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| 1. All sites: Please supply topographic maps to allow assessing the flooding and tsunami hazard.   CS:  We can provide Sinotech CSNPP site Elevation Survey Report.  KS: As attached  KS- ENSREG PQ-第二批 TOPIC-1(38題附件 )-AB渠道集水區  MS:  Refer to detailed drawing. (Tsunami Inundation Elevation Map of MSNPP Site)    LM: | **48~50** |
| 1. LM: What is the seismic margin for the raw water reservoir structure?   The seismic margin for the raw water reservoir structure for LMNPP site is USNRC seismic category IIA (SSC whose collapses could result in loss of required function of seismic category I SSC required for safe shutdown.) | **50** |
| 1. CS, KS; MS: Do the safe shutdown path claim the availability of the raw water reservoirs? What are the seismic margins of these reservoirs?   The safe shutdown paths do not need to rely on raw water reservoirs in DBA, but it can be one of the water sources for safe shutdown under extended loss of AC power and loss of ultimate heat sink events.  CS:  The raw water reservoir structures will be reinforced to withstand 0.4g.  KS:  The raw water reservoirs will be reinforced to withstand 0.4g.  MS:  The reinforcement work of the raw water reservoir structure to the extent of 0.42g is in progress. | **50** |
| 1. KS: Is the availability of the gas turbine and EDGs necessary to secure safe shutdown? What is the seismic margin of the western reservoir which may lead to flooding of these SSCs upon its failure?     EDGs are necessary for securing safe shutdown, and gas turbines are for a backup electricity supply. When earthquake exceeds seismic category II level, western raw water reservoir B may rupture, but flood barrier panels have been installed at the entrance of gas turbine building to prevent it from damage. | **50** |
| 1. All sites: What is the database for assessing tsunami run-up heights?   CS:  The tsunami run-up height is based on the historical records, the biggest tsunami happened in 1867 with estimated surge height of 7.5m. The tsunami was assumed to be initiated by an eruption of submarine volcano, 134 km northern east to Keelung coast. It was calculated that the tsunami level from this event was 2.12 meters high in Chinshan coast.  KS:  Tsunami run-up height was assessed according to the past tsunami records of the Taiwan Central Weather Bureau and other information from Japanese publications, two serious tsunamis occurred in Taiwan in 1867 and 1918. The first and larger one caused great damage in Keelung with an estimated wave height of 7.5 meters (a combined effect of shoaling, contraction and runup). The tsunami was assumed to be initiated by an eruption of submarine volcano, 134 km northern east to Keelung coast.  MS:  Because the plant faces toward south, its threat of tsunamis is from Bashi Channel, Luson Strait, and South China Sea, which are induced by superficial epicenter of big massive earthquakes. Thus, if an earthquake that measures 8.0 on Richter magnitude scale induces tsunamis and the tsunamis wave height at the epicenter location is 5 m, then the tsunamis wave height at the coast of Maanshan would be approximately 11 m, causing the tsunamis run-up height near the plant to be approximately 8 m. Conservatively, if the tsunamis run-up height is added with 4.03 m of typhoon surge water level and 0.5 m of safety margin, then the maximum tsunamis run-up water level at the plant is 12.53 m. Consequently, the ground elevation of the main building area at MSNPP is designed to be 15 m to prevent the seizure of tsunamis. (refer to page 39 of MS stress test report Section 3.1.1.1)  LM:  Same as CS and KS NPPs. | **55** |
| 1. All sites: Has there been an assessment of paleo-tsunami deposits to validate the assumed maximum tsunami runup?   There is no assessment of paleo-tsunami deposit for the time being, but the investigation is in progress by both National Science Council (Globally for northern and southern Taiwan) and TPC (locally for areas near NPPs) . | **55** |
| 1. CS: Why is storm surge not included in the maximum flood height?   The storm surge has been included in the maximum flood height evaluation. The maximum flood is considered with following data:  From FSAR 2.4.6.5, when tsunami and maximum wave occur concurrently, the run up flood height will be 9 meters for a slope of sea bed of 1/5. Combine this figure with storm surge of 1.73m (from FSAR 2.4.5.3) will get the maximum flood height of 10.73m. | **55** |
| 1. CS: How is the PMP of 297 mm/h justified at the background of a record of 325 mm/h for a historical storm?   The PMP of 297mm/h is justified from two set of records, these records include Tanshui (PMP 252.7mm/h) and Anpu (PMP 325.2mm/h) 30 years (1943-1972) Maximum Hourly Rainfall Order of Magnitude. | **55** |
