Environmental and Social Compliance Audit Report

September 2013

TAJ: Golovnaya 240 Megawatt Hydropower Plant Rehabilitation Project

This Audit Report is prepared by Corporate Solutions for Barki Tojik of the Republic of Tajikistan and for the Asian Development Bank (ADB)

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ABBREVIATIONS

ADB	Asian Development Bank
EC	European Community
EMF	Electric and magnetic fields
EN	European Norm
EIA	Environmental Impact Assessment
EHS	Environment Health and Safety
GIS	Gas Insulated Substation
HPP	Hydro Power Plant
Hz	Hertz, unit of frequency
IEC	International Electrotechnical Commission
IEE	Initial Environmental Examination
IC	Implementation Consultant
OSHPC	Open Stock Holding Power Company
PCB	Polychlorinated Biphenyls
PMU	Project Management Unit
SF6	Sulfur Hexafluoride
V	Volt
WHO	World Health Organization

TAJ: Golovnaya 240 MW Hydropower Plant Rehabilitation Project¹ Environmental and Social Compliance Audit Report

1. REPORT DISCLAIMER

This report has been prepared by Corporate Solutions Consulting Ltd., Manitoba Hydro International Ltd. and Hatch Ltd. (the "Contractor") for the sole and exclusive use of the Asian Development Bank (ADB) and Barki Tojik (BT) (the "Client") for the purpose of assisting the management of the Client in making decisions with respect to its Technical Services – Rehabilitation of the Golovnaya Hydroelectric Station and shall not be (a) used for any other purpose, or (b) provided to, relied upon or used by any third party.

This report contains opinions, conclusions and recommendations made by the Contractor, using its professional judgment and reasonable care. Use of or reliance upon this report by the Client is subject to the following conditions:

- (a) the report being read in the context of and subject to the terms of the agreement between Contractor and Client including any methodologies, procedures, techniques, assumptions and other relevant terms or conditions that were specified or agreed therein;
- (b) the report being read as a whole, with sections or parts hereof read or relied upon in context;
- (c) the conditions of the site may change over time (or may have already changed) due to natural forces or human intervention, and the Contractor takes no responsibility for the impact that such changes may have on the accuracy or validity or the observations, conclusions and recommendations set out in this report; and
- (d) the report is based on information made available to the Contractor by the Client or by certain third parties; and unless stated otherwise in the Agreement, The Contractor has not verified the accuracy, completeness or validity of such information, makes no representation regarding its accuracy and hereby disclaims any liability in connection therewith.

¹ The audit report was prepared in compliance with the 2009 ADB Safeguards Policy Statement (SPS), Safeguards Requirements (SR) 4 covering Special Requirements for facilities/business activities that already exist or on-going at the time of assistance consideration. The audit aims to (i) identify past or present concerns related to impacts on involuntary resettlement (physical or economic displacement) and ethnic minorities/Indigenous Peoples; (ii) determine whether actions were in accordance with ADB SPS SR 2 (Involuntary Resettlement) and SR3 (Indigenous Peoples) principles and requirements.

2. EXECUTIVE SUMMARY

1 The current report has been prepared in a line with ADB's requirements for environmental and social assessment of investment projects.

As part of the project preparation, the detailed technical and financial feasibility study for Golovnaya rehabilitation project was prepared along with IEE. The environmental and social compliance audit report complements these studies with the description of the environmental impacts and operational practices and social aspects, associated with the current plant's operations.

2 Among the major environmental findings and concerns are:

- <u>Oil leaks from power transformers</u> and lack of the oil containment facility and oil/water separators. Current relatively low level of leakage is managed/removed manually by the staff (using sand or wood particles), the leaks during rains are not prevented and end up in the river. In case of emergency larger spill, the manual oil removal is sufficient, and the oil will end up in the river too.
- Leakage of turbine and hydraulic oil is not necessary visible, but also takes place.
- Turbine and Transformer Oil Handling System. The common oil handling system for the governor, turbine-generator bearings, transformers and switchyards comprises steel tanks located in the open area, a pumping station, filtering station and piping system with flexible piping connections for connections to individual units. Although the turbine oil handling system is functional, the equipment is antiquated. Existing oil spills in the room housing the equipment are a hazard. With no adequate fire protection the present arrangement is a hazard for equipment and personnel. It is recommended that the oil handling system be replaced in the future with a modern system comprising a mobile cart with filter press, a portable system of drums and flexible piping. The equipment can be lowered to the turbine floor with an equipment cage using the powerhouse crane. There is no gases removal unit at the plant. When needed, the mobile unit is rented from other sites of BT, but this practice is ranked by Golovnaya as not efficient ad not sufficient for proper oil management.
- Presence of SF6 in breakers of new generator 4. This is not an environmental concern, at this stage, as the equipment is new (operated since 2012) and in proper operation, but this is a new practice at the plant and in general in the sector in the country to use this gas as isolation in breakers, instead of transformer oil. The gas is greenhouse gas and under certain circumstances can be toxic to humans. The breakers are equipped with leak detectors and staff is trained in its handling. It is extremely important to provide the adequate maintenance of these detectors on a regular basis.

