Proposed Construction and Operation of the new Chinese

Dome A Station,

Dome A，Antarctica

DRAFT COMPREHENSIVE ENVIRONMENTAL EVALUATION

Chinese Arctic and Antarctic Administration

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Contents

CONTACT DETAILS

The Draft Comprehensive Environmental Evaluation (Draft CEE) for the construction and operation of the Chinese Dome A Station in Antarctica is prepared by Chinese Arctic and Antarctic Administration（CAA）of State Oceanic Administration (SOA) based in Beijing.

The present Draft CEE has been approved and endorsed by Ministry of Foreign Affairs and State Oceanic Administration of People’s Republic of China and made public on 31 January 2008. The document is currently available on CAA website. A paper copy of the Draft CEE will be circulated to each Contracting Party via diplomatic channels at the beginning of February, and submitted as an Working Paper and Information Paper to Antarctic Treaty Consultative Meeting (ATCM) XXXI (2 June 2008, Kiev, Ukraine) and the Committee for Environmental Protection (CEP) XI .

CAA welcomes any comments and recommendations on the Draft CEE.

For further information on this Draft CEE and its contents or if you would like to make any comment, please contact:

Ms. CHEN Danhong, Senior Engineer and Environmental Officer
Chinese Arctic and Antarctic Administration
No. 1, Fuxingmenwai Ave., Beijing, China

Web: http://www.chinare.cn/en/
Tel: 0086-10-68036469
Fax: 0086-10-68012776
E-mail: chinare@263.net.cn

NON-TECHNICAL SUMMARY

(1) INTRODUCTION

The Draft Comprehensive Environmental Evaluation (draft CEE) has been carried out by Chinese Arctic and Antarctic Administration (CAA) of State Oceanic Administration (SOA) of China for the proposed construction and operation of the Chinese Dome A Station. The Draft CEE has been prepared in accordance with Annex I of the Protocol on Environmental Protection to the Antarctic Treaty (1998).The Guidelines for Environmental Impact Assessment in Antarctica (Resolution 4, XXVIII ATCM, 2005) was also consulted. The Draft CEE describes the following contents：

- The construction, operation and maintenance of the Chinese Dome A Station
- The operation during the construction stage
- The transportation process for cargos and personnel to Dome A
- Analysis of potential environmental impacts
- Prevention and mitigation measures to minimize environmental impacts
- Gaps and uncertainties

The Chinese Dome A Station is proposed to be built in the hinterland of East Antarctica at summit in the central part of the major ice dividing of Dome A ice sheet. Its location will be at 80°22′00″S and 77°21′11″ E， with an elevation of 4093 m. It might be one of the highest place under ice cover in the inland Antarctica and the coldest place in the world with a measured annual average temperature of -58.4℃ by auto meteorological station in 2005.The air pressure is between 550-590 hPa. The annual average wind velocity is lower than 5m/s, with the maximum wind force less than 8m/s, and generally 2-4m/s. The proposed location is 1228 km straight away from the Zhongshan Station and the measured distance by snow vehicle is 1280 km. According to satellite altimeter information, the summit of Dome A is a platform in the form of a water drop with an area of 10-15 km wide and about 60 km long extending along the NE-SW direction. The platform is only 2-3m in elevation difference and the highest point is on the north side of the platform.

The Dome A Region is selected as the site for the new station because it is an ideal site for the study on global climatic and environmental changes. Dome A is one of the most suitable site for drilling and obtaining deep ice cores with an age exceeding one million years, a favorable site for monitoring and detecting global background atmospheric baseline environments, a suitable site for astronomical observations and monitoring ozone holes. In addition, Dome A is one of the sites with the greatest challenges in geological survey in Antarctica. The Gamburtsev， the highest mountains under the icecap in East Antarctica is the direct geo-morphological cause for the formation of Dome A. As it is at an elevation of about 4100 meters and has the greatest potential for obtaining geological samples directly under the ice sheet in the broad inland Antarctica， it is a site with the greatest attraction for geological studies. With unique geographic and natural conditions, Dome A can be a good experimental site for science advancement in some special areas such as low temperature engineering materials, telecommunication technologies and human medical sciences under extremities.

In XXII SCAR(1992)，the Chinese scientists offered to undertake the sectional expedition from the Zhongshan Station to Dome A. The Chinese National Antarctic Research Expedition (CHINARE) had carried out five surveys on the inland ice sheet along the Zhongshan Station-Dome A from 1996 to the early 2008 and successfully arrived for the first time at the summit of Dome A in January 2005. The CHINARE has set up a sectional landmark system on the route from the Zhongshan Station to Dome A and carried out multidisciplinary observations and sampling, which accumulated rich experiences in the logistic support in field expeditions. The CHINARE has also accomplished the pre-study for the establishment of the Chinese Dome A Station in Antarctica, including scientific and logistic supports.

Since 2003, SOA of China has organized several meetings of experts to expound and prove the establishment of an inland station in the Antarctic. In 2004, with the approval of the State Council of China, SOA organized pre-project surveys and feasibility studies. In February 2007，the State Council of China approved the proposal to establish an inland station in Antarctica. The SOA has listed it as a higher priority task in the 11^{th} Five-Year Plan (2006-2010) for Polar Expeditions.

In the initial years of operation, priorities will be focused on deep ice core drilling, geological survey to the mountains under the icecap, astronomical observations, ice sheet movement observations, glacier climatic observations, atmospheric background observations, gravitational and geomagnetic observation, human medical studies and medical ensuring service studies. The Station will also be an important knot in the geophysical and meteorological observation network in Antarctica.

During the scientific research, the station will launch simultaneously publicity campaigns and carry out educational programs to popularize among the public, students of various schools the knowledge about the importance and challenges from polar study for the further enhancement of the public understanding of and attention to climatic and environmental changes and for the promotion of the harmonious social and natural development.

The Dome A Station adopts an open-up policy in its operation and studies to provide a platform for the scientists both from home and abroad. A great number of global scientific plans are difficult to be accomplished by just relying on the efforts of the scientists from one or two countries. Rich scientific achievements can be obtained only by joint and integrated efforts through international cooperation. In this view, the previous 3 International Polar Years have set best examples for achieving significant science achievements through cooperation among various countries. China intends to set up the Dome A Station during the period of the 4^{th} International Polar Year. The Station will become an important supportive base for the scientists from various countries to conduct the field surveys on the inland ice sheets in the region of 80^0S and 70-80^0 E.

(2) DESCRIPTION OF THE PROPOSED ACTIVITIES

The construction of Dome A Station is planned to be initiated in the austral summer of 2008/09 and completed in two austral summers of 2008/09 and 2009/10. In at least ten years after its completion of construction, the Dome A Station will be operated just as a summer station.

The total construction area of the Dome A Station is defined by the scientific programs, the number of expeditioners and the inland transport capacity of vehicle convoy. The total construction area will be 623 m^2 ,of which, 204m^2 for the container-type building and 419m^2 for the assembly building，1000m^2 is for the simple storage area and operational yard and 200 m^2 for the solar energy photovoltaic facilities. The short term objective is to accommodate 15-20 people for summering and the long term objective is to satisfy the best utilization by 25 people in the year-round station. However, the daily facilities (including kitchen, sanitary facilities and offices) and emergency shelters will be designed to accommodate more people.

The Station will minimize its environmental and landscape impact during its construction, operation and decommissioning .

The systematic design of the station follows the principles of environmental protection, safety, energy saving and economical.

In terms of material transport, R/V Xuelong will ship materials and personnel along her routine navigation route to the Chinese Zhongshan Station in Antarctica and unload at the existing dock of the Zhongshan Station. Then the inland vehicle convoy will continue the transport to the Dome A Region.

In terms of building material selection，environmental protection and durability will be the two criteria. Major building materials will be compound thermal insulation materials with higher strength, fire-proof, heat insulation, low weight and easiness for processing and a full applicability to low temperature environments. The selection of instruments and equipment is based on the criteria of higher energy efficiency, lower emission and lower noise.

In terms of the mode of construction, upon an integral consideration on the extreme geographical and climatic conditions in Dome A, especially its low oxygen deficiency in the plateau area（the oxygen concentration is equal to that in the area of 5000 m above the sea in the Mt.Nyainqentanglha in China），great difficulties in logistics support and field construction and the need to minimize the environmental impacts, the construction team will combine home-prefabricated containers and assembling structures in the field to minimize workload on site.

In terms of energy consumption，the Station will use clean fossil fuel-aviation kerosene and renewable energy as much as possible. The power generation, heating and operation of the vehicles and mechanical equipment will all be based on the use of aviation kerosene. In addition, the solar energy will be used as much as possible. The solar energy photovoltaic generation facilities will be fixed and adjusted in situ during the construction of the Station so as to realize the complementary power generation by both the electric generator and the solar energy facilities. Hopefully, in 2-4 years the solar energy can be a main power with the clean fossil fuel as a supplementary energy source in austral summer. At the same time, an experiment on heating by solar energy will be conducted. When such a technology is available, the heating at the station in summer can be partly or totally done by solar energy in the long run.

By adopting an integrated energy management regime, it will ensure the use of fossil fuel to be kept at a minimum level.

In terms of waste management, the Station will develop a comprehensive waste management plan. All the solid waste will be classified and properly stored to be taken home by the R/V Xuelong for further treatment. The Station will employ advanced technology for sewage and all liquid waste treatment，the recycle use of the non-drinking water, so as to minimize the residual water , which has been treated and come up to the standard. The Station will keep a complete record on the waste management and ensure it is in accordance with the rules in Annex III of the Protocol on Environmental Protection to the Antarctic Treaty.

In terms of maintenance, the design of the Station demands low maintenance and recycling use. It is designed to be easy not only in repairing, but also in controlling. The operation and maintenance including annual close-down, normal operation and final dismantlement of all the facilities, will be reduced to the lowest extent. The Station will formulate a contingency plan.

In terms of future development, the Dome A Station is designed with a life span of at least 25 years. The design has taken into full consideration of the capacity for extension and upgradeability of the Station and the design of the daily facilities (including kitchen, sanitary facilities and offices) and the emergency shelters will be good for accommodating more people. Moreover, the design of energy supply has taken into consideration the sustainable heating and power supply. Therefore, it will be easy to adopt new technologies to turn the seasonal station to a perennial station with the least efforts in the future.

In terms of dismantlement of the station, the station will be very easy to be dismembered, dismantled and shipped home without any distinct traces in case that the station has to be closed down due to technical causes or the limited life of operation. The dismantling and clearance of the station should be done in accordance with the minimum environmental impact.

In terms of staffing，environment officials and experts will be disposed to guarantee the implementation of the environmental management and monitoring measures and physical and psychological safety of CHINARE team members. At the same time, publicity campaigns for environmental protection will be launched to educate the team members and constructors to guarantee their full understanding of and compliance with the regulations in the Protocol on Environmental Protection to the Antarctic Treaty and its Annexes as well as domestic laws and regulations.

(3) ENVIRONMENTAL IMPACT AND MITIGATION MEASURES

At the initial stage of design of the Station, CAA has fully considered the potential environmental impacts from the construction and operation of the station. The geographical regions under impact include the route (1280 km) from the Zhongshan Station to the Dome A Station, the relay points (place some fuel drums) set en route, the proposed site for the construction, the site for field scientific expeditions, aircraft flight route and the navigational channels of ships.(The marine vessel will follow the regular navigational route and unloading will be done at the existing dock close to the Zhongshan Station, of which, the environmental impact will not be included in this CEE.) The operational activities will be on the whole carried out within the radius of 80 km around the Station.

The direct impact from the major impact sources are identified in the assessment as follows：

- Cumulative air pollutant produced by the combustion of fossils fuels
- Potential contamination of snow and ice by fuel spill or leaks
- The discharge of treated water up to the standards

During the construction of the Chinese Dome A Station, these impacts might be evident as large amounts of cargoes will be shipped to the field and comparatively more people exchange. Meanwhile, the renewable energy system need more time to be put into operation in full function after installation. However, once the Station starts her operation, these impacts will be comparatively smaller; for example, the air emission of pollution will be reduced greatly due to significantly lower use of clean fossil fuels.

The direct impact will be illustrated and summarized in the impact matrices, which will also identify the prevention and mitigation measures to avoid or minimize these predicted impacts.

The Station, by adopting the principles of environmental protection and energy saving in its design and with the development of Environmental Management Plan (EMP) and the Waste management Plan (WMP) , will guarantee lower ecological footprints, lower energy consumption and lower waste production and thus will not cause distinct indirect impacts on the environments. The accumulative impacts during the construction and operation of the Station might come from the discharge of atmospheric pollutants, fuel spill and the discharge of treated water up to standards, which might reduce part of the scientific value at the site of the Station.

In order to minimize environmental impacts, prevention and mitigation measures for environmental impacts have been adopted as early as the design stage. The Station is to use clean fuel—aviation kerosene and renewable energy; to use equipment as much as possible with higher energy efficiency, lower emission and lower noise; to use prefabricated containers to reduce in situ workload; to use recycle water after treatment and to minimize production of all kinds of the wastes. The environmental performance of the Station and logistics will be improved gradually during the operation of the Station. These measures will avoid or minimize environmental impacts and play a positive role in the environmental protection. CAA is obligated to realizing the objectives of the EMP.

In addition, by following the guidelines developed by COMNAP and SCAR, China will develop an Environmental Monitoring Plan (EMP) and record the impacts of the activities of the Station on the Antarctic environments. During the site selection period for the Station by the CHINARE in 2004/05 and 2007/08, a baseline monitoring was carried out. CAA will conduct environmental monitoring programme to measure the actual impacts on the local environments.

The environmental monitoring programme will study the potential impacts from the activities to identify the adverse impacts timely. The environmental management information during the operation of the Dome A Station will be recorded normally, including the recording of the information on the emission of atmospheric pollutants, fuel spill and wastes produced. Once the Station is put into operation, CAA will carry out environmental evaluation and review to assess whether the impacts are the same as predicted and evaluate the effectiveness of the mitigation measures.

(4) GAPS IN KNOWLEDGE AND UNCERTAINTIES

Gaps and uncertainties in the environmental impact assessment of the construction and operation of Chinese Dome A Station have been identified. They include the unpredictability of the weather conditions, changes in the contents of future scientific programs and the related activities in the Dome A Station, the use of newer energy technologies, and the minor adjustment to construction modes. These might lead to the delay of the capital construction works and minor changes in future scientific and logistic support.

(5) CONCLUSION

China will construct and operate the Dome A Station in Dome A region of the inland Antarctica .The Station will make its particular contributions to global climatic observations, the Antarctic geological structure study, environmental monitoring and astronomical observations. It will be an important platform for international cooperation in the Antarctic scientific study. Obviously, the establishment of the Dome A Station is necessary and is of great scientific significance.

Full consideration has been taken into the environmental protection and energy saving in relation to the construction and operation of the Station. Full use will be made of the clean energy sources and the update technology for environmental protection, so as to minimize the impact to the environment. The design of the Dome A Station is scientific, rational and technically practicable. The construction and operation of the Station may only cause minor or transitory impacts on the surrounding environments. Moreover, the implementation of the prevention and mitigation measures outlined in this draft CEE will further reduce such impacts. Therefore, China considers that it is fully justifiable to launch the project.

1. INTRODUCTION

1.1 The Purpose of Constructing Dome A Station

Scientific study shows that the Polar regions play an important role in global climate environmental systems. The Dome A region is the summit of the Antarctic ice sheet. With its unique geographical location, the Dome A region possesses irreplaceable important scientific value and attracts worldwide attention (Fig. 1).

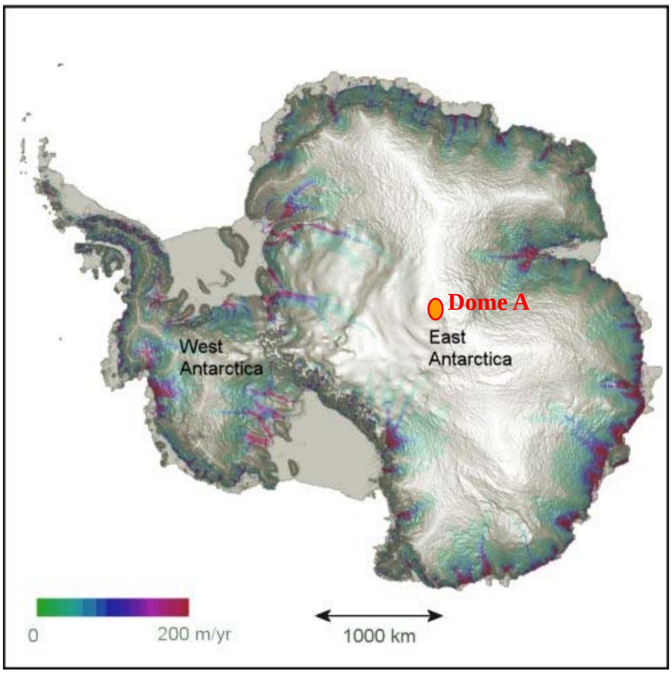

Fig. 1 Geographical location of Dome A
（Source：Hppt://environmentalresearchweb.org/.../1/antarctica）

Located at the summit of ice sheet and with low accumulation rate of ice and snow (0.023m water equivalent/a, Hou *et al.*, 2007）and least ice-flowing impacts, the Dome A region is acknowledged one of the most ideal sites for deep ice cores drilling from Antarctic ice sheet. By studying the climate environmental records with high resolution in the un-deformed glacier body, it is expected to restore the records dated back to the Miocene Period of the Earth (Hou *et al.*, 2007; Xiao *et al.*, 2008). In addition, the deep ice cores from Dome A might provide references to the deep ice core studies in the accomplished or on-going deep drilling projects such as those at Vostok Station, Glacier Dome C and Glacier Dome F.

The Dome A Region is one of the sites in the world with the strongest “heat sink”. At this point, the global average background atmospheric environment might be monitored and detected and useful parameters for improving global atmospheric circulation models might be obtained, and therefore the Dome A region is one of the best sites for observing modern climate environmental background on the earth (Fig. 2). As Dome A is situated near the center of ozone hole, it is also the ideal site for detecting the ozone hole.

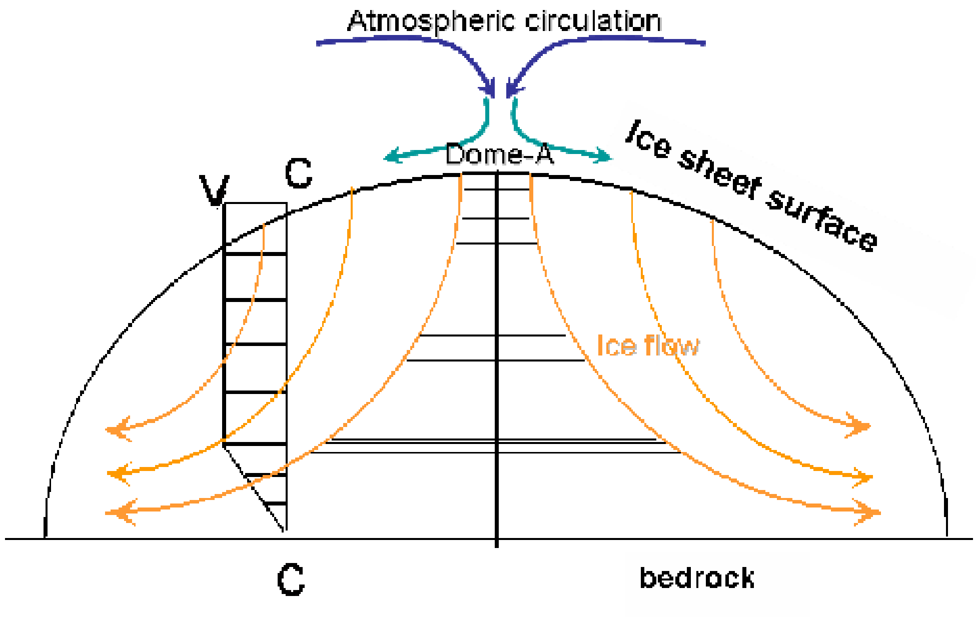

Fig. 2 Geomorphology of Dome A

Dome A region is characterized with excellent atmospheric transparency and seeing, 3 to 4 months for continuous observation, comparatively low wind velocity, rather broad electromagnetic wave band. Space observation conditions are similar to those in the spaceship, but with rather lower cost. Dome A region is regarded as one of the best sites for an observatory in the world. China has cooperated with the United States of America and Australia in the background survey of astronomical observations in Dome A during 2007/2008 (Lawrence *et al.*, 2006).

Dome A is one of the regions with the greatest challenges in geological survey in Antarctica. The Gamburtsev covered by the ice sheet in East Antarctica is the core of the ice-divide and the direct geo-morphological cause for the formation of Dome A (Alberts, 1995). As it is at an elevation of about 4100 meters, with a sharp peak almost piercing the ice surface, so it has the greatest potential for obtaining geological samples directly under the ice sheets in the broad Antarctic hinterland, thus it has become a site with the greatest attraction for geological studies.

The ice sheet materials in the broad area to the north of Dome A ice divide flows to the Amery Ice Shelf through Shelf-Lambert Glacier Basin and further into the ocean from the ice shelf and constitutes the most important ice sheet- ice shelf- ocean substance equilibrium system in the East Antarctica as well as the most important component in the ice sheet –ocean substantial equilibrium system in the East Antarctica. The integration of this system with the atmospheric and sea ice process builds up an integrated ice sheet-atmosphere-sea ice- ocean system. The key study areas such as the Prydz Bay - Amery Ice Shelf-Lambert Glacier Basin and Dome A are of demonstrative significance to the studies of ice sheet substantial equilibrium and sea level changes in the Antarctic.

There exist at the peak of Dome A some natural phenomena seldom known to people, such as the deposition mechanism of substances, absence or not of troposphere. Therefore, Dome A will be a good study site for new scientific discoveries.

The unique geographical and natural conditions in the Dome A Region will provide a good experimental site for other significant scientific projects and for technical progress in some special areas such as low temperature engineering materials, telecommunications and human medical sciences under extreme conditions.

However, with harsh climate environmental conditions, the Dome A Region has been regarded as “an inaccessible area” for human beings since the International Geophysical Year of 1957-1958 and very few countries have carried out scientific activities in this area. Therefore, the scientific studies in that area to some extent, are blank on the whole.

In order to meet the challenge and to promote the progress of the scientific study in this region, CAA has organized five surveys on the inland ice sheet along the Zhongshan Station-Dome A from 1996 to the early 2008. The expeditions carried out systematic science surveys and successfully arrived at the summit of Dome A in January 2005 for the first time(Fig.3). Since 2003, SOA has organized several meetings of specialists to expound and prove the establishment of an inland station in the Antarctic. In 2004, with the approval of the State Council, SOA organized pre-project surveys and feasibility studies. In February 2007，the State Council of China approved the proposal to establish an inland station in Antarctica. SOA has listed it as a higher priority in the 11th Five-Year Plan(2006-2010) for Polar Expeditions.

