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Moscow, Obraztsova St., 7 tel. 795-03-83, 631-22-55, www.hi-audit.ru

REPORT №O-905

ON MARKET VALUE ASSESSMENT OF EXCLUSIVE INTELLECTUAL PROPERTY AND KNOW-HOW RIGHTS ON THE "STRING-AND-RAIL TRANSPORTATION SYSTEM OF ENGINEER YUNITSKIY"

Report date: May 20, 2013

2013

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To the attention of: Yunitskiy Anatoly Eduardovitch.

Letter of transmittal of the Report №O-905 dated May 22, 2013

"On market value assessment of exclusive intellectual property and know-how rights on the "String-and-rail Transportation System of Engineer Yunitskiy"

Moscow *May 22, 2013*

In accordance with the Paid Services Agreement №O-905 dated May 14, 2013, between Yunitskiy Anatoly Eduardovitch (hereinafter – the Customer) and HOLD-INVEST-AUDIT Consulting Company CJSC (hereinafter – the Contractor), the Appraiser of the Contractor performed assessment of market value of the object – exclusive intellectual property and know-how rights on the "String-and-rail Transportation System of Engineer Yunitskiy".

This letter of transmittal includes main information on the results of the performed assessment, presented in the Assessment Report №O-905 dated May 22, 2013. The information is shown below:

Object	Exclusive intellectual property and know-how rights on the "String-and-rail Transportation System of Engineer Yunitskiy"
Assessed rights on the object	Ownership
Type of estimated value	Market value
Purpose of the assessment	Estimation of market value of the object
Intended use of the assessment	For following contribution to the authorized capital
Assessment date	May 20, 2013
Report date	May 22, 2013

Resulting from the performed investigation based on the available information and general and special assumptions as of the assessment date, May 20, 2013, the total market value of the assessed object at the exchange rates acting on the assessment date amounted to[1]:

12,584,471,411,000 (Twelve trillion five hundred eighty four billion four hundred seventy one million four hundred eleven thousand) rubles,

400,867,433,000 (Four hundred billion eight hundred sixty seven million four hundred thirty three thousand) US dollars,

[1] *Per currency exchange rates of Central Bank of the Russian Federation as of the date of the assessment, value stated without VAT and rounded to 1 thousand units of currency*

311,692,010,000 (Three hundred eleven billion six hundred ninety two million ten thousand) Euro;

263,122,633,000 (Two hundred sixty three billion one hundred twenty two million six hundred thirty three thousand) UK pound sterling.

by countries of investment project implementation employing the assessed object:

Table 1. Market value of the assessed object by countries of investment project implementation employing the assessed object

No.	Country	Length of transportation network, km	Market value, rubles	Market value, US dollars	Market value, Euro	Market value, UK pound sterling
1	China	130,000	1,635,981,283,430	52,112,766,290	40,519,961,300	34,205,942,290
2	India	95,000	1,195,524,784,045	38,082,406,135	29,610,740,950	24,996,650,135
3	Russia	70,000	880,912,998,770	28,060,720,310	21,818,440,700	18,418,584,310
4	The USA	50,000	629,223,570,550	20,043,371,650	15,584,600,500	13,156, 131,650
5	Brasilia	40,000	503,378,856,440	16,034,697,320	12,467,680,400	10,524,905,320
6	Canada	30,000	377,534,142,330	12,026,022,990	9,350,760,300	7,893,678,990
7	Australia	25,000	314,611,785,275	10,021,685,825	7,792,300,250	6,578,065,825
8	Indonesia	25,000	314,611,785,275	10,021,685,825	7,792,300,250	6,578,065,825
9	Mexico	15,000	188,767,071,165	6,013,011,495	4,675,380,150	3,946,839,495
10	Pakistan	15,000	188,767,071,165	6,013,011,495	4,675,380,150	3,946,839,495
11	Nigeria	15,000	188,767,071,165	6,013,011,495	4,675,380,150	3,946,839,495
12	Democratic Republic of Congo	13,000	163,598,128,343	5,211,276,629	4,051,996,130	3,420,594,229
13	Argentina	12,000	151,013,656,932	4,810,409,196	3,740,304,120	3,157,471,596
14	Iran	11,000	138,429,185,521	4,409,541,763	3,428,612,110	2,894,348,963
15	Algeria	11,000	138,429,185,521	4,409,541,763	3,428,612,110	2,894,348,963
16	Bangladesh	11,000	138,429,185,521	4,409,541,763	3,428,612,110	2,894,348,963
17	Japan	10,000	125,844,714,110	4,008,674,330	3,116,920,100	2,631,226,330
18	Kazakhstan	10,000	125,844,714,110	4,008,674,330	3,116,920,100	2,631,226,330
19	Ethiopia	10,000	125,844,714,110	4,008,674,330	3,116,920,100	2,631,226,330
20	Saudi Arabia	9,000	113,260,242,699	3,607,806,897	2,805,228,090	2,368,103,697
21	Egypt	9,000	113,260,242,699	3,607,806,897	2,805,228,090	2,368,103,697
22	Sudan	8,000	100,675,771,288	3,206,939,464	2,493,536,080	2,104,981,064
23	South African Republic	8,000	100,675,771,288	3,206,939,464	2,493,536,080	2,104,981,064
24	Turkey	8,000	100,675,771,288	3,206,939,464	2,493,536,080	2,104,981,064
25	Vietnam	7,000	88,091,299,877	2,806,072 031	2,181,844,070	1,841,858,431
26	Philippines	7,000	88,091,299,877	2,806,072 031	2,181,844,070	1,841,858,431
27	Peru	7,000	88,091,299,877	2,806,072,031	2,181,844,070	1,841,858,431
28	Tanzania	7,000	88,091,299,877	2,806,072,031	2,181,844,070	1,841,858,431
29	Columbia	7,000	88,091,299,877	2,806,072,031	2,181,844,070	1,841,858,431
30	Germany	6,000	75,506,828,466	2,405,204,598	1,870,152,060	1,578,735,798
31	France	6,000	75,506,828,466	2,405,204,598	1,870,152,060	1,578,735,798
32	Thailand	6,000	75,506,828,466	2,405,204,598	1,870,152,060	1,578,735,798

No.	Country	Length of transportation network, km	Market value, rubles	Market value, US dollars	Market value, Euro	Market value, UK pound sterling
33	Libya	6,000	75,506,828,466	2,405,204,598	1,870,152,060	1,578,735,798
34	Mongolia	6,000	75,506,828,466	2,405,204,598	1,870,152,060	1,578,735,798
35	Chad	6,000	75,506,828,466	2,405,204,598	1,870,152,060	1,578,735,798
36	Angola	6,000	75,506,828,466	2,405,204,598	1,870,152,060	1,578,735,798
37	Myanmar	6,000	75,506,828,466	2,405,204,598	1,870,152,060	1,578,735,798
38	Italy	5,000	62,922,357,055	2,004,337,165	1,558,460,050	1,315,613,165
39	Ukraine	5,000	62,922,357,055	2,004,337,165	1,558,460,050	1,315,613,165
40	Great Britain	5,000	62,922,357,055	2,004,337,165	1,558,460,050	1,315,613,165
41	Kenya	5,000	62,922,357,055	2,004,337,165	1,558,460,050	1,315,613,165
42	Niger	5,000	62,922,357,055	2,004,337,165	1,558,460,050	1,315,613,165
43	Venezuela	5,000	62,922,357,055	2,004,337,165	1,558,460,050	1,315,613,165
44	Afghanistan	5,000	62,922,357,055	2,004,337,165	1,558,460050	1,315,613165
45	Spain	5,000	62,922,357,055	2,004,337,165	1,558,460,050	1,315,613,165
46	Mali	5,000	62,922,357,055	2,004,337,165	1,558,460,050	1,315,613,165
47	Republic of Korea	4,000	50,337,885,644	1,603,469,732	1,246,768,040	1,052490,532
48	Bolivia	4,000	50,337,885,644	1,603,469,732	1,246,768040	1,052,490,532
49	Mauritania	4,000	50,337,885,644	1,603,469,732	1,246,768,040	1,052,490,532
50	Mozambique	4,000	50,337,885,644	1,603,469,732	1,246,768,040	1,052,490,532
51	Chile	4,000	50,337,885,644	1,603,469,732	1,246,768,040	1,052,490,532
52	Madagascar	4,000	50,337,885,644	1,603,469,732	1,246,768,040	1,052,490,532
53	Yemen	4,000	50,337,885,644	1,603,469,732	1,246,768,040	1,052,490,532
54	Uzbekistan	4,000	50,337,885,644	1,603,469,732	1,246,768,040	1,052,490,532
55	Morocco	4,000	50,337,885,644	1603,469,732	1,246,768,040	1,052,490,532
56	Iraq	4,000	50,337,885,644	1,603,469,732	1,246,768,040	1,052,490,532
57	Poland	4,000	50,337,885,644	1,603,469,732	1,246,768,040	1,052,490,532
58	Malaysia	3,000	37,753,414,233	1,202,602,299	935,076,030	789,367,899
59	Namibia	3,000	37,753,414,233	1,202,602,299	935,076,030	789,367,899
60	South Sudan	3,000	37,753,414,233	1,202,602,299	935,076,030	789,367,899
61	Cameroon	3,000	37,753,414,233	1,202,602,299	935,076,030	789,367,899
62	Zambia	3,000	37,753,414,233	1,202,602,299	935,076,030	789,367,899
63	Uganda	3,000	37,753,414,233	1,202,602,299	935,076,030	789,367,899
64	Nepal	2,600	32,719,625,669	1,042,255,326	810,399,226	684,118,846
65	Ghana	2,500	31,461,178,528	1,002,168,583	779,230,025	657,806,583
66	Cote d'Ivoire	2,500	31,461,178,528	1,002,168,583	779,230,025	657,806,583
67	DPRK	2,200	27,685,837,104	881,908,353	685,722,422	578,869,793
68	Romania	2,200	27,685,837,104	881,908,353	685,722,422	578,869,793
69	Zimbabwe	2,200	27,685,837,104	881,908,353	685,722,422	578,869,793
70	Burkina-Faso	2,200	27,685,837,104	881,908,353	685,722422	578,869,793
71	Syria	2,100	26,427,389,963	841,821,609	654,553,221	552,557,529
72	Somali	2,000	25,168,942,822	801,734,866	623,384,020	526,245,266
73	CAR	2,000	25,168,942,822	801,734,866	623,384,020	526,245,266

No.	Country	Length of transportation network, km	Market value, rubles	Market value, US dollars	Market value, Euro	Market value, UK pound sterling
74	Botswana	2,000	25,168,942,822	801,734,866	623,384,020	526,245,266
75	Turkmenistan	2,000	25,168,942822	801,734,866	623,384,020	526,245,266
76	Ecuador	2,000	25,168,942,822	801,734,866	623,384,020	526,245,266
77	Papua-New Guinea	2,000	25,168,942,822	801,734,866	623,384,020	526,245,266
78	Sweden	2,000	25,168,942,822	801,734,866	623,384,020	526,245,266
79	Republic of the Congo	1,900	23,910,495,681	761,648,123	592,214,819	499,933,003
80	Paraguay	1,800	22,652,048,540	721,561,379	561,045,618	473,620,739
81	Republic of China (Taiwan)	1,800	22,652,048,540	721,561,379	561,045,618	473,620,739
82	Sri Lanka	1,700	21,393,601,399	681,474,636	529876,417	447,308,476
83	Finland	1,600	20,135,154,258	641,387,893	498,707,216	420,996,213
84	Guinea	1,600	20,135,154,258	641,387,893	498,707,216	420,996,213
85	Senegal	1,600	20,135,154,258	641,387,893	498,707,216	420,996213
86	Cambodia	1,600	20,135,154,258	641,387,893	498,707,216	420,996,213
87	Malawi	1,600	20,135,154,258	641387,893	498,707,216	420,996,213
88	the Netherlands	1,400	17,618,259,975	561,214,406	436,368,814	368,371,686
89	Belarus	1,400	17,618,259,975	561,214,406	436,368,814	368,371,686
90	Tunis	1,400	17,618,259,975	561,214,406	436,368,814	368,371,686
91	Norway	1,400	17,618,259,975	561,214,406	436,368,814	368,371,686
92	Oman	1,200	15,101,365,693	481,040,920	374,030,412	315,747,160
93	New Zealand	1,200	15,101,365,693	481,040,920	374,030,412	315,747,160
94	Laos	1,200	15,101,365,693	481,040,920	374,030,412	315,747,160
95	Greece	1,200	15,101,365,693	481,040,920	374,030,412	315,747,160
96	Portugal	1,100	13,842,918,552	440,954,176	342,861,211	289,434,896
97	Benin	1,100	13,842,918,552	440,954,176	342861,211	289,434,896
98	Cuba	1,100	13,842,918,552	440,954,176	342,861,211	289,434,896
99	Kyrgyzstan	1,100	13,842,918,552	440,954,176	342,861,211	289,434,896
100	Azerbaijan	1,000	12,584,471,411	400,867,433	311,692,010	263,122,633
101	Gabon	1,000	12,584,471,411	400,867,433	311,692,010	263,122,633
102	Tajikistan	1,000	12,584,471,411	400,867,433	311,692,010	263,122,633
103	Other countries, overseas dominions and territories	104,500	1,315,077,262,450	41,890,646,749	32,571,815,045	27,496,315,149

Best regards,
Director General
HOLD-INVEST-AUDIT Consulting Company CJSC _____/I. N. Drozdov/

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1 BASIC FACTS AND FINDINGS OF THE ASSESSMENT REPORT

1.1 Assignment definition

Table 1-1 Assignment definition

Basis of the assessment	Paid Services Agreement №O-905 dated May 14, 2013
Assessed object	Exclusive intellectual property and know-how rights on the "String-and-rail Transportation System of Engineer Yunitskiy"
Assessed rights on the object	Ownership
Type of estimated value	Market value
Purpose of the assessment	Assessment of market value of the object
Intended use of the assessment	For following contribution to the authorized capital
Limitations of possible use of the assessment results	This Report may be used as the document determining market value of the assessed object for following contribution to the authorized capital. Any other use of the Assessment Report as a document containing information of evidentiary value is allowed only with written consent of the Appraiser.
Assessment date	May 20, 2013
Assessment activities period	May 14, 2013 to May 22, 2013
Report date	May 22, 2013
Date of inspection (examination) of the assessed object	Not applicable for the assessed object
Customer	Citizen of the Russian Federation Yunitskiy Anatoly Eduardovitch Date of birth: April 16, 949 Passport _____, issued in _____ by _____ Russia in Moscow, (department code _____) Registered address: Moscow, _____. INN 772577968329 dated February 10, 2006
Contractor	HOLD-INVEST-AUDIT Consulting Company Residence: 127055, Moscow, Obraztsova St., 7 OGRN 1027739150328 date of OGRN registering: September 04, 2002 INN 7709034316 KPP 770901001 Bank information: s/a 40702810100000001400 in Baltiyskiy bank razvitiya, CJSC, Moscow c/a 30101810500000000769 BIK 044583769 Tel./fax (495) 631-22-55, 795-03-83
Appraiser	Krutskaya Olga Viktorovna Passport, series _____, issued _____ by _____, Moscow IVS Diploma 0043202 issued June 18, 2003 by State University of Land Development, specialized in "Urban register" PP Diploma No. 499144 issued December 10, 2003 by State University of Land Development, certifies the right to operate in the "Assessment of enterprises (business)" sector. Working experience in assessment – from 09.09.2002 The Appraiser is an acting member of the Russian Society of Appraisers CJSC, listed in the RSA Member Register on June 24, registration No. 006681 The Appraiser's professional activity is insured by Guta-Strakhovanie CJSC for the amount of 50 mln. rub., insurance policy No. GS4K-OCST/002652-12 dated August 28, 2012, valid from c September 9, 2012 till September 8, 2013. The Appraiser has a work contract with HOLD-INVEST-AUDIT Consulting Company CJSC Place of residence of the Appraiser: Moscow, Obraztsova, 7

Source of information: Paid Services Agreement No. O-905 dated May 14, 2013

1.2 Results of the assessment

As the result of the performed estimation with regard to the limiting conditions and assumptions the Appraiser achieved the following findings[2]:

Table 1-2 Results of the assessment with the used principles and methods, estimation of the approved market value of the assessed object

Currency	Value estimated with the cost principle, currency	Value estimated with income principle, currency	Value estimated with comparative principle, currency	Final agreed market value, currency
US dollar	Not applied due to reasonable refusal	400,867,433,000	Not applied due to reasonable refusal	400,867,433,000
Russian ruble	Not applied due to reasonable refusal	12,584,471,411,000	Not applied due to reasonable refusal	12,584,471,411,000
Euro	Not applied due to reasonable refusal	311,692,010,000	Not applied due to reasonable refusal	311,692,010,000
UK pound sterling	Not applied due to reasonable refusal	263,122,633,000	Not applied due to reasonable refusal	263,122,633,000
Specific weight of the principle	-	*1,00*	-	

Source of information: the estimation of the Appraiser

1.3 Compliance statement

The Appraiser performing the assignment confirms that:

- The performed analysis, expressed opinions and obtained findings are valid exclusively within the limits of the assumptions and limiting conditions stipulated in this Report, and are personal, unprejudiced, professional analyses, opinions and findings of the Appraiser.
- The Appraiser has neither presently, nor in the future any interest in the assessed property, nor has any personal interest or prejudice in regard to involved parties.
- The Appraiser's remuneration is in no way connected with anticipatory declaration of a predetermined value or a tendency to assess the value in favor of the Customer or its client, with arrival at a anticipatorily agreed result or events ensuing from analysis, opinions or findings contained in the Report.

1.4 Scope and volume of assessment activities

1. Effecting the Assessment Agreement;
2. Obtaining source information on the assessed object from the Customer by way of an inquiry of the Appraiser;
3. Examination of technical, operational, legal, financial and other documentation for the assessed object and subsequent analysis of the obtained information;

[2] *Per currency exchange rates of Central Bank of the Russian Federation as of the date of the assessment, value stated without VAT and rounded to 1 thousand units of currency*

4. Monitoring and analysis of economic data and market indicators, validation of the collected information;
5. Selection of the principles and methods of estimation of the assessed object;
6. Estimation of value of the assessed object within the scope of the used principles and methods;
7. Coordination of the assessment results and estimation of the final market value of the assessed object;
8. Compilation of this Report.

1.5 Main limitations and limits of application of the assessment results

The following main limitations and limits of application of the assessment results are an integral part of this Report:

- Effecting a transaction with the assessed object is not a prerequisite of estimation of its value.
- The opinion of the Appraiser regarding market value of the assessed object is valid only at the date of estimation. The Appraiser shall not be liable for changes in economic, legal or other factors, which may arise after the date of estimation and affect market situation and, consecutively market value of the assessment object.
- The Assessment Report contains professional opinion of the Appraiser regarding market value of the assessment object and may not guarantee the sale of the object at commercial market at the price equal to the value of the object stated in this Report.
- This Report shall be valid only in its entirety and only for the objects and purposes stated therein, with regard to limitations and assumptions stipulated both in this section and elsewhere in the Report, used for value estimation. Publication of the complete Report or of its separate parts, as well as any references thereto or to values contained therein, or to names and profession of the Appraiser may be possible only after written consent of the Customer and the Appraiser to the form and context of the publication.
- As per item. 26 of FVS No. 1 "General notions on assessment, principles and requirements for its performance", enacted by Decree of the Ministry of Economic Development and Trade of the Russian Federation of July 20, 2007, No. 256 "The final value of an assessment object, stated in an assessment report may be acknowledged to be recommended for the purposes of effecting a transaction with the assessment object, if no more than 6 months passed from the date of assessment report till the date of effecting a transaction or till the date of a public offer.
- As per item. 26 of FVS No. 1 "General notions on assessment, principles and requirements for its performance", enacted by Decree of the Ministry of Economic Development and Trade of the Russian Federation of July 20, 2007, No. 256 "If the performance of an assessment is mandatory in accordance with legislation of the Russian Federation than no more than three months shall pass from the date of the assessment, with exception to such cases when otherwise established by legislation of the Russian Federation".

  All estimations were performed with the use of Microsoft Office Excel 2003 (11.5612.5703). Values of estimated parameters contained shown in this Report in tables are

truncated which may result in variances between final values calculated in Excel 2003 and those calculated mechanically.

1.6 Basic assumptions of the assessment

The following basic assumptions of the assessment are integral part of this Report:

- All information and documents received from the Customer in written form and certified by the Customer are considered valid, unless they are in contradiction with the Appraisers' professional experience.
- Within assessment of the value the Appraiser did not perform legal examination of ownership rights to the assessed object and of related legal documents. The Appraiser performed assessment presented in this Report with an assumption that ownership rights on the assessed object are in full compliance with international and Russian legislation, and further assumption, that the assessed object is free from any claims and limitations, except as explicitly stipulated in the Report.
- Information and documents provided by the Customer describing "quantitative and qualitative characteristics of the assessed object… and elements of the assessed object of specific nature influencing the results of the assessment of the assessed object"[3], are listed in section "List of information provided by the Customer" of this Report. Copies of such information and documents provided by the Customer are enclosed in section Addendum 3. "Copies of documents provided by the Customer" of this Report.
- Basic documents (originals) provided by the Customer in electronic form and on paper (originals) determining quantitative and qualitative characteristics of the assessed object and elements within the assessed object, are stored in the Appraiser's depository and may be provided to stakeholders only with permission of the Customer.
- The assessment assumed absence of defects or hidden facts of the assessed object or elements of the assessed object of specific nature influencing the results of the assessment of the assessed object, which the Appraiser had no knowledge of during assessment period.
- All pictures provided in the Report are used exclusively for facilitation of visual perception of content of the Report by a reader. The pictures are not results of inspection of the assessed object or its elements by the Appraiser.
- While using information from outside sources the Appraiser acted on the principle of adequacy and reliability of the used information. Nevertheless the Appraiser cannot guarantee its absolute accuracy, therefore the Appraiser references sources of information.

In addition to the general assumptions stipulated above there may be special assumptions elsewhere in the text of the Report used by the Appraiser during value estimations.

[3] *Federal Valuation Standard "Requirements to valuation report (FVS No. 3)"), enacted by decree of the Ministry of Economic Development and Trade of the Russian Federation of 20.07.2007 No 254*

1.7 Standards applied in valuation activities

The Appraiser is an Agent acting on the territory of the Russian Federation. Therefore the Appraiser must comply with valuation activities standards acting on the territory of the Russian Federation.

The Appraiser is also accredited in Moscow regional division of the Russian Society of Appraisers (RSA). Therefore the Appraiser must use the Russian Society of Appraisers standards.

Since the RSA is a member of International Valuation Standards Committee (IVSC), and for better clarity and structuring of reported information the Appraiser used International Valuation Standards (IVS) used by the said organization.

This Report compiled in full compliance with the following standards and regulations:

Valuation standards and regulations mandatory in the Russian Federation:

- Federal Law dated July 29, 1998 No. 135-FZ (rev. of December 03, 2011, amend. of July 28, 2012) "On assessment activities in the Russian Federation" (hereinafter No. 135-FZ);
- Federal Valuation Standard "General notions on assessment, principles and requirements for its performance", (FVS No. 1) enacted by decree of the Ministry of Economic Development and Trade of the Russian Federation of July 20, 2007, No. 256 (rev. of 22.10.2010) (hereinafter FVS No. 1);
- Federal Valuation Standard "Purpose of valuation and types of values (FVS No. 2)", enacted by decree of the Ministry of Economic Development and Trade of the Russian Federation of July 20, 2007 No. 255 (rev. of October 22, 2010) (hereinafter FVS 2);
- Federal Valuation Standard "Requirements to valuation report (FVS No. 3)"), enacted by decree of the Ministry of Economic Development and Trade of the Russian Federation of July 20, 2007 No. 254 (hereinafter FVS No. 3).

The Russian Society of Appraisers standards:

- SSO ROO 1-01-2010. Concepts being the basis of conventional valuation principles (CVPs);
- SSO ROO 1-02-2010. Rules of business and professional ethics of the all-Russian social organization The Russian Society of Appraisers;
- SSO ROO 1-03-2010. Types of property;
- SSO ROO 2-01-2010. Market value as the basis of valuation;
- SSO ROO 2-02-2010. Compilation of valuation report;
- SSO ROO 2-03-2010. Assessment for financial statement;
- SSO ROO 2-04-2010. Assessment for mortgage finance;
- SSO ROO 2-05-2010. Assessment of immovable property;
- SSO ROO 2-06-2010. Assessment of leasehold interests [rights];
- SSO ROO 2-07-2010. Assessment of plants, machines and equipment;
- ROO 2-08-2010. Assessment of intangible assets;
- SSO ROO 2-09-2010. Assessment of personal estate;

- SSO ROO 2-10-2010. Assessment of business;
- SSO ROO 1-11-2010. Assessment involving dangerous and toxic matter;
- SSO ROO 2-12-2010. Cost principle to financial reporting;
- SSO ROO 2-13-2010. Analysis of discounted cash flow (DCF) for market-based assessment and investment analysis;
- SSO ROO 2-14-2010. Assessment of agricultural assets;
- SSO ROO 2-15-2010. Examination (editing) of valuation;
- SSO ROO 2-16-2010. Assessment of commerce-related assets;
- SSO ROO 2-17-2010. Routine assessment for property taxation;
- SSO ROO 2-18-2010. Assessment of assets in extractive sectors;
- SSO ROO 3-19-2010. Assessment of assets of historical value.

International valuation standards:

- International Valuation Standards (IVS) 2011, International Valuation Standards 2011.

1.8 List of used information

1.8.1 List of information provided by the Customer

1. Copy of passport of Yunitskiy Anatoly Eduardovitch (the Customer) number 45 10 472646, date of issue March 30, 2010;
2. Copy of Certificate of registration in tax authorities of a physical person at place of residence in the Russian Federation of Yunitskiy Anatoly Eduardovitch (the Customer);
3. Information provided by the customer: background, quantitative and qualitative characteristics, competitive advantages and effectiveness of the "String-and-rail Transportation System of Engineer Yunitskiy" (20 pages);
4. Information provided by the customer: Data on capital investments for development and construction of the "String-and-rail Transportation System of Engineer Yunitskiy", "Schedule of development and construction of the "String-and-rail Transportation System of Engineer Yunitskiy", standard 1000 km section (5 pages);
5. A. E. Yunitskiy – YUNITSKIY TRANSPORT SYSTEM (variants) and method of construction of the transportation system. Eurasian patent No. 006359, cl. B 61 B 3/00, 2004. (copy);
6. A. E. Yunitskiy – YUNITSKIY TRANSPORT SYSTEM (variants) and method of construction of the transportation system. Eurasian patent No. 006112, cl. B 61 B 3/00, 2004. (copy);
7. A. E. Yunitskiy – YUNITSKIY TRANSPORT SYSTEM (variants) and the method of construction of the transportation system. Eurasian patent No. 004917, cl. E 01 B 25/00, 2002. (copy);
8. A. E. Yunitskiy – YUNITSKIY TRANSPORT SYSTEM (variants) and the method of construction of the transportation system. Patent of the Russian Federation No. 2224064, cl. E 01 B 26/00, 2002. (copy);

9. A. E. Yunitskiy – YUNITSKIY TRANSPORT SYSTEM (variants) and the method of construction of the transportation system. Patent of the Russian Federation No. 2220249, cl. E 01 B 26/00, 2002. (copy);
10. Report on the innovative transportation technology "Yunitskiy String Transportation" / the Institute of Transportation Problems Named after N. S. Solomenko of the Russian Academy of Sciences. – S-Petersburg, October 5th, 2009 – 13 pages. (copy).

All the above listed documents are originals or copies certified by the Customer on every page.

There are no reports of special examinations of the assessed object. Copies of documents provided by the Customer are enclosed in section "Addendum 3. Copies of documents provided by the Customer" of this Report.

1.8.2 Reference list

1. U. B. Leontiev "Method of professional assessment of intellectual property and nontangible assets" Moscow, 2005;
2. Procedural recommendations on assessment of market value of intellectual property / MIO RF. M., 2002;

   Procedural recommendations on assessment of market value of nontangible assets of enterprises / TPP RF. M., 2003;
3. Procedural recommendations on assessment of market value of intellectual property, approved by the Ministry of Property relations of the Russian Federation on 26.11.2002, No. SK-4/21297;
4. Shannon P. Pratt. Business valuation. Analysis and assessment of closed companies. Translation: Economic Development Institute of the World Bank under the editorship of Lavrentiev V. N., PhD in Economics, second edition;
5. Valuation of business. Course book. Gryaznova A. G., Fedotova M. A., Lenskaya S. A., M: "Finance and statistics," 2000;
6. Coupland T., Koller T., Murrin D. Company value: assessment and management / Translation - M.: "Olymp-Busines" CJSC, 1999;
7. B. B. Leontiev, H. A. Mamadjanov "Fundamentals of intellectual property assessment in Russia" – INIC of Rospatent, Moscow, 2006;
8. Kozyrev A. N. Assessment of intellectual property. M, RIC GSH VS RF, 2003;
9. Azgaldov G. G., Karpova N. N. Valuation of intellectual property and nontangible assets: Study guide - M.: International Assessment and Consulting Academy, 2006.

1.8.3 Other sources of information in the Internet

1. Studies of Ministry of Economic Development and Trade of the Russian Federation, /www.economy.gov.ru/;
2. Studies of the Center for Macroeconomic Analysis and Short-term Forecasting, /www.forecast.ru/;
3. Information of the Central Bank of the Russian Federation /www.cbr.ru/.

Throughout the report there are references to other sources of information used in the study and not listed in this section, they are also listed in Addendum 2 of the Report "Information from Internet used in the report".

1.9 General terms and definitions used in the Report

1.9.1 General terms and definitions used in the Report

This Report includes terms and definitions that conform to general terms and definitions of mandatory use.

Report:	a document compiled in compliance with legislation of the Russian Federation regulating assessment activities, federal assessment activities standards, standards and regulations of a self-governed appraisers' organization, which the reporting appraiser is a member of, the report is intended for the customer of the assessment and other stakeholders (users of the assessment report) and contains the appraiser's opinion on the value of the assessed object confirmed by the obtained information and estimations.
Assessed object:	objects of civil rights deemed by the legislation of the Russian Federation liable for civil transactions.
Assessment date:	the date at which the value of the assessed object is determined.
Ownership right:	the right to own, use and dispose of owned property at discretion, transfer the authority to other person, use of the property as a security or encumber it otherwise, to transfer ownership or management rights in the property to other person, and to perform any actions with the property not contradicting the law. The right of ownership is the ability to own the property. The right of use is the ability to use the property. The right of disposal is the ability to determine legal future of the property (alienate in any form, destroy, etc.).
The owner:	a physical or a legal person having legal ownership right.
Price:	a sum of money offered, inquired or paid for the assessed object by parties of a completed or planned transaction.
Value:	estimated quantity of the price of the assessed object determined on the assessment date in accordance with the selected type of value.
Market value:	a most possible price at which the assessed object may be alienated on the assessment date on competitive commercial market with parties of the transaction acting reasonably basing on all the required information, the transaction price is not affected by any extraordinary circumstances, in other words, when: w One of the parties of the transaction is not obliged to alienate the assessed object and the other party is not obliged to accept the transaction w The parties of the transaction are well informed about the object of the transaction and act in their best interests w The assessed object is offered to the commercial market by a public offer typical for similar assessed objects w The price of the transaction is a reasonable reward for the assessed object and there is no pressure to complete the transaction by any party w The payment for the assessed object is expressed in monetary form.
Value of the assessed object:	an estimated measure of price of the assessed object determined on assessment date in accordance with the selected type of value.
Final value of the assessed ob-	is determined by estimation of the value of the assessed object with the use of assessment principles and adjustment (generalization) of the results ob-

ject:	tained by application of various assessment principles, substantiated by the appraiser.
Assessment process:	a sequence of procedures used to achieve an assessment of value. The assessment process usually results in an assessment report granting evidential effect to the assessment of value.
Assessment principle:	a set of assessment methods, united by a common methodology.
Assessment method:	a sequence of procedures allowing to assess the value of the object within an assessment principle basing on information substantial to this method.
Cost principle:	a set of methods of assessment of an assessed object based on estimation of costs necessary for reestablishment or replacement of the assessed object with regard to deterioration and obsolescence.
Comparative principle:	a set of methods of assessment of an assessed object based on comparison of the assessed object with similar objects that have information on their transactions.
Income principle:	a set of methods of assessment of an assessed object based on estimation of perspective revenue of the assessed object.
Intellectual property:	the right in the result of intellectual activities or methods of individualization enshrined by law.
Author of the result of intellectual activities:	a citizen that created such result by means of creative labour.
Patent:	a title of protection certifying the exclusive right, authorship and priority of an invention, a useful model or a design. Term of validity of a patent depends of patent and may last 10 to 25years. A patent is issued by a state intellectual property executive authority, in the Russian Federation this authority is Federal Service for Intellectual Property, Patents and Trademarks Rospatent.
Trade secret:	confidentiality of information that allows its owner in current or possible conditions to increase income, avoid unreasonable risks, maintain its status in the commodities, works and services market, or gain other commercial advantage.
Classified information:	Scientific, technical, technological, production, financial, economic or other information, including production secrets ("know-how"), having actual or potential commercial value due to being unknown to third persons that have no free legal access to it, and constituting a trade secret.
License agreement:	under a license agreement one party – the owner of exclusive rights on the result of intellectual activities or in methods of individualization (licensor) – grants or undertakes to grant to the other party (licensee) the right to use such result or such means within limits determined by the agreement.
Exclusive right in production secret ("know-how"):	the right of the rights owner to allow or forbid, at discretion, the use of the result of intellectual activities, including production secret ("know-how"), to other persons. The absence of prohibition is considered as consent (permission).
Ordinary nonexclusive license:	a license agreement granting to the licensee the right to use a result of intellectual activities or methods of individualization while maintaining the licensor's right to grant licenses to other persons.
Exclusive li-	a license agreement granting to the licensee the right to use a result of intel-

cense:	lectual activities or methods of individualization without maintaining the licensor's right to issue licenses to other persons.
Royalty:	author's fee, periodic payments payable to holder of author's rights for every publication, public reproduction or other use of the work. It is a compensation for use of a patent, author's right and other types of intellectual property, paid as a percent of the sold goods and services that use patents, author's rights, etc. for their production. In practice the amount of author's fee is set in the form of fixed fees paid by licensee over agreed periods of time within the term of validity of license agreement. The amount of author's fee is set as a percent of the value of net sales of the licensed products, its prime costs, gross profit, or is determined per unit of produced goods. The most common method is calculation of author's fee as a percent of value of products.

Источник: Нормативные документы, представленные в п. 1.7 Отчёта; "Гражданский кодекс Российской Федерации (часть четвёртая)" от December 18, 2006 N 230-ФЗ (rev. of 08.12.2011).

1.9.2 Legislative regulations relating to the assessment object

Excerpts from Civil Code of the Russian Federation (part four) dated December 18, 2006 No. 230-FZ:

Article 1225. Protected results of intellectual activity and methods of individualization

1. The following are results of intellectual activity and methods of individualization equated to them, of legal persons, goods, works, services and enterprises that are provide with legal protection (intellectual property): 1) works of science, literature and art; 2) programs for electronic computers (programs for computers); 3) databases; 4) performances; 5) phonograms; 6) transmission to air or by cable of radio or television broadcasts (broadcasting of air or cable broadcasting organizations); 7) inventions; 8) useful models; 9) industrial samples; 10) selective achievements; 11) integrated circuit topologies; 12) trade secrets (know-how); 13) firm names; 14) trademarks and service marks; 15) names of places of goods' origin; 16) commercial designations.

2. Intellectual property is protected by law.

Article 1226. Intellectual rights

The intellectual rights that include exclusive right, being ownership right, and in cases, provided by the present Code, also personal non-ownership rights and other rights (right of sequence, right of access, etc.) are considered to be the results of intellectual activity and methods of individualization equated to them (results of intellectual activity and methods of individualization).

Article 1227. Intellectual rights and right of ownership

1. Intellectual rights do not depend on the right of ownership to tangible object (item) in which the corresponding result of intellectual activity or method of individualization are expressed.

2. The transfer of ownership right in the item does not result in transferring or granting intellectual rights to the result of intellectual activity or method of individualization, expressed in the item, except for the case, provided by item 2, Article 1291 of the present Code.

Article 1228. Author of the result of intellectual activity

1. The citizen, by whose creative labour such result is created, is considered the author of the result of intellectual activity.

The citizens who have not made personal creative contribution in creating such result, in particular rendered its author only technical, advisory, organizational or financial assistance or help or

only assisted to register rights to such result or its use, as well as citizens, exercising control for executing corresponding work, are not considered authors of the result of intellectual activity.

2. The right of authorship belongs to the author of the result of intellectual activity, and in cases, provided by the present Code, right to name and other personal non-ownership rights.

The right of authorship, right to name and other personal non-ownership rights of the author are inalienable and non-transferable. The rejection of these rights is null.

The authorship and author's name are protected by law. After the author's death any interested person can protect his authorship, except for the cases, provided by item 2, Article 1267 and item 2, Article 1316 of the present Code.

3. The exclusive right to the result of intellectual activity created by creative labour initially arises with its author. This right can be transferred by the author to the other person according to the agreement; it can also be transferred to other persons on other grounds, established by law.

Article 1345. Patent rights

1. The intellectual rights to inventions, useful models and industrial samples are patent rights.

2. The following rights belong to the author of invention, useful model or industrial sample.

1) exclusive right;

2) authorship's right.

3. In the cases, provided by the present Code, other rights also belong to the author of invention, useful model or industrial sample, including the right to obtain patent, right to reward for using official invention, useful model or industrial sample.

Article 1349. Objects of patent rights

1. Objects of patent rights are results of intellectual property in scientific technical sphere, meeting the requirements, established by the present Code, to inventions and useful models, and results of intellectual property in the sphere of industrial design, meeting the requirements, established by the present Code, to industrial samples.

4. The following cannot be objects of patent rights:

1) methods of cloning person;

2) methods of modifying genetic integrity of cells of human germ line;

3) use of human embryos in industrial and commercial purposes;

4) other decisions, conflicting with public interests, principles of humanity and morality.

Article 1465. Trade secret (know-how)

Data of any character (industrial, technical, economic, organizational, etc.), in particular on results of intellectual activity in scientific-research sphere, as well as data on methods of exercising professional activity that have valid or potential commercial value by virtue of their uncertainty to third persons to which the third persons have no free access on legal ground and in which respect the regime of commercial secret is introduced by the holder of such data are considered trade secret (know-how).

Article 1466. Exclusive right to trade secret

1. The exclusive right of using trade secret belongs to its holder in accordance with article 1229 of the present Code by any way not conflicting with law (exclusive right to trade secret), in particular in producing articles and realizing economic and organizational decisions. The holder of trade secret can dispose of the mentioned exclusive right.

2. The person, being conscientiously and irrespective of other holders of trade secret the holder of data, constituting the essence of protected trade secret, acquires independent exclusive right to this trade secret.

Article 1467. Validity of exclusive right to trade secret

The exclusive right to trade secret is valid until there is confidentiality of data, constituting its essence. All right holders forfeit the exclusive right to trade secret since the loss of confidentiality of the respective data.

Source of information: Art. 69, "Civil Code of the Russian Federation (part four)"dated December 18, 2006 No. 230-FZ (rev. of 08.12.2011).

2 DESCRIPTION OF THE ASSESSMENT OBJECT

The Appraiser performed neither legal examination of ownership rights for the assessed object nor technical examination of the documents on the assessed object provided by the Customer. Description of main characteristics of the assessed object is compiled on the basis of summarizing of data and documents, provided by the Customer (they are listed in section "Addendum 3. Copies of documents provided by the Customer" of this Report).

2.1 Information on ownership rights and encumbrances of the assessed object

Table 2-1 Information on ownership rights and encumbrances

Characteristic	Value
Assessment object	Exclusive intellectual property and know-how rights on the "String-and-rail Transportation System of Engineer Yunitskiy"
Type of assessed right	Ownership
Object of law	Citizen of the Russian Federation Yunitskiy Anatoly Eduardovitch Date of birth: April 16, 1949 Passport _____, issued _____ by _____ Moscow, (department code _____) Registered address: Moscow, _____. INN 772577968329 dated February 10, 2006
Existing limitations and encumbrances of right	Not found/not registered
Original/depreciated balance cost of the assessed object	The assessed object is owned by a physical person, this concept is not applicable

Source of information: Paid Services Agreement No. O-905 dated May 14, 2013

2.2 The essence of the assessed object

The assessed object is the exclusive intellectual property and know-how rights on the "String-and-rail Transportation System of Engineer Yunitskiy".

The assessed object is a complex object embodying the results of 35 years of intellectual, scientific and experimental activities of engineer Yunitskiy, certified by 99 industrial patents, a variety of research papers (over 100) and monographs (18), popular scientific articles (over 200), technical, technological, design and engineering know-hows (over 100) and other results of intellectual activity of the author and the owner of this intellectual property.

Legally the assessed object is intellectual rights in the results of intellectual activity and methods of individualization equated to them (results of intellectual activity and methods of individualization) including exclusive rights which is an ownership right.

Based on Civil Code of the Russian Federation the String-and-rail Transportation System of engineer Yunitskiy is, in its turn, classified as a "structure" in the category of immovable property.

Article 130. The Movables and the Immovables

1. To the immovables (the immovable property, realty) shall be referred land plots, land plots with mineral deposits, ***and everything else, which is closely connected with the land, i.e., such objects that cannot be moved with-***

***out causing an over-proportionate damage to their purpose**, including buildings, structures, and assets in construction.*

(in rev. of Federal Laws dated December 30, 2004 No. 213-FZ, dated June 03, 2006 No 73-FZ, dated December 04, 2006 No. 201-FZ)

art. 130, "Civil Code of the Russian Federation (part one)" dated November 30, 1994 No. 51-FZ (rev. of February 11, 2013) {KonsultantPlus}.

Source of information: information provided by the Customer, Civil Code of the Russian Federation (part one) dated December 18, 2006 No. 230-FZ.

2.3 Background of creation of the assessed object

The 21st century will be the century of resource saving – energy, raw materials, minerals, space, etc. This has direct relation to transportation and infrastructural projects.

As an example the authorities of China set a course to construction of high-speed railways. Their track panels are set on gravel cushion over earth embankment, since overhung railways, especially high-speed types, are extremely expensive. Specifically, China built the world's longest high-speed railway "Beijing – Shanghai".

However there are private expert reports dated twenty years earlier in which foreign experts make the following forecasts. If China builds a network of traditional European type high-speed railways their numerous embankments will impair river heads, movement of surface and ground waters, animal migration paths, etc. This will effectively obliterate agriculture of the country and may result in mass starvation comparable in its severity to starvation during the Cultural Revolution when steel casting furnaces were constructed in every village, and when over 10 million people died of hunger.

The same adverse effects may be created by a network of conventional high-speed railroads constructed on any territory, if the rails will pass on embankments. As an example, in 1990s a decree of the President of the Russian Federation banned the construction of the "Moscow – Saint-Petersburg" high-speed railway owing to ecologists, since according to the estimations of environmentalist environmental damage to the country in the result of the project would be commensurable with the aftermath of the Chernobyl Power Plant breakdown.

The most valuable mineral-biological resource is fertile soil which enables growth of the "green lungs" of the planet and cultivation of major portion of our food. The soil's humus developed by the living nature for millions of years should have other use than be covered with earth embankment with sand-and-gravel cushion and railway track panels.

The planet's main transportation communications of the 20 century, rail and motor ways on embankments, by now have destroyed soil by burying it under railway crossties and road pavement on a territory exceeding the total area[4] of such countries as Germany, Great Britain and Portugal.

Nothing growth on this soil, it is dead. On a still greater territory, larger by one to two orders of magnitude movement of ground and surface waters is impaired, since any embankment is a low

[4] *About 100 mln. hectares of the planet's land are appropriated for transportation lines, mainly for rail and motor ways. This land does not breathe; no plants grow there to produce oxygen necessary for breathing of humans and animals. It produces no oxygen also used for combustion (consumed by billions of tons every year) both in internal combustion engines of transport moving along the roads (locomotives, cars, buses, etc.), and in remote thermal electric power stations in case of electrified transport. Territory still larger by several orders of magnitude was degraded by moving hundreds of billions tons of earth, sometimes transported via dirt roads to construction sites for tens of kilometers. Soils immediately adjacent to roadways are constantly, for decades, polluted by carcinogens and mutagenous products of use of these transportation lines: motor vehicles exhaust products, products of tire and pavement wear, deicing salts, transportation wastes, etc.*

dam[5]. This leads to bogging of huge territories and desertification of other similarly vast territories resulting in irreversible destruction of existing natural ecosystems and biogeocenoses, destruction of certain habitats of rare flora and fauna. In agricultural areas this often leads to degradation of productive soils.

According to McKinsey Global Institute (MGI), one of the world's most esteemed expertise organizations, the world enters an era of expensive resources. The 3-billion growth of the middle class by 2030 will boost the demand for resources drastically, while development of new sources of energy, water and food is difficult and very costly (see: http://www. mckinsey.com/mgi).

A report by MGI states that in 20 century the population of the planet grew four times over, and GDP – by 20 times resulting in 2.000% growth of demand in natural resources, whereas commodity exchange prices dropped by half. However this price drop was set back during the last decade, as the authors stress. In their opinion the low-price era is in the past. According to a forecast of MGI from 2010 till 2030 the world's middle class (that is, those capable of spending $50-100 daily, with regard to purchasing power parity) will grow by 3 billion from todays 1.8 billion. The demand will surge just at the time when development of new resource sources is difficult, and we fill face the "resource revolution".

According to MGI, lack or price growth of one of the resources may spread into the others. For example, climate warming may call for more water for irrigation, thus reducing volume of electricity generated by hydroelectric power plants. And the rise of the World ocean due to the climate warming will cause flooding of large territories and damage of agriculture and infrastructure, including land-based (i.e. "first level") transportation.

