NON-TECHNICAL SUMMARY

1. Introduction

The CEP has considered the draft CEE prepared by China for the proposed construction and operation of a new Chinese research station at Victoria Land, as well as the related ICG report and comments in 2014. According to the advice of CEP XVII to ATCM XXXVII, the draft CEE generally conformed to the requirements of Article 3 of Annex I to the Protocol on Environmental Protection to the Antarctic Treaty, and was generally clear, well structured, and well presented. CEP XVII also suggested that several specific issues to be considered in the final CEE. With the concern of the potential impact of the construction and operation of the new station may have on the habitat of Adelie Penguins in the North of the Inexpressible Island due to the proximity, China has decided to move the planned station site 2km to the south, after a careful assessment of the possible impact. This new version of draft CEE has fully considered the comments and suggestions raised during the discussion in CEP XVII in 2014, and particularly addressed the change of the site to avoid the potential impact on the penguin habitat.

The Polar Research Institute of China (PRIC) and Tongji University have conducted this Comprehensive Environmental Evaluation (CEE) for the proposed construction and operation of the new Chinese research station in Victoria Land, Antarctica based on the CEE in 2014, and drafted a Report on the new CEE (the Draft CEE). The new Draft CEE has been prepared in accordance with Annex I of the Protocol on Environmental Protection to the Antarctic Treaty, and the domestic laws and procedures. It also referred to the Guidelines for Environmental Impact Assessment in Antarctica (Resolution 1, XXXIX ATCM, 2016). The new Draft CEE describes the following contents：

- Construction, operation, and maintenance of the new Chinese research station
- Transportation process for cargos and personnel to the new Chinese research station
- Analysis of potential environmental impact
- Prevention and mitigation measures to minimize environmental impact
- Gaps in knowledge and uncertainties

The site of proposed Chinese Scientific Research Station was fixed at 74°55′S 163°42′E on the Inexpressible Island, Terra Nova Bay in the Ross Sea Region. Three initial candidate

locations as shown in the draft CEE were considered in the evaluation process, taking into account of the convenience of scientific research and supporting logistic activities, and the minimization of possible impact on the surrounding environment. When the Inexpressible Island was chosen as the premise of the Station, five alternative sites were investigated and compared, and the Adelie Penguin habitat was given particular consideration when decided the final site.

The new year-round Chinese station will function as one of the key platforms of the Antarctic observatory network in the Ross Sea region. It will be valuable to compare the data obtained in the proposed Chinese Station with those in the Zhongshan Station in the East Antarctica. China believes that understanding the change and variation of the climate, ice and ocean undergoing in Antarctica is a matter of priority for the Antarctic community. The main purpose of the new Chinese station is to provide a platform for regional multidisciplinary research focusing on the climate, cryosphere and ocean system.

The priority of scientific research in the new station will focus on, *inter alia*, interaction between atmosphere ice, and the ocean, interaction between ice sheet and ice shelf, marine and terrestrial ecosystem, space physics and the geological environment evaluation studies etc.

(1) Interaction among Atmosphere Ice and the Ocean

To build an international atmospheric observation platform and an ocean-ice-atmosphere observation system, together with the stations operating in the Ross Sea region, to carry out a year-round long-term monitoring of the atmospheric environment (both physical and chemical), sea ice change and marine environment to provide basic information for the study of climate change.

- Measuring the long-term marine environmental properties, including sea temperature, salinity, current speed, current direction, air pressure and other elements,
- Monitoring the long-term of the sea ice distribution and change using shore-based facilities and satellite remote sensing,
- Measuring sea ice thickness and drifting by ice buoy automatically, consistent sea ice-air vertical temperature change, and consistent ice-atmosphere turbulent flux, radiation flux and sea ice albedo above the ice surface,

- Building a gradient wind profile observation system and measuring the air temperature, humidity, wind speed and wind direction of upper atmosphere using balloons,
- Building an atmospheric observation platform to measure the main greenhouse gas (CO_2, N_2O, CH_4 and O_3, etc.) and aerosol (Heavy metal such as Hg, POPs and microorganisms).

