

# Turbine Fluid Flushing Best Practice at Malakoff Prai Power Plant

## Introduction

This article discusses the best practice of oil turbine oil flushing and oil filling for a combined cycle in a turbine system for power generation. Petronas Lubricant Marketing (M) Sdn Bhd (PLMMSB) as a vendor for supplying the turbine lubricating oil, we are expected to make recommendations to the turbine operator concerning compatibility with the turbine oil.

As part of After Sales Support, PLMMSB Technical Service Department always prepared to ensure satisfactory performance of the lubricant, such as examination of oil samples and recommendations for corrective action, if required.

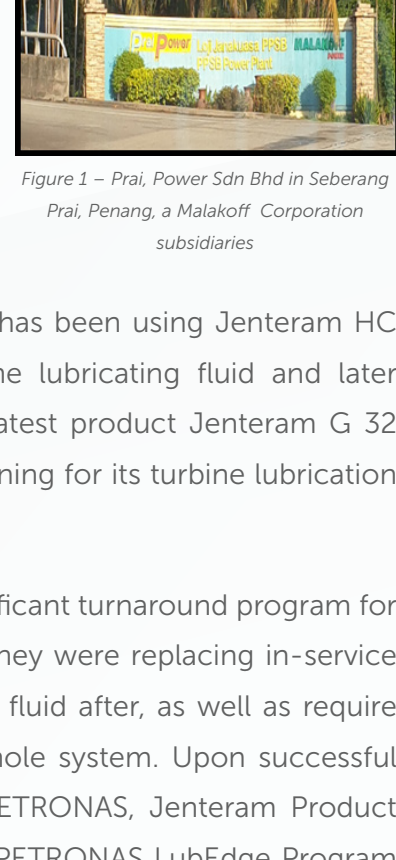


Figure 1 - Prai, Power Sdn Bhd in Seberang Prai, Penang, a Malakoff Corporation subsidiary

## Project Background

On 28 February 2020, PLMMSB Commercial Key Account Team and Technical Service Department (TSD) has participated in a Turbine Oil filling activity with, Prai Power Sdn Bhd (PPSB) located in Penang, Malaysia. A total of 40,000 liters of turbine fluid was successfully delivered to PPSB by PLMMSB.

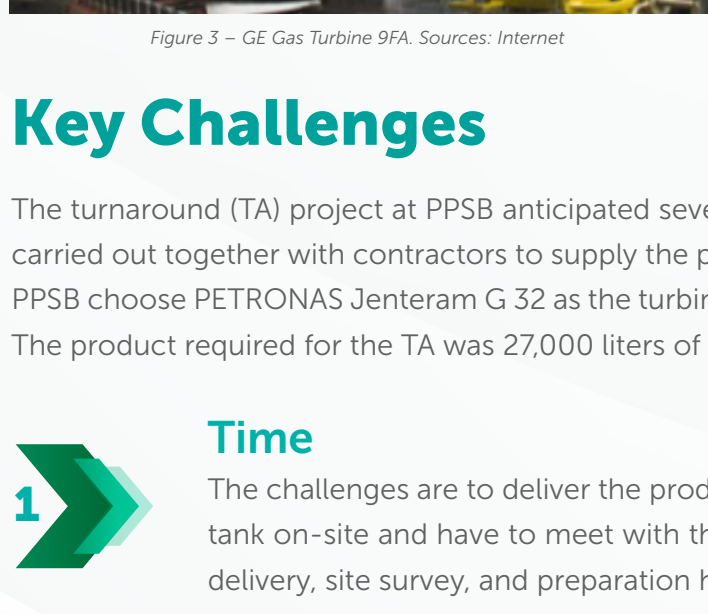


Figure 2 - PLMMSB Technical Service Personnel on-site collaborating with PPSB and maintenance contractor on site

Since 2010, PPSB has been using Jenteram HC Extra 32 as turbine lubricating fluid and later upgraded to the latest product Jenteram G 32 for routine sweetening for its turbine lubrication system.