The authors note that efforts to meet the growing demand by proportionate growth of production will require up to $3 trillion of additional investments annually, which is at least $1 trillion more than the world invested in the accounted past, and will bear serious risks. Drinking water consumption by 2030 will increase by 30% and its deficit in arid countries will aggravate. Half of new copper deposits are located in countries with high political risks, and over 80% of unused arable lands are situated in countries with underdeveloped infrastructure or severe political problems. It should be noted that increase of investment will be necessary just in the time when money will be difficult to earn and expensive, experts estimate additional costs of money attraction as $400 – 500 billion per year.

Should the production not just be expanded but its effectiveness also enhanced, up to $3 trillion (in current prices) may be saved. If subsidies and other preferences of the energy sector, transportation, agriculture, are removed the total saving will amount to about $4 trillion per year.

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[5] The high-speed railways require that not only embankment earth but also underlying ground (totaling over 10,000 m^3/km) be compacted by about 10%, otherwise safety of movement will be undermined due to low stiffness of the base. This turns earth embankment of such roadways into a low dam which impairs movement of ground and surface waters, including flood waters. This, in turn, leads to bogging of large areas on one side of the embankment and desertification of areas as large on the other side. Besides such roadways require, at least for safety reasons, double-sided fencing since an elk, a cow, or a wild boar standing on the roadway may result in crash and derailment of a high-speed train. Thus the embankment complemented with the high-speed railway fence makes an impassable obstacle for wild animal migration across railway and similarly for travel of domestic animals, humans and agricultural machines. Sometimes it results in destruction of habitats of rare plants and animals. Furthermore the numerous traffic accidents and disasters are very much due to the fact that motor and railways pass on the ground level, i.e. on the "first level", just where all the nature, including humans, is situated. Yearly more than a million people and a billion animals (especially small ones) die on the roads of the planet, every year over 10 million people are disabled. The accident rate grows over years and in 100 next years this will result in loss of life for over 100 million people and more than 1 billion will be disabled. (For comparison: accident rate in aviation which operates high above the ground level is about thousand times lower annually, much less than one thousand people die in air disasters).

However one can hardly rely on the increase of effectiveness of resource use alone. Though it will allow saving 20 QBTU (Quadrillion British Thermal Units), it will not abate the demand of additional 400 QBTU due to oil, gas and coal reserves depletion. Enhancement of effectiveness will require additional capital investments estimated by McKinsey at almost $1 trillion per year.

The main consumer of the majority of resources today is the world's transport and infrastructure complex (motor and railways with motor transport, trains and infrastructure; aviation and its aircrafts, airports, and infrastructure; sea transport with vessels, ports, infrastructure, etc.).

That is why the world's future overpass-based transportation and infrastructure railway complex (since embankment-based roadways should, considering the aforesaid, be prohibited by law as extremely dangerous to the nature and people), must satisfy the following mutually exclusive criteria:

a. Construction resource demand must be cut by an order of magnitude as compared to railways and motorways, with consideration not only to conventional mineral resources – steel, reinforced concrete, but also to other no less important resources – ground safety exclusion areas, volume of excluded arable soil, of used earth, construction sand, gravel, and besides that – the fuel burned not just by the engines of construction machines during construction works, but also considering its previous consumption for extraction of mineral resources, their transportation and processing into structural materials and structures for both the roadway and infrastructure transportation objects, etc.;
b. The cost of the complex must be much less than the cost of the known overhung transportation systems – monorail, transportation systems with magnetic suspension of carriages, standard high-speed railway trestles, bridges, overpasses, and trestles of the conventional railway;
c. The railway transportation complex including its infrastructure shall be located only on the "second level" with minimal land exclusion and minimal intrusion into the natural environments.

In this case the resources – mineral, energy, and other, including financial resources, will be enough for the humankind not only to re-equip/converse to other standards of development of a conceptually new "second level" communications, but also to operate this network for the following centuries.

Railways shall over time be deployed over the ground surface on lightweight laced supports, and the land occupied by today's roadways shall be re-cultivated and returned to the land user. The road structure of the "second level" shall also comprise communication lines and power lines, and its support and structure shall integrate sun and wind electric plants. This will allow developing a conceptually new network, not as much transportational as communicational for transporting passengers and freights, and besides – electrical energy and electronic information.

Railways located at the "second level" will bring double economy.

Firstly, the freight routes of the "second level" will provide access to presently unavailable mineral resources, located for example in mountains, tundra, at the Arctic Ocean shelf, deep in vast deserts, deep within a continent, for example in Australia, etc. These mineral resources will allow the world's economy to continue to develop dynamically, but to develop within the logic of maximum saving of resources, and not in the unlimited growth of consumption, as it was before.

Secondly, the high-speed freight-and-passenger roadways of the "second level" will allow developing a distributed worldwide network of ecologically safe transportation communications, integrated with information and energy communications, cheaper and with less expense of mineral and energy resources.

Upon that within the 21st century practically all of transportation of the planet shall pass to the "second level", leaving the "first level" to the nature and people. This will allow increasing communicativeness of the Earth's civilization, according to UNO the demand of the people to travel shall multiply 3 to 5 times within the next 50 years, with considerable increase in speed and distance of these travels.

The basis of the proposed railway infrastructure complex is an improved railway trestle – a transportation system of the "second level" with pre-strained string-and-rail track structure. It uses conventional railway rails, on which traditional freight, passenger and high-speed trains may travel.

Total length of the world's railway network reached its peak in mid-20 century – 1.3 mln. km. Presently the length of this network totals 1.1 mln. km. and starts to expand again due to construction of high-speed railways. The three countries with the longest railroad networks (including service and special freight railroads): the USA – 230 thous. km, Russia – 149 thous. km, China – 119 thous. Km.

Like in the 20 century railway has passed from steam locomotion to diesel and electric locomotion, in the 21st century it shall, due to the above reasons, pass from ground level placement onto the "second level" – the trestle.

Newly constructed roadways, all of which will be high-speed roadways, shall initially be performed on the "second level", but this does not happen because of one reason – it is very expensive. Under current conditions railway trestle with infrastructure costs minimum $100 mln./km, or for networks with length of 1 mln. km – $100 trillion, which will amount 150% of the present world's GDP. Also, this construction will require enormous, even limitless quantity of construction and structural and structural materials – about 100 thousand tons of steel and reinforced concrete for one 1 km of length of a two-track road, or for a 1 mln. km. network – 100 billion tons, which will be beyond the capabilities of the world's industry not only due to resource, but also to economic and ecological reasons.

If the cost of a trestle, most of all a high-speed one, could be reduced by at least 5 times, than such construction would be in the humanity's capacity, since it would cost $20 trillion, which would amount to no less than 30% of the world's GDP.

In the end of the 19th century (1880 – 1890) the rate of construction of railroads reached its historical peak of 20 thousand kilometers per year (for comparison: construction of hard-paved motor ways, also very costly in resources and costs, reached its historical peak of 200 thous.km/year in the 20 century).

Instead of construction of new high-speed railways a conservative course of the railway complex development is possible – by investments in reconstruction of the existing road network with the aim of increasing average train travel speed. Reinforcement of the existing upper section of railway may provide conditions for train travel at speeds of 140 to 200 km/h. This practice is widely used in France, Germany, China and Russia.

For instance, in 2007 JSCo "RZD" (Russian Railroads) repaired 12 thous. km. of railway tracks, spending 73.5 bln. rub. In the case cost of repair of 1 km. of the railway amounted to 6.125 mln. rub. The repair works allowed to increase average speed of passenger trains by 0,8 km/h – from 88.3 km/h to 89,1 km/h (http://www.kommersant.ru/doc/831539/print).

In order to increase speed on RZD railroads at least up to the speeds supported by the "Sapsan" trains purchased in Germany (250 km/h), the reconstruction will need investment of 1.23 bln. rub./km, or $40 mln./km. And increase of the speed to 450 km/h RZD will require over 400 years; in this case reconstruction expenses for every kilometer of the existing railways will exceed $100 mln.

That is why construction of an innovative transportation infrastructure on the "second level," based on string-and-rail technologies of engineer Yunitskiy, will be more advisable and rational, since it will be cheaper by an order of magnitude and faster by an order of magnitude.

High-speed roadways are quite competitive with aviation. Furthermore, air lines need to be unburdened. High-speed roadways will allow reducing air traffic of metropolises' airports thus opening additional possibilities for international air traffic.

Any high-speed road is an object of advanced technology. Not only maintenance and auxiliary services need to be integrated into it, it is also necessary to develop infrastructure, develop new cities, launch new energy facilities and other objects. This will mean millions of workplaces which will be an asset in today's time of crisis. Furthermore, a network of cost-effective high-speed roads will boost economic and social development of regions, including the depressed ones. The concept of "remote regions" will change drastically. Their residents will be able to travel 300 – 400 km to work.

When one speaks of high-speed roads, we think of the economics first: when will the spent money return and when the money will give profit. The string-and-rail trestle is the only self-repaying type of high-speed roadways both due to low capital investments for construction and to low operation costs and a longer service life. Yet projects of high social importance must not be judged from the viewpoint of immediate benefit. There are different benefits. The main significance of the high-speed roads is political, since a country with such roads is an unambiguous developed country. Their social significance is no less important, since they elevate the level of development of human capital.

Source of information: Information provided by the Customer

2.4 Quantitative and qualitative characteristics of the assessed object

String-and-rail transportation system design of engineer Yunitskiy is a transportation system of the "second level" with pre-strained string-and-rail track structure. It uses conventional railway rails, on which traditional freight, passenger and high-speed trains may travel.

The string-and-rail transport system of engineer Yunitskiy, located over the ground level on the "second level" has low material intensity and consequently low demand for mineral resources for its construction: steel and steel structures, nonferrous metals, reinforced concrete, concrete, cement, steel reinforcement, gravel, sand, earth, etc.[6]

The above said applies equally to the type of string-and-rail roads that uses conventional railway rails as the track structure for travel of both low- and high-speed conventional railway rolling stock.

Furthermore, due to continuous design of string-and-rail way (it has no deformation seams or seams of other types on its whole length thanks to being welded into one string, including railway rail), the bearing capacity of the carrying supports is increased by an order of magnitude. And since these structures constitute the major part of a "second level" road (for one anchor support there are 100 intermediate supports) material intensity and cost of the supports is halved[7].

[6] *A. E. Yunitskiy Optimization of surface transportation system. International magazine "Problems of Mechanical Engineering and Automation" – M.: IMASH, MosgorCNTI, 2005, No. 4, pp.. 45 – 50.*

[7] *A. E. Yunitskiy String transportation systems: on Earth and in space. – Gomel: Infotribo, 1995. – 337 p.: gr.; A. E. Yunitskiy Transport System Yunitskiy (TSU) in questions and answers. 100 questions – 100 answers / Monograph. Eighth edition, revised and enlarged, – Moscow, May 25th, 2012 – 80 p.: gr.*

For a string-and-rail railway type trestle it is most advisable to use a track structure, protected by industrial patents[8] – they provide for the track structure in the form of a spatial structure, in particular, in the form of a string trestle without the use of conventional crossties and gravel-and-sand cushion. This track structure, while having a low material intensity (steel intensity), will provide nevertheless a high static and dynamic evenness and stiffness of the trestle structures under the effect of the assumed mobile load of railway trains.

In order to ensure comfortable travel of high-speed means vehicles, including high-speed trains, unevenness of the way, with regard to deformability of the trestle must be very low: no more than 8 mm for a 30 m span for the speed of 100 m/sec (360 km/h), or in relative values – no more than 1/3.750; no more than 9 mm for the speed of 125 m/sec (450 km/h) for a 40 m span, or in relative values – no more than 1/4.440.

Characteristics of the proposed high-speed pre-strained string-and-rail trestle (SRT) for travel of high-speed trains on conventional (serially produced) railway rails:

- span length – 40 m;

- intermediary supports (a separate support for each way): vertical load on the support – up to 400 tons, that is 10 times less than in a competitive conventional high-speed trestle. Support foundation – two injection piles with diameter of 60 cm and length of up to 18 m. Weight of the support including the weight of the foundation – up to 80 tons;

- one massive anchor supports placed, depending on the relief, every 3 – 5 km. Weight of this support (made mainly of reinforced concrete) – up to 2,000 tons, or up to 500 t/km;

- two-way span structure: string trusses with height of 3 m, housing in their booms strings (tension reinforcement), pre-strained to total load of up to 1,200 tons. On the upper booms of the trusses standard rails for high-speed travel are located, on which wheel-sets of trains travel. Empty spaces between strings and walls of rectangular steel tubes of booms of the trusses are filled with special concrete. Material demand for 1 kilometer of stretch of a two-way truss-and-string rail track structure (without rails) is: steel – up to 1,250 tons, including finished steel (rectangular tubes) – up to 1,150 tons, strings (high-tensile steel wire) – up to 100 tons; concrete – up to 2,200 tons (approximately up to 0,9 m^3/m).

Accordingly, one kilometer of length of the proposed high-speed railway SRT will require, including supports, up to 6,000 thousand tons of structural materials – steel and reinforced concrete, including up to 1,500 t/km of steel. The weight of 4 R65 rails must be added to this – 260 t/km.

The string-and-rail trestles designed by engineer Yunitskiy encompass tens of structural, technological and other know-hows, allowing material intensity and cost of the "second level" railroads.

The know-hows may not be published since their value and the value of the business developed on their basis will in this case be nullified. However it is possible and quite reasonable to describe their essence without divulging the know-hows themselves. It should be noted that these know-hows are in their engineering substance are quite simple solutions. As they work jointly they create a synergy effect. The know-hows may be grouped in separate systems.

[8] *A. E. Yunitskiy Transport System Yunitskiy (variants) and method of construction of the transportation system. Eurasian patent No. 006359, cl. B 61 B 3/00, 2004.; A. E. Yunitskiy Transport System Yunitskiy (variants) and method of construction of the transportation system. Eurasian patent No. 006112, cl. B 61 B 3/00, 2004.; A. E. Yunitskiy Transport System Yunitskiy (variants) and method of construction of the transportation system. Eurasian patent No. 004917, cl. E 01 B 25/00, 2002.; A. E. Yunitskiy Transport System Yunitskiy (variants) and the method of construction of the transportation system. Patent of the Russian Federation No. 2224064, cl. E 01 B 26/00, 2002.; A. E. Yunitskiy Transport System Yunitskiy (variants) and the method of construction of the transportation system. Patent of the Russian Federation No. 2220249, cl. E 01 B 26/00, 2002.*

First, one of the reasons of the high material intensity of conventional railroad trestles is that they consist of separate beams, separated lengthwise by expansion (temperature) seams. There is no other way to construct these trestles due to the large cross-section of the span structures. Under temperature variations this would create extreme longitudinal temperature strains which would be unbearable by the structure of the trestle. For example if the high-speed railway trestle described above, similar to the one built at Taiwan Island, would be continuous, than under temperature variations within 100 °C (environmental conditions of Russia make possible temperature variations of up to 120 °C) longitudinal temperature strains could reach 200 thousand tons.

Expansion seam in a trestle with other conditions being equal would result in increase of the trestle material intensity by 2 times, and that of the supports – by 16 times (including 8 times increase due to alteration of loading pattern of the support, since under compressive strain it would become cantilevered, with an unfixed top, and 2 times due to the increase of weight load from heavier span structures).

Besides, the temperature seam undergoes a dynamic impact from wheel-sets, since they are the point of bend of a high-speed train travel trajectory. Together with other disadvantages of such transversal gaps in the structure this makes the expansion seam the weakest and the most problematic location of the modern trestles.

The String-and-rail Trestle (SRT) has no expansion seams, providing all the ensuing advantages.

Second, notwithstanding the fact that steel structures have a number of advantages over the ones made of reinforced concrete, Japanese trestle designers still use reinforced concrete. This has an explanation. During the development of the high-speed Shinkansen railway network in Japan 30 – 40 years ago initially steel trestles were constructed. However after numerous complaints from townships surrounding the high-speed railways about powerful high-frequency noise, construction of steel trestles was legally banned. None of the tested measures used to abate the noise generated by steel structures, including covering them with rubber and polyurethane revealed positive results.

The SRT solves this problem by effective and simple methods that Japanese trestle developers never proposed or tried.

Third, due to the continuous type of the trestle (in other words it is "endless"), braking forces of a train which may in some cases total hundreds of tons, are transferred not to the intermediate supports (they do not participate in distribution of longitudinal horizontal stress), but to the anchor supports. Thus only one of 100 supports is under horizontal breaking stress, whereas in a competitive trestle due to the presence of the deformation seams this stress shall be borne by every support. This results in additional increase of material intensity and cost of conventional railroad trestles. It should be noted that the continuous structure of the proposed SRT trestle results in decrease of breaking power transferred to the anchor support since this force will be spread to 2 supports simultaneously, both to the one situated in the front, and in the back.

Fourth, a continuous statically indeterminate and pre-strained truss-and-string trestle required new solutions for all of its structural elements and construction techniques, from the booms and diagonal ties of trusses, to supports and their foundations, besides the need to reinforce truss booms by pre-strained strings. All these solutions have been created. The main development criteria are the following: the trestle must be durable under the heaviest load, have a long operation time (of no less than 100 years), stable under cyclical stress (strained elements and welded seams especially) – no less than 100 mln. strain cycles, quiet, designed for temperature variations (with a 1 in 100 years possibility) of 120 °C and hurricane wind with speed of over 250 km/h (storm, tornado), and be resistant to Richter scale grade 9 earthquakes.

Fifth, the crossties of the conventional railway track make it a heavily loaded beam resting on discrete supports (crossties) working in high-frequency bending during passing of each wheel the

movement (rolling) speed of which may exceed 10 m/sec. This places extraordinary requirements for both strength of high-alloy grade steel of the rails, and for the geometry and structure of the rail itself and its resting on the crosstie. Nevertheless this does not rule out breaking of the rails resulting in crashes and disasters, and derailing of trains from the track structure which is especially dangerous in high-speed travel.

In the proposed string-and-rail trestle traditional crossties are not used and each rail rests on one of the "endless" continuous (having no cross seams) longitudinal "crosstie". That is why it practically does not suffer bending stresses and prevents ensuing breaks since the rail will work as a beam resting not on supports, but on a continuous elastic base. That is why the SRT may use much lighter rails (for instance, instead of R75 rails R50 rails may be used), nevertheless these rails will be more reliable and long-lasting elements of the rail track structure.

Sixth, concrete in the SRT is encased in steel tubes and does not contact with the ambient air. One of the main known disadvantages of concrete is that it practically does not work in tension (that is why steel reinforcement is needed) and it cracks in tensioned areas. Through the cracks ambient moisture permeates to the steel reinforcement resulting in its corrosion damage. In time it may result in collapse of a reinforced concrete structure.

Cracking of concrete in the so-called steel-confined concrete poses no danger to the structure since the pre-strained reinforcement (strings) are effectively protected from external environmental and mechanical effects not only by concrete but also by the continuous walls of steel tubes, within which the concrete and the strings are situated. Furthermore, encased concrete increases its carrying capacity by 2 to 3 times which will considerably increase the safety factor of the string-and-rail trestle (even oil having no bearing capacity, placed in a standard hydraulic cylinder will endure the pressure of 1,00 atmospheres due to the enclosed space).

Seventh, where for low-speed railways the main criterion is strength of the trestle, for high-speed railways it is evenness of track. Unevenness at each span is the results of both construction unevenness and dynamic oscillation of span structures under the weight of a passing high-speed multi-wheel train. At speeds of around 100 m/sec (360 km/h) unevenness of track on 35 – 50 m spans must be within 10 mm.

It is known that welding of steel structures makes them shift and it is virtually impossible to achieve high evenness of span structures. That is why special technique and equipment needed to be developed for welding of string-and-rail truss structures (partially in a shop, partially in the field), so that construction unevenness in a span would not exceed 2 to 3 mm. However, one needs to remember that unevenness is the result not only of steel span structures, but also of supports and foundations of the trestle.

Eighth, exclusion from the track structure of a solid slab working as an aerodynamic shield will reduce aerodynamic resistance of a high-speed train's movement by half and at the same time will considerably reduce aerodynamic noises. This will reduce by about 1.5 times the needed power output of a high-speed train driving gear, that is, the economy of the installed power for one train may amount to 7,000 – 8,000 kW and more (total power output of drive gear of modern and perspective high-speed trains may exceed 20,000 kW).

Ninth, there are other groups of know-hows without which it will be impossible to construct string-and-rail trestles with high quality and at low costs. These are:

(1) the technology of production and special additives to make concrete more flexible and to provide corrosion protection to steel structures contacting it;

(2) the technology and equipment for laying and straining of the strings and their fixing on the support and anchor units;

(3) the technology and equipment for continuous assembly of lengthy and rather heavy steel-reinforced concrete span structures in the field;

(4) designs of the intermediate and anchor supports not only in relation to supporting units for fixing continuous and statically indeterminate span structures, but also in relation to the structure and erection of their body and their foundation;

(5) design and technological solutions for combining the string-and-rail track structure with communication channels (fiber-optic, wire, radio repeating, cellular), with high voltage aerial and cable lines, with wind and solar energy plants and other renewable and alternative power sources;

(6) design and technological solutions for the infrastructure of the "second level" (switches, systems of control of energy supply and communication on the linear (the trestle) section of the railways, etc.);

(7) prospective design and technological solutions for a larger scale (about two times) reduction of material intensity and cost of string-and-rail trestles by improving railway rolling-stock, etc.

The layout of capital investments for development and construction of the "Sting-and-rail Transportation System of Engineer Yunitskiy" on an example of an averaged section with length of 1,000 km, and the schedule of capital investments, are shown on the table and the figure below.

Sources of information: information provided by the Customer

Table 2-2 Capital investments for development and construction of the "Sting-and-rail Transportation System of Engineer Yunitskiy" for an averaged 1,000 km section

Capital expenses (capex)						
Length of route				1,000	km	
Cost of construction and turnkey development, including track structure, supports and infrastructure:						
	per 1 km of track		$13,449,013			
	Total cost per 1,000 km			$13,449,012,500		
Design data						
				1.00		1,000
			per 1 km			per 1,000 km
		minimum	average	maximum	units	average
1. Design development						640,429,167
	Estimation based on the length and total cost of all works at the rate of		5%			
	Total					
Total						
	per 1 km of track		$640,429			$640,429,167
2. Construction of the SRT track						$10,022,333,333
1)	Steel-reinforced concrete string-and-rail track structure					
	Estimation based on cost of 1 ton of installed steel structure	$4,000	$5,000	$6,000		
	Number of string-and-rail structures per 1 kilometer of track (steel)	1,500	1,050	800	tons/km	
	Total					
	per 1 km of		$5,250,000			$5,250,000,000
2)	Intermediate supports					
	Cost of one support	$30,000	$40,000	$50,000		
	Support height	4	7	10	meters	
	Distance between adjacent supports	30	40	50	meters	
	Number of supports for 1 km (x2 for a two-way track)		40		units	
	Total					
	per 1 km of track		$1,600,000			$1,600,000,000
3)	Anchor supports					

Capital expenses (capex)							
		Cost of one anchor support	$400,000	$500,000	$600,000		
		Height of a support	4	7	10	meters	
		Distance between adjacent supports	2,000	3,000	4,000	meters	
		Number of supports for 1 km (x2 for a two-way track)		0,667		units	
	Total						
		per 1 km of track		$333,333			$333,333,333
4)	Increasing factors						$2,801,500,000
		Uneven and difficult terrain		100%		of the track cost	
		In percent of the track length and in kilometers		8%		km	
		Estimated total		$1,149,333			
		Mountainous terrain		150%		of the track cost	
		In percent of the track length and in kilometers		5%		km	
		Estimated total		$897,917			
		Sea regions		250%		of the track cost	
		In percent of the track length and in kilometers		3%		km	
		Estimated total		$754,250			
	Total						
		per 1 km of track		$2,801,500			$2,801,500,000
5)	Land allocation (appropriation) for the track supports						37,500,000
		Estimation is based on standard	200	250	300	sq. m/km	
		Cost of land	$1,000,000	$1,500,000	$2,000,000	ha	
	Total						
		per 1 km of track		$37,500			37,500,000
3.	Infrastructure						2,786,250,000
1)	Stations			3		units	
		Metric area		10,000		sq.m	
		Including commercial section		5,000		sq.m	
		Cost of construction of 1 sq. m	$3,000	$5,000	$5,000	per 1 sq. m	

Capital expenses (capex)						
	Cost of high-speed switch (x2 for two-way track)		$4,000,000			
	per 1 station		$54,000,000			
	Total		162, 000			$162,000,000
2)	Stations					
	Quantity		5		units	
	Metric area		2,000		sq. m	
	Including commercial area		1,000		sq. m	
	Cost of construction per 1 sq. m.	$3,000	$5,000	$4,000	per 1 sq. m	
	Cost of high-speed switch (x2 for two-way track)		$4,000,000			
	Cost of construction per 1 station		$14,000,000			
	Total		$70,000			$70,000,000
3)	Servicing shops					
	Quantity		2		units	
	Metric area		1,000		sq. m	
	Cost of construction per 1 sq. m.	$4,000	$5,000	$6,000	per 1 sq. m	
	per 1 servicing shop		$5,000,000			
	Total		10,000			$10,000,000
4)	Freight terminals					
	Quantity		3		units	
	Metric area		4 000		sq. m	
	Cost of construction per 1 sq. m.	$2,000	$2,500	$3,000	per 1 sq. m	
	per 1 freight terminal		$10 000 000			
	Total		30,000			$30,000,000
5)	Servicing station					
	Quantity		2		units	
	per 1 servicing station		$3,000,000			
	Total		6,000			6,000,000
6)	Land allocation (appropriation) for infrastructure					
	Estimation based on the area of infrastructure with factor	1,5	2,0	2,5		
	Total area		5,50		ha	
	Cost of land	$1,000,000	$1,500,000	$2,000,000		

Capital expenses (capex)					
	Total		8,250		8,250,000
7)	Train driver-based control system				
	per 1 km (controlled with preset data)	$300,000	$350,000	$400,000	
	per 1 km of track		$350,000		
	Total		350,000		350,000,000
8)	Electrification				
	per 1 km	$1,000,000	$1,250,000	$1,500,000	
	Total		1,250,000		1,250,000,000
9)	Automatic control system (without train drivers)				
	per 1 km	$800,000	$900,000	$1,000,000	
	Total		900,000		900,000,000

Sources of information: information provided by the Customer (data shown without VAT)

Figure 2-1 Diagram schedule of development and construction of the "Sting-and-rail Transportation System of Engineer Yunitskiy" for an averaged 1,000 km section

Этапы проекта	Project stages
Начало	Start
Длительность	Duration
Год 1	Year 1
Год 2	Year 2
Год 3	Year 3
Год 4	Year 4
Месяц	Month
Месяцев	Months
Сбор исходно-разрешительной документации на трассу	Collection of basic documents and approvals for the track
Сбор исходно-разрешительной документации	Collection of basic documents and approvals
Предпроектные работы, ТЭО трассы	Front end engineering, Technical and Economic Assessment
Разработка технических условий (ТУ) для путевой структуры	Development of Technical Specifications (TS) for the track structure
Разработка ТУ инфраструктуры	Development of TS for infrastructure
Разработка ТУ на оборудование станций и сервисных центров	Development of TS for station and servicing center equipment
Разработка ТЭО	Development of Technical and Economic Assessment
Проектные работы	Project design works
Проект путевой структуры и опор	Design of track structure and supports
Проект пассажирских станций и вокзалов	Design of passenger stations and terminal stations
Проект сервисных депо и др. объектов инфраструктуры	Design of servicing depots and other objects of infrastructure
Проект стандартизированного оборудования	Design of standard equipment
Приобретение технологий для трассы	Procurement of technologies for the track
Проведение согласовательных работ и получение разрешений на строительство	Approval activities and obtaining permits
Подготовительные работы к строительству трассы	Track construction preparatory works
Оформление документов на земельные участки трассы	Processing of documents for land plots of the track
Подготовка строительства	Construction preparation
Строительные работы на трассе	Construction works on the track
Строительство путевой структуры	Construction of the track structure
Строительство вокзалов и станций трассы	Construction of stations and terminal stations on the track
Строительство сервисных депо и объектов инфраструктуры	Construction of servicing depots and objects of infrastructure
Монтажные работы на трассе	Installation works on the track
Монтаж оборудования	Equipment installation
Монтаж систем путевой структуры	Installation of track structure systems
Выполнение комплекса пуско-наладочных работ на трассе ТСЮ	Pre-commissioning of the YTS track
Опытная эксплуатация	Operational testing
Запуск рабочей эксплуатации	Launching of commercial operation

Source of information: information provided by the Customer

2.5 Competitive advantages of the assessed object

For a relevant comparison of resource intensity of the two competing transportation systems a comparative analysis of the proposed string-and-rail trestle and a railway trestle of conventional design needs to be performed. For instance, a comparison with a railway situated on ground level will be irrelevant. These competing systems shall have the same level of user characteristics: movement speed of 500 km/h and a prospective passenger traffic of no less than 100 thous. pass./day, with similar level of comfort, safety, and service life.

A high-speed trestle railway would partially meet these requirements, particularly the one constructed in 2000 – 2005 on Taiwan Island with Japanese technology (see: http://www.niizhb.ru/engin06.htm). Movement speed on this road, however, is limited to 350 km/h, since its further increase would entail even greater material intensity of the trestle and growth of its cost.

Main resource characteristics of this railroad which has the length of 345 km and the cost of 15 to 18 billion US dollars, depending on reports (or $43.5 – 52.2 mln./km in 2005 prices; these numbers shall be doubled for 2013 prices):

- span length – 35 m;

- massive supports of reinforced concrete with diameter of several meters (vertical load of each support amounts to 4,000 tons), each having a thick foundation placed on four injection piles of reinforced concrete with diameter of 2 m and length of 60 m (weight of pile foundation under each support amounts to 1,800 tons);

- massive span structures in the form of two pre-strained prefabricated reinforced concrete beams with width of 6 m, height of 3 m and weight of 800 tons each. On the bearing beams similarly massive pre-strained slabs of reinforced concrete with width of 13 m (the weight of the slab on the span may be estimated at 500 tons) are placed, on which a two-way high-speed rail track panels are located.

One kilometer of length of such conventional high-speed railway trestle requires up to 100 thousand ton of structural materials (considering supports and their foundations) – of steel and reinforced concrete, including up to 10,000 ton/km of high-alloy steel needed only for reinforcement of the concrete.

Similar characteristics of the proposed high-speed two-way pre-strained String-and-rail Trestle (SRT) designed for travel of the very same high-speed trains on the very same rails, are shown in the section above.

Let us compare demand of materials needed for the construction of the competing transportation systems on an example of a worldwide network of high-speed railroads with total length of 1 mln. km, as shown in the table below.

Table2-3 Demand of structural materials for construction of a network of railroad trestles with total length of 1 mln. km

Structural element	Conventional high-speed railroad trestle		String-and rail trestle designed by engineer Yunitskiy	
	Steel, tons	Reinforced concrete, m^3	Steel, tons	Reinforced concrete, m^3
1. Bearing span structure for two tracks (total length – 1,000,000 km)	-	24,000,000,000	1,250,000,000 (string truss)	920,000,000 (truss gap filler)
2. Two-way rail track structure	350,000,000	390,000,000	210,000,000	—

Structural element	Conventional high-speed railroad trestle		String-and rail trestle designed by engineer Yunitskiy	
	Steel, tons	Reinforced concrete, m^3	Steel, tons	Reinforced concrete, m^3
(length – 2,000,000 km for one way)	(rails and rail fasteners)	(crossties)	(rails and rail fasteners)	
3. Supports: - intermediary - anchor	— —	800,000,000 —	95,000,000 6,000,000	160,000,000 210,000,000
4. Support foundations	—	16,000,000,000	280,000,000	460,000,000
5. Other uses and contingencies (10%)	35,000,000	4,200,000,000	184,000,000	175,000,000
Total	385,000,000	45,400,000,000 (including 11,000,000,000 tons for steel reinforcement)	2,020,000,000	1,920,000,000 (including 240,000,000 tons for steel reinforcement)

Sources of information: information provided by the Customer

It needs to be pointed out that for construction of these competing railway transportation trestles similar materials with similar initial costs are used: steel reinforcements for reinforced concrete, rails, high-tensile wire for strings, etc., are manufactured from high-alloy steel commercially produced today, on the existing equipment, reinforced and ordinary concretes have conventional compositions, conventional strength, and are produced on standard equipment. For example, the railway trestle constructed on Taiwan Island used class K-7 reinforcement cables with diameter of 15 mm (twisted cables with 7 5-mm wires each) and high-tensile steel reinforcement wire as prestrained reinforcement, that is, just the materials used as strings by the proposed string-and-rail trestle.

To estimate the amount of reinforcement used in construction of the high-speed railway trestle of Taiwan Isle (this data is not disclosed by the system developer), let us assume a minimal standard reinforcement factor for reinforced concrete structures of 3%. This figure represents cross-section, if demand by weight is estimated it will amount about 10% of the weight of reinforced concrete, or 240 of reinforcement steel for 1 m^3 of reinforced concrete.

Analysis of the data of the table above results in the following conclusions:

1) The demand of steel for construction of the proposed worldwide high-speed network of string-and-rail trestles with total length of 1 mln. km, will be lower than that of a conventional high-speed railway trestle (constructed with Japanese Shinkansen technologies) of the same length, by 5 times, the demand of reinforced concrete structures – 23 times lower. The estimation takes into consideration the "hidden" steel used as reinforcement in the reinforced concrete: for a conventional railway trestle it is 11 billion tons of high-alloy steel, for a string trestle – 240 mln. tons. Here resource saving will total: for steel – 9,1 billion tons, for reinforced concrete – 43.5 billion cubic meters (104 billion tons).
2) Construction of trestles uses special implements and equipment at every stage – from production of prefabricated units in factories to their transportation to the construction site and performing construction and installation works involving not only installation equipment, but also welding, encasement, corrosion protection, etc. Therefore the cost of "turnkey" installation of structures constructed sometimes out in the field within thousands kilometers

from the supplier, would multiply several times as compared to the selling price of the initial raw materials – steel and concrete. Under highly mechanized flow-line construction in the field international average cost of the mentioned construction works will increase: for steel structures constructed on the "second level" – up to $4,000 – 6,000 or more per one ton, for reinforced concrete structures constructed on the "second level" – up to $900 – 1,200 or more per one cubic meter.

3) Based on the stated efforts and their costs the cost of the string-and-rail trestle for the network of high-speed rail roads with the length of 1 mln. km will total, on the average (without the cost of infrastructure and rolling stock):

- with traditional trestle design, similar to the high-speed railroad build with Japanese technologies: $49.4 trillion ($49.4 mln./km),

- with string-and-rail design (SRT): $11.1 trillion ($11,1 mln./km).

Therefore the economy of investments for construction of the network of trestle railroads with the total length of 1 mln. km will total $38.3 trillion, or, in terms of 1 km of length – $38.3 mln./km.

In reality the proposed string-and-rail trestle may be about twice cheaper since the table above shows the most massive variant of such trestle designed for load per unit of length of 6 t/m. This weight load would be brought by two massive diesel or electric locomotives in a train of total mass of up to 200 tons, for heavy-duty ore transportation routes. Whereas high-speed railways use motor cars with specific weight load of up to 3 t/m, construction costs of string-and-rail trestles for such trains may be twice lower.

A special stress must be made of the following fact. A conventional reinforced concrete railway trestle is pre-strained. That is, steel reinforcement of the reinforced concrete bearing beams of conventional span structures is preliminary strained, so this structure in its engineering essence is also a string. Since the developer of the railway trestle constructed at Taiwan does not disclose the force of pre-stress of the reinforcement, let us estimate these forces independently.

Load per unit of length of such span structure (taking into account two trains and two track panels) will be about 68 t/m. Thus the maximum bending moment in the middle of the span, considering the dynamics of high-speed rolling stock will amount to about 10,500 t/m. Since cracking of the strained zone's concrete of the pre-strained reinforced structures is undesirable, the pre-strain force of the reinforcement which compresses the concrete must exceed the bending force in this strained zone. With the bending moment of 10,500 t/m and the height of the bearing beams of 3 m this force may be estimated at 3,800 tons. This is the force of compression of the concrete of a conventional span structure, that is, the concrete will also be pre-strained, since it will be pre-compressed longitudinally with a force of no less than 3,800 tons.

Thus the "strings" (the pre-strained steel reinforcement) of a conventional "non-string" railway trestle must be strained with a force of minimum 3,800 tons, and strings (pre-strained steel reinforcement) of the proposed string-and-rail trestle will be strained only at 1,200 tons, that is, 3 limes less.

Also, the pre-strained conventional reinforced concrete trestle is not strained longitudinally, so from the engineering standpoint it is not a "string" – reinforcement strain forces are compensated by equal forces of train of concrete, resulting in zero total longitudinal forces.

Thus the term "string" included in the definition of the string-and rail trestle design proposed by engineer Yunitskiy refers not as much to the presence of a preliminary strain, as to the definition of a pre-strained, continuous and statically indeterminate transportation trestle:

1) The bearing structure must be raised over the ground level and set up on intermediate and anchor supports (similar to, e.g., a pre-stretched guitar string);

2) Compensating compressing forces are transmitted not to structure of the trestle, since it would be over-stressed, but to the Earth's crust which has extremely high bearing capacity[9] (for instance, in a guitar these compensating compressing forces are transmitted to the neck, serving as an analogue of the Earth's crust).

For comparison, the costs of construction of conventional high-speed railroads, both constructed and planned for construction in the near future in various countries, are shown. The cost of these railroads where track panels and gravel-and-sand cushions are laid on earth embankment which is cheaper than a trestle depends on the country, the estimated travel speeds of trains, the relief, the applied technologies and many other factors. It should be noted that while the operational speeds of these railroads are moderate, up to 300 – 350 km/h, their costs is rather high:

- "Frankfurt – Cologne" (Germany): $47 mln./km;
- "Pretoria – Johannesburg Airport" (SAR; speed 160 km/h): $62 mln./km;
- "Astana – Almaty" (constructed with the use of Chinese technologies): $24 mln./km;
- "San-Francisco – Los Angeles – San Diego" (the USA): $32 mln./km;
- "London – Edinburgh" (The UK; speed up to 400 km/h): $83 mln./km.

(http://mosurforum.ucoz.ru/news/skorostnoj_gudok_na_zheleznoj_doroge_pojavjatsja_poezda_novogo_pokolenija/2010-03-30-64).

The figures shown above correlate with estimations of cost of similar conventional high-speed railway mainline reported recently, in particular in the Russian press. For example, the cost of the high-speed railway "Moscow – Saint-Petersburg" with the length of 660 km which is 1.515 times shorter than the discussed trestle type railway network with the total length of 1 mln. km, is estimated by the experts at a sum starting $40 billion (a road on an embankment), up to $60 billion or more (a road on trestle). A high-speed railway network with the total length of 1 mln. km constructed with these conventional technologies would cost the customer $60 to $90 trillion.

Some experts (e.g., the Head of RZD in his public speeches) express the opinion, with reference to their foreign colleagues, that, for instance, in Russian environment with its harsh climate any high-speed railroad, whether it is built on an embankment or on a trestle, cannot be constructed for less than 100 million Euro per kilometer.

The conclusions of high recourse effectiveness of string-and-rail trestle roads in comparison with the known transportation systems are also upheld by an independent report of the Institute of Transportation Problems Named after N. S. Solomenko of the Russian Academy of Sciences[10].

Source of information: information provided by the Customer

2.6 Characteristics of the investment project implemented employing the assessed object

[9] All constructed structures sometimes weighing millions of tons or more are supported by the Earth's crust: buildings, including high-rise buildings; the Pyramid of Cheops, suspension and cable bridges with total forces in bearing cables of 100 thousand tons or more; dams amd man-made lakes (weighing billions tons); artificial islands, etc. Therefore horizontal efforts of about 1,000 tons transmitted to the Earth's crust from trestle strings are environment-friendly, considering also seismic activity. Furthermore, these efforts will be concentrated only on the terminal anchor supports of all, even the longest roadways, which, also will be combined with passenger stations and freight terminals, whereas at intermediate anchor supports this effort will be internal -- the effort on one side of a support will be compensated by the same effort on the other side.

10 Executive Summary of Innovative Transport Technology "String Transport Unitsky" / Institute of Transportation Problems Named after N. S. Solomenko of the RAS. - St. Petersburg, 24 May 2010. - 13 p. (see: http://www.yunitskiy.com/author/2010/2010_14.pdf)

Within the implementation of the investment project employing the assessed object – the exclusive intellectual property and know-how rights on the "String-and-rail Transportation System of Engineer Yunitskiy", establishment of a holding company is assumed.

The authorized capital of the holding company established for construction on the planet within 50 years of 1 mln. km of string-and-rail trestle type railroads will be raised by means of the Exclusive intellectual property and know-how rights on the "String-and-rail Transportation System of Engineer Yunitskiy". In effect this authorized capital characterizes the possible (probable) capitalization of the company in future, within 30 – 35 years, when the main part of roads of this type with total length of around 500 thous. km and total cost of $7 trillion will be constructed[11].

The initial sale of stock of the established company, which authorized capital will be raised by means of the intellectual property will be performed at a large discount from 1:100 to 1:20, that is, for 1 – 5% of the reported value. That is why for the realization of this program in Russia, for instance, it will be possible to attract on the venture stage no more than $50 mln., which will, however, enable the launch of this large-scale project.

With constructions rate of trestle type railroads (construction of new roads and replacement of the old roads build on embankments) at 20 thous.km/year, as it was 120 years ago a principally new network of railroads with length of 1 mln. km may be constructed in 50 years. Virtually all of these roads, excluding service and special-purpose (ore-bearing, coal-bearing, etc.) shall be high-speed roads.

The length of roads network in a particular country relates not only to transportation of the country's residents, manufactured goods, and extracted materials, but also to transit traffic, and besides that – to development of new deposits of mineral resources. Furthermore the territory itself will become one of the main resources of the man in the 21st century, therefore underdeveloped and presently hardly accessibly territories of all countries and continents will be developed and populated.

The proposed within the scope of this assessment infrastructural network of railroads of the "second" level with length of 1 mln. km is divided into regions (zones) in proportion to the area of territory of each country and its population (total area of land on the planet totals 149 mln. km^2, total population of the Earth – 7,143 mln. individuals):

1. China (9,60 mln. km^2, 1.357 mln. residents) – 130,000 km.
2. India (3,29 mln. km^2, 1.234 mln. residents) – 95,000 km.
3. Russia (17,10 mln. km^2, 143 mln. residents) – 70,000 km.
4. the USA (9,52 mln. km^2, 316 mln. residents) – 50,000 km.
5. Brazil (8,51 mln. km^2, 198 mln. residents) – 40,000 km.
6. Canada (9,98 mln. km^2, 34 mln. residents) – 30,000 km.
7. Australia (7,69 mln. km2, 24 mln. residents) – 25,000 km.
8. Indonesia (1,90 mln. km2, 245 mln. residents) – 25.000 km.
9. Mexico (1,97 mln. km2, 117 mln. residents) – 15.000 km.
10. Pakistan (0,80 mln. km2, 179 mln. residents) – 15.000 km.

[11] *For instance, the capitalization of the American company Apple Inc. which works in a smaller market niche than the established company in the end of February, 2012, 35 years from the date of creation, exceeded $500 bil. Due to innovative technologies and aesthetically attractive design the Apple corporation created a unique reputation, comparable to a cult, in the industry of consumer electronics, thus in May, 2011 the Apple trade mark (which is a part of its intellectual property) was recognized as the world's most valuable brand estimated $153,3 bil. in a rating of the Millward Brown international research agency. Such capitalization is possible in development of the network of trestle railroads based on the Exclusive intellectual property and know-how rights on the "String-and-rail Transportation System of Engineer Yunitskiy".*

11. Nigeria (0,92 mln. km2, 167 mln. residents) – 15.000 km.
12. Democratic Republic of Congo (2,35 mln. km2, 70 mln. residents) – 13.000 km.
13. Argentina (2,77 mln. km2, 41 mln. residents) – 12.000 km.
14. Iran (1,65 mln. km2, 77 mln. residents) – 11.000 km.
15. Algeria (2,38 mln. km2, 36 mln. residents) – 11.000 km.
16. Bangladesh (0,14 mln. km2, 152 mln. residents) – 11.000 km.
17. Japan (0,38 mln. km2, 128 mln. residents) – 10.000 km.
18. Kazakhstan (2,72 mln. km2, 17 mln. residents) – 10.000 km.
19. Ethiopia (1,123 mln. km2, 91 mln. residents) – 10.000 km.
20. Saudi Arabia (2,15 mln. km2, 29 mln. residents) – 9.000 km.
21. Egypt (1,00 mln. km2, 83 mln. residents) – 9.000 km.
22. Sudan (1,89 mln. km2, 36 mln. residents, 31 mln. residents) – 8.000 km.
23. South African Republic (1,22 mln. km2, 51 mln. residents) – 8.000 km.
24. Turkey (0,78 mln. km2, 75 mln. residents) – 8.000 km.
25. Vietnam (0,33 mln. km2, 89 mln. residents) – 7.000 km.
26. Philippines (0,30 mln. km2, 92 mln. residents) – 7.000 km.
27. Peru (1,29 mln. km2, 30 mln. residents) – 7.000 km.
28. Tanzania (0,95 mln. km2, 48 mln. residents) – 7.000 km.
29. Columbia (1,14 mln. km2, 47 mln. residents) – 7.000 km.
30. Germany (0,36 mln. km2, 82 mln. residents) – 6.000 km.
31. France (0,55 mln. km2, 64 mln. residents) – 6.000 km.
32. Thailand (0,51 mln. km2, 66 mln. residents) – 6.000 km.
33. Libya (1,76 mln. km2, 7 mln. residents) – 6.000 km.
34. Mongolia (1,57 mln. km2, 3 mln. residents) – 6.000 km.
35. Chad (1,28 mln. km2, 11 mln. residents) – 6.000 km
36. Angola (1,25 mln. km2, 20 mln. residents) – 6.000 km.
37. Myanmar (0,68 mln. km2, 49 mln. residents) – 6.000 km.
38. Italy (0,30 mln. km2, 61 mln. residents) – 5.000 km.
39. Ukraine (0,60 mln. km2, 46 mln. residents) – 5.000 km.
40. Great Britain (0,24 mln. km2, 63 mln. residents) – 5.000 km.
41. Kenya (0,58 mln. km2, 43 mln. residents) – 5.000 km.
42. Niger (1,27 mln. km2, 17 mln. residents) – 5.000 km.
43. Venezuela (0,91 mln. km2, 30 mln. residents) – 5.000 km.
44. Afghanistan (0,65 mln. km2, 33 mln. residents) – 5.000 km.
45. Spain (0,50 mln. km2, 46 mln. residents) – 5.000 km.
46. Mali (1,24 mln. km2, 15 mln. residents) – 5.000 km.
47. Republic of Korea (0,10 mln. km2, 50 mln. residents) – 4.000 km.
48. Bolivia (1,10 mln. km2, 10 mln. residents) – 4.000 km.
49. Mauritania (1,03 mln. km2, 4 mln. residents) – 4.000 km.
50. Mozambique (0,80 mln. km2, 24 mln. residents) – 4.000 km.