| 1. CS: What is the actual elevation of the plant? The report contains contradicting numbers: 5-20 m, 12 m, 11.2 m (p.2, p.69).   The elevation 5 to 20m shown in page 2 is the elevation range of the plant site. 11.2m is the elevation of the power block where C/S building and T/B Building are located. | **55** |
| 1. KS: Why is storm surge not included in the maximum flood height?   Storm surge has been included in the maximum flood height evaluation to determine the elevation of the power block .We took wave action (including the wave induced by both northeast monsoon and typhoon) and astronomical tide into account while assessing the maximum tsunami runup. | **55** |
| 1. KS: Why is the PMP estimated for 10,000 years recurrence (241 mm/h) lower than historical measurements listed for the close-by CS NPP (252 and 325 mm/h)?   Because KSNPP and CSNPP are not in the same area. KSNPP assessed PMP according to precipitation data of Chinshan and Keelung. | **NA** |
| 1. MS: Why is storm surge not included in the maximum flood height?   Storm surge has been included in the maximum flood height evaluation to determine the elevation of the power block. | **55** |
| 1. MS: The PMP is significantly lower than the values recorded near CS NPP (up to 325 mm/h). How is this discrepancy justified?   It is because of the different geographical location of two power plants. | **56** |
| 1. MS: The use of two DBFs is unclear. Please explain.   The plant’s DBF is (1)120 mm/hr precipitation intensity once every 100 year, and (2) 228 mm/hr precipitation intensity once every 10,000 year. | **56** |
| 1. LM: Why is storm surge not included in the maximum flood height?   Storm surge (EL.11.85m, including 0.5m margin) has been included in the maximum flood height evaluation in 1985 to determine the elevation of the power block. | **56** |
| 1. LM: The PMP is lower than the values recorded near CS NPP (up to 325 mm/h). How is this discrepancy justified?   The PMP is a site-specific data | **56** |
| 1. CS, KS: What is the reason for assuming different maximum tsunami heights of 10.4 and 7.5 m for the two sites which are relatively close to each other?   CS:  Per CSFSAR 2.4.6.1 and 2.6.11, the final design maximum tsunami height for CS is 10.73m, which is 9m+1.73m.  Where:  --9m came from the combination of maximum wave height caused by monsoons and tsunami wave height caused by the governing 1867 submarine volcano eruption event.  --1.73m came from the storm surge including maximal astronomical tide, sea level rise due to low barometric pressure, and wind setup.  KS:  The final design maximum tsunami height is 10.28m, which is 9m+1.28m.  The 7.5m is the estimated wave height in Keelung harbour (24km southeast to the CS site) caused by the 1867 submarine volcano eruption event. | **57** |
| 1. KS: It appears that the maximum tsunami runup height equals the largest recorded event (150 years observation period), which is clearly not equal to an event with a probability of 10-4. Is the current approach justified by the Taiwanese regulations?   Maximum tsunami run up height in FSAR was derived based on deterministic calculation done more than thirty years ago. A probability evaluation is not a requirement currently. However, re-evaluation of the maximum tsunami runup height with a probability of 10-4 is in progress. | **57** |
| 1. LM: It appears that the maximum tsunami runup height equals the largest recorded event (150 years observation period), which is clearly not equal to an event with a probability of 10-4. Is the current approach justified by the Taiwanese regulations?   According to NUREG/CR-6966，tsunami generation from earthquakes, landslides, volcanoes and historical occurrences of tsunamis are included for assessing the tsunami runup. However, re-evaluation of the maximum tsunami runup height with a probability of 10-4. Is in progress. | **58** |
| 1. All sites: Please explain drainage capabilities, which are given im cms (meaning cubic meters per second?) . A measure in mm/h defining the maximum precipitation that can be drained from the site would be more easily understood.   The mm/h is the measurement of Probable Maximum Precipitation based on 10,000 years of recurrence. The cms is the calculation of probable maximum flood derived from PMP and the area of site, based on which the drainage channel capability is designed. | **58** |
| 1. MS: The evaluation of the design basis tsunami is unclear. The evaluation on p. 58 accounts for additional 4 m typhoon surge, on p. 55 storm surge is not included. Please explain.   (Section 3.1.1.3 in P42) 4 m typhoon surge, 8m＋4m＋0.5m＝12.5m is included in P55 and P58.  Original text of P56：”it is estimated that the maximum tsunami run-up height near the plant is 12.5 m. Therefore, there is no concern of tsunami-induced flooding at the plant.”  Original text of P58：the tsunami run-up height near the plant will be approximately 8 m. Conservatively adding a 4.0 m typhoon surge wave and 0.5 m safety margin, the maximum tsunami run-up level at the plant is 12.5 m.  The content on P56 only indicates the sum of MSNPP maximum tsunami run-up height of 12.53 meters, does not includes the factor of the tsunami run-up height. The content on P58 indicates the factor of the tsunami run-up height in details. | **58** |