As part of the significant turnaround program for the power plant, they were replacing in-service turbine lubricating fluid after, as well as require performance of the whole system. Upon successful flushing of PETRONAS, Jenteram Product at their plant and PETRONAS LubEdge Program has improved their equipment reliability and prevented unscheduled downtime and give them significant savings in operating expenses.

The plant installed with the General Electrics (GE) 9FA gas turbine. It combined with Heat Recovery Steam Generator (HRSG) and GE D10 Steam Turbine as main equipment driving the 390H Hydrogen Cooled Generator with a production capacity of 350MW. The plant, in its 16th year of operations, delivered a total of 1,662 GWh of electricity to the national grid in 2018.

## Key Challenges

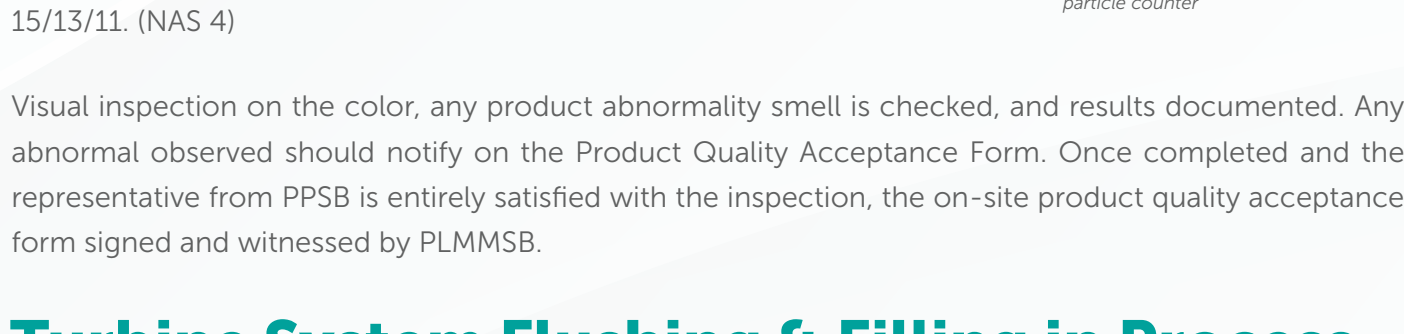
The turnaround (TA) project at PPSB anticipated seven months before a planned outage. The activity has carried out together with contractors to supply the product and perform the maintenance for their plant. PPSB choose PETRONAS Jenteram G 32 as the turbine oil due to confident with our product and services. The product required for the TA was 27,000 liters of Turbine Lube Oil, and 13,000 liters of flushing oil.

- Time**  
The challenges are to deliver the product within the time planned and have to send in ISO tank on-site and have to meet with the cleanliness turbine oil specification by GE. Before delivery, site survey, and preparation has done.
- Cleanliness**  
Cleanliness test equipment readiness and calibration with contractors, identify hose mounting, route for the connection with the length requirement for pipe the turbine oil from ISO tank to the turbine reservoir. Safety measures have carried out concerning the lube oil spillage, work on-site, and ISO tank parking location.
- Communication**  
Communication and close engagement with the MLBP production plant, logistics, marketing, and PPSB is vital to meet with a dateline of the delivery and to fit with the PPSB maintenance schedule.

It was cautioned by PPSB to deliver the product on the exact window due to the outage schedule power plant, and any delay may impose a risk on affecting the electricity supply to Penang Main island and fine by the authority

## Scope of Work

Before Turbine Oil filling activities, PLMMSB Technical Services has a series of obligations to ensure the integrity of the product delivered. Scope of work for Technical Services involves inspection of the product before acceptance, documentation such as safety data sheet (SDS), certificate of analysis, product acceptance, and standby on-site for immediate support and observe the filling activities.



Toolbox meetings conduct with all parties involved before the turbine oil change and the new turbine oil filling activities. The brief assembly is to develop a mutual understanding of each party's job scope and responsibility and any Health and Safety (HSE) concern during the activities.