- <u>Soil erosion</u>: erosion of the left river bank, close to the site of 220 kV switchyard, and to the smaller extent erosion of the both banks of the irrigation canal, also close to that switchyard site.
- Presence of hazardous materials at the site. Currently, no PCB has been traced in the power transformers and in the old generators breakers. Asbestos paper is used in between wiring of rotors. The paper layers were installed originally by the manufacturer and now during maintenance works, these paper layers, covered on both sides with lacquer are removed mechanically and new paper is installed. Asbestos emissions into the air and degree of protection of workers are not measured. Asbestos sheets (thicker paper) are also used as fire prevention border during various welding works.
- <u>Significant amount of metal wastes</u>, originating from the previous project and from the day to day maintenance works. While, currently, some elements of this dismantled equipment can be of a value as spare parts, the remaining part is completely obsolete and can be better used, if given for recycling. The lack of action towards efficient use of resources in this regard is a concern.
- Occupational health and safety. Personnel's safety at the electricity generation plant is not a simple formality. The safety knowledge is compulsory part to the training for each new staff. In the current realities, the central office of BT and Golovnaya management are trying to keep the safety on the stable level. The lack of funds and lack of knowledge of the development in this area in the recent decades leaves the safety tools, infrastructure and practices a way behind the state of the art. Electrical safety conditions prevailing in the plant are inadequate by any international standards.

3 As for social issues, currently taking place at the plant; there are no any social issues, the plant is located in the closed area with restricted access. The land is owned by the state, but transferred to the Golovnaya plant for sole and permanent operations, since 1957. Currently the land is certified in the recent land cadastre and the plant pays the land use tax to the local authorities in Sarband. The findings of the audit are in a full consistency with the recommendations of the IEE. The project will address the current environmental impacts, covered in its scope.

3. INTRODUCTION

4. The Government of Republic of Tajikistan has requested the ADB to provide the technical assistance to prepare the Power Transmission Project. The technical assistance has started in 2012 under financing of ADB grant 0213-Taj. One of the components of this TA is to prepare the Feasibility Study of the Golovnaya Hydro Power Plant, the plant with the largest installed capacity at the Vakhsh Cascade (cascade includes 3 HPPs). The Executive Agency for the Project is Open

Stock Power Company Barki Tajik, which has the mandate from the Government of RT to own, operate and maintain all power generation, transmission and distribution enterprises within the country. This report is prepared as pert of the Environmental Assessment of the proposed investment project, along with IEE report.

4.1 ENERGY SECTOR BACKGROUND

5. The country is principally supplied with electricity generated by hydroelectric power plants. The Golovnaya Hydroelectric Power Plant (Golovnaya HPP) is one of these hydroelectric power plants with a present installed capacity of approximately 240 MW. In order to demonstrate the importance of the hydropower generation in the context of the country's economy a d future prospects, the brief overview of the energy sector in Tajikistan is provided below.

6. Surface water resources of Tajikistan equate to almost 4% of the world's total resources in hydropower. Only small portion of Tajikistan's considerable hydropower resources are currently being utilised and there is therefore considerable potential for the future development. At present, there is total installed generation capacity of 5,244 MW including 5,211 MW of hydro-power. In other words, 99% of Tajikistan's electricity generation is provided by only 5% of the potential hydro generation capacity that is currently being utilised.