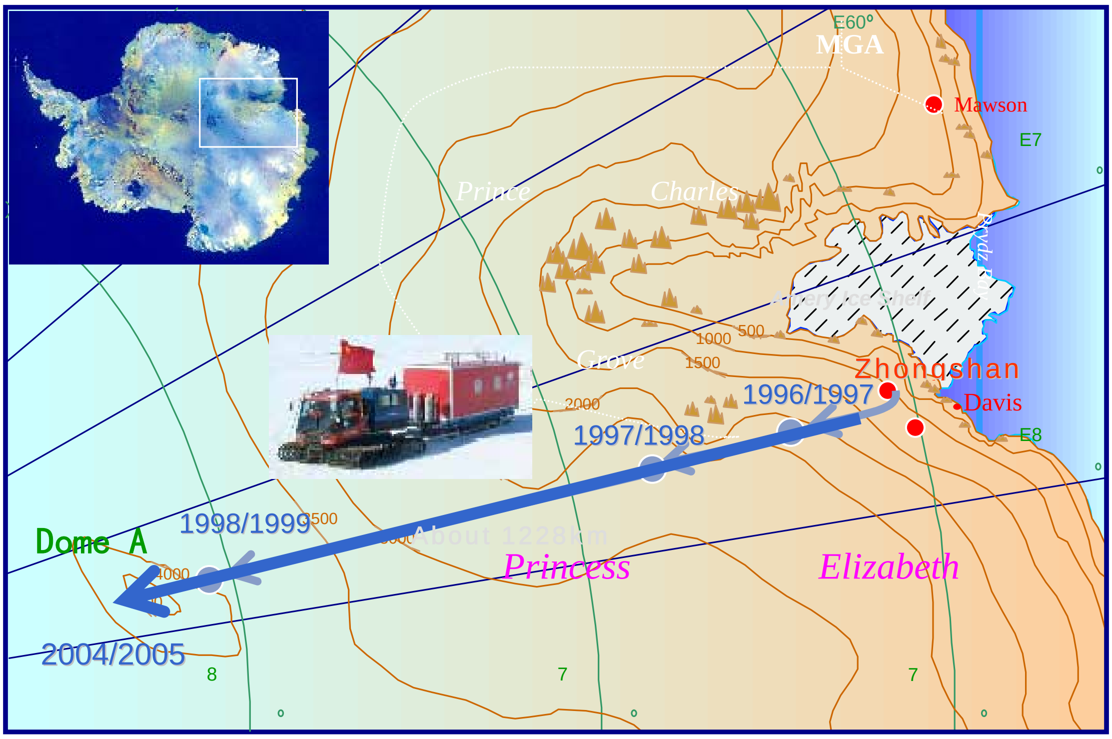

Fig. 3 The route line of CHINARE from Zhongshan Station to Dome A

With the deep-going scientific study in Antarctica, Dome A region has attracted great attention from the Antarctic scientists worldwide. Among the scientific action plans proposed by various countries for the recent International Polar Year，some involve the Dome A Region. In the International Workshop on Dome A Expedition during IPY held in May 2007 in Shanghai, scientists from Australia, Germany, and the United States exchanged views on the scientific activities to be undertaken in the Dome A region and carried out discussions on how to develop scientific activities and strengthen international cooperation in the Dome A region.

The Dome A Station is proposed to be built in Dome A region, the highest area of the major ice sheet in Antarctica.(Fig. 4) As measured by the 21st CHINARE, the highest elevation of the Dome A is located at 80°22′00″S and 77°21′11″ E，with an elevation of 4093 m. It might be one of the coldest place in the world with an observed annual average temperature of -58.4℃. This highest place is 1228 km straight away from the Zhongshan Station (69°22′24″S, 76°22′40″E) and the actual distance by snow vehicle will be 1280km. The thickness of ice changes greatly from 1500m to 3000m with the difference of underlying features and concentrates in a small area. Meanwhile, as detected by the ice radar, the snow layer in this area is level and stable. According to the satellite altimeter information, the summit of Dome A is a platform with an area of 10-15 km wide and about 60 km long in the form of a water drop extending along the NE-SW direction. The platform is only 2-3m in elevation difference and the summit is on the north side of the platform.

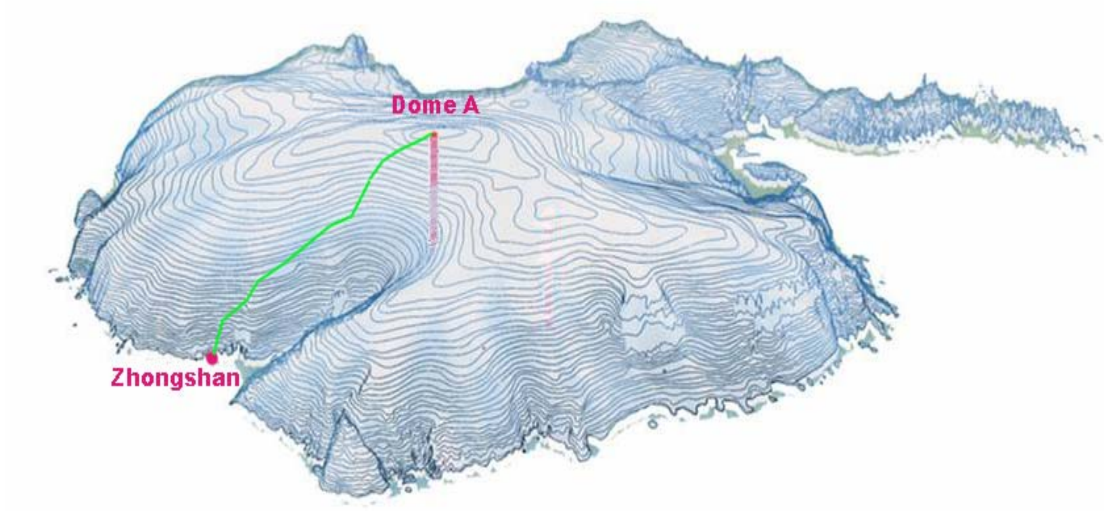

Fig. 4 Topography of East Antarctica

The design and the operation of the Station will be in compliance with regulations of the Protocol on Environmental Protection to the Antarctic Treaty and the relevant Chinese regulations concerning environmental protection. Its designing principles are based on environmental protection, safety, energy saving and economy. The Station will be used currently as a summer station, and the designed lifetime of the station will be at least 25 years.

However, the design of construction facilities and power and heat supply system has taken into consideration the needs of a full year station, so only with very litter effort, it can be upgraded into a full year station. If dismantling of the station is required, no obvious remnants of the Station will be left on the site.

The construction of the station is proposed to start in the 4th IPY. China would try to use as much new technologies as possible in construction and operation of the Station. China wishes to make the Station a platform for scientists worldwide engaged in the Antarctic study. The Station will be a supportive base for international field surveys on ice sheet in the region of 75^0～85^0S, 70^0～80^0 E.

1.2 History of the Chinese Antarctic Activities

Chinese Antarctic activities were initiated in the 1980s. During that period, China sent scientists to Australia and some other countries to participate in their Antarctic programs and expedition activities. They thus learned knowledge of Antarctic environment and gained experience in Antarctic studies. These international cooperation helped China a lot in establishing Chinese Antarctic stations and lunching its Antarctic programs (Stone, 2007).

In November 1984, China sent its first Antarctic expedition to Southwest Antarctica and the expeditioners landed on King George Island in December of the same year. A ceremony for the foundation of the Great Wall Station (62°12′59.″S, 58°57′52″W Fig. 5) was held. In February 1985, the Great Wall Station was successfully built up and some expeditioners spent the winter there in the same year. In November 1988, China dispatched an expedition to the East Antarctica and built up the second Chinese Antarctic Base, the Zhongshan Station in the Miller Peninsula in February 1989 (69°22′24.″S, 76°22′40″E Fig.5). Up to the present, China has successfully organized 24 Antarctic scientific expeditions and sent in total more than 3000 expeditioners including a certain number of scientists to the Antarctica for scientific survey and logistic support, gradually forming a management system of “one ship and two stations”, namely, with R/V Xuelong (Fig. 6) providing logistic support to the Great Wall Station and the Zhongshan Station (Fig. 7). Both stations have become not only good bases for the scientists to carry out scientific study in Antarctica but also a window for China opening to the outside world to cooperate with other countries in the Antarctic scientific study.

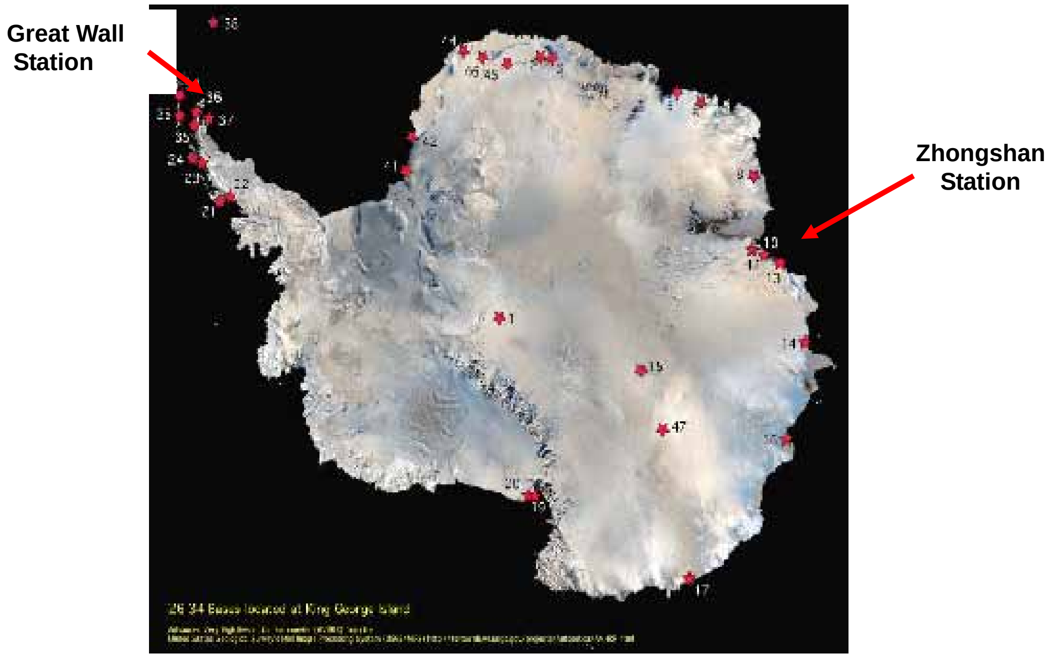

Fig. 5 Geographical Location of the Great Wall Station and the Zhongshan Station
（Source: www.scar.org/information/winteringstations/2004/）

Fig. 6 Chinese R/V Xuelong (Left is the old one, and the right is the newest one)

Fig. 7 China’s Great Wall Station（Left）and the Zhongshan Station (Right）

Over the last 20 years, the Chinese Antarctic scientists have carried out multiple disciplinary observations and surveys in glaciology, oceanography, atmosphere science, biology, geology and mapping (Fig. 8). They have collected a great amount of precious samples, data and information from multi-years of arduous field surveys under harsh conditions. In terms of geological studies, a deepened understanding of the crust evolution in the East Antarctica has been scored through the studies on the pan-African tectonic structure. At the same time, with arduous efforts in the past years, the CHINARE have collected more than 9 000 pieces of meteorolite samples and have laid down a foundation for further studies on the movement of celestial bodies. The ecological studies took Antarctic krill as an important indicator and combined it with environmental and climatic changes. The glaciology studies have initially accomplished the detection on the basic observation profiles in the area from the Zhongshan Station to Glacier Dome A in China's 9^{th} and 10^{th} Five-Year Plan Periods, which have laid down a foundation for China's studies on inland ice sheets and the construction of a new station in the inland Antarctica. Base on this, the interaction between Emery ice shelf and ocean has been carried out and promoted a more broad combination between glaciology and the international frontier sciences. In the solar-terrestrial studies, a cooperative project between China and Japan for medium and long-term observation was implemented from which a group of important phenomena such as afternoon aurora was discovered and proved. The project further promoted the construction of the Arctic observation station which is mutually conjugated with the Zhongshan Station by taking the observation in the Zhongshan Station as basis thus promoting the joint observation of the solar-terrestrial space from the South and North Poles. In the studies on recent modern environmental evolution in the Antarctic, the geochemical index elements integrated study was proposed with the scale of thousand years to study the evolution of important biological populations. In addition, much progress has been made in climate studies, landform mapping, earthquake observation and physical oceanography survey of the Southern Ocean. These scientific studies have enriched the understanding of the ice and snow world of the Antarctica and made contribution to the conservation of global ecological environment and the common prosperity of the human society in the world.

Fig. 8 CHINARE team members in the field survey

At present, China is actively participating in the 4^{th} International Polar Year activities and has developed China’s Action Plan for the International Polar Year. The Plan consists of mainly PANDA Plan in the Antarctic (Fig 9), Scientific Survey Plan in the Arctic Ocean, the Plan for International Cooperation, the Plan for Sharing of the Data and Information, Plan for Science Popularization and Publicity, and the Plan for Establishment of Dome A Station. These scientific plans are also the major contents of China’s Polar Plan for the 11^{th} Five Year Plan. China hopes to deepen the study on polar and global climatic environmental changes by the implementation of these plans and makes contribution to better environmental conservation, promotion of sustainable development and further enhancement of the scientific quality of the public.

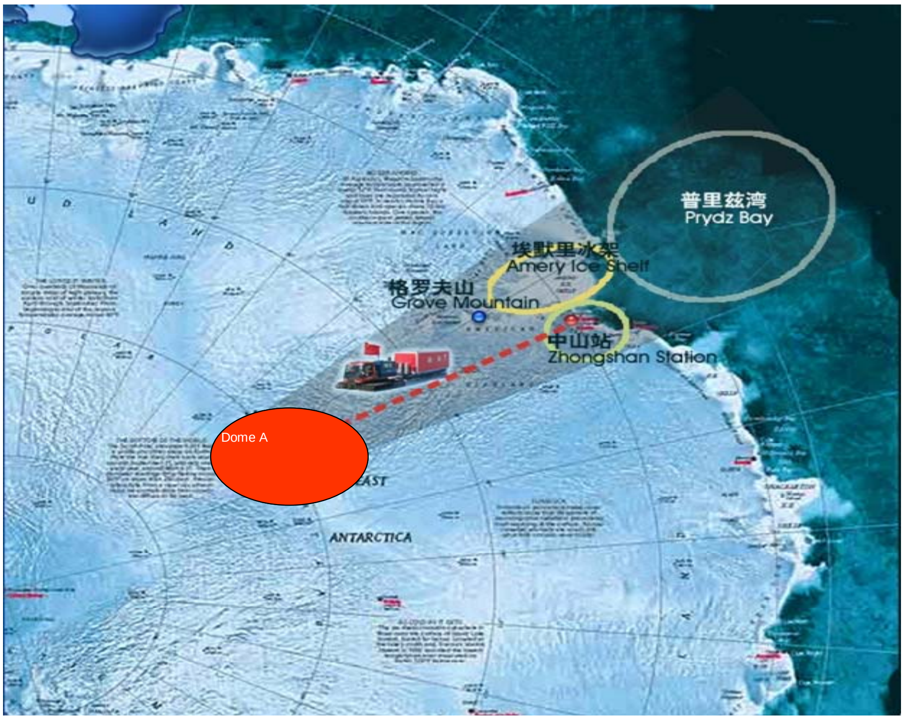

Fig. 9 Diagram for the implementation of PANDA Plan

1.3 Science Programs for the Dome A Station

The new Station that China will build during 2008~2010 will focus on the study of the role of Antarctica in the global climatic environments by making full use of the unique geographic location of Dome A and by undertaking multiple disciplinary science activities, so as to provide service to the development of the whole human society. The scientific programs of the station reflects the major science themes of IPY：

- Study on the response and feedback of Antarctica to global climate-environment changes and improve projection of the future change
- Determine the present environmental status of the polar regions
- Investigate the frontiers of science in the polar regions(such as deep ice core studies and sub-glacier geological studies)
- Use the unique vantage point of the polar regions to develop and enhance observations from the interior of the earth to the sun and the cosmos beyond（such as studies on geology, atmospheric environment, astronomy and upper atmospheric physics）

Obviously, without international cooperation it is impossible to accomplish many significant science programs by just relying on the efforts of the scientists from one or two countries. International Polar Year provides a good opportunity for scientists from various countries to conduct joint large scale science programs. China takes international cooperation as an important link in China’s Action Plan and endeavors to incorporate various scientific programs into international cooperation. China will make the Dome A station a platform and open it to scientists from various countries for scientific studies.

The science programs to be undertaken at Dome A Station are important parts of China's Action Plan for IPY and 11^{th} Five Year Polar Expedition Plan approved by SOA. The location of the Station is suitable for the multidisciplinary studies on the Earth System. It will be an important knot on the Antarctic geophysical and meteorological observation network. The design of the Station follows the principles of sustainable development, environmental protection, safety, energy saving and economy. Although the station is built for summer only for the time being, however, the design of construction facilities and power and heat supply system has take into consideration the needs of a full year station, so only with very small efforts, it may be upgraded into a full year station. Therefore, the project is in accordance with a long-term objective that Antarctica is the last natural reserved area on the Earth and it should be used for scientific purpose and peaceful use only.

1.3.1 Glaciological observation and the project of deep ice core drilling at Dome A

Antarctic ice sheet preserves unique records of the climate changing system on the Earth. The paleo-environmental records have become one of the important scientific study areas on the global changes in the past decade. The studies on the records in the ice cores have indicated that the rhythm of the climatic change changes with time and moves from gradual changes to sudden changes,. The results from the relevant studies have brought about a revolutionary progress in the concepts of the historical evolution and stability of the ice sheets, the climatic and environmental evolutionary series, the rise and fall of sea level and the variations in the oceanic thermohaline circulations.

The unique natural conditions of the Dome A region have provided an important object for observation and studies of the global changes. The thickness of ice plateau in Dome A is above 3000m and the accumulation rate is lower than those of other plateaus. It is believed through preliminary study that there exists the paleo-ice core with age between 1.2~1.5 million years. Therefore, carrying out the deep ice cores drilling in the Dome A region may reconstruct the evolutionary series in the multi-temporal scales of the climatic system on Earth in the past million years or longer. It will play an active role in understating the mechanism of climatic changes on an orbit scale, and the movement and extension and retreat of the ice sheet system as well as the demonstration and illustration of the role of the Antarctica in the global changes (Fig 10).

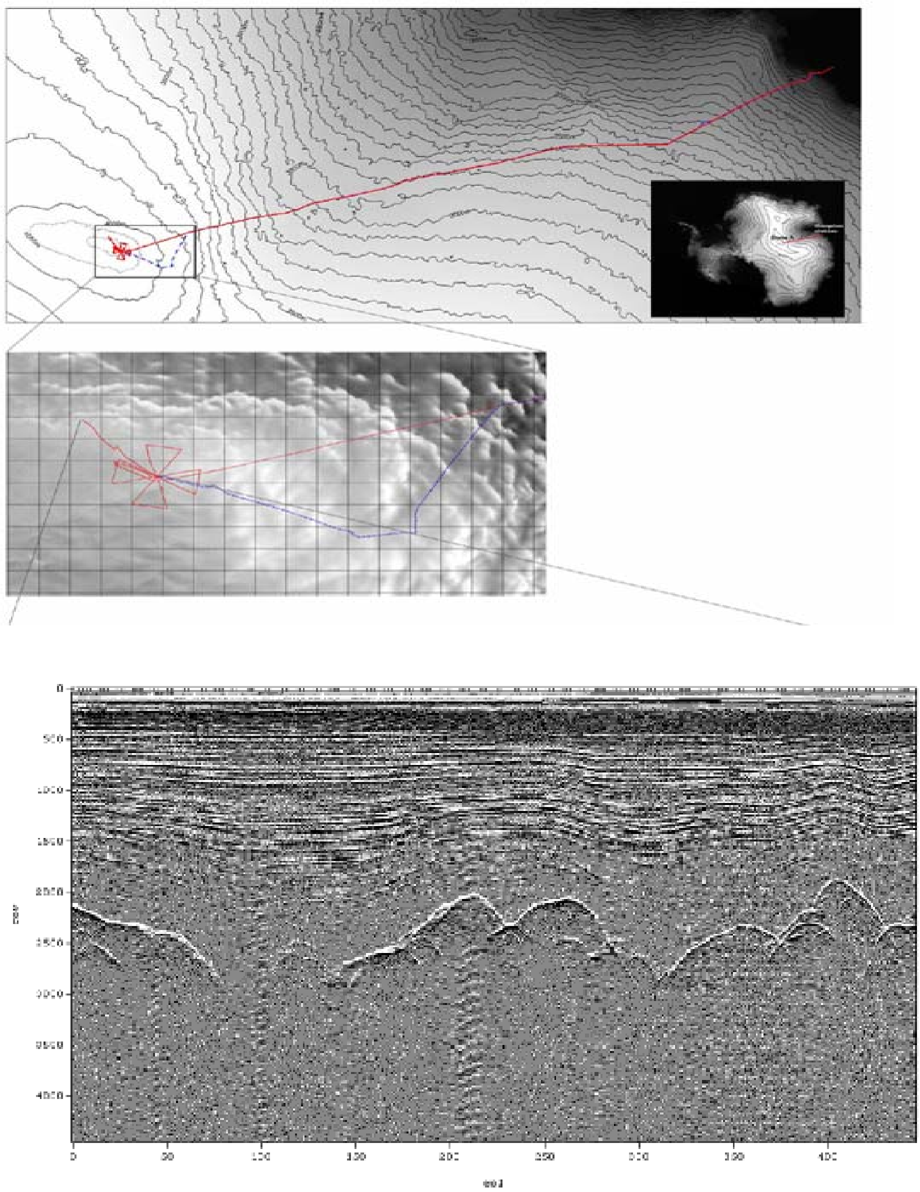

Fig. 10 Echo–sounder detection shows that the Dome A ice sheet is characterized
by horizontal distribution layers which is ideal site for deep ice core drilling

Integrated Glaciological Observation System：It will take 3-8 years to build up a complete observation system for glacial meteorology, atmospheric and snowing environment, substance equilibrium, ice sheet movement and rapid ice flow monitoring and the unmanned ground receiving system for satellite monitoring of ice sheet changes, on the basis of which to establish a long-term observation and monitoring system with hi-technology and broad coverage.

Deep Ice Core Drilling: This includes drilling, in situ description of ice cores, sectioning and multi-parameter physiochemical analysis of ice cores and storage of at least 1500 meters of ice core. After completion of ice core drilling, a continuous observation on multi-parameters in the drilled holes will be made for 5~8 years to obtain observation information and carry out sub-glacier geological drilling in the ice core holes.

1.3.2 Program on Gamburtsev Sub-Glacier Mountains

The main body of the Antarctic continent used to be the core unit of the super-continent in the geological history. However, as over 98% of the area in the Antarctic continent is covered by ice or snow, understanding of the inner geological and tectonic distribution in the broad continent of Antarctica could only come from the studies on scatted outcropped rocks along the coast of Antarctica and a few inland mountains. This illustrates that the understanding about the craton in East Antarctica might be very incomplete and the information for basic geographic elements in the inner part of the eastern section of Antarctica is still much needed.

Gamburtsev sub-glacier mountains run about in the South-North direction at less than 100 km away to the north of Dome A in East Antarctica. As a continent pieced together in the pan-African tectonic period, the most distinct geomorphological features of the continent of East Antarctica must have been related to its formation. Therefore, Gamburtsev sub-glacier mountains might be an extension to the Antarctic inland of the Prydz Orogenic Belt during the pan-African tectonic period.