## Product Delivery

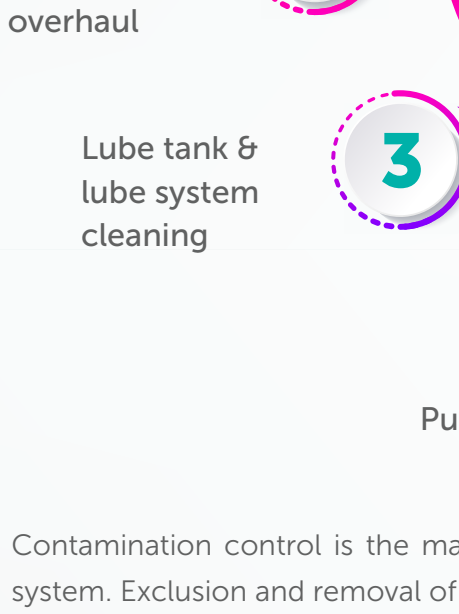


Figure 5 - The tanker truck is inspected together with the customer

The total of 27,000 Liter PETRONAS turbine oil Jenteram G 32 is delivered on-site with ISO tank to PPSB site. Technical Services Engineer, along with site representative from Prai Power, was on-site to conduct product inspection on the tanker.

The security seal on the discharge valve on the tanker had to be witness together to ensure product integrity, correct oil, grade, and quantity. On the Delivery Order document, the net weight of the delivery load must be tally with the amount of the bulk in liter.

Before delivery of the product of the Jenteram G 32 to the site, product manufacturer, PLI-MLBP have to provide the Certificate of Analysis (COA) stating the level cleanliness level of the delivered batch number as per test method ISO 4406:1999