51. Chili (0,76 mln. km2, 18 mln. residents) – 4.000 km.
52. Madagascar (0,59 mln. km2, 22 mln. residents) – 4.000 km.
53. Yemen (0,53 mln. km2, 26 mln. residents) – 4.000 km.
54. Uzbekistan (0,45 mln. km2, 30 mln. residents) – 4.000 km.
55. Morocco (0,45 mln. km2, 33 mln. residents) – 4.000 km.
56. Iraq (0,44 mln. km2, 34 mln. residents) – 4.000 km.
57. Poland (0,31 mln. km2, 39 mln. residents) – 4.000 km.
58. Malaysia (0,33 mln. km2, 30 mln. residents) – 3.000 km.
59. Namibia (0,83 mln. km2, 2,3 mln. residents) – 3.000 km.
60. South Sudan (0,62 mln. km2, 8,3 mln. residents) – 3.000 km.
61. Cameroon (0,48 mln. km2, 20 mln. residents) – 3.000 km.
62. Zambia (0,75 mln. km2, 14 mln. residents) – 3.000 km.
63. Uganda (0,24 mln. km2, 36 mln. residents) – 3.000 km.
64. Nepal (0,14 mln. km2, 31 mln. residents) – 2.600 km.
65. Ghana (0,24 mln. km2, 26 mln. residents) – 2.500 km.
66. Cote d'Ivoire (0,46 mln. km2, 7,2 mln. residents) – 2.500 km.
67. DPRK (0,12 mln. km2, 25 mln. residents) – 2.200 km.
68. Romania (0,24 mln. km2, 21 mln. residents) – 2.200 km.
69. Zimbabwe (0,39 mln. km2, 13 mln. residents) – 2.200 km.
70. Burkina-Faso (0,27 mln. km2, 18 mln. residents) – 2.200 km.
71. Syria (0,19 mln. km2, 21 mln. residents) – 2.100 km.
72. Somali (0,64 mln. km2, 9.8 mln. residents) – 2.000 km.
73. Central African Republic (0,62 mln. km2, 4,6 mln. residents) – 2.000 km.
74. Botswana (0,58 mln. km2, 2,1 mln. residents) – 2.000 km.
75. Turkmenistan (0,49 mln. km2, 5,2 mln. residents) – 2.000 km.
76. Ecuador (0,28 mln. km2, 15 mln. residents) – 2.000 km.
77. Papua-New Guinea (0,46 mln. km2, 7,2 mln. residents) – 2.000 km.
78. Sweden (0,45 mln. km2, 9,5 mln. residents) – 2.000 km.
79. Republic of Congo (0,34 mln. km2, 4,2 mln. residents) – 1.900 km.
80. Paraguay (0,41 mln. km2, 6,3 mln. residents) – 1.800 km.
81. Republic of China (Taiwan) (0,04 mln. km2, 23 mln. residents) – 1.800 km.
82. Sri-Lanka (0,07 mln. km2, 21 mln. residents) – 1.700 km.
83. Finland (0,34 mln. km2, 5,4 mln. residents) – 1.600 km.
84. Guinea (0,25 mln. km2, 10 mln. residents) – 1.600 km.
85. Senegal (0,20 mln. km2, 13 mln. residents) – 1.600 km.
86. Cambodia (0,18 mln. km2, 14 mln. residents) – 1.600 km.
87. Malawi (0,12 mln. km2, 16 mln. residents) – 1.600 km.
88. The Netherlands (0,04 mln. km2, 17 mln. residents) – 1.400 km.
89. Belarus (0,21 mln. km2, 9,5 mln. residents) – 1.400 km.
90. Tunisia (0,18 mln. km2, 11 mln. residents) – 1.400 km.

91. Norway (0,32 mln. km2, 5,1 mln. residents) – 1.400 km.
92. Oman (0,31 mln. km2, 2,8 mln. residents) – 1.200 km.
93. New Zealand (0,27 mln. km2, 4,5 mln. residents) – 1.200 km.
94. Laos (0,24 mln. km2, 6,3 mln. residents) – 1.200 km.
95. Greece (0,13 mln. km2, 11 mln. residents) – 1.200 km.
96. Portugal (0,09 mln. km2, 11 mln. residents) – 1.100 km.
97. Benin (0,11 mln. km2, 9,4 mln. residents) – 1.100 km.
98. Cuba (0,10 mln. km2, 11 mln. residents) – 1.100 km.
99. Kyrgyzstan (0,20 mln. km2, 5,7 mln. residents) – 1.100 km.
100. Azerbaijan (0,09 mln. km2, 9,2 mln. residents) – 1.000 km.
101. Gabon (0,27 mln. km2, 1,6 mln. residents) – 1.000 km.
102. Tajikistan (0,14 mln. km2, 8,0 mln. residents) – 1.000 km.

The listed 102 countries account for 895,500 km of the proposed trestle type railways, so the remaining 104,500 km of the "second type" of the 1,000,000 km will account for the rest 163 countries, dominions and territories.

2.7 Information about the author of the intellectual property of the Yunitskiy string-and-rail technologies

Anatoly Eduardovitch Yunitskiy is a chief designer with more than 150 inventions, including the principally new design of Yunitskiy string-and-rail transportation system. 29 of the A. E. Yunitskiy's inventions are used in construction, transportation, mechanical engineering, electronics and chemical industry, in scientific researches, conducted in the Russian Federation, the Republic of Belarus, Ukraine, and other countries of the CIS.

A full member (academician) of the Russian Academy of Natural Sciences (1999), of the Russian Academy (1998) and of the International Academy for Integration of Science and Business (2011). Three university degrees (1973, 1985 and 2006): railway engineer; technical-engineering worker and researcher in patenting and invention; design engineer of high-rise buildings. A Doctor of Philosophy in transport (2002).

Awarded by the honorary title and a badge of honor the "Knight of science and arts" of the Russian Academy of Natural Sciences, two gold medals "Laureate of the All-Russian Exhibition Center", three gold high-quality awards "The Russian Mark" for the technology of string-and-rail transportation, projects of freight and passenger rail vehicles (awarded by Russian Union of Industrialists and Entrepreneurs).

A. E. Yunitskiy conducts research of string-and-rail transportation since 1977. By this time static and dynamic models of SRT were created, the basics of which were stated in the first research monograph of the author – "String transportation systems on Earth and in space" (1995 г.). This allowed to create the theory of a resonance-free movement of rolling stock on a string-and-rail track structure with speeds up to 600 km/hour, ensuring more even and tough track in comparison with the modern beam trestle for monorail tracks and magnetic suspension trains, and allowing to reduce the cost of the track structure, supports and rolling stock, by 5 – 10 times or more as compared with the latter. Principally new transportation standards were developed for: string-and-rail track structure of overhead and suspended types for various speed modes and various mass-and-dimension characteristics of the rolling stock; intermediate and anchor supports; anchor fixing of

the string; the string-and-rail for superlight, light, medium, heavy, and super-heavy trestle types for various travel modes; the steel wheel with anti-derailing system and its independent suspension; the automatic hitching device; switches; stations, terminal stations and freight terminals of the "second level"; the technology of manufacture and organization of movement of passenger and freight rolling stock on the "second level", etc.

Wind tunnel testing of model of the unibus

In 1995 – 2001 a set of aerodynamic tests of high-speed rolling stock (on 1:5 scale) was performed in wind tunnel of the Academician Krylov Memorial Central Research Institute (Saint-Petersburg). The data collected allowed designing a high-speed rail vehicle with the best aerodynamic qualities among all of the known wheeled vehicles.

For this reason the specific consumption of fuel (energy) as compared with a conventional high-speed railway train is lower by 6 – 8 times and more. This will allow the proposed string-and-rail trestles with improved rolling stock to become the most environment-friendly and the most economical type of high-speed transportation not only by energy consumption for movement, but also by the minimal appropriation of land for tracks owing to the location of the track structure at the "second level" – on cheap and compact supports.

A labouratory complex based on a freight ZIL-131 truck at the testing ground in Ozery

In 2001 at Ozery, Moscow region, "Unitran" Fund led by A. E. Yunitskit build a testing section of light trestle string-and-rail, being the world's first completed full-scale segment of actual string-and-rail transportation system. It had length of 150 m, support height of up to 15 m, maximum span of 48 m, string tension of 450 tons, track pitch of 10%, weight of travelling load of up to 15 tons.

At the testing ground methods of estimation and front-end and engineering research, technique of straining and fixing the strings, the design of string-rail and of steel wheel, the anchor and intermediate supports, were successfully tested, as well as static and dynamic loads and effects of weather and climate conditions. The results of the series of tests allow the developer to start front-end and engineering research of specific trestle type freight and passenger tracks and work on industrial production of string-and-rail track structures and supports.

The string-and-rail transportation system was displayed as working models of 1:15, 1:10 and 1:5 scale at more than 50 exhibitions, trade fairs, workshops, forums, including events held in Berlin, Leipzig, Hannover, Dubai, Sharjah, Malmoe, Cape Town, Tripoli, Islamabad, Karachi, Baku, Kiev, Sevastopol, Moscow, Saint-Petersburg, Khabarovsk, Hanty-Mansijsk, Minsk, Sydney, and other cities, and was awarded with more than 30 diplomas, certificates and medals.

For the period from 1977 to 2012 A. E. Yunitskiy created a scientific school dealing with string-and-rail technologies with its specialists in Russia, Belarus, Ukraine and other countries. A set of labouratory, test-bench, model and testing-ground tests were performed. 18 monographs were published (see www.yunitskiy.com), including "String transportation systems on Earth and in space" (1995, 337 p.), over 60 string-and-rail technology inventions and more than 100 know-hows were created (the author and the patent owner is A. E. Yunitskiy). Unique unprecedented results were achieved. Two grants of the United Nations Organization were awarded (1998 and 2002).

Source of information: information provided by the Customer

3 MARKET ANALYSIS

For the estimation of market value of the assessed object the Appraiser performed a review of the world economy, being the place of possible realization of the "String-and-rail Transportation System of Engineer Yunitskiy, an analysis of industry environment of the assessed object – the world's market of high-speed surface transportation, and an analysis of the world's air transportation market, being an indirect competitor.

The analysis was performed with the aims of additional substantiation of the estimations and opinions stated in the Report.

3.1 Overview of the world economy

International Monetary Fund (IMF) adjusted downwards its forecast of the global economic growth stating that many developed countries will face considerable hardships on the way to recovery. According to the opinion of IMF experts growth of the world economy will total 3,3% which is 0,2% less than was projected in the beginning of the year. The experts believe that the growth will gain momentum in 2014. IMF forecasts that depression of the world economy will last another half of a year. An adjusted report was published by IMF on April 16th, 2013, when representatives of financial authorities of the world were preparing for the annual meetings of IMF and World Bank, held in Washington.

The economies of the USA and Europe being the fastest in recovery are believed to be the driver of the world's growth. The recovery of the developing countries, including BRIC, will be somewhat slower, and the poorer countries will recover the slowest. According to estimations of IMF growth of the economy of the USA will total this year no more than 1.9% due to reduction of government spending; however in 2014 GDP of the largest economy of the world will start to grow at a faster rate.

Meanwhile recession continues in the Euro zone, resulting in rebating of its GDP by 0.3%. Nevertheless IMF believes that the recession in Europe will end soon and in the next year economy of the countries of the currency union will somewhat strengthen.

Despite the proposal of Cyprus to part with at least some of its gold reserves and other assets with the aim of at least partial settlement of losses with its investors, in April 2013 discussions of its possible forthcoming withdrawal from the Eurozone intensified.

Unemployment level in Spain has soared this quarter up to 27,1%. Judging by the published preliminary data of GDP dynamics of Great Britain it has barely avoided official recession in 1st quarter of 2013. In Germany exceptionally poor reports in terms of business optimism and consumer confidence have been published by ZEW and Ifo.

The activities of the developed countries are expected to be much higher – growth of their economies this year will total 5,3%, and will continue to grow in the following year. GDP of China, the world's third largest economy, will increase this year by 8%.

Another considerable change in the report is the increase of growth forecast for the five ASEAN countries (Indonesia, Malaysia, Philippines, Thailand and Vietnam) for 2013 and a sudden drop of the activities in 2014. IMF believes that these countries will gain temporarily from certain reduction of China's activities for this year, but the situation will reestablish itself for China in 2014.

Forecasts for Russia are somewhat outside of this logic: estimates of growth for 2013 are reduced to 3,4% (and are still higher than the one forecasted by the Ministry of Economy, 2.8%) and re-

main unchanged for 2014 with GDP growth of 3.8%. It is estimated that in 2013 rate of growth of the country will be above the world average, but as soon as in 2014 it will abate. IMF believes that on the whole primary goods' prices in 2013 will be 2% lower than in 2012, furthermore the share of hydrocarbon product producers outside OPEC (the USA, Canada, Russia and China are named) in the world's export will grow. IMF also expects growth of Russian grain export, object to a good harvest in 2013. However as per IMF estimations by the end of 2014 Russia's "year-on-year" growth rate will reduce to 2.8% after growing in 2013 to 4.8%.

Table 3-1 Macroeconomic forecasts of international organizations for 2013

GDP growth rate, %	UNO, Jan., 13	IMF, Apr., 13	WB, Jan, 13	For reference: 2012 (estimation)
Worldwide (with PPP)	3.3	3.3	3.4	3.2
The USA	1.7	1.9	1.9	2.2
Euro zone	0.3	-0.3	-0.1	-0.6
Japan	0.6	1.6	0.8	2.0
China	7.9	8.0	8.4	7.8
India	6.1	5.7	6.1	4.0
Brazil	4.0	3.0	3.4	0.9
Russia	3.6	3.4	3.6	3.4
petroleum, doll./bar.	105	102.6	102	106

Source of information: Noncommercial Partnership "Center of Macroeconomic Analysis and Short-term Prognostication" (http://www.forecast.ru/_ARCHIVE/Analitics/WORLD_LEADS/2013/World_trends_april_2013.pdf)

Petroleum

In mid-April, 2013, prices of petroleum, alike the majority of commodity assets have dropped considerably in comparison to $107 – 115 for Brent for the previous 8 months. The drop was more than 10%. At some point price of Brent grade oil dropped to $97.5 per barrel. Nevertheless in the end of April the North Sea grade won back half of the reduction, returning the price to a more comfortable level of $104 per barrel.

Petroleum prices are being depressed by the growth of oil production in the USA. Owing to slate oil it has grown to 7,3 mln. barrels per day – a record in the last 20 years. Also, the oil reserves of the USA also increased to the historic maximum of 390 mln. barrels.

The drop of petroleum prices prompted a reaction of OPEK. It should be reminded that the cartel's representatives previously stated the $100 price level to be convenient for both sellers and buyers. If this level will not hold the members of the petroleum cartel may take measures to reduce quotas for extraction.

The spread between the two main oil grades – the European Brent and the American WTI continues to reduce. As of the end of April it was under $10. Considering the restoration of Seaway pipeline with virtual cessation of further construction of pipeline under the Keystone XL project in the USA and the decrease of reserves of the "black gold" in Cushing, this trend may remain in the nearest future. Furthermore, petroleum quotations in May will depend much on development of the situation in the Middle East. Lately tension arose around Syria.

Precious metals

April 2013 was the month of reduction of quotes of precious metals when gold fell in price by 15%. Notably, prices for the "yellow metal" reached two years minimum again and broke the decade-long ascending trend (during this period the price of an ounce grew 7 times over). The drop was unexpected to many market players.

By the end of the month the situation has settled somewhat, and gold has made a successful attempt of an upward rebound, growing by 8%. Nevertheless it did not quite succeed in reestablishing its standing. Silver, platinum and palladium demonstrated similar dynamics: they fell in price by 5 – 15% and also did not completely recover. ETF funds reduced their investments in metals, though the level of physical demand (for bullions, coins, adornments) of central banks and consumers was and remains high. This is confirmed by the presence of a "bubble" in this market: fund investments exceeded physical quantity of metal. Quantities of gold sold at exchange amounted hundreds tons which is comparable with gold reserves of the Gold and Foreign Currency Reserve of Russia.

Foreign exchange market

In the past month Russian ruble did not feel its best, resulting in drop to both components of the bi-currency basket. The exchange rate of common European currency at the Moscow Exchange grew an impressive 2.9% – up to the level of 40.95 ruble/Euro (+1.19 rub.). The exchange rate of dollar grew insignificantly by the end of April 2013, by 0.2% (31.12 ruble/dollar; + 6.1 kop.). Bank of Russia even had to perform currency interventions (this time selling foreign currency) in order to support ruble. Increased volatility of the exchange market is one of the main features of the reviewed period. Traders had plenty occasions (of both external and internal origins) for speculations which were actively pursued.

Threatening petroleum activities played against the national currency, with price of oil dropping in the second decade of April almost to $97 per barrel – below the psychologically important level.

Confident domination of euro over ruble was the result of an ascending dynamics of the euro/dollar pair and in many aspects was the consequence of an ascending trend of euro/dollar pair on the Forex market. The activity managed to gain 2.7%, reaching the level of 1.317. Yield of 10-year bonds of problematic European countries managed a notable reduction: Spain (4.12% per annum interest; -93 points); Italy (3,89% per annum interest; -87 points); Greece (10,88% per annum interest; -138 points).

Comparison of ruble with its main competitors, the 35 currencies quoted daily by the Bank of Russia, reveals that it dropped to 23 of them. Most remarkably the national currency dropped in comparison to Romanian leu (+4.2%), Hungarian forint (+3.3%), SAR rend (+2.7%), euro. Ruble gained the most to Japanese yen (-3.9%).

Primary commodity markets

The primary commodity markets with the exception of agricultural futures in April demonstrated their extreme dependency on the negative events around gold and oil prices. With this regard investors did not take into consideration any news or, especially, fundamental factors.

As was expected the distinct negative reports of the April macro-statistical data from China hit, above all, copper and nickel prices which lost more than 6% during the month. Even larger losses were experienced by tin (- 11% at the end of April) and steel (steel billets, -31%) bought before correction. Nevertheless led and primary aluminum contracts finished the month with minimal price changes, not least because of recommencement of purchases by Boeing & Co. aerospace corporation, and now they are technically speaking quite stable.

In the sector of agricultural futures a special attention was deserved by the prices of wheat contracts that soared by 9% in a month due to the unusually cold April in main agricultural states of the USA (with sudden snows in some parts), making USDA adjust downwards its forecast of this year's crop sprouting. The trend of growth of cereals will remain until the new estimation of the portion of the sprouted crops in the end of May.[12]

Source of information: "Nord-Capital" Investment Group, http://www.ncapital.ru/news/global/2013/05/16052.html

Summary: the main macroeconomic event in the in April 2013 market was the reduction of quotations of gold and precious metals; however this situation was rectified by Central Banks along with private consumers of India and China. On the whole the economy of the USA is now relatively stable. The economies of the depressed countries of the Eurozone are in a steady poor condition, unemployment grows in Spain, Cyprus is on the verge of withdrawal from the Eurozone.

3.2 Overview of the world's market of air transport

International Air Transport Association (IATA) published data on traffic in April 2012, evidencing growth of demand for passenger transport by 6.1%, whereas the demand for freight transport reduced by 4.2% as compared with the same period of the previous year, according to the press-service of the Association.

By 2030 a deficit of carrying capacity of the world's fleet will accrue. Average annual deficit growth will total 21%. The total demand for new airplanes for the reviewed period will amount 29 thous. units, with 15.6 thous. units due to decommissioning of the existing fleet, 13.4 thous. will be the response to the growth of traffic. Thus the world's fleet of airships shall grow 1.5 times and will total about 34 thous. airplanes. Two thirds of the demand will be covered by narrow-body airships, share of wide-body airplanes will also increase. Regional airship fleet will develop through the upper class with capacity of 85 – 100 berths.

Despite the ongoing economic recession in some countries the demand for air transportation continues to grow. The 6.1% growth in April, 2013, was the greatest for the last twenty years. Stable demand for air transportation along with insignificant increase of carrying capacity have led to the increase of passenger occupancy factor up to a record-breaking level of April, of 79.3%, according to IATA.

Quoting Tony Tyler, General Manager of IATA: "the present world situation may be called unstable and quite risky. Airline officers manage their business cautiously in the unstable conditions. The demand for passenger traffic increased in April by 6.1%, and the growth of carrying capacity remained at 3.8%. There are signs that the demand for freight traffic has reached its lower limit. Despite many factors influencing the industry for the first four months of the year we now observe

[12] http://www.ncapital.ru/news/global/2013/05/16052.html

a tendency of growth of demand in freight traffic in some countries. However, taking into account economic instability in Europe it is hard to make optimistic forecasts for immediate and midle-term future."

According to IATA the number of passengers of international lines in Europe grew by 5.9%, average load amounted to 80%, for the Asian-Pacific region – by 9.3% (average load – 78%), in Latin America – by 9% (average load – 78%).

An impressive growth was noted in the Middle East: +16%, and the lowest growth – in North America, where international passenger traffic grew only by 1.6%. Nevertheless the level of load in North America amounted almost 81%, whereas in the Middle East – 78%. On the whole domestic passenger traffic with the increase of 3.9% in April did not demonstrate the same growth as international, according to IATA reports.

Passenger traffic in the USA increased by 1% (83% load), in Brazil – by 2% (70% load), in China – by 6.3% (82% load), in India – by 8.6% (75% load).

The strongest growth of passenger traffic in April 2012 was demonstrated by Japan: almost by 28%, with a rather low level of load within the country – 57%.

With the exception of Africa all regions experienced expansion of traffic capacities, being, however, lower than the growth of demand. "In the circumstances of economic instability many managers will return to the basic principles – a weighted management approach to carrying capacity, control of expenses and capital savings. Exercising these principles will be a common practice until the world's economy stabilizes. Undoubtedly uncertainty affects general results. This concerns all of the industry, with no exceptions. Airlines will rely heavily on appropriate activities of partners in the industry to control expenses", – believes Tyler.

Source of information: web-portal "Transportation of Ukraine, CIS, and the world" http://transukr.dp.ua/2012/06/11/mirovoj-rynok-v-aprele-2012-goda-uvelichenie-sprosa-na-passazhirskie-perevozki-sostavilo-61.html, http://www.atorus.ru/ratings/analitic_mrch/new/20790.html, http://www.aviaport.ru/news/2013/04/27/254185.htm, lhttp://www.rbcdaily.ru/industry/opinion/562949986067493

Summary: Despite the continuing economic recession in some countries the air transportation demand continues to grow. The present world's situation may be called unstable and rather speculative. Airline managers conduct their business cautiously in instable conditions. Considering economic instability in Europe it is hard to make optimistic forecasts for immediate and medium-term future.

3.3 Review of the world sector of high-speed surface transportation

High-speed surface transportation (HSST) is surface railway transportation providing travel of high-speed trains with speeds of over 200 km/h (120 miles/h). These trains travel, as a rule, on special railways – high-speed mainlines (HSML), or on magnet suspension (maglev).

The modern high-speed trains normally operate at speeds of up to 350 – 400 km/h, and in tests may show speed up to 560 – 580 km/h. Owing to fast servicing and high speed of travel they will represent serious competition to other types of transportation, while preserving common features of all trains – low prime costs of transportation and large passenger traffic.

Japan pioneered in regular traffic of high-speed trains in 1964. In 1981 HSST trains started to travel in France, and soon the major part of Western Europe, including even the insular Great Britain, was united into a common high-speed railway network. In the beginning of 21st century China became the world leader in the network of high-speed lines and the owner of the first regular high-speed maglev line.

The majority of technologies used in HSST are similar to standard technologies of railway transport. The differences are, above all, the result of the high speed of travel which leads to increase of such characteristics as centrifugal forces (which appear while a train passes curved sections of track and may be uncomfortable to passengers), an order of degree higher resistance of motion and extremely high requirements to dynamic evenness of the track. On the whole increase of speed of trains is limited by the following factors:

- aerodynamics;
- mechanical resistance of the track;
- traction and breaking efforts;
- dynamic stability of travel;
- reliability of current pickup (for electric trains).

To improve aerodynamic properties trains have streamlined front and a minimum of projections, while the projections (e.g. current collectors) are equipped with special streamlined casings. Besides that the undercar equipment is covered by special screens. These constructive measures also reduce aerodynamic noise so the train becomes less noisy.

Mechanical resistance consists mainly in interaction of the "wheel-rail" pairs, that is, to reduce the resistance the bend (sagging) of rails needs to be reduced. For this purpose, first of all, rail track is reinforced, employing heavy types of rails, reinforced concrete crossties, special reinforced gravel ballast, placed on reinforced sand cushion and earth embankment. The load of wheels on the rails is also reduced by using aluminum alloys and plastic in carriage body structure.

Also in an effort to completely eliminate wheel friction, that is, to make train to hover over track (non-rail guides or path), trains on air cushion were developed with turbo-prop and turbo-jet engines (the French airtrains, etc.), that were not widely spread, as well as trains with magnetic suspension (maglevs) with linear traction electric motors and superconductors, that have a modest spread around the world.

International experience demonstrates that development of high-speed railway communication has significant social and economic effect on any country. At distances of up to 700 – 1000 km travel time of a high-speed train is similar to flying an airplane, considering the time of travel to airport and from airport to the destination and of registration. Furthermore, diverting passenger traffic from air and motor transport to high-speed lines results in considerable saving of energy resources. In this case specific energy consumption for 1 passenger-km will be lower by 2.5 – 3 times, and in the case of diverting of passenger traffic from conventional railroads to high-speed lines – by no less than 1.5 times.

Transportation sector today experiences a considerable increase of attention. This was convincingly demonstrated by the IV Eurasian Transportation and Logistics Forum held by "Vedomosti" Newspaper in Moscow, and by the summit of the leaders in transportation construction, the Merano Forum, held in Italy. High ranking officials, representatives of business, and experts alike are unanimous in that investments in development of railway infrastructure today are both necessary and advisable. Experts talk mainly about multiplicative effect gained by economy and social sphere from development of railroads. This effect is expressed in development of regions, optimization of transport network, stimulation of science-intensive production. Without application of innovative solutions in transportation and in development of rolling stock progress is impossible.

High-speed trains (high-speed surface transport, HSST) have not yet reached the speeds of passenger airplanes of 900 – 950 km/h. One can travel from one city to another faster by an airplane,

than by a train. However there is the factor that airports are mainly located outside city centers and travelling to them takes considerable time. Besides that flight registration also takes a rather long time (about 1 hour). High-speed trains, on the contrary, may depart from cities' central stations and the period from ticket purchase to train departure may be about 15 minutes. This time difference gives trains a certain advantage to airplanes. The figure below shows some time tables of estimated time of travel by a train and by an airplane with consideration to time of travel to a station or to an airport and for registration. Based on it one could see that at certain speeds of trains on certain distances the total time of travel in a train will be less than that of travel in an airplane.

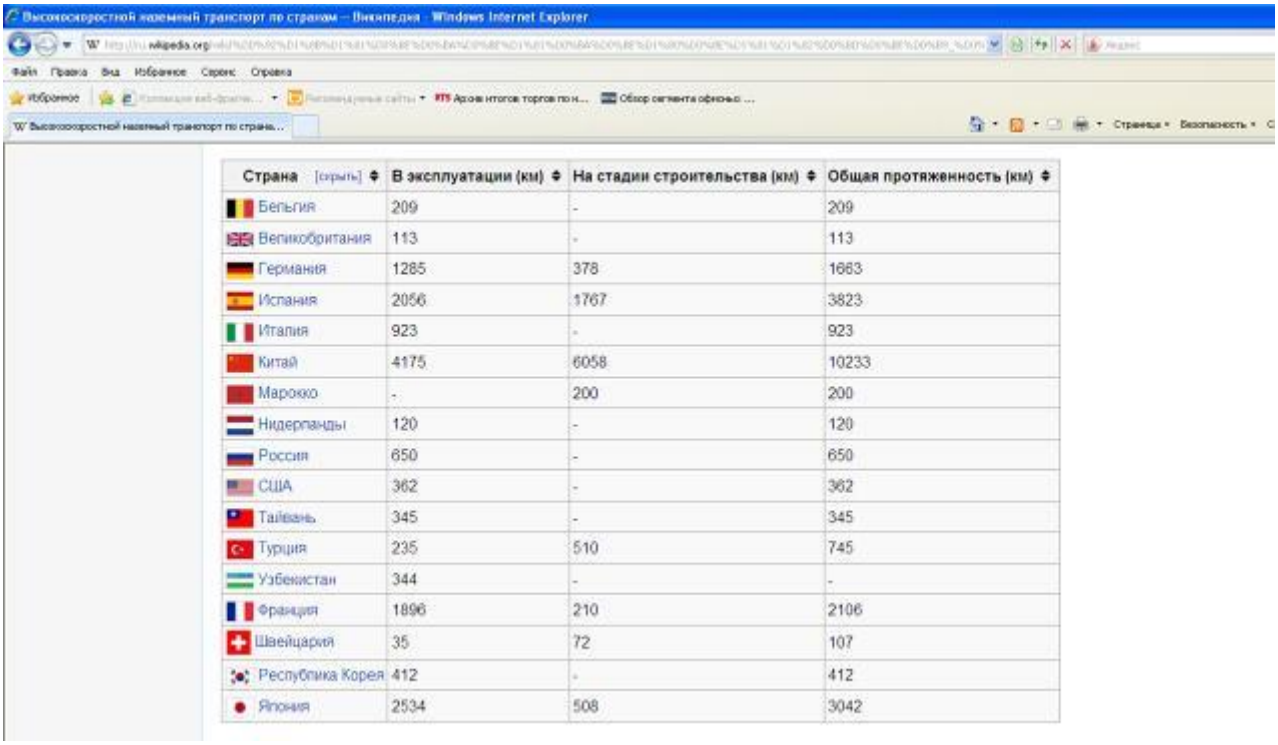
Replacement of air communication with HSST will basically allow relieving a substantial number of airplanes which will in its turn allow saving on expensive aviation fuel, and will allow to relieve airports. The latter will allow increasing the number of long-haul flights, including intercontinental flights. It should be noted that soon after launch of the first HSMLs a considerable reflux of passenger traffic from inland airlines in favor of HSST occurred, resulting in reduction of number of such trips by airlines, or in their attempts to attract passengers by lowering ticket prices and accelerating customer servicing.

Development of advanced-speed and high-speed railroad networks is today a priority for many countries. Presently the total length of high-speed lines of the world exceeds 14 thous. km, over 10 thous. km are under construction, construction of about 24 thous. km is included in middle-term plans. Total length of estimated world's high-speed lines operating by 2030 is about 50 thous. km.

China leads the development of high-speed train communication. In 2009 China became the world's No. 1 by the length of high-speed railroads network (3.3 thous. km), in 2010 the figure exceeded 7 thous. km. It is expected that in 2013 the length of high-speed railroads network will exceed 13 thous. km. Other countries, including Russia, intensify the construction of high-speed railroad lines. These plans, however, have a more long-term nature. It is expected that by 2030 the length of high-speed lines in Spain will total 5.5 thous. km, in France – 4.8 thous. km, in Japan – 3.6 thous. km.

The table below lists all of the mentioned high-speed lines (with speed of 250 km/h or more) which are in operation or are being constructed in the shown countries, as of 2011.

Table 3-2 High-speed transportation by countries as of January, 2011



Страна [скрыть]	В эксплуатации (км)	На стадии строительства (км)	Общая протяженность (км)
Бельгия	209	-	209
Великобритания	113	-	113
Германия	1285	378	1663
Испания	2056	1767	3823
Италия	923	-	923
Китай	4175	6058	10233
Марокко	-	200	200
Нидерланды	120	-	120
Россия	650	-	650
США	362	-	362
Тайвань	345	-	345
Турция	235	510	745
Узбекистан	344	-	-
Франция	1896	210	2106
Швейцария	35	72	107
Республика Корея	412	-	412
Япония	2534	508	3042

The table below shows scheduled high-speed lines (with speed of 250 km/h or more), as of January, 2011.

Table 3-3 Scheduled high-speed lines (speed of 250 km/h or more), as per January, 2011

Страна [скрыть]	На стадии планирования (км)
Аргентина	315
Бразилия	511
Великобритания	204
Германия	670
Индия	495
Иран	475
Испания	1702
Италия	395
Китай	2901
Марокко	480
Польша	712
Португалия	1006
Россия	650 (ВСЖМ-1, ВСМ-2)
Саудовская Аравия	550
США	900
Турция	1679
Франция	2616
Швеция	750
Япония	583

Аргентина	Argentine
Бразилия	Brazil
Великобритания	Great Britain
Германия	Germany
Индия	India
Иран	Iran
Испания	Spain
Италия	Italy
Китай	China
Марокко	Morocco
Польша	Poland
Португалия	Portugal
Россия	Russia
Саудовская Аравия	Saudi Arabia
США	The USA
Турция	Turkey
Франция	France
Швеция	Sweden
Япония	Japan

Investments in the development of rail roads, including advanced-speed and high-speed mainlines have a tremendous multiplicative effect. Realization of infrastructural projects promotes the creation of added value and growth of national wealth; it "binds" state investments for a long time and thus compensates the risks of inflation growth. In addition the development of transportation infrastructure forms a real foundation for modernization of economy and provides conditions for its growth.

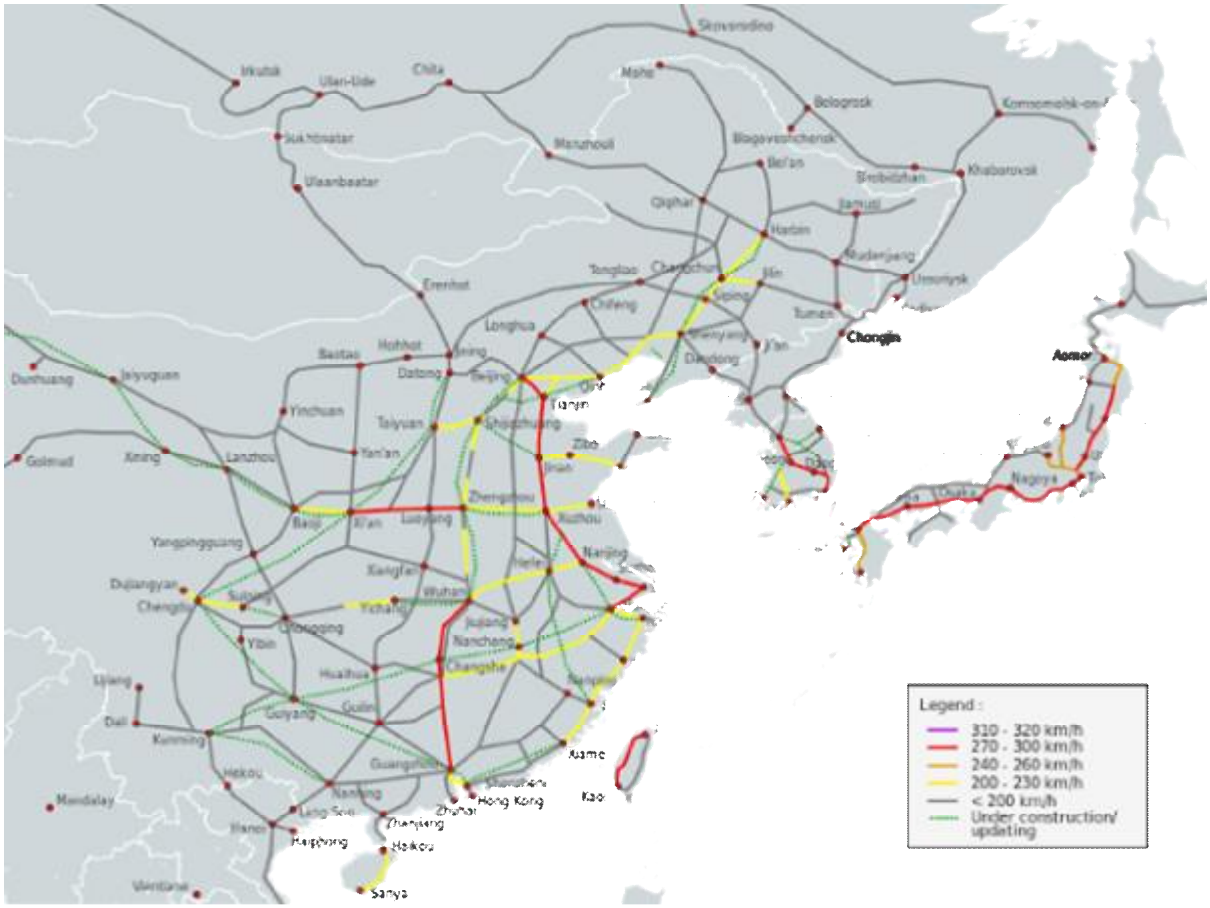
On the whole, international tendency of growth of state support of railroad development, including during the crisis period, is notable. Another important trend is the outrunning growth of state expenditures in railroad transportation. Over the last five years the share of state financing in the overall structure of income of rail roads has grown from 25% to 32%. A similar general trend remained through the crisis period.

In the first half of April, 2013 it has become known that Australia examines a project to construct a high-speed railroad on the east coast of the country. The railway is projected to be constructed in 40 years; the project will require investments totaling 114 billion Australian dollars (120 billion US dollars). The length of the high-speed mainline shall be 1,748 kilometers; it is projected that trains will travel at speeds of up to 350 kilometers per hour. The railway will link almost all of the large cities on the highly populated eastern coast, including Brisbane, Sydney, Canberra and Melbourne, and the estimated passenger traffic is set to 84 million passengers per annum. The future of the project has not been finally defined due to its high cost and complexity: about 144 kilometers of the track will pass through tunnels.

In 2013 China intends to invest about 100 billion dollars in railway transportation. Last year China invested in railway communication a similar amount and in 2010 – a third more. By 2013 the country plans to increase the length of railway mainlines up to 120 thousand kilometers, in-

cluding 18 thousand kilometers of high-speed railroads, and 40 thousand of express railroads. On the whole China plans to increase the length of roads almost by a third – today the country's railway network has the length of 90 thousand kilometers.

Figure 3-1 High-speed surface transportation of Asian countries



Asian high-speed mainlines 320-350 km/h 300 km/h 250-280 km/h 200-230 km/h Under construction

The European Union does not stay back of the "railway boom" either, over the next eight years it plans to invest in infrastructure development more than 600 billion dollars. The largest project within this plan is Rail Baltic, intended to develop railway and ferry communication between Finland, the Baltic States, Poland, and other EU countries. The project assumes to connect by the common European track Tallinn, Riga, Warsaw, Berlin, and Helsinki. The route is planned to continue to Venice. The first stage of the railway construction is projected to be completed by 2013, the second stage – by 2020.

Figure 3-2 High-speed surface transportation in European countries

European high-speed mainlines 320-350 km/h 270-300 km/h 250 km/h 200-230 km/h Under construction

Lastly, the USA also turns its attention towards railroads: President Barak Obama promised to make the development of high-speed railway mainlines a priority of the country's transportation policy as far back as in 2009. Over 12 billion dollars was spent on the program. However, according to CNN the program failed: the funds were spent mainly to support the existing infrastructure, no new mainlines were built. Nevertheless the development of railroad communications is a national project of the USA up to 2030.

It appears that the majority of the world' regions have large-scale projects of railway development of some sort. However only a few decades ago it seemed that trains lost competition to cars and airplanes. In the mentioned USA government sponsored construction of highways and airports and "forgot" about trains, the result being only a single operating high-speed mainline Washington – Boston that passes through Baltimore, Philadelphia, and New York. The line's trains speed is not high, averaging only 110 kilometers per hour.

Given the widely-accepted drop of development of the world's economy and the forecast by the Ministry of Economic Development and Trade of a similar drop of growth rate of Russia's GDP to 2,4%, the resolution of the Government of the Russian Federation to assign funds for development and modernization of transportation infrastructure of the Far East with the aim of increasing

traffic capacity of Baikal-Amur Mainline and the Trans-Siberian Railway can hardly be overestimated.

The investments (amounting 260 bln. rubles) will be assigned during three years and will allow to virtually triple freight traffic to Far Eastern ports (by 25 mln. tons per annum) as compared to current figures.

RZD JSCo has rather ambitious plans. Firstly, it is HSML-1 (the High-speed Mainline), projected to link Moscow and Saint-Petersburg with a new railway line. Secondly, it is HSML-2 that shall connect Moscow and Yekaterinburg. Kazan and Samara, Omsk and Novosibirsk, Novorossiysk and Krasnoyarsk are also planned to be linked by an HSML.

However these projects have as of yet not been approved – today RZD only prepares investment justification of the projects. In 2006 RZD already adopted a project involving construction of 21 high-speed mainlines, but over seven years the projects never started. The state monopoly assures that private investments will be attracted to the HSML construction, but it is already obvious that realization of these extensive plans would require considerable state investments. It should be noted that the railway monopoly has its opponents, believing that it already has been given too much preference by the authorities in organizing passenger traffic.

At the transportation summit at Merano possibilities of attracting Italian, Spanish and German specialists to the development of the Moscow railway junction, and of development of a high-speed railroad Moscow-Kazan-Yekaterinburg, were discussed. Europeans are interested in development traffic potential of the Trans-Siberian Railway which will make it possible to deliver goods from China to the center of Europe in ten days.

Sources of information: http://lenta.ru/articles/2013/04/12/railways/,

http://ru.wikipedia.org/wiki/%D0%A1%D0%BF%D0%B8%D1%81%D0%BE%D0%BA_%D1%81%D1%82%D1%80%D0%B0%D0%BD_%D0%BF%D0%BE_%D0%B4%D0%BB%D0%B8%D0%BD%D0%B5_%D1%81%D0%B5%D1%82%D0%B8_%D0%B6%D0%B5%D0%BB%D0%B5%D0%B7%D0%BD%D1%8B%D1%85_%D0%B4%D0%BE%D1%80%D0%BE%D0%B3, http://www.rzd-partner.ru/interviews/blogs/sobytiia-zheleznodorozhnoi-otrasli/

Summary: recently the interest in the field of transportation increased considerably. All countries are unanimous in that investments in development of railway infrastructure are both necessary and advisable.

International experience demonstrates that development of high-speed railroad communication has a significant social and economic effect for any country. Investments in development of railroads, including advanced-speed and high-speed mainlines, bring a tremendous multiplicative effect to economy and social sphere due to development of railroads. It is expressed in development of regions, optimization of transportation network, stimulation of science-intensive production. Realization of infrastructural projects promotes creation of added value and growth of national wealth, "binds" state investments for a long time, resulting in inflation compensation. The development of transportation infrastructure forms a real foundation for modernization of economy and provides conditions for its growth. Without application of innovative solutions in transportation and in development of rolling stock progress is impossible.

Development of networks of advanced-speed and high-speed railroads is a priority for many countries. High-speed trains (High-speed Surface Transportation, HSST) have not yet reached the speeds of passenger jet planes, nevertheless diversion of passenger traffic from air

and motor transport to high-speed mainlines results in a considerable economy of energy resources and in some cases – of time.

On the whole a trend of growth of governmental support of railroad development (including support during the crisis period) is noticeable. Another important trend is the outrunning growth of state spending on railway transportation.

Based on the above world review of high-speed transportation and with the aim of further estimation of value of the assessed object the Appraiser has performed the analysis of cost of construction of 1 km of conventional high-speed railroad mainline on the basis of the information on the realized and planned for implementation projects for 2010-2013. The analysis follows below.

Table 3-4 Analysis of cost of construction of 1 km of conventional high-speed railroad mainline based on infrastructure as of the moment of data publication

Country	Line	Line length, km	Train travel speed, km/h	Stated investments as of the moment of data publication, currency	Currency	Stated investments 3 as of the moment of data publication, currency/km	Period	Source of information
Russia	Moscow-Yekaterinburg	2,100	350-400 km/h	2,500,000,000,000	rub.	1,190,476,190	information dated end of 2010, project not commenced	http://forum.nashtransport.ru/index.php?showtopic=3693&st=115
China	Shanghai – Suzhou	6		254,000,000	US dollars	42,333,333	statement dated end of 2010, commissioning in the end of 2012	http://www.begusha.com/info/shownew/206
Taiwan	Taipei-Kaohsiung	346	300 km/h	15,000,000,000	US dollars	43,352,601	information dated 2011	http://www.infuture.ru/article/392
Australia	West coast of the country	1,748	up to 350 km/h	120,000,000,000	US dollars	68,649,886	information dated April, 2013, project duration – 40 years	http://lenta.ru/articles/2013/04/12/railways/

Source of information: Internet

4 SELECTION OF PRINCIPLES AND METHODS OF ASSESSMENT

4.1 General description of the used principles and methods of assessment

In the estimation of the market value of the assessed object a most likely price at which the assessed object may be alienated is estimated as of the assessment date on commercial market in conditions of competition, with parties of the transaction acting reasonably basing on all the required information, the transaction price is not affected by any extraordinary circumstances, in other words, when:

- One of the parties of the transaction is not obliged to alienate the assessed object and the other party is not obliged to accept the transaction;
- The parties of the transaction are well informed about the object of the transaction and act in their best interests;
- The assessed object is offered to the commercial market by a public offer typical for similar assessed objects;
- The price of the transaction is a reasonable reward for the assessed object and there is no pressure to complete the transaction by any party;
- The payment for the assessed object is expressed in monetary form.

Methods used in estimation of value of objects of intellectual property (hereinafter OIP), are determined by the character of value type, and by the purpose of the assessment and the intended use of its results.

In estimation of OIP value methods of cost, comparative and income principles may be used.