7. Over the last decade, Tajikistan had an average annual demand for electricity is about 16 000 -17 000 GWh, reaching its maximum in 2007 (due to extremely cold winter). About 40% of demand accounts for TALCO) state owned aluminium smelter), the second largest group is population, with about 44% of electricity consumption. As for the country's population, about 70% lives in rural areas, accounting of 38% of residential electricity use. The demand for electricity varies considerably over the year, due to cold winter, relatively low electricity tariffs and lack of other heating alternatives in most of cases (use of gas or thermal power for district heating). The gas and electricity import has stopped in 2009, leaving the load of domestic winter energy generation nearly solely to hydropower with reduced river flow in winter. In 2012, the un-served demand was estimated as 2 700 GWh at the consumer level. Taking into account losses during transmission and distribution of electricity, the deficit at the generation level is about 3 100 GWh during winter comparing to winter supply requirements of 11 200 GWh, a gap of about 24%. The corresponding deficit in the system's firm capacity is about 1250 MW. Thus, despite the fact, that the potential for hydropower far exceeds the own needs of Tajikistan, currently, there is not enough energy generated during winter season. This affects about 70% of population and all the businesses in the country².

² Tajikistan: Winter energy report, 2012, WB

8. The largest hydropower plants (HPP) operating in the country are: Nurek HPP (3000 MW, commissioned in 1972-1979), Baipaza (600 MW, commissioned in 1986). Vakhsh cascade, including Golovnaya (240 MW, commissioned in 1962), Perepadnaya (30MW, commissioned in 1959), Centralnaya (15 MW, commissioned in 1962); Varzob cascade (25 MW, commissioned in 1936, 1949 and in 1952), Kairakkukm HPP (126 MW, commissioned din 1957), Sanktuda 1 (670MW commissioned in 2008-2009), Sanktuda 2 (220MW, commissioned in 2011).

8.1 **PROJECT SITE DESCRIPTION**

9. Golovnaya HPP is located about 80 km south of the capital, Dushanbe, and 11 km east of Kurgan-Tyube. The Golovnaya HPP is presently a close-coupled, 6 unit, 240 MW run-of-river hydroelectric plant that was commissioned in 1964. The facility is located on the Vakhsh River at the head of Vakhsh Cascade. Two of the Golovnaya units discharge into an irrigation canal (capacity 350 m³/s) which supplies the downstream Perepadnaya and Centralnaya HPPs. The other four units discharge directly downstream into the Vakhsh River.

10. This is now 50 years old, and is in serious need of complete rehabilitation and/or refurbishment. The project consists of six Kaplan units operating under a maximum head of 31 m with a total discharge of 1050 m³/s. Unit 4 was totally replaced by Barki Tojik (BT) in 2012 under a project funded by the Islamic Development Bank. One transformer was replaced in 2004 and it is still in good condition. Various generator repairs/refurbishments have been done over the years. However, the remaining five units are all essentially original equipment in very questionable condition.

The Golovnaya HPP includes

• small reservoir with no effective operational storage (hence this is a run-of-river facility)

- · a concrete dam that includes the close-coupled powerhouse
- an embankment dam
- a single large gated spillway with an ogee-crested control
- six low level sediment sluices that also provide significant flood spill capacity
- a siphon bypass to provide water to the downstream irrigation canal when either or both of Units 1 and 2 are not operating and providing their outflow to the canal;
- 110 kV and 220 kV switchyards

11. The principal objective of the present Asian Development Bank (ADB) project is to rehabilitate the Golovnaya Hydroelectric Plant so that it can continue to provide electricity to Tajikistan for at least the next 50 years in accordance with modern technical, operational, safety and environmental standards. The rehabilitation/replacement program will need to address the entire issue of plant maintenance. It is important that any new equipment is adequately maintained in the future using both proper maintenance procedures and an adequate maintenance management.

10.1 DESCRIPTION OF THE PROPOSED PROJECT

12 The scope of the proposed project covers the rehabilitation of the generation part of the plant: replacement of 3 generator units and rehabilitation of the remaining 2 old generator units, rehabilitation of the spillway and replacement of the 2 transformers. In addition, the project will finance the embankment of the eroded left river bank. Improvement of both switchyards is beyond the project.

11. ENVIRONMENTAL AUDIT FINDINGS

12. The present evaluation of environmental issues relates only to specific issues within the existing facility in the context of typical western environmental standards and practices in hydroelectric plants.

13. <u>Environmental Management System (EMS)</u>: There is no Environmental Management System (EMS) in place for the Golovnaya facility.

