Japan Oil, Gas and Metal National Corporation (JOGMEC) has constructed the world’s largest underground LPG storage caverns in Kurashiki of Okayama prefecture and Namikata of Ehime prefecture from 2002. Kurashiki site is composed by four 488m-640m length storage caverns with the volume and areal dimension of 18m(W)×24m(H) to storage 400,000 tons propane. Comparatively, Namikata site was designed as a 430m butane/propane dual propose cavern and two 485m propane caverns to contribute 450,000 tons capacity. Both the constructions were completed in 2010 and passed the air-tightness test in 2012. After certification, the two storage cavern have received LPG and launched their operation to contribute more than half of the 1,500,000 tons national stockpile target. From an economical viewpoint, both Namikata and Kurashiki sites adopt unlined underground storage caverns to preserve the LPG (vapor pressure 0.8MPa at 20°C). Therefore, the storage caverns are located in sufficient depth (Kurashiki site: EL.-160m, Namikata site: EL.-150m) to maintain the permanent inward groundwater flow and ensure the tightness. Despite of economy, the underground storage caverns also have merits on: (1) Large storage capacity only by small area for surface facilities. (2) Minimizing the risk of mega disaster (e.g. earthquake, typhoon, tsunami, etc.) and providing protection on fire and explosion. (3) Environmental protection by the excellent tightness.

Even there are construction experiences of underground LPG storage caverns in the worldwide and also underground crude storage caverns in Japan. However, the hydraulic containment type underground LPG storage cavern has to be designed and constructed with detail consideration on the local hydro-geological and geological characteristics. Especially, in order to maintain the stable groundwater level during cavern excavation, the horizontal and vertical boreholes have been designed to enclose the storage caverns with high water pressure. Therefore, in order to ensure the water curtain efficiency during cavern excavation, a new hydraulic evaluation system has been developed by the integration of the original 3-dimensional hydrogeological modelling method together with the high accuracy hydraulic behaviors monitoring system and the detail hydrogeological/geological investigations. Additionally, for the high permeable fractured zone in Kurashiki site, numerous grouting tests were conducted for obtaining well grouting efficiency and reducing the rock permeability with geological considerations.

On the other hand, considering the development of excavation disturbed zone (EDZ) under high water injection pressure in great depth, the numerical rock mechanical analysis has been conducted and rock mechanical behaviors have been monitored to determine the cavern shape and support patterns for ensuring the stability. After the cavern excavation and facilities were completed, the storage caverns were pressurized to a specified test pressure around 1MPaG and evaluated the variation of cavern pressure in 72 hours’ duration as tightness test. In order to evaluate the tightness with high accuracy, extreme high precision pressure and temperature measurement instruments were utilized, also the layout of temperature measurement instruments were determined by 3-dimensional computational fluid dynamics (CFD) simulation.

The achievement of the first hydraulic containment type underground LPG storage caverns has proven the domestics geotechnical design and construction on the large underground cavern, also contributes precious experience on design/construction and operation for the future underground energy storage caverns and civil structures in rock mass.