The Gamburtsev sub-glacier mountains program consists of the detailed geomorphological survey in the core area of Gamburtsev sub-glacier mountains which will choose a best point for drilling and sampling; carrying out geophysical investigation such as geomagnetic and gravitational surveys to define the type of rock of the sub-glacier mountains and the composition and structure of the lithosphere; through sub-glacier geomorphological survey to define the moulding and formation process of the sub-glacier geomorphology and determine where the most ancient glacier and sub-glacier lake could be identified in Antarctica; based on rock core drilling and ice core drilling to conduct inland geological and structural study, paleo-climatic and paleo-environmental study in the inland Antarctica.

1.3.3 Aircraft remote sensing and unmanned observational network system

Recent years have witnessed the development of remote sensing technologies, various remote sensors to the Earth are emerging and aircraft remote sensing has been playing a more and more important role in the Polar observation.

The unmanned observation network system will be mainly based on radio sensing technology or “intelligent dust” technology with low energy consumption, low cost and auto-adjusting features and has been applied successfully in various environmental monitoring. At present, some countries have succeeded in the application of the technology to polar monitoring.

The objective of the project is to set up a continuous monitoring network system for ice and snow environment by aircraft remote sensing and unattended observation. Aircraft remote sensing technology obtains the geophysical, glacial and atmospheric information above and under ice on a large scale and unmanned observation network can automatically assemble the net and concentrate into the base station continuously the observation data from various observation points and send them back to the Zhongshan Station or homeland China.

1.3.4 Astronomical observation

Dome A region has unique natural conditions favorable for astronomical observation, such as excellent atmospheric transparency and seeing, comparative longer continuous observation opportunity, lower wind velocity and broader electromagnetic wavelengths. These conditions are very important for approaching the solutions of some modern astronomical studies, such as the monitoring and pre-warning of special targets and detritus, the study on the early cosmos and the essential of the dark energy in the cosmos, the origins of quasi-Earth planets which are related to the studies on the origins of life, the Earth, the stellar system and the cosmos.

According to the program, during IPY between 2007-2009, the astronomical observation and a series of astronomical atmospheric observation will be carried out during two expeditions and winter time by automatic observation system and to accomplish the measurements of the conditions for astronomical observation. During the construction stage of the Dome A Station, instruments for visible, infrared and millimeter wave lengths observations will be installed. As a long-term objective, a systematic selection of a site for observatory in the Dome A region will be conducted through broad international cooperation and an observatory will be build up in the Antarctic plateau to provide an excellent observation platform for the astronomical study.

1.3.5 Physical geodetic measurement and remote sensing information application

The Dome A region is short of information on detailed mapping and the state of ice sheet movement and this information is an important basis for multi-disciplinary scientific study. During the construction and operation of the Dome A Station as well as the field survey in the region, China will conduct studies on geodetic measurement and remote sensing information application, aiming at the construction of “digital Dome A”, including obtaining the multi-layer digital information about the ice and snow environment and sub-glacier base rock with multi-source and various spatial and temporal distribution features by the integrated satellite, aircraft and ground observation system for the building of a dynamic analysis system for the “digital Dome A” and providing a network platform to share with the geographic information with multidisciplinary integrated surveys and studies.

The program consists mainly of the building of a unattended GPS tracing station in Dome A, a digital model of elevation above and under ice topography in the Dome A region, a service platform to provide digital map information relating to expedition route between Zhongshan Station and the Dome A region and the three-dimensional digital landscape with high resolution glacier images, etc.

Among all this, the unattended GPS tracing station in Dome A will not only provide geographic information and digital supports to the multi-disciplinary surveys in the Dome A region, but also precisely monitor the dynamic process of China’s Dome A Station and obtain digital spatial information from multiple sources for the remote sensing application and the atmospheric environmental studies on high ionosphere. The reconstruction of the three-dimensional landscapes with high resolution from the Zhongshan Station to Dome A Ice Sheet and the development of digital elevation model (DEM) of sub-glacier topography are of great significance in science either to the safe expedition and surveys on the inland ice sheet, or to the studies on the formation mechanism of the ice sheet at the summit of the Antarctica and the tectonic structure of the Gamburtsev sub-glacier mountains.

1.3.6 Formation of the geomagnetic chains from the Zhongshan Station -Dome A

The Polar regions are the windows of the Earth open to the space and play very important role in the monitoring of the space. The spatial weather effects are always most sensitive to the Polar regions and happen earliest there. The environmental monitoring of the polar space is of great importance to the study of the solar wind-magnetosphere-ionosphere coupling and the forecasting of disaster weather in the space.

The program taking the Zhongshan Station as the core station, arranges and establishes a chain of magnetometers along the expedition route between the Zhongshan Station and Dome A . This is a chain for science observation in the high latitude region and near the latitudinal circle of the magnetospheric crevice in the polar region and is of positive significance to the geomagnetic observation, the studies on the spatial plasma wave, the traveling convection vortex (TCV) studies and the inversion studies on the ionospheric currents. The geomagnetic observation chain will be an integral part of the geomagnetic station network on the Antarctica for data sharing and for the provision of most convenient conditions for scientific study.

At the same time, the geomagnetic observation chain has a conjugated station near the Yellow River Station in the Arctic which is very suitable for a series of south-north conjugated studies on space physics such as ULF waves, TCV and the absorption of cosmos noises.

1.3.7 Medical studies

The extreme environments in Antarctica exert various impacts on human physiology and psychology. The Dome A region is characterized by such harsh factors as low oxygen, bitter coldness, strong ultraviolet, difficult access and greater risks which all have rather great impact on human body. The significance of the program lies in guaranteeing that the expeditioners selected exclude the ones sensible to plateau diseases; enhancing the tolerance and adaptability to low oxygen and the ability to deal with the interaction between low oxygen and coldness on human body; mitigating the reduction of diseases-resistant ability due to psychological retardants by adjusting the immune and endocrine functions of human body; studying the physiological impacts of ultraviolet, round-the-clock rhythm and geomagnetism, and heir prevention and control. These studies will provide references to the medical sciences in the special environments such as high mountains, aerospace and seafaring.

The program will use advanced detection instruments and devices to start the study from the whole body, key organs (such as heart, brain, lung and blood) , society－psychology－immunology－nerve－body fluid－endocrine network modulation and extends to the studies on the environmental genomics, the exploration of the sense and adaptation and their mechanism of team members to various environmental stress sources in the fields of physiology, disease physiology, biochemistry, protein and gene. It aims to identify the distinct physiological and molecular biological indicators, such as relevant gene sensible to low oxygen, for the low oxygen sensible population，to develop an individualized assessment system for low oxygen sensibility, to selected qualified team members by screening the low oxygen sensible population, to enhance the tolerance and adaptability to low oxygen and the ability to deal with the interaction between low oxygen and coldness on human body and to provide a scientific basis for the development of prevention and control countermeasures.

1.3.8 Atmospheric vertical structure and ozone observation

The Dome A region is at the vicinity of the Antarctic climate centre which is featured by air temperature and atmospheric circulations. The establishment of an observation system for atmospheric structure and ozone vertical distribution and related studies is of special significance for the understanding the ozone holes over Antarctica and global ozone deficit as well as the structure of weather, climate and atmosphere and the relationship between Antarctica and global changes.

The observational studies on the atmospheric structure and ozone distribution in Antarctica normally use such apparatus as laser radar, radiosounder, wind-temperature profiler as well as TMT anchored boats and meteorological towers. Based on the geographical conditions and logistic supportive conditions in the Dome A region and the needs for the studies on the atmospheric structure and ozone distribution in the inland Antarctica, as the first phase for the construction of the Station and atmospheric observation system, China will cooperate with relevant countries in carrying out ozone observation by radiosounder and the observations over small meteorological towers (Fig. 11).

Fig. 11 Automatic Meteorological Stations established jointly by China and Australia in Dome A

1.3.9 Education and publicity

While the expedition activities are carried out at Dome A Station, the educational program will be launched to popularize among the public, students from various schools the knowledge about the importance and challenges from polar studies for the further enhancement of the public understanding of and attention to climatic and environmental changes and for the promotion of the harmonious social and natural development.

The Dome A Station adopts an open policy in its operation and in scientific study, to provide a platform for the scientists from home and abroad and an important supportive base for scientists from various countries to conduct field surveys on inland ice sheet in the region of 75^0～85^0 S, 70^0～80^0 E.

1.4 The Future Development of Dome A Station

The Dome A Station is planned to start its construction during the austral summer of 2008/09 and the construction will be accomplished in two austral summers of 2008/09 and 2009/10. In the decade after the completion of the construction, the Dome A Station will be operated only as a summer station.

The design has taken into full consideration the capacity for extension and upgradeability of the Station and the routine facilities (including kitchen, sanitary facilities and offices) and the emergency shelters are suitable for accommodating more people. Moreover, the design of energy supply has taken into consideration the sustainable heat and power supply. Therefore, it will be easy to adopt new technologies to turn the seasonal station into a perennial station with the least effort in the future.

The designed minimum operation lifetime of the Dome A Station is 25 years, which is longer than the existing two perennial Chinese stations. When it approaches the end of its lifetime, an assessment will be made to determine whether it could be repaired and prolonged for service. The design scheme also takes into consideration the dismantling when the station is out of service. The Dome A Station will be very easy to be dismembered, dismantled and shipped home without any distinct traces in case that the station has to be closed down due to technical causes or needs. The dismantling and clearance of the station will be done in accordance with environmental impact assessment procedures.

1.5 The Preparation and Submission of the Draft CEE

The Draft CEE of the Chinese Dome A Station in Antarctica is prepared by CAA based in Beijing , with support and input from China's institutions of environmental impact assessment, the institutions for designing Dome A, technical support units and scientists. The Draft CEE has been approved by China's Ministry of Foreign Affairs and SOA.

The present Draft CEE has been made public. The document is currently available on the CAA website (http://www.chinare.cn/en/)and comments from the public are welcome. The

Chinese Government will circulate the Draft CEE to each Party 120 days before ATCM XXXI. The Committee for Environmental Protection will review the Draft CEE at ATCM XXXI by following the procedures of the Protocol on Environmental Protection to the Antarctic Treaty.

After the review of the Draft CEE by ATCM XXXI, CAA will finalize the CEE and make it public at least 60 days before the commencement of the proposed activity and the public might make comments via the same channel as that for the Draft CEE.

1.6 Laws, Standards and Guidelines

During the preparation of this Draft CEE, full reference has been given to some international public laws such as the Antarctic Treaty, the Convention on Biological Diversity, the Kyoto Protocol on Climate Change, the Protocol of the International Convention for the Prevention of Marine Pollution from Ships (MARPOL 73/78) and the Convention on the Dumping of Wastes at Sea as well as China's relevant laws and regulations. The guidelines and documents for environmental impact assessment developed by the COMNAP and SCAR have been followed in the course.

1.6.1 International laws, standards and guidelines

The Antarctic Treaty (1959), which came into force in 1961, and its measures, resolutions and decisions and a series of conventions relevant to Antarctica have shaped up the Antarctic Treaty System, which includes the Convention for the Conservation of Antarctic Seals (CCAS 1972), the Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR 1980) and the Protocol on Environmental Protection to the Antarctic Treaty (Environmental Protocol, 1998).

China acceded to the Antarctic Treaty in 1983 and obtained consultative party status in 1985. China ratified the Environmental Protocol in 1994 and has implemented it since its coming into force in 1998. The Protocol set out environmental principles, procedures and obligations for the comprehensive protection of the Antarctic environment and its dependent and associated ecosystems. Compiling and submission of this CEE is an important act of China to implement her obligations under the Protocol.

The international conventions such as the Convention on Biological Diversity (1993) ,the Kyoto Protocol on Climate Change (2005), the Protocol of the International Convention for the Prevention of Marine Pollution from Ships((MARPOL 73/78) and the Convention on the Dumping of Wastes at Sea(1975), to which China has become a contracting party, have established in different aspects the requirements for environmental protection and sustainable development and have become important bases for the development of the Draft Comprehensive Environmental Evaluation (Draft CEE) for the construction and operation of the Chinese Dome A Scientific Research Station.

The Council of Managers of National Antarctic Programmes (COMNAP) and the Scientific Committee on Antarctic Research (SCAR) are two international organizations involved in the Antarctic affairs. They have developed relevant guidelines and documents regarding the activities in Antarctic. Among them, the draft CEE has made reference mainly to the Guidelines for Oil Spill Contingency Planning (COMNAP, 1992), the Environmental Monitoring Manual in Antarctic (COMNAP, 2000), The Technical Standards for Environmental Monitoring in Antarctica (COMNAP, 2000), the Practical Guidelines for the Development and Design of Environmental Monitoring Programs (COMNAP, 2005b) and the Guidelines for Environmental Impact Assessment in Antarctica (COMNAP/ATCM, 2005a) and etc.

1.6.2 Domestic laws, standards and guidelines

The construction and operation of Dome A Station will enforce strictly relevant domestic environmental laws, and standards as well as technical guidelines for environmental impact assessment, as listed below：

（1） Legal Instruments

- PRC Law on Environmental Protection , 26 December 1989
- PRC Law on Solid Waste Prevention and Control , 30 October 1995
- PRC Law on Water Pollution Prevention and Control , 15 May 1996
- PRC Law on Environmental Noise Prevention and Control, 29 October 1996
- PRC Law on Energy Saving, 1 November 1997
- PRC Law on Marine Environmental Protection, 1997
- Regulations Concerning the Management of Hazardous Wastes Transfer Bills, 31 May 1999
- Implementation Rules of PRC Law on Water Pollution Prevention and Control, 20 March 2000
- PRC Law on Atmospheric Pollution Prevention and Control, 29 April 2000
- Policies on Urban Sewage Treatment and Pollution Prevention and Control Technologies, 13 July 2000
- PRC Law on Environmental Impact Assessment,28 October 2002
- PRC Law on Renewable Energy, 28 February 2005
- National Scheme for Emergent Environmental Incidents, 24 January 2006
- Regulations Concerning Environmental Monitoring Management, 25 July 2007

（2） Environmental Standards

- PRC Standards on Surface Water Environmental Quality, GB3838-2002）；
- Water Quality Standards for Using Regenerated Water for Urban Miscellaneous Uses,（GB/T18920-2002）

（3） Environmental Assessment Guidelines

- PRC Technical Guidelines for Environmental Impact Assessment-Principals (HJ/T2.1-1993)

- PRC Technical Guidelines for Environmental Impact Assessment-Atmospheric Environments (HJ/T2.2-1993)
- PRC Technical Guidelines for Environmental Impact Assessment-Aquatic Environments (HJ/T2.3-1993)
- PRC Technical Guidelines for Environmental Impact Assessment-Acoustic Environments (HJ/T2.4-1995)

1.7 Project Management System

Under the direct leadership of SOA, and with the support from the Ministry of Foreign Affairs, the State Development and Reform Commission, the Ministry of Science and Technology and National Natural Science Foundation, CAA takes responsibility for coordinating the design and construction of the Chinese Dome A Station.

The designing institution of the station has broadly analyzed the architectural history in Antarctica, compared and studied various modes of buildings, conducted on-site investigations, learned lessons and experiences of building in Antarctica and absorbed comments and recommendations from specialists in architecture, scientific research, logistics and management. The systematic design of the Station gives priorities to the environmental protection, safety, energy saving and economy as the important basis for assessing and guiding all the conceptual decision-makings and adopts the sustainable and high energy efficiency technologies as much as possible without prejudice to functional, comfort and safety needs and minimize environmental impacts.

The construction of the Station is expected to be finished in 2010 and then it will go into trail operation. The Chinese Polar Research Institute is responsible for the management and maintenance of the Station and CAA responsible for the planning of the follow-up scientific researches, logistic support, environmental management, as well as organization implementation of monitoring projects.

1.8 Acknowledgements

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The preparation process has won the support and inputs from the following institutions and experts:

1. Environmental management officers:

Ms. CHEN Danghong, environmental officer, CAA
Ms. JIANG Mei, environmental officer, CAA
Mr. LONG Wei, environmental officer, CAA
Dr. HE Jianfeng, researcher, PRIC
Dr.CAI Minghong, researcher, PRIC
Ms. LI Ting, first secretary, Chinese Ministry of Foreign Affairs
Mr. PAN Xinchun, senior engineer, National Marine Consulting Center

Mr. XIANG Youquan, senior engineer, National Marine Consulting Center

2. Research Scientists：

Mr. LI Yuansheng, researcher, PRIC

Dr. XIAO Cunde, researcher, Chinese Meteorological Academy

Mr. LIU Xiaohan, geological scientist, Institute of Qinghai-Tibetan Plateau of the Chinese Academy of Sciences

3. Environmental impact assessment experts:

Professor YANG Haizhen, Environmental Science and Technology Institute of Tongji Universit

Dr. LU Zhibo, associated professor, Environmental Science and Technology Institute of Tongji University;

Dr. WANG Juan, associated professor, Environmental Science and Technology Institute of Tongji University

Mr. SHU Jianmin, researcher, Chinese Research Academy of Environmental Sciences

Mr. LI Yanwu, researcher, Chinese Research Academy of Environmental Sciences

Mr. MENG Fan, researcher, Chinese Research Academy of Environmental Sciences

Mr. YU Xingguang, researcher, Third Institute of Oceanography of SOA

Mr. CHEN Hui, researcher, Chinese Meteorological Academy

Mr. WANG Gengcheng, researcher, Chinese Meteorological Academy

4. Architecture design expert:

Dr. ZHANG Yi, Architecture Academy of Qinghua University

2. DESCRIPTION OF THE PROPOSED ACTIVITIES

2.1 Scope

The Draft CEE prepared by CAA is developed in accordance with Annex I of the Protocol on Environmental Protection to the Antarctic Treaty by making references to the Guidelines for Environmental Impact Assessment in Antarctica (Resolution 4 , ATCM XXVIII ,2005)

The construction of the Chinese Dome A Station is planned to be initiated in the austral summer of 2008/09 and completed in the two austral summers of 2008/09 and 2009/10. In at least ten years after its completion of construction, the Dome A Station will be operated just as a summer station. The operational life of the Station is designed to be a minimum lifetime of 25 years.

2.2 Location

The proposed location of the new Station will be at 80°22′00″S and 77°21′11″E. The elevation of the site is 4093 m. It might be one of the coldest regions on earth as the annual average temperature by the field measurement is -58.4℃. The snow layer above 500 m at the site is level and stable, with an annual accumulation rate of 2 cm of water equivalent. The actual location of the Station will be finally determined after field survey by the inland expedition of 24^{th} CHINARE.

The Dome A is one of the remotest ice Domes in Antarctica, but it is the nearest one to the Chinese Zhongshan Station. The site is situated at the middle section of the major ice-divide of the ice sheet in the East Antarctica. According to sketch map based on satellite altimeter information，the region is 10～15 km wide from east to west and about 60 km long in the form of a water drop extending along NE-SW direction. The platform is only 2-3m in elevation difference and the summit point is on the north side of the platform.

The automatic meteorological observation data shows that the annual lowest temperature in 2005 was -82.3℃（27 July,2005）and the highest temperature in summer was -35℃.The annual average wind velocity is lower than 5m/s，with the maximum wind force less than 8m/s，normally 2～4m/s. The annual average air pressure is about 550- 590hPa. The concentration of oxygen is low, and equal to that in Mt.Nyainqentanglha with the elevation of 5000m in China. No snow dune develops from the wind blown on the surface. The preliminary observation indicates that the surface snow consists mainly of fine ice crystals and frost. The upper 15～20cm of the snow surface is the very soft accumulated snow and it turns into hard snow once being trod on. The observation of the transect of 2.5m snow pits indicates that the snow turns harder downward with 2～3 hard snow layer. The snow at the summit is flat on the surface and an aircraft equipped with altimeter and sledge might make direct take-off or landing (Fig. 12).

Fig. 12 Natural Conditions in the Dome A region

2.3 Site Selection

2.3.1 Site pre-selection

CAA has organized five CHINARE to the inland ice sheet along the direction between Zhongshan Station and Dome A from 1996 to the early 2008 and the CHINARE successfully arrived at the summit of Dome A in January 2005 for the first time. During systematic scientific surveys, the landmark system along the route from the Zhongshan Station to Dome A have been set up and multiple disciplinary observations and sampling have been carried out, which enriches CHINARE with experiences for logistic support in field expeditions. The first-phase study for the establishment of a Chinese Dome A Station in Antarctica has been accomplished, including scientific and logistic supports.

The systematic survey was carried out along the west side of Lambert Glacier Basin southward to the summit of Dome A, with the total distance of 1228 km (straight distance). The scientists and engineers have made analysis on the transects along the Zhongshan Station－Dome A and concluded that Dome A is a comparatively ideal site for the construction of a new station.

The first 300 km section from the Chinese Zhongshan Station to Dome: This section is highly accumulated with substances, the elevation of the point at 300 km is about 2200 m above the sea level. Except the concentrated belt of ice crevices 60 km along the coast, the other parts are rather flat. This section is near the Zhongshan Station and various scientific observations might take the Zhongshan Station as a base without building additional base.

The 300 km~800km section: This section varies between 2200~2900 m in elevation and the sub-transect between 400km and 650 km is at the upper reach of Grove Mountain, with concentrated ice crevices and very strong katabatic wind. There have developed great a mount of snow dunes which indicated great changes in the accumulation rate. Among these, the sub-transect from 500 km to 700km is a denudation area, with part of it being the fast glacier movement zone where it is difficult to locate a proper site with continuous snow accumulation for ice core drilling. The climatic monitoring indicated that the site is of less global significance as it is under the control of regional oceanic air masses. As a result, this section is not suitable to be a site for the station.

The section from 800 km to Dome A summit: From the 800km on, it is a continuous accumulation zone and starting from there, the magnitude in elevation rise increases greatly. According to chemical analysis results of surface snow, the sub-transect at 800 km is a zone with the interaction between the oceanic and inland air masses and also the turning point of elevation change of the section. The sub-transect rises from around 2900 m to about 4 100 m in elevation as it is the section with the greatest rise of elevation in the sections 60 km away from the coast. From the point of 800 km southward, the impact from the oceanic air gasses decreases gradually while the impact from the inland air gasses increases accordingly. In the area above 800 km, the impact from the oceanic air gasses disappears basically and it is a proper site for the construction of an inland station.

At the same time, the site selection also takes into consideration the needs for science. The site selected must have outstanding significance for science and involves scientific issues closely related to human survival environments and other important scientific resources. For example, this site must be an observation point representing the baseline of the climatic and environmental conditions and good for setting up an observation system for long-term monitoring to obtain the continuous data of the baseline change of the climate and environmental conditions for proper evaluation of the state of art and evolutionary trends of the climate and environment on the Earth. The site should be fit for deep ice core drilling so as to obtain valuable samples for the reconstruction of the climatic and environmental records with high resolution in the past million years or longer. This is beneficial for the formation of the representative ice sheet-glacier-ice shelf-ocean system by combining with the existing research results for the studies on the ice sheet mass balance, dynamic mechanism and its interaction with the ocean in the context of climatic changes. The site should be suitable for sub-glacier geological drilling at the summit of the sub-glacier mountain in East Antarctica for further understanding the substance composition and features of the core land mass in the Antarctic continent by analyzing the samples from the drilling. It is good for solar-earth interactions and astronomical observations.

Of course, the site must be accessible and be able for logistic supports and for human survival.

Through the comprehensive consideration of the above-mentioned factors, the Dome A region is considered as the most suitable location as the site of the new station.

2.3.2 Relay site selection

Since the straight distance from Zhongshan Station to Dome A is 1228 km, it is quite necessary to set a relay site on the way for providing fuels and a landing place for the inland convoy, aircrafts in mission and the emergency rescue in the hinterland.