(2) Interaction between Ice sheet Ice shelf-Ocean

Along with the records of collapse of numerous small Antarctic ice shelves in recent decades and the discovery that the Southern Ocean is warming to depth, major concern was raised about the stability of the ice shelfs in the Ross Sea region. The Ross Ice Shelf, the largest on Earth, separates the West Antarctic Ice Sheet, which is largely grounded below sea level, from the open ocean. The loss of this floating natural barrier would put West Antarctica's grounded ice in grave danger of melting and/or detaching, either of which would raise global sea level by up to six meters.

The observation and research of ice shelf and oceanography in Ross Sea region would contribute to improving the understanding of interaction between the ice shelf and the ocean in this area, and its influence on the regional climate pattern, sea ice distribution, water mass characteristics, and the ecosystem. The observation and studies include sea level, glacier, ice-shelf and ice-shelf-ocean interaction.

(3) Marine and Terrestrial Ecosystem

The function of Ross Sea ecosystem has been well-maintained compare to other regions. The top predators, which are still abundant in this region, drives the ecosystem and shapes the food web in a unique way. The Ross Sea is the most productive region in the Southern Ocean. It has the richest diversity of Southern Ocean fishes, an incredible array of benthic invertebrates and massive populations of mammals and seabirds. More than a third Adélie penguins, as well as almost a third of the world's Antarctic petrels and Emperor penguins, makes their home here. Also found here are Antarctic Minke whales, Weddell and Leopard seals, and Orcas, including a population specially adapted to feed on Antarctic toothfish, the top fish predator of the Ross Sea. With the support of the new station, a long-term research and monitoring program on the marine and terrestrial ecosystem could be planned and carried out in this region, together with the efforts of neighbor stations, to enhance the understanding of nature, status and trend of the ecosystem in the Ross Sea Region. The priority of the research and monitoring program will

include:

- Environmental variation monitoring (sea ice, T, S, Nutrients, Chlorophyll, et al).
- Research and monitoring on the marine ecosystem, including plankton, krill and ice fish, penguins and birds, and marine mammals, et al.
- Research and monitoring on the terrestrial ecosystem, including moss and lichens, penguin habitats and their response to the climate;
- Carbon flux (CO_2, particle flux by the sediment traps).

Scientists from the United States, New Zealand, Italy, Germany, and Korea have done a lot of studies on the ecosystem in the Ross Sea. However, there are still uncertainties in the understanding of the ecosystems in the region, for example, the polynya and its role in the ecosystem. The establishment of the new station may provide great opportunities to scientific research and international cooperation, which may contribute to constrain the scientific gaps and uncertainties in the Ross Sea Region and benefit the whole scientific community interested in this region.

(4) Space physics

The location of the new station will be the Chinese first scientific base in the Ross Sea region where the magnetic field lines are open to space. This station will be an ideal platform for high latitude aurora and related phenomena study. On the other hand, this station and Zhongshan, with 10 hours difference in Magnetic Local Time, is an ideal pair of stations to monitor the evolution of space phenomena in the polar region. Two research fields are planned to be carried out:

- Middle and upper atmosphere - mesosphere and thermosphere

The research will focus on atmospheric temperature changes and dynamics of temperature and neutral winds from troposphere to a few hundred kilometers at altitude, particularly in atmospheric waves and climate change dynamics.

- Near-Earth solar wind, magnetosphere, and ionosphere.

The research will focus on Solar Wind-Magnetosphere-Ionosphere Coupling and its implication for space weather. Solar wind energy and momentum are transported into the coupled magnetosphere and ionosphere, causing dynamic phenomena in polar Geospace, such as Aurora, ionospheric disturbances, and scintillation， plasma waves and convection.

(5) Geological Environment evaluation

The location of the new station belongs to the south part of Deep Freeze Range ridge's southward extension. The altitude of Deep Freeze Range inclines northwest to southeast and the highest altitude is 3070m. The location of the new station, situated at the junction between East Antarctic block and West Antarctic block, possesses an advantageous position to investigate the geological evolution histories of these two different geologic bodies. The general aim of the study is to carry on the investigation of different geological evolution histories between East Antarctic block and West Antarctic block.