Table 4-1 Recommended preference of the use of principles in estimation of ITAs and OIPs

ITA and OIP types	Primary priority	Secondary priority	Rarely used
Patents and technologies	**Income**	**Market**	**Cost**
Trade marks	Income	Market	Cost
Copyright objects	**Income**	**Market**	**Cost**
Skilled manpower	Cost	Income	Market
Information management software	Cost	Market	Income
Software products	Income	Market	Cost
Distribution networks	Cost	Income	Market
Core deposits	Income	Market	Cost
Franchise rights	Income	Market	Cost
Corporate practice and procedures	Cost	Income	Market

Each of the principles is realized through certain assessment methods.

Accordingly the most applicable method for assessment of intellectual property and know-hows is the income principle, then the comparative principle, and the cost principle is used rarely.

4.2 The cost concept

"The cost principle is a body of methods of estimation of value of an assessed object, based on estimation of costs necessary for reproduction or replacement of the assessed object with regard to its wear and obsolescence. Reproduction costs of an assessed object are the costs necessary to create an exact copy of the assessed object with the use of materials and technologies utilized in the creation of the assessed object. Replacement costs of an assessed object are the costs necessary to create a similar object with the use of materials and technologies utilized at the date of the assessment"[13].

The cost principle of assessment of an OIP is based on determination of costs, necessary for reproduction or replacement of an assessed object with regard to its technological obsolescence and economic wear. The cost principle is used if reconstruction or replacement of the assessed object and associated costs is possible.

Methods of the cost principle imply that the value of an OIP is determined not only by its utility which creates demand, but also by the supply of similar objects in a market, and this supply will take place when the value is higher than the producer's costs. Thus costs are an important criterion in composition of value, especially in the case of creation of a new, original OIP. A case is possible when investor itself is willing to create the object of interest and to bear certain expenses related therewith, that will reflect the value of the object. All these provisions are the basis of the cost principle of estimation of value of an OIP.

Within the cost principle of assessment of intangible assets (ITAs) several analytical methods are used. Each group of analytical methods uses a respective general definition of the cost type relevant to the performed assessment. The most widely used types, or definitions, of costs include:

- Reproduction costs.
- Replacement costs.

There are somewhat subtle but important differences between definitions of these two types of costs.

Reproduction costs involve creation (or purchase) of an exact copy of the assessed intangible asset. Before performing necessary adjustments for the aim of determination of cost parameter, reproduction costs do not account neither for market demand for the assessed intangible asset, nor for its market acceptance. In other words, before performing necessary assessment adjustments the estimated reproduction costs will not provide information on whether anyone will wish to have an exact copy of the assessed intangible asset at all (moreover, the issue is not examined).

Replacement costs involve costs for reproduction of utility of the assessed intangible asset; however such reproduced asset may differ considerably in form or in appearance from an exact copy of the actual assessed intangible asset. Utility is an economic concept, relating to the ability of the replacing object to provide an equivalent degree of satisfaction as compared to the assessed intangible asset.

All methods of the cost principle are usually connected with performance of comprehensive or all-including analysis of relevant constituent costs. Namely, all definitions of costs (i.e. costs of reproduction, replacement, etc.) usually include examination of all components of costs of materials, manpower, overheads, profit of the developer of the intangible asset (i.e. adequate margin

[13] *Federal Valuation Standard No. 1"General notions on assessment, principles and requirements for its performance", (FVS No. 1) enacted by decree of the Ministry of Economic Development and Trade of the Russian Federation of 20.07.2007, No. 256*

profit against the incurred expenses related to payments for materials, manpower and overheads), the entrepreneurial stimulus (i.e. profit of the developer of the intangible asset per capital, including expenses for coordination and labour inputs during the development period, adequate to stimulate the process of development of the intangible asset).

All these components or elements of costs must be encompassed within each specific type of costs, estimated with the use of each specific method of intangible assets assessment.

The value of an OIP is defined as the difference between the adjusted quantity of cost and the quantity of the accrued wear.

Summary: the cost principle is not applicable for assessment of the object in view of the fact that the assessed object is a complex object, involving the results of 35 years of intellectual, research and experimental activities of engineer Yunitskiy, certified by 99 patents for inventions, multiple scientific reports (over 100) and 18 monographs, by popular science articles (over 200), technical, technological, design and engineering know-hows (over 100) and other results of intellectual activities of the author and the owner of this intellectual property.

Retrospective expenses for the development of the assessed object cannot be reproduced and substantiated by actual documents, and their reproduction/replacement cannot be imitated hypothetically.

4.3 The comparative concept

"The Comparative concept is a body of methods of estimation of the value of an assessed object, based on comparison of the assessed object with similar objects that have price information available. An object similar to the assessed object is defined as an object similar to the assessed object in main economic, material, technological and other characteristics, determining its value".[14]

The comparative concept is based on the principle of an effectively operating market where investors purchase and sell similar assets while taking independent individual decisions. Data on similar transactions is compared to the assessed OIP. Economic advantages and disadvantages of the identified assets are accounted in comparison to the selected equivalents by introducing appropriate adjustments. Here adjustments that account for qualitative variations between the identified assets and their equivalents are introduced.

When using the methods of comparative sales analysis the following activities are performed:

1. Data on completed transactions for similar objects of intellectual property is gathered. OIPs similar in profit and revenue should be selected. Transaction markets of OIPs in the same industry will not be deemed comparable if their profitability is not the same.
2. Main criteria to be considered in selection of compared transactions: similar OIPs; uniform events and equivalence of compared objects; geographical coincidence of transactions; duration of agreement; exclusive rights; end of production; marketing support and distribution channels of the products.
3. A list of characteristics to be used in comparison of OIPs is determined.

[14] *Federal Valuation Standard No. 1"General notions on assessment, principles and requirements for its performance", (FVS No. 1) enacted by decree of the Ministry of Economic Development and Trade of the Russian Federation of 20.07.2007, No. 256*

4. Actual prices of OIPs are adjusted for the values of the compared characteristics of the identified OIP.
5. The value of the identified OIP is estimated basing on the adjusted actual data on comparable transactions.

Summary: the comparative concept is not applicable in the assessment of the assessed object of intellectual property, in view of the fact that the assessed object is a complex object, involving the results of 35 years of intellectual, research and experimental activities of engineer Yunitskiy, certified by 99 patents for inventions, multiple scientific reports (over 100) and 18 monographs, by popular science articles (over 200), technical, technological, design and engineering know-hows (over 100) and other results of intellectual activities of the author and the owner of this intellectual property.

The assessed object has no equivalent in Russia or anywhere in the world. For that reason methods of the comparative concept are not applicable to its assessment.

4.4 The income concept

The income concept is a body of methods of estimation of value of an assessed object, based on determination of expected revenues from the use of the assessed object[15].

A particular feature of assessment of an OIP is that the estimate of its market value is based, as a rule, on the use of a single standard concept – the income concept.

The income concept is based on estimation of economic benefits expected from the use of an OIP. The method involves estimation of income associated with the identified assets, capitalization (or discount) rates that reflect the level of risk related to the profitability of the OIP and its remaining economic service life.

For different methods of income concept of assessment of intangible assets various measures of economic income may be relevant.

Alternative measures of economic income include, in particular: gross or net earnings, gross revenue, net operating income, net revenue before taxes, net revenue after taxes, cash flow from operations, net cash flow and some other measures.

There are at least as many methods of the income concept to assess intangible assets, as there are measures of economic income. Nevertheless the majority of methods can be grouped in several categories of similar conceptual bases and similar practical applications. Let us describe some categories of methods of the income concept:

Premium profit methods. These are methods of quantitative assessment of added economic income (i.e. the owner will receive more economic income due to the ownership of the assessed intangible asset as compared to the situation when that person is not the owner of the asset).

Cost savings methods. These are methods of quantitative assessment of decrease of economic costs (i.e. due to the ownership of the assessed intangible assets the owner will bear economic costs, such as investments in capital assets, that would have been needed in other circumstances,

[15] Federal Valuation Standard No. 1"General notions on assessment, principles and requirements for its performance", (FVS No. 1) enacted by decree of the Ministry of Economic Development and Trade of the Russian Federation of 20.07.2007, No. 256

or operating costs – in smaller quantities as compared to the situation when that person is not the owner of the asset).

Royalty relief methods. These are methods of estimation of hypothetical royalties or license fees that the owner will be relieved of (i.e. sums of royalties and license payments that the owner would have to pay to an independent third party, owning the intangible asset in order to have the possibility to use the asset and accrue legal rights to it).

Revenues methods. These are methods of quantitative assessment of cost difference of a business or a similar economic subject in general in the result of ownership of the assessed intangible asset (and its use by a business) as compared to the case when the owner would not own the asset (and would not use it in a business). This group of methods suggests estimation of value of an intangible asset as the remainder of the value of the whole business (or of the value of a similar business).

Thus the ways of discriminating the economic effect together with the used mathematical tools (extended form of discounting of monetary concepts or a formula of express capitalization) lead to a system of classification of income concept methods (see the table below).

All of the methods of estimation of intangible assets value within the income concept are fully described and examined in the course book by A. N. Kozyrev and V. L. Makarov "Assessment of value of intangible assets and intellectual property," Moscow, "Interreklama", 2003, where all intangible assets assessment methods within the income concept are divided in three methods: D1, D2, D3, with a certain set of modifications.

The main methods of the income concept:

- D1 Method "Royalty relief";
- D2 Method "Discounting/capitalization of advantage in revenues";
- D3 Method "Discounting/capitalization of costs saving".

Table4-2 Methods of the income concept

<table>
<tr><td colspan="2" rowspan="2">Criteria of classification

Methods of discriminating of economic effect</td><td colspan="2">Used mathematical tools</td></tr>
<tr><td>Methods using the formula of discounted cash flow (DCF)</td><td>Methods using the express capitalization procedure</td></tr>
<tr><td rowspan="8">Methods based on assessment of actual economic effect</td><td>1. Above-limit profit</td><td>EVA methods</td><td>Surplus profit method</td></tr>
<tr><td>2. Price advantage</td><td rowspan="8">Advantage in profit methods</td><td rowspan="8">Approximate estimation methods (quick estimate)</td></tr>
<tr><td>3. Advantage in prime costs within variable costs</td></tr>
<tr><td>4. Advantage in prime costs within conditionally fixed costs</td></tr>
<tr><td>5. Advantage in volume of product sales</td></tr>
<tr><td>6. Economy on amount of investments</td></tr>
<tr><td>7. Actual license fees</td></tr>
<tr><td>Methods of simulation</td><td>8. "Royalty relief" method</td></tr>
</table>

Criteria of classification **Methods of discriminating of economic effect**		**Used mathematical tools**	
		Methods using the formula of discounted cash flow (DCF)	**Methods using the express capitalization procedure**
construction of economic effect	9. The method of estimation of licensor's share in licensee's income (the "25 percent rule")		

Each of the three main options may be executed in two modifications, indicated by letters (a) and (b). Modification (a) is based on capitalization of averaged income (cash flow), modification (b) – on discounting of expected cash flows (expected incomes).

In both cases either income (before or after taxes), or cash flow may be selected as the income index. The choice of income index is determined basing on the purposes of an assessment and the type of value to be estimated.

The D1 method of estimation of market value is the most popular among appraisers. It can be applied either in modification (a) with income capitalization (before taxes), or in modification (b) with discounting of the expected income (also before taxes).

Assumed license fees in the form of royalty – regular payments calculated as percent of proceeds collected as the result of sales of licensed products, are assumed as the calculation basis.

The advantages of the D1 method are: the possibility of its use in both assessment of ITA (rights to OIPs) already in use, and of rights to OIPs only intended to be used; relative simplicity of application; possibility to use standard industry royalty rates.

The D1(a) method is easier to apply and allows to use standard royalty rates as well, however it may be applied only in the process of assessment of an asset already in use, generating a stable income. In other cases application of the method results in not just crude but admittedly false estimates.

Capitalization is a simpler procedure than discounting. However it is advised to be applied in cases when the assessed object is already in use and has generated stable income, or when a rather crude estimate is required of an asset that will presumably generate stable income.

For assessment of an OIP used in an investment project it is, as a rule, advised to use the method of discounting of advantages in income.

The D2 and D3 methods are applicable for estimation of value of assets used by scientific and technical organizations (companies) that produce products using ITA independently. Here the D2 method is more suitable for estimation of exclusive rights to patentable solutions realized in products, and the D3 method – for assessment of technological know-hows.

The selection of the D2 or D3 methods is determined by specific conditions of the assignment. For example, to estimate the value of the use of know-hows the capitalization (discount) method of cost saving is preferable.

The D2 method allows to take into account not only advantages in income from sale of each product but also from expansion of market at the expense of competitors. In the cases when it is possible to calculate additional income received as the result of use of a specific intangible asset with adequate accuracy, the D2 method is preferable. As a rule there is no such possibility for scientific-technical organizations and enterprises. That is why the D3 method is used more often.

The essence of the D3 method is as follows. Effectiveness of production technology of a given enterprise is compared to that of technology used in production of similar products on other enterprises which does not have the assessed technological know-hows, but which sells its products at the prices as the examined enterprise. The comparison is performed in monetary terms; however it is more advisable to use physical indicators, such as: demand of electricity, materials, labour. (Otherwise the correlation between saving and know-how is doubtful).

The procedure of application of this method depends on the choice of specific modification: D3(a) or D3(b). First two stages of estimation are the same.

1. Cost savings are estimated for the whole volume of production, produced within a year. The estimation is performed for a succession of years during which exclusive ownership of know-how is assumed.
2. From the calculated sums expenses related to securing the confidentiality of information related to the know-how are deducted, and risks associated with the possibility of accidental disclosure of the know-how or of its independent development by competitors are accounted. Risk assessment consists in reducing the value of the expected savings by deducting penalties estimated by expertise.
3. If the expected savings differ considerably for various years of the examined period than the D2(b) method is used. For each year within the base period discount factor is calculated. The revenues expected from cost saving are multiplied by respective factors. As a result a set of discounted receipts is produced.
4. Reduced value of cost saving for the total period of use of the know-how is determined. For this purpose discounted revenues from cost saving are summed up.

Is it possible to use methods based on assessment of cost saving in assessment of and ITA not used at the moment of the assessment?

To solve this problem the "Slider rule" or the "25% rule" is used.

The basic idea of the "Slider rule" of cost assessment is that the overall value created by transaction (license) must be distributed fairly between the seller and the buyer of the license.

An agreement reached by the interested seller and buyer shall be considered as a value-creating event. Digressing for a moment from the issue of who receives what portion of the created value, it is important to note that the transaction will necessarily create benefit expectation. If it would have been otherwise neither the buyer, nor the seller would wish to conclude the agreement.

According to the "25% rule" a fair distribution of conditional 100% of saving is 25% for the seller and 75% for the buyer. Thus in this simple example royalty rate shall be 25% of the saving per one unit of the produced product, with some conditions allowing for possible changes of the saving benefit in time.

When the "25% rule" is used to estimate value of an ITA not in use as of the moment of assessment, based on estimation of cost saving, the following procedure is used:

1. Estimation of annual figures of saving with the use of the ITA;
2. Estimation of licensor's share in this saving;
3. Estimation of costs of maintenance or redesign of the ITA;
4. Estimation of annual cash flows from the ITA with regard of revenue and costs components;

5. Estimation of discount rate;
6. Discounting of cash flows and calculation of current value of the ITA.

Source of information: A. N. Kozyrev and V. L. Makarov "Assessment of value of intangible assets and intellectual property," Moscow, "Interreklama", 2003, p. 153, item 3.5.

Summary: the income principle is based on estimation of actual simulated economic benefits expected from the use of an IP object. This concept consists of estimation of the value of economic income generated by the assessed object and of capitalization (discount) rates accounting for degree of rick related with profitability of the IP object and for the remaining economic service life.

The following documents were provided to the Appraiser by the Customer: description of the assessed object, including its quantitative and qualitative characteristics, level of capital expenses for construction, time schedule of construction, and major parameters of investment project employing the assessed object.

Consequently the Appraiser is able to perform assessment of the assessed object using the income concept, with the method of discounted cash flows, based on estimation of actual economical effect created on the basis of saving in the amount of investment expenditures, necessary for construction of the String-rail Transportation System of Engineer Yunitskiy, as compared to the amount of investment expenditures necessary for construction of a transportation system of conventional high-speed railway transport with technologies available as of the assessment date.

Since the assessed object is not in use and requires certain time and monetary expenditures for redesign, certification, expert examination, etc., the "25% rule" was used to discriminate the share of economic income due to the owner of the assessed object.

The Appraiser believes that the information provided by the Customer and the information obtained by the Appraiser during market research, is adequate to estimate the value of the assessed object by means of the income concept, using the method of discounted cash flows that reflect the actual economic effect of the use of the assessed object.

Therefore the Appraiser made a decision to perform estimation of the value of the assessed object by means of the income concept, using the method of discounted cash flows (the methods of discrimination of actual economic effect).

4.5 Summary of the selection of concepts and methods of assessment

Based on the data available to the Appraiser and the purpose of the assessment the Appraiser believes that in order to perform estimation of market value of the assessed object it is appropriate to use the income concept, the method of discounted cash flows based on discrimination of actual economic effect in the form of saving of investment expenditures. The use of this concept and method, in the opinion of the Appraiser will allow to arrive at an unbiased and the most adequate and reliable estimation of market value of the assessment object.

5 ESTIMATION OF VALUE OF THE ASSESSED OBJECT USING THE INCOME PRINCIPLE

5.1 Calculation procedure

The Appraiser made a decision that for estimation of market value of the assessed object it is appropriate to use the income principle, with the method of discounted cash flows based on discrimination of actual economic effect in the form of saving of investment expenditures. In the opinion of the Appraiser the use of this concept and method will allow to produce an unbiased and the most adequate and reliable estimation of market value of the assessment object.

Estimation under the method of discounting of cash flows is performed in stages and includes successive calculation of the following indicators of the assessed object:

1. Analysis of the base information provided by the Customer and of the data of the market research performed by the Appraiser;
2. Selection of cash flow model and the method for its estimation;
3. Assessment of the forecast period;
4. Analysis and forecast of capital expenditures saving;
5. Estimation of the amount of cash flow from the saving for each year of the forecast period;
6. Estimation of licensor's share of this saving;
7. Estimation of the ITA maintenance or redesign costs;
8. Estimation of annual cash flows from the ITA with regard of revenue and costs components;
9. Estimation of discount rate;
10. Estimation of current value of future cash flows as of the date of assessment (the value of the assessed object as of the date of assessment).

5.2 Selection of cash flow model and the method for its estimation

As was stated earlier for this assessment the Appraiser chose to simulate cash flows reflecting actual economic effect, including capital expenditures saving due to the use of the assessed object.

Summary: estimation of cash flows was performed on the basis of cash flows, reflecting actual economic effect, including capital expenditures saving.

Depending on whether cash flow accounts for inflation component, nominal and actual cash flows are distinguished (the former, in contrast to the latter, accounts for the effect of inflation).

Based on the information provided by the Customer and on the market research performed by the Appraiser it can be concluded that the market of the assessment object (the market of high-speed railway traffic) is liable to fluctuations and presently experiences an unstable period, caused by both the inflation component, and by other external factors in the world's freight and passenger traffic market.

The monograph by A. Damodaran titled "Investment assessment" (it has already run into several editions in Russian) presents quite solid justifications of the necessity to analyze of the effect of inflation in the estimation of the results of a company's activities or of an investment project. He states the following: "in the conditions of a high and stable inflation the estimation is often expressed in real terms… This means that cash flows are estimated on the basis of real growth rate, disregarding the growth resulting from high price inflation. In order to perform a consistent estimation, the discount rates used in such case must be real discount rates. That is, if proceeds were estimated without regard to effect of inflation (the inflation component was left out) then a corresponding discount rate must be determined with the same exception."[16]

Summary: the estimation of cash flows from the assessed object was performed on the basis of real cash flows, without regard to inflation component. For discounting of the cash flows such respective discount rate will be determined that will also be estimated excluding this effect.

5.3 Estimation of forecast period and of other parameters of the investment project

According to the method of discounting of cash flows the value of the assessed object is estimated on the basis of future cash flows within the forecast period.

Forecast period is a duration within which monetary income is forecasted. As the forecast period a duration lasting until cash flows growth rates stabilize or come to zero, is assumed.

Based on the information provided by the Customer the Appraiser set the forecast period to 55 years, including the first 3 years necessary for development of engineering documentation, construction of test site, certification, various expert examinations and other activities concerning the assessed object, within all of the 55 years the construction of 1 mln. km of string-rail trestle railway lines all over the world is planned.

Since the development of engineering documentation, construction of test site, certification, various expert examinations and other activities concerning the assessed object within the first 3 years of the forecast period will also need investments, the Appraiser, based on the information of the Customer, projected respectively 50, 100 and 150 mln. US doll. for these expenses.

Distribution of the length of the transportation system among countries of the world is shown in the table below. The infrastructural network of railroads of "the second level," with total length of 1 mln. km., proposed within this Report, is divided into regions (zones) proportionally to the area of territory of a country and its population (total land area of the planet is 149 mln. km^2, its population totals 7,143 mln. residents):

1. China (9,60 mln. km2, 1.357 mln. residents) – 130.000 km.
2. India (3,29 mln. km2, 1.234 mln. residents) – 95.000 km
3. Russia (17,10 mln. km2, 143 mln. residents) – 70.000 km.
4. The USA (9,52 mln. km2, 316 mln. residents) – 50.000 km.
5. Brazil (8,51 mln. km2, 198 mln. residents) – 40.000 km.
6. Canada (9,98 mln. km2, 34 mln. residents) – 30.000 km.

[16] *Sources of information:* http://www.sroarmo.ru/info/articles/article012

7. Australia (7,69 mln. km2, 24 mln. residents) – 25.000 km.
8. Indonesia (1,90 mln. km2, 245 mln. residents) – 25.000 km.
9. Mexico (1,97 mln. km2, 117 mln. residents) – 15.000 km.
10. Pakistan (0,80 mln. km2, 179 mln. residents) – 15.000 km.
11. Nigeria (0,92 mln. km2, 167 mln. residents) – 15.000 km.
12. Democratic Republic of Congo (2,35 mln. km2, 70 mln. residents) – 13.000 km.
13. Argentina (2,77 mln. km2, 41 mln. residents) – 12.000 km.
14. Iran (1,65 mln. km2, 77 mln. residents) – 11.000 km.
15. Algeria (2,38 mln. km2, 36 mln. residents) – 11.000 km.
16. Bangladesh (0,14 mln. km2, 152 mln. residents) – 11.000 km.
17. Japan (0,38 mln. km2, 128 mln. residents) – 10.000 km.
18. Kazakhstan (2,72 mln. km2, 17 mln. residents) – 10.000 km.
19. Ethiopia (1,123 mln. km2, 91 mln. residents) – 10.000 km.
20. Saudi Arabia (2,15 mln. km2, 29 mln. residents) – 9.000 km.
21. Egypt (1,00 mln. km2, 83 mln. residents) – 9.000 km.
22. Sudan (1,89 mln. km2, 36 mln. residents, 31 mln. residents) – 8.000 km.
23. South African Republic (1,22 mln. km2, 51 mln. residents) – 8.000 km.
24. Turkey (0,78 mln. km2, 75 mln. residents) – 8.000 km.
25. Vietnam (0,33 mln. km2, 89 mln. residents) – 7.000 km.
26. Philippines (0,30 mln. km2, 92 mln. residents) – 7.000 km.
27. Peru (1,29 mln. km2, 30 mln. residents) – 7.000 km.
28. Tanzania (0,95 mln. km2, 48 mln. residents) – 7.000 km.
29. Columbia (1,14 mln. km2, 47 mln. residents) – 7.000 km.
30. Germany (0,36 mln. km2, 82 mln. residents) – 6.000 km.
31. France (0,55 mln. km2, 64 mln. residents) – 6.000 km.
32. Thailand (0,51 mln. km2, 66 mln. residents) – 6.000 km.
33. Libya (1,76 mln. km2, 7 mln. residents) – 6.000 km.
34. Mongolia (1,57 mln. km2, 3 mln. residents) – 6.000 km.
35. Chad (1,28 mln. km2, 11 mln. residents) – 6.000 km
36. Angola (1,25 mln. km2, 20 mln. residents) – 6.000 km.
37. Myanmar (0,68 mln. km2, 49 mln. residents) – 6.000 km.
38. Italy (0,30 mln. km2, 61 mln. residents) – 5.000 km.
39. Ukraine (0,60 mln. km2, 46 mln. residents) – 5.000 km.
40. Great Britain (0,24 mln. km2, 63 mln. residents) – 5.000 km.
41. Kenya (0,58 mln. km2, 43 mln. residents) – 5.000 km.
42. Niger (1,27 mln. km2, 17 mln. residents) – 5.000 km.
43. Venezuela (0,91 mln. km2, 30 mln. residents) – 5.000 km.
44. Afghanistan (0,65 mln. km2, 33 mln. residents) – 5.000 km.
45. Spain (0,50 mln. km2, 46 mln. residents) – 5.000 km.
46. Mali (1,24 mln. km2, 15 mln. residents) – 5.000 km.

47. Republic of Korea (0,10 mln. km2, 50 mln. residents) – 4.000 km.
48. Bolivia (1,10 mln. km2, 10 mln. residents) – 4.000 km.
49. Mauritania (1,03 mln. km2, 4 mln. residents) – 4.000 km.
50. Mozambique (0,80 mln. km2, 24 mln. residents) – 4.000 km.
51. Chili (0,76 mln. km2, 18 mln. residents) – 4.000 km.
52. Madagascar (0,59 mln. km2, 22 mln. residents) – 4.000 km.
53. Yemen (0,53 mln. km2, 26 mln. residents) – 4.000 km.
54. Uzbekistan (0,45 mln. km2, 30 mln. residents) – 4.000 km.
55. Morocco (0,45 mln. km2, 33 mln. residents) – 4.000 km.
56. Iraq (0,44 mln. km2, 34 mln. residents) – 4.000 km.
57. Poland (0,31 mln. km2, 39 mln. residents) – 4.000 km.
58. Malaysia (0,33 mln. km2, 30 mln. residents) – 3.000 km.
59. Namibia (0,83 mln. km2, 2,3 mln. residents) – 3.000 km.
60. South Sudan (0,62 mln. km2, 8,3 mln. residents) – 3.000 km.
61. Cameroon (0,48 mln. km2, 20 mln. residents) – 3.000 km.
62. Zambia (0,75 mln. km2, 14 mln. residents) – 3.000 km.
63. Uganda (0,24 mln. km2, 36 mln. residents) – 3.000 km.
64. Nepal (0,14 mln. km2, 31 mln. residents) – 2.600 km.
65. Ghana (0,24 mln. km2, 26 mln. residents) – 2.500 km.
66. Cote d'Ivoire (0,46 mln. km2, 7,2 mln. residents) – 2.500 km.
67. DPRK (0,12 mln. km2, 25 mln. residents) – 2.200 km.
68. Romania (0,24 mln. km2, 21 mln. residents) – 2.200 km.
69. Zimbabwe (0,39 mln. km2, 13 mln. residents) – 2.200 km.
70. Burkina-Faso (0,27 mln. km2, 18 mln. residents) – 2.200 km.
71. Syria (0,19 mln. km2, 21 mln. residents) – 2.100 km.
72. Somali (0,64 mln. km2, 9.8 mln. residents) – 2.000 km.
73. Central African Republic (0,62 mln. km2, 4,6 mln. residents) – 2.000 km.
74. Botswana (0,58 mln. km2, 2,1 mln. residents) – 2.000 km.
75. Turkmenistan (0,49 mln. km2, 5,2 mln. residents) – 2.000 km.
76. Ecuador (0,28 mln. km2, 15 mln. residents) – 2.000 km.
77. Papua-New Guinea (0,46 mln. km2, 7,2 mln. residents) – 2.000 km.
78. Sweden (0,45 mln. km2, 9,5 mln. residents) – 2.000 km.
79. Republic of Congo (0,34 mln. km2, 4,2 mln. residents) – 1.900 km.
80. Paraguay (0,41 mln. km2, 6,3 mln. residents) – 1.800 km.
81. Republic of China (Taiwan) (0,04 mln. km2, 23 mln. residents) – 1.800 km.
82. Sri-Lanka (0,07 mln. km2, 21 mln. residents) – 1.700 km.
83. Finland (0,34 mln. km2, 5,4 mln. residents) – 1.600 km.
84. Guinea (0,25 mln. km2, 10 mln. residents) – 1.600 km.
85. Senegal (0,20 mln. km2, 13 mln. residents) – 1.600 km.
86. Cambodia (0,18 mln. km2, 14 mln. residents) – 1.600 km.

87. Malawi (0,12 mln. km2, 16 mln. residents) – 1.600 km.
88. The Netherlands (0,04 mln. km2, 17 mln. residents) – 1.400 km.
89. Belarus (0,21 mln. km2, 9,5 mln. residents) – 1.400 km.
90. Tunisia (0,18 mln. km2, 11 mln. residents) – 1.400 km.
91. Norway (0,32 mln. km2, 5,1 mln. residents) – 1.400 km.
92. Oman (0,31 mln. km2, 2,8 mln. residents) – 1.200 km.
93. New Zealand (0,27 mln. km2, 4,5 mln. residents) – 1.200 km.
94. Laos (0,24 mln. km2, 6,3 mln. residents) – 1.200 km.
95. Greece (0,13 mln. km2, 11 mln. residents) – 1.200 km.
96. Portugal (0,09 mln. km2, 11 mln. residents) – 1.100 km.
97. Benin (0,11 mln. km2, 9,4 mln. residents) – 1.100 km.
98. Cuba (0,10 mln. km2, 11 mln. residents) – 1.100 km.
99. Kyrgyzstan (0,20 mln. km2, 5,7 mln. residents) – 1.100 km.
100. Azerbaijan (0,09 mln. km2, 9,2 mln. residents) – 1.000 km.
101. Gabon (0,27 mln. km2, 1,6 mln. residents) – 1.000 km.
102. Tajikistan (0,14 mln. km2, 8,0 mln. residents) – 1.000 km.
103. Other countries, domains and territories – 104.500 km.

The listed 102 countries account for 895,500 km of the proposed trestle type railways, so the remaining 104,500 km of the "second type" of the 1,000,000 km will account for the rest 163 countries, dominions and territories.

For the purposes of this Report the duration of the forecast period is assumed to be 55 years, starting with the date of assessment, May 20, 2013.

5.4 Estimation of cash flows from capital expenditure saving

Estimation of values and periods of realization of capital investments in construction of world-wide network of string-rail transportation system designed by engineer Yunitskiy with total length of 1 mln. km. is based on the information provided by the Customer.

Based on the information provided by the Customer the Appraiser estimated that averaged cost of construction of 1 km. of transportation system of Yunitskiy including the required infrastructure (stations, servicing depots, switches, etc.) and without the cost of rolling stock, amounts to 13,449,013 US doll./km.

Based on the market research performed previously the Appraiser estimated world average cost of construction of a conventional high-speed railway mainline, also including the necessary infrastructure and excluding the cost of rolling stock at 52,121,862 US doll./km (part 3, item 3.3 of the Report).

Since analytical information contained figures of investment sums of various dates (2010 to 2013) the Appraiser conduced these investment amounts to the assessment date using price indexes for engineering equipment, construction and assembly works in corresponding country, with the use of the Interregional Information and Analytical Bulletin CO-INVEST (price indexes for construc-

tion), part 82, January, 2013, for Russia, and data on similar indexes for other countries from Internet[17].

Further the Appraiser estimated the value of savings of capital investment expenditures for the construction of the String-rail Transportation System of Yunitskiy as compared to world average cost of construction of similar conventional high-speed railway mainline – in the amount of 38,672,849 US doll./km.

All calculations are shown in the table below.

The value of savings of capital investment expenditures was estimated at 38,672,849 US doll./km of the transportation mainline as of the assessment date, May, 20, 2013.

[17] *Sources of information: http://www.ereport.ru/stat.php?razdel=country&count=china&table=inecia, http://novostiua.net/ekonomika/3817-inflyaciya-v-kitae-v-2012-godu-sostavit-4.html*

Table5-1 Analysis of cost of 1 km of a conventional high-speed railroad mainline

Country	Mainline	Currency	Projected amount of investment as of the date of publication, currency/km	Duration	Source of information	Price index from the announcement date till the assessment date	Exchange rate of the currency to US doll. as of the assessment date	Cost as of assessment date, US doll./km
Russia	Moscow - Yekaterinburg	rub.	1,190,476,190	information dated end of 2010, project not commenced	http://forum.nashtransport.ru/index.php?showtopic=3693&st=115	1.224	31.393	46,428,292
China	Shanghai - Suzhou	US doll.	42,333,333	statement dated end of 2010, commissioning in the end of 2012	http://www.begusha.com/info/shownew/206	1.131	1.000	47,889,038
Taiwan	Taipei - Kaohsiung	US doll.	43,352,601	information dated 2011	http://www.infuture.ru/article/392	1.050	1.000	45,520,231
Australia	East coast of the country	US doll.	68,649,886	information dated April, 2013, project duration – 40 years	http://lenta.ru/articles/2013/04/12/railways/	1.000	1.000	68,649,886
Average value of cost of construction of 1 km of a conventional high-speed railway mainline								**52,121,862**
Capital expenditures on construction of the Transportation System of engineer Yunitskiy								**13,449,013**
ECONOMY, US doll./km								**38,672,849**

Source of information: estimation of the Appraiser

5.5 Estimation of licensor's share of the saving

Since the assessed object is not in use and still requires certain time and cash expenditures for re-design, certification, expert examination, etc., in order to discriminate the licensor's share of economic income the Appraiser made a decision to use the "25% rule" after prior analysis of the four elements being the basis of the "Slider rule":

- Full cost (or value);
- Proportional distribution (discrimination);
- Investment;
- Risk.

Full cost

As the result of the transaction the buyer (licensee) will be able to produce products and service which will create a flow of income. It is assumed that in future the buyer of the license will become the seller of products produced with the use of the technology. It is the licensee that will receive all the revenues from all the sales, and their share shall further be distributed between the licensee and the licensor/seller. The distributed income will be received gradually, in the course of many years.

Proportional distribution

The second element is proportional distribution. This is the essence of application of the "Slider rule" in cost assessment. Proportional distribution in the "25 percent rule" is 25 percent of the full value for the licensor (the seller) and 75 percent for the licensee (the buyer).

There is a long list of the above mentioned business processes that the buyer shall implement and apply in order to realize the value of the technology. Many, if not all of these processes may be viewed as productive assets which the buyer has created before the transaction and which need to be intensified to draw value from the technology. Than the "25 percent rule" states that 75 percent of work necessary in order to convert the unprocessed (created but practically realized) engineering technology into cash of a client, will be performed by the licensee with the use of vast productive assets in its possession and developed by it independently, however these assets are also needed for commercialization of the technology.

It is fair to say that development of technology for production of a new product or service is one big step. Making it manufacturable is the second big step. The third and the fourth steps in this succession are production and sale of the product. That is why development of a technology is one of four big steps to commercialization, thus one fourth is determined, or 25 percent of the value.

Investment

The third value is investment. The licensor made investment to bring the technology to its current state. From this stage on the licensee independently or, in some cases with the aid of the licensor must make further investments in order to develop the product and the business. When two parties developing business start at the same stage usually the reward is distributed in the same way as the complete value of investment: whoever does the most of the work receives the major part of the reward. This principle is universal. Since under a license transaction the parties did not start at the same stage by definition, there was a period when only the licensor invested its capital and there will be a period when only the licensee will invest capital. In addition to varying timing of

investments the amount of investments will most likely vary, as will the risk of such investments. That is why it should not come as a surprise that 50:50 distribution is rarely used.

Risk

The above argumentation leads us to the fourth and the final element: risk. Not all investments result in equal output. It would be appropriate to mention that the higher investment risk usually borne by the licensor deserves a higher output proportionally to the amount of the investment, than the lower investment risks borne by the licensee with all other factors equal. The majority of new technology projects starting as concepts fail. Thought failure may occur on any stage including after launching the product in the market, it is well known that the rate of unforeseen consequences occurrence in new ideas is the highest during the research and development stage which usually precedes licensing.

5.6 Estimation of discount rate

Mathematically the value of capital is the interest rate used to convert future income flows into the unified quantity of current value. Economically the value of capital is an alternative profitability that may be achieved in stock market by investing in securities similar in risk and maturity date to the assessed subject of investment.

There are several approaches to estimation of discount rate. Three models are used most often in practice: Capital Asset Pricing Model (CAPM), the cumulative arrangement model, and the multiplier model.

The Appraiser made a decision to estimate the discount rate with the cumulative arrangement method, since there is not enough long-term statistical data for β-factor to construct the CAPM model (the project uses intellectual property with no equivalents around the world), the multiplier model is not applicable here since the Appraiser has not found equivalent comparable realized investment projects in the market, the project is unique.

The cumulative assessment method is determined with the following formula:

$$r_m = r_f + r_i, \quad where$$

r_m – discount rate for the investment project;

r_f – risk-free yield rate;

r_i – the rate accounting for the degree of investment risk for the assessed object.

Hypothetically the ***risk-free yield rate*** equals to profitability of a security or a security portfolio that are in no circumstances liable to risk of default, thus it does not correlate with other profitabilities of the economy. Theoretically the best matter of the risk-free yield rate would be profitability of an investment portfolio with a null beta. However putting together such null-beta portfolios is expensive and quite complicated, this tool of assessment of a risk-free rate is not used. In global practice usually yield rate on long-term state promissory notes (bonds or bills of exchange) with investment duration similar to the assessed project are used as the risk-free yield rate.[18] For the estimation the Appraiser assumed the value of yield rate of the US thirty-years state promissory notes (Government Bonds) amounting 3,18 % as of the assessment date.

[18] Copeland T., Moel A. Comments on beta and on the risk-free rate when using the CAPM to calculate WACC. Monitor Group, July 2003; Coupland T., Koller T., Murrin D. Company value: assessment and management / Translation - M.: "Olymp-Busines", 2000, p. 283

Figure 5-1 Yield rates of Government Bonds as of the assessment date

Source of information: Bloomberg Agency, http://www.bloomberg.com/markets/rates-bonds/government-bonds/us/

Firstly, this long-term interest rate reflects the duration of cash flows of the investment project more accurately than the others. In fact it is geometrical mean of expected short-term rates of treasury bills during the whole of the assessment period. Secondly, a long-term interest rate is more stable over time, and thus, is less risky than a short-term one. This rate is defined by a lesser sensitivity to sudden inflation fluctuations, and by lower liquidity premium as related to rates of longer periods.

Thirdly, the time duration of the rate is similar to the one of a share portfolio of market index, and thus it is compatible with the beta and the market risk premium related to market portfolio.

The rate accounting for investment risk degree. Risk premium was estimated by the aggregated method on scale of risk premiums at 19%. This method is described in the "Regulations of assessment of effectiveness of investment projects in competitive allocation of centralized investment resources of the Russian Federation" (enacted by Decree of Government of the Russian Federation No.1470 dated November 22, 1997).

The regulations describe the recommended procedure of discount rate estimation for analysis of a project. The following "ladder" of risk premiums is proposed (see the table below).

Table 5-2 The procedure of risk premium estimation used in competitive allocation of centralized investment resources of the budget of the Russian Federation

Project type	Risk premium
Investments in intensification of production based on assimilated equipment	3 – 5%
Increase of sales of the existing products	8 – 10%
Production and market promotion of a new product	13 – 15%
Investments in research and innovations	**18 – 20%**

Source of information: Series of procedural documentation on the subject of "Practice of commercial assessment and expert examination of industrial investment projects". Alt-Invest CJSC, Moscow, 2006, p. 71.

Since the String-rail transportation System of engineer Yunitskiy lies in the category of innovations requiring the development of engineering documentation, certification, expert examination and other works prior to actual implementation in an investment project of construction of the transportation system itself, the investment risk premium was assumed to be the average of the last range (investments in research and innovations) – 19 %.

Based on all the presented data of the components of discount rate of the cumulative arrangement model the calculation of the discount rate of the object assessed within this Report is as follows:

$$r_{ж} = 3{,}18\% + 19{,}00\% = 22{,}18\%$$

Consequently the discount rate for the assessed object is estimated in the amount of 22,18%.

5.7 Estimation of the value of the assessed object

The Appraiser further performed estimation of the following indicators:

1. Total cash flow by years of the forecast period (cash flow owing to saving);
2. Discount multipliers by years of the forecast period (at the middle of each period);
3. Discounted cash flows from the assessed object;
4. The value of the assessed object in US doll., UK pound sterling, Euro, and Russian rubles at exchange rates as of the date of assessment, May 20, 2013.[19]

The formula for estimation of discounted cash flows will be the following:

PV = FV * [1/(1+i)^n], where

FV – future value of monetary unit (cash flow, US doll.);

PV – present value of monetary unit (discounted cash flow);

i – yield rate (discount rate, %);

n – time factor (at the middle of each period for cash flows and at the end of the forecast period for reversion value).