The relay sites for the inland Antarctic survey are arranged at the site with flat ground and lower snow accumulation rate and without snow dunes of more than 30 cm high. Based on our field investigation and the experience achieved by some other countries, the relay site is selected at the point of 806 km away from the Zhongshan Station straightly and 422 km from the summit of Dome A. The 800km section is a continuous accumulation zone and starting from there, the magnitude in elevation rise increases greatly. However, the location selected for the relay station has higher elevation than the surroundings and lower snow accumulation rate (lower than about 30 cm /a). The location is 2880 m above sea level，with the annual average air temperature of -43.0℃.The snow accumulation rate is low and the snow surface is rather soft. The wind force is weak and no snow dune develops. The snow surface is flat and suitable for the take-off and landing of aircrafts. The velocity of the movement of ice sheet is rather low, less than 50 m in 6 years. The ice layer is comparatively stable.

No construction will be made in the relay site as it is only for the storage of some tanked oils for emergency rescue and needs for a few flights.

At the same time, for guaranteeing the safety of field scientific surveys, the original shelter for the Grove Mountain Survey by the CHINARE which is 500 km away from the Zhongshan Station is taken as the shelter for the Dome A expedition. This is at the furthest point that a helicopter can arrive from the Zhongshan Station, and a light snow vehicle can arrive in a rather short time for rescue and sheltering.

2.4 Principal Characteristics of Proposed Activities

The activities covered by this CEE are:

- construction, operation and maintenance of the Dome A Station
- the transportation process for cargoes and personnel to Dome A
- Analysis on the potential environmental impact
- prevention and mitigation measures to reduce environmental impacts

The systematic design of the Station gives priorities to the environmental protection, safety, energy saving and economy as the important basis for assessing and guiding all the conceptual decision-makings and makes the sustainable and high energy efficiency technologies the basis as much as possible without prejudice to functional, comfort and safety needs and will minimize environmental impacts.

2.4.1 General specifications of the Station

The construction of the Dome A Station is planned to be initiated in the austral summer of

2008/09 and completed in the two austral summers of 2008/09 and 2009/10. In at least ten years after its completion of construction, the Dome A Station will be operated just as a summer station. The operational life of the Dome A Station is designed to be a minimum lifetime of 25 years.

The Station has the following characteristics:

- Austral summer Station: open from the early January to the early February of the next year
- The main building of the Station is designed for accommodating 15~20 people for a short term and 25 people for a long term. The station's routine facilities and emergency shelter are designed for more people
- Expected design lifetime：25 years at minimum
- The total construction area of the Station will be 623 m^2 (among which, 204m^2 for the container building and 419m^2 for the assembly building), 1000m^2 for the simple storage area and operational yard, and 200 m^2 for housing solar energy photovoltaic facilities.
- The Station will be equipped with instruments and facilities to meet scientific research needs and transport facilities suitable for field operation
- The construction, operation and dismantlement of the Station are conducted in compliance with the regulations concerning the reduction of the environmental impacts to the minimum in the Protocol on Environmental Protection to the Antarctic Treaty
- The system design of the Station follows the principles of environmental protection, safety, energy saving and economy and adopts sustainable and high energy efficiency technologies
- The health and safety risks will be reduced as much as possible and the design, planning, training and supply of the facilities of the Station will ensure that no significant health or safety accidents will happen
- The construction of the Station will combine the pre-fabricated container building and assembly building made in China to reduce the workload of installation in situ
- The building will be designed for easy maintenance, repair and damage control, and the needs for equipment maintenance will be reduced or simplified
- The manual handling and multiple handling of all stores and equipment will be minimized across all operations, including annual maintenance, normal operation and eventual decommissioning of the facilities
- The Station is designed to have extension and upgrading capabilities. It will be easy to integrate updated technologies. The Station will be upgradeable to a perennial station with minimal effort
- To assure the constant energy supply and meet the needs for a perennial station in a long term expectation, three back-up generators, one more generator for emergency use and a boiler will be installed
- The environmental impact will be minimized during its lifetime operation of the

Station

- The Station will use as much renewable energy as possible and try to accomplish that both fossil fuel energy and solar energy can be supplemented each other, and hopefully in 2-4years taking the solar energy as the main power source while the fossil fuel energy as a supplementary one. At the same time, an experiment on heating by solar energy will be conducted
- The fossil fuel used at the Station is solely the aviation kerosene. The use of fossil fuel will be minimized
- A comprehensive waste management regime will be formulated
- Solid wastes will be stored according to classification and brought back to the Zhongshan Station when the expedition withdraws. Waste water will be treated and reused as much as possible
- An Environmental Management Plan will be enforced, including the adoption of measures to mitigate environmental impacts
- An Environmental Monitoring Plan will be implemented to monitor the potential environmental impacts and assess the effectiveness of mitigation measures

2.4.2 Materials and personnel required

1) Major Materials and Mode of Preparation

The major materials needed for the construction of the Dome A Station include building materials, power generators and heating facilities, engineering machineries and equipment, vehicles, fuels, oils, various kinds of spare parts for maintenance and repair, communication facilities, medical devices, fire extinction equipment, foods, labor protection articles, daily use necessities, safety and emergency facilities and part of materials for scientific purpose, etc.

Except the aviation kerosene, most of the materials and fuels needed for the construction of Dome A Station and for vehicles inland expedition are featured by less amount and greater varieties. The supply must take into consideration the principles of procurement mainly from the domestic market, cost-effectiveness, time-saving, flexibility and convenience and quality guarantee. In general, the greater part of the materials and fuels needed for the construction of the Dome A Station and the vehicle convoy in the inland will be purchased from the domestic market and part of the machineries and equipment and their assemblies might be purchased in the international markets.

2) Total Amount of Materials Required

The Dome A Station requires more than 500 tons of materials for the construction and about 80 tons for its normal operation. The major materials for the construction will be shipped to the Dome A region in 2008/09 and 2009/10.The inland transportation will be carries out once a year between the Zhongshan Station and the Dome A region. Based on that consideration about 200 tons of materials are to be transported per year (Table 1, Table 2).

Table 1 Materials required for the Dome A Station in the austral summer of 2008/09

No.	Items	Weight（t）
1.	materials for station construction	148
2	Oil	Jet kerosene 30 (15t for the station and 15t for machines and vehicles in one austral summer), other oils 2
3	Auxiliary and spare parts for repairing of machinery and vehicles	1.5
4	Materials for maintenance and repairing of construction facilities	7
5	Auxiliary parts for environmental protection	1.5
6	Auxiliary parts for repairing and maintaining power generators and power facilities	2
7	Auxiliary parts for repairing and maintaining heat insulation facilities	2
8	Auxiliary parts for satellite communications	0.5
9	Articles for medical uses	1
10	Fire extinction materials	1
11	Foods and beverage	3
12	Garments and articles for labor protection and prevention	0.5
13	Articles for daily life	1
14	Parts for repairing and maintaining of other facilities and equipment	1
15	Safety and emergency equipment	1
16	Substances for scientific surveys	4
	Subtotal	207

Table 2 Materials required for the Dome A Station in the austral summer of 2009/10

No.	Items	Weight（t）
1.	Major materials for station construction	182
2	Oils	Jet kerosene 28(13t for station site 15t for machines and vehicles), other oils 2
3	Auxiliary and spare parts for repairing of machine and vehicles	1
4	Materials for maintenance and repairing of construction facilities	8
5	Auxiliary parts for environmental protection	1
6	Auxiliary parts for repairing and maintaining power generators and power facilities	2
7	Auxiliary parts for repairing and maintaining heat insulation facilities	2.5
8	Auxiliary parts for satellite communications	0.5
9	Articles for medical uses	1.5
10	Fire extinction materials	0.5
11	Foods and beverage	3
12	Garments and articles for labor protection and prevention	1
13	Articles for daily life	0.5
14	Parts for repairing and maintaining of other facilities and equipment	1
15	Safety and emergency equipment	1
16	Miscellaneous	0.5
17	Substances for scientific surveys	20
	Subtotal	256

3) Personnel Required

It is planned to send 12 personnel each year in the two austral summers to the site for the Station construction, in addition, 8 scientists will be sent for scientific survey. They will go by inland vehicles to the proposed construction site.

2.4.3 The mode of Transport

The R/V Xuelong will ship the personnel and materials for the construction of the Dome A Station. She will leave Shanghai Port and sail along the conventional route to the two Chinese stations in Antarctica. Once Xuelong arrives in the waters off the Zhongshan Station, personnel and cargoes will be unloaded at the pier of the Zhongshan Station and then transported to the site by the inland convoy (Fig. 13).

Fig 13 Conventional navigation route of R/V Xuelong to and from the Antarctica

1) Shipping（Domestic/International—The Zhongshan Station）

Fuel

The Dome A Station will completely use clean fossil fuel—aviation kerosene. It is planned to purchase the kerosene. from the domestic or international markets and stored in special cabin. of R/V Xuelong, once she arrives at the existing unloading pier of the Zhongshan Station, the kerosene will be transferred by a barge or a helicopter to the fuel tanks at the Zhongshan Station.

Materials for the Station construction

Materials needed for the construction of the Dome A Station and for inland vehicle convoy will be purchased from both domestic and foreign markets and then transported to the

Zhongshan Station by R/V Xuelong along her traditional navigational route. There will be three ways to transfer these cargoes from R/V Xuelong to the Zhongshan Station, namely by barges, by snow tractors on the ice or by helicopters if the ice condition is severe there. After sorting out, these materials will be transported to the construction site in Dome A region (Table 3).

Table 3 Plan for marine transportation during the construction period

Time	Personnel and cargoes
October 2008	Shipping 207 tons of cargos and 20 expeditioners for the Station construction
March 2009	Shipping home all the wastes and bringing expeditioners back to China
October 2009	Shipping 256 tons of cargoes and 20 expeditioners
March 2010	Shipping home all the wastes and bringing summering expeditioners back to China

2) Transport by vehicles (Zhongshan Station -- Dome A)

The transportation of materials and personnel for the station construction by vehicles covers the distance of 1 200 km on ice sheet between Zhongshan Station and the Dome A region as shown in figure 14, so the inland vehicle convoy is the necessary transportation means for re-supplying and safety rescue. Without the support of transportation system, the construction and operation of the Dome A Station would be impossible.

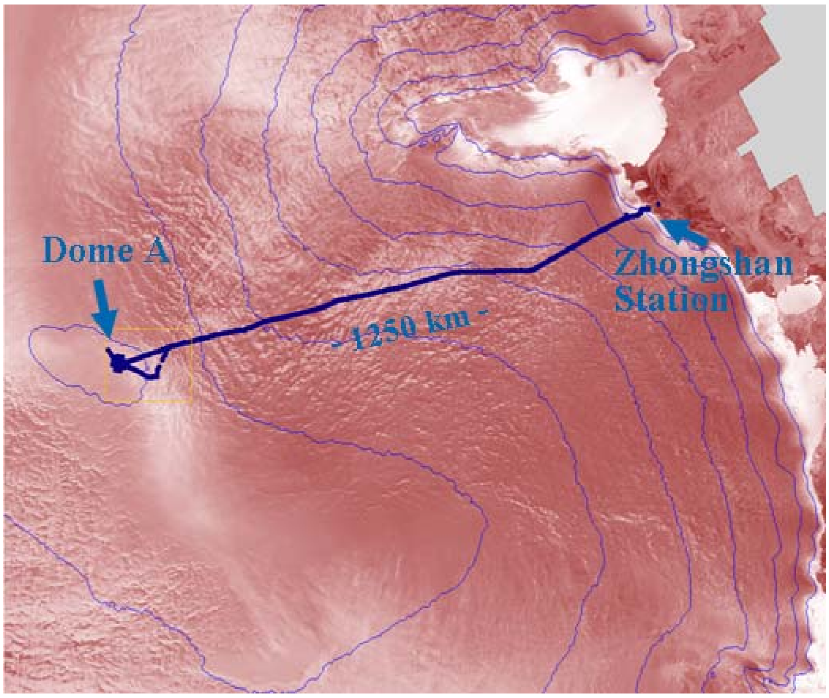


Fig 14 Zhongshan to Dome A route

The composition of the inland vehicle convoy is as follows:

Heavy snow tractors: 4 heavy snow tractors, each with the loading capacity of 65-75 t.

Medium snow vehicles (PB300): 2 Medium snow vehicles, each with the loading capacity of 35-40t.

Light snow vehicle (PB240): 3 light snow vehicles, each with the loading capacity of 30t.

Sledged fuel tanks: The inland vehicle convoy of each expedition needs 110 tons of fuel and the Dome A Station needs 30 tons of fuel in summer (for 2008/09 and 28 tons for 2009/10). They make up 140 tons of fuel and will be stored in 16 sledged fuel tanks, each 15 m^3.

Cabins for accommodation, communications and power generation: The inland vehicle convoy will be equipped with one communication cabin, one power generation cabin and several accommodation cabins.

Heat insulation cabin: The Station construction in Dome A and the inland transportation need a heat insulation cabin to store foods, non-staple foodstuffs, vegetables and beverage.

Sledges and Sledged fuel tanks: the inland convoy will haul 26 sledges and 16 sledged fuel tanks (Table 4).

Table 4 Materials needed by the inland vehicle convoy

No.	Items	Amounts required (t)
1	Aviation kerosene	110
2	Various oils in small amounts	3.5
3	Auxiliary and spare parts for repairing of machine and vehicles	2.5
4	Auxiliary parts for repairing and maintaining power generators and power distribution systems	3
5	Repairing and maintaining for heat insulation facilities	1
6	Auxiliary parts for satellite communications	0.5
7	Medical appliances	0.5
8	Fire extinction materials	0.5
9	Foods and beverages	3.5
10	Garments and labor protection and prevention necessities	2.5
11	Daily necessities	1.5
12	Safety and emergency equipment	1
13	Repairing and maintenance for other mechanical equipment	2
14	Miscellaneous	2
Total		134

2.4.4 Medical security system

It is an important premise to guarantee the life safety and work efficiency of the expeditioners in the construction of the Dome A Station under the harsh environments. Therefore, a system for medical care, prevention and control, field rescue will be set up, and in the future a remote medical system will also be possible to set up so as to develop a Chinese medical security system in the inland Antarctica. This is of great importance for the smooth implementation of the exploration and surveys in the inland Antarctica.

The medical post will be created in the expedition team which will be manned with medical staff with experiences on plateau diseases. Necessary trainings are provided for the medical staff and the expeditioners. The expedition will be equipped with various types of steel oxygen bottles, oxygen producers, portable pressurized bags, suitable high pressure oxygen cabin, emergency medicines for critical plateau diseases and other conventional medicines and medical instruments.

2.5. Station Construction Plan

The Dome A Station will be built to support the field survey and study on the ice sheet of East Antarctic. The Station will meet both the needs for scientific purpose and the requirements of environmental protection. Therefore the Station will use as much as possible sustainable and higher energy- efficiency technologies and renewable energy to minimize the production of wastes. The design of the Station has taken into consideration its capacity for extension and upgradeability and easy application of new technologies to turn the seasonal station to a perennial station with the least efforts in the future.

2.5.1 Principles for the construction of the Dome A Station

1) Principle of giving priority to environmental protection

In order to protect the Antarctic, which receives the least impact from human activities, the principles of giving top priority to environmental protection will be adhered to in the construction of the inland station in Antarctica and the principle will be applied in the whole process from the design stage to the operation stage. Every step, whether the selection of materials, selection of equipment, engineering process, operation of the station or the disposal of wastes must be in compliance with the regulations stated in the Protocol on Environmental Protection to the Antarctic Treaty to minimize unfavorable environmental impacts.

2) Principle of safety and feasibility

The harsh environmental conditions of Antarctica require special measures for safety. Particular considerations have been taken to some extreme conditions such as lower oxygen,, low temperature, transport difficulties and some other unexpected difficulties in order to ensure the safety of the personnel.

There exist similar environmental conditions in the Qinghai-Tibetan Plateau in China. China has been implementing programs since 1950s to prevent and control plateau diseases and promote human adaptation to low oxygen in the plateau regions. In the course, the first international standards for the diagnosis of chronicle plateau diseases and some national or sectoral standards have been established. The practical experiences and effective safeguard measures enriched in the past years will provide basic guarantee for the prevention and control of plateau diseases in the inland Antarctica.

3) Principle of energy-saving and waste-reduction

Energy saving and waste reduction is a key principle for the design of the Dome A Station. Energy saving is an important component of the environmental protection, which means minimizing environmental pollution and the reduction of operational cost. . The fuel stored and re-provisioned in the Station will be transported to the Station with higher costs and limited amounts, so reduction in the consumption of the fuel means the reduction of cost for the station.

By following the Protocol on Environmental Protection to the Antarctic Treaty and the Energy Conservation Law of the People's Republic of China, the design of the Station has taken the principle into full consideration to save energy and try to achieve the best equilibrium among the harsh climatic conditions, logistic capabilities, construction capacity and technical capacity, and among the practicability, economy, feasibility and creativeness. Various energy-saving measures have been adopted for developing renewable energy, heating source and mode, recycle of waste heat, structure maintenance, and reduction of ventilation energy and the control of water consumption so as to minimize environmental impacts as much as possible.

4) Principle of economy and feasibility

The construction of a station in inland Antarctica can not be completed in a short period; normally it would take several years to complete the whole construction due to the extreme harsh environmental conditions there. A simple construction may be completed in a short period, but a construction without integrated design may lead to the overlapping and lower utilization rate, as an independent construction may not be favorable for its maximum use under such harsh environmental conditions. Therefore, there should be an integrated design and the construction and operation of each building should be accomplished step by step. The philosophy of construction by steps may adapt to the harsh conditions in Antarctica and to ensure the earlier operation of the part of the finished construction. Once the whole construction project is accomplished, various parts can be integrated into an organic complex with highly operation efficiency.

Comprehensive consideration is also given to the short term and long term efficiency. Some construction items require a larger mount of investment, such as solar energy facilities and heating by solar energy, but the advantages they bring will effectively reduce the cost for maintenance and operation, and earn better long-term efficiency and benefit to environmental protection.

2.5.2 Station Construction

1) Details and scale of the construction

The size of the Dome A Station is defined by several factors such as the need of scientific programs, the number of the expeditioners it can support, and inland transportation capacity, etc. The total construction area will be 623 m^2 (of which, 204m^2 for the container building and 419m^2 for the assembly building)， 1000m^2 for a simple storage area and operational yard and 200 m^2 for housing solar energy photovoltaic facilities. The short-term objective is to accommodate 15~20 people for summering and the long-term objective is to satisfy the best utilization by 25 people in a full year station. However, the daily facilities (including kitchen, sanitary facilities and offices）and emergency and shelters will be designed to accommodate more people (Fig 15).

Fig. 15 Main Building of the station

The construction of the Station consists of a main building (including accommodation sector, communication sector living sector, medical clinic and science sector), logistic area(including power house, garage, emergency sector, solar energy sector, oil tanks), ice core drilling area, and scientific observation area.(Table 5)

Table 5 Details of the Construction

Items		Engineering time	Size（m^2）	Mode of construction
Main Building	Multifunctional Hall	2008/2009	283	assembling in situ
	Accommodation			
	Science			
	Medical			
	Boiler and water supply1			1container building

Items		Engineering time	Size （m^2）	Mode of construction
	Sewage treatment			1container building
Logistic	power generator room (3 x 100kw)		18	1container building
	Garage	2009/10	100	assembling in situ
Logistic	Storage 1		18	1container building
	Storage 2		18	1container building
	House for generators		24	assembling in situ
Logistic (emergency)	Emergency power supply	2008/09	18	1container building
	Emergency accommodation		24	1container building
	Emergency living room		24	1container building
	Emergency storage	2009/10	18	1container building
Logistic (Oil storage)	Pump house	2009/10	12	1container building
	Oil tank			10 sledge-type oil tank
Logistic (Solar energy)	Solar energy photovoltaic facilities	2008/09 20kw 2009/10 30kw		200 m^2 Not include in the construction area
Ice core drilling	Control room of ice core drilling equipment	2009/10	24	assembling in situ
	Workshop for maintenance		24	Assembling in situ

Items		Engineering time	Size (m^2)	Mode of construction
	Operation yard	2009/10		Half underground simple structure(not include in construction area)
	Ice core storage			Half underground simple structure(not include in construction area)
Science observation	Earth-space environmental observation	2009/10	18	1container structure
	Operation ground			
Total			623	11 container buildings (204 m^2) 419 m^2 Assembling building 1000 m^2 simple structure 200 m^2 simple structure for solar energy 10 sledge-type oil tanks

2) Basic distribution of buildings

The construction of the Station consists of a main building (with its functions for accommodation, communication, living, medical service and scientific study), logistic buildings includes (power generation house, storage structure, emergency sectors, solar energy facilities and oil tanks), ice core drilling area and science observation area. (Fig.16 and 17).

Fig. 16 Bird’s-eye view of the Station construction

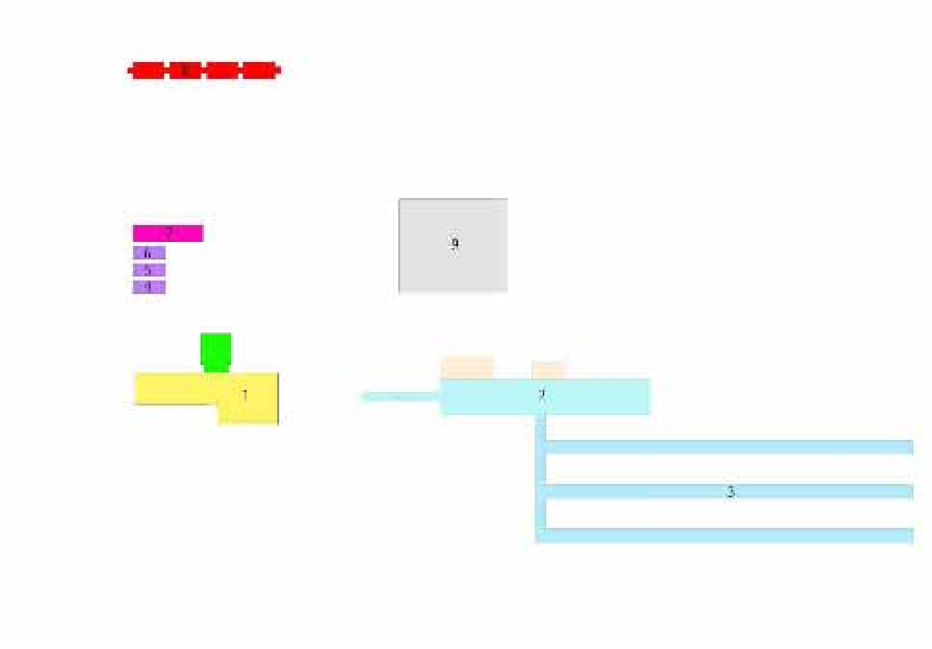


Fig. 17 Site plan of the Station

（1）Main building; (2)Ice core drilling site ; (3)Ice core storage ; (4)Generator unit; (5)Storage; (6)Storage; (7)Garage & workshop; (8)Emergency shelter; (9)Solar photovoltaic panels

The main building includes accommodation rooms, recreational sector, office sector and technological supporting sector (such as a boiler and sewage treatment facilities) (Fig 18).

Fig. 18 The construction of the Main building

（1）infirmary; （2）sleeping area;（3）entrance; （4）buffer;

（5）office area & lab; （6）kitchen;（7）living area;（8）technical area & storage

Sectors which need to be heated will be concentrated and arranged effectively in order to save energy; such concentration and arrangement of sectors with different functions would be convenient for communication and reduce interference from each other.