The new Chinese station is also expected to promote the multinational and multidisciplinary research collaborations in Ross Sea region. Currently, the United States, New Zealand, Italy, Germany, and Korea have operated their research stations in the Ross Sea. We will build cooperation and share observing and monitoring data with other stations. The scientists who are interested in the Antarctic research are also welcome to utilize the facilities of the station based on cooperation agreements.

2. Description of Proposed Activities

Inexpressible Island is a rocky island located in Terra Nova Bay with the latitude of 74°51′00″-74°56′00″S and the longitude of 163°35′00″-163°45′20″E. And the proposed site for the Chinese new station is located on a relatively flat ground in the south of the Inexpressible Island (74°55′S, 163°42′E).

The Terra Nova Bay region is bordered by Cape Washington to the northeast and Inexpressible Island to the southwest in the western Ross Sea region. The proposed site for the China's new station is about 29 km far from the Mario Zucchelli Station, and the distances from the site to Gondwana Station and Jang Bogo Station are about 37 and 38 km respectively.

The CEE takes into account of the activities to be conducted in the following years: construction, operation, and dismantlement of the station, installation, and use of temporary facilities during the construction, and transportation of supplies and personnel to the station. The construction is planned to start in December 2018 and continues for four Austral summer seasons. The station will begin to operate in early 2022.

The station includes the central buildings, research facilities, and maintenance and operation facilities with a building area of 5500 m^2. The station is planned to be used for around

25 years. It will accommodate up to 80 personnel in the summer and 30 personnel in the winter. The expected ratio of science to support personnel is 1:1 in summer and 1:2 in winter.

The design for the new station is based on many light-weight and modular buildings that can be combined in a variety of ways. The modularity allows for user requirements change, easier construction and maintenance. The design incorporates energy efficiency measures by maximum use of natural lighting, the double outer walls, as well as five-time glazed windows, low energy products, and phase change materials.

The stable aerodynamic structure of the central buildings will provide increased resistance against strong winds. Furthermore, the combination of the elevated and slanting structures helps to minimize the amount of snow pile-up around the buildings.

The use of hybrid Solar-Wind-Diesel power supply system will significantly minimize the consumption of fossil fuels and reduce CO_2 emission as following:

- During 2022-2025, if the hybrid solar-wind-power system (100kW solar+100kW wind) successfully installed and operated, the renewable energy will be the priority energy source for the whole station. The reduction of the emission by renewable energy system will be as follows: CO, 0.11 ton, NO_x, 1.55 ton, SO_2, 0.10 ton, PM_{10}, 0.14 ton, CO_2, 64.97 tons as shown in Tab 5-5.
- During 2026-2035, if the hybrid solar-wind-power system (150kW solar+200kW wind) successfully installed and operated, the renewable energy will be the priority energy source for the whole station. The reduction of the emission by renewable energy system will be as follows: CO, 0.20 ton, NO_x, 2.87 tons, SO_2, 0.19 ton, PM_{10}, 0.25 ton, CO_2, 119.91 tons as shown in Tab 5-6.
- After 2035, if the hybrid solar-wind-power system (150kW solar+300kW wind) successfully installed and operated, the renewable energy will be the priority energy source for the whole station. The reduction of the emission by renewable energy system will be as follows: CO, 0.27 ton, NO_x, 3.91 tons, SO_2, 0.25 ton, PM_{10}, 0.35 ton, CO_2, 163.88 tons as shown in Tab 5-7.

A comprehensive high-level sewage treatment and solid waste disposal system will be installed and operated， to prevent wastes and wastewater from affecting the surrounding

environment. All wastes will be stored in accordance with an appropriate management plan, until safely treated or transported outside of the Antarctic Treaty Area. Furthermore, the wastewater will be recycled as much as possible by using the gray water reclamation and recycle system.