[19] *http://www.cbr.ru/currency_base/daily.aspx?C_month=05&C_year=2013&date_req=20.05.2013*

Table 5-3 Estimation of value of the assessed object

Parameter	TOTAL	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Commissioning of mainlines (around the world), km	**1,000,000**	**0**	**0**	**0**	**5,000**	**10,000**	**15,000**	**20,000**
Mainline commissioning, progressive total, km	1,000,000	0	0	0	5,000	15,000	30,000	50,000
Costs of development of engineering documentation, certification, expert examination, etc., mln. US doll.	–15	–50	–100	–150	0	0	0	0
Savings of the licensee, mln. US doll.	38,672,849	0	0	0	193,364	386,728	580,093	773,457
Savings, mill. US doll./km	*38.673*	*38.673*	*38.673*	*38.673*	*38.673*	*38.673*	*38.673*	*38.673*
Royalty payments based on savings, mln. US doll.		0	0	0	48,341	96,682	145,023	193,364
Savings-based royalty rate, %	*25%*	*25%*	*25%*	*25%*	*25%*	*25%*	*25%*	*25%*
Cash flow, mln. US doll.	**9,764,594**	**-50**	**-100**	**-150**	**48,341**	**96,682**	**145,023**	**193,364**
Cash flow, progressive total, mln. US doll.	9,764,594	-50	-150	-300	48,041	144,723	289,746	483,111
Discounted cash flow, mln. US doll.	**400,867.433**	**-45.235**	**-74.046**	**-90.906**	**23,978.155**	**39,250.540**	**48,187.764**	**52,586.636**
Discounted cash flow, progressive total, mln. US doll.	400,867.433	-45.235	-119.280	-210.186	23,767.969	63,018.509	111,206.273	163,792.909
Time factor		*0.50*	*1.50*	*2.50*	*3.50*	*4.50*	*5.50*	*6.50*
i	*22.18%*	*22.18%*	*22.18%*	*22.18%*	*22.18%*	*22.18%*	*22.18%*	*22.18%*
i+1		*1.22*	*1.22*	*1.22*	*1.22*	*1.22*	*1.22*	*1.22*
Unit current value index		*0.9046903*	*0.7404570*	*0.6060378*	*0.4960204*	*0.4059752*	*0.3322763*	*0.2719564*

Source of information: estimation by the Appraiser

Continued

Parameter	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
Commissioning of mainlines (around the world), km	**20,000**	**20,000**	**20,000**	**20,000**	**20,000**	**20,000**	**20,000**	**20,000**
Mainline commissioning, progressive total, km	70,000	90,000	110,000	130,000	150,000	170,000	190,000	210,000
Costs of development of engineering documentation, certification, expert examination, etc., mln. US doll.	0	0	0	0	0	0	0	0
Savings of the licensee, mln. US doll.	773,457	773,457	773,457	773,457	773,457	773,457	773,457	773,6457
Savings, mill. US doll./km	*38.673*	*38.673*	*38.673*	*38.673*	*38.673*	*38.673*	*38.673*	*38.673*
Royalty payments based on savings, mln. US doll.	193,364	193,364	193,364	193,364	193,364	193,364	193,364	193,364
Savings-based royalty rate, %	*25%*	*25%*	*25%*	*25%*	*25%*	*25%*	*25%*	*25%*
Cash flow, mln. US doll.	**193,364**	**193,364**	**193,364**	**193,364**	**193,364**	**193,364**	**193,364**	**193,364**
Cash flow, progressive total, mln. US doll.	676,475	869,839	1,063,203	1,256,568	1,449,932	1,643,296	1,836,660	2,030,025
Discounted cash flow, mln. US doll.	**43,040.298**	**35,226.959**	**28,832.017**	**23,597.984**	**19,314.114**	**15,807.918**	**12,938.220**	**10,589.475**
Discounted cash flow, progressive total, mln. US doll.	206,833.207	242,060.165	270,892.182	294,490.167	313,804.280	329,612.198	342,550.419	353,139.893
Time factor	*7.50*	*8.50*	*9.50*	*10.50*	*11.50*	*12.50*	*13.50*	*14.50*
i	*22.18%*	*22.18%*	*22.18%*	*22.18%*	*22.18%*	*22.18%*	*22.18%*	*22.18%*
i+1	*1.22*	*1.22*	*1.22*	*1.22*	*1.22*	*1.22*	*1.22*	*1.22*
Unit current value index	*0.2225866*	*0.1821793*	*0.1491073*	*0.1220390*	*0.0998846*	*0.0817520*	*0.0669111*	*0.0547644*

Source of information: estimation by the Appraiser

Continued

Parameter	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23
Commissioning of mainlines (around the world), km	**20,000**	**20,000**	**20,000**	**20,000**	**20,000**	**20,000**	**20,000**	**20,000**
Mainline commissioning, progressive total, km	230,000	250,000	270,000	290,000	310,000	330,000	350,000	370,000
Costs of development of engineering documentation, certification, expert examination, etc., mln. US doll.	0	0	0	0	0	0	0	0
Savings of the licensee, mln. US doll.	773,457	773,457	773,457	773,457	773,457	773,457	773,457	773,457
Savings, mill. US doll./km	*38.673*	*38.673*	*38.673*	*38.673*	*38.673*	*38.673*	*38.673*	*38.673*
Royalty payments based on savings, mln. US doll.	193,364	193,364	193,364	193,364	193,364	193,364	193,364	193,364
Savings-based royalty rate, %	*25%*	*25%*	*25%*	*25%*	*25%*	*25%*	*25%*	*25%*
Cash flow, mln. US doll.	**193,364**	**193,364**	**193,364**	**193,364**	**193,364**	**193,364**	**193,364**	**193,364**
Cash flow, progressive total, mln. US doll.	2,223,389	2,416,753	2,610,117	2,803,482	2,996,846	3,190,210	3,383,574	3,576,939
Discounted cash flow, mln. US doll.	**8,667.110**	**7,093.722**	**5,805.960**	**4,751.973**	**3,889.321**	**3,183.272**	**2,605.395**	**2,132.423**
Discounted cash flow, progressive total, mln. US doll.	361,807.003	368,900.726	374,706.686	379,458.659	383,347.980	386,531,251	389,136.646	391,269.070
Time factor	*15.50*	*1650*	*17.50*	*18.50*	*19.50*	*20.50*	*21.50*	*22.50*
i	*22.18%*	*22.18%*	*22.18%*	*22.18%*	*22.18%*	*22.18%*	*22.18%*	*22.18%*
i+1	*1.22*	*1.22*	*1.22*	*1.22*	*1.22*	*1.22*	*1.22*	*1.22*
Unit current value index	*0.0448227*	*0.0366858*	*0.0300260*	*0.0245752*	*0.0201140*	*0.0164626*	*0.0134740*	*0.0110280*

Source of information: estimation by the Appraiser

Continued

Parameter	Year 24	Year 25	Year 26	Year 27	Year 28	Year 29	Year 30	Year 31
Commissioning of mainlines (around the world), km	**20,000**	**20,000**	**20,000**	**20,000**	**20,000**	**20,000**	**20,000**	**20,000**
Mainline commissioning, progressive total, km	390,000	410,000	430,000	450,000	470,000	490,000	510,000	530,000
Costs of development of engineering documentation, certification, expert examination, etc., mln. US doll.	0	0	0	0	0	0	0	0
Savings of the licensee, mln. US doll.	773,457	773,457	773,457	773,457	773,457	773,457	773,457	773,457
Savings, mill. US doll./km	*38.673*	*38.673*	*38.673*	*38.673*	*38.673*	*38.673*	*38.673*	*38.673*
Royalty payments based on savings, mln. US doll.	193,364	193,364	193,364	193,364	193,364	193,364	193,364	193,364
Savings-based royalty rate, %	*25%*	*25%*	*25%*	*25%*	*25%*	*25%*	*25%*	*25%*
Cash flow, mln. US doll.	**193,364**	**193,364**	**193,364**	**193,364**	**193,364**	**193,364**	**193,364**	**193,364**
Cash flow, progressive total, mln. US doll.	3,770,303	3,963,667	4,157,031	4,350,396	4,543,760	4,737,124	4,930,488	5,123,853
Discounted cash flow, mln. US doll.	**1,745.313**	**1,428.477**	**1,169.158**	**956.914**	**783.200**	**641.022**	**524.654**	**429.410**
Discounted cash flow, progressive total, mln. US doll.	393,014.383	394,442.860	395,612.018	396,568.932	397,352.132	397,993.154	398,517.807	398,947.218
Time factor	*23.50*	*24.50*	*25.50*	*26.50*	*27.50*	*28.50*	*29.50*	*30.50*
i	*22.18%*	*22.18%*	*22.18%*	*22.18%*	*22.18%*	*22.18%*	*22.18%*	*22.18%*
i+1	*1.22*	*1.22*	*1.22*	*1.22*	*1.22*	*1.22*	*1.22*	*1.22*
Unit current value index	*0.0090260*	*0.0073875*	*0.0060464*	*0.0049488*	*0.0040504*	*0.0033151*	*0.0027133*	*0.0022207*

Source of information: estimation by the Appraiser

Continued

Parameter	Year 32	Year 33	Year 34	Year 35	Year 36	Year 37	Year 38	Year 39
Commissioning of mainlines (around the world), km	**20,000**	**20,000**	**20,000**	**20,000**	**20,000**	**20,000**	**20,000**	**20,000**
Mainline commissioning, progressive total, km	550,000	570,000	590,000	610,000	630,000	650,000	670,000	690,000
Costs of development of engineering documentation, certification, expert examination, etc., mln. US doll.	0	0	0	0	0	0	0	0
Savings of the licensee, mln. US doll.	773,457	773,457	773,457	773,457	773,457	773,457	773,457	773,457
Savings, mill. US doll./km	*38.673*	*38.673*	*38.673*	*38.673*	*38.673*	*38.673*	*38.673*	*38.673*
Royalty payments based on savings, mln. US doll.	193,364	193,364	193,364	193,364	193,364	193,364	193,364	193,364
Savings-based royalty rate, %	*25%*	*25%*	*25%*	*25%*	*25%*	*25%*	*25%*	*25%*
Cash flow, mln. US doll.	**193,364**	**193,364**	**193,364**	**193,364**	**193,364**	**193,364**	**193,364**	**193,364**
Cash flow, progressive total, mln. US doll.	5,317,217	5,510,581	5,703,945	5,897,310	6,090,674	6,284,038	6,477,402	6,670,767
Discounted cash flow, mln. US doll.	**351.457**	**287.655**	**235.436**	**192.696**	**157.715**	**129.084**	**105.651**	**86.471**
Discounted cash flow, progressive total, mln. US doll.	399,298.675	399,586.330	399,821.766	400,014.461	400,172.176	400,301.260	400,406.910	400,493.381
Time factor	*31.50*	*32.50*	*33.50*	*34.50*	*35.50*	*36.50*	*37.50*	*38.50*
i	*22.18%*	*22.18%*	*22.18%*	*22.18%*	*22.18%*	*22.18%*	*22.18%*	*22.18%*
i+1	*1.22*	*1.22*	*1.22*	*1.22*	*1.22*	*1.22*	*1.22*	*1.22*
Unit current value index	*0.0018176*	*0.0014876*	*0.0012176*	*0.0009965*	*0.0008156*	*0.0006676*	*0.0005464*	*0.0004472*

Source of information: estimation by the Appraiser

Continued

Parameter	Year 40	Year 41	Year 42	Year 43	Year 44	Year 45	Year 46	Year 47
Commissioning of mainlines (around the world), km	**20,000**	**20,000**	**20,000**	**20,000**	**20,000**	**20,000**	**20,000**	**20,000**
Mainline commissioning, progressive total, km	710,000	730,000	750,000	770,000	790,000	810,000	830,000	850,000
Costs of development of engineering documentation, certification, expert examination, etc., mln. US doll.	0	0	0	0	0	0	0	0
Savings of the licensee, mln. US doll.	773,457	773,457	773,457	773,457	773,457	773,457	773,457	773,457
Savings, mill. US doll./km	*38.673*	*38.673*	*38.673*	*38.673*	*38.673*	*38.673*	*38.673*	*38.673*
Royalty payments based on savings, mln. US doll.	193,364	193,364	193,364	193,364	193,364	193,364	193,364	193,364
Savings-based royalty rate, %	*25%*	*25%*	*25%*	*25%*	*25%*	*25%*	*25%*	*25%*
Cash flow, mln. US doll.	**193,364**	**193,364**	**193,364**	**193,364**	**193,364**	**193,364**	**193,364**	**193,364**
Cash flow, progressive total, mln. US doll.	6,864,131	7,057,495	7,250,859	7,444,223	7,637,588	7,830,952	8,024,316	8,217,680
Discounted cash flow, mln. US doll.	**70.774**	**57.926**	**47.410**	**38.804**	**31.759**	**25.994**	**21.275**	**17.413**
Discounted cash flow, progressive total, mln. US doll.	400,564.155	400,622.081	400,669.491	400,708.294	400,740.054	400,766.048	400,787.323	400,804.735
Time factor	*39.50*	*40.50*	*41.50*	*42.50*	*43.50*	*44.50*	*45.50*	*46.50*
i	*22.18%*	*22.18%*	*22.18%*	*22.18%*	*22.18%*	*22.18%*	*22.18%*	*22.18%*
i+1	*1.22*	*1.22*	*1.22*	*1.22*	*1.22*	*1.22*	*1.22*	*1.22*
Unit current value index	*0.0003660*	*0.0002996*	*0.0002452*	*0.0002007*	*0.0001642*	*0.0001344*	*0.0001100*	*0.0000901*

Source of information: estimation by the Appraiser

Continued

Parameter	Year 48	Year 49	Year 50	Year 51	Year 52	Year 53	Year 54	Year 55
Commissioning of mainlines (around the world), km	**20,000**	**20,000**	**20,000**	**20,000**	**20,000**	**20,000**	**20,000**	**20,000**
Mainline commissioning, progressive total, km	870,000	890,000	910,000	930,000	950,000	970,000	990,000	1,010,000
Costs of development of engineering documentation, certification, expert examination, etc., mln. US doll.	0	0	0	0	0	0	0	0
Savings of the licensee, mln. US doll.	773,457	773,457	773,457	773,457	773,457	773,457	773,457	773,457
Savings, mill. US doll./km	*38.673*	*38.673*	*38.673*	*38.673*	*38.673*	*38.673*	*38.673*	*38.673*
Royalty payments based on savings, mln. US doll.	193,364	193,364	193,364	193,364	193,364	193,364	193,364	193,364
Savings-based royalty rate, %	*25%*	*25%*	*25%*	*25%*	*25%*	*25%*	*25%*	*25%*
Cash flow, mln. US doll.	**193,364**	**193,364**	**193,364**	**193,364**	**193,364**	**193,364**	**193,364**	**193,364**
Cash flow, progressive total, mln. US doll.	8,411,045	8,604,409	8,797,773	8,991,137	9,184,502	9,377,866	9,571,230	9,764,594
Discounted cash flow, mln. US doll.	**14.252**	**11.665**	**9.547**	**7.814**	**6.395**	**5.234**	**4.284**	**3.506**
Discounted cash flow, progressive total, mln. US doll.	400,818.987	400,830.652	400,840.199	400,848.013	400,854.408	400,859.643	400,863.927	400,867.433
Time factor	*47.50*	*48.50*	*49.50*	*50.50*	*51.50*	*52.50*	*53.50*	*54.50*
i	*22.18%*	*22.18%*	*22.18%*	*22.18%*	*22.18%*	*22.18%*	*22.18%*	*22.18%*
i+1	*1.22*	*1.22*	*1.22*	*1.22*	*1.22*	*1.22*	*1.22*	*1.22*
Unit current value index	*0.0000737*	*0.0000603*	*0.0000494*	*0.0000404*	*0.0000331*	*0.0000271*	*0.0000222*	*0.0000181*

Source of information: estimation by the Appraiser

Therefore the value of the assessed object estimated within the income concept with the discounted cash flows method, as of the assessment date, May 20, 2013, amounts to[20] 400,867,433,000 US doll.

The appraiser further performed estimation of the value of the assessed object in the currencies stated above[21].

Table 5-4 Estimation of the value of the assessed object in the following currencies: Russian ruble, Euro, UK pound sterling

Currency	Currency exchange rate to the Russian ruble	Conversion factor	Value in the currency
US dollar	31.3931	1.0000	400,867,433,000
Ruble of the Russian Federation	1.0000	31.3931	12,584,471,411,000
Euro	40.3747	0.7775	311,692,010,000
United Kingdom pound sterling	47.8274	0.6564	263,122,633,000

Source of information: estimation by the Appraiser, exchange rates of the Central Bank of the Russian Federation as of the assessment date (http://www.cbr.ru/currency_base/daily.aspx?C_month=05&C_year=2013&date_req=20.05.2013)

[20] *Rounded to 1 thous. US doll.*

[21] *At the exchange rates of the Central Bank of the Russian Federation as of the assessment date, value stated without VAT and rounded to 1 thousand units of currency*

6 COORDINATION OF THE ASSESSEMENT RESULTS AND ESTIMATION OF THE FINAL AMOUNT OF MARKET VALUE OF THE ASSESSED OBJECT

6.1 Coordination of the assessment results

Coordination of the results of application of the concepts is advisable if there are values obtained as the result of use of varying concepts of the assessment. Since only the income concept was used to estimate market value of assessed object the Appraiser assumed the amount estimated within the concept as the final amount of market value of the assessed object, with specific weight of 1.00.

6.2 Estimation of the final amount of market value of the assessed object

The results of estimation of the final amount of the market value of the assessed object are shown in the following calculation table[22]:

Table 6-1 Estimation of the final amount of the market value of the assessed object

Currency	Value estimated with the cost principle, currency	Value estimated with income principle, currency	Value estimated with comparative principle, currency	Final agreed market value, currency
US dollar	Not applied due to reasonable refusal	400,867,433,000	Not applied due to reasonable refusal	400,867,433,000
Ruble of the Russian Federation	Not applied due to reasonable refusal	12,584,471,411,000	Not applied due to reasonable refusal	12,584,471,411,000
Euro	Not applied due to reasonable refusal	311,692,010,000	Not applied due to reasonable refusal	311,692,010,000
United Kingdom pound sterling	Not applied due to reasonable refusal	263,122,633,000	Not applied due to reasonable refusal	263,122,633,000
Net value	-	*1,00*	-	

Source of information: calculations of the Appraiser

[22] *At the exchange rates of the Central Bank of the Russian Federation as of the assessment date, value stated without VAT and rounded to 1 thousand units of currency*

7 CONCLUSION ON THE VALUE OF THE ASSESSED OBJECT

In accordance with the Paid Services Agreement No. O-905 dated May 14, 2013, between Yunitskiy Anatoly Eduardovitch (the Customer) and HOLD-INVEST-AUDIT Consulting Company CJSC (the Contractor), the Appraiser of the Contractor performed assessment of market value of the object – exclusive intellectual property and know-how rights on the "String-and-rail Transportation System of Engineer Yunitskiy".

The assessment was performed as of May 20, 2013 and is stated in the Assessment Report No.O-905 dated May 22, 2013.

The assessment was performed and the Report was executed in compliance with the requirements of Federal Law dated July 29, 1998, No 135-FZ "On assessment activities in the Russian Federation", Federal Valuation Standards "General notions on assessment, principles and requirements for its performance" enacted by decree of the Ministry of Economic Development and Trade of the Russian Federation of July 20, 2007, No. 256, Federal Valuation Standard "Purpose of valuation and types of values" enacted by decree of the Ministry of Economic Development and Trade of the Russian Federation of July 20, 2007 No. 255, Federal Valuation Standard "Requirements to valuation report", enacted by decree of the Ministry of Economic Development and Trade of the Russian Federation of July 20, 2007, No. 254, Valuation Standards Code of the Russian Society of Appraisers (SSO ROO 2010).

The information characterizing the assessed object, the estimation procedures, the conclusions, the main assumptions of the assessment, as well as the other information used in the process of estimation of market value of the assessed object, is presented in respective sections of the Report. The constituent sections of this Report may not be interpreted separately, but only in relation to the complete text, with regard to all the assumptions and limitations contained therein. Any modifications in the base conditions and input data, affecting the assessment, will result in partial or complete revision of the Report. The Customer is responsible for reliability of the presented information.

Resulting from the performed investigation based on the available information and general and special assumptions as of the assessment date, May 20, 2013, the total market value of the assessed object at the exchange rates acting on the assessment date amounted to[23]:

12 584 471 411 000 (Twelve trillion five hundred eighty four billion four hundred seventy one million four hundred eleven thousand) rubles,

400 867 433 000 (Four hundred billion eight hundred sixty seven million four hundred thirty three thousand) US dollars,

311 692 010 000 (Three hundred eleven billion six hundred ninety two million ten thousand) Euro;

263 122 633 000 (Two hundred sixty three billion one hundred twenty two million six hundred thirty three thousand) UK pound sterling,

By countries of investment project implementation employing the assessed object:

[23] *At the exchange rates of the Central Bank of the Russian Federation as of the assessment date, value stated without VAT and rounded to 1 thousand units of currency*

Table 7-1 Market value of the assessed object by countries of investment project implementation employing the assessed object

No.	Country	Length of transportation network, km	Market value, rubles	Market value, US dollars	Market value, Euro	Market value, UK pound sterling
1	China	130,000	1,635,981,283,430	52,112,766,290	40,519,961,300	34,205,942,290
2	India	95,000	1,195,524,784,045	38,082,406,135	29,610,740,950	24,996,650,135
3	Russia	70,000	880,912,998,770	28,060,720,310	21,818,440,700	18,418,584,310
4	The USA	50,000	629,223,570,550	20,043,371,650	15,584,600,500	13,156, 131,650
5	Brasilia	40,000	503,378,856,440	16,034,697,320	12,467,680,400	10,524,905,320
6	Canada	30,000	377,534,142,330	12,026,022,990	9,350,760,300	7,893,678,990
7	Australia	25,000	314,611,785,275	10,021,685,825	7,792,300,250	6,578,065,825
8	Indonesia	25,000	314,611,785,275	10,021,685,825	7,792,300,250	6,578,065,825
9	Mexico	15,000	188,767,071,165	6,013,011,495	4,675,380,150	3,946,839,495
10	Pakistan	15,000	188,767,071,165	6,013,011,495	4,675,380,150	3,946,839,495
11	Nigeria	15,000	188,767,071,165	6,013,011,495	4,675,380,150	3,946,839,495
12	Democratic Republic of Congo	13000	163,598,128,343	5,211,276,629	4,051,996,130	3,420,594,229
13	Argentina	12,000	151,013,656,932	4,810,409,196	3,740,304,120	3,157,471,596
14	Iran	11,000	138,429,185,521	4,409,541,763	3,428,612,110	2,894,348,963
15	Algeria	11,000	138,429,185,521	4,409,541,763	3,428,612,110	2,894,348,963
16	Bangladesh	11000	138,429,185,521	4,409,541,763	3,428,612,110	2,894,348,963
17	Japan	10,000	125,844,714,110	4,008,674,330	3,116,920,100	2,631,226,330
18	Kazakhstan	10,000	125,844,714,110	4,008,674,330	3,116,920,100	2,631,226,330
19	Ethiopia	10,000	125,844,714,110	4,008,674,330	3,116,920,100	2,631,226,330
20	Saudi Arabia	9,000	113,260,242,699	3,607,806,897	2,805,228,090	2,368,103,697
21	Egypt	9,000	113,260,242,699	3,607,806,897	2,805,228,090	2,368,103,697
22	Sudan	8,000	100,675,771,288	3,206,939,464	2,493,536,080	2,104,981,064
23	South African Republic	8,000	100,675,771,288	3,206,939,464	2,493,536,080	2,104,981,064
24	Turkey	8,000	100,675,771,288	3,206,939,464	2,493,536,080	2,104,981,064
25	Vietnam	7,000	88,091,299,877	2,806,072 031	2,181,844,070	1,841,858,431
26	Philippines	7,000	88,091,299,877	2,806,072 031	2,181,844,070	1,841,858,431
27	Peru	7,000	88,091,299,877	2,806,072,031	2,181,844,070	1,841,858,431
28	Tanzania	7,000	88,091,299,877	2,806,072,031	2,181,844,070	1,841,858,431
29	Columbia	7,000	88,091,299,877	2,806,072,031	2,181,844,070	1,841,858,431
30	Germany	6,000	75,506,828,466	2,405,204,598	1,870,152,060	1,578,735,798
31	France	6,000	75,506,828,466	2,405,204,598	1,870,152,060	1,578,735,798
32	Thailand	6,000	75,506,828,466	2,405,204,598	1,870,152,060	1,578,735,798
33	Libya	6,000	75,506,828,466	2,405,204,598	1,870,152,060	1,578,735,798
34	Mongolia	6,000	75,506,828,466	2,405,204,598	1,870,152,060	1,578,735,798
35	Chad	6,000	75,506,828,466	2,405,204,598	1,870,152,060	1,578,735,798
36	Angola	6,000	75,506,828,466	2,405,204,598	1,870,152,060	1,578,735,798
37	Myanmar	6,000	75,506,828,466	2,405,204,598	1,870,152,060	1,578,735,798
38	Italy	5,000	62,922,357,055	2,004,337,165	1,558,460,050	1,315,613,165

No.	Country	Length of transportation network, km	Market value, rubles	Market value, US dollars	Market value, Euro	Market value, UK pound sterling
39	Ukraine	5,000	62,922,357,055	2,004,337,165	1,558,460,050	1,315,613,165
40	Great Britain	5,000	62,922,357,055	2,004,337,165	1,558,460,050	1,315,613,165
41	Kenya	5,000	62,922,357,055	2,004,337,165	1,558,460,050	1,315,613,165
42	Niger	5,000	62,922,357,055	2,004,337,165	1,558,460,050	1,315,613,165
43	Venezuela	5,000	62,922,357,055	2,004,337,165	1,558,460,050	1,315,613,165
44	Afghanistan	5,000	62,922,357,055	2,004,337,165	1,558,460050	1,315,613165
45	Spain	5,000	62,922,357,055	2,004,337,165	1,558,460,050	1,315,613,165
46	Mali	5,000	62,922,357,055	2,004,337,165	1,558,460,050	1,315,613,165
47	Republic of Korea	4,000	50,337,885,644	1,603,469,732	1,246,768,040	1,052490,532
48	Bolivia	4,000	50,337,885,644	1,603,469,732	1,246,768040	1,052,490,532
49	Mauritania	4,000	50,337,885,644	1,603,469,732	1,246,768,040	1,052,490,532
50	Mozambique	4,000	50,337,885,644	1,603,469,732	1,246,768,040	1,052,490,532
51	Chile	4,000	50,337,885,644	1,603,469,732	1,246,768,040	1,052,490,532
52	Madagascar	4,000	50,337,885,644	1,603,469,732	1,246,768,040	1,052,490,532
53	Yemen	4,000	50,337,885,644	1,603,469,732	1,246,768,040	1,052,490,532
54	Uzbekistan	4,000	50,337,885,644	1,603,469,732	1,246,768,040	1,052,490,532
55	Morocco	4,000	50,337,885,644	1603,469,732	1,246,768,040	1,052,490,532
56	Iraq	4,000	50,337,885,644	1,603,469,732	1,246,768,040	1,052,490,532
57	Poland	4,000	50,337,885,644	1,603,469,732	1,246,768,040	1,052,490,532
58	Malaysia	3,000	37,753,414,233	1,202,602,299	935,076,030	789,367,899
59	Namibia	3,000	37,753,414,233	1,202,602,299	935,076,030	789,367,899
60	South Sudan	3,000	37,753,414,233	1,202,602,299	935,076,030	789,367,899
61	Cameroon	3,000	37,753,414,233	1,202,602,299	935,076,030	789,367,899
62	Zambia	3,000	37,753,414,233	1,202,602,299	935,076,030	789,367,899
63	Uganda	3,000	37,753,414,233	1,202,602,299	935,076,030	789,367,899
64	Nepal	2,600	32,719,625,669	1,042,255,326	810,399,226	684,118,846
65	Ghana	2,500	31,461,178,528	1,002,168,583	779,230,025	657,806,583
66	Cote d'Ivoire	2,500	31,461,178,528	1,002,168,583	779,230,025	657,806,583
67	DPRK	2,200	27,685,837,104	881,908,353	685,722,422	578,869,793
68	Romania	2,200	27,685,837,104	881,908,353	685,722,422	578,869,793
69	Zimbabwe	2,200	27,685,837,104	881,908,353	685,722,422	578,869,793
70	Burkina-Faso	2,200	27,685,837,104	881,908,353	685,722422	578,869,793
71	Syria	2,100	26,427,389,963	841,821,609	654,553,221	552,557,529
72	Somali	2,000	25,168,942,822	801,734,866	623,384,020	526,245,266
73	CAR	2,000	25,168,942,822	801,734,866	623,384,020	526,245,266
74	Botswana	2,000	25,168,942,822	801,734,866	623,384,020	526,245,266
75	Turkmenistan	2,000	25,168,942822	801,734,866	623,384,020	526,245,266
76	Ecuador	2,000	25,168,942,822	801,734,866	623,384,020	526,245,266
77	Papua-New Guinea	2,000	25,168,942,822	801,734,866	623,384,020	526,245,266
78	Sweden	2,000	25,168,942,822	801,734,866	623,384,020	526,245,266

No.	Country	Length of transportation network, km	Market value, rubles	Market value, US dollars	Market value, Euro	Market value, UK pound sterling
79	Republic of the Congo	1,900	23,910,495,681	761,648,123	592,214,819	499,933,003
80	Paraguay	1,800	22,652,048,540	721,561,379	561,045,618	473,620,739
81	Republic of China (Taiwan)	1,800	22,652,048,540	721,561,379	561,045,618	473,620,739
82	Sri Lanka	1,700	21,393,601,399	681,474,636	529876,417	447,308,476
83	Finland	1,600	20,135,154,258	641,387,893	498,707,216	420,996,213
84	Guinea	1,600	20,135,154,258	641,387,893	498,707,216	420,996,213
85	Senegal	1,600	20,135,154,258	641,387,893	498,707,216	420,996213
86	Cambodia	1,600	20,135,154,258	641,387,893	498,707,216	420,996,213
87	Malawi	1,600	20,135,154,258	641387,893	498,707,216	420,996,213
88	the Netherlands	1,400	17,618,259,975	561,214,406	436,368,814	368,371,686
89	Belarus	1,400	17,618,259,975	561,214,406	436,368,814	368,371,686
90	Tunis	1,400	17,618,259,975	561,214,406	436,368,814	368,371,686
91	Norway	1,400	17,618,259,975	561,214,406	436,368,814	368,371,686
92	Oman	1,200	15,101,365,693	481,040,920	374,030,412	315,747,160
93	New Zealand	1,200	15,101,365,693	481,040,920	374,030,412	315,747,160
94	Laos	1,200	15,101,365,693	481,040,920	374,030,412	315,747,160
95	Greece	1,200	15,101,365,693	481,040,920	374,030,412	315,747,160
96	Portugal	1,100	13,842,918,552	440,954,176	342,861,211	289,434,896
97	Benin	1,100	13,842,918,552	440,954,176	342861,211	289,434,896
98	Cuba	1,100	13,842,918,552	440,954,176	342,861,211	289,434,896
99	Kyrgyzstan	1,100	13,842,918,552	440,954,176	342,861,211	289,434,896
100	Azerbaijan	1,000	12,584,471,411	400,867,433	311,692,010	263,122,633
101	Gabon	1,000	12,584,471,411	400,867,433	311,692,010	263,122,633
102	Tajikistan	1,000	12,584,471,411	400,867,433	311,692,010	263,122,633
103	Other countries, overseas dominions and territories	104,500	1,315,077,262,450	41,890,646,749	32,571,815,045	27,496,315,149

The Appraiser **_____/O. V. Krutskaya/**

8 ADDENDUM 1. DOCUMENTS CONFIRMING COMPETENCE OF THE ASSESSMENT

Форма № Р 5 0 0 0 3

Федеральная налоговая служба

СВИДЕТЕЛЬСТВО

о внесении записи в Единый государственный реестр юридических лиц

Настоящим подтверждается, что в соответствии с Федеральным законом "О государственной регистрации юридических лиц и индивидуальных предпринимателей" в Единый государственный реестр юридических лиц внесена запись о государственной регистрации изменений, вносимых в учредительные документы юридического лица

Закрытое акционерное общество Аудиторская компания "ХОЛД-ИНВЕСТ-АУДИТ"
(полное фирменное наименование юридического лица на русском языке с указанием организационно-правовой формы)

ЗАО Аудиторская компания "ХОЛД-ИНВЕСТ-АУДИТ"
(сокращенное фирменное наименование юридического лица на русском языке)

Основной государственный регистрационный номер 1 0 2 7 7 3 9 1 5 0 3 2 8

03 (число) декабря (месяц прописью) 2012 (год) за государственным регистрационным номером

9 1 2 7 7 4 7 1 5 4 7 8 0

Межрайонная инспекция Федеральной налоговой службы № 46 по г. Москве
(наименование регистрирующего органа)

Главный государственный налоговый инспектор Межрайонной ИФНС России № 46 по г. Москве — Н. П. Вздорик
(подпись, ФИО)

МП

серия 77 №016099374

Form R50003

Federal Tax Service
CERTIFICATE

of registering in the Unified State Register of Legal Persons

We hereby confirm that in compliance with Federal Law "On state registration of legal persons and private entrepreneurs" changes in constituent documents of a legal person were recorded in the Unified State Register of Legal Persons"

Closed Joint Stock Company HOLD-INVEST-AUDIT Consulting Company
(full company name and legal status of the legal person in Russian)

HOLD-INVEST-AUDIT Consulting Company CJSC
(short company name of the legal person in Russian)

Main state registration number 1027739150328

December 03, 2012 assigned state registration number
(month) (date)(year)

9127747154780

Inter-district Inspectorate No 46 of the Federal Tax Service, Moscow
(mane of regulating authority)

Chief State Tax Inspector
Of Inter-district I FTS of Russia */Signature/* N. P. Vzdorik
No 46, Moscow Official seal: *(illegible)*

Series 77 No 016099374

РООО

РОССИЙСКОЕ ОБЩЕСТВО ОЦЕНЩИКОВ

СВИДЕТЕЛЬСТВО
ОБ АККРЕДИТАЦИИ

Удостоверяет, что

ЗАО «Аудиторская компания «ХОЛД-ИНВЕСТ-АУДИТ»
г. Москва
аккредитовано при РОО и включено в Реестр оценщиков и оценочных фирм РОО

№ 0064/77-1111/01

ЗАО «Аудиторская компания «ХОЛД-ИНВЕСТ-АУДИТ»

признается профессионально занимающимся предоставлением оценочных услуг, включается в систему делового сотрудничества РОО в соответствии с Положением об аккредитации РОО от 03.04. 98г.

Президент НП «Партнерство РОО»
И.Л.Артеменков

13 марта 2013 г.

Действительно до 12.03.2016 г.

RSA
RUSSIAN SOCIETY OF APPRAISERS CJSC

CERTIFICATE OF
ACCREDITATION

To certify that

HOLD-INVEST-AUDIT Consulting Company CJSC
Moscow
Was accredited at the RSA and recorded in the Record of Appraisers and Valuation Companies of the RSA

No. 0064/77-1111/01
HOLD-INVEST-AUDIT Consulting Company CJSC
is deemed to professionally provide valuation services, is incorporated into the system of business cooperation of the RSA in compliance with Regulations on Accreditation in the RSA dated 03.04.1998.

the President of NP "RSA Partnership"
I. L. Artemenkov */Signature/*
Seal: *All-Russia non-governmental organization, OGRN 102770149146, Moscow, Russian Society of Appraisal*
March 13, 2013 *Valid till March 12, 2016*

ГУТА СТРАХОВАНИЕ

ПОЛИС № ГС4Т-ГОАД/000003-10
страхования гражданской ответственности
при осуществлении аудиторской деятельности

Настоящий полис выдан в подтверждение того, что заключен договор страхования № ГС4Т-ГОАД/000003-10 от 16 «июня» 2010г. (далее – «Договор») в соответствии с «Правилами добровольного страхования гражданской ответственности при осуществлении аудиторской деятельности» ЗАО «ГУТА-Страхование» (далее – «Правила страхования»)

СТРАХОВАТЕЛЬ:	*Закрытое акционерное общество Аудиторская компания «ХОЛД-ИНВЕСТ-АУДИТ»*
АДРЕС, ТЕЛЕФОН, ФАКС:	*101000, Москва, ул. Маросейка, дом 6/8; (495) 795-03-83*
ОБЪЕКТ СТРАХОВАНИЯ:	*Не противоречащие законодательству РФ имущественные интересы Страхователя, связанные с возникновением у него обязанности возместить причиненный им ущерб имущественным интересам третьих лиц в результате ошибки, небрежности или упущения при осуществлении Страхователем аудиторской деятельности (аудиторских услуг).*
СТРАХОВОЙ СЛУЧАЙ:	*Возникновение обязанности Страхователя возместить имущественный ущерб, причиненный третьему лицу в результате совершенной Страхователем ошибки, небрежности или упущения при осуществлении следующей аудиторской деятельности:* *- проведение обязательного аудита (в соответствии с требованиями законодательства РФ);* *- проведение инициативного аудита (добровольная проверка, проводимая по собственному желанию организации или индивидуального предпринимателя на основе заключенного с аудитором договора);* *- проведение налогового аудита (аудиторская проверка систем бухгалтерского и налогового учета организации или индивидуального предпринимателя на основе заключенного с аудитором договора);* *- постановка, восстановление и ведение бухгалтерского учета, составление бухгалтерской (финансовой) отчетности;* *- постановка, восстановление и ведение налогового учета, составление налоговых расчетов и деклараций;* *- анализ финансово-хозяйственной деятельности организаций и индивидуальных предпринимателей;* *- автоматизация бухгалтерского учета и внедрение информационных технологий;* *- оценка стоимости имущества, оценка предприятий как имущественных комплексов;* *- проведение научно-исследовательских и экспериментальных работ в областях, связанных с аудиторской деятельностью, и распространение их результатов, в том числе на бумажных и электронных носителях.*
СТРАХОВАЯ СУММА:	***50 000 000 (Пятьдесят миллионов) рублей***
ЛИМИТ ВОЗМЕЩЕНИЯ НА ОДИН СТРАХОВОЙ СЛУЧАЙ:	***10 000 000 (Десять миллионов) рублей***
БЕЗУСЛОВНАЯ ФРАНШИЗА:	***25 000 (Двадцать пять тысяч) рублей***
СТРАХОВАЯ ПРЕМИЯ:	***120 000 (Сто двадцать тысяч) рублей***
УСЛОВИЯ ОПЛАТЫ СТРАХОВОЙ ПРЕМИИ:	*В рассрочку, тремя ежегодными платежами в соответствии с п.4.3 договора страхования*
СРОК ДЕЙСТВИЯ ДОГОВОРА (СРОК СТРАХОВАНИЯ):	***с 16 «июня» 2010г. по 15 «июня» 2013г.***
ПРИЛАГАЕМЫЕ ДОКУМЕНТЫ, являющиеся неотъемлемой частью Полиса:	*Приложение 1 - Заявление на страхование.* *Приложение 3 - Правила добровольного страхования гражданской ответственности при осуществлении аудиторской деятельности ЗАО «ГУТА-Страхование».*

СТРАХОВЩИК: ЗАО «ГУТА-Страхование»

Директор ТА «Петровско-Разумовское»
На основании доверенности №467 от 15.04.2010г.

(Асташов С.В.)

м.п.

СТРАХОВАТЕЛЬ: ЗАО Аудиторская компания «ХОЛД-ИНВЕСТ-АУДИТ»

Генеральный директор на основании Устава

(Дроздов И.Н.)

м.п.

138201

GUTA Insurance
POLICY No. GS4T-GOAD/0000003-10

Of insurance of civil liability in
Auditing

This policy was issued in confirmation of execution of an insurance contract No. GS4T-GOAD/000003-10 dated June 16, 2010 (hereinafter – "the Contract") in compliance with "Regulations of Voluntary Insurance of Civil Responsibility in Auditing" by GUTA-Insurance CGSC (hereinafter – "Insurance Regulations")

The insured: Address, telephone, fax	***Closed Joint Stock Company "HOLD-INVEST-AUDIT Consulting Company"*** ***11000, Moscow, Maroseyka, 6/8; (495) 795-03-83***
Insurance object:	*Proprietary interests of the Insured not contradictory to legislation of the Russian Federation, related to appearance of liabilities to compensate damage caused by it to property interests of third parties in the result of a mistake, negligence, or omission in performing by the Insured of auditing services.*
Insured accident:	*Appearance of liability of the Insured to compensate property damage caused to a third person as the result of a mistake, negligence or omission of the Insured during performance of auditing services:* - *performance of compulsory auditing (in compliance with the requirements of the Russian Federation);* - *performance of voluntary auditing (voluntary examination, conducted after the inquiry of an organization or a private entrepreneur based on a contract with auditor);* - *performance of a tax auditing (auditing of business and tax accounting systems of and organization or a private entrepreneur based on a contract with auditor);* - *organization, recovery and conduct of accounting, accounting (financial) reporting;* - *organization, recovery and conduct of accounting, execution of tax statements and declarations;* - *analysis of financial and business activities of organizations and private entrepreneurs;* - *automation of accounting and implementation of information technologies;* - *estimation of value of property, assessment of businesses as business complexes;* - *conduct of research and experiments connected with auditing, distribution of results thereof, including paper and electronic media.*
Insurance sum:	*50,000,000 (Fifty million) rubles*
Reimbursement limits per one insured accident:	*10,000,000 (Ten million) rubles*
Franchise deductible:	*25,000 (Twenty five thousand) rubles*
Insurance premium:	*120,000 (One hundred thousand) rubles*
Terms of payment of the insurance premium:	*Installments, by three annual payments as per item. 4.3 of the Insurance Contract*
Term of validity of the Contract (term of insurance):	*June 16, 2010 till June 15, 2013*
Attached documents, being integral part of the Policy:	*Addendum 1 – Application for insurance* *Addendum 3 – Regulations of voluntary insurance of civil responsibility in auditing of GUTA Insurance CJSC*

The Insurer: GUTA Insurance CJSC
Director of "GA Petrovsko-Razumovskoye"
By Power of Attorney No.467 dated 15.04.2010
Seal: *GUTA Insurance CJSC, (illegible)*
/Signature/ (S. V. Astashov)

The Insured: "HOLD-INVEST-AUDIT Consulting Company" CJSC
Director General, under the Statute
Seal: *"HOLD-INVEST-AUDIT Consulting Company" CJSC (illegible)*
/Signature/ (I. N. Drozdov)

138201

ОБЩЕРОССИЙСКАЯ ОБЩЕСТВЕННАЯ ОРГАНИЗАЦИЯ
„РОССИЙСКОЕ ОБЩЕСТВО ОЦЕНЩИКОВ"

СВИДЕТЕЛЬСТВО

о членстве в саморегулируемой организации оценщиков

Общероссийская общественная организация «Российское общество оценщиков» зарегистрирована Федеральной регистрационной службой в едином государственном реестре саморегулируемых организаций оценщиков 9 июля 2007 г. регистрационный № 0003.

Оценщик:

Крутская Ольга Викторовна

(фамилия, имя и отчество)

паспорт: серия 4505 № 851432, выдан 05.05.2003г.
ОВД района Лианозово города Москвы

(орган, выдавший документ)

включен в реестр членов РОО:
« 24 » июня 2010г., регистрационный № 006681

Оценщик имеет право осуществлять оценочную деятельность на всей территории Российской Федерации в соответствии с Федеральным законом «Об оценочной деятельности в Российской Федерации» №135-ФЗ от 29.07.1998г.

Срок действия настоящего свидетельства 3 года с даты выдачи.
Выдано « 25 » июня 2010 года.

Президент С.А. Табакова

М.П.

0007415 *

All-Russian Social Organization
RUSSIAN SOCIETY OF APPRAISERS CJSC

CERTIFICATE
of membership in self-governed appraisers' organization

The All-Russian Social Organization "Russian Society Of Appraisers," registered by the Federal Registration Service in the Unified State Registry of Self-governed Organization of Appraisers" dated July 9th, 2007, registration No. 0003.

The Appraiser:

Olga Viktorovna Krutskaya
(name, patronymic name, family name)

Passport: series 4505 No. 851432, issued 05.05.2003.
DIA of Lianozovo district, Moscow
(issuing authority)

was recorded in the Register of Members of the RSA:
June, 24, 2010, registration No. 006681
The Appraiser has the right to perform assessment activities on whole of the territory of the Russian Federation in compliance with Federal Law "On assessment activities in the Russian Federation" No. 135-FZ dated July 29, 1998.
Term of validity of this Certificate is three years from the date of issue.
Issued on June 25, 2010.

Seal: *All-Russia non-governmental organization, OGRN 102770149146, Moscow, Russian Society of Appraisal*

0007415*

ОБЩЕРОССИЙСКАЯ ОБЩЕСТВЕННАЯ ОРГАНИЗАЦИЯ
«РОССИЙСКОЕ ОБЩЕСТВО ОЦЕНЩИКОВ»

СЕРТИФИКАТ

НАСТОЯЩИЙ СЕРТИФИКАТ ПОДТВЕРЖДАЕТ, ЧТО ОЦЕНЩИК

Крутская

Ольга Викторовна

успешно сдал(а) квалификационный экзамен

в соответствии с решением

СОВЕТА РОССИЙСКОГО ОБЩЕСТВА ОЦЕНЩИКОВ

Протокол № 371 от 21.12.2010 г.

ему(ей) присвоено квалификационное звание

«СЕРТИФИЦИРОВАННЫЙ РОО ОЦЕНЩИК НЕДВИЖИМОСТИ»

Президент РОО **С.А. Табакова**

Регистрационный номер 0171

Выдан 22.12.2010 г. **Действителен до** 22.12.2015 г.

ALL-RUSSIAN SOCIAL ORGANIZATION
"RUSSIAN SOCIETY OF APPRAISERS CJSC"

CERTIFICATE
To certify that the appraiser
Krutskaya
Olga Viktorovna
Has successfully passed a qualifying examination
as per the Resolution
Of The Council of the Russian Society of Appraisers
Minutes No. 371 dated 21.12.2010.
He(she) was awarded the qualifying title of
"REALTY APPRAISER CERTIFIED BY THE RSA"

President of the RSA */Signature/* S. A. Tabakova
Seal: *All-Russia non-governmental organization, OGRN 102770149146, Moscow, Russian Society of Appraisal*

Registration number 0171

Issued on December 22, 2010 Valid till December 22, 2015

ГУТА СТРАХОВАНИЕ

ПОЛИС № ГС4К-ОЦСТ/002652-12
страхования ответственности оценщика

Настоящий Полис выдан в подтверждение того, что заключен договор обязательного страхования ответственности оценщика № ГС4К-ОЦСТ/002652-12 от 29.08.2012г. в соответствии с Правилами страхования ответственности оценщиков ЗАО «ГУТА-Страхование» и на основании Заявления на страхование.

СТРАХОВАТЕЛЬ:	*Крутская Ольга Викторовна*
АДРЕС РЕГИСТРАЦИИ:	*г. Москва, ул. Псковская, 10-1-76*
ОБЩАЯ СТРАХОВАЯ СУММА:	*50 000 000 (Пятьдесят миллионов) рублей*
ЛИМИТ ВОЗМЕЩЕНИЯ НА ОДИН СТРАХОВОЙ СЛУЧАЙ:	*50 000 000 (Пятьдесят миллионов) рублей*
ФРАНШИЗА:	*Не установлена*
СТРАХОВАЯ ПРЕМИЯ:	*25 000 (Двадцать пять тысяч) рублей*
ПОРЯДОК УПЛАТЫ СТРАХОВОЙ ПРЕМИИ:	*Единовременно, безналичным платежом*
СРОК ДЕЙСТВИЯ ДОГОВОРА (СРОК СТРАХОВАНИЯ):	*с «09» сентября 2012 г. по «08» сентября 2013 г.*
ОБЪЕКТ СТРАХОВАНИЯ:	*Объектом страхования являются имущественные интересы, связанные с риском ответственности Страхователя (Застрахованного лица) по обязательствам, возникающим вследствие причинения ущерба заказчику, заключившему договор на проведение оценки, и (или) третьим лицам (Выгодоприобретателям).*
СТРАХОВОЙ СЛУЧАЙ:	*Страховым случаем является установленный вступившим в законную силу решением арбитражного суда или признанный Страхователем с предварительного согласия Страховщика факт причинения вреда (ущерба) Выгодоприобретателю действиями (бездействием) Страхователя (Застрахованного лица) при осуществлении застрахованной деятельности в результате нарушения требований федеральных стандартов оценки, стандартов и правил оценочной деятельности, установленных саморегулируемой организацией оценщиков, членом которой являлся Страхователь (Застрахованное лицо) на момент причинения ущерба.* *Настоящий полис (договор) заключается с условием возмещения вреда, причиненного Страхователем в период действия настоящего договора, в течение срока исковой давности (3 года), установленного законодательством Российской Федерации.*
Прилагаемые документы, являющиеся неотъемлемой частью Полиса:	*1. Правила страхования ответственности оценщиков ЗАО «ГУТА-Страхование»* *2. Заявление на страхование ответственности оценщика от 29.08.2012г.*

Страховщик:
ЗАО «ГУТА-Страхование»
Директор ТА «Выпотское»
На основании доверенности №1231 от 06.08.2012г.

(Потапова Е.Ю.)

М.П.
«29» августа 2012г.

Страхователь:
Крутская Ольга Викторовна

(Крутская О.В.)

«29» августа 2012г.

284918

GUTA-INSURANCE
POLICY No. GS4K-OCST/002652-12

Of insurance of liability of an appraiser

This policy was issued in confirmation of execution of an insurance contract No. GS4K-OCST/002652-12 dated 29.08.2012 in compliance with "Regulations of Voluntary Insurance of Civil Responsibility in Auditing" by GUTA-Insurance CGSC and on the basis of the Insurance Application

The insured: Registered address	***Olga Viktorovna Krutskaya*** ***Moscow, Pskovskaya Str., 10-1-76***
Total insurance sum:	*50,000,000 (Fifty million) rubles*
Reimbursement limits per one insured accident:	*50,000,000 (Ten million) rubles*
Franchise deductible:	*Not set*
Insurance premium:	*25,000 (Twenty five thousand) rubles*
Terms of payment of the insurance premium:	*Once only, cashless*
Term of validity of the Contract (term of insurance):	*September 9, 2012 till September 8, 2013*
Insurance object:	*Proprietary interests of the related to risk of responsibility of the Insured on liabilities arising due to damages to a customer under an assessment contract and (or) to third persons (Beneficiaries).*
Insured accident:	*The insured accident is a fact, acknowledged by a valid judgment of an arbitration court or acknowledged by the Insured with the Insured prior consent, of damage (harm) to the Beneficiary by actions (failure to act) of the Insured in performing the insured activity as the result of violation of federal valuation standards, of standards and regulations of assessment, accepted by self-governed organization of appraisers, a member of which is the Insured at the moment of damage.*
Attached documents, being integral part of the Policy:	1. *Rules of liability insurance of appraisers of "GUTA-Insurance" CJSC* 2. *Liability Insurance Application of the Insured dated 29.08.2012*

The Insurer: GUTA Insurance CJSC
Director of "GA Krylatskoye"
By Power of Attorney No.1231 dated 06.08.2012
Seal: *GUTA Insurance(illegible) /Signature/ (E. U. Potapova)*
August 29, 2012

The Insured:
Olga Viktorovna Krutskaya
/Signature/ (O. V. Krutskaya)
August 29, 2012

РОССИЙСКАЯ ФЕДЕРАЦИЯ

ДИПЛОМ

О ПРОФЕССИОНАЛЬНОЙ ПЕРЕПОДГОТОВКЕ

ПП № 499144

Настоящий диплом выдан Крутской Ольге Викторовне

в том, что он(а) с 26 мая 2003 г. по 10 декабря 2003 г. прошел(а) профессиональную переподготовку в (на) Государственном университете по земельным отношениям

по Оценка стоимости предприятий (бизнеса)

Государственная аттестационная комиссия решением от 10 декабря 2003 г. удостоверяет право (соответствие квалификации) Крутской Ольги Викторовны на ведение профессиональной деятельности в сфере оценки стоимости предприятий (бизнеса)

Председатель аттестационной комиссии

Ректор (директор)

Город Москва 2003 год

Регистрационный номер 1791

Диплом является государственным документом о профессиональной переподготовке

Диплом дает право на ведение нового вида профессиональной деятельности

The Russian Federation

DIPLOMA

of professional training

PP No. 499144

This diploma was issued to *Krutskaya Olga Victorovna* in that he (she) from *May, 26, 2003* till *December 10, 2003* received professional training at the *State University of Land Development* in *assessment of value of enterprises (businesses)*.