3) Foundation and structure of the Station

The lifetime of the inland station in Antarctica is about 20 years in general. Because these stations are built mostly on accumulated snow and the annual snow precipitation varying from several centimeters to several meters which may bury the buildings or make them sink and thus lead to their shorter lifetime of service.

In order to meet this challenge, some countries build their inland Antarctic stations on the pressed snow above the ground for prolonging the lifetime or lift or flyover the whole building over the ground, such as the new station of the United States at the Pole point, the new building of France and Italy in DOME C and Station Kohnen of Germany are all flyover buildings over the ground.

The annual snow precipitation in the DOME A region was 110 mm in 2005 and 50 mm in 2006 as observed. If the annual snow precipitation of 110 mm taken as the reference, in a lifetime of 25 year of the buildings, the maximum thickness of accumulated snow should be 2.75 m.

Therefore, the foundation supporting structure of the main Station and some container-buildings which are not suitable to be suspended are designed in flyover form. The pre-made steel foundation will be laid on the pressed snow, and the supporting structure and the platform will be installed above the foundation. The supporting structure is 2.5m in height with an additional adjustable part of 30cm so as to adapt to the different sinking rate, which ensures the minimum lifetime of the station will be 25 years.

4) Mode, materials and installation of buildings

Upon an integral consideration on the extreme geographical and climate conditions in Dome A, especially its low oxygen concentration which causes great difficulties for construction, as well as the need for minimizing environmental impacts, the construction of the Dome A Station will combine the home-prefabricated container buildings and in situ assembly structures in order to overcome the difficulties and to minimize workload.

In terms of construction mode, there will be two forms: One is based on pre-fabricated containers combined with in situ assembly structures, such a construction form is mainly to meet the needs of heat insolating buildings such as the main building of the Station which consists of accommodation rooms, dining hall and science laboratories. The outer protection finish will be done in situ to ensure its heat isolating performance; and the internal work is mainly to joint and fix the models in the containers to reduce the workload in situ. Another form is the individual container, which serves as the independent power generation house, storage, emergency facilities, and science observatory. The bottom of some containers is different in its shape-profile(Fig.19), such as emergency accommodation cabin and emergency living cabin to adapt the different activity need inside, so convertible bases are installed for easy transport by snow vehicles(Fig. 20, 21).

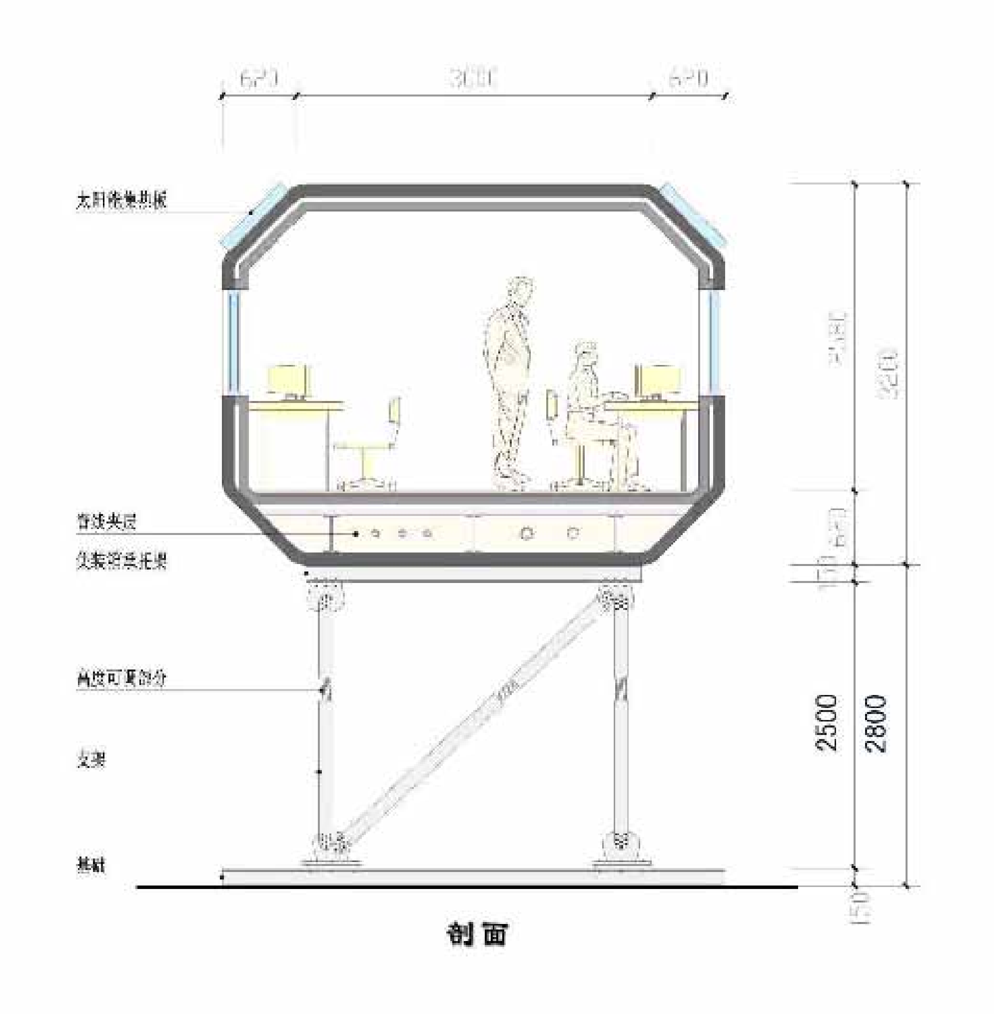


Fig. 19 Sectional drawing of deformed container

Fig. 20 A diagram of pre-fabricated containers in the office area

Fig. 21 A diagram of pre-fabricated containers in the living area

The following three considerations are the main reasons for adopting different construction mode: The first is transportation consideration. The distance from the Zhongshan Station to Dome A region is about 1280km and the transportation capacity is limited under such conditions, the combined containers are easy for transport. The second consideration is to reduce workload in situ. With the higher elevation and lower oxygen concentration, it is obviously difficult to do engineering work there and is necessary to reduce in situ workload to guarantee the safety of expeditioners. The last but not the least is to minimize environmental impact by reducing in situ workload.

In terms of building material selection，environmental protection and durability are the two criteria. Major building materials will be compound thermostatic board with higher strength, fire-proof, heat insulation, low weight and easiness for processing and a full applicability to low temperature environments. No building materials with environmental hazards will be used and special attention will be paid to volatile gases inside the materials in order to ensure that no toxic gases will emit from the building materials.

The steps of installation in situ are as follows：compacting accumulated snow, laying down the pre-fabricated caisson foundation，building of flyover platform, lifting and laying the container on the platform， connecting containers and assembling larger buildings.

2.5.3 Oil storage system

During the initial construction stage of the Station in 2008/09, 15 tons of aviation kerosene will be needed for power generation and heating, another 15 tons for the vehicles and engineering machineries in each austral summer. By meetings the needs for continuous power generation and emergencies, tanks of around 50 tons for oil will be needed if the capacity of oil tanks will be 1.5 times of that of oil stored. By taking into consideration full year operation of the station in future, the capacity of oil tanks in the Station will be about 150 cubic meters. Therefore, there will be 10 oil tanks, each volume will be 15 cubic meters plus oil pumping room and necessary pipelines.

2.5.4 Heating and ventilation system

1) In-door design parameters

For energy-saving and comfort feeling, room temperature will be controlled between 15 to 20℃. The specific heating parameters for various rooms are indicated in Table 6.

Table 6 Design parameters for heating

construction area	Room temperature（℃）
Multifunctional room, scientific Labs, dormitory, communication room and medical clinic	20
Kitchen, power generation house	15
Canteen	18
WC	16

2) Out-door design parameters

Dome A is at the summit of ice sheet in Antarctica ,according to the data from the automatic weather station，the lowest temperature in 2005 was -82.3℃（27 July）and the highest temperature in the austral summer was -35℃，the annual average temperature was -58.4℃，the annual average air pressure is between 550 and 590 hPa，the annual average wind velocity is lower than 5m/s, with a maximum of less than 8m/s，normally 2～4m/s.

3) Heating system

The heating of Dome A Station is based on the boiler heating system and residual heat from the power generators. The experiment to use solar energy for heating will be conducted and hopefully, for long term consideration, solar energy may be used partly or even totally for heating during austral summer seasons.

The boiler heating system including a boiler room (integrated system), boilers, pressure -switching pumps for water supply, water tanks and controlling unit. The ending section of the heating system consists of radiators with the pipes for heating fixed in between-layers of the containers. Aviation fuel is used for heating.

As mentioned above, the experiment by using solar energy for heating will be carried out to reduce the cost of heating and the protection of the environment. It is believed that, Dome A region is an ideal place in which to make such an experiment.

The solar energy system which consists of the heat collector for heating the air, heat converters, heat insulation water tanks, ice melting tanks, wind pipes, water pumps and wind fans. Mounted on the wall, the heat collector of the system warms up the air that will be sent by the wind fans into the rooms via the wind pipes. 50 m^2 of the heat collector will be installed during 2008/2009 austral summer.

4) Ventilation system

As the outdoor temperature will be very low, it is planned to use the concentrated ventilation system with heat recovery units. At the same time, since the Dome A Station has a high elevation and is short of oxygen, it is planned to set up an oxygen generation station to supply oxygen for the staff in the station. Oxygen will be sent to various rooms by pipelines and the supply will be adjusted in accordance with the information form the carbon dioxide monitoring system so as to satisfy the basic physiological needs of the staff.

2.5.5 Water supply and drainage system

The principles guiding the design of the water supply and disposal system are firstly, to minimize environmental impact and be able to ship as much as possible solid and liquid waste back home; secondly, to make rational layout for minimizing land occupation; and thirdly, to operate safely and reliably and make the system easy to manage and operate with higher auto-control functions.

1) Water supply

Once the Dome A Station is in operation, the Station will need 740 liters water per day for 20 summering expeditioners’ daily use including drinking, cooking, brushing, washing, bathing and sanitary water. Among which, 440 liters are from melting snow, for daily drinking, cooking and brushing, the rest 300 liters of daily use water will be the recycling water up to the standard after treatment.

Table 7 Estimation of water consumption and drainage

<table>
<tr><th>No.</th><th>Use</th><th>Rate</th><th>Number of people</th><th>Water used（L/d）</th><th>source</th><th>Drainage（L/d）</th></tr>
<tr><td>1</td><td>Drinking</td><td>2 L/head/d</td><td>20</td><td>40</td><td>Melted snow</td><td rowspan="7">Discharge 70L/d

Sludge and oil residue 100% shipping back

Stool and urine 100% shipping back</td></tr>
<tr><td>2</td><td>Cooking, utensils cleaning, brushing and washing</td><td>10 L/head/d</td><td>20</td><td>200</td><td>Melted snow</td></tr>
<tr><td>3</td><td>Simple cleaning of clothes and articles</td><td>10L/head/d</td><td>20</td><td>200</td><td>Reuse of grey water</td></tr>
<tr><td>4</td><td>Bath</td><td>20L/head/time</td><td>20/2</td><td>200</td><td>Melted snow</td></tr>
<tr><td>5</td><td>Sanitation cleaning,</td><td></td><td></td><td>100</td><td>Reuse of grey water</td></tr>
<tr><td>6</td><td>Toilet（stool）</td><td>1Kg/head/d</td><td>20</td><td></td><td></td></tr>
<tr><td>7</td><td>Toilet（urine）</td><td>2Kg /head/d</td><td>20</td><td></td><td></td></tr>
</table>

2) Water drainage

Upon the consideration of small amount of water consumption, environmental protection, easy management and simplification of treatment facilities, a negative pressure free-of-flushing system will be used in the toilet to reduce the capacity of black water. The human excrements (including night soil and urine) will be packed automatically and shipped back to Zhongshan Station for treatment. The lower contaminated waste water through super-filtration can be turned as intermediate water for cleaning, then through further treatment by a reverse osmosis system, the treated water will be in compliance with the standards of Category II of Surface Water in China (GB 3838-2002) and be recycled for simple cleaning of clothes in the station. The residual water after filtration is roughly about 70 liter per day will be discharged into the ice pits. (Table 7, Fig 22)

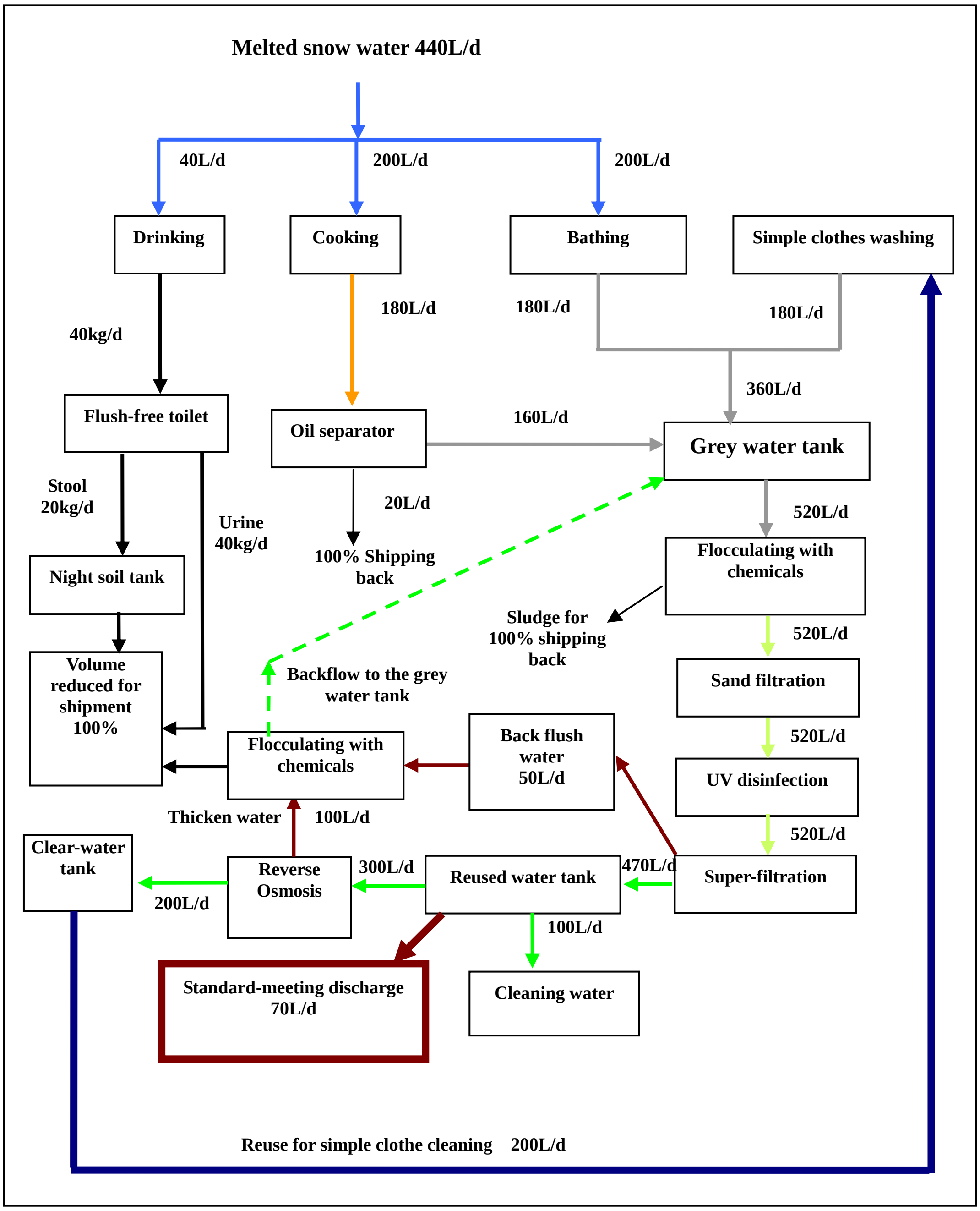


Fig. 22 Water balance and technological process in the Dome A Station

3) Techniques for sewage treatment

The Dome A Station will build an integrated container-type of sewage treatment system. The system mainly consists of sewage tank, reactor tank, out-tank pump valve and filters. It is a sealed unit made of stainless steel plate. Without special attendee, it will operate continuously or intermittently then stops at night. One person might be appointed to make routine inspection and maintenance. Residual black water comes from super-filtering unit and reverse osmosis unit will flow into a combined rector, there water will precipitate and flocculate under the function of a chemical, the upper clear water in this combined rector will flow back to low pollutant water tank. The filtering core will be changed when the effectiveness drops. According to the dimensions of the container, the sewage treatment and recycling system will be installed in a space of 3700 x 2700 x 2400 mm as an integrated unit. The major techniques of treatment and recycling system is given bellows (Fig.23).

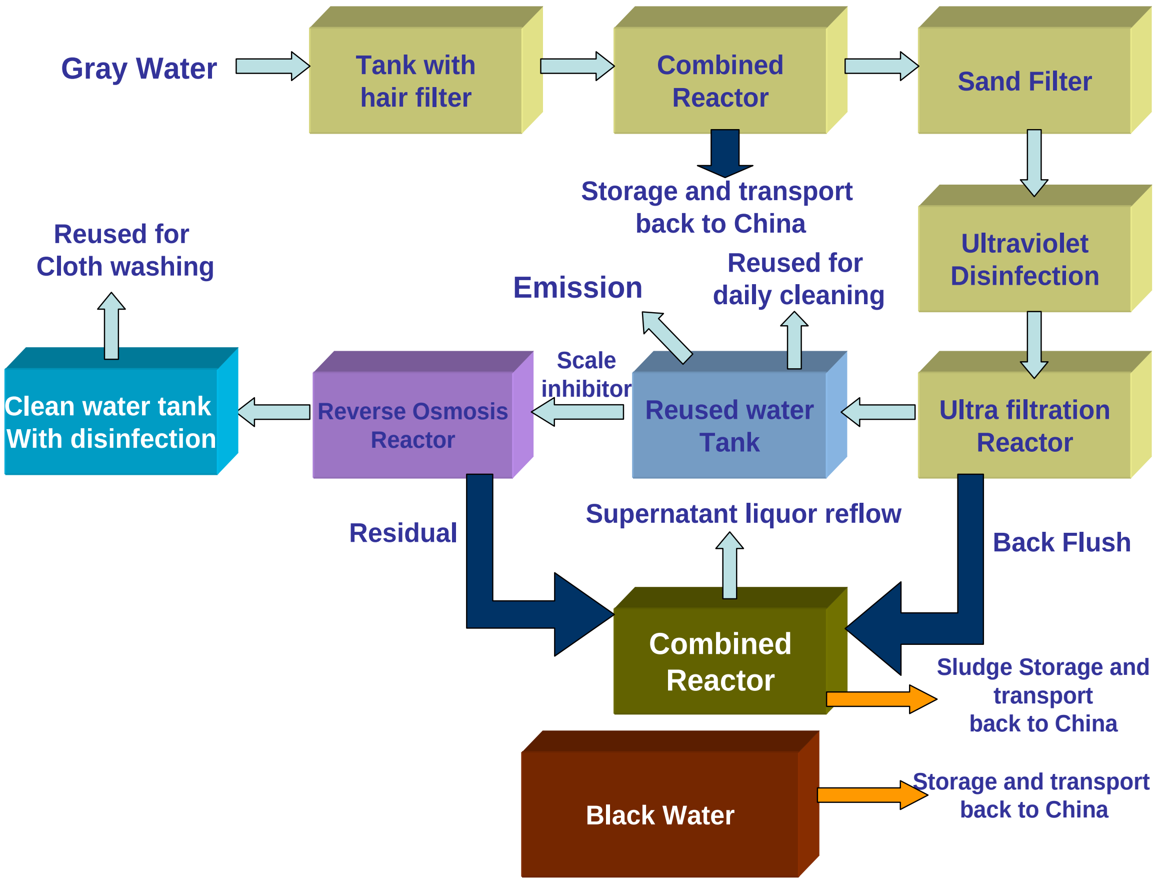


Fig. 23 Techniques for sewage treatment and recycling system

- Designed input water quality

The low-contaminated sewage collecting-tank adopts integrated techniques by super-filtration and reverse osmosis. The indicators for the input water quality of low contaminated sewage are shown in Table 8.

Table 8 Designed input water quality

Indicator	pH	COD_{Mn} (mg/L)	BOD_5 (mg/L)	SS (mg/L)	NH_3-N (mg/L)	Fecal colon bacillus （ind /L）
Designed input water quality	6～9	80～120	30～50	40～60	5	100000

- Designed output water quality

The water quality of the swage treated for recycling use or discharge will be in compliance with the standards of Category II (mainly for 1st Category of protection zone for concentrated drinking water source, habitat for rare and endangered species, spawning ground for commercial species and feeding ground for larval and young fishes) of China Water Quality Standards for Surface Water（GB/3838-2002）The control indicators for water quality are shown in Table 9.

Table 9 Quality of recycling and discharged water

Indicator	pH	COD_{Mn} (mg/L)	BOD_5 (mg/L)	SS (mg/L)	Turbid -ity (NTU)	NH_3-N (mg/L)	Fecal colon bacillus（ind/L）
Output water from the mixing and flocculating pool	6～9	40～60	15～25	20～30	20	3	≤10000
Output water after super-filtering	6～9	≤6	≤4	≤5	≤1	≤1	≤200
Output water from reverse osmosis	6～9	≤4	≤3	≤2	≤0.5	≤0.5	≤20
Discharged water	6～9	≤4	≤3	≤2	≤0.5	≤0.5	≤20
Removal rate of pollutants（%）	—	96	95	95		90	99

2.5.6 Electric system

1) Power source system

The power source of the Station is mainly based on power generator system with a solar energy photovoltaic system as a supplementary power source. The maximum power loading capacity is about 50kw not including the loading capacity for scientific equipment and supportive vehicles.

The diesel power generation system consists of 3 sets of 100kw water-cooling diesel power generators. As oxygen concentration is comparatively low in the Dome A region, the operation efficiency of diesel power generators will be restricted to some extent and each power generator set will produce about 60kw of power at its full load, while maximum power needed by the Station is about 50kw. In normal conditions, the 3 sets of engines will work alternately: one is in operation, one is at standby and one is under examination and repair. At the initial stage of the station construction, a wind-cooling diesel engine with a power generation capacity of 100kw will be carried by the inland convoy so that it could work when the hydro-cooling diesel engines are not in place for operation. The fuel for power generation is totally kerosene. In addition, an emergency power generating set with smaller capacity will be equipped.

Due to the harsh environments out of door, the personnel will stay more inside the building.

Therefore, the power load for the fire prevention and warning, emergency light, the communications room and the control room are of especially importance in the Class A power load. The power load for the boiler room and important science rooms are of the class A power load and the rest will be of the Class C load.

2) Solar energy power generation system

Energy saving will be one of the key indicators in the design of the Station. The polar day in the Dome A region will be as long as 182 days and the daily radiation in the daytime of December is 40MJ/m^2. The radiation is even stronger in the period from December to the next February, so there are excellent conditions to develop the solar energy as the renewable energy source. However, the elevation of Dome A is more than 4000 m which means it is at the highest elevation among all the stations in Antarctica. The measured annual average temperature is -58.4^{O}C, it might be one of the coldest places on the Earth. It is somewhat difficulty and challenge for the experiment and operation of solar energy under such conditions.