3. Alternatives to Proposed Activities

Several alternatives including the no-action alternative, three alternative locations around Ross Sea region and five alternative sites on the Inexpressible Island have been compared.

The opportunities and benefit that may derived from the future Station overweighs the no-action alternative. The new station will provide substantial opportunities and support for Chinese scientists, as well as scientists from other nations, to conduct further studies and monitoring on the characters and effects of the climate and environmental change and the response of both terrestrial and marine ecosystem. The results of such scientific research will contribute to constraining the knowledge gaps and scientific uncertainties and addressing the concerns of Antarctic Treaty System. The new station will also strengthen the potential logistics cooperation with surrounding stations in this region, promoting the overall cost-effectiveness of the operation of these stations, and thus reduce the cumulative environmental impact in the long-term. On this basis, China concluded that building and operating a new station is the best practical option, compared to no-action alternative.

After comprehensive assessment of the suitability for construction and operation of a station, the demand for future scientific research priorities and the minimization of environmental impact, together with the consideration variety of issues including logistics support, engineering and safety, China has chosen Inexpressible Island to build the new station. The new version of the draft CEE has fully considered the comments provided during CEP XVII in 2014, and the merit of shifting the station site to 2 km away south, to reduce the potential disturbance and impact on the penguin habitat.

During the design of the new station, three alternative layouts and shapes of the main buildings have been compared, while considering the construction capacity, convenience for operation, energy saving and safety. The design of the station combines centralization and decentralization. Modules with similar functions are centralized to form an energy-saving layout and provide better operation convenience. The layout of the station is designed to divide

the noisy sections from the quiet ones, provide convenient communication, reduce the impact of snow drift， keep main modules away from hazardous materials, and in the meantime ensure a convenient traffic route.

Marine plus land transportation is better than air plus land transportation, taking into account of the cost, logistics convenience, and on-time performance under uneven weather conditions.

To minimize impact on the environment, considering the quantity of the solid waste during the year-round operation and the difficulty for storage and transportation in Antarctica circumstances, magnetization pyrolysis furnace will be applied as an effective means to deal with the wastes, after a comparison of three waste disposal approaches.

4. Initial Environmental Reference State of the Region

On the Inexpressible Island, where the new research station will be located, there are several typical Antarctic species like Antarctic skuas and Adélie penguins. However, there are no colonies or habitats of any species close to the proposed site within 3.5 km.

According to the data from the automatic weather station Manuela (1988-2012), the wind speed in the proposed region is extremely high and variable. Strong westerly (the main direction is 265.3 degrees) wind can reach a maximum instantaneous speed of 43.5 m/s, the maximum daily average wind speed is 34.2 m/s, and there are more than 117 days with strong wind above 15 m/s in average annually. The annual average temperature and wind speed of the region are -18.5℃ and 12.0m/s, respectively. The extremely low temperature is -42.3℃ (September. 1st, 1992), while the highest temperature is 6.9℃.

The elevation of the island is relatively higher in the west than in the east. There is a north-southward mountain ridge on the west side, while the ground and hilly land in the east. According to the geological, geomorphological and engineering survey in different areas on the Inexpressible Island, it can be seen that the surface material composition of the area is basically consistent：most of the island are covered by moraine gravel, and the general thickness is within 1m with partial deepness; bedrock is dominated by monzonite and granite veins. Through the comparison of different fields, the advantages of the proposed site in the southern part of the Inexpressible Island are obvious. The proximity to the coastline and the low elevation makes it easier for construction and transportation. In comparison with the long and narrow area in the

central concave valley, the characteristics of this site, like the flat terrain, square shape and bigger size is more conducive for the layout of the buildings. The ground exposed to bedrock with consistent lithology with other areas and high rock compressive degree, is favorable for the foundation.

There are three lakes near the proposed site, located in the middle part of the island. Lake 1 is about 546 meter in the perimeter, covering an area of about 21235 m^2. Lake 2 is about 1127m in the perimeter, covering an area of about 49540 m^2. Lake 3 is about 408 meter in the perimeter, covering an area of about 11566 m^2. All the lakes are freshwater lakes.