| 1. LM: What is the justification for considering only tsunamis triggered by earthquakes N and NE of Taiwan in the hazard assessment?   LMNPP site is located in Yenliao Bay. The north and south ends of the bay are Bitou Cape and Cape San diego, respectively. The tsunamis triggered by earthquakes from the directions other than N and NE of Taiwan will be blocked and will not affect the LMNPP site. | **58** |
| 1. LM: What is the justification for adopting the historical PMP for the DBF and not a more conservative value that corresponds to a lower probability (e.g., 10-4)?   According to LM FSAR 2.4.3.1, the precipitation records of Keelung from 1901 through 1982 have been used in the derivation of the LMNPP site specific PMP formula. The PMP return period is more than 15,000 years. | **59** |
| 1. All sites: Sites seem to have only small safety margins with respect to tsunami flooding. What are the uncertainties related to the assumed maximum tsunami runup elevations?   Since modern computer codes that could predict tsunami run-up were unavailable when the Final Safety Analysis Report (FSAR) was written, the original calculations in the FSAR of design basis tsunami were based on the empirical formula and thus very simple. In addition, the FSAR analysis used an approximate sea-bed slope (e.g. 1/5 or 1/10) instead of actual bathymetry data.  According to the recent tsunami and flooding analyses performed by Sinotech Engineering Consultants Ltd, under the contract of TPC (although there are still significant uncertainties in tsunami run-up predictions due to the definition, its Magnitude of tsunami sources, and the use of approximate near-shore topography instead of accurate bathymetry and refined numerical cell size), the analyses result showed much lower predicted tsunami run-up height than that stated in the CS/KS NPP Final Safety Analysis Report (FSAR).  In addition, the planned tsunami seawalls (design tsunami runup height + 6 meters) could compensate for the uncertainties embedded in the definition of tsunami sources.  CS, KS:  A tsunami wall of 17 meters high above MSL is scheduled to be completed before the end of 2016. It may properly compensate the uncertainties.  MS:  A 19 m anti-tsunami wall is planned to be built.  LM：  A 14.5 m anti-tsunami wall is planned to be built.  . | **59** |
| 1. KS: What is the maximum hourly precipitation that could be drained from the site?   The 30-year hourly records of Keelung station from 1947 to 1976 were used to calculate the probable maximum rainfall of KSNPP site. The maximum hourly rainfall in various return periods are smaller than the results described in the FSAR. For conservatism, the 10,000-year maximum hourly rainfall of 241 mm at Keelung is still assumed as the probable maximum precipitation for the site area. | **62** |
| 1. MS: The nuclear service cooling water system is located at an elevation of 12.6 m. Does this imply that only 0.1 m safety margin is available with respect to the DBF tsunami?   A 19M height tsunami resistant capability has been planned to strengthen the protection of the nuclear service cooling water system (NSCW). | **63** |
| 1. CS: The construction of the NPP on top of filled soil may have as an effect that seismic ground motion is amplified (site effect). Have such possible effects been accounted for in seismic hazard assessment?   Combination structure, ECWB, and 5th EDG are founded on hard bedrock. There is no site effect issue. | **64** |
| 1. All sites: How is early tsunami warning organized?   When the plant finds signs of tsunami or receives tsunami warnings from Central Weather Bureau by facsimile, it complies with procedure “Operation during tsunami warning period” and considers the amount of warning lead time to prepare in advance.  The tsunami warning of Central Weather Bureau is based on Pacific Tsunami Warning Center (PTWC) notification. | **73** |
| 1. CS, KS, MS: What are the heights of the planned tsunami walls (m above sea level)?   Tsunami walls of 17, 17, and 19 meters high above MSL is scheduled to be completed before the end of 2016 for CS,KS, and MS, respectively. | **76** |
| 1. CS, KS: What is the drainage capability expressed in terms of precipitation intensity (mm/h)?   CS:  The drainage capability expressed in terms of precipitation intensity is 323mm/h.  KS:  The 10,000-year maximum hourly rainfall of 241 mm at Keelung is assumed as the probable maximum precipitation for the site area. After re-evaluation, the drainage capability of KSNPP is 507 mm/hr for creek A and 242 for creek B. | **80** |