14. Transformer/Breaker Oil Spill Containment

There is no oil containment or oil-water separator equipment at this site. Any oil leaks will find their way either directly or indirectly to the downstream river. It was reported by BT staff that the Tajikistan environmental authorities, in recent years, have routinely cited the facility for not having this equipment but because of lack of available funds, nothing has been done to rectify the problem. The following is a list of the facilities that require oil containment and/or oil-water separators. The oil-water separators can be either automatic or manually operated to be used before the separated water is discharged downstream.

- 1. Powerhouse sumps should have oil/water separators.
- 2. Tailrace deck transformers should have oil containment equipment with oil-water separators.
- 3. Eighteen out of 24 single pole 220 kV switchyard breakers contain a large amount of oil (approximately 9 t per pole) and they have no oil containment basins or oil-water separators. These breakers are all near the end of their service life and any new replacement breakers will not contain oil. If any old oil filled breakers are to remain in service for more than several years, consideration should be given to installing appropriate environmental protection equipment.
- 4. The 10.5 kV breakers within the powerhouse and the110 kV switchyard breakers are of a different type and contain approximately 20 to 50 l of oil per pole and do not warrant having individual oil containment. However, emergency oil containment/cleanup supplies and equipment should be available at the site to deal

with such situations. Any oil spilled from the powerhouse breakers, and not cleaned up immediately, could make its way to the powerhouse sump where the equipment recommended above under point 1 would rectify the problem. Any oil spilled from the 110 kV switchyard breakers could make its way to the river if not cleaned up immediately;

- 5. The storage tanks for hydraulic oil and transformer oil, located just south east of the control room, should have oil containment basins under the tanks and oil-water separators.
- 6. Turbine and Transformer Oil Handling System. The common oil handling system for the governor, turbine-generator bearings, transformers and switchyards comprises steel tanks located in the open area, a pumping station, filtering station and piping system with flexible piping connections for connections to individual units. Although the turbine oil handling system is functional, the equipment is antiquated. Existing oil spills in the room housing the equipment are a hazard. With no adequate fire protection the present arrangement is a hazard for equipment and personnel. It is recommended that the oil handling system be replaced in the future with a modern system comprising a mobile cart with filter press, a portable system of drums and flexible piping. The equipment can be lowered to the turbine floor with an equipment cage using the powerhouse crane. There is no gases removal unit at the plant. When needed, the mobile unit is rented from other sites of BT, but this practice is ranked by Golovnaya as not efficient ad not sufficient for proper oil management

15 Hazardous Materials and Waste Management

There does not appear to be any management system for storing or handling hazardous materials at Golovnaya. Hazardous materials are stored rather haphazardly throughout the facility wherever they are used. Accumulated upstream river trash is either flushed downstream through the spillway or picked off of the trashracks and deposited in the downstream flood plain (where it is subject to local scavenging of firewood before it is flushed downstream in the subsequent flood waters).

- <u>Presence of SF6 in breakers</u> of new generator 4. This is not an environmental concern, at this stage, as the equipment is new (operated since 2012) and in proper operation, but this is a new practice at the plant and in general in the sector in the country to use this gas as isolation in breakers, instead of transformer oil. The gas is greenhouse gas and under certain circumstances can be toxic to humans. The breakers are equipped with leak detectors and staff is trained in its handling. It is extremely important to provide the adequate maintenance of these detectors on a regular basis.
- <u>Asbestos paper</u> is used in between wiring of rotors. The paper layers were installed originally by the manufacturer and now during maintenance works, these paper layers, covered on both sides with lacquer are removed mechanically and new paper is installed. Asbestos emissions into the air and degree of protection of workers are not measured. Asbestos sheets (thicker paper) are also used (in a wet form) as fire prevention border during various welding works.
- <u>Metal wastes</u>, originating from the previous project and from the day to day maintenance works. While, currently, some elements of these dismantled equipment can be of a value as spare parts, the remaining part is completely obsolete and can be better used, if given for recycling. The lack of action towards efficient use of resources in this regard is a concern.

16 Operation Practices/Efficent use of water resurces for power generaion

The Golovnaya HPP is operated as a run-of-river plant where any available water (up to the plant capacity) is used for generation. Units 1 and 2, which discharge into the downstream irrigation canal, operate continuously throughout the year. The other units are operated as water is available in the river throughout each day and varying throughout each year. Operations at Golovnaya are done in accordance with directives from the BT head office dispatch centre in Dushanbe. There does not appear to be a system in place to ensure the most efficient use of available water in terms of maximizing generation and related revenue from the available water. This issue will need to be addressed as part of any rehabilitation/replacement program. Efficient use of water for generation will be addressed more globally in the Power Sector Master Plan that is presently underway for all of Tajikistan. This issue of efficient use of water is essential and will require a significant reeducation of BT operations staff.