The solar energy photovoltaic facilities were initially used in the satellites and space stations. The solar batteries exposed directly to the outer space under harsh and changeable environmental conditions. They are subject to the change of temperature between -180~80^{O} C and 1-2 magnitudes higher in total of radiation from high-energy electricity particles than other units on the satellite, as well as the high pressure static charge/discharge effects in various plasma environments in the space. The effects include serious atomic oxygen denudation if the satellite moves in a lower orbit. Under such harsh environments, the solar batteries still work reliably and stably. Therefore, solar batteries may guarantee the adaptation and reliability of the solar energy photovoltaic generation system in the Dome A Station

The development and application of solar energy in Antarctica is still at the exploration stage in various countries and this is true for China. However, China has gained some very good practices and results in the broad development and studies on the application of solar energy photovoltaic in the space and on the ground. In past few years, the solar energy industry in China has been developing with 20% to 30% increase per year. The progress has provided technologies for the application of solar energy photovoltaic in Antarctica. The application of the solar energy system in the Dome A Station will be a test for cold weather and wind resistance, thus to improve its performance and promote its development.

The Dome A Station will build a 50kw solar energy photovoltaic generation system and make it as main power source in 2-4 years for normal operation of the Station.

Solar energy photovoltaic generation system relies on battery arrays of solar energy photovoltaic system to convert solar energy into direct current and, through DC/AC converter, turns the direct current into alternative current The surplus power will be stored in the batteries. (Fig. 24)

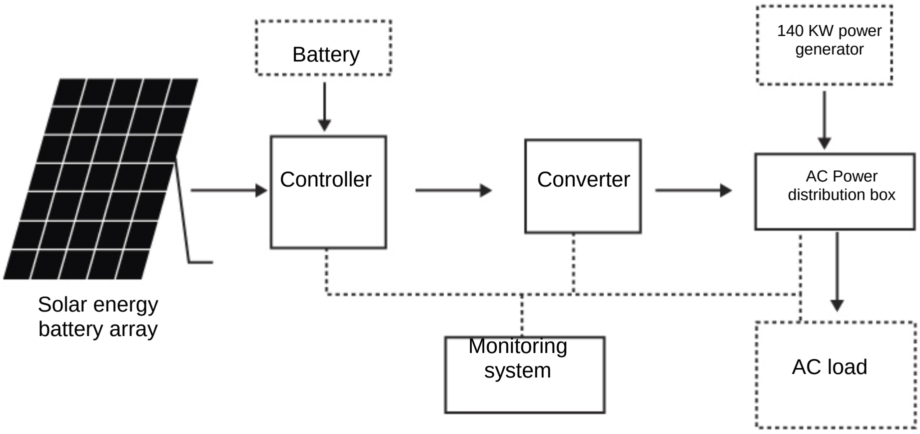


Fig. 24 Solar energy photovoltaic power generation system

Solar energy photovoltaic generation system consists of photovoltaic arrays, solar energy battery, supportive structure, connection boxes and cables, etc; DC/AC inverter system including grid inverters; power distribution and lightning protection unit, DC distributor, DC lightning prevention, AC distributor, AC lightning prevention; system-monitoring unit, system -control unit, data-detecting and-processing and display system, telecommunication and exchange facilities and the indication unit for system operation.

The 50kw solar energy photovoltaic generation system under design will be an assemble of 304 blocks of 165w solar energy batteries, in which 16 blocks in series connection and 19 blocks in parallel connection constitutes a large matrix. The solar energy batteries are installed with an incline of 80^o to the north.

In consideration of the harsh environmental conditions and the needs for environmental protection in the Dome A region, it is planned to purchase pre-fabricated solar energy battery board system which will be assembled on the site. The units are connected with plug-in connectors before being shipped. This design will not only be convenient for the installation, but also for reduction of risks from the direct contact with the wire in the field. The field work will be connection of the existing AC distributors of the power generation system.

In addition, in order to facilitate the installation, the units, by design, can be integrated with the holders, therefore no media or tools are needed for the assembling. In the shipment, the holders of the units can be folded to make the units more compacted and reduce the assembling steps.

It is planned to install and adjust $60m^2$ of the solar energy photovoltaic generation facilities in 2008/09 austral summer, and $140m^2$ of the facilities in 2009/10. Hopefully, through adjustment by 2-4 years, it can be the main power source for summer operation.

The maintenance of the solar power station will be very simple. Once the power station is put into operation, the control software will automatically control the power generation without any fixed professionals for maintenance or operation. The lifetime of the whole unit is expected to be 20 years. In the Qinghai-Tibet Plateau, the similar units have been running for 10 years and are still in good conditions up to now (Fig. 25).

The dismantlement of the solar energy power station will be rather simple. Once they are out of service, they will be cleared out of the Dome A region and transported back to China.

Fig. 25 Solar energy photovoltaic power generation system in the Qinghai-Tibet Plateau

3) Power distribution system

A power distribution cabinet will be equipped in the power generation room. In addition, an emergency power distribution cabinet that switches with the emergency power source will be also equipped.

The output cable will be laid in a radiation way to various buildings along the bridges in the intercalated layer of the buildings. An overall power distribution box or power distribution cabinet will be equipped in each functional zone from where power is distributed to each electric equipment or systems.. The lines inside the room that uses combustion-preventive or fire-preventive cables for safety will be arranged in the line trough. The out-door cables can tolerate as low temperature as -90℃ for working and -50℃ for installation.

4) Lighting system

The lighting system consists of general room lighting, out-door lighting and emergency lighting by functions.

The in-door lighting source will consist of fluorescent lamps and energy conservation lamps and the out door lighting source will consist of metal halogen lamps (working temperature lower than -90℃), more tolerant to low temperature. The emergency lamps equipped with individual batteries will be fixed in the power distribution rooms, the key engine rooms, the stairs and the corridors. Indicator lamps will be arranged in the evacuation route and the exits for safe evacuation.

5) Grounding and safety system

As the Station is on the ice sheet and the electric resistance of ice is very high, it will be very difficult to make the ground resistance rather low. In consideration of the reliability of power supply, the power distribution system in the Dome A Station will adopt the mode of non-grounding of the neutral point. The safety measures will include the connection between the overall iso-electric potential and local iso-electric potential for balancing the potential and decreasing the contact voltage so as to bring the voltage below the safe value and prevent electric shock accidents. An insulation monitoring unit with warning function will be connected to the outlet of the general power distribution board，which will remind the manager of examination and repair by sending out warning signals. No neutral line or single-phase load will be allowed for the power distribution system and a 400/230V transformer and a return-circuit with leakage breaker will be used for protection. Static electricity prevention measures (by static electricity prevention ground coiled material) will be used on the special electronic facilities. Special soft grounding cables buried under ice will be used as the grounding unit.

Grounding resistance: The grounding of the electric appliances will be made together with the grounding in the overall iso-electric potential combination in the station.

6) Automatic fire alarm system and fire-fighting linkage control system

The fire-fighting linkage control system controls the non-fire protection power source and acoustic and light alarming units for fire accidents, etc. The central alarming controller for fire-fighting that monitors the entire station area will be installed in the room with people on duty. Regional warning controllers are distributed inside the building base on needs. Fire alarming lines, linkage control lines, fire protection telephone lines and broadcasting lines are laid in steel tubes inside the wall. The circuits out of door are armored and laid along the supporters of the facilities.

The system leaves a remote terminal in advance by which the communication system may transmit important data and information.

7) Monitoring and control system for facilities installed

The monitoring and control center for facilities installed is set up in the building of power generators.

The monitoring and control system will monitor and control the boiler system, ventilation system, water supply and drainage system, in-door and out-door lighting system and power distribution system in the station for energy-saving operation and intelligent management.

The monitoring and control cables will be deployed openly in the wire trough on the wall inside the generator room and the out-door trunk cable are armored and will be deployed along the supporters of the facilities.

The system leaves a remote communication terminal in advance by which the communication system can transmit important data and information.

8) Communication and information system

In consideration of its remote location and harsh environmental conditions of the Station , it is imperative to build up an effective telecommunication system.

The maintenance of no interruption of the telecommunication system at any case will be a major issue to be considered in the design of the communication system. As a result, the system design takes into consideration not only the preparation of the duplicate equipments for that between different and in the same communication systems, but also the distribution of the location of the communication equipment. The construction of the communication and information system will include radio telecommunication system, local computer network, telephone auto-exchanger system inside the station, radio communication system inside the station, remote tracking and management system for the transport vehicle convoy, aircraft radio communication system and the software application system.

2.5.7 Emergency facilities

For guaranteeing human life and living safety, the Dome A Station has taken into consideration the construction of emergency facilities, which consists of emergency power generation cabin, emergency accommodation cabin, emergency living cabin, life vests, tents and other emergency facilities, for their specification and quantity, please see Table 10.

Table 10 Description of emergency construction

No.	Item	Description	Remarks
1	Emergency power generation cabin	1container building	
2	Emergency accommodation cabin	1container building	15people
3	Emergency living cabin	1container building	
4	Emergency storage	1container building	
5	Life vests	15 sets	
6	Tents	8	2 people in each
7	Other emergency facilities	Snow sticks, bags, ropes, walky-talkies	

2.5.8 Special machineries and vehicles for station construction and transportation

The machineries and vehicles in the Dome A Station will be mainly used for the construction project, construction maintenance and repair, loading and unloading operation, clearance of road surface and accumulated snow, hauting and lifting operations and materials transport, etc. The transport vehicles are used inside the Station or for short-distance transport in the field.

1) Environmental requirement for special machineries and transport vehicles

Firstly, the storage batteries, starters, hydraulic, oil lines and electricity systems for special machineries and vehicles should tolerate low temperature and meet the requirements operating in the Dome A area. On these facilities, electricity or boiler pre-warming systems will be installed to guarantee the normal starting. Secondly， as the annual average wind velocity is 2-4m/s in the Dome A region, the particular machineries selected should have excellent properties of sealing and heat insulation, and easy to remove effectively accumulated snow from them. Thirdly, the low atmospheric pressure which is about 40% of that on the sea surface and low oxygen concentration in Dome A region will cause lower combustion and dynamics of the machineries. Therefore, these challenges have been taken into consideration in the selection of the vehicles. At the same time, measures should be adopted to control the overflowing of hydraulic oil and anti-freeze liquid under lower atmospheric pressure.

2) Selection and composition of special machineries and vehicles for the construction project

In consideration of the mission of the Station and the composition of machineries and vehicles in the foreign Antarctic inland stations, the Dome A Station will be equipped with one light snow vehicle, one caterpillar carrier and five snow motor vans, among which the light snow vehicle is used for the clearance of road surface and accumulated snow and the handling of small articles inside the station, the caterpillar will be used for construction engineering, piling of materials and snow removal and melting and the snow motor vans will be used for the transport of small articles between buildings.

2.5.9 Test and acceptance

Test and acceptance of the container buildings will be made one by one in accordance with the performance in the design. The major buildings of the station will be pre-assembled and comprehensively tested at home first. In addition, the test will be made on some key systems such as the power generation system, solar energy photovoltaic system and sewage treatment system to ensure their designed function and reliability.

2.5.10 Transportation

Having past the test, the buildings are dismantled and packed for shipping in ISO-norm containers. No damage should be made to the building materials in the course of normal shipping. The installing and internal finish for containers have been completed, so that those containers can be transported directly.

In the course of transportation to the Dome A , foods for the staff will be mainly airline food that is ready once heated. The packing articles are compressed and stored. The vehicle convoy will bring with it a packet toilet free of water and all the human excretions will be packed and brought back. The vehicle convoy will bring with it a small solar energy boiler for melting snow and heating water by solar energy for daily brushing and washing. At present, a solar energy water boiler will be in trial use in 24th CHINARE in the inland Antarctic.

2.5.11 Engineering work in situ

In consideration of the extreme geographical and climatic conditions, especially the low oxygen concentration of Dome A (which is equal to the oxygen concentration in Mt.Nyainqentanglha with an elevation of 5000m in China) as well as to reduce the environmental impacts to the greatest extent, the construction will be done mainly by assembling pre-prefabricated containers in the field to reduce as much workload as possible.

The solar energy power generation system will be built up with the battery boards pre-fabricated at home and by assembling them in situ. The parts are connected with plug-pull connectors before the shipping. This way of design will not only be convenient to the installation, but also reduce the risks of electricity shock against the expeditioners in the filed.

2.5.12 Upgradeability

The Dome A Station is designed to have a minimal lifetime of 25 years. The design has taken into full consideration its upgradeability and capacity for extension, such as the routine facilities (including kitchen, sanitary facilities and offices) and emergency shelters. In design, the station will be suitable for accommodating more people. For the supply of energy to the station, the issues of keeping sustainable power and heat supply have been considered. Therefore，it will be easy to use new technologies in the future to turn the station into a perennial station with minimal efforts.

2.5.13 Documentation

To manage the station more properly，relevant data and documents will be recorded and preserved, which include users' manuals, maintenance manuals, assembly drawings and instructions, spare part lists and emergency procedures. Three sets of backup data will be available for the filing in the Dome A Station, the Zhongshan Station and domestic management platform for guaranteeing the exchange of ideas and solving technical problems.

2.5.14 Decommissioning of the station

The design of the station will take environmental protection, safety, energy saving and economy as the principles. It will use as much as possible the sustainable and high energy efficiency technology as well as the renewable energy so as to reduce the waste to the maximum extent. Once the station has to be closed due to technical reasons or other requirements, the station will be easily decommissioned, disassembled and removed, and no obvious remnants of the occupation will be left. The eventual clean-up of the removed station should be also subject to an EIA.

2.5.15 Minimum environmental impact objectives

1) Design criteria

- The designed maximum target energy load is 50 KW for the station, excluding a few scientific equipment and support vehicles. The station is designed to use aviation kerosene during the process of construction, operation and decommission
- An experiment on photovoltaic solar energy for power generation and heating will be conducted with an intention to adopt solar energy as the power source in austral summer at the Station in 2-4 years. For terms of long objective, the solar energy will provide a portion or overall power for heating and some scientific equipment
- To use as much recycle water and solid waste as possible and to minimize disposal of solid wastes and discharge of treated water up to the standards
- The station has been designed to guarantee keeping the environmental impact to a minimum degree during the construction, operation and decommissioning

2) Construction and operation

The methodologies of construction, operation and decommissioning have been planned to meet the requirements of the Protocol on Environmental Protection to the Antarctic Treaty and the relevant Chinese domestic laws and regulations.

The construction, operation and decommissioning of the station will be managed under the framework of the Environmental Management Plan which includes the waste management regime. The construction, operation and decommissioning has been planned to minimize health and safety risks during all stages. The training courses and necessary protection equipment will be provided for all personnel involved to reduce the likelihood of major health or safety incidents. The construction team will be managed by CAA. The key-construction team has already been involved in the pre-construction in Beijing and Shanghai in order to become acquainted with the construction itself. Expeditioners and constructors will be briefed by the staff of CAA prior to their departure for Antarctica to ensure that they understand and fully comply with the relevant provisions of the Protocol on Environmental Protection to the Antarctic Treaty and its Annexes and related domestic laws. Environment officers will also be appointed to practise and monitor the environmental protection in situ.

2.6 Area of Disturbance

2.6.1 Operation area

The area of disturbance includes construction site, material storing area, the route between the Zhongshan Station and the Dome A Station and the area around the station. The maximum range of field scientific activities in summer will be 80 km from the station.

Once the station is put into operation, the area of disturbance within the Station will include the buildings and facilities. Around the Station there will be camp base for ice drilling, observatory. So the total disturbed area will be about 2 km^2. There will be additional disturbances by the yearly long-distance transportation from the Zhongshan Station to the Dome A Station, the transportation of few personnel and small amounts of cargo to and from the Station by planes in the future. The waste removal from the Station will also cause disturbance.

2.6.2 Duration and intensity of the construction

The total construction area for the Dome A station is 623 m^2 (of which, 204 m^2 for the container building and 419m^2 for the assembled building), along with 1000 m^2 for the simple depot area and the operational yard and 200 m^2 for the solar energy photovoltaic facilities.

The construction of the Station is planed to start in the austral summer of 2008/09 and completed in two austral summers in 2008/09 and 2009/10. In at least ten years after the construction is completed, the Dome A Station will be just operated as a summer station. The minimum lifetime of the Dome A Station will be 25 years. Of course, the duration of the construction depends on weather conditions and transport availability. The capital construction projects consist of the main buildings (accommodation, communication, living, medical service, scientific research, etc.), the logistic section (power generation house, storehouse, emergency structures and solar energy facilities), ice drilling area and scientific observation area (Table 5).

The construction plan will be carried out by Polar Research Institute of China in accordance with Chinese relevant laws and regulations. Polar Research Institute of China will issue bidding calls for the construction and company which wins the bidding will be the contractor for the construction. A supervising company will undertake the responsibility for supervising the construction. Polar Research Institute of China and the supervising company will jointly check and accept the construction. A small part of scientific facilities will be installed simultaneously with the construction and most of the scientific facilities will be installed in 2010/11, namely the first planned season for scientific and logistic operation.

A minimum lifetime of 25 years for the station is expected.

2.6.3 Measures and Standards

CAA is developing a series of measures and standards for the management of the operation of the Dome A Station in order to guarantee the safe and effective operation of the Station. The measures and standards will minimize the risks in Antarctic expedition and environmental impacts to the maximum extent.

CAA, with the support from Station leaders will oversee and ensure the effective enforcement of environmental management plan, scientific programs, rescue plan, medical service plan and other emergency response plan and other activities in accordance with Emergency Response and Contingency Plan.

2.7 Accommodation and related Facilities

During the two austral summers for the construction, there will be 12 people working on construction site. They will live in the accommodation cabins on the sledges just as the inland expeditioners do, and the heat and electricity will be provided by the vehicle-carried power generation cabin. Before the completion of the construction of the main buildings, the food will be mainly airline food that is ready once heated. The packing articles will be compressed and stored. They will use the packet toilet free of water on the vehicles and all the human excretions will be packed and brought back to the Zhongshan Station. The vehicle convoy will bring with it a small solar energy boiler for melting snow and heating water by solar energy for daily brushing and washing.

In addition, some tents will be set up if necessary.

2.8 Waste Collection and Disposal

A Waste Management Plan (WMP) will be drawn up that will comply with all the requirements of Annex III of the Protocol on Environmental Protection to the Antarctic Treaty. The plan will comprise waste reduction, storage and disposal, removal of treated waste out of Antarctica, as well as the training and education on environment protection to the expeditioners.

The Waste Management Plan will consist of two parts. The first part will cover the management of the waste produced due to the construction of the Station and the associated activities. The second part will cover the management of the waste produced due to ongoing operation of the Station. The Plan will be regularly reviewed and updated.

The Waste Management Plan covers. management and responsibilities,. minimization of waste, waste storage and handling, waste disposal, prohibited products to be brought into and used in Antarctica.

2.8.1 Waste

At the station, the wastes will be classified and separately stored in different cans. Most of the wastes will be removed from the Station to the Zhongshan Station and then transported back to China for treatment, and only a very few will be left and treated in the Zhongshan Station.

The Station will practise a waste classification management system. All the wastes will be classified into four categories, including recoverable wastes, organic wastes, hazardous wastes and unrecoverable wastes, and they will be stored in different rubbish containers respectively. The recoverable wastes consist of 9 categories, such as plastic, rubber, metals, glass, paper, textiles, bamboo or wooden articles, discarded units of electrical appliances. The organic wastes mainly come from food and they will be sealed and stored timely. The hazardous wastes will be further classified into two sub-categories as the used batteries and light tubes and other harmful wastes. The amount of unclassified wastes will be controlled to the minimum extent. These wastes will be sealed and stored timely when the container is full up. They will be compacted if necessary. Wastes bins for classified wastes will be put in such wastes generated sources as the multifunctional hall, accommodation rooms and science rooms for common rubbish such as waste paper, plastic, metals, organic rubbish and inseparable rubbish. These wastes will be taken and stored in the turnover wastes van in the wastes container by a person specially in charge of the work, and other rubbish will be taken directly to the wastes container for classification and storage.

All the human excretions will be packed and brought back to the Zhongshan Station for treatment.

The waste water will be treated and recycled as much as possible, and the limited residual treated water will be discharged into an ice pit which will be dug at a suitable place in the vicinity of the station.

The container will be transported by the inland vehicles to Zhonsghan Station, then brought back to China by R/V Xuelong. When R/V Xuelong arrives, the container full of wastes will be exchanged for an empty one. Additionally, the transport boxes are designed to be easy moved out of the container for relocation when necessary. Packing material should be minimized as much as possible in the process of logistic preparation so as to reduce the production and transportation of the waste. A garbage compactor will be used to compact the solid waste if required.

2.8.2 Fuel drums

The empty drums will be reused repeatedly in situ after a serious quality check. Those which do not comply with the requirement will be compacted and transported back to the Zhongshan Station by the inland vehicle convoy and eventually transported back to China.

2.8.3 Hazardous wastes

Purchase and use of hazardous products will be strictly restricted so as to keep the hazardous products in a minimum quantity. For instance, it will be encouraged to use rechargeable batteries. The hazardous products and their empty packaging will be stored in specific areas and subject to strict monitoring. Those hazardous wastes will be packed in a uniform way before transportation so as to ensure that they will not drop and leak out. Shipped back to China, the wastes will be subject to treatment by qualified departments.

3. ALTERNATIVES TO PROPOSED ACTIVITY

Several alternative plans of locations and designs have been examined for the construction of the new station, taking into account scientific, environmental, logistic, engineering, health and safety requirements.

3.1 Alternative for not building the station

Starting the scientific expedition in the Antarctic in the 1980s, China has established the Great Wall Station on George King Island and the Zhongshan Station in Larsemann Hills area in East Antarctica. These two stations have become not only good bases for the Chinese scientists in the full year scientific activities, but also a platform for international cooperation.

However, as the two stations are all situated in the coastal area, they can not satisfy the needs of undertaking inland scientific activities in Antarctica

Currently, in the inland Antarctica, 6 countries have established 5 stations. They are the South Pole Station of the United States, the Vostok Station of Russia, the DOME C Station of France and Italy, the Fuji Station of Japan and the Kohnen Station of Germany. With less scientific activities in the inland Antarctica, the area thus leaves more gaps in scientific study.

The Dome A Region selected for the establishment of a new station is based on scientific needs and comparatively mature logistic conditions.

The Dome A Region is an ideal site for the study on global climatic environmental changes. It is internationally recognized as a suitable site for deep ice cores drilling, the best site for monitoring and detecting the global atmospheres average baseline environment, a favorable site for detecting the variation of ozone holes and for astronomical observations. In addition, Dome A is one of the sites with the greatest challenges in geological studies in the Antarctic. The Gamburtsev, the highest base rock covered by the ice sheet in East Antarctica is the direct geo-morphological causes of the formation of Dome A. As it is at an elevation of about 4100 meters and has the greatest potential for obtaining geological samples directly under the ice sheet in the Southeast Antarctic. It might be a place with the greatest attraction for geological studies. With its extreme natural conditions, Dome A can be a good experimental site for other major scientific engineering projects to promote science advancement in some special areas such as low temperature engineering materials, telecommunication technologies and human medical sciences under extremities.

CAA has organized five expeditions on the inland ice sheet along the Zhongshan Station-Dome A from 1996 to the early 2008, and the 21th CHINARE successfully arrived at the summit of Dome A in January 2005 for the first time. The systematic science surveys carried out by CHINARE have laid foundation for the site selection and the exploration of possible logistic support pattern for the establishment of Chinese station in the inland Antarctica.