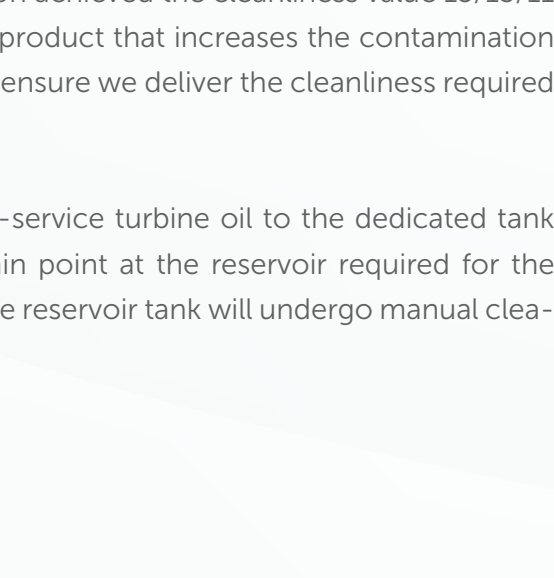
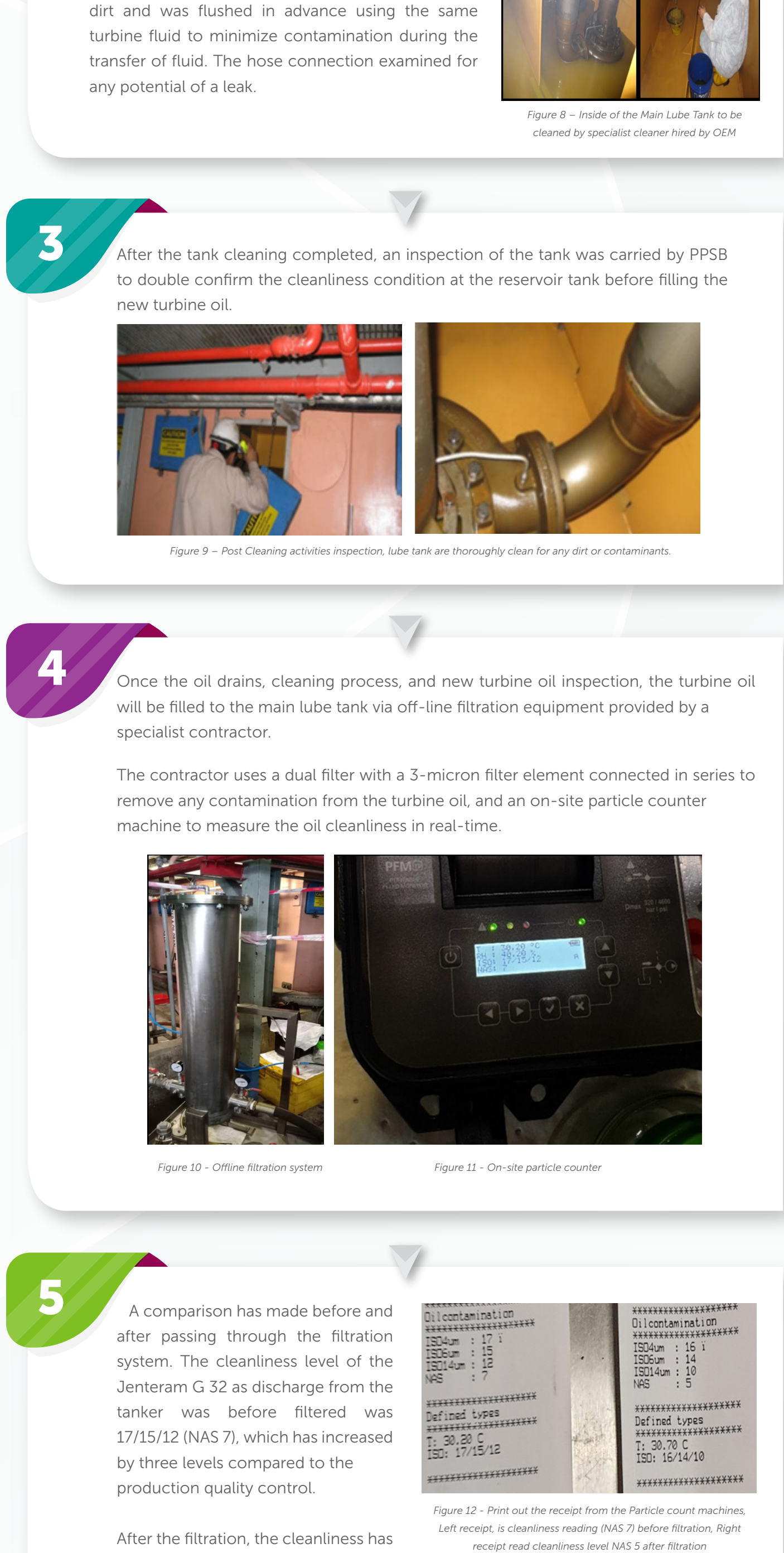


Figure 6 - Certificate of Analysis stated the Physical properties of the product, and the critical highlight is the particle counter

PETRONAS Lubricants practicing standard monitor and blending process, before the transfer of product into shipment packaging, Quality Assurance at PLI MLBP has ensured the product delivered at least meet minimal cleanliness 16/14/12. (NAS 5) For the delivery to PPSB Sdn Bhd, The Jenteram G 32, Batch number: B163B177, the cleanliness level is 15/13/11. (NAS 4)

Visual inspection on the color, any product abnormality smell is checked, and results documented. Any abnormal observed should notify on the Product Quality Acceptance Form. Once completed and the representative from PPSB is entirely satisfied with the inspection, the on-site product quality acceptance form signed and witnessed by PLMMSB.

## Turbine System Flushing & Filling in Process



Contamination control is the main list of obtaining and maintaining a clean lubricant and lubrication system. Exclusion and removal of contaminants are necessary for a successful flushing program.