To fully understand the distribution of lichens and mosses on the Inexpressible Island, an investigation was carried out during the 31st and 33rd CHINARE from December 26th, 2014 to January 4th, 2015 and February 3rd – 5th, 2017. A total of 8 lichens and 1 moss were recorded on the Inexpressible Island. The 8 lichens are *Acarospora gwynnii, Bullia frigida, Candelariella flava, Lecanora expectans, Lecanora fuscobrunnea, Umbilicaria decussate, Xanthoria elegans and Xanthomendoza borealis.* Only one moss is found as *Bryum argenteum.* The distribution and density of the moss and lichens found during the survey has been described in Chapter 4.

An average of ~24 450 breeding pairs of Adélie Penguin were present each season from 1981 – 2012 (Lyver et al. 2014). Approximately 60 breeding pairs of South Polar Skuas were present on Inexpressible Island both within and near the vicinity of the IBA (ANT 178) in 1982 (Ainley et al. 1986), although the precise breeding area has not been defined (IBA, 2015).

Based on the on-site investigation from 2012 to 2017, on the Inexpressible Island, animals found are mainly Adélie Penguin (*Pygoscelis adeliae*), Antarctic Skua (*Stercorarius maccormicki*) and Weddell seals (*Leptonychotes weddellii*). There are about 20000 pairs of breeding penguins in a small bay, along with the northern coast of the island. And the altitude of the nest is from no more than 1m to 33m. There is a separated small colony, including about 130 breeding pairs of Adélie Penguin, in the south of 600m away from the larger one. Around the rookery of the Penguin, about 60 breeding pairs of Antarctic Skua are distributed there. According to GPS data and on-site estimation, the penguin community covers an area of 0.5 square kilometers. In the northernmost part of penguin colony, there is a small lagoon, where small amount Weddell seals appear occasionally. There are some seal bodies nearby, some has already been air-dried.

The penguin colony is located to the northern part of the Inexpressible Island while the

proposed site is in the southern part of the Inexpressible Island. The discovered seal bodies are also located to the northern part of the Inexpressible Island. China has decided to move the planned station site 2km to the south, after a careful assessment of the possible impact and the distance between the southern boundary of the colony to the proposed new station is more than 3.5 km.

5. Identification and Prediction of Environmental Impact, Assessment and Mitigation Measures of the Proposed Activities

A comprehensive environmental impact identification, prediction, and assessment of the station's full life cycle period including the construction, operation and dismantling has been done based on the data and experiences acquired by the survey and provided by references.

In addition, the environmental impact on air, snow, ice, ocean and ecosystem in the period of the station construction and operation was estimated according to major factors including air pollutants, potential fuel and oil leakage, solid waste disposal, wastewater treatment and discharge, noise, man-made light, alien species introduction and ecosystem disturbance.

The main environmental impact of proposed activities includes:

- Atmospheric pollutants from fuel consumption
- Risks of fuel and oil spills from fuel transfer and refueling process as well as the leakage of fuel pipelines and tanks
- Discharge of hazardous and non-hazardous wastes such as construction waste, domestic waste, waste oil, chemical and food waste
- Wastewater from the construction and operation of the station
- Noise from loading and unloading activities, equipment operations and other activities
- Disturbance to the local ecosystem of both marine and land bio-species (e.g., penguins, skuas and lichens)

Prevention and mitigation measures have been identified in the impact matrices to avoid or minimize these predicted impacts.

Hybrid solar-wind-diesel power supply system will be used as a priority energy source to reduce the emissions of air pollutants. The use of fossil fuels will be minimized by increasing renewable energy, maximizing the indoor use of natural sunlight, and recycling the residue heat.

To prevent fuel spills, fuel tanks will be double-skinned and oil impermeable bund wall

will be built around the fuel storage area. For prevention and clean-up of spills, appropriate equipment will be prepared in the station in accordance with associated guidelines such as the guidelines of COMNAP/SCALOP (2003) and fuel manual by COMNAP (2008), etc. Intelligent Monitoring System based on internet technology (including automatic control operations, security monitoring, safety warning, remote data transmission and so on) will be applied to the fuel storage area.