17 <u>Review of Maintenance Practices</u>

Current practice of the use of asbestos containing materials for the purpose of fire protection during welding should be changed in the future.

18 <u>Occupational safety</u> Personnel's safety at the electricity generation plant is not a simple formality. The safety knowledge is compulsory part o the training for each new staff. In the current realities, the central office of BT and Golovnaya management are trying to keep the safety on the stable level. The lack of funds and lack of knowledge of the development in this area in the recent decades leaves the safety tools, infrastructure and practices a way behind the state of the art. The targeted improved safety set of measures should cover:

- Consistent use of personal protective equipment (PPE) such as hardhats, safety boots, hearing protection, etc.
- Proper fall arrest awareness and use of equipment like fall arrest harnesses, lanyards, etc
- Proper hazardous material use, storage;
- Arc flash protection ;
- Lockout/tagging procedures;
- Identification (and correction) of dangerous slip/fall hazards throughout the facility

19 <u>Soil erosion</u> of the left river bank, close to the site of 220 kV switchyard, and to the smaller extent erosion of the right bank of the irrigation canal, also close to that switchyard site.

15. AUDIT OF SOCIAL ISSUES AND ITS FINDINGS

The project site is a fenced area with restricted access. The site is located in 800 m from the nearest housing area (Sarband town border) and in 600 m from the summer housing area 9dachnyi poselok, the majority of owners are resided in Sarband). No housing or other illegal estate has been observed at the territory of the plant. No additional land is required for the purpose of the project. Therefore ADB's resettlement and indigenous people safeguards polices are not triggered.

21 The project scope and implementation arrangements were was discussed with representatives of the Sarband town community. The major conclusions are;

- All the works will be carried within the bordered area of the plant;
- No workers camp will be required at the site, so the staff of the contractor will be residing in Sarband (in hotels or rented housing);
- No major transport impacts as: noise, vibration and traffic interruptions are expected as the project will use the existing 5 km bypass road, starting at the entrance to Sarband from Kurgan Tube motorway;
- The project may require local unskilled labor for the period of construction;

15.1 EXTENT OF LAND FOR THE PROJECT

110 The land for Golovnaya – 60,01 ha was acquired in 1957, as soon as detailed design for the HPP was ready. The detailed design was carried by GLAVENERGO trust of USSR, with the regional branch office in Tashkent. The land was acquired for sole and permanent use by the plant (the schematic layout is attached below). Since the economic and political transition in Tajikistan, the changes to the legal framework have occurred. Today, the land in Tajikistan is the property of the state. Transaction on the land market only involve the land use rights. Currently the Golovnaya HPP pays the land use tax to the local authorities in Sarband. The water use tax (royalty) is paid to the central budget.

During the recent land certification in 2008, the Sarband town office of land registry has confirmed that he land plot of the same size and within the same borders belongs to Golovnya HPP (see the letter below). This refers to all the constructions, equipment, open area and under river area, while the water reservoir is owned by the Ministry of Melioration and Water Resources.

ЧУМХУРИИ ТОЧИКИСТОН ВИЛОЯТИ ХАТЛОН КУМИТАИ ЗАМИНСОЗИИ ШАХРИ САРБАНД



РЕСПУБЛИКИ ТАДЖИКИСТАН ХАТЛОНСКОЙ ОБЛАСТИ КОМИТЕТ ПО ЗЕМЛЕУСТРОЙСТВУ ГОРОДА САРБАНД

Инд. 735140 ш. Сарбанд кучаи Каленин 23 Тел: 6 – 15 – 04, 2-40-36 Nº 32

Инд. 735140 г. Сарбанд улица Каленин 23 Тел: 6 – 15 – 04, 2-40-36 «(3)»____6___200 g.c.