The Dome A Station adopting an open policy for the operation of the Station and scientific study will be a platform for China and other countries to undertake scientific expeditions in the Antarctic. The Station will serve as a supportive base for the scientists from home and abroad who engage in the field surveys in the area of 80^0 S and 70-80^0E in East Antarctica.

Without the establishment of the Dome A Station, some important inland Antarctic scientific programs such as ice core drilling, astronomical observation and geological survey on ice sheet-covered Gamburtsev mountains could not be carried out. If taking the nearest station such as Zhongshan Station as a base for supporting scientific activities, it may cause some problems. Because of the long distance, firstly, the safety of expeditioners cannot be guaranteed; and secondly, some key science programs could not be carried out continuously.

The proposed station will adopt the sustainable and high energy efficiency technologies so as to minimize environmental impacts. China considers this decision in line with its position as one of the contracting party of the Antarctic Treaty. The "Alternative for not building the station" is considered as against further study on the Antarctica's key role in global change.

3.2 Location Alternatives

CAA has organized five expeditions on the inland ice sheet along the Zhongshan Station-Dome A from 1996 to 2005, which have carried out the comprehensive site selection survey for the inland station. Scientific needs and logistic support are the two major factors for the site selection.

The first 300 km section from the Chinese Zhongshan Station to the Dome A region is an area with highly accumulated materials. The elevation is about 2200m at the point of 300 km away from the Zhongshan Station. Except the concentrated belt of ice crevices 60 km away along the coast, this section is rather flat. It is near the Zhongshan Station and various scientific observations might take the Zhongshan Station as a base. Therefore, this section is not considered as an alternative site.

The elevation varies between 2200-2900m at the section from 300 km to 800km, and the section between 400km and 650 km is the upper reach of the Grove Mountain. This section is abundant with ice crevices, dominated by very strong katabatic wind and with a great deal of snow dunes developed, which indicates great changes in the accumulation rate. The section from 500 km to 700km is a denudation area, where a fast glacier movement exists and it is difficult to locate a proper site with continuous snow accumulation for ice core drilling. The climatic monitoring indicated that the site is of less global significance as it is under the control of regional oceanic air masses. Therefore, this section is not suitable as an alternative site.

The last section is from 800 km to the summit of Dome A. The area at 800 km is a continuous accumulation zone and from the point of 800 km onward, the magnitude of elevation rise becomes greater. Based on the chemical analysis results of surface snow in the transects, the point of 800 km is a area with the interaction between the oceanic and inland air masses, and also the turning point of elevation change. The elevation of this section rises greatest in the transect 60km away from the coast as its elevation rises from around 2900 m to about 4100 m. From the point of 800 km southward, the impact of the oceanic air gasses decreases gradually while the impact of the inland air gasses increases accordingly. In the area above 3800 km, the impact of the oceanic air gasses almost disappears and it is a proper site for the construction of an inland station (Fig 26).

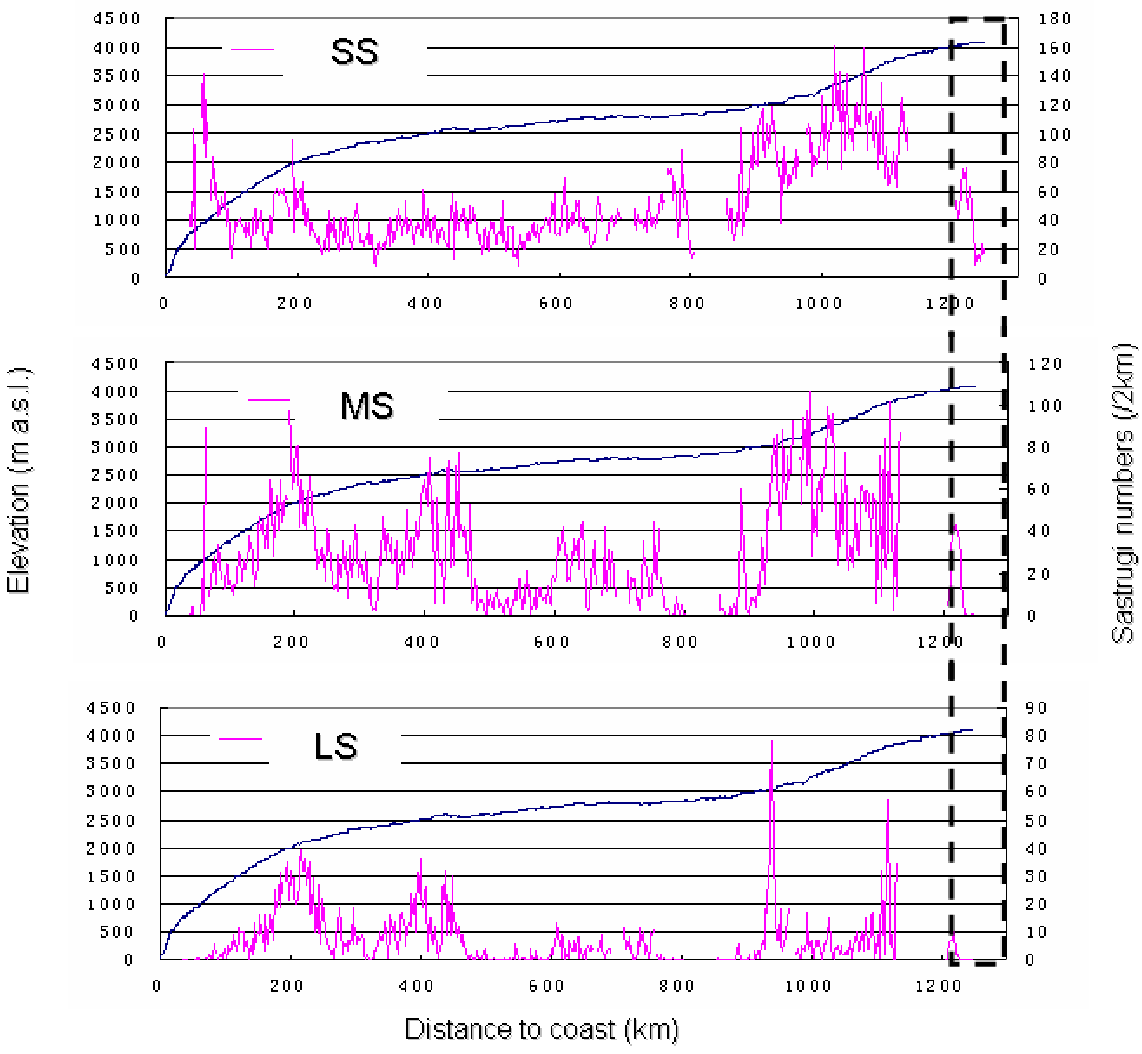


Fig. 26 The distribution of snow from Zhongshan station to Dome A
(SS: small snow drift; MS: middle snow drift; LS: large snow drift)

3.3 Alternative solutions for designs/technologies

The construction plan of Dome A Station is designed by the Architectural Design and Research Institute of Tsinghua University. During the design period, several alternative solutions have been taken into consideration upon which assessment and analysis on the environmental impacts, economic cost, personnel safety and the satisfaction on scientific planning and complexity of dismantling etc. have been made, and finally, the design summarized in Section 2.5 has been selected.

As for energy conservation, the solutions to use aviation kerosene only or supplement it with fossil fuel or solar power was considered. If the aviation kerosene is used, 30t of kerosene will be needed for one austral summer (the work time is about one month) during the construction period.

By using the aviation kerosene as the main power source and the solar energy as the supplementary source, the pollutant emission is shows in Table 11

Table 11 The pollutant emission during the construction period of the Station

SN		Aviation kerosene consumption	Pollutants emission (kg/year)						
	Item	kg/year	CO_2	NOx	CO	HC	VOC	PM	SOx
1	Emission quota (German Federal Environmental Agency, 2005)	1	3.18	0.0404	0.0169	0.0018	0.005975	0.0022	0.001
2	Fuel consumption	30000	95400	1212	507	54	179.25	66	30

If the solar energy is be adopted as the main energy during its summer operation in future, the pollutants emission to the local environment will be greatly reduced. At the same time, the pollutants emission caused by the fuel transportation and fuel consumption during the transportation process and the environmental risk accidents such as oil spill will decrease too. While the photovoltaic solar energy is to be used in future, only 16t of aviation kerosene will be needed during the period of one austral summer. Based on that, the pollutants emission during the operation stage is shown in Table 12.

Table 12 The pollutant emission during the summer operation of the Station

SN		Aviation kerosene consumption	Pollutants emission (kg/year)						
	Item	kg/year	CO_2	NOx	CO	HC	VOC	PM	SOx
1	Emission quota	1	3.18	0.0404	0.0169	0.0018	0.005975	0.0022	0.001
2	Fuel consumption	16000	50880	646.4	270.4	28.8	95.6	35.2	16

As for building design, selection was made between two options, one is to form the main structure of the Station by combined containers which would greatly reduce workload on site and the other is to form the main structure partly by combined containers and partly by assembling buildings prefabricated at home. The advantages of the former are less field construction workload, less adverse impacts on personnel safety and environment and low cost of the construction, its disadvantages are each container is independent and the energy consumption will be higher; The advantages of the later are the low energy consumption, efficient arrangement and linkage between different functioning sections in a limited area which will be convenient for communication and reduce the disturbance, its disadvantages are heavy workload on site and more cost. Through a comprehensive study made by the specialists, the later i.e., the present design was decided based on the consideration of the long term energy conservation and safety.

3.4 Alternative solutions for transportation

During the construction and operation stages of Dome A Station, both personnel and cargoes will be shipped from home to the Zhongshan Station by the R/V Xuelong, and then be transported from the Zhongshan Station to the station-building site by the inland vehicle convoy. For the transportation of personnel and materials by the inland vehicle convoy, not only the capability, safety and cost, but also environmental impacts are taken into consideration. After the Station is put into operation, some expeditioners and scientific equipment may fly to Zhongshan Station if the flight is available.

From the Zhongshan Station to Dome A, some other transportation means, such as fixed wing aircraft, can also be used. However, air transport may give rise to the following problems：

1. Feasible but high cost. The cargo carrying capacity is limited, and several flights are required to carry out transportation tasks, especially under the condition that various kinds of building materials are as heavy as 300t during the construction stage. 2. Safety. Because the weather on the way is changeable, it may be impossible to have a non-stop flight, thus giving rise not only to the delay of transportation, but also to the insufficient guarantee of the safety of the flight crew and the aircraft. 3. Relatively great impact on environment. As for the utilization of air transportation, fossil fuel consumed by aircraft will be much more than that consumed by the inland vehicle convoy, and that holds true of gas emissions. Moreover, it is necessary to build a special ice field runway. So, it is obvious that there is a greater impact on environment by air transportation than by the inland vehicle convoy. 4. Logistical support capability. For the flight of fixed wing aircraft, the supports such as navigational system etc. is essential, however, it is not available at the present time. Based on the above, it is the inland vehicle convoy, not the fixed wing aircraft that will be used as the means of the transportation from the Zhongshan Station to the Dome A Station.

4. REFERENCE ON THE PRIMITIVE ENVIORNMENT IN THE DOME A REGION

4.1 Geographical location

Dome A region is the remotest ice dome from the coastal line of Antarctica, as well as the summit of an inland ice sheet with the shortest distance to the Zhongshan Station. It is located in the East Antarctic Plateau hinterland and the middle section of the main ice divide of ice sheet. The 21st CHINARE has determined that the highest position of Dome A is at 80°22′00″S, 77°21′11″E and the elevation is 4093 m. The linear distance from the plateau point to the Zhongshan Station is 1228km, and the actual driving distance is 1280km by snow vehicles.

According to the satellite altimeter information, the summit of Dome A is a platform in the form of a water drop with an area of 10-15 km wide and about 60 km long extending along the NE-SW direction. The platform is only 2-3m in elevation difference and the highest point is on the north side of the platform.

According to the observation data of automatic meteorological station set up at the highest point of Dome A by the 21st CHINARE, the minimum temperature of the area in 2005 was -82.3℃(observed on July 27, 2005), the maximum temperature in summer was -35℃, the atmospheric pressure was between 550～590 hPa, the yearly average wind velocity was less than 5m/s, and the maximum wind force did not exceed 8m/s, normally 2～4m/s.

Ice radar monitoring shows that the ice thickness ranging from 1500m to above 3000m at the highest area of Dome A varies a lot with the changes of landform covered beneath, and the variation is concentrated in a relatively small area. The snow layers with a thickness of more than 500m are level, stable and the yearly accumulation rate is very low.

Due to its harsh climate environmental conditions, this area is regarded as an “inaccessible area” and a few scientific expeditions have been made since the 1957-1958 International Geophysical Year.

4.2 Geology

The Antarctic continent was the core of super-continent in the geological history. However, over 98% area of the Antarctic is covered by ice and snow, therefore, human’s knowledge on the vast internal geology and structure of the Antarctic mainland comes only from the coastal scattered outcrops and the rare inland mountain ranges of the Antarctic. This indicates that information on the basic geographical elements inside the East Antarctica is still very deficient, and human’s knowledge on the East Antarctic craton can be possibly very incomplete.

Dome A area is one of the most challenging place in the Antarctic geological study. Gamburtsev Sub-glacier Mountains located at the highest point of under-ice bedrock of the East Antarctic is the core part of the East Antarctic ice divide mountain chain, as well as the direct forming cause of the formation of Dome A landform. The most distinct relief feature of the East Antarctic may also have a bearing on its formation. Therefore, Gamburtsev Sub-glacier

Mountains are probably the inland outspread of the Prydz Orogen in the Pan-African period. Because that it is nearly 4100 m above sea level and its peak almost pierces the ice cover, it is very likely to become the place in which to directly obtain geological samples from the Antarctic inland ice sheet. Therefore, it is the most attracting area for the study of Antarctic geology. Cooperated with some other countries, China will conduct comprehensive geological survey in this area (Fig 27).

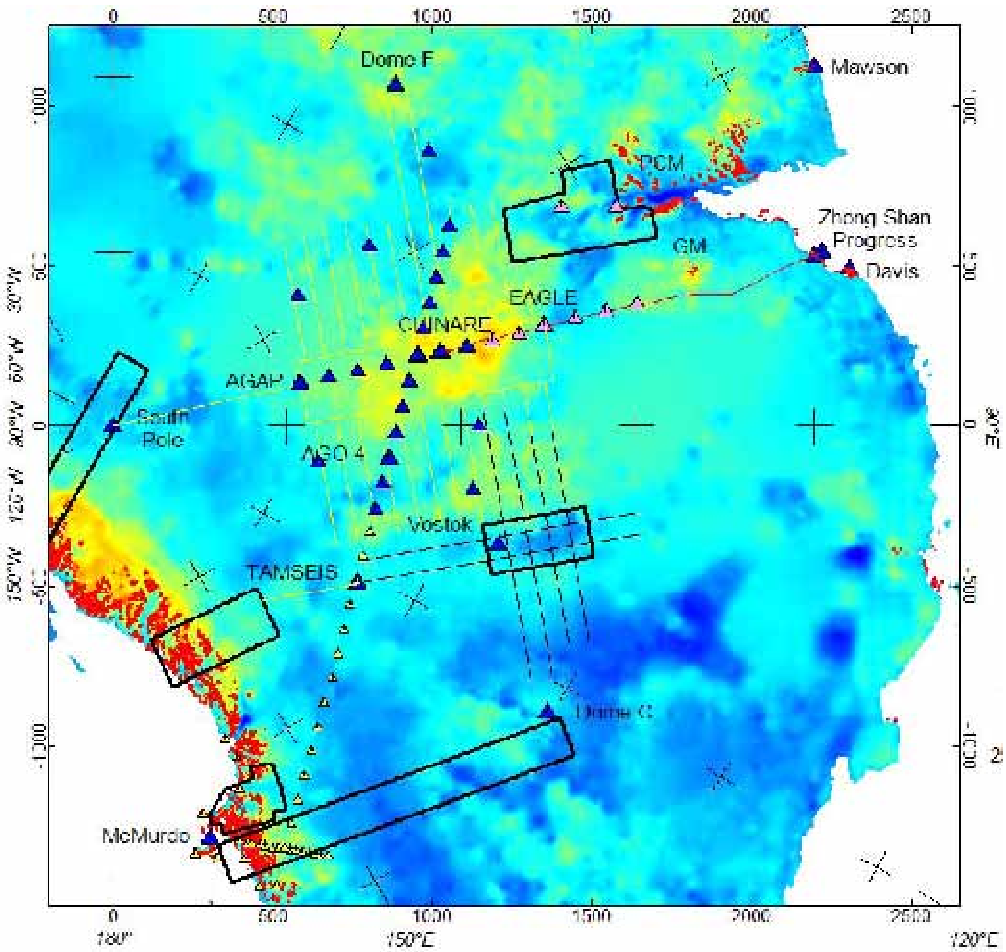


Fig. 27 Geological surveying route during the 4th IPY

4.3 Glaciology

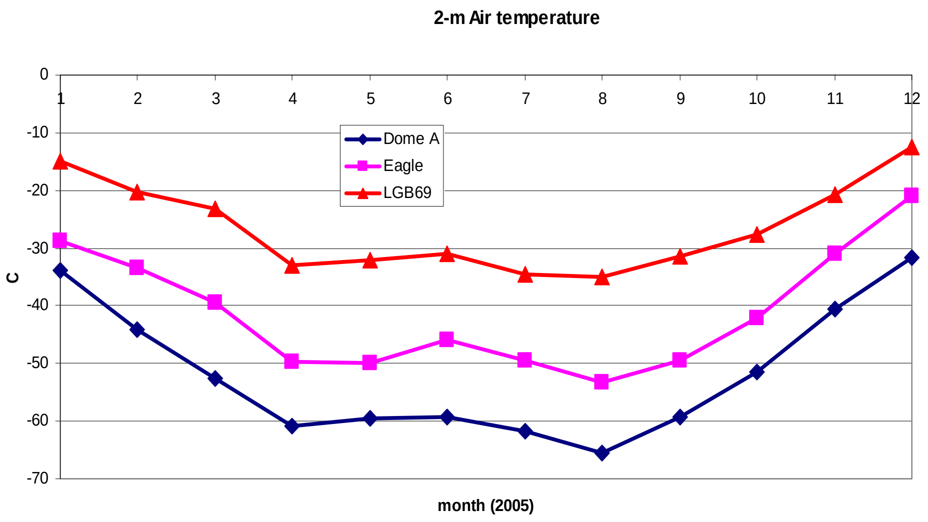
Dome A area is a recognized ideal place for drilling ice cores with an age exceeding one million years (1Ma). A 1Ma-exceeding ice core has been earnestly longed by the palaeoclimate circle of the world because it can be used to unveil the function of greenhouse air masses in the cycle change of earth orbit. At the present time, one of the most important IPICS objectives is to seek such a drilling place. Therefore, Dome A area has become an expedition place in which countries and regions including China, the U.S.A., EU and Australia etc. are interested (Fig. 28). From the point of view of glaciology, being located at the top of ice sheet, Dome A is crucial to the precise simulation of ice sheet flow and the study on the relationship between the ice sheet and the sea level.

Fig. 28 Collection of Antarctic snow ice samples

4.4 Climate

4.4.1 Air temperature

According to the observation data of automatic meteorological station set up at the highest point of Dome A by the Inland Ice sheet Expedition Team of the 21st CHINARE ,the average yearly temperature determined in the whole year of 2005 was -58.4℃, the minimum temperature was -82.3℃(observed on July 27, 2005) (Fig. 29), the maximum temperature in summer is -35℃. It is an area with the lowest temperature of the earth. Due to global warming, the meteorological record for the past 3 years has not broken through the value of the Vostok extremely low temperature, however, in the present climate context, Dome A area is a place with the lowest global ground-surface temperature and is the global "Cold Pole". This special condition provides a natural place for the study of the medicine of the human body (physiology and psychology), microbiology and materials science under extreme environment.



Dome A extreme minimum 2005: -82.3 July 27

Fig. 29 Monthly average temperature of 2005 between Zhongshan Station and Dome A at different elevations

4.4.2 Wind velocity and direction

As Dome A is located in the heat sink area of the atmospheric circulation of the South Hemisphere, wind velocity there is the lowest throughout Antarctica; the average yearly wind velocity is about 2-4m/s, the maximum wind force does not exceed 8m/s, and there is no fixed wind direction. Wind velocity in that area is even lower than that in other places of Antarctic ice divides like Dome C and Dome F (Fig. 30). These data show that Dome A provides not only comparatively comfortable apparent temperature to human Beings, but also a good place for astronomical observation and snow-air interface process study. And of course, low wind velocity and low snow accumulation rate (<2cm w.e./a) also mean that the buildings of the Station are not apt to be buried by snow.

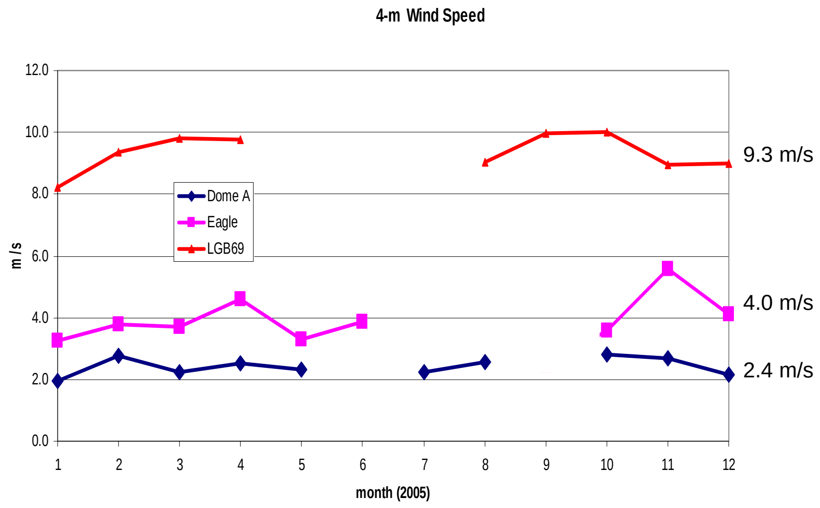


Fig. 30 The average monthly wind velocity in 2005
of the Zhongshan Station-Dome A section at different elevations

4.4.3 The atmospheric pressure

The atmospheric pressure of Dome A is about 550-590 hPa, without large amplitude of seasonal change. The altitude acclimatization and the sensitivity of various kinds of instruments are adaptable to the pressure. (Fig 31)

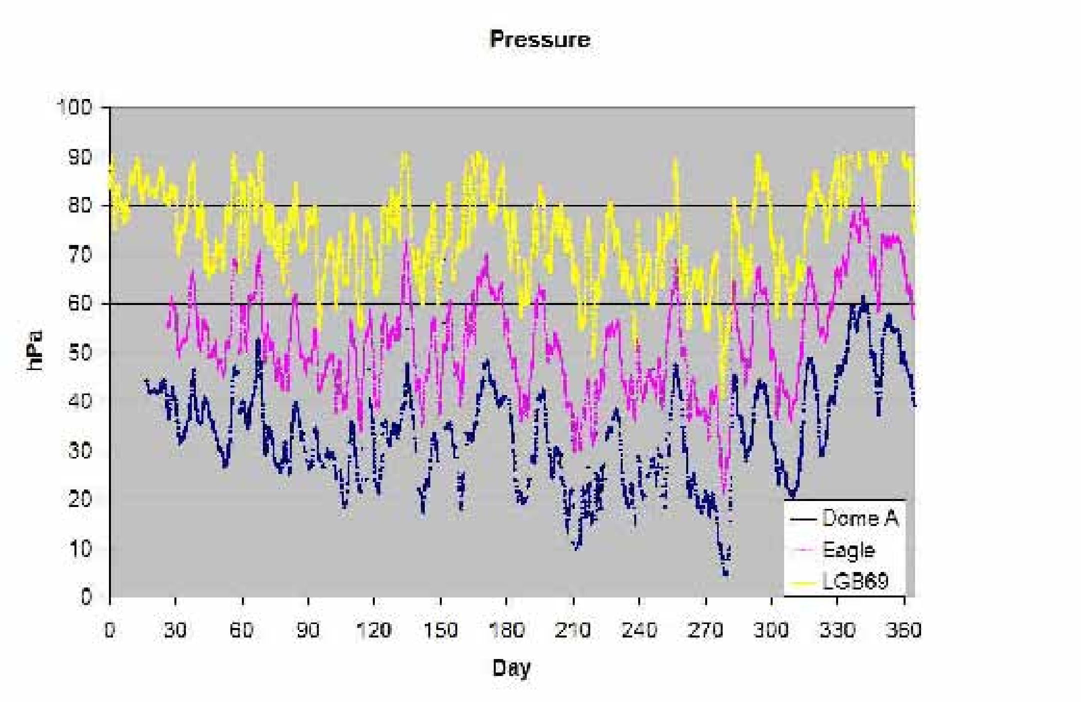


Fig. 31 The atmospheric pressure change of the Zhongshan Station- Dome A section at different elevations in 2005

4.5 Biodiversity

Due to the harsh environment of Dome A area, there is no fauna and flora living in the area of the Station to be built. There might be some microorganism fauna on which no information concerned is available for reference for the time being. The Chinese scientists are making analysis of the snow ice samples collected from the area, so as to obtain relevant basic data.