State examination committee with its resolution dated *December 10, 2003* certifies the conformity of the competence of Krutskaya Olga Victorovna to conduct professional activities in the field of *assessment of value of enterprises (businesses)*.

The Chairman of the State examination committee */Signature/*

Rector */Signature/*

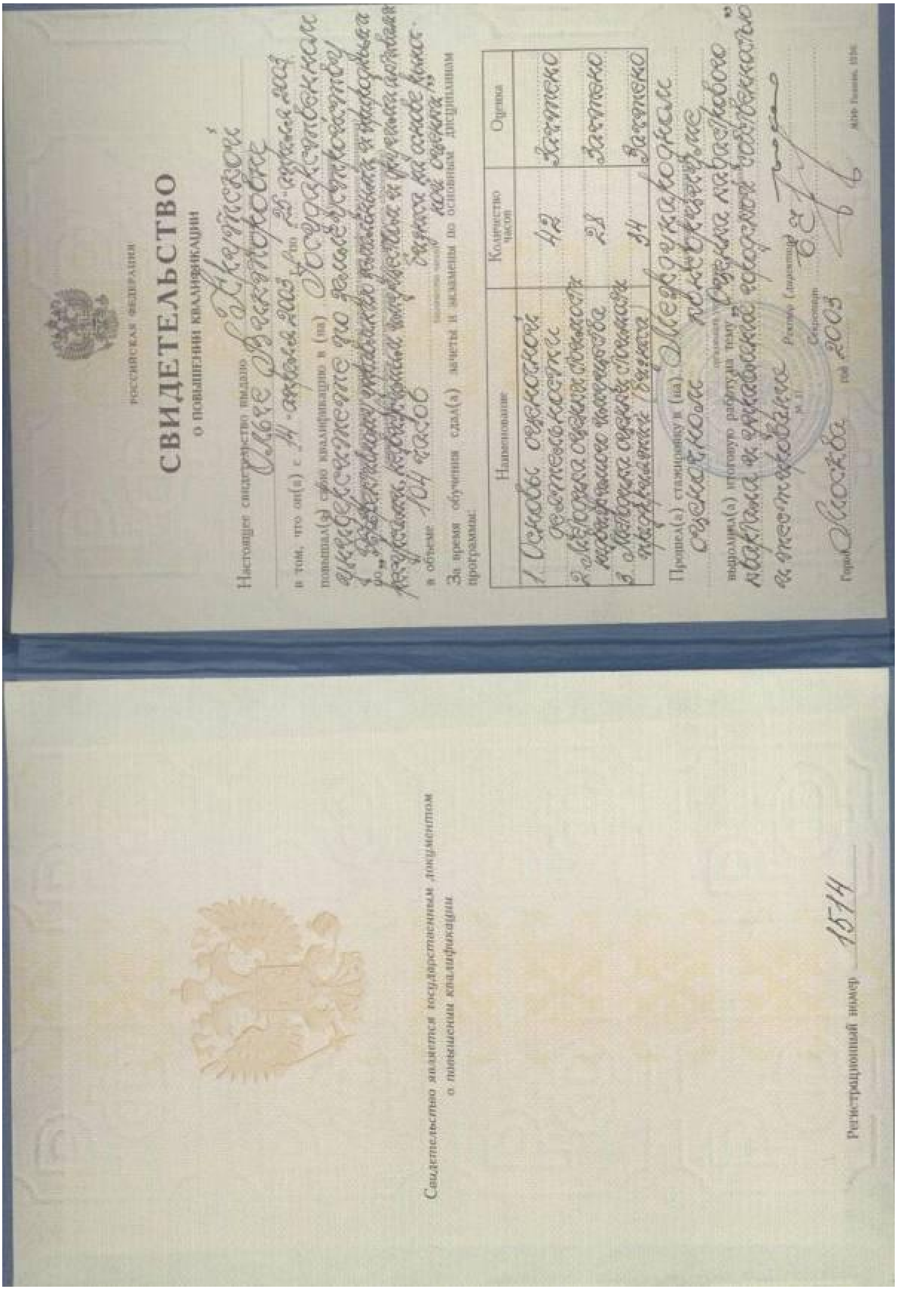
Official seal: *(illegible)*

Moscow 2003

The diploma is a state document certifying professional training

The diploma grants the right to conduct new type of professional activities

Registration number 1791



Свидетельство является государственным документом о повышении квалификации

Регистрационный номер 1514

РОССИЙСКАЯ ФЕДЕРАЦИЯ

СВИДЕТЕЛЬСТВО

О ПОВЫШЕНИИ КВАЛИФИКАЦИИ

Настоящее свидетельство выдано Якутской Ольге Викторовне

в том, что он(а) с 14 апреля 2003 г. по 25 апреля 2003 г.

повышал(а) свою квалификацию в (на) Государственном университете по землеустройству

по "Эффективному управлению земельными и природными ресурсами, недвижимым имуществом и другими активами бизнеса на основе рыночной оценки"

в объеме 104 часов

За время обучения сдал(а) зачеты и экзамены по основным дисциплинам программы:

Наименование	Количество часов	Оценка
1. Основы оценочной деятельности	42	Зачтено
2. Методика оценки стоимости недвижимого имущества	28	Зачтено
3. Методика оценки стоимости предприятий (бизнеса)	34	Зачтено

Прошел(а) стажировку в (на) Международном оценочном консорциуме

выполнил(а) итоговую работу на тему "Оценка кадастрового квартала и управление городской собственностью и ее эффективное использование"

Ректор (директор)

Секретарь

М.П.

Город Москва год 2003

Russian Federation

CERTIFICATE

of advanced professional training

This Certificate was issued to *Krurskaya Olga Viktorovna*

in that he (she) from *April 14, 2003* till *April 25, 2003* received professional training at the *State University of Land Development* in *effective management of land and natural resources, immovable property and other business assets on the basis of market assessment* for *104 academic hours.*

During the training he (she) passed tests and examinations on the main training courses of the program:

Name	Hours	Grade
1. Basics of assessment	42	Passed
2. Procedure of assessment of value of immovable property	28	Passed
3. Procedure of assessment of value of a business (enterprise)	34	Passed

He (she) was on probation at the *International Assessment Consortium*

and presented the final report on *"Assessment of Cadastral Unit and Management of City Property and Registration"*

Rector */Signature/*

Secretary */Signature/*

Official seal: *(illegible)*

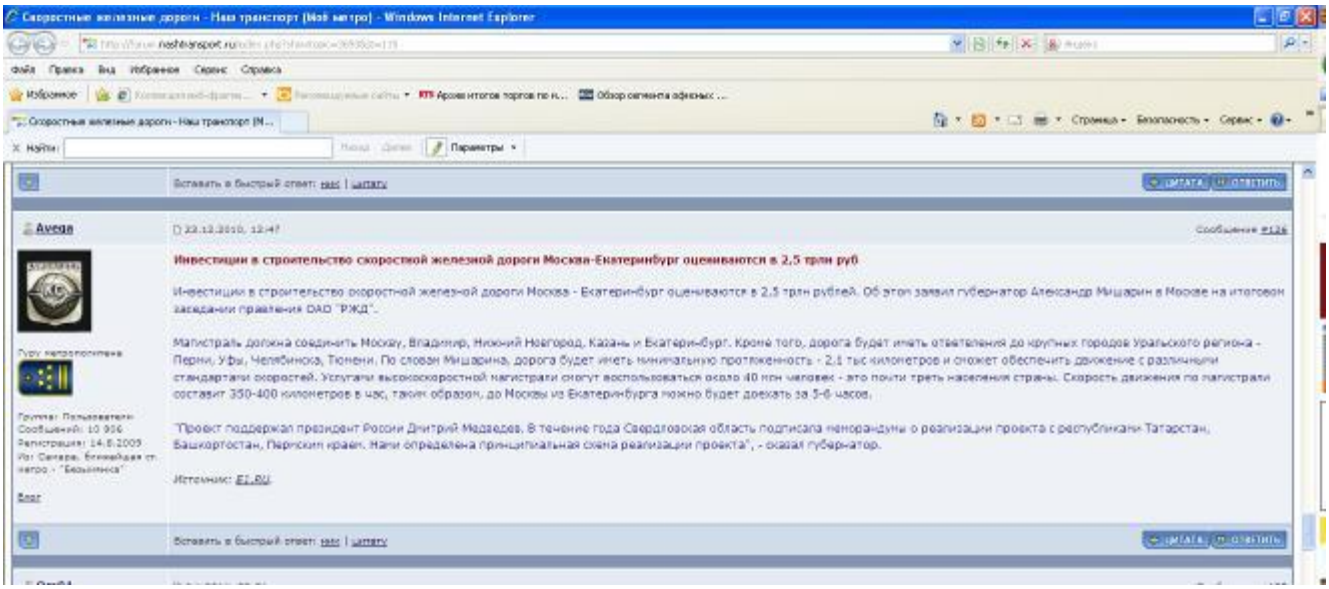
Moscow 2003

The certificate is a state document certifying professional training

The diploma grants the right to conduct new type of professional activities

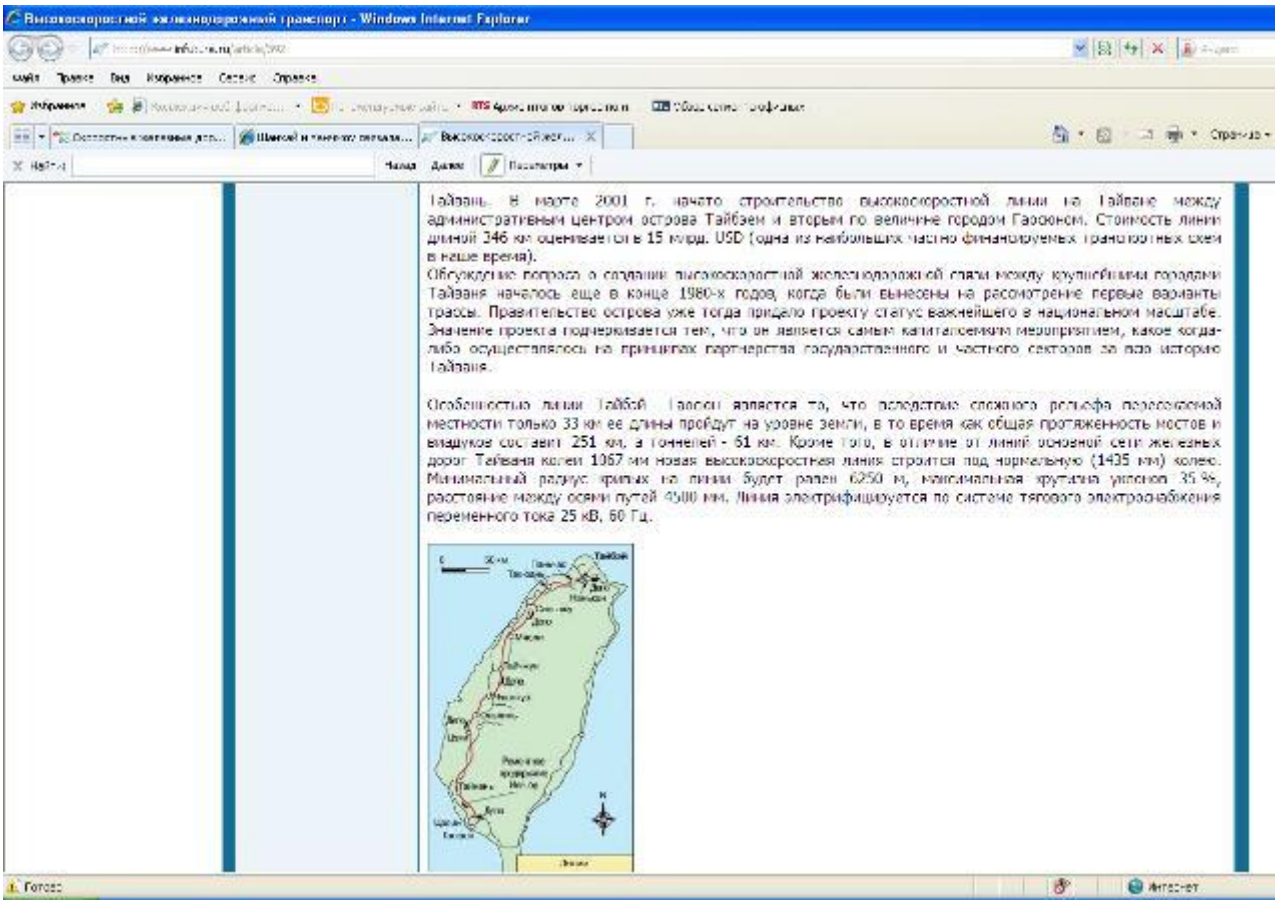
Registration number 1514

9 ADDENDUM 2. INFOMATION AQUIRED FROM INTERNET USED IN THE ASSESSMENT



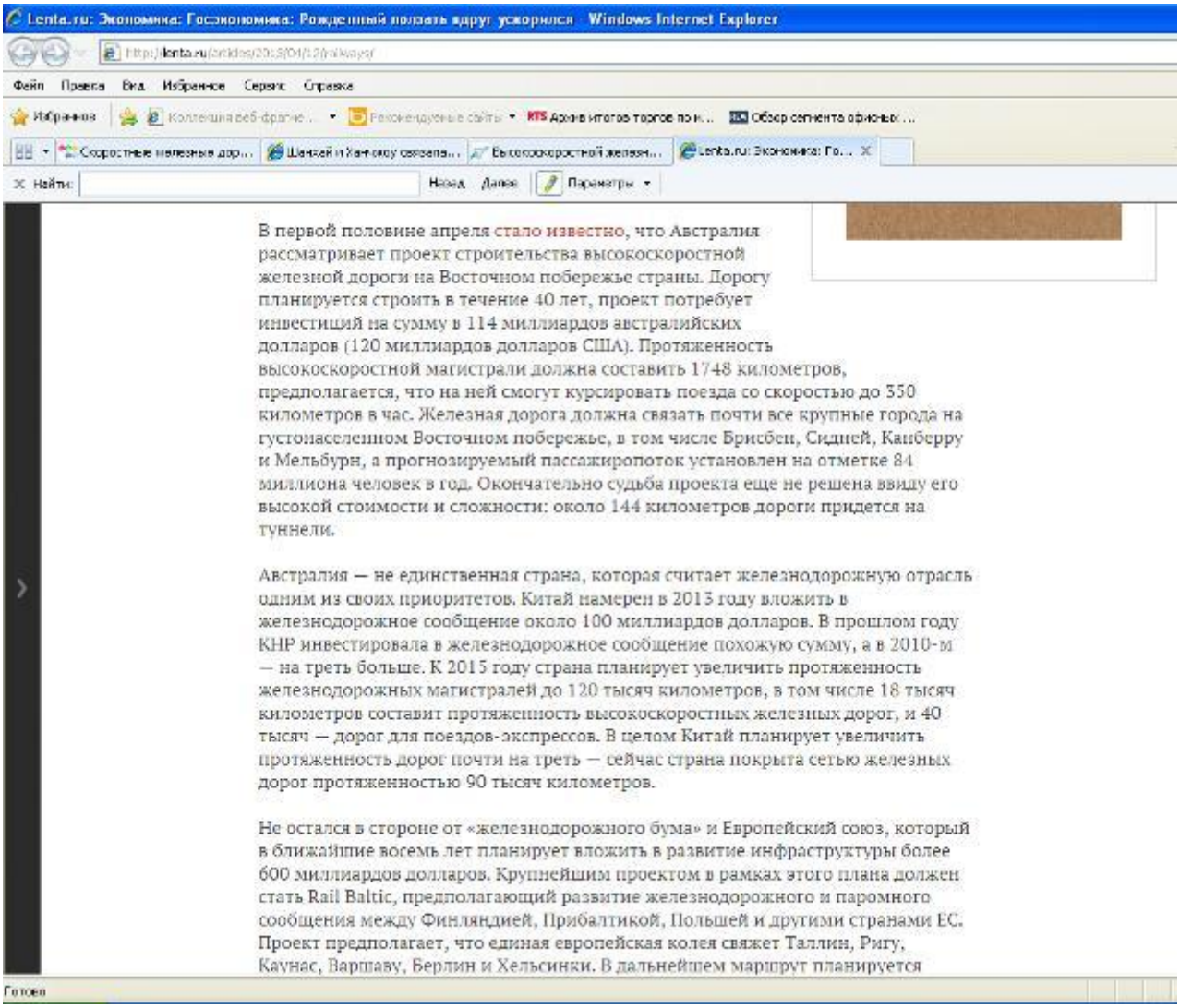
http://forum.nashtransport.ru/index.php?showtopic=3693&st=115

Investments in construction of high-speed railway line Moscow-Yekaterinburg are valued at 2.5 tril. Rubles… [the article discusses construction of high-speed railway line Moscow-Yekaterinburg]



http://www.infuture.ru/article/392

[the article discusses the construction of the Taipei-Kaohsiung high-speed railway line in Taiwan]



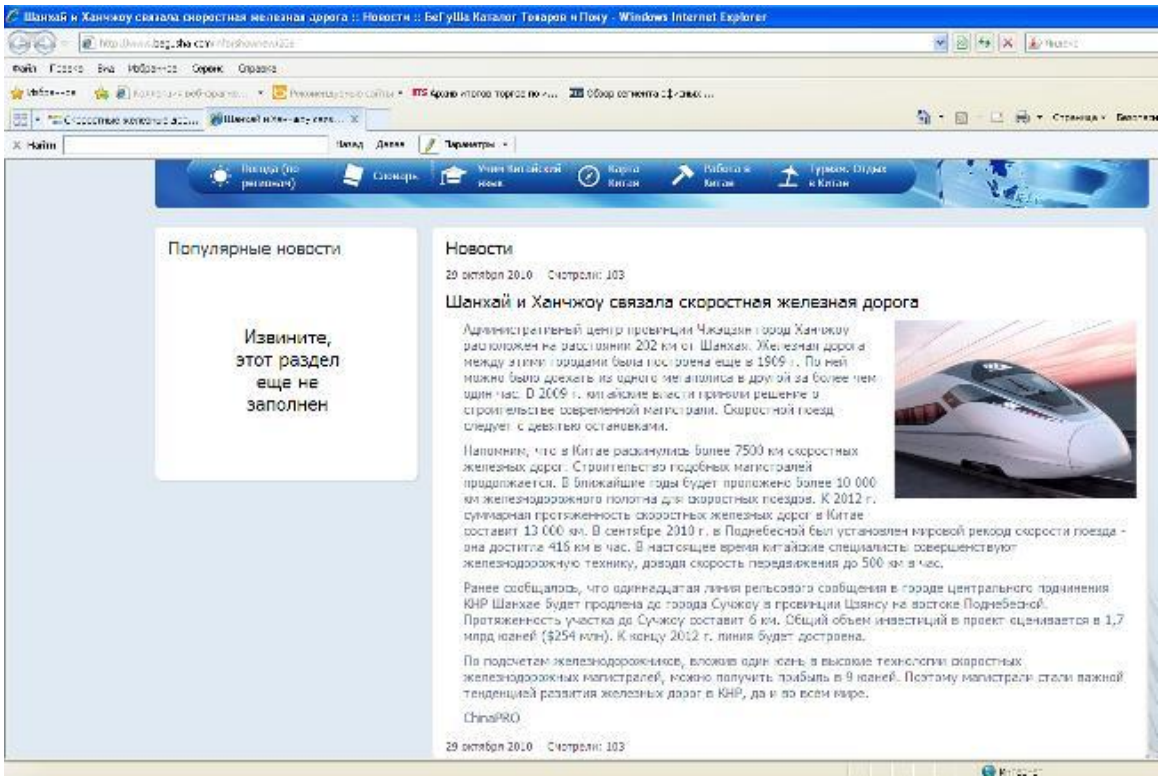
В первой половине апреля стало известно, что Австралия рассматривает проект строительства высокоскоростной железной дороги на Восточном побережье страны. Дорогу планируется строить в течение 40 лет, проект потребует инвестиций на сумму в 114 миллиардов австралийских долларов (120 миллиардов долларов США). Протяженность высокоскоростной магистрали должна составить 1748 километров, предполагается, что на ней смогут курсировать поезда со скоростью до 350 километров в час. Железная дорога должна связать почти все крупные города на густонаселенном Восточном побережье, в том числе Брисбен, Сидней, Канберру и Мельбурн, а прогнозируемый пассажиропоток установлен на отметке 84 миллиона человек в год. Окончательно судьба проекта еще не решена ввиду его высокой стоимости и сложности: около 144 километров дороги придется на туннели.

Австралия — не единственная страна, которая считает железнодорожную отрасль одним из своих приоритетов. Китай намерен в 2013 году вложить в железнодорожное сообщение около 100 миллиардов долларов. В прошлом году КНР инвестировала в железнодорожное сообщение похожую сумму, а в 2010-м — на треть больше. К 2015 году страна планирует увеличить протяженность железнодорожных магистралей до 120 тысяч километров, в том числе 18 тысяч километров составит протяженность высокоскоростных железных дорог, и 40 тысяч — дорог для поездов-экспрессов. В целом Китай планирует увеличить протяженность дорог почти на треть — сейчас страна покрыта сетью железных дорог протяженностью 90 тысяч километров.

Не остался в стороне от «железнодорожного бума» и Европейский союз, который в ближайшие восемь лет планирует вложить в развитие инфраструктуры более 600 миллиардов долларов. Крупнейшим проектом в рамках этого плана должен стать Rail Baltic, предполагающий развитие железнодорожного и паромного сообщения между Финляндией, Прибалтикой, Польшей и другими странами ЕС. Проект предполагает, что единая европейская колея свяжет Таллин, Ригу, Каунас, Варшаву, Берлин и Хельсинки. В дальнейшем маршрут планируется

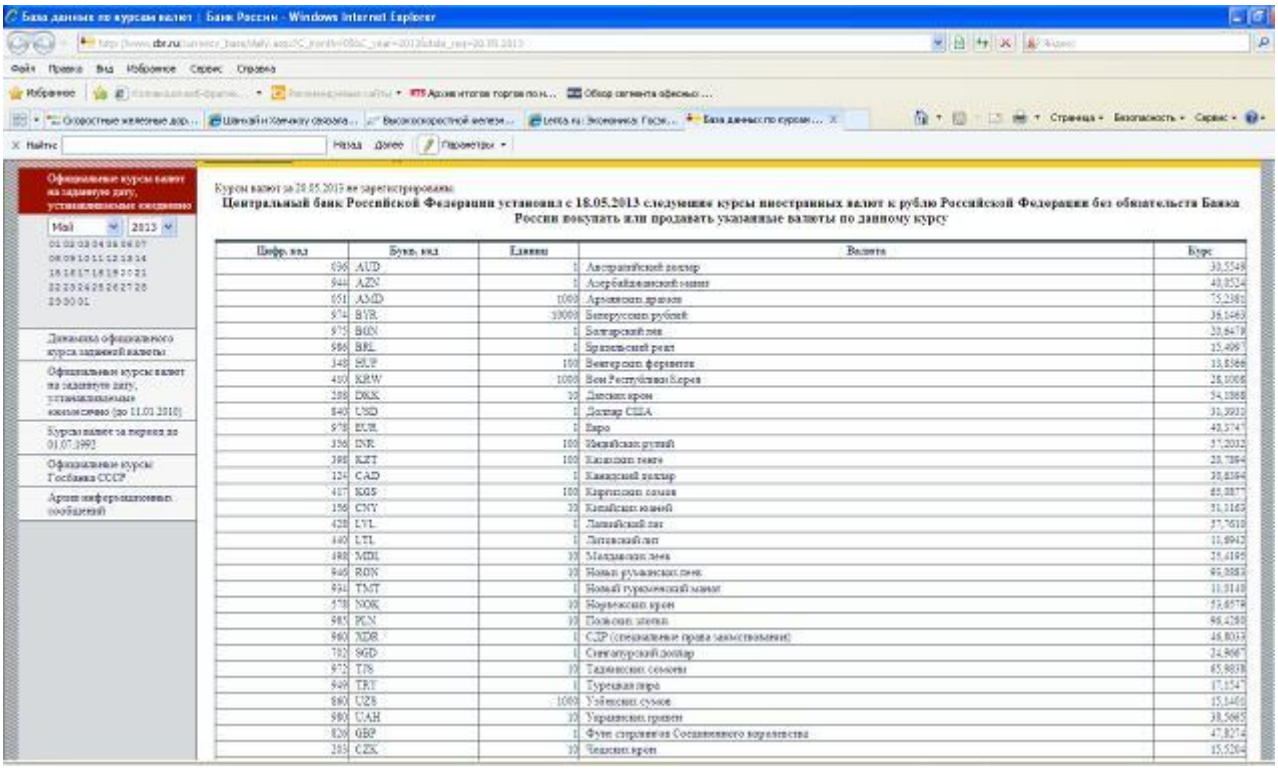
http://lenta.ru/articles/2013/04/12/railways/

[the article discusses the plans of Australia's and China's authorities for construction of high-speed railway lines]



http://www.begusha.com/info/shownew/206

[the article discusses the plans of China's authorities for construction of high-speed railway lines]



http://www.cbr.ru/currency_base/daily.aspx?C_month=05&C_year=2013&date_req=20.05.2013

[currency exchange rates of the Central Bank of the Russian Federation on 20.05.2013]

77 01013967

Министерство Российской Федерации по налогам и сборам

СВИДЕТЕЛЬСТВО

о постановке на учет в налоговом органе физического лица по месту жительства на территории Российской Федерации

Настоящее Свидетельство выдано в соответствии с положениями Налогового кодекса Российской Федерации

физическому лицу **ЮНИЦКИЙ АНАТОЛИЙ ЭДУАРДОВИЧ**

пол **МУЖСКОЙ**

дата рождения **16.04.1949**

место рождения **ГОМЕЛЬСКАЯ ОБЛ.,БРАГИНСКИЙ Р-Н,ДЕР. КРЮКИ**

и подтверждает постановку физического лица на учет **10 февраля 2006г.**

в **ИФНС России №25 по г. Москве** | 7 | 7 | 2 | 5 |

Идентификационный номер налогоплательщика	7	7	2	5	7	7	9	6	8	3	2	9

Свидетельство применяется во всех предусмотренных законодательством случаях и предъявляется вместе с документом, удостоверяющим личность физического лица и место его жительства на территории Российской Федерации. Индивидуальными предпринимателями дополнительно предъявляется Свидетельство о государственной регистрации физического лица в качестве индивидуального предпринимателя.

Свидетельство подлежит замене в случае если новое место жительства физического лица расположено на территории, подведомственной другому налоговому органу, изменения приведенных в нем сведений, а также в случае его утраты.

Зам. руководителя МП **Мельничук А.Г.**

серия 77 № 001013967

Stamp: (illegible) 77 01013967
Ministry of Taxes and Assessments of the Russian Federation

CERTIFICATE

of registration in a tax authority
of a physical person at the place of residence on the territory of the Russian Federation

This Certificate was issued in compliance with regulations of the Tax Codex of the Russian Federation to

physical person YUNITSKIY ANATOLY EDUARDOVITCH
sex MALE
date of birth April 16, 1949
place of birth GOMEL REGION, BRAGIN DISTRICT, KRUKI
and confirms the registration of the physical person on **February 10, 2006**

in FTAI of Russia No. 25 in Moscow 7 7 2 5

Taxpayer's identification number **7 7 2 5 7 7 9 6 8 3 2 9**

The Certificate is used in all instances provided by law and is presented together with a document confirming the person of the physical person and the place of residence on the territory of the Russian Federation. Private entrepreneurs additionally shall present the Certificate of state registration of a physical person as a private entrepreneur.

The certificate shall be replaced in the event when the new place of residence of the physical person is located on the territory subordinate to other tax authority, when information stated therein changes, or in the event of its loss.

Deputy Head Melnichuk A. G. */Signature/*
Official seal: *Federal Tax Service, Administration of the Federal Tax Service for Moscow, Inspectorate of the Federal Tax Service No. 25 for Moscow (illegible)*

Series 77 No. 001013967

Memorandum
on purchase of the exclusive rights on the know-how «String Technologies Yunitskiy – STY»

Moscow, June 26, 2011

The owner of the exclusive rights to the production secrets (know-how) "String Technologies Yunitskiy – STY" is its author, developer, general designer, and the owner of the know-how Anatoly Eduardovitch Yunitskiy, a citizen of the Russian Federation (passport series 45 10 No. 472646, issued March 30, 2010 by Nagatino-Sadovniki Department of DAFMS of Russia in Moscow, SAD (department code 770-037).

The know-how "String Technologies Yunitskiy – STY" is an innovative transportation, infrastructural and industry-forming technology. Within development of STY technologies starting A. E. Yunitskiy developed principally new rolling stock, track structure and infrastructure of various types and kinds. Principally new standards of structural section, technologies, materials science, aerodynamics, and ergonomics were developed. Necessary series of labouratory, testing bench and model experiments and tests were conducted. Unique results were obtained with no equivalents in the world. In 2001 a testing site was established in Ozery, Moscow region. Concepts of various types, makes and models of passenger freight, dual-purpose and special rail vehicles (passenger unibuses and freight unicars, string-rails), intermediary and anchor supports, stations, terminals, service garages-depots, freight terminals of the "second level", as well as various units, assemblies, production tools, and special equipment. The technique of their large-scale production and construction was developed. Tens of inventions and over a hundred patentable know-hows were developed. A scientific school was created and tens of monographs and research reports were published. Into the development of STY technologies over the period of 1977 – 2011 private funds were invested, grants were received (Cosmonautics Federation of the USSR and the Soviet Peace Fund – 1988, UNO – 1998 and 2002), external investments were attracted in the amount of about 3 mln. USD.

In respect of the know-how "String Technologies Yunitskiy – STY" the regime of commercial secret was introduced on 20.06.2011 by A. E. Yunitskiy. By virtue of Article 1466 of the Civil Code of the Russian Federation Anatoly Eduardovitch Yunitskiy has acquired independent exclusive rights to the know-how "String Technologies Yunitskiy – STY".

Anatoly Yunitskiy

РОССИЙСКАЯ ФЕДЕРАЦИЯ

ПАТЕНТ

НА ИЗОБРЕТЕНИЕ

№ 2224064

ТРАНСПОРТНАЯ СИСТЕМА ЮНИЦКОГО (ВАРИАНТЫ) И СПОСОБ ПОСТРОЕНИЯ ТРАНСПОРТНОЙ СИСТЕМЫ

Патентообладатель(ли): *Юницкий Анатолий Эдуардович, Терёхин Дмитрий Владимирович*

Автор(ы): *Юницкий Анатолий Эдуардович*

Заявка № 2002113321

Приоритет изобретения 21 мая 2002 г.

Зарегистрировано в Государственном реестре изобретений Российской Федерации 20 февраля 2004 г.

Срок действия патента истекает 21 мая 2022 г.

Генеральный директор Российского агентства по патентам и товарным знакам

А.Л. Корчагин

UTILITY PATENT

No. 2224064

YUNITSKIY TRANSPORT SYSTEM (VARIANTS) AND METHOD OF CONSTRUCTION OF THE TRANSPORTATION SYSTEM

Patent holder(s): ***Yunitskiy Anatoly Eduardovitch***
Teryokhin Dmitry Valdimirovitch

Autor(s): ***Yunitskiy Anatoly Eduardovitch***

Application No. **2002113321**
Priority of the invention **May 21, 2002**
Registered in the State Registry of inventions of the Russian Federation on ***February 20, 2004***
Patent expires on **May 21, 2002**

Director General of Russian Agency for Patents and Trademarks

Official Seal: *Russian Agency for Patents and Trademarks*

/Signature/ A. D. Korchagin

РОССИЙСКАЯ ФЕДЕРАЦИЯ

ПАТЕНТ

НА ИЗОБРЕТЕНИЕ

№ 2220249

Российским агентством по патентам и товарным знакам на основании Патентного закона Российской Федерации, введенного в действие 14 октября 1992 года, выдан настоящий патент на изобретение

ТРАНСПОРТНАЯ СИСТЕМА ЮНИЦКОГО (ВАРИАНТЫ) И СПОСОБ ПОСТРОЕНИЯ ТРАНСПОРТНОЙ СИСТЕМЫ

Патентообладатель(ли):

Юницкий Анатолий Эдуардович,
Терёхин Дмитрий Владимирович

по заявке № 2002113320, дата поступления: 21.05.2002

Приоритет от 21.05.2002

Автор(ы) изобретения:

Юницкий Анатолий Эдуардович

Патент действует на всей территории Российской Федерации в течение 20 лет с **21 мая 2002 г.** при условии своевременной уплаты пошлины за поддержание патента в силе

Зарегистрирован в Государственном реестре изобретений Российской Федерации

г. Москва, 27 декабря 2003 г.

Генеральный директор

А.Л. Кирчанов

UTILITY PATENT

No. 2220249

Russian Agency for Patents and Trademarks, basing on the Patent Law of the Russian Federation, encated October 14, 1992, issued this utility patent

YUNITSKIY TRANSPORT SYSTEM (VARIANTS) AND METHOD OF CONSTRUCTION OF THE TRANSPORTATION SYSTEM

Patent holder(s): ***Yunitskiy Anatoly Eduardovitch***

Teryokhin Dmitry Valdimirovitch

After the application No. 2002113320, date of arrival: May 21, 2002

Priority of May 21, 2002

Autor(s):

Yunitskiy Anatoly Eduardovitch

The patent is valid on all of the territory of the Russian Federation within 20 years from **May 21, 2002** subject to timely payment of the duty for keeping the patent valid

Registered in the State Registry of inventions of the Russian Federation

Moscow, February 27, 2003

Director General

Official Seal: *Russian Agency for Patents and Trademarks*

/Signature/ A. D. Korchagin

ЕВРАЗИЙСКАЯ ПАТЕНТНАЯ ОРГАНИЗАЦИЯ
ЕВРАЗИЙСКОЕ ПАТЕНТНОЕ ВЕДОМСТВО

ЕВРАЗИЙСКИЙ ПАТЕНТ

№ 004917

Название изобретения:
«ТРАНСПОРТНАЯ СИСТЕМА ЮНИЦКОГО И СПОСОБ ПОСТРОЕНИЯ ТРАНСПОРТНОЙ СИСТЕМЫ»

Патентовладелец (льцы):

ЮНИЦКИЙ АНАТОЛИЙ ЭДУАРДОВИЧ (RU);
КАПИТОНОВ АЛЕКСАНДР АЛЕКСАНДРОВИЧ (UA)

Изобретатель (и):

Юницкий Анатолий Эдуардович (RU)

Заявка №:	200200992
Приоритет изобретения:	
Дата подачи заявки:	17 октября 2002 г.
Дата выдачи патента:	26 августа 2004 г.

Настоящим удостоверяется, что евразийский патент выдан на изобретение, изложенное в прилагаемом описании и формуле изобретения.

При уплате установленных годовых пошлин патент действует на территории государств участников Евразийской патентной конвенции – Азербайджанской Республики, Кыргызской Республики, Республики Армения, Республики Беларусь, Республики Казахстан, Республики Молдова, Республики Таджикистан, Российской Федерации, Туркменистана

ГРИГОРЬЕВ Александр Николаевич
Президент Евразийского патентного ведомства

THE EURASIAN PATENT ORGANIZATION
THE EURASIAN PATENT OFFICE

EURASIAN PATENT

No. 004917

Name of the invention:

"YUNITSKIY TRANSPORT SYSTEM AND METHOD OF CONSTRUCTION OF THE TRANSPORTATION SYSTEM"

Patent holder(s): **YUNITSKIY ANATOLY EDUARDOVITCH (RU)**
KAPITONOV ALEXANDER ALEXANDROVITCH (UA)

Autor(s):

Yunitskiy Anatoly Eduardovitch (RU)

application No. **200200992**

Priority of the invention:

Date of application: **October 17, 2002**

Date of issue of the patent: **August 26, 2004**

This certifies that the Eurasian patent was issued for the invention stated in claim of the attached description.

Subject to payment of respective annual duties the patent is valid on the territory of the member-states of the Eurasian Patent Convention –Azerbaijan Republic, Kyrgyz Republic, Republic of Armenia, Republic of Belarus, Republic of Kazakhstan. Moldova Republic, Republic Tajikistan, the Russian Federation, Turkmenistan.

/Signature/

GRIGORIEV Alexandr Nikolaevitch

President of the Eurasian Patent Office

Seal: *Eurasian Patent Organization, Eurasian Patent Office*

ЕВРАЗИЙСКАЯ ПАТЕНТНАЯ ОРГАНИЗАЦИЯ
ЕВРАЗИЙСКОЕ ПАТЕНТНОЕ ВЕДОМСТВО

ЕВРАЗИЙСКИЙ ПАТЕНТ

ЕВРАЗИЙСКИЙ ПАТЕНТ

№ 006112

Название изобретения:
«ТРАНСПОРТНАЯ СИСТЕМА ЮНИЦКОГО (ВАРИАНТЫ) И СПОСОБ ПОСТРОЕНИЯ ТРАНСПОРТНОЙ СИСТЕМЫ»

Патентовладелец (льцы):
ЮНИЦКИЙ АНАТОЛИЙ ЭДУАРДОВИЧ (RU)

Изобретатель (и):
Юницкий Анатолий Эдуардович (RU)

Заявка №: 200400905
Приоритет изобретения:
Дата подачи заявки: 09 июля 2004 г.
Дата выдачи патента: 25 августа 2005 г.

Настоящим удостоверяется, что евразийский патент выдан на изобретение, изложенное в прилагаемом описании и формуле изобретения.

При уплате установленных годовых пошлин патент действует на территории государств участников Евразийской патентной конвенции – Азербайджанской Республики, Кыргызской Республики, Республики Армения, Республики Беларусь, Республики Казахстан, Республики Молдова, Республики Таджикистан, Российской Федерации, Туркменистана

ГРИГОРЬЕВ Александр Николаевич
Президент Евразийского патентного ведомства

THE EURASIAN PATENT ORGANIZATION
THE EURASIAN PATENT OFFICE
EURASIAN PATENT
No. 006112

Name of the invention:
"YUNITSKIY TRANSPORT SYSTEM (VARIANTS) AND METHOD OF CONSTRUCTION OF THE TRANSPORTATION SYSTEM"

Patent holder(s):
YUNITSKIY ANATOLY EDUARDOVITCH (RU)

Autor(s):
Yunitskiy Anatoly Eduardovitch (RU)

application No. **200400905**
Priority of the invention:
Date of application: **July 9, 2004**
Date of issue of the patent: **August 25, 2005**

This certifies that the Eurasian patent was issued for the invention stated in claim of the attached description.

Subject to payment of respective annual duties the patent is valid on the territory of the member-states of the Eurasian Patent Convention –Azerbaijan Republic, Kyrgyz Republic, Republic of Armenia, Republic of Belarus, Republic of Kazakhstan. Moldova Republic, Republic Tajikistan, the Russian Federation, Turkmenistan.

/Signature/

GRIGORIEV Alexandr Nikolaevitch
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ЕВРАЗИЙСКАЯ ПАТЕНТНАЯ ОРГАНИЗАЦИЯ
ЕВРАЗИЙСКОЕ ПАТЕНТНОЕ ВЕДОМСТВО

ЕВРАЗИЙСКИЙ ПАТЕНТ

ЕВРАЗИЙСКИЙ ПАТЕНТ

№ 006359

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«ТРАНСПОРТНАЯ СИСТЕМА ЮНИЦКОГО (ВАРИАНТЫ) И СПОСОБ ПОСТРОЕНИЯ ТРАНСПОРТНОЙ СИСТЕМЫ»

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Настоящим удостоверяется, что евразийский патент выдан на изобретение, изложенное в прилагаемом описании и формуле изобретения.

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Name of the invention:
"YUNITSKIY TRANSPORT SYSTEM (VARIANTS) AND METHOD OF CONSTRUCTION OF THE TRANSPORTATION SYSTEM"

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Subject to payment of respective annual duties the patent is valid on the territory of the member-states of the Eurasian Patent Convention –Azerbaijan Republic, Kyrgyz Republic, Republic of Armenia, Republic of Belarus, Republic of Kazakhstan. Moldova Republic, Republic Tajikistan, the Russian Federation, Turkmenistan.

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Executive Summary
Of Innovative Transport Technology
"String Transport Unitsky"

1. Introduction

Analysis of transport state-of-the-art and its perspectives was carried out as the part of the Transport Strategy of Russian Federation till 2030. It proves that there are a number of limitations for transport development in Russia. Among them one can mention high rate of capital and energy output, severe climatic conditions, long period of project implementation, low transport infrastructure payback.

In such conditions formation of competitive transport services market is impossible without progressive achievements of techniques and technologies which are in conform to the security standards. The most important development direction becomes the implementation of innovative technologies in transport sphere. Therefore, introduction of Unitsky String Transport (STU) may become one of the most perspective directions in innovative transport technologies development. In November, 2008 Transport Committee of State Duma of the Federal Assembly of the Russian Federation admitted STU to be the best innovative project in terms of Consultative Council "Transport unites Russia" on project "Innovative Types of XXI Century Transportation in Russia". STU was also recommended for early implementation to the economic scheme of the country.

String transport is the transport of "the second level". Its infrastructure doesn't need great deal of land resources. STU has spans (from 30-50m to 1-2km) between supports which provide STU passing through swampy, sand and mountain terrain, water barriers, boreal forest, cold desert and above ever frozen ground. STU has large energy efficiency and is less capital-intensive in comparison with monorail, elevated roads with magnetic levitation trains or high speed railways. STU is resistant enough to atmospheric effects, earthquakes, floods and other natural disasters. STU system meets Russian standards SNiP (Construction Standards and Regulations) and GOST (all-Union State Standard), has Russian and international patents. Basic compounds and details of the system have been tested and are certified in accordance with

Russian legislation. Above mentioned advantages allow to introduce a new type of transport in a small period of time. It will solve public, suburban and intercity transportation problems and also the problem of passenger and transportation overload.

2. String Transport Concept

String transport consists of several supports located at a distance one from another, string-rails tensed on them and self-moving vehicles called unibuses. The main difference between STU and conventional railway is that string-rails are raised above the terrain 3 and even more meters high, they are strained between supports and are pretensioned up to 100-500 tons efforts and even more. It provides high stiffness of a string-rail track which is determined from relation of span structure deflection to the length of a span (about 1/1000). At the same time, there is no necessity of making subgrades, building crossovers, viaducts, bridges, pipe-culverts and other constructions. It results in high economic effectiveness of STU and its rapid building-up.

The string itself is a metallic box with pretensioned ropes inside of it. The ropes are made of 3-5mm diameter wires encapsulated with modified concrete or other filling on the basis of epoxide resin. The metallic box is covered with rail top where unibus wheeling takes place. Such string-rail construction provides not only protection against corrosion of load-bearing steel wires, but also high reliability of system functioning, because rail excursion on a span doesn't exceed ±15mm (towards midline) at low speeds and ±5mm at high unibus speed. Oscillation decay time is about 0.1 sec. Eventual uprise of resonant effects in a string-rail is compensated by choosing of reasonable unibus speed rate (low-, average-, high- and extra high speed string versions were designed). Eventual uprise of resonant effects in a string-rail may also be compensated by the rate of string-rail bending stiffness, string tension force and physical-mechanical specifications of a filling.

In comparison with conventional vehicles unibus is more cost-efficient due to its distinctive aerodynamic features. At speed rates over 200 km/h on a string railway unibus air resistance coefficient may be reduced to 0.1and lower because of screen effect elimination and due to patented highly aerodynamic mold lines.

STU transport system has different speed rate versions: up to 50km/h, up to 100 km/h, up to 150 km/h, up to 200 km/h, up to 300 km/h, up to 400 km/h, up to 500 km/h.

3. Short List of Work Performed

Since "String Transport Unitsky" Ltd was founded (1988) a large scope of scientific, experimental and development work has been implemented. It includes the following results classified in accordance with the abovementioned STU concept.

3.1 Supports

-Basic types of supports (anchor and intermediate) were designed; their configuration (mainly T-frame and Π-frame) was determined for suspended and mounted STU.
-Optimum distances between anchor (up to 10km) and intermediate (30-50m for mounted and 100-300m for suspended STU) supports were determined. Besides, supports height (not less than 3m), depth of support setting (1.5-2.5m and more for panel-wall foundation and 6-8m and more for pile foundation, depending on physical-mechanical ground features and the depth of frost penetration) and support setting technology were determined.
-The types of support foundation were determined.
-The types of support malfunctions and their admissible values were determined.
-Admissible support leans were determined.
-Concrete grades necessary for building of supports and string-rail filling were determined in accordance with GOST 18105-86.

Building of supports and string-rail transport system of "the second level" is supposed to be implemented in accordance with Russian standard SNiP 2.05.03-84* "Bridges and pipes". Thus, string-rail constructions of a double-line track will be less resource-demanding, because there is no need of making continuous rail coverage.