Ба директори СНОБВ-и шахри Сарбанд мухтарам Эмомов А

Чавоб ба мактуби Шумо аз 11.06.2008 сол № 1/21-168

Кумитаи заминсозии шахри Сарбанд ба маьлумоти Шумо мерасонад, ки китьаи замини СНОБВ-и шахри Сарбанд дар майдони 60,01 га чойгир шуда, аз чумла заминхои саноати 22,70 га, чарогох 7,77 га, зери об 0,90 га, богдори ва полезкори 12,42 га, посиракори 4,74 га, майдонхо 1,0 га, сангзор 7,75 га, камишзор 1,0 га, анор ва бог 0,63 га, нуктаи санчиши 0,45 га, ва захбурхо 0,65 га-ро ташкил медихад.

РАИСИ КУМИТАИ ЗАМИНСОЗИИ	ak	
ШАХРИ САРБАНД	grace	Х.САЛИМОВ

Ичрокунанда: Абдуллоев С



16. CONCLUSIONS

23. The findings of the audit are in a full consistency with the recommendations of the IEE. The project will address the current environmental impacts, covered in its scope. It is clear, that most of the currently undergoing impacts will be prevented for the future as a result of the project in these parts of he pant, covered with the project scope. Other uncovered aspects of the plant's operation, varying from the required investments in rehabilitation of remaining units of the plant to optimisation of the river regime will be within the priorities of further development and modernization of BT enterprises.

17. PHOTOS:



1. Leak of transformer oil; tailrace deck;



2. Asbestos paper used in between wiring of rotor



3. The storage tanks for hydraulic oil and transformer oil, located just south east of the control room, should have oil containment basins under the tanks and oil-water separators.



4. Left. Te highly eroded left river bank. There are no traces of the original embankment. The erosion is very close to the site of the 220kV switchyard, affecting its structural stability.



5. Left: irrigation canal, right wall; right: irrigation canal: left bank - erosion;

18. ANNEXES

ANNEX 1. TRANSFORMER OIL T-1500 PROPERTIES

T-1500 is transformer oil of sulfuric acid and solvent refined oils.

It is used to fill transformers, oil circuit breakers and other high voltage equipment as the primary insulating material. T-1500 oil combines high insulation properties with active cooling medium and heat-transfer agent.

In oil circuit breakers, it performs the function of arc-suppressing fluid (neutralizer). T-1500 oil contains anti-oxidizing additive ionol (2.6 di-tert-butyl paracresol), which provides the most important property of oil - oxidation stability, and securely stores all of its performance after prolonged use. Oil T-1500 does not contain water and mechanical impurities, which ensures high dielectric strength of the oil.

According to the International Classification of transformer oils, T-1500 relates to a class II (for northern regions with a pour point not higher than -45 ° C). Transformer oil is used to fill the power and instrument transformers, reactor equipment, and oil circuit breakers. Dielectric properties of oil are mainly determined by dielectric loss tangent. Moreover, the dielectric "strength" of transformer oil is mainly determined by the presence of fibers and water, so the mechanical impurities and water in these oils must be completely absent.

To ensure the efficient removal of heat transformer oil should have a viscosity at lower flash point not less than 95, 125, 135 and 150 ° C for different brands. The most important property of the transformer oil is its stability against oxidation, i.e., the ability to save its settings after prolonged use. Generally, all kinds of such domestic oil contain an effective antioxidant such as lonol additive (Agidol-1 and others).

The transformer oil serves as an insulator and also the cooling sustance. To ensure reliable and troublefree operation of electrical equipment it is necessary to properly operate the transformer oil. During the operation of transformer oil its individual quality indicators and properties change, it gets old. Aging of transformer oil during operation is determined by the change in the acid number, the number of generated sludge therein.

The sludge drops from oil as a result of aging and deposited in the cooling ducts, insulation, cores for transformers and other electrical equipment, worsening the cooling condition of the equipment. In this case, isolation of the electrical equipment is aging rapidly and collapses what can lead to accidents such as inter-winding fault in the transformer windings.

The reaction of aqueous extract is used to determine the presence of dissolved acids and bases with the help of specific indicators that are able to change colour in the presence of acids and alkalis in transformer oil. The physical properties of transformer oil are essential for the reliable operation of electrical equipment. Changing these properties indicates a malfunction of equipment and oil degradation.

During the operation the flash point of oil in transformers can dramatically decrease as a result of oil degradation by the localized heating effect. Fresh transformer oil before filling the newly started transformers arriving without oil have to be tested on the solids content, the content of suspended coal, the clarity, the overall stability against oxidation, in addition dielectric loss tangent, flash point and the temperature must be defined.