GE, as OEM, specifies the minimal turbine oil cleanliness level, which is ISO 16/14/11 or a NAS 1638 cleanliness level 5. Even though the product filtered during production achieved the cleanliness value 15/13/11 (NAS 4), they're always a possibility of micro ingestion in the product that increases the contamination level of the fluid. On-site, we work closely with the specialist to ensure we deliver the cleanliness required by GE by doing the off-line filtration equipment.

Before the filling process, the first step is to drained oil the in-service turbine oil to the dedicated tank prepare on-site. The remaining fluid in the reservoir and drain point at the reservoir required for the proper step to be fully cleared. After draining out the used oil, the reservoir tank will undergo manual cleaning and conducted by the contractor hired by OEM.

### Filling in Process

- The technician/worker that involved for tank cleaning must equip with new and clean coverall, rubber boot, rubber glove, and dust-free cloth.
- The tanker delivery hose is inspected from any visible dirt and was filtered in advance using the same turbine fluid to minimize contamination during the transfer of fluid. The hose connection examined for any potential of a leak.
- After the tank cleaning completed, an inspection of the tank was carried by PPSB to double confirm the cleanliness condition at the reservoir tank before filling the new turbine oil.
- Once the oil drains, cleaning process, and new turbine oil inspection, the turbine oil will be filled to the main lube tank via off-line filtration equipment provided by a specialist contractor. The contractor uses a dual filter with a 3-micron filter element connected in series to remove any contamination from the turbine oil, and an on-site particle counter machine to measure the oil cleanliness in real-time.
- A comparison has made before and after passing through the filtration system. As cleanliness level of the Jenteram G 32 as discharge from the tanker was before filtered was 17/15/12 (NAS 7), which has increased by three levels compared to the production quality control.
- After the filtration, the cleanliness has improved 16/14/10 (NAS 5), complying with the GE cleanliness requirement.
- The flow rate of the dual filter arrangement flow at an average of 112L/minute. It took 4 hours to complete the filtration of a 27,000 Liter of turbine fluid before the filling. During the process of filtering and filling up the turbine lube oil system, a cautionary step has taken to ensure safety and hazard protection. All connection of hose from a tanker or any connected connector in between are infirm connection and free from leakage. A secondary containment are in-place as a precautionary measure for oil spillage, and the area barricaded

- After filling in the Turbine Oil at a minimum level, the oil will be circulated to the system for a few hours (which will be determined by OEM) as a flushing purpose. The purpose of flushing is to remove contaminants until the target cleanliness of the system achieved. For major turnaround activity for a used method such as Prai Power, flushing emphasizes the removal of contaminants that are generated during operation or introduced to the system during overhaul. For PPSB, they carried out a displacement flush method which utilizes a displacement flush oil of the same chemistry as the operating oil, Jenteram G 32. System pumps and flow channels being used to circulate the displacement of flush oil. The cleanliness of the flushing fluid monitored during and after the circulation via an on-site particle counter machine. All pipes and drain points properly drained out the second round of tank cleaning carried out. The flushed fluid will be disposed of and considered as scheduled waste.
- Oil waste collectors licensed by the Department of Environment (DOE) will be elected to collect the waste oil. DOE license and proper documentation need to submit to customer for reviewing before collecting the waste oil. After flushing has been carried out and all pipes appropriately drained from the flushing fluid, the filling of a new Turbine fluid, Jenteram G 32, will begin, the same process repeated until the turbine lube tank filled.

