveyor. This unprecedented energy efficiency is better even than a railroad 0.4-0.5 KWt in STU against 0.8-1 KWt in railroad per ton of freight.
   - STU ensures much higher speeds of transportation due to it being a form of rail transport. Higher speed increases turnover of the rolling stock and correspondingly reduces the number of dump-cars required, their cost and maintenance cost of the system.

- STU string-rail welded continuously can be as long as needed. Bearing cable of a cable conveyor n the other hand cannot be longer than 2-3 kilometers. Because of that cable conveyor requires cable-to-cable transfer mechanisms. This increases accident and breakdown rates.
- STU system is more stable to high speed winds than cable conveyor.
- Unlike cable conveyor, STU dump-cars are hermetically sealed this ensures better aerodynamics and prevents coal spillage.
- Due to very low energy requirements even relatively modest slope will be enough to use for powering the system. If the loading terminal is higher than unloading terminal by 4 meters per 1 kilometer the system will be operational without power at 36 km/h speed. If the slope is more the system will be able to operate as electricity generator.
- STU supports can also be used for power transmission lines etc.
- Significant reduction in running costs:
  - Simpler and more cost effective monitoring of supports and track structure;
  - Lower environmental damage due to absence of coal spillage and lower amount of particles from operating of the system. Lower amount of noise pollution;
  - Lower by 4-6 times energy consumption;
  - Lower personnel requirements;
- Coupler cable performs few functions which enables to reduce cost and increase reliability of the system, specifically:
  - Enables to forgo self-propelled modules and autonomous electric motors in every dump-car in favor of a single electric motor in every anchor support. This generates saving of at least 50,000 USD/km for light system;
  - Enables to forgo expensive and unreliable contact network. This generates saving of at least 100,000 USD/km for light system;
  - Enables to forgo complex and expensive automated control system that monitors movements of dozens of dump-cars. Coupler cable is inexpensive and enables to use much simpler and more reliable control system. This generates saving of at least 150,000 USD/km for light system;
  - Enables to forgo expensive and unreliable electric-mechanical breaking system in favor of single break on electric drive of the coupler cable. This generates saving of at least 50,000 USD/km for light system.

8. Running costs

Index	Cost per 5 MTA capacity	Cost per 17.5 MTA capacity
Labor (20 people per shift, 3 shifts)	$ 252,000	$ 252,000
Electricity @ USD 0.075 per KWT/hr	$ 88,700	$ 310,500
Maintenance @ $1000 per km per month	$ 102,000	$ 102,000
Total	**$ 442,700**	**$ 664,500**
Running cost per ton/km	**$ 0.0104**	**$ 0.0031**

9. Financial viability in comparison with other modes of transport with similar capacity. Assuming 3 year time span.

Mode of transport	Capital cost	Running cost	Total	Total per ton/km
STU				
5 MTA (28.6% of max. design capacity)	**$ 19,838,000**	**$ 1,328,100**	**$ 21,166,100**	**$ 0.166**
17.5 MTA (100% design capacity)	**$ 22,098,000**	**$ 1,993,500**	**$ 24,091,500**	**$ 0.054**
Barge				
5 MTA	**$ 10,000,000***	**$ 10,200,000**	**$ 20,200,000**	**$ 0.158**
17.5 MTA	**$ 10,000,000***	**$ 35,700,000**	**$ 45,700,000**	**$ 0.102**
Conveyor				
5 MTA	**$ 28,000,000**	**$ 3,800,000**	**$ 31,800,000**	**$ 0.250**
17.5 MTA	**$ 42,500,000**	**$ 13,400,000**	**$ 55,900,000**	**$ 0.125**

*** capital cost of loading terminal**