"Azerneftyag"

CERTIFICATE № <u>668</u>

Transformer Oil T -1500

GOST 982-80 with amendments No. 2,3

Manufacture date of the product 29/VII-02

Reservoir number 45

Reservoir measurement 742

(Russian Classification of Production) OKI $\,$ 02 5376 0105 $\,$

No	Item name	Rate	In fact
1	2	3	4
1	Kinematic viscosity, m^2 / s (cSt), not more than:		-6
	at 50. ° C	8.10 ⁻⁶ (8)	7,58.10 17.5816
	at -30 ° C.	11000.10 ⁶ (110)	897,5.10
2	Acid number, mg KOH per 1 g of oil, not more than	0,01	1897
3	Flash point identified in closed crucible, ° C, min	135	0,0044 141
4	Water-soluble acids and alkalis	absence	absence
5	Content of mechanical impurities	absence	absence
6	Pour point, ° C, not above	- 45	-45
7	Sodium sample, the optical density of no more than	0,4	0,4
8	Transparency at 5 ° C,	withstands	withstands
9	The color of the calorimeter CNT, CNT unit, not more	1,5	1,5
10	Oxidation stability, no more:		
	volatile low-molecular weight acids		
	mg KOH per 1 g of oil	0,04	0,038
	the mass fraction of sediment,%	absence	absence
	acid number of oxidized oil		
	mg KOH per 1 g of oil	02	0,18
11	The dielectric loss factor,%, not more at 90 ° C	0,5	0,5
12	Density at 20 ⁰ C, g/cm ³ , not more than	0,885	877,8

Conclusion: Complies with GOST 982-80 with amendments No. 2 and 3

ANNEX 2. TURBINE OL TΠ-30 OIL PROPERTIES

TP-30 oil (GOST 9972-74) is produced from waxy oils with use of selective solvents. It contains improvers that ameliorate oxidation, corrosion, and other properties of the oil. TP-30 is used for the turbines, some turbo-compressors and centrifugal-flow compressors.

TП-30 turbine oils GOST9972-74

Turbine oils are designed for the lubrication of bearings and turbine auxiliary machinery (steam gas turbines, turbo-machinery, turbines, marine steam turbine plant and other similar types of equipment), as well as in control systems of these machines as hydraulic fluids

N⁰	Indicator name	Rate		Testing methods
		ТП - 30	ТП - 46	
1	Kinematic viscosity at 400C, mm '/ s, within	41,4 – 50,6	61,2 -74,8	GOST 33
2	Viscosity Index, minimum	95	95	GOST 25371
3	Acid number, mg KOH per 1 g of oil, not more than	0,5	0,5	GOST 11362
4	Stability against oxidation:			GOST 981
	-residue after oxidation,% max	0,01	0,008	And till 4.2
	-acid number after oxidation mgKOH / g, more than	0,5	0,7	Of GOST
5	Ash content,%, not more than	0,005	0,005	GOST 1461
6	Demulsification number, min, not more than	3,5	3,0	GOST 12068
7	Corrosion of steel rods	Absence/miss		GOST 19199
8	Colour at chromometer unit, not more than	3,5	3,5	GOST 20284
9	Flash point in open crucible, 0 C, not lower than	190	220	GOST 4333
10	Pour point, 0C, not higher than	-10	-10	GOST 20287

11	The phenol content of the base oil	Absence/miss		GOST 1057
12	Content of mechanical impurities	Absence/miss		GOST 6370
13	Water content	Absence/miss		GOST 2477
14	Sulphur content in the base oil,%, not more than	0,3	0,3	GOST 1437
15	Water-soluble acids and alkalis	Absence/miss		GOST 6307
16	Corrosion effect on metals, groups,	1	1	GOST 2917
				And till 4.4.
				of GOST
17	Yield temperature, ⁰ C, not more than	-6	-6	GOST 20287
18	Density at200C g/cm3, not more than	0,895	0,895	GOST 3900
19	Stability against oxidation in the			GOST
	universal device:			18136 and till
	 -mass fraction of residue after oxidation,% not more than 	0,03	0,10	4.2. of
	acid number after oxidation, mg KOH / g, not more than	0,40	1,50	GOSI

ANNEX 3. SCHEMATIC LAYOUT OF THE OIL TREATMENT INFRASTRUCTURE





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