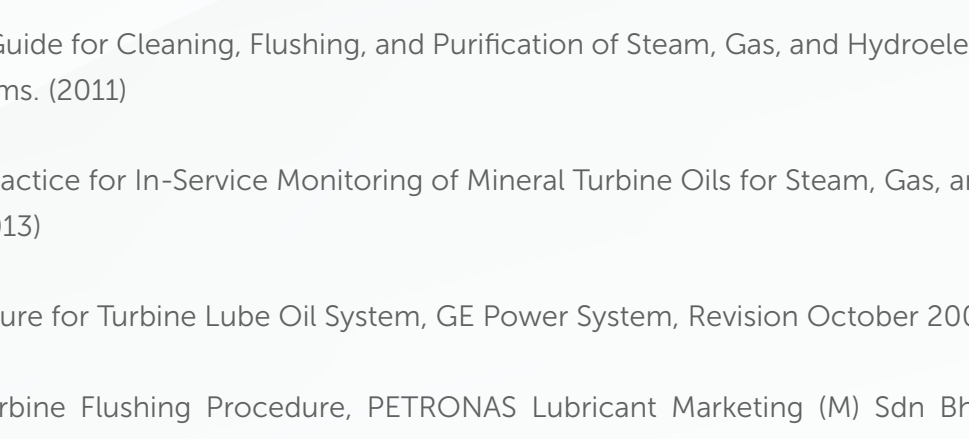
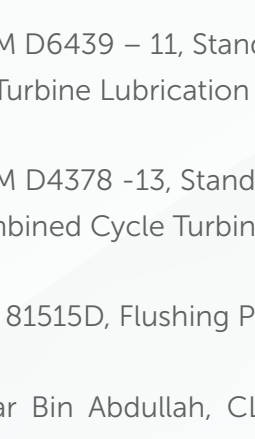
Upon completion of the filling of the fresh turbine oil, the final reading of the cleanliness level of the fluid recorded and confirmed to the GE the OEM requirement cleanliness level, which is ISO 16/14/11 or a NAS 1638 cleanliness level 5. One liter of the turbine fluid is sampled from the main lube tank for future reference if there is dispute may arise. Housekeeping carried out, and any oil spillage and stained thoroughly cleaned using a chemical degreaser. PPSB assessed on the completion of the job and will sign-off the Job-completion form together with PLMMSB. All parties involved discussed for any remarks during the activities as a post-mortem.

## Way Forward

This best practice for flushing and filling procedure for turbine fluid primarily act as general guidance for the future use of Jenteram G 32. This guide applies to both large and small lubrication systems for turbine power plants utilizing petroleum-based (non-synthetics) lubricating oil.

The OEM provides specific guidelines and procedures, and such methods should take supersede over the recommendations of this guide.

- To obtain the maximum reliability of the turbine system, a good lubricating oil that is free of contaminants need to be carefully selected. Lubricating oil such as Jenteram G 32 offered premium performance formulated with ashless additives to ensure excellent filterability for optimum filter efficiency, removing any contaminants in the system.
- PPSB, as a first power plant operator outside of the Operating Petronas Unit (OPU) to utilizes Jenteram G 32 for its combined cycle gas turbine (CCGT); this will give a significant on the success Proof of Performance of the Jenteram G product.
- The way forward after-sales service PLMMSB provided to the customer, an ongoing program oil monitoring program will be deployed until 8000 hours of turbine operating hours. This program will ensure that the oil quality is within the specification and to provide a diagnosis for corrective action to minimize contaminant generation.



## Reference:

ASTM D6439 – 11, Standard Guide for Cleaning, Flushing, and Purification of Steam, Gas, and Hydroelectric Turbine Lubrication Systems. (2011)  
 ASTM D4378 -13, Standard Practice for In-Service Monitoring of Mineral Turbine Oils for Steam, Gas, and Combined Cycle Turbines (2013)  
 GEK 81515D, Flushing Procedure for Turbine Lube Oil System, GE Power System, Revision October 2003  
 Azhar Bin Abdullah, CLS, Turbine Flushing Procedure, PETRONAS Lubricant Marketing (M) Sdn Bhd, (March 2020)  
 Azhar Bin Abdullah, CLS & Hajar Zunnur Binti Sabtu, MLA II, Best Practice for Turbine Oil Change at Prai Power Station, Pulau Pinang, PETRONAS Lubricant Marketing (M) Sdn Bhd, (July 2016)  
 MALAKOFF Annual Report 2018, Powering Excellence, (2019)