3.2 String-Rail

-The shape of string-rail frame and its inner structure were determined for suspended and mounted STU in all versions (extralight, light, average, heavy and extraheavy).
-Strength properties of string steel ropes were determined in accordance with SNiP 2.05.03-84* "Bridges and pipes". Strings and frame bonding technique was also determined.
-The project principle is "the higher unibus speed is the stiffer a track should be and the more pretension in a string should be". In accordance with this principle string pretension values were determined (10-20 tons for extralight suspended track and 500-1000 tons and even more for extraheavy mounted string-rail track) depending on span length, gauge size, dynamical load mass and unibus speed rate.
-Safety coefficients of constantly and variably loaded tracks were determined.
-String weight per running meter was determined for different string-rail versions.
-The diagrams of static and dynamic string-rail deflections, caused by total weight of a track and a rolling stock taking into account different speed rates, were determined.
-Specific and absolute values of track irregularities on different spans of a track at different temperature rates were determined. For example, for high-speed STU (speed rate of 180km/h) maximum irregularity on 30m span will be 18mm (1/1667) at a specified temperature of +55°C and minimum irregularity will be 4mm (1/7500) at a temperature of 0°C.
-To increase dynamic evenness of a track it was recommended to make bending (deflection) of a rail frame in horizontal position upgrade to the extent equal to an average dynamic value of span deformation depending on string-rail vertical forces. Seamless linkage of string-rails was accepted. The diagrams of track deformation in terms of extreme atmospheric temperature were developed.
- Estimate of "wheel-rail top" contact stresses was fulfilled. They are 4-6 times lower than contact stresses of conventional railroads due to another type of wheel and rail bearing. The coefficient of unibus wheel rolling resistance was determined; the diagrams were developed and string-rail assumed service life (up to 100 years) was determined.
-In accordance with string-rail bending stiffness the values of a track curve radius both static and dynamic were determined. They should be no less than 1000m at unibus speed of 100km/h, no less than 10000m at unibus speed of 350km/h, no less than 20000m at unibus speed of 500km/h.

3.3 Unibuses

- A number of design solutions were suggested. Among them the design of passenger unibuses of different passenger capacity and the design of freight unicars intended for various cargo transportation (bulk and liquid cargoes, raw wood, containers, etc.) on different string-rail tracks (double-line of different gauge size and suspended or mounted monorail type).
-To increase unibus resistance on string-rails wheels with two bearing ribs are equipped with additional derailment side rollers. Clearance has negative value of approx. 100mm. Resonant vibrations dampeners are provided.
-Unibus design is worked out. It is based on the best equipment of world manufacturers.
-Fuel (energy) consumption per 100 km was determined.
-Track and dynamic analyses of high-speed (up to 450 km/h) passenger unibuses (two-wheel and multiwheel in the shape of a train) with 1m, 1.25m, 1.5m gauge and also of city bus (1.5m gauge) and city suspended mono-unibus were carried out.
-Braking distance changing intervals at speed rates up to 450 km/h for unibuses of different weight and capacity were determined.

-1:5 scale unibus models of different versions were tested several times in aerodynamic tunnel in Krylov Central Research Institute (St. Petersburg). Thereby drag coefficient was below 0.1.
-The analysis of how the above mentioned coefficient influences technical and economic features of high speed unibuses was carried out.
-Calculation of costs of unibus prototypes production was made. Its potential manufacturer was chosen.
-Acting models of high speed mounted STU with track of 1.5m (1:20 scale), 2m (1:5 scale), city unibus with a track of 2m (1:10 scale) were produced and tested.

3.4 Optional Equipment and Associated Systems

-Various types of unibus control systems were suggested. It can be either manual, semiautomatic or automatic control systems.
-STU was suggested to be equipped with automatic control systems produced in Russia which are used, for example, in light metro. The system might also be equipped with automatic control system produced abroad, in particular, by THALES (France), the world leader in this branch. They are widely used in public and intercity railway transport systems.
-Unibus point work constructions were developed.
-Passenger stations and suspended and mounted STU depots were designed.
-Alternate arrangement of suspended and mounted unibuses on string-rails was analyzed.

3.5 Transportation Process Organization

-Unibus traffic time intervals were determined (20-30sec. in the city STU in rush hours and 3-5 min. and more in the intercity high speed STU.
-Arrangements of passenger evacuation in case of emergency are provided. They include transportation of out-of-order unibuse to the nearest station or to the depot, he use of a special recovery vehicle. In extremely critical situations passengers are supposed to come down with the help of ropes or rope ladders.
-Satellite navigation system and unmanned control of the unibus are stipulated.
-A complex system of designing dynamic STU with speed rates up to 500 km/h was developed. Its main principle stipulates motionless strings and supports while unibus moving. All static and dynamic analyses were carried out with the aid of Patran-Marc and Patran-Nastran programmes.
-Equipment operation demands and environmental safety demands were determined.
-Alternatives of STU location in different cities, regions and countries were considered. The strategy of "the second level" transport system foundation was developed for the Khanty-Mansijsk Autonomous District – Yugra. It envisages installing of 3km of city, intercity and freight tracks. Expectative social-economic effect of the strategy realization is estimated at RUB 1.2 trillion.

Taking into account the effect in the abovementioned region (GDP growth, road accidents loss reduction, fuel economy, mineral resources and stock economy, environmental improvement, etc.) on a nationwide scale the strategy realization effect is estimated at RUB 100 trillion.

3.6 String Transport Performance Evaluation

-Metal structures (100-250kg) and iron concrete (0.1-0.3m^3) consumption per installation of 1m of double-line string-rail track was determined.
-Comparative evaluation of metal structures and iron concrete consumption for the installation of a conventional railroad (400-800kg/m of metal structures and 0.5-0.8m^3/m of iron concrete) and monorail (1500-3000kg/m of metal structures and 0.5-1.5m^3/m of iron concrete) was fulfilled taking into account earthwork in the scope of 10-50m^3/m.
-Evaluation costs (USD 1-1.2mln) of 1km of high-speed mounted light STU (1.5m gauge) installation in conditions of northland were determined. As a comparison, costs of 1km of a

conventional railroad (USD 3-5mln) and of a high-speed railway (USD 50-60mln) were estimated.

-Prime cost of track building was determined for all STU versions (suspended and mounted, extralight, light, average, heavy and extraheavy) of different speed rates (up to 100km/h, 200 km/h, 300 km/h, 400 km/h, 500 km/h) taking into account different geographical conditions. Different STU versions were considered (with contact wire line or without it, with manual, semiautomatic or automatic control systems, etc). The same with all STU components: string-rail track of "the second level", rolling stock and "the second level" infrastructure.

-Land allocation (about 100m²) per 1km of a string-rail track was determined. In comparison highway or railroad land allocation (5ha/km) was estimated.

-Estimation of STS efficiency was made which is determined by:

-environmental friendliness. Emissions of harmful substances into the atmosphere correlate as 0.01 per 100 passenger kilometers in comparison with 0.1 for conventional automobile transport. Electromagnetic emission rate is lower than it is in a trolleybus.

-small energy consumption (0.2-03 liters of gasoline per 100 passenger kilometers in comparison with bus consumption (1.8-2.5 liters/passenger km), tram and trolleybus consumption (1.6-1.9 liters/passenger km, energy converted to fuel), monorail consumption (1.3-1.6 liters/passenger km, depending on a speed rate).

-fewer land resources are needed (150-200 times fewer in comparison with motor and railway transport).

-fewer resource consumption (at the same time, STU building is 3-4 times faster than it is needed for motor roads or railroads).

-lower expenses (2-3times lower in comparison with railway building, 10-15 an more times lower in comparison with high-speed railway building, 15-20 and more times lower in comparison with monorail building, 20-25 and more times lower in comparison with maglev train, 3-4 and more times lower in comparison with autobahn).

The possibility of STU realization was presented with the help of one of the possible freight versions in Ozyory-town near Moscow in 2001-2008.

4. STU analysis in comparison with other transport systems. The possibility of its practical realization in adverse climatic and geographical conditions of Russian Federation (in terms of the Khanty-Mansijsk Autonomous District – Yugra).

Any transport system consists of three basic components: a track, a rolling stock and supporting infrastructure. Cost estimate of a new transport system is a great challenge. Usually only track costs are mentioned, not very often infrastructure costs are mentioned, and hardly ever rolling stock costs are mentioned. Table 4.1 represents the costs of different transport systems (rolling stock costs are not included).

Table 4.1

Transport Systems Cost

Transport System	Description of a System	Project Location	Double-line System Cost per 1km, USD mln.	Referral Source
City STU*	City line, up to 100kmh	Khanty-Mansijsk	2.4	Project Designer STU Ltd.
Speed STU*	Intercity line, up to 300kmh	Khanty-Mansijsk-Surgut, 250 km	1.3	Project Designer STU Ltd.
PRT-Ultra	City automated system, up to 40kmh	Heathrow airport in London	9.4	Manufacturer www.atsltd/co.uk/prt/faq
LRT-Tram	City tram line, up to 60kmh	Portland, Oregon, USA, 13.4km	43	Texas Association for Public Transport Development http://lightrailnow.org

Transport System	Description of a System	Project Location	Double-line System Cost per 1km, USD mln.	Referral Source
BRT-Isolated bus line	Exclusive Bus Line, up to 80kmh	Jacksonville, USA, 54.4km	10.6	Jacksonville Transport Department www.jtaonthemove.com
Monorail	Automated city line, up to 60kmh	Las Vegas, USA, 6.3km	103	Developer-Operator www.lvmonorail.com
Speed railway*	Diesel trains, up to 200kmh	Wentworthville-Las Vegas, 6.3km	10	Consortium of Developer-Operators http://www.desertexpress.com/economics.php
High-speed railway*	Electrified, up to 300kmh	California, USA, 1200km	35.5	CA Department of High-Speed Railways www.cahighspeedrail.ca.gov
High-speed railway*	Electrified, up to 350kmh	Moscow-Nizhny Novgorod, 400km	31	www.nta-nn.ru
Railway*	Intended for ore transportation, up to 80kmh	The Chita Region, Naryn-Lugokan, 375km	5.7	www.rzd-partner.ru
Light metro	Overhead city metro, up to 80kmh	Butovo, Moscow	34	www.metro.molot.ru
Motor road*	Intercity line, up to 120kmh	Moscow-St.Petersburg, 650km	13.5	www.g2p.ru
High-speed railway	Overhead electrified , up to 320kmh	Taiwan, the north-the south, 345km	43.5	www.niizhb.ru

* The data given is based on pre-design offers. STU data was taken from reports on contracts №7y and №12y concluded with the Khanty-Mansijsk Autonomous District – Yugra administrative authorities and performed in 2007.

Analysis of the data represented in Tab. 4.1 proves that STU is 10-20 times cheaper than other transport systems (including "the second level" systems on elevated structures).

Table 4.2 represents energy intensity of different transport systems in terms of crude energy (for electric systems in terms of thermal power stations fuel consumption taking into account energy loss in electric lines and other losses).

Table 4.2

Transport Systems Energy Intensity

Transport Facility	Fuel Consumption liters/100pass.km	Derived Energy Consumption Watt/pass.km	Efficiency of Crude Energy to Derived Energy Conversion, pct	Crude Energy Consumption Watt/pass.km
Electric unibus of city double-line mounted STU (12 passengers)	-	5.9	33.5	18
Electric unibus of city mono-rail suspended STU (12 passengers)	-	2.1	33	6.3
Electric unibus of speed intercity STU (200kmh, 11 passengers)	-	19.9	33.5	59

Transport Facility	Fuel Consumption liters/100pass.km	Derived Energy Consumption Watt/pass.km	Efficiency of Crude Energy to Derived Energy Conversion, pct	Crude Energy Consumption Watt/pass.km
Motor car (on average 1.7 passengers, 100kmh)	5.35	178	90.5	197
Bus (on average 80 pct of occupied seats, 60kmh)	0.71	23.7	90.5	26.2
Airplane (on average 70 pct of occupied seats, 900kmh)	5.30	177	92.0	192
Express train, 10 wagons (160kmh)	-	50	33.5	149
High-speed train, 14 wagons (250kmh)	-	61	33.5	182
High-speed maglev train Transrapid, 5 wagons (430 kmh)	-	176	31.0	568

The data, represented in Tab.4.2 (except for STU data), was taken from "Research on feasibility of high-speed railway with magnetic levitation train Berlin-Hamburg construction", VIEREGG-RÖSSLER GmbH Innovative Verkehrsberatung (the leading transport consulting company in Germany, http://www.vr-transport.de/transrapid.de/transrapid-energy/n003.html).

The analysis of the data, represented in Tab.4.2, proves that STU is the most cost-effective transport system. For example, in comparison with an airplane, intercity high-speed electric STU will be 3.3 times more cost-effective and non-electric diesel-drive STU will be 3.3×90.5%/33.5%=8.9 times more cost-efficient. In comparison with a high-speed rail, STU will be 2.5-3.1 times more cost-efficient. And in comparison with "Transrapid" maglev train, which is more energy-consuming than an airplane is, STU is 9.6 times more cost-efficient. City mounted STU, due to lower speed rates, will be approx. 3.3 times more efficient in comparison with intercity speed STU. Crude energy consumption of the city suspended STU will be 29 times even lower. And in comparison with a motor-car, STU energy consumption will be 31 times lower.

Taking all this data into account, STU is supposed to be the most environment friendly transport system ever known.

Due to string-rail specific characteristics, stated by a system designer, STU is less resource-demanding, more reliable and has longer service life than any other transport system.

Taking into account technical and economic benefits of the system, STU can also be exploited in the northlands and at river crossings (with the help of string highway and railroad bridges and crossings). Thus, the territories will be provided with up-to-date communications. At the present time "the second level" transport system produced on the basis of string technologies is supposed to be implemented in the Khanty-Mansijsk Autonomous District – Yugra. The necessity of making high-speed, economic, environmental friendly, long lasting and safe tracks, which meet the demands of the XXI century, in this region is clear enough. The Khanty-Mansijsk Autonomous District – Yugra is the most effective region of the Russian Federation, and its total area exceeds the territories of the majority of European countries. The project implementation is entirely possible and will depend on administrative and financial possibilities of region authorities. In the future STU might be developed and integrated into the transport infrastructure of the Russian Federation. The usage of radically new transport technologies will improve investment climate in any region of the Russian Federation. It will also move a base to solving of main social-economic problems.

5. STU Designing, Certification and Technical (Technological) Realizability

STU consists of three self-contained parts, which are separately designed and certified:
-rolling stock;
-"the second level" track and supports;
-"the second level" infrastructure.

5.1 Rolling Stock

Introduced by the project designer STU transport system refers to railway transport and serves for city and intercity transportation of passengers and cargoes.

City transportation rolling stock is a self-moving tram-type wagon. In fact, it is the sort of a conventional tram wagon in accordance with GOST 8802-78. STU tram wagon has a passenger cabin and drive endtrucks. There are doors, seats, ventilation, heating and conditioning systems, glass fixing, handrails and lighting in a passenger cabin. Endtrucks have electric drive, reduction gear and undercarriage equipped with brakes and mounting. The abovementioned compounds of a conventional tram wagon are mass produced by a number of Russian companies and by many foreign companies. These compounds might be in use for unibus construction or might be adapted to it. It follows that unibus might be developed and realized from technical point of view.

Intercity transportation rolling stock (a rail car) is a version of a motor car (passenger car, truck, minibus, bus, etc.), which is mounted on steel wheels.

The designed construction of a rail car (except for undercarriage) consists of the same compounds as a conventional motor car. There is a body, the doors, system motor, seats, cabin ventilation, heating and conditioning systems, glass fixing, handrails and lighting in a rail car. All the abovementioned compounds are also mass produced by many Russian and well-known foreign companies. These compounds might be in use for unibus construction or might be adapted to it.

Thus, self-moving city wagon is supposed to be equipped with the following certificated equipment produced by the leading foreign manufacturers of electric railway compounds:

-VEM Sachsenwerk GmbH, Germany (drive motors);
-L-3 Communications Magnet-Motor GmbH, USA-Germany (electric drive);
-Knorr-Bremse, Germany (brake system);
-VosslohKiepe GmbH, Germany (traction invertors);
-Bonatrans a.S. Bohumin, Czech Republic (undercarriage compounds);
-Gummi-Metall-Technik GmbH, Germany (undercarriage rubber-metal details);
-Webasto, Germany (conditioning system);
-Hübner, Germany (doors with opening device).

The production of these companies is supplied with the certificates, where equipment conformance to the requirements is stated.

The use of the certificated equipment, aggregates, details and system compounds, produced by well-known companies, will help the project designer to shorten rolling stock development time and will provide its high quality and reliability. It follows that unibuses and unicars might be developed and realized from technical point of view.

Rolling stock design and engineering is implemented in accordance with international requirements (UNECE, EN Standards, etc) and CIS regulations (GOSTs, OSTs, etc.) in the sphere of transport engineering. STU is supposed to make use of the following regulations:

-ambient noise level in accordance with UNECE Standard #51;
-electromagnetic compatibility in accordance with UNECE Standard #10;
-brake system requirements in accordance with GOST 8802-78 and EN Standard 13452-1;
-construction refractory features in accordance with UNECE Standard #52 and NPB Standard 20-2000;

-protective properties of a passenger cabin in accordance with UNECE Standard #29;

-interior layout of a passenger cabin concerning service and emergency doors accessibility, gangway dimensions, passenger seats size, seat pitch, the dimensions and construction of service and emergency doors, fire extinguishers equipment and hand-rail construction in accordance with UNECE Standard #36 and #52;

-in-cab noise level in accordance with GOST P 51616-2000;

-in-cab content of harmful substances in accordance with GOST P 51206-2004, GOST 12.1.005-88;

-radiointerference in accordance with GOST P 51318.12-99;

-heating, ventilation and conditioning in accordance with GOST P 50993-96;

-electrosafety in accordance with GOST 8802-78.

Meeting the requirements of transport engineering will help the project designer to ensure the rolling stock compliance with safety, reliability, ergonomics and environmental engineering demands.

To perform elaborating of normative documentation and certification of a rolling stock, the project designer has completed a cooperation arrangement with Science Research Institute of Electric Transport of Russian Federation (SRIET) in the sphere of city railway transport.

Thus, the project designer in cooperation with SRIET plans to fulfil the following scope of work:

-development of programs and techniques of rolling stock and its compounds stationary and running tests;

-organization of rolling stock prototype stationary and running tests and its certification;

-elaborating of rolling stock normative documentation;

The cooperation of the project designer with the Research Institute (SRIET) will help to shorten time needed for rolling stock certification.

The use of a certified equipment in rolling stock construction, fulfilling the requirements of Russian and international normative documentation in the sphere of transport engineering, cooperation with the Research Institute will help the project designer:

-to develop a rolling stock of high quality and in time;

-to provide a rolling stock with high safety, reliability, ergonomics and environmental protection standards;

-to shorten time needed for certification.

Taking into account the availability of facilities, technologies and equipment in Russia and in foreign countries, STU rolling stock might be developed and implemented in any climatic conditions of any region of Russian Federation including the Northlands.

5.2 Track Structure and Supports

STU string-rail track structure and supports are the variety of flying or cable-stayed bridges, because they represent trestle bridges. That is why making design documentation, the head engineering company follows bridge standards of Russian Federation SNiP 2.05.03-84* "Bridges and pipes". These standards cover railway, road and passenger bridges, subway and express tramway bridges, trestle bridges, pipe bridges and rail-road bridges.

STU Ltd has a conforming license № ГС-1-99-02-26-0-77045332-62-038379-1 "Designing of Buildings and Constructions of the I, II Importance Level in Accordance with the State Standard" including designing of high-speed transport lines and city electric transport, ropeways, bridges, high-rise buildings, etc. The license was issued to STU by the Russian Federal Agency for Construction, Housing Maintenance and Utilities on 02/05/2006. Besides, STU makes use of Russian standards in steel construction designing (SNiP II-23-81), some articles of European Standard (ENV) and new bridge standards of the USA (AASHTO). At the same time STU meets the most severe safety and durability requirements of all abovementioned standards.

Construction and building materials used in STU track structure designing are not unique. They consist of metals and alloy materials which are produced in a large scope by Russian and foreign manufacturers. They can be bought, they are certified, and there is no need of making extra expenses and performing technology development. Besides, there is no need in creation of manufacturing facilities and in certification of these materials.

Rail body and rail top are produced from already existing and manufactured according to GOST steel shapes (as a string rail top in some of its versions the designer suggests to make use of a conventional rail, for example, P50) or high-tension aluminum alloy shapes. These shapes under agreement with the manufacturers might be supplied with appropriate certificates to any region of Russian Federation, where a certain version of STU will be implemented.

As a rail compound it is supposed to make use of certified high-tension galvanized steel wire of 3mm diameter (ЖБК ТС71915393-053-06) in accordance with GOST 7348-81.

This type of wire is produced by Volgograd factory "VolgoMetiz", which is the part of Cherepovets holding company. Sample lot of this wire was produced on STU Ltd request in 2007. 4mm, 5mm, 6mm and other diameter wire might also be in use. According to SNiP 2.05.03.84* "Bridges and pipes", reinforced ropes which consist of 3-5mm diameter wires might be in use in regions with an average temperature of -40°C. In fact, the string represents multi-wire unrolled rope, which is assembled on a building area with the help of separate wires. The string is located in a close rail channel protected with encapsulating material, which is an anticorrosive agent. That is why in accordance with the requirements, min. 3mm diameter wire without zinc or any other protective covering can be used.

STU track structure and supports are built structures, which are installed directly on a building area. That is why "the second level" transport line doesn't have to be certified, such as other analogous built structures like roads, railways, bridges, viaducts, causeways, etc.

Taking into account the availability of facilities, technologies and equipment in Russia and in foreign countries, STU track structure and supports might be developed and installed in any region of Russian Federation including the Northlands.

5.3 Infrastructure

STU infrastructure consists of stations, depots, etc. Their functions are similar to the functions of bus stations and depots, which installation process is already worked out.

Constructional and finishing agents, elevators, lifting devices, sanitary ware and other equipment which is in use of STU infrastructure might be purchased from the best certified manufacturers. It will provide high quality and reliability of this equipment.

Price and other specifications of constructional materials and station equipment might be corrected by the customer in the developmental stage. These changes shouldn't provoke deterioration in quality and reliability of the construction project.

Construction and handover of such projects is implemented in accordance with GOSTs, SNIPs and other normative documentation worked out by the Russian Federal Agency for Construction, Housing maintenance and Utilities.

Thus, taking into account the availability of facilities, technologies and equipment in Russia and in foreign countries, STU infrastructure might be developed and installed in any region of Russian Federation including the Northlands.

5.4 Development and Expert Evaluation of Design and Estimate Documentation

STU design and estimate documentation, STU track and infrastructure building and their introduction into service are the similar as the designing and building of bridges, high-rise structures and other complicated construction projects.

6. STU Implementation Specifics

Documentation submitted to estimate and all abovementioned facts prove that the project designer has serious intentions to implement STU project to transport sector of Russian Federation. A large scope of research and development work has been implemented. But still there is a question of interest:

How will STU behave in terms of permanent frost, and will it retain its normal operation and technical and economic features in the longer term?

The climate in the North of Russia is characterized with large temperature gradient (about 100°C), high winds, high humidity and permafrost. The abovementioned temperature gradient and wind are taken into account in the estimates. But permafrost influence on a string-rail track evenness, which is a weak spot of any high-speed transport system including STU, is not adequately researched. And it is permafrost that can disturb required ideal evenness of a track. This fact can negatively influence STU implementation in the Northland, if it is taken into account in a wrong way.

6.1. About Permafrost Influence on STU

It is known that in terms of permafrost, which specifies so-called cryolithic zone of the Northern regions of Russia, such processes as thermokarst, frost fracturing and frost lift of dispersive ground may occur.

Thermokarst is the formation of subsidence and downwarping land forms due to melting of ground ice or melting of frozen ground. Thermokarst is caused by exchange flux on the land surface, when the depth of season melting exceeds the depth of ground ice lay or icy frozen ground.

Frost fracturing of ground surface is caused by freezing due to in-depth nonuniform temperature distribution in frozen earth materials. In such case compression and tension stress take place and lead to earth materials crevice and crack formation.

Frost lift of dispersive grounds comes from ground surface lift, caused by increase of frozen moisture, and ice formation, due to water migration at soil freezing.

The abovementioned permafrost peculiarities have negative influence on building of conventional roads. The roads lay on the ground, which stores heat in summer. It results in uneven frost melting and ground subsidence.

According to the estimates of the project designer, STU doesn't have such disadvantages due to its partial reference to permafrost. STU foundation piles are installed at sufficient depth and are made in such a way that they don't store heat and they transfer freeze into the depth of permafrost in winter, which provides stabilization of the foundation piles for the whole period of "the second level" track exploitation. Such solutions are already in use (for example, gas pipe-line in Alaska, open pile foundations of high-rise buildings in the Northland, etc.). But concerning STU additional researches should be conducted. Though SNiP 2.05.03.84* "Bridges and pipes" stipulates designing of bridges in terms of permafrost, and the project designer has the license № ГС-1-99-02-26-0-77045332-62-038379-1 dated on 02/05/2006 issued by the Russian Federal Agency for Construction, Housing Maintenance and Utilities. According to the license STU may design buildings and constructions (including high-speed lines) in the regions with severe geotechnical conditions (subsident, bulging, karst and deeply frozen). Still STU implementation in such regions has specific requirements.

Suspended STU is more resistant to the influence unstable actions of ground freeze. But it is influenced by strong crosswinds due to small bending and torsional stiffness of a string rail. It should be mentioned that the project designer has studied maximum deflection angle of IO-372П unibus cabin in terms of the overall impact of maximum asymmetric location of the passengers and the force of stormy crosswind (3.5° slope angle). Still these researches should be continued taking into consideration supports installment on permafrost grounds. Effective operational

experience of ropeways, where ropes don't have torsional stiffness at all, proves that the problem has technical solutions, but additional researches have to be conducted.

6.2 About STU High Technological Effectiveness

The abovementioned concept in our case includes string-rail manufacturing technology, supports installment technology, and the way pre-tensioned string rails are mounted on supports.

String-rail manufacturing technology is rather simple. There is rail top and rail body industrial rolling, placement and fixing of reinforcing ropes in it, filling of a rail body, welding of a long, narrow metallic strip to a rail body for unibus wheeling. These procedures require approx. 50-75 kg per 1 running meter (the same amount is needed for manufacturing of a conventional rail). All these procedures are less complicated than building of huge steel-reinforced concrete bridges with large spans or installation of monorail beam trestles. The designer has already demonstrated effective filling of a long and narrow string body with concrete, made without cracks and splits. Testing took place in experimental area in Ozyory-town. The concrete was squeezed to the pipe with the inner diameter of 82mm filled with nine K-7 ropes with the inner diameter of 15.2 mm at a temperature of -7°C.

A string serves as a principal reinforcement in a string-rail. That is why requirements to it will be the same as the requirements to pre-tensioned reinforcement of concrete structures. As the concrete is squeezed to a close rail frame, it follows that ready-mounted string-rail represents a concrete pipe. And it is easier to control and eliminate the process of cracks and splits occurrence, which weakens the construction, than it is in conventional reinforced concrete structures. As the external surface of concrete is all around covered with solid steel sheet, it will help to eliminate moisture penetration to the concrete. Thereafter, it will help to eliminate corrosion of the steel ropes and will increase their service life in comparison with conventional reinforced concrete bridges, which service life is approx. 50-100 years.

Supports installment technology and string-rail mounting to the supports in summer might be implemented with the help of special manufacturing equipment. At the same time there is no need of building access roads or platforms, because the string rails might be mounted on the supports from already installed sites of a track structure. In winter, when the ground is frozen, the installment might be implemented in accordance with a simpler process scheme.

6.3 About Transportation Process Safety in STU and its Convenience

STU transport system, as any other high-speed system, is rather sensitive to external actions, including mechanical influences. But it should be mentioned, that in distinction from conventional rail transport STU is equipped with anti-derailment system. It will considerably decrease the possibility of unibus derailment. And it should be also mentioned, that it would be more difficult for terrorists to put any hazardous large items at a height of 5-6 and more meters on narrow rails, than it might be done to unactivate conventional railroads.

Due to the possibility of permafrost influence on STU, track structure may become uneven. That is why the supports should be equipped with track adjusting mechanisms, which eliminate the effects of supports leans and sagging.

While moving across certain string-rail sites (in the top and in the final quarters of each span the bottom of a mono-unibus might be inclined. This incline is supposed to be in the limits of admissible inclination value of bottoms of city automobile, tram and bus transport.

In case of emergency passengers' psychological state won't be critical. If the unibus gets out of order away from the station at snow-storm, the passengers are supposed to be immediately transported to the station by the moving next properly functioning unibus. Unibus traffic interval is supposed to be 1-2 min.

6.4 About Technical State Diagnostics of a Track and its Maintainability

The diagnostics of technical state of a string-rail track may be implemented with the help of sensors installation. The sensors should control unibus state and transfer data to the diagnostics service division.

The rate of track maintainability is rather high. For example, a closed pre-tensioned STU string is less unstable than an open pre-tensioned rope of a conventional ropeway. But in case of string break off, caused by any reasons, its pre-tension force (up to 500t) will cause decrease of length in a special rail channel. The string will get out of order, but at the same time pre-tension force in a string rail will decrease (rail top and rail body pretension will remain, i.e. 20-30 per cent of primary tension). Basic equipment may proceed on such a track, and the string may be replaced or strengthened with additional external strings in the shortest possible period of time. If such emergency situations occur during exploitation of conventional bridges (for example, stay cable or load cable break off, or abruption of pre-tensioned reinforcement strand) it will lead to bridge collapse and long-lasting repair.

7. Conclusions and Recommendations

7.1. The designer presented plenty of documentation, which provides the idea of STU objectives, goals, investment character, principles and directions of STU implementation in Russian Federation and abroad.

In terms of transport system development of any region of Russian Federation, and in general, STU might be implemented as one of its constituent parts along with the implementation of conventional transport systems.

7.2. To put STU implementation into practice, it is necessary to move from investment stage of a project to engineering design, which will take into account construction and service peculiarities of "the second level" transport system in certain climatic conditions. Precise estimate of any STU project might be fulfilled only after design work on a particular STU version has been implemented. In this case all necessary analyses and explanations will be carried out. And adequate engineering solutions concerning infrastructure, track structure and rolling stock will be introduced.

7.3. On the stage of engineering design additional range of works, aimed at providing STU with effective implementation, should be completed. When high-speed passenger STU will be in the stage of implementation, additional researches concerning STU safety and reliability (towards passengers and personnel life, health and property) should be conducted. Comfort psychological state of passengers should also be taken into consideration.

7.4. Taking into account the development of the Transport Strategy of Russian Federation till 2030 and the tendencies in transportation industries of the country, STU designer should initiate in accordance with the established procedures a special-purpose program of state and private cooperation. It will be concerned with the implementation of projects of federal significance and with the creation of a new transport system in Russian Federation, which is String Transport.

To make a real step in such cooperation, it is reasonable to construct all basic types of track structures and STU versions on the experimental area of the Technology Development zone in the town of Dubna (Russian Special Economic zone, which resident is STU-Dubna Ltd, subdivision of STU Ltd) in order to carry out prototype testing and further certification.

Deputy Director of Science
Institute of Transportation Problems
Named after N.S. Solomenko RAS
Doctor of Engineering Science, Professor Y.M. Iskanderov

To the attention of: HOLD-INVEST-AUDIT Consulting Company CJSC

From: Anatoly Eduardovitch Yunitskiy

Purpose: for assessment of market value of exclusive intellectual property and know-how rights on the "String-and-rail Transportation System of Engineer Yunitskiy"

Background, quantitative and qualitative characteristics, competitive advantages and effectiveness of the "String-and-rail Transportation System of Engineer Yunitskiy"

1. Introduction

The 21st century will be the century of resource saving – energy, raw materials, minerals, space, etc. This has direct relation to transportation and infrastructural projects.

As an example the authorities of China set a course to construction of high-speed railways. Their track panels are set on gravel cushion over earth embankment, since overhung railways, especially high-speed types, are extremely expensive. Specifically, China built the world's longest high-speed railway "Beijing – Shanghai".

However there are private expert reports dated twenty years earlier in which foreign experts make the following forecasts. If China builds a network of traditional European type high-speed railways their numerous embankments will impair river heads, movement of surface and ground waters, animal migration paths, etc. This will effectively obliterate agriculture of the country and may result in mass starvation comparable in its severity to starvation during the Cultural Revolution when steel casting furnaces were constructed in every village, and when over 10 million people died of hunger.

The same adverse effects may be created by a network of conventional high-speed railroads constructed on any territory, if the rails will pass on embankments. As an example, in 1990s a decree of the President of the Russian Federation banned the construction of the "Moscow – Saint-Petersburg" high-speed railway owing to ecologists, since according to the estimations of environmentalist environmental damage to the country in the result of the project would be commensurable with the aftermath of the Chernobyl Power Plant breakdown.

The most valuable mineral-biological resource is fertile soil which enables growth of the "green lungs" of the planet and cultivation of major portion of our food. The soil's humus developed by the living nature for millions of years should have other use than be covered with earth embankment with sand-and-gravel cushion and railway track panels.

The planet's main transportation communications of the 20 century, rail and motor ways on embankments, by now have destroyed soil by burying it under railway crossties and road pavement on a territory exceeding the total area[24] of such countries as Germany, Great Britain and Portugal.

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[24] *About 100 mln. hectares of the planet's land are appropriated for transportation lines, mainly for rail and motor ways. This land does not breathe; no plants grow there to produce oxygen necessary for breathing of humans and animals. It produces no oxygen also used for combustion (consumed by billions of tons every year) both in internal combustion engines of transport moving along the roads (locomotives, cars, buses, etc.), and in remote thermal electric power stations in case of electrified transport. Territory still larger by several orders of magnitude was degraded by moving hundreds of billions tons of earth, sometimes transported via dirt roads to construction sites for tens of kilometers. Soils immediately adjacent to roadways are constantly, for decades, polluted by*

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Nothing growth on this soil, it is dead. On a still greater territory, larger by one to two orders of magnitude movement of ground and surface waters is impaired, since any embankment is a low dam[25]. This leads to bogging of huge territories and desertification of other similarly vast territories resulting in irreversible destruction of existing natural ecosystems and biogeocenoses, destruction of certain habitats of rare flora and fauna. In agricultural areas this often leads to degradation of productive soils.

According to McKinsey Global Institute (MGI), one of the world's most esteemed expertise organizations, the world enters an era of expensive resources. The 3-billion growth of the middle class by 2030 will boost the demand for resources drastically, while development of new sources of energy, water and food is difficult and very costly (see: http://www. mckinsey.com/mgi).

A report by MGI states that in 20 century the population of the planet grew four times over, and GDP – by 20 times resulting in 2.000% growth of demand in natural resources, whereas commodity exchange prices dropped by half. However this price drop was set back during the last decade, as the authors stress. In their opinion the low-price era is in the past. According to a forecast of MGI from 2010 till 2030 the world's middle class (that is, those capable of spending $50-100 daily, with regard to purchasing power parity) will grow by 3 billion from todays 1.8 billion. The demand will surge just at the time when development of new resource sources is difficult, and we fill face the "resource revolution".

According to MGI, lack or price growth of one of the resources may spread into the others. For example, climate warming may call for more water for irrigation, thus reducing volume of electricity generated by hydroelectric power plants. And the rise of the World ocean due to the climate warming will cause flooding of large territories and damage of agriculture and infrastructure, including land-based (i.e. "first level") transportation.

The authors note that efforts to meet the growing demand by proportionate growth of production will require up to $3 trillion of additional investments annually, which is at least $1 trillion more than the world invested in the accounted past, and will bear serious risks. Drinking water consumption by 2030 will increase by 30% and its deficit in arid countries will aggravate. Half of new copper deposits are located in countries with high political risks, and over 80% of unused arable lands are situated in countries with underdeveloped infrastructure or severe political problems. It should be noted that increase of investment will be necessary just in the time when money will be difficult to earn and expensive, experts estimate additional costs of money attraction as $400 – 500 billion per year.

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carcinogens and mutagenous products of use of these transportation lines: motor vehicles exhaust products, products of tire and pavement wear, deicing salts, transportation wastes, etc.

[25] The high-speed railways require that not only embankment earth but also underlying ground (totaling over 10,000 m^3/km) be compacted by about 10%, otherwise safety of movement will be undermined due to low stiffness of the base. This turns earth embankment of such roadways into a low dam which impairs movement of ground and surface waters, including flood waters. This, in turn, leads to bogging of large areas on one side of the embankment and desertification of areas as large on the other side. Besides such roadways require, at least for safety reasons, double-sided fencing since an elk, a cow, or a wild boar standing on the roadway may result in crash and derailment of a high-speed train. Thus the embankment complemented with the high-speed railway fence makes an impassable obstacle for wild animal migration across railway and similarly for travel of domestic animals, humans and agricultural machines. Sometimes it results in destruction of habitats of rare plants and animals. Furthermore the numerous traffic accidents and disasters are very much due to the fact that motor and railways pass on the ground level, i.e. on the "first level", just where all the nature, including humans, is situated. Yearly more than a million people and a billion animals (especially small ones) die on the roads of the planet, every year over 10 million people are disabled. The accident rate grows over years and in 100 next years this will result in loss of life for over 100 million people and more than 1 billion will be disabled. (For comparison: accident rate in aviation which operates high above the ground level is about thousand times lower annually, much less than one thousand people die in air disasters).

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Should the production not just be expanded but its effectiveness also enhanced, up to $3 trillion (in current prices) may be saved. If subsidies and other preferences of the energy sector, transportation, agriculture, are removed the total saving will amount to about $4 trillion per year.

However one can hardly rely on the increase of effectiveness of resource use alone. Though it will allow saving 20 QBTU (Quadrillion British Thermal Units), it will not abate the demand of additional 400 QBTU due to oil, gas and coal reserves depletion. Enhancement of effectiveness will require additional capital investments estimated by McKinsey at almost $1 trillion per year.

The main consumer of the majority of resources today is the world's transport and infrastructure complex (motor and railways with motor transport, trains and infrastructure; aviation and its aircrafts, airports, and infrastructure; sea transport with vessels, ports, infrastructure, etc.).

That is why the world's future overpass-based transportation and infrastructure railway complex (since embankment-based roadways should, considering the aforesaid, be prohibited by law as extremely dangerous to the nature and people), must satisfy the following mutually exclusive criteria:

d. Construction resource demand must be cut by an order of magnitude as compared to railways and motorways, with consideration not only to conventional mineral resources – steel, reinforced concrete, but also to other no less important resources – ground safety exclusion areas, volume of excluded arable soil, of used earth, construction sand, gravel, and besides that – the fuel burned not just by the engines of construction machines during construction works, but also considering its previous consumption for extraction of mineral resources, their transportation and processing into structural materials and structures for both the roadway and infrastructure transportation objects, etc.;

e. The cost of the complex must be much less than the cost of the known overhung transportation systems – monorail, transportation systems with magnetic suspension of carriages, standard high-speed railway trestles, bridges, overpasses, and trestles of the conventional railway;

f. The railway transportation complex including its infrastructure shall be located only on the "second level" with minimal land exclusion and minimal intrusion into the natural environments.

In this case the resources – mineral, energy, and other, including financial resources, will be enough for the humankind not only to re-equip/converse to other standards of development of a conceptually new "second level" communications, but also to operate this network for the following centuries.

Railways shall over time be deployed over the ground surface on lightweight laced supports, and the land occupied by today's roadways shall be re-cultivated and returned to the land user. The road structure of the "second level" shall also comprise communication lines and power lines, and its support and structure shall integrate sun and wind electric plants. This will allow developing a conceptually new network, not as much transportational as communicational for transporting passengers and freights, and besides – electrical energy and electronic information.

Railways located at the "second level" will bring double economy.

Firstly, the freight routes of the "second level" will provide access to presently unavailable mineral resources, located for example in mountains, tundra, at the Arctic Ocean shelf, deep in vast deserts, deep within a continent, for example in Australia, etc. These mineral resources will allow the world's economy to continue to develop dynamically, but to develop within the logic of maximum saving of resources, and not in the unlimited growth of consumption, as it was before.

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Secondly, the high-speed freight-and-passenger roadways of the "second level" will allow developing a distributed worldwide network of ecologically safe transportation communications, integrated with information and energy communications, cheaper and with less expense of mineral and energy resources.

Upon that within the 21st century practically all of transportation of the planet shall pass to the "second level", leaving the "first level" to the nature and people. This will allow increasing communicativeness of the Earth's civilization, according to UNO the demand of the people to travel shall multiply 3 to 5 times within the next 50 years, with considerable increase in speed and distance of these travels.

The basis of the proposed railway infrastructure complex is an improved railway trestle – a transportation system of the "second level" with pre-strained string-and-rail track structure. It uses conventional railway rails, on which traditional freight, passenger and high-speed trains may travel.

2. The demand for railway trestle type in the 21st century

Total length of the world's railway network reached its peak in mid-20 century – 1.3 mln. km. Presently the length of this network totals 1.1 mln. km. and starts to expand again due to construction of high-speed railways. The three countries with the longest railroad networks (including service and special freight railroads): the USA – 230 thous. km, Russia – 149 thous. km, China – 119 thous. Km.

Like in the 20 century railway has passed from steam locomotion to diesel and electric locomotion, in the 21st century it shall, due to the above reasons, pass from ground level placement onto the "second level" – the trestle.

Newly constructed roadways, all of which will be high-speed roadways, shall initially be performed on the "second level", but this does not happen because of one reason – it is very expensive. Under current conditions railway trestle with infrastructure costs minimum $100 mln./km, or for networks with length of 1 mln. km – $100 trillion, which will amount 150% of the present world's GDP. Also, this construction will require enormous, even limitless quantity of construction and structural and structural materials – about 100 thousand tons of steel and reinforced concrete for one 1 km of length of a two-track road, or for a 1 mln. km. network – 100 billion tons, which will be beyond the capabilities of the world's industry not only due to resource, but also to economic and ecological reasons.

If the cost of a trestle, most of all a high-speed one, could be reduced by at least 5 times, than such construction would be in the humanity's capacity, since it would cost $20 trillion, which would amount to no less than 30% of the world's GDP.

In the end of the 19th century (1880 – 1890) the rate of construction of railroads reached its historical peak of 20 thousand kilometers per year (for comparison: construction of hard-paved motor ways, also very costly in resources and costs, reached its historical peak of 200 thous.km/year in the 20 century).

3. Resource efficiency prestressed string-rail rail road overpass

The string-and-rail transport system of engineer Yunitskiy, located over the ground level on the "second level" has low material intensity and consequently low demand for mineral resources for

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its construction: steel and steel structures, nonferrous metals, reinforced concrete, concrete, cement, steel reinforcement, gravel, sand, earth, etc.[26]

The above said applies equally to the type of string-and-rail roads that uses conventional railway rails as the track structure for travel of both low- and high-speed conventional railway rolling stock.

Furthermore, due to continuous design of string-and-rail way (it has no deformation seams or seams of other types on its whole length thanks to being welded into one string, including railway rail), the bearing capacity of the carrying supports is increased by an order of magnitude. And since these structures constitute the major part of a "second level" road (for one anchor support there are 100 intermediate supports) material intensity and cost of the supports is halved[27].

For a string-and-rail railway type trestle it is most advisable to use a track structure, protected by industrial patents[28] – they provide for the track structure in the form of a spatial structure, in particular, in the form of a string trestle without the use of conventional crossties and gravel-and-sand cushion. This track structure, while having a low material intensity (steel intensity), will provide nevertheless a high static and dynamic evenness and stiffness of the trestle structures under the effect of the assumed mobile load of railway trains.

In order to ensure comfortable travel of high-speed means vehicles, including high-speed trains, unevenness of the way, with regard to deformability of the trestle must be very low: no more than 8 mm for a 30 m span for the speed of 100 m/sec (360 km/h), or in relative values – no more than 1/3.750; no more than 9 mm for the speed of 125 m/sec (450 km/h) for a 40 m span, or in relative values – no more than 1/4.440.

For a relevant comparison of resource intensity of the two competing transportation systems a comparative analysis of the proposed string-and-rail trestle and a railway trestle of conventional design needs to be performed. For instance, a comparison with a railway situated on ground level will be irrelevant. These competing systems shall have the same level of user characteristics: movement speed of 500 km/h and a prospective passenger traffic of no less than 100 thous. pass./day, with similar level of comfort, safety, and service life.

A high-speed trestle railway would partially meet these requirements, particularly the one constructed in 2000 – 2005 on Taiwan Island with Japanese technology (see: http://www.niizhb.ru/engin06.htm). Movement speed on this road, however, is limited to 350 km/h, since its further increase would entail even greater material intensity of the trestle and growth of its cost.

Main resource characteristics of this railroad which has the length of 345 km and the cost of 15 to 18 billion US dollars, depending on reports (or $43.5 – 52.2 mln./km in 2005 prices; these numbers shall be doubled for 2013 prices):

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[26] *A. E. Yunitskiy Optimization of surface transportation system. International magazine "Problems of Mechanical Engineering and Automation" – M.: IMASH, MosgorCNTI, 2005, No. 4, pp.. 45 – 50.*

[27] *A. E. Yunitskiy String transportation systems: on Earth and in space. – Gomel: Infotribo, 1995. – 337 p.: gr.; A. E. Yunitskiy Transport System Yunitskiy (TSU) in questions and answers. 100 questions – 100 answers / Monograph. Eighth edition, revised and enlarged, – Moscow, May 25th, 2012 – 80 p.: gr.*

[28] *A. E. Yunitskiy Transport System Yunitskiy (variants) and method of construction of the transportation system. Eurasian patent No. 006359, cl. B 61 B 3/00, 2004.; A. E. Yunitskiy Transport System Yunitskiy (variants) and method of construction of the transportation system. Eurasian patent No. 006112, cl. B 61 B 3/00, 2004.; A. E. Yunitskiy Transport System Yunitskiy (variants) and method of construction of the transportation system. Eurasian patent No. 004917, cl. E 01 B 25/00, 2002.; A. E. Yunitskiy Transport System Yunitskiy (variants) and the method of construction of the transportation system. Patent of the Russian Federation No. 2224064, cl. E 01 B 26/00, 2002.; A. E. Yunitskiy Transport System Yunitskiy (variants) and the method of construction of the transportation system. Patent of the Russian Federation No. 2220249, cl. E 01 B 26/00, 2002.*

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- span length – 35 m;

- massive supports of reinforced concrete with diameter of several meters (vertical load of each support amounts to 4,000 tons), each having a thick foundation placed on four injection piles of reinforced concrete with diameter of 2 m and length of 60 m (weight of pile foundation under each support amounts to 1,800 tons);

- massive span structures in the form of two pre-strained prefabricated reinforced concrete beams with width of 6 m, height of 3 m and weight of 800 tons each. On the bearing beams similarly massive pre-strained slabs of reinforced concrete with width of 13 m (the weight of the slab on the span may be estimated at 500 tons) are placed, on which a two-way high-speed rail track panels are located.