Wastes will be managed according to the Waste Management Manual by COMNAP (2006). All wastes will be separated and securely stored until safely treated or transported outside of Antarctic region for disposal or recycling.

Wastewater will be treated using advanced treatment system. The treated water will be discharged up to the stringent level of wastewater standards e.g., BOD_5 less than 4mg/ℓ and COD_{Mn} less than 6mg/ℓ according to Chinese Environmental Quality Standards for Surface Water (GB3838-2002) (Grade Ⅲ, normally for source water).

Noise will be kept at the level without disturbing the Antarctic skua or penguin colonies by appropriately uses of construction equipment. The maximum noise level of the construction facilities will no more than 85 dB, the noise will decrease to less than 35 dB within 200m from the boundary of the construction site.

Given that there is no area playing an important role as habitats or colonies of a certain species close to the proposed site within 3.5 km, the impact of the station on the surrounding habitats or colonies of certain species, including the important bird areas on the Inexpressible Island (IBA,2015), will be minimized. During the construction and operation period, visitors without clear scientific research or monitoring purposes will be prohibited from getting close to the penguin colony.

6. Environmental Management and Environmental Impact Monitoring Plan

Before the construction, PRIC will formulate the Environmental Management Plan. The Environmental Management Plan will cover the protection measures for penguins and skuas, refueling and fuels transportation, waste collection and disposal, sewage treatment and gray water recycling, equipment, field operation and the tackling of emergencies etc. It will guarantee the safety and orderly progress of various activities, and consequently prevent the occurrence of environmental accidents and minimize environmental impact.

PRIC will establish a station environmental monitoring plan to observe the actual impacts on the surround environment. The monitoring activities can be divided into two categories. One is to monitor the potential environmental impact, to discover as early as possible the disadvantageous impact and take actions immediately to reduce or eliminate such impact. Another is to monitor and record the relevant station operation information to verify the CEE and determine whether the impact conforms to those estimated.

7. Gaps in Knowledge and Uncertainties

Knowledge limitations and uncertainties have been fully considered in this CEE for the Chinese new Station in Ross Sea area， Antarctica, including the unpredictability of environmental conditions such as global climate change and regional weather variation, the changes in future activities of the station, the application of upgraded energy technology, the change of scientific activities, and small adjustments to the construction mode etc. These may lead to the delay of the construction and the slight changes in the scientific research and logistic support in the future.

8. Conclusion

Building on the CEE considered by ATCM XXXVII and CEP XVII in 2014, and taking fully account of the shifting station sites 2 km away from the Adelie penguin habitat with a view to minimize the impact, China conducted this CEE under domestic rules and procedures in accordance with Protocol, and concludes that:

The new station will further contribute to the understanding of, *inter alia,* the character and effect of the climate and environmental changes, and the response of Terrestrial and marine ecosystem in Antarctica, while enhance the collaboration on logistic support with neighboring stations, and provide support for more opportunities and activities of international collaboration and multidisciplinary research.

China has developed the management plan, including the adoption of green technology, the selection of materials and equipment, the engineering process, the operation of the station, and the disposal of wastes, etc., to minimize the impact of the construction and operation of the new station on the environment. The location of the station site will be shifted 2 km away to the southern part of the Inexpressible Island, to avoid the potential disturbance to the Adelie penguins' habitat and local floras, to ensure the adverse impact will be minimized. China will also monitor

any adverse impact on the surrounding environment and emergencies during the construction and operation of the new station in accordance with the Monitoring and/or Emergency Plan.

On the basis above, China concludes that the benefit that will be derived from scientific research and monitoring activities and the opportunities of international collaboration with the support of the new Chinese Antarctic station outweighs the more than minor and transitory impact of the construction and operation of the station on the Antarctic environment and fully justifies this activity proceeding.