| 1. CS: Does the assessment of landslide/mud slide/dip slope sliding hazards account for the combined adverse effects of meteorological conditions (high precipitation) and seismic triggering?   From the basic photograph of environmental geology published by Central Geological Survey, the site base stratum belongs to volcano conglomerate, the geological calamity there does not have a level which will slip and because the Shanchiao fault near the site base is a category 2 active fault, the probability of triggering by earthquake is extremely low. | **82** |
| 1. CS: What is the lithology of the slopes E and W to the plant?   Agglomorate tuff. | **82** |
| 1. CS: Are the slopes adjacent to the NPP susceptible to mass movements triggered by extreme precipitation and/or seismic shaking?   Because the Shanchiao fault near the site base is a category 2 active fault, the probability of triggering by earthquake is extremely low. As vegetation in the hillside is good near the CSNPP, CSNPP has not experienced any side slope slip caused by heavy rain or earthquake since the plant’s initial operation more than 30 years ago. | **82** |
| 1. KS: Does the assessment of landslide/mud slide/dip slope sliding hazards account for the combined adverse effects of meteorological conditions (high precipitation) and seismic triggering?   Since the hills inside the plant area are separated from safety related structures with a large space and covered with vegetation, according to the data published by Central Geological Survey, the probability of landslide is low. Therefore, it was not taken into account. Because of Mudslide will not be triggered by earthquake, besides, there are no river or stream passing through the plant area, and the drainage systems are designed to carry the 10,000-year maximum hourly rainfall of 241 mm/hr, the probability of mud slide is relatively low. For dip slope, according to the data published by Central Geological Survey, since there is no dip slope inside the power block, therefore, it is not a significant concern for KSNPP. | **83** |
| 1. KS: What is the lithology of the slopes 60 m S of the plant?     The lithology of the slopes located on 60m S of the power block area is similar to the power block area. Approximately 10 meters of terrace deposits covered the foundation rocks. The rocks consist of sedimentary deposits belonging to the middle portion of the Mushan Formation. The foundation rocks consist of a sequence of estuarine and near shore deposits. These deposits include sandstone, shale, siltstone, and mudstone. | **83** |
| 1. KS: Are the slopes adjacent to the NPP susceptible to mass movements triggered by extreme precipitation and/or seismic shaking?   According to the investigation results from Central Geological Survey, dip-slope landscape locates at 400 meters southeast of the main buildings. The dip-slope area is well maintained and vegetated and chances of landslide are minimal. | **83** |
| 1. MS: Does the assessment of landslide/mud slide/dip slope sliding hazards account for the combined adverse effects of meteorological conditions (high precipitation) and seismic triggering?   According to the investigation results from Central Geological Survey, there is no landslide/mud slide/dip slope sliding issues at MSNPP site. Therefore, no combined adverse effects are taken into account. | **85** |
| 1. LM: What is the lithology of the slopes adjacent to the plant?   The slopes of formation major comprised silt to fine-grained sandstone (siltstone) intercalated with alternation of thinly bedded, sandstone and siltstone. | **87** |
| 1. LM: The report mentions heavy measures to stabilize slopes. Please explain the local topographic position of the plant (distance of slopes from plant, slope angles etc.).   The distance from the west slope to the safety related SSC (such as reactor building) is about 94.5 meters. Therefore, if the slope fails, it will not affect the safety of plant.  The first and second slopes are benched 1:1 (V:H) in rock. The third slope is benched 1:2 (V:H) in deeply weathered rock and overburden. Each bench has a vertical height of 7.5 meters and has 4 meters-wide horizontal bench. The top of the third slope ended to EL. 30 meters.  image003 | **87** |
| 1. All sites: Are volcanic hazard assessments available for all sites?   For CS and KS, if Tatun volcano erupts, eruptive material would flow in all direction. However, due to topology, lava would not affect CS and KS site area.  For MS, volcano is not a concern as stated in the FSAR.  For LM, based on the conclusion of research by Dr. Y. B. Tsai and his group in 2001, the volcanic hazard assessment of gueishan island or submarine volcanoes could be ignored.  However, volcanic hazard assessments according to NURGE-1407,  ASME/ANS RA-Sa-2009, JEAG-4625 in addition to IAEA SSG-21 required by AEC orders is still in progress. | **94** |