One kilometer of length of such conventional high-speed railway trestle requires up to 100 thousand ton of structural materials (considering supports and their foundations) – of steel and reinforced concrete, including up to 10,000 ton/km of high-alloy steel needed only for reinforcement of the concrete.

Characteristics of the proposed high-speed pre-strained string-and-rail trestle (SRT) for travel of high-speed trains on conventional (serially produced) railway rails:

- span length – 40 m;

- intermediary supports (a separate support for each way): vertical load on the support – up to 400 tons, that is 10 times less than in a competitive conventional high-speed trestle. Support foundation – two injection piles with diameter of 60 cm and length of up to 18 m. Weight of the support including the weight of the foundation – up to 80 tons;

- one massive anchor supports placed, depending on the relief, every 3 – 5 km. Weight of this support (made mainly of reinforced concrete) – up to 2,000 tons, or up to 500 t/km;

- two-way span structure: string trusses with height of 3 m, housing in their booms strings (tension reinforcement), pre-strained to total load of up to 1,200 tons. On the upper booms of the trusses standard rails for high-speed travel are located, on which wheel-sets of trains travel. Empty spaces between strings and walls of rectangular steel tubes of booms of the trusses are filled with special concrete. Material demand for 1 kilometer of stretch of a two-way truss-and-string rail track structure (without rails) is: steel – up to 1,250 tons, including finished steel (rectangular tubes) – up to 1,150 tons, strings (high-tensile steel wire) – up to 100 tons; concrete – up to 2,200 tons (approximately up to 0,9 m^3/m).

Accordingly, one kilometer of length of the proposed high-speed railway SRT will require, including supports, up to 6,000 thousand tons of structural materials – steel and reinforced concrete, including up to 1,500 t/km of steel. The weight of 4 R65 rails must be added to this – 260 t/km.

Let us compare demand of materials needed for the construction of the competing transportation systems on an example of a worldwide network of high-speed railroads with total length of 1 mln. km, as shown in the table below.

Table 1

Demand of structural materials for construction of a network of railroad trestles with total length of 1 mln. km

Structural element	Conventional high-speed railroad trestle		String-and rail trestle designed by engineer Yunitskiy	
	Steel, tons	Reinforced concrete, m^3	Steel, tons	Reinforced concrete, m^3
1. Bearing span structure for two tracks (total length – 1,000,000 km)	-	24,000,000,000	1,250,000,000 (string truss)	920,000,000 (truss gap filler)

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Structural element	Conventional high-speed railroad trestle		String-and rail trestle designed by engineer Yunitskiy	
	Steel, tons	Reinforced concrete, m^3	Steel, tons	Reinforced concrete, m^3
2. Two-way rail track structure (length – 2,000,000 km for one way)	350,000,000 (rails and rail fasteners)	390,000,000 (crossties)	210,000,000 (rails and rail fasteners)	—
3. Supports: - intermediary - anchor	 — —	 800,000,000 —	 95,000,000 6,000,000	 160,000,000 210,000,000
4. Support foundations	—	16,000,000,000	280,000,000	460,000,000
5. Other uses and contingencies (10%)	35,000,000	4,200,000,000	184,000,000	175,000,000
Total	385,000,000	45,400,000,000 (including 11,000,000,000 tons for steel reinforcement)	2,020,000,000	1,920,000,000 (including 240,000,000 tons for steel reinforcement)

Sources of information: information provided by the Customer

It needs to be pointed out that for construction of these competing railway transportation trestles similar materials with similar initial costs are used: steel reinforcements for reinforced concrete, rails, high-tensile wire for strings, etc., are manufactured from high-alloy steel commercially produced today, on the existing equipment, reinforced and ordinary concretes have conventional compositions, conventional strength, and are produced on standard equipment. For example, the railway trestle constructed on Taiwan Island used class K-7 reinforcement cables with diameter of 15 mm (twisted cables with 7 5-mm wires each) and high-tensile steel reinforcement wire as prestrained reinforcement, that is, just the materials used as strings by the proposed string-and-rail trestle.

To estimate the amount of reinforcement used in construction of the high-speed railway trestle of Taiwan Isle (this data is not disclosed by the system developer), let us assume a minimal standard reinforcement factor for reinforced concrete structures of 3%. This figure represents cross-section, if demand by weight is estimated it will amount about 10% of the weight of reinforced concrete, or 240 of reinforcement steel for 1 m^3 of reinforced concrete.

Analysis of the data of the table above results in the following conclusions:

4) The demand of steel for construction of the proposed worldwide high-speed network of string-and-rail trestles with total length of 1 mln. km, will be lower than that of a conventional high-speed railway trestle (constructed with Japanese Shinkansen technologies) of the same length, by 5 times, the demand of reinforced concrete structures – 23 times lower. The estimation takes into consideration the “hidden” steel used as reinforcement in the reinforced concrete: for a conventional railway trestle it is 11 billion tons of high-alloy steel, for a string trestle – 240 mln. tons. Here resource saving will total: for steel – 9,1 billion tons, for reinforced concrete – 43.5 billion cubic meters (104 billion tons).
5) Construction of trestles uses special implements and equipment at every stage – from production of prefabricated units in factories to their transportation to the construction site and performing construction and installation works involving not only installation equipment, but also welding, encasement, corrosion protection, etc. Therefore the cost of “turnkey” installa-

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tion of structures constructed sometimes out in the field within thousands kilometers from the supplier, would multiply several times as compared to the selling price of the initial raw materials – steel and concrete. Under highly mechanized flow-line construction in the field international average cost of the mentioned construction works will increase: for steel structures constructed on the "second level" – up to $4,000 – 6,000 or more per one ton, for reinforced concrete structures constructed on the "second level" – up to $900 – 1,200 or more per one cubic meter.

6) Based on the stated efforts and their costs the cost of the string-and-rail trestle for the network of high-speed rail roads with the length of 1 mln. km will total, on the average (without the cost of infrastructure and rolling stock):

- with traditional trestle design, similar to the high-speed railroad build with Japanese technologies: $49.4 trillion ($49.4 mln./km),

- with string-and-rail design (SRT): $11.1 trillion ($11,1 mln./km).

Therefore the economy of investments for construction of the network of trestle railroads with the total length of 1 mln. km will total $38.3 trillion, or, in terms of 1 km of length – $38.3 mln./km.

In reality the proposed string-and-rail trestle may be about twice cheaper since the table above shows the most massive variant of such trestle designed for load per unit of length of 6 t/m. This weight load would be brought by two massive diesel or electric locomotives in a train of total mass of up to 200 tons, for heavy-duty ore transportation routes. Whereas high-speed railways use motor cars with specific weight load of up to 3 t/m, construction costs of string-and-rail trestles for such trains may be twice lower.

A special stress must be made of the following fact. A conventional reinforced concrete railway trestle is pre-strained. That is, steel reinforcement of the reinforced concrete bearing beams of conventional span structures is preliminary strained, so this structure in its engineering essence is also a string. Since the developer of the railway trestle constructed at Taiwan does not disclose the force of pre-stress of the reinforcement, let us estimate these forces independently.

Load per unit of length of such span structure (taking into account two trains and two track panels) will be about 68 t/m. Thus the maximum bending moment in the middle of the span, considering the dynamics of high-speed rolling stock will amount to about 10,500 t/m. Since cracking of the strained zone's concrete of the pre-strained reinforced structures is undesirable, the pre-strain force of the reinforcement which compresses the concrete must exceed the bending force in this strained zone. With the bending moment of 10,500 t/m and the height of the bearing beams of 3 m this force may be estimated at 3,800 tons. This is the force of compression of the concrete of a conventional span structure, that is, the concrete will also be pre-strained, since it will be pre-compressed longitudinally with a force of no less than 3,800 tons.

Thus the "strings" (the pre-strained steel reinforcement) of a conventional "non-string" railway trestle must be strained with a force of minimum 3,800 tons, and strings (pre-strained steel reinforcement) of the proposed string-and-rail trestle will be strained only at 1,200 tons, that is, 3 limes less.

Also, the pre-strained conventional reinforced concrete trestle is not strained longitudinally, so from the engineering standpoint it is not a "string" – reinforcement strain forces are compensated by equal forces of train of concrete, resulting in zero total longitudinal forces.

Thus the term "string" included in the definition of the string-and rail trestle design proposed by engineer Yunitskiy refers not as much to the presence of a preliminary strain, as to the definition of a pre-strained, continuous and statically indeterminate transportation trestle:

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3) The bearing structure must be raised over the ground level and set up on intermediate and anchor supports (similar to, e.g., a pre-stretched guitar string);

4) Compensating compressing forces are transmitted not to structure of the trestle, since it would be over-stressed, but to the Earth's crust which has extremely high bearing capacity[29] (for instance, in a guitar these compensating compressing forces are transmitted to the neck, serving as an analogue of the Earth's crust).

For comparison, the costs of construction of conventional high-speed railroads, both constructed and planned for construction in the near future in various countries, are shown. The cost of these railroads where track panels and gravel-and-sand cushions are laid on earth embankment which is cheaper than a trestle depends on the country, the estimated travel speeds of trains, the relief, the applied technologies and many other factors. It should be noted that while the operational speeds of these railroads are moderate, up to 300 – 350 km/h, their costs is rather high:

- "Frankfurt – Cologne" (Germany): $47 mln./km;
- "Pretoria – Johannesburg Airport" (SAR; speed 160 km/h): $62 mln./km;
- "Astana – Almaty" (constructed with the use of Chinese technologies): $24 mln./km;
- "San-Francisco – Los Angeles – San Diego" (the USA): $32 mln./km;
- "London – Edinburgh" (The UK; speed up to 400 km/h): $83 mln./km.

(http://mosurforum.ucoz.ru/news/skorostnoj_gudok_na_zheleznoj_doroge_pojavjatsja_poezda_novogo_pokolenija/2010-03-30-64).

The figures shown above correlate with estimations of cost of similar conventional high-speed railway mainline reported recently, in particular in the Russian press. For example, the cost of the high-speed railway "Moscow – Saint-Petersburg" with the length of 660 km which is 1.515 times shorter than the discussed trestle type railway network with the total length of 1 mln. km, is estimated by the experts at a sum starting $40 billion (a road on an embankment), up to $60 billion or more (a road on trestle). A high-speed railway network with the total length of 1 mln. km constructed with these conventional technologies would cost the customer $60 to $90 trillion.

Some experts (e.g., the Head of RZD in his public speeches) express the opinion, with reference to their foreign colleagues, that, for instance, in Russian environment with its harsh climate any high-speed railroad, whether it is built on an embankment or on a trestle, cannot be constructed for less than 100 million Euro per kilometer.

Instead of construction of new high-speed railways a conservative course of the railway complex development is possible – by investments in reconstruction of the existing road network with the aim of increasing average train travel speed. Reinforcement of the existing upper section of railway may provide conditions for train travel at speeds of 140 to 200 km/h. This practice is widely used in France, Germany, China and Russia.

For instance, in 2007 JSCo "RZD" (Russian Railroads) repaired 12 thous. km. of railway tracks, spending 73.5 bln. rub. In the case cost of repair of 1 km. of the railway amounted to 6.125 mln. rub. The repair works allowed to increase average speed of passenger trains by 0,8 km/h – from 88.3 km/h to 89,1 km/h (http://www.kommersant.ru/doc/831539/print).

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[29] *All constructed structures sometimes weighing millions of tons or more are supported by the Earth's crust: buildings, including high-rise buildings; the Pyramid of Cheops, suspension and cable bridges with total forces in bearing cables of 100 thousand tons or more; dams amd man-made lakes (weighing billions tons); artificial islands, etc. Therefore horizontal efforts of about 1,000 tons transmitted to the Earth's crust from trestle strings are environment-friendly, considering also seismic activity. Furthermore, these efforts will be concentrated only on the terminal anchor supports of all, even the longest roadways, which, also will be combined with passenger stations and freight terminals, whereas at intermediate anchor supports this effort will be internal -- the effort on one side of a support will be compensated by the same effort on the other side.*

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In order to increase speed on RZD railroads at least up to the speeds supported by the "Sapsan" trains purchased in Germany (250 km/h), the reconstruction will need investment of 1.23 bln. rub./km, or $40 mln./km. And increase of the speed to 450 km/h RZD will require over 400 years; in this case reconstruction expenses for every kilometer of the existing railways will exceed $100 mln.

That is why construction of an innovative transportation infrastructure on the "second level," based on string-and-rail technologies of engineer Yunitskiy, will be more advisable and rational, since it will be cheaper by an order of magnitude and faster by an order of magnitude.

High-speed roadways are quite competitive with aviation. Furthermore, air lines need to be unburdened. High-speed roadways will allow reducing air traffic of metropolises' airports thus opening additional possibilities for international air traffic.

Any high-speed road is an object of advanced technology. Not only maintenance and auxiliary services need to be integrated into it, it is also necessary to develop infrastructure, develop new cities, launch new energy facilities and other objects. This will mean millions of workplaces which will be an asset in today's time of crisis. Furthermore, a network of cost-effective high-speed roads will boost economic and social development of regions, including the depressed ones. The concept of "remote regions" will change drastically. Their residents will be able to travel 300 – 400 km to work.

When one speaks of high-speed roads, we think of the economics first: when will the spent money return and when the money will give profit. The string-and-rail trestle is the only self-repaying type of high-speed roadways both due to low capital investments for construction and to low operation costs and a longer service life. Yet projects of high social importance must not be judged from the viewpoint of immediate benefit. There are different benefits. The main significance of the high-speed roads is political, since a country with such roads is an unambiguous developed country. Their social significance is no less important, since they elevate the level of development of human capital.

The conclusions of high recourse effectiveness of string-and-rail trestle roads in comparison with the known transportation systems are also upheld by an independent report of the Institute of Transportation Problems Named after N. S. Solomenko of the Russian Academy of Sciences[30].

4. Structural and technological know-how in the string-rail racks

The string-and-rail trestles designed by engineer Yunitskiy encompass tens of structural, technological and other know-hows, allowing material intensity and cost of the "second level" railroads.

The know-hows may not be published since their value and the value of the business developed on their basis will in this case be nullified. However it is possible and quite reasonable to describe their essence without divulging the know-hows themselves. It should be noted that these know-hows are in their engineering substance are quite simple solutions. As they work jointly they create a synergy effect. The know-hows may be grouped in separate systems.

First, one of the reasons of the high material intensity of conventional railroad trestles is that they consist of separate beams, separated lengthwise by expansion (temperature) seams. There is no other way to construct these trestles due to the large cross-section of the span structures. Under temperature variations this would create extreme longitudinal temperature strains which would be unbearable by the structure of the trestle. For example if the high-speed railway trestle de-

30 Executive Summary of Innovative Transport Technology "String Transport Unitsky" / Institute of Transportation Problems Named after N. S. Solomenko of the RAS. - St. Petersburg, 24 May 2010. - 13 p. (see: http://www.yunitskiy.com/author/2010/2010_14.pdf)

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scribed above, similar to the one built at Taiwan Island, would be continuous, than under temperature variations within 100 °C (environmental conditions of Russia make possible temperature variations of up to 120 °C) longitudinal temperature strains could reach 200 thousand tons.

Expansion seam in a trestle with other conditions being equal would result in increase of the trestle material intensity by 2 times, and that of the supports – by 16 times (including 8 times increase due to alteration of loading pattern of the support, since under compressive strain it would become cantilevered, with an unfixed top, and 2 times due to the increase of weight load from heavier span structures).

Besides, the temperature seam undergoes a dynamic impact from wheel-sets, since they are the point of bend of a high-speed train travel trajectory. Together with other disadvantages of such transversal gaps in the structure this makes the expansion seam the weakest and the most problematic location of the modern trestles.

The String-and-rail Trestle (SRT) has no expansion seams, providing all the ensuing advantages.

Second, notwithstanding the fact that steel structures have a number of advantages over the ones made of reinforced concrete, Japanese trestle designers still use reinforced concrete. This has an explanation. During the development of the high-speed Shinkansen railway network in Japan 30 – 40 years ago initially steel trestles were constructed. However after numerous complaints from townships surrounding the high-speed railways about powerful high-frequency noise, construction of steel trestles was legally banned. None of the tested measures used to abate the noise generated by steel structures, including covering them with rubber and polyurethane revealed positive results.

The SRT solves this problem by effective and simple methods that Japanese trestle developers never proposed or tried.

Third, due to the continuous type of the trestle (in other words it is “endless”), braking forces of a train which may in some cases total hundreds of tons, are transferred not to the intermediate supports (they do not participate in distribution of longitudinal horizontal stress), but to the anchor supports. Thus only one of 100 supports is under horizontal breaking stress, whereas in a competitive trestle due to the presence of the deformation seams this stress shall be borne by every support. This results in additional increase of material intensity and cost of conventional railroad trestles. It should be noted that the continuous structure of the proposed SRT trestle results in decrease of breaking power transferred to the anchor support since this force will be spread to 2 supports simultaneously, both to the one situated in the front, and in the back.

Fourth, a continuous statically indeterminate and pre-strained truss-and-string trestle required new solutions for all of its structural elements and construction techniques, from the booms and diagonal ties of trusses, to supports and their foundations, besides the need to reinforce truss booms by pre-strained strings. All these solutions have been created. The main development criteria are the following: the trestle must be durable under the heaviest load, have a long operation time (of no less than 100 years), stable under cyclical stress (strained elements and welded seams especially) – no less than 100 mln. strain cycles, quiet, designed for temperature variations (with a 1 in 100 years possibility) of 120 °C and hurricane wind with speed of over 250 km/h (storm, tornado), and be resistant to Richter scale grade 9 earthquakes.

Fifth, the crossties of the conventional railway track make it a heavily loaded beam resting on discrete supports (crossties) working in high-frequency bending during passing of each wheel the movement (rolling) speed of which may exceed 10 m/sec. This places extraordinary requirements for both strength of high-alloy grade steel of the rails, and for the geometry and structure of the rail itself and its resting on the crosstie. Nevertheless this does not rule out breaking of the rails

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resulting in crashes and disasters, and derailing of trains from the track structure which is especially dangerous in high-speed travel.

In the proposed string-and-rail trestle traditional crossties are not used and each rail rests on one of the “endless” continuous (having no cross seams) longitudinal “crosstie”. That is why it practically does not suffer bending stresses and prevents ensuing breaks since the rail will work as a beam resting not on supports, but on a continuous elastic base. That is why the SRT may use much lighter rails (for instance, instead of R75 rails R50 rails may be used), nevertheless these rails will be more reliable and long-lasting elements of the rail track structure.

Sixth, concrete in the SRT is encased in steel tubes and does not contact with the ambient air. One of the main known disadvantages of concrete is that it practically does not work in tension (that is why steel reinforcement is needed) and it cracks in tensioned areas. Through the cracks ambient moisture permeates to the steel reinforcement resulting in its corrosion damage. In time it may result in collapse of a reinforced concrete structure.

Cracking of concrete in the so-called steel-confined concrete poses no danger to the structure since the pre-strained reinforcement (strings) are effectively protected from external environmental and mechanical effects not only by concrete but also by the continuous walls of steel tubes, within which the concrete and the strings are situated. Furthermore, encased concrete increases its carrying capacity by 2 to 3 times which will considerably increase the safety factor of the string-and-rail trestle (even oil having no bearing capacity, placed in a standard hydraulic cylinder will endure the pressure of 1,00 atmospheres due to the enclosed space).

Seventh, where for low-speed railways the main criterion is strength of the trestle, for high-speed railways it is evenness of track. Unevenness at each span is the results of both construction unevenness and dynamic oscillation of span structures under the weight of a passing high-speed multi-wheel train. At speeds of around 100 m/sec (360 km/h) unevenness of track on 35 – 50 m spans must be within 10 mm.

It is known that welding of steel structures makes them shift and it is virtually impossible to achieve high evenness of span structures. That is why special technique and equipment needed to be developed for welding of string-and-rail truss structures (partially in a shop, partially in the field), so that construction unevenness in a span would not exceed 2 to 3 mm. However, one needs to remember that unevenness is the result not only of steel span structures, but also of supports and foundations of the trestle.

Eighth, exclusion from the track structure of a solid slab working as an aerodynamic shield will reduce aerodynamic resistance of a high-speed train’s movement by half and at the same time will considerably reduce aerodynamic noises. This will reduce by about 1.5 times the needed power output of a high-speed train driving gear, that is, the economy of the installed power for one train may amount to 7,000 – 8,000 kW and more (total power output of drive gear of modern and perspective high-speed trains may exceed 20,000 kW).

Ninth, there are other groups of know-hows without which it will be impossible to construct string-and-rail trestles with high quality and at low costs. These are:

(1) the technology of production and special additives to make concrete more flexible and to provide corrosion protection to steel structures contacting it;

(2) the technology and equipment for laying and straining of the strings and their fixing on the support and anchor units;

(3) the technology and equipment for continuous assembly of lengthy and rather heavy steel-reinforced concrete span structures in the field;

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(4) designs of the intermediate and anchor supports not only in relation to supporting units for fixing continuous and statically indeterminate span structures, but also in relation to the structure and erection of their body and their foundation;

(5) design and technological solutions for combining the string-and-rail track structure with communication channels (fiber-optic, wire, radio repeating, cellular), with high voltage aerial and cable lines, with wind and solar energy plants and other renewable and alternative power sources;

(6) design and technological solutions for the infrastructure of the "second level" (switches, systems of control of energy supply and communication on the linear (the trestle) section of the railways, etc.);

(7) prospective design and technological solutions for a larger scale (about two times) reduction of material intensity and cost of string-and-rail trestles by improving railway rolling-stock, etc.

5. Information about the author of the intellectual property of the Yunitskiy string-and-rail technologies

Anatoly Eduardovitch Yunitskiy is a chief designer with more than 150 inventions, including the principally new design of Yunitskiy string-and-rail transportation system. 29 of the A. E. Yunitskiy's inventions are used in construction, transportation, mechanical engineering, electronics and chemical industry, in scientific researches, conducted in the Russian Federation, the Republic of Belarus, Ukraine, and other countries of the CIS.

A full member (academician) of the Russian Academy of Natural Sciences (1999), of the Russian Academy (1998) and of the International Academy for Integration of Science and Business (2011). Three university degrees (1973, 1985 and 2006): railway engineer; technical-engineering worker and researcher in patenting and invention; design engineer of high-rise buildings. A Doctor of Philosophy in transport (2002).

Awarded by the honorary title and a badge of honor the "Knight of science and arts" of the Russian Academy of Natural Sciences, two gold medals "Laureate of the All-Russian Exhibition Center", three gold high-quality awards "The Russian Mark" for the technology of string-and-rail transportation, projects of freight and passenger rail vehicles (awarded by Russian Union of Industrialists and Entrepreneurs).

A. E. Yunitskiy conducts research of string-and-rail transportation since 1977. By this time static and dynamic models of SRT were created, the basics of which were stated in the first research monograph of the author – "String transportation systems on Earth and in space" (1995 r.). This allowed to create the theory of a resonance-free movement of rolling stock on a string-and-rail track structure with speeds up to 600 km/hour, ensuring more even and tough track in comparison with the modern beam trestle for monorail tracks and magnetic suspension trains, and allowing to reduce the cost of the track structure, supports and rolling stock, by 5 – 10 times or more as compared with the latter. Principally new transportation standards were developed for: string-and-rail track structure of overhead and suspended types for various speed modes and various mass-and-dimension characteristics of the rolling stock; intermediate and anchor supports; anchor fixing of the string; the string-and-rail for superlight, light, medium, heavy, and super-heavy trestle types for various travel modes; the steel wheel with anti-derailing system and its independent suspension; the automatic hitching device; switches; stations, terminal stations and freight terminals of the "second level"; the technology of manufacture and organization of movement of passenger and freight rolling stock on the "second level", etc.

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Wind tunnel testing of model of the unibus

In 1995 – 2001 a set of aerodynamic tests of high-speed rolling stock (on 1:5 scale) was performed in wind tunnel of the Academician Krylov Memorial Central Research Institute (Saint-Petersburg). The data collected allowed designing a high-speed rail vehicle with the best aerodynamic qualities among all of the known wheeled vehicles.

For this reason the specific consumption of fuel (energy) as compared with a conventional high-speed railway train is lower by 6 – 8 times and more. This will allow the proposed string-and-rail trestles with improved rolling stock to become the most environment-friendly and the most economical type of high-speed transportation not only by energy consumption for movement, but also by the minimal appropriation of land for tracks owing to the location of the track structure at the "second level" – on cheap and compact supports.

A labouratory complex based on a freight ZIL-131 truck at the testing ground in Ozery

In 2001 at Ozery, Moscow region, "Unitran" Fund led by A. E. Yunitskit build a testing section of light trestle string-and-rail, being the world's first completed full-scale segment of actual string-and-rail transportation system. It had length of 150 m, support height of up to 15 m, maximum span of 48 m, string tension of 450 tons, track pitch of 10%, weight of travelling load of up to 15 tons.

At the testing ground methods of estimation and front-end and engineering research, technique of straining and fixing the strings, the design of string-rail and of steel wheel, the anchor and intermediate supports, were successfully tested, as well as static and dynamic loads and effects of weather and climate conditions. The results of the series of tests allow the developer to start front-end and engineering research of specific trestle type freight and passenger tracks and work on industrial production of string-and-rail track structures and supports.

The string-and-rail transportation system was displayed as working models of 1:15, 1:10 and 1:5 scale at more than 50 exhibitions, trade fairs, workshops, forums, including events held in Berlin, Leipzig, Hannover, Dubai, Sharjah, Malmoe, Cape Town, Tripoli, Islamabad, Karachi, Baku, Kiev, Sevastopol, Moscow, Saint-Petersburg, Khabarovsk, Hanty-Mansijsk, Minsk, Sydney, and other cities, and was awarded with more than 30 diplomas, certificates and medals.

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For the period from 1977 to 2012 A. E. Yunitskiy created a scientific school dealing with string-and-rail technologies with its specialists in Russia, Belarus, Ukraine and other countries. A set of labouratory, test-bench, model and testing-ground tests were performed. 18 monographs were published (see www.yunitskiy.com), including "String transportation systems on Earth and in space" (1995, 337 p.), over 60 string-and-rail technology inventions and more than 100 know-hows were created (the author and the patent owner is A. E. Yunitskiy). Unique unprecedented results were achieved. Two grants of the United Nations Organization were awarded (1998 and 2002).

6. Information about the investment projects on the basis of exclusive rights to intellectual property and know-how, "a string-rail system engineer Unitsky

Within the implementation of the investment project employing the assessed object – the exclusive intellectual property and know-how rights on the "String-and-rail Transportation System of Engineer Yunitskiy", establishment of a holding company is assumed.

The authorized capital of the holding company established for construction on the planet within 50 years of 1 mln. km of string-and-rail trestle type railroads will be raised by means of the Exclusive intellectual property and know-how rights on the "String-and-rail Transportation System of Engineer Yunitskiy". In effect this authorized capital characterizes the possible (probable) capitalization of the company in future, within 30 – 35 years, when the main part of roads of this type with total length of around 500 thous. km and total cost of $7 trillion will be constructed[31].

The initial sale of stock of the established company, which authorized capital will be raised by means of the intellectual property will be performed at a large discount from 1:100 to 1:20, that is, for 1 – 5% of the reported value. That is why for the realization of this program in Russia, for instance, it will be possible to attract on the venture stage no more than $50 mln., which will, however, enable the launch of this large-scale project.

With constructions rate of trestle type railroads (construction of new roads and replacement of the old roads build on embankments) at 20 thous.km/year, as it was 120 years ago a principally new network of railroads with length of 1 mln. km may be constructed in 50 years. Virtually all of these roads, excluding service and special-purpose (ore-bearing, coal-bearing, etc.) shall be high-speed roads.

The length of roads network in a particular country relates not only to transportation of the country's residents, manufactured goods, and extracted materials, but also to transit traffic, and besides that – to development of new deposits of mineral resources. Furthermore the territory itself will become one of the main resources of the man in the 21st century, therefore underdeveloped and presently hardly accessibly territories of all countries and continents will be developed and populated.

The proposed within the scope of this assessment infrastructural network of railroads of the "second" level with length of 1 mln. km is divided into regions (zones) in proportion to the area of territory of each country and its population (total area of land on the planet totals 149 mln. km^2, total population of the Earth – 7,143 mln. individuals):

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[31] *For instance, the capitalization of the American company Apple Inc. which works in a smaller market niche than the established company in the end of February, 2012, 35 years from the date of creation, exceeded $500 bil. Due to innovative technologies and aesthetically attractive design the Apple corporation created a unique reputation, comparable to a cult, in the industry of consumer electronics, thus in May, 2011 the Apple trade mark (which is a part of its intellectual property) was recognized as the world's most valuable brand estimated $153,3 bil. in a rating of the Millward Brown international research agency. Such capitalization is possible in development of the network of trestle railroads based on the Exclusive intellectual property and know-how rights on the "String-and-rail Transportation System of Engineer Yunitskiy".*

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1. China (9,60 mln. km^2, 1.357 mln. residents) – 130,000 km.
2. India (3,29 mln. km^2, 1.234 mln. residents) – 95,000 km.
3. Russia (17,10 mln. km^2, 143 mln. residents) – 70,000 km.
4. the USA (9,52 mln. km^2, 316 mln. residents) – 50,000 km.
5. Brazil (8,51 mln. km^2, 198 mln. residents) – 40,000 km.
6. Canada (9,98 mln. km^2, 34 mln. residents) – 30,000 km.
7. Australia (7,69 mln. km2, 24 mln. residents) – 25,000 km.
8. Indonesia (1,90 mln. km2, 245 mln. residents) – 25.000 km.
9. Mexico (1,97 mln. km2, 117 mln. residents) – 15.000 km.
10. Pakistan (0,80 mln. km2, 179 mln. residents) – 15.000 km.
11. Nigeria (0,92 mln. km2, 167 mln. residents) – 15.000 km.
12. Democratic Republic of Congo (2,35 mln. km2, 70 mln. residents) – 13.000 km.
13. Argentina (2,77 mln. km2, 41 mln. residents) – 12.000 km.
14. Iran (1,65 mln. km2, 77 mln. residents) – 11.000 km.
15. Algeria (2,38 mln. km2, 36 mln. residents) – 11.000 km.
16. Bangladesh (0,14 mln. km2, 152 mln. residents) – 11.000 km.
17. Japan (0,38 mln. km2, 128 mln. residents) – 10.000 km.
18. Kazakhstan (2,72 mln. km2, 17 mln. residents) – 10.000 km.
19. Ethiopia (1,123 mln. km2, 91 mln. residents) – 10.000 km.
20. Saudi Arabia (2,15 mln. km2, 29 mln. residents) – 9.000 km.
21. Egypt (1,00 mln. km2, 83 mln. residents) – 9.000 km.
22. Sudan (1,89 mln. km2, 36 mln. residents, 31 mln. residents) – 8.000 km.
23. South African Republic (1,22 mln. km2, 51 mln. residents) – 8.000 km.
24. Turkey (0,78 mln. km2, 75 mln. residents) – 8.000 km.
25. Vietnam (0,33 mln. km2, 89 mln. residents) – 7.000 km.
26. Philippines (0,30 mln. km2, 92 mln. residents) – 7.000 km.
27. Peru (1,29 mln. km2, 30 mln. residents) – 7.000 km.
28. Tanzania (0,95 mln. km2, 48 mln. residents) – 7.000 km.
29. Columbia (1,14 mln. km2, 47 mln. residents) – 7.000 km.
30. Germany (0,36 mln. km2, 82 mln. residents) – 6.000 km.
31. France (0,55 mln. km2, 64 mln. residents) – 6.000 km.
32. Thailand (0,51 mln. km2, 66 mln. residents) – 6.000 km.
33. Libya (1,76 mln. km2, 7 mln. residents) – 6.000 km.
34. Mongolia (1,57 mln. km2, 3 mln. residents) – 6.000 km.
35. Chad (1,28 mln. km2, 11 mln. residents) – 6.000 km
36. Angola (1,25 mln. km2, 20 mln. residents) – 6.000 km.
37. Myanmar (0,68 mln. km2, 49 mln. residents) – 6.000 km.
38. Italy (0,30 mln. km2, 61 mln. residents) – 5.000 km.
39. Ukraine (0,60 mln. km2, 46 mln. residents) – 5.000 km.
40. Great Britain (0,24 mln. km2, 63 mln. residents) – 5.000 km.

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41. Kenya (0,58 mln. km2, 43 mln. residents) – 5.000 km.
42. Niger (1,27 mln. km2, 17 mln. residents) – 5.000 km.
43. Venezuela (0,91 mln. km2, 30 mln. residents) – 5.000 km.
44. Afghanistan (0,65 mln. km2, 33 mln. residents) – 5.000 km.
45. Spain (0,50 mln. km2, 46 mln. residents) – 5.000 km.
46. Mali (1,24 mln. km2, 15 mln. residents) – 5.000 km.
47. Republic of Korea (0,10 mln. km2, 50 mln. residents) – 4.000 km.
48. Bolivia (1,10 mln. km2, 10 mln. residents) – 4.000 km.
49. Mauritania (1,03 mln. km2, 4 mln. residents) – 4.000 km.
50. Mozambique (0,80 mln. km2, 24 mln. residents) – 4.000 km.
51. Chili (0,76 mln. km2, 18 mln. residents) – 4.000 km.
52. Madagascar (0,59 mln. km2, 22 mln. residents) – 4.000 km.
53. Yemen (0,53 mln. km2, 26 mln. residents) – 4.000 km.
54. Uzbekistan (0,45 mln. km2, 30 mln. residents) – 4.000 km.
55. Morocco (0,45 mln. km2, 33 mln. residents) – 4.000 km.
56. Iraq (0,44 mln. km2, 34 mln. residents) – 4.000 km.
57. Poland (0,31 mln. km2, 39 mln. residents) – 4.000 km.
58. Malaysia (0,33 mln. km2, 30 mln. residents) – 3.000 km.
59. Namibia (0,83 mln. km2, 2,3 mln. residents) – 3.000 km.
60. South Sudan (0,62 mln. km2, 8,3 mln. residents) – 3.000 km.
61. Cameroon (0,48 mln. km2, 20 mln. residents) – 3.000 km.
62. Zambia (0,75 mln. km2, 14 mln. residents) – 3.000 km.
63. Uganda (0,24 mln. km2, 36 mln. residents) – 3.000 km.
64. Nepal (0,14 mln. km2, 31 mln. residents) – 2.600 km.
65. Ghana (0,24 mln. km2, 26 mln. residents) – 2.500 km.
66. Cote d'Ivoire (0,46 mln. km2, 7,2 mln. residents) – 2.500 km.
67. DPRK (0,12 mln. km2, 25 mln. residents) – 2.200 km.
68. Romania (0,24 mln. km2, 21 mln. residents) – 2.200 km.
69. Zimbabwe (0,39 mln. km2, 13 mln. residents) – 2.200 km.
70. Burkina-Faso (0,27 mln. km2, 18 mln. residents) – 2.200 km.
71. Syria (0,19 mln. km2, 21 mln. residents) – 2.100 km.
72. Somali (0,64 mln. km2, 9.8 mln. residents) – 2.000 km.
73. Central African Republic (0,62 mln. km2, 4,6 mln. residents) – 2.000 km.
74. Botswana (0,58 mln. km2, 2,1 mln. residents) – 2.000 km.
75. Turkmenistan (0,49 mln. km2, 5,2 mln. residents) – 2.000 km.
76. Ecuador (0,28 mln. km2, 15 mln. residents) – 2.000 km.
77. Papua-New Guinea (0,46 mln. km2, 7,2 mln. residents) – 2.000 km.
78. Sweden (0,45 mln. km2, 9,5 mln. residents) – 2.000 km.
79. Republic of Congo (0,34 mln. km2, 4,2 mln. residents) – 1.900 km.
80. Paraguay (0,41 mln. km2, 6,3 mln. residents) – 1.800 km.

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81. Republic of China (Taiwan) (0,04 mln. km2, 23 mln. residents) – 1.800 km.
82. Sri-Lanka (0,07 mln. km2, 21 mln. residents) – 1.700 km.
83. Finland (0,34 mln. km2, 5,4 mln. residents) – 1.600 km.
84. Guinea (0,25 mln. km2, 10 mln. residents) – 1.600 km.
85. Senegal (0,20 mln. km2, 13 mln. residents) – 1.600 km.
86. Cambodia (0,18 mln. km2, 14 mln. residents) – 1.600 km.
87. Malawi (0,12 mln. km2, 16 mln. residents) – 1.600 km.
88. The Netherlands (0,04 mln. km2, 17 mln. residents) – 1.400 km.
89. Belarus (0,21 mln. km2, 9,5 mln. residents) – 1.400 km.
90. Tunisia (0,18 mln. km2, 11 mln. residents) – 1.400 km.
91. Norway (0,32 mln. km2, 5,1 mln. residents) – 1.400 km.
92. Oman (0,31 mln. km2, 2,8 mln. residents) – 1.200 km.
93. New Zealand (0,27 mln. km2, 4,5 mln. residents) – 1.200 km.
94. Laos (0,24 mln. km2, 6,3 mln. residents) – 1.200 km.
95. Greece (0,13 mln. km2, 11 mln. residents) – 1.200 km.
96. Portugal (0,09 mln. km2, 11 mln. residents) – 1.100 km.
97. Benin (0,11 mln. km2, 9,4 mln. residents) – 1.100 km.
98. Cuba (0,10 mln. km2, 11 mln. residents) – 1.100 km.
99. Kyrgyzstan (0,20 mln. km2, 5,7 mln. residents) – 1.100 km.
100. Azerbaijan (0,09 mln. km2, 9,2 mln. residents) – 1.000 km.
101. Gabon (0,27 mln. km2, 1,6 mln. residents) – 1.000 km.
102. Tajikistan (0,14 mln. km2, 8,0 mln. residents) – 1.000 km.

The listed 102 countries account for 895,500 km of the proposed trestle type railways, so the remaining 104,500 km of the “second type” of the 1,000,000 km will account for the rest 163 countries, dominions and territories.

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9. Report on the innovative transportation technology "Yunitskiy String Transportation" / the Institute of Transportation Problems Named after N. S. Solomenko of the Russian Academy of Sciences. – S-Petersburg, October 5th, 2009 – 20 pages.

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From: Anatoly Eduardovitch Yunitskiy

Purpose: for assessment of market value of exclusive intellectual property and know-how rights on the "String-and-rail Transportation System of Engineer Yunitskiy"

Table 1 Capital investments for development and construction of the "Sting-and-rail Transportation System of Engineer Yunitskiy" for an averaged 1,000 km section

Capital expenses (capex)							
Length of route					1,000	km	
Cost of construction and turnkey development, including track structure, supports and infrastructure:							
	per 1 km of track			$13,449,013			
	Total cost per 1,000 km				$13,449,012,500		
Design data							
					1.00		1,000
				per 1 km			per 1,000 km
		minimum		average	maximum	units	average
1.	Design development						640,429,167
	Estimation based on the length and total cost of all works at the rate of			5%			
	Total						
	Total						
	per 1 km of track			$640,429			$640,429,167
2.	Construction of the SRT track						$10,022,333,333
1)	Steel-reinforced concrete string-and-rail track structure						
	Estimation based on cost of 1 ton of installed steel structure	$4,000		$5,000	$6,000		
	Number of string-and-rail structures per 1 kilometer of track (steel)	1,500		1,050	800	tons/km	
	Total						
	per 1 km of			$5,250,000			$5,250,000,000
2)	Intermediate supports						

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Capital expenses (capex)						
	Cost of one support	$30,000	$40,000	$50,000		
	Support height	4	7	10	meters	
	Distance between adjacent supports	30	40	50	meters	
	Number of supports for 1 km (x2 for a two-way track)		40		units	
	Total					
	per 1 km of track		$1,600,000			$1,600,000,000
3)	Anchor supports					
	Cost of one anchor support	$400,000	$500,000	$600,000		
	Height of a support	4	7	10	meters	
	Distance between adjacent supports	2,000	3,000	4,000	meters	
	Number of supports for 1 km (x2 for a two-way track)		0,667		units	
	Total					
	per 1 km of track		$333,333			$333,333,333
4)	Increasing factors					$2,801,500,000
	Uneven and difficult terrain		100%		of the track cost	
	In percent of the track length and in kilometers		8%		km	
	Estimated total		$1,149,333			
	Mountainous terrain		150%		of the track cost	
	In percent of the track length and in kilometers		5%		km	
	Estimated total		$897,917			
	Sea regions		250%		of the track cost	
	In percent of the track length and in kilometers		3%		km	
	Estimated total		$754,250			
	Total					
	per 1 km of track		$2,801,500			$2,801,500,000
5)	Land allocation (appropriation) for the track supports					37,500,000
	Estimation is based on standard	200	250	300	sq. m/km	
	Cost of land	$1,000,000	$1,500,000	$2,000,000	ha	
	Total					
	per 1 km of track		$37,500			37,500,000

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Capital expenses (capex)							
3.	Infrastructure						2,786,250,000
	1)	Stations		3		units	
		Metric area		10,000		sq.m	
		Including commercial section		5,000		sq.m	
		Cost of construction of 1 sq. m	$3,000	$5,000	$5,000	per 1 sq. m	
		Cost of high-speed switch (x2 for two-way track)		$4,000,000			
		per 1 station		$54,000,000			
		Total		162, 000			$162,000,000
	2)	Stations					
		Quantity		5		units	
		Metric area		2,000		sq. m	
		Including commercial area		1,000		sq. m	
		Cost of construction per 1 sq. m.	$3,000	$5,000	$4,000	per 1 sq. m	
		Cost of high-speed switch (x2 for two-way track)		$4,000,000			
		Cost of construction per 1 station		$14,000,000			
		Total		$70,000			$70,000,000
	3)	Servicing shops					
		Quantity		2		units	
		Metric area		1,000		sq. m	
		Cost of construction per 1 sq. m.	$4,000	$5,000	$6,000	per 1 sq. m	
		per 1 servicing shop		$5,000,000			
		Total		10,000			$10,000,000
	4)	Freight terminals					
		Quantity		3		units	
		Metric area		4 000		sq. m	
		Cost of construction per 1 sq. m.	$2,000	$2,500	$3,000	per 1 sq. m	
		per 1 freight terminal		$10 000 000			
		Total		30,000			$30,000,000
	5)	Servicing station					
		Quantity		2		units	
		per 1 servicing station		$3,000,000			
		Total		6,000			6,000,000

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Capital expenses (capex)						
6)	Land allocation (appropriation) for infrastructure					
	Estimation based on the area of infrastructure with factor	1,5	2,0	2,5		
	Total area		5,50		ha	
	Cost of land	$1,000,000	$1,500,000	$2,000,000		
	Total		8,250			8,250,000
7)	Train driver-based control system					
	per 1 km (controlled with preset data)	$300,000	$350,000	$400,000		
	per 1 km of track		$350,000			
	Total		350,000			350,000,000
8)	Electrification					
	per 1 km	$1,000,000	$1,250,000	$1,500,000		
	Total		1,250,000			1,250,000,000
9)	Automatic control system (without train drivers)					
	per 1 km	$800,000	$900,000	$1,000,000		
	Total		900,000			900,000,000

Sources of information: information provided by the Customer (data shown without VAT)

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Figure 10-1 Diagram schedule of development and construction of the "Sting-and-rail Transportation System of Engineer Yunitskiy" for an averaged 1,000 km section

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Этапы проекта	Project stages
Начало	Start
Длительность	Duration
Год 1	Year 1
Год 2	Year 2
Год 3	Year 3
Год 4	Year 4
Месяц	Month
Месяцев	Months
Сбор исходно-разрешительной документации на трассу	Collection of basic documents and approvals for the track
Сбор исходно-разрешительной документации	Collection of basic documents and approvals
Предпроектные работы, ТЭО трассы	Front end engineering, Technical and Economic Assessment
Разработка технических условий (ТУ) для путевой структуры	Development of Technical Specifications (TS) for the track structure
Разработка ТУ инфраструктуры	Development of TS for infrastructure
Разработка ТУ на оборудование станций и сервисных центров	Development of TS for station and servicing center equipment
Разработка ТЭО	Development of Technical and Economic Assessment
Проектные работы	Project design works
Проект путевой структуры и опор	Design of track structure and supports
Проект пассажирских станций и вокзалов	Design of passenger stations and terminal stations
Проект сервисных депо и др. объектов инфраструктуры	Design of servicing depots and other objects of infrastructure
Проект стандартизированного оборудования	Design of standard equipment
Приобретение технологий для трассы	Procurement of technologies for the track
Проведение согласовательных работ и получение разрешений на строительство	Approval activities and obtaining permits
Подготовительные работы к строительству трассы	Track construction preparatory works
Оформление документов на земельные участки трассы	Processing of documents for land plots of the track
Подготовка строительства	Construction preparation
Строительные работы на трассе	Construction works on the track
Строительство путевой структуры	Construction of the track structure
Строительство вокзалов и станций трассы	Construction of stations and terminal stations on the track
Строительство сервисных депо и объектов инфраструктуры	Construction of servicing depots and objects of infrastructure
Монтажные работы на трассе	Installation works on the track
Монтаж оборудования	Equipment installation
Монтаж систем путевой структуры	Installation of track structure systems
Выполнение комплекса пуско-наладочных работ на трассе ТСЮ	Pre-commissioning of the YTS track
Опытная эксплуатация	Operational testing
Запуск рабочей эксплуатации	Launching of commercial operation