4.6 Tourism

At present, there are only a few scientific expeditions organized by the governments of some countries, and no expedition organized by non-governmental organizations has been found. It is estimated that the cost of entering this area and the safety considerations will constitute the factors restricting such kinds of activities in a long future period of time. This area is not suitable for the tourism activities of mankind.

4.7 Protected area, Historical sites and Monuments

In the area where the Station is proposed to be built by China, there is neither Antarctic Specially Protected Area (ASPA), nor Antarctic Specially Managed Area (ASMA), nor Historical sites or Monuments.

4.8 Prediction of the future environment reference state in the absence of the proposed activities

Under the condition that the proposed activities are not be conducted, the primitive snow-and-ice landform of the area will maintain, the value of wildness in the area will not be affected, and the meteorological and glacial processes will keep on affecting the landform of the area. However, limited scientific expedition activities will be conducted in this area by some countries including China.

5. IDENTIFICATION OF THE ENVIRONMENTAL IMPACTS AND PREVENTATIVE OR MITIGATING MEASURES

In the Dome A region the area which will be mostly interfered by construction and operation of the Station covers the whole area of the Station with a circumference of approx. 1 km^2. Additionally, the transportation route of inland vehicle convoy etc. will also be affected area to some extent.

The following sections define the direct impacts of the proposed construction, operation and logistic support activities of the Station on the local environment. The inputs and outputs of the activities as well as their potential impacts on the environment are assessed by means of the source-channel-receiving process. And then, measures for the mitigation of these impacts are presented. Assessment on the impacts and measures of impacts mitigation is provided in the Impacts Matrix at the end of the report.

The direct environmental impacts derive from：

- Construction activities
- Emission of exhausted gas and oil spill
- Drainage of waste water up to the standard after treatment

Among these impacts, air pollution and particle fallout are determined as the most important ones. However, the probability of large-scale oil leakage is relatively low. The adverse impact of residual water is relatively low as the related treatment meets the standards required. As far as the scientific research is concerned, the estimated impacts include the air pollution caused by consuming fossil fuel which may affect atmospheric chemical determination, interference to snow surface and hence affect meteorological observation, the potential impacts of light haze derived from the construction of the Station and the interference of electro-equipment and vehicles of the Station in electromagnetic observation.

As a matter of course, this design plan also formulates prevention and mitigation measures, so as to avoid or reduce all the estimated impacts.

All construction work and operation activities in the Dome A Station, as well as any other activities in the actual process beyond the original plan must meet the requirements of the Protocol on Environmental Protection to the Antarctic Treaty. CAA will carefully supervise the implementation of the contract, and provide environmental protection education and pre-departure training for the personnel participating in the station construction and scientific expedition activities.

Sustainable and highly efficient techniques are taken into full consideration on the aspects of materials selection, the utilization of renewable energy sources, maintenance and management, waste treatment, recycling utilization, the development, dismantlement and clearance of the station in the future. Therefore, it will be of great advantage to the mitigation of impacts on environment.

Description of indirect and cumulative impacts is shown in Section 6.

5.1 Methods and data used to predict impacts

The environmental impacts of the construction and operation of the Dome A Station are predicted on the basis of expert judgment, using the results of scientific research. The following indexes are used to make qualitative and quantitative assessment on the potential environmental impacts in Sections 5.3 ~5.12. These indexes and assessment guidelines are applied in the impact matrix of Section 5.13.

Nature

The nature of the impacts caused by the activities on potential receptor.

Extent

Affected geographical areas including local, regional, the Antarctic and global areas.

Duration

Whether the duration of impacts is in very short term (minute to days), short (weeks to months), medium (years), long (decades) , permanent and unknown. There may be a lag time between the occurrence of the result and the time of the impacts.

Intensity

General impact seriousness is assessed at different degrees (low, medium and high)；low degree means that there is only the influence of small effect on the natural function or process, and that this influence is reversible；medium degree means that there is the influence of effect on the natural function or process, but the process is not affected by a long-term change and this influence is reversible；high degree means there is the influence of long-term or cumulative effect on the natural function or process, and such impacts is probably irreversible.

Probability

Possibility of impact arising is assessed at different extents of probability, i.e., low, medium，high and certain.

Significance

The overall significance of impacts is assessed at different degrees (very low, low, medium, high and very high).

Description of effect

Specific impacts are qualitatively classified as direct impact, indirect impact and cumulative impact. Specific descriptions of these three categories of impacts are shown in Section 3 of Annex 1 of the Protocol on Environmental Protection to the Antarctic Treaty. Various definitions made by the CEP (2005) are adopted in this comprehensive environment assessment report.

(1) Direct impact：Any first order effect, impact or consequence that may be associated with activities.

(2) Indirect or second order impact：Any second order effect, impact or consequence that may be casually associated with activities.

(3) Cumulative impact：Effect, impact and consequence that may come from similar or varied sources, but that are additive, antagonistic or synergistic in the effect, impact and consequence.

5.2 Source, pathways and receptors

The source-pathways-receptors principle has been used for identification the impacts possibly arising from activities and it conforms to the Protocol on Environmental Protection. The impact may be greater than estimated.

Environmental impacts arise from：

- Activities of capital construction
- Emission of exhausted gas and oil spill
- Emission of waste water up to the standard after treatment
- Noise
- Influence from the interference of visitors

The geographical areas to be affected include the route from the Zhongshan Station to Dome A and the location of Dome A station. The areas where scientific activities are conducted relying on the Dome A Station will also be affected to some extent. Besides, the unloading point of the Zhongshan Station and the navigation route of ships are all likely to be impacted.

The position where the Station will be located is on the inland ice sheet. As ice is a medium, derived waste or discharging phenomena arising in some areas may move to another area with the floating medium, though it may take a long time.

5.3 Atmospheric emission

Energy-saving is one of principles for the design of the Station, the purpose of which is to utilize renewable energy sources as far as possible in order to reduce the demand for the fossil fuel and to lower the impact of atmospheric emission on environment. At the initial stage of capital construction, the demand for fossil fuel may be greater, because that the solar power equipment can not be put into operation. However, as soon as the solar energy facilities in operation, the demand for fossil fuel will be reduced to the lowest possible extent.

Fuels to be used include:

- Aerial kerosene JetA1(Vehicles, and power supply)
- Lubricating oil and hydraulic oil (Mechanical equipment and vehicles)

All the solid waste of the Station will be brought to the Zhongshan Station, no incinerator will be provided in the Dome A Station, and no waste will be burned there. Hence, there will be no atmospheric emission arising from the burning of waste. The atmospheric emission during the capital construction will mainly arise from the consumption of fuel used for vehicle operation and heating-oriented power generation. During the operation stage of the Station, the vehicle operation will become the main emission source. Besides, carbon dioxide emitted from the process of waste water treatment will also give rise to slight impact on the atmosphere.

5.3.1 Estimation on fuel consumption

During the initial stage of station construction and operation, the fuel will be mainly used for four purposes: firstly, for power generation, secondly, for the operation of machinery and transportation vehicles, thirdly for boiler heating and lastly for the operation of the aircraft. After the successful experiment of taking solar energy power as alternative energy source and the solar energy is partly used for heating, fuels will mainly be used for the operation of construction machinery, transportation vehicles, boiler heating and the aircraft.

The Station will be annually re-supplied with fuels which will be shipped by R/V Xuelong to the Zhongshan Station from where the fuels will be further transported to the inland Station. These fuels will be used for the operation of the Station, as well as field transportation for scientific activities. It can be foreseen that the fuels required by the Station (excluding those for transportation) will be kept at the lowest possible amount, and accordingly, the environmental impact arising therefrom will be very limited.

The approximate fuels consumption by the Station during the construction and operation stages, before and after the operation of the solar energy is shown in Table 13. Fuel input needed by the transportation of the inland vehicle convoy has been estimated mainly according to the data on the fuel consumed respectively in the several inland expeditions that have been made by China (including the Dome A expedition in 2005). Data regarding the construction of Antarctic stations by other countries have also been taken for reference when making the estimation.

Table 13 Estimated fuel consumption required in the stages of construction and operation of the Station (tons/year)

Type and use of fuels	**Construction stage(t/y)**		**Operation stage(t/y)**	
	1st year	2nd year	before use of solar energy	after use of solar energy
$JetA_1$(Inland vehicle transportation)	110	110	60	60
$JetA_1$(Station area operation)	30	28	28	16
Subtotal	140	138	88	76

Table 13 does not cover the fuel consumption of maritime transportation, because maritime transportation has constituted part of China's regular annual Antarctic expedition activities, and it is necessary for China to undertake annually the shipment of fuels, materials and personnel to the Zhongshan Station.

5.3.2 Assessment of pollution impact on the atmosphere

1) Unloading from the vessel along the coast

Unloading from the vessel will be carried out mainly by boats, a small number of expeditioners and some cargos would be carried to Zhongshan Station by helicopter. The days which are needed for the unloading work depends on several factors such as sea ice and weather conditions, time required for carrying oil or construction materials to the Zhongshan Station. Normally it will take 7 days for unloading from the dock at the Zhongshan Station. One or two extra days may be needed for unloading during the construction and operation stages of Dome A Station. Emissions along the coast will be spread out rapidly, hence, no obvious impact will be brought to the wildlife, oceanic system or atmospheric quality.

2) Transportation route

The transportation between the Zhongshan Station and Dome A Station will be carried out by the inland vehicle convoy. The exhausted gas arising therefrom will be emitted on the way to the atmosphere. This kind of emission will repeat every year. However, as soon as the Station comes into operation, the emission of exhausted gas will be reduced due to the decrease of the transported materials and personnel. The emitted exhausted gas will spread out rapidly. However, in some local areas where the exhausted gas stays for a longer time, the concentration of the emissions may increase. Because of the difference in wind velocity, the emissions in lower elevation will spread out faster than that in higher elevation.

3) Construction and operation stages

In the capital construction stage, as there will be more human and vehicles activities, and absent of solar energy power, the fuel consumption at the Dome A Station will be relatively high and, so is the atmospheric emission. However, once the solar energy power is put into operation and partly heating will carried out by the solar energy, the fuels will mainly be used to support the field work and the operation of number-limited vehicles, and as a result, the atmospheric emissions will be reduced. In the station area, another source of impact on the atmosphere will be the carbon dioxide arising from the treatment of wastewater.

The fallout of burnt substances occurring in the Station may possibly deteriorate the snow and ice surface of Dome A area and its surrounding areas. And this may result in cumulative impacts on these areas in the service life of the Station. In the Dome A area, there is no fixed wind direction (See section 4.4 Climate), therefore, the atmospheric emission will generally spread out from the Dome A area.

Heavy particulates may deposit in the areas near the Station, which may result in adverse impacts on the future study of ice. The study results of the Stations of other countries show that, the downwind direction pollution to snow and ice may reduce rapidly to their initial level at the place 10 km away from where the pollution originates.

(1) Estimated atmospheric emission in the stage of station construction

The stage of station construction will cover two austral summers, and each construction stage will last approximately 1 month.

During the austral summer of 2008/2009, it is estimated that 140 tons of aviation fuels will be needed, of which 110 tons will be used for inland transportation, and 30 tons for the operation of the Station area. In that year, the total annual emissions of various pollutants will be as follows respectively: CO_2 445, 200kg; NO_x 5,656kg; CO 2366 kg; HC, 252 kg; VOC, 836.5 kg; PM, 308kg; SO_x , 140 kg. (Table14)

Table 14 Pollutant emission into the atmosphere in the construction stage of 2008/2009

SN.	Item	Consumption kg/y	Pollutant emissions (kg/y)						
			CO_2	NOx	CO	HC	VOC	PM	SOx
	Emission quota	1	3.18	0.0404	0.0169	0.0018	0.005975	0.0022	0.001
1	Inland vehicle convoy (Jet A1)	110000	349800	4444	1859	198	657.25	242	110
2	Station area operation (Jet A1)	30000	95400	1212	507	54	179.25	66	30
3	Subtotal	**140000**	**445200**	**5656**	**2366**	**252**	**836.5**	**308**	**140**

During the austral summer of 2009/2010, the estimated consumption of aviation kerosene will be138 tons, of which 110tons will be for the inland transportation, and 28 tons for the short distance transportation of vehicles in the station area. In that year, the total annual emissions of various kinds of pollutants will be respectively as the follows: CO_2, 438,840kg; NOx 5, 575.2kg; CO 2, 332.2 kg; HC, 248.4 kg; VOC, 824.55 kg; PM,303.6kg; SO_x , 138 kg. （Table. 15）

Table 15 Pollutant emissions into the atmosphere in the construction stage of 2009/2010

SN	Item	Consumption kg/y	Pollutant emissions (kg/y)						
			CO_2	NOx	CO	HC	VOC	PM	SOx
	Emission quota	1	3.18	0.0404	0.0169	0.0018	0.005975	0.0022	0.001
1	Inland vehicle	110000	349800	4444	1859	198	657.25	242	110

	team (Jet A1)								
2	Station area operation (Jet A1)	28000	89040	1131.2	473.2	50.4	167.3	61.6	28
3	**Subtotal**	**138000**	**438840**	**5575.2**	**2332.2**	**248.4**	**824.55**	**303.6**	**138**

(2) Estimated atmospheric emission in the operation stage

During the first 2 years of operation of the Station, as the solar energy photovoltaic facilities and the heating system are in the state of adjustment, the Station will take the clean fuel as the main power source. It is estimated that 28 tons of aviation fuel is needed for the vehicles transportation in the station area and 60 tons for the inland transportation. The total annual emissions of various kinds of pollutants will be respectively as follows: CO_2, 279,840kg; NOx , 3,555.2kg; CO, 1,487.2 kg; HC, 158.4kg; VOC, 525.8kg; PM, 193.6 kg; SO_x, 88kg. (Table 16)

Table 16 Pollutant emissions into the atmosphere before the solar energy is put into operation

SN	Item	Consumption kg/y	Pollutant emissions (kg/y)						
			CO_2	NOx	CO	HC	VOC	PM	SOx
	Emission quota	1	3.18	0.0404	0.0169	0.0018	0.005975	0.0022	0.001
1	Inland vehicle team(Jet A1)	60000	190800	2424	1014	108	358.5	132	60
2	Station area operation (Jet A1)	28000	89040	1131.2	473.2.	50.4	167.3	61.6	28
3	Subtotal each year	**88000**	**279840**	**35555.2**	**1487.2**	**158.4**	**525.8**	**193.6**	**88**

If the experiment of the solar energy photovoltaic facilities will be successful and the solar energy will be a supplementary power source, the estimated consumption of the clean fuel--aviation kerosene will be 76 tons among which 60 tons for the inland transportation, 16 tons of that is needed for the vehicles transportation in the station area. The total annual emissions of various kinds of pollutants will be respectively as follows: CO_2 241,680kg; NOx, 3,070.4kg; CO, 1,284.4 kg; HC, 136.8kg; VOC, 454.1kg; PM, 167.2 kg; $SO_{x,}$ 76kg (Table 17).

Table 17 Pollutant emissions into the atmosphere after the solar energy is put into operation

SN	Item	Consumption kg/y	Pollutant emissions (kg/y)						
			CO_2	NOx	CO	HC	VOC	PM	SOx
	Emission quota	1	3.18	0.0404	0.0169	0.0018	0.005975	0.0022	0.001
1	Inland vehicle team(Jet A1)	60000	190800	2424	1014	108	358.5	132	60
2	Station area operation (Jet A1)	16000	50880	646.4	270.4	28.8	95.6	35.2	16
3	Subtotal each year	**76000**	**241680**	**3070.4**	**1284.4**	**136.8**	**454.1**	**167.2**	**76**

(3)Emission impacts

Substances derived from fuel combustion are: carbon dioxide, sulfur dioxide, nitrogen oxide and particulates etc.. These substances will cause some impacts on air quality. However, generally speaking, these impacts are small. This is because, firstly, the emission of all the fossil fuels will only take place in 2 or 3 months in summer, the time will be relatively short; Secondly, most atmospheric emissions take place during the long-distance transportation, so the emissions can spread out quickly; and thirdly, there are relatively good out-spreading conditions around the Station area where there are no plants or animals. Therefore, the emitted pollutants will spread to the very low concentration.

R/V Xuelong sails along its regular navigational route, thus, the arising atmospheric emissions will spread out quickly and will not generate obvious impacts on wildlife, ocean and atmospheric quality.

The estimated impacts include those on the snow and ice surface of the Station area. This kind of pollution may affect part of the scientific value of the area. The particulates may exist in the snow and ice for a long time.

The atmospheric emission will accumulate, and some emitted gas will affect the atmospheric environment of the area, CO (Like NOx, is the catalyst consumed by ozone) will stay in the air for about 1 month, and will finally become CO_2. CO_2 is the product of maximum quantity in the combustion process. It will not directly affect human's health, however, as a greenhouse gas it will obstruct heat spreading from the earth into the atmosphere, thus having the potential to warm up the earth.

5.3.3 The mitigation measures for atmospheric pollution

Use clean fossil fuel entirely. All the fossil fuel used by the Station and mechanical vehicles will all be clean fossil fuel— aerial kerosene. The aerial kerosene has appropriate density, high calorific value, good combustion performance, and the combustion process is fast, stable, continuous and complete. It has few carbon deposits but high cleanliness and is uneasy to coke. It has no mechanical impurity or water content. Its content of sulphur, especially mercaptan sulfur content is low, thus resulting in much less corrosion to machine elements. Light oil will also be used as ship oil to the utmost, so as to meet the criteria of atmospheric emission stipulated in Appendix VI of MARPOL. The utilization of clean energy sources will greatly reduce atmospheric emission and environmental impacts.

Try to use renewable energy sources as much as possible. Energy-saving is a key indicator in the design of the Station. The Polar daytime of Dome A area is as long as 182 days. In the daytime period of December, the total solar radiation is 40 MJ/m^2 (36 MJ/m^2 for the Zhongshan Station and 24 MJ/m^2 for the Qinghai-Tibet Plateau of China in December). In the period from December to February of the next year, the solar radiation is even higher. Therefore, pretty good conditions are available to make the renewable energy—solar energy as the main energy source. Utilization of solar energy will not only reduce the energy consumption of fossil fuel, but also lower the operation cost, reduce transportation risks and the labor intensity of the expeditioners, and play a good role in the protection of the Antarctic environment.

Select equipment with high efficiency. The combustion efficiency and environmental efficiency are the principal conditions for equipment selection. For example, when selecting power generating sets and boilers, products with excellent performance and advanced technology will be selected and periodical maintenance and service shall be conducted. Vehicles will also be selected according to their combustion efficiency and environmental efficiency. Vehicles purchased or plan to purchase meet EU-Ⅳ Standards.

Adopt energy-saving technology. For example, try to reduce the use of vehicles. In the operation stage, only 1-2 heavy vehicles will be used, and periodical maintenance and service will be provided for the vehicles. If possible, catalytic converters will be installed in the vehicles to reduce the pollutant emission. In the mean time, try to reduce the operation of mechanical equipment, and provide skillful maintenance and service for the equipment so as to prevent extra fuel consumption as well as leakage. Meanwhile, the centralized ventilation device with heat recovery will be adopted.

Additionally, perfect energy management system will be set up in the Station. Scientific energy-management will not only mitigate the atmospheric emission of pollutants but will also reduce the operation cost.

5.4 Fuels and Oil spill

5.4.1 Assessment on the risk of oil spill

Clean fuels, lubricating oil and hydraulic oil will be used for the transportation of materials during the construction and operation of the Station. Most fuels will be transported in closed sledge-type fuel tanks and a small amount of fuel and oil will be stored and carried in small oil tanks during field investigation of the Station. Fuel and oil consumption is shown in Section 5.3.1.

Fuel and oil spill may occur in the following processes: in the maintaining and refueling process (including relay point) of vehicles and generators, fuel spill arises owing to the leakage of fuel tank or small oil tank, an accident occurs in the driving process of vehicle carried with fuel tank or small oil tank, in the process of refueling, pipeline breaks or leaks, during refueling and the leakage of broken fuel tank, etc. Among all the above-said cases, the refueling of vehicle and the leakage of broken tank may probably be the main cause of fuel and oil spill.

Besides, fuel spill accidents can also occur in the ship's sailing process. However, as the sailing of R/V Xuelong has become one of the regular activities in China's Antarctic expedition, the fuel spill risk in the maritime transportation process is not covered in the assessment of this report.

Fuel has relative volatility, the spilled fuel volatilizes rapidly, while its residues will still exist. Some fugitive emissions depend on the range of fuel spill. If fuel spills onto the snow, it will move to the ice layer where it may be wrapped up and kept there until it is released again. (Table 18)

Table 18 Assessment on the risks of estimated fuel oil spill at the Dome A Station

Type of spill	Probability	Max.spill (l)	Type of fuel oil
Vehicle's collision with ice sheet or grounding	Low	30,000	Jet A_1 and other oil products
Terrible breakdown of bulk fuel tank	Extremely low	15,000	Jet A_1
Carrying tank's damage caused by sea ice	Low	5000	Jet A_1
Breakage or spill of daily-used oil tank	Low	<4000	Jet A_1
Breakage or spill of boiler tank	Low	<2000	Jet A_1
Breakage or spill of waste oil tank	Low	<2000	Waste oil and lubricating oil
Pipeline breakage or leakage(ship to carrying tank) during refueling	Low	1000	Jet A_1

Damage upon lifting of fuel tank	Low	200	Jet A_1
Leakage of oil/fuel caused by generator	Low	40	Jet A_1/ lubricating oil
Small scale spill may happen when refueling vehicle or aircraft	Medium	5	Jet A_1/ lubricating oil

5.4.2 Mitigation measures for fuel and oil spill risks

Double-layer fuel tank will be provided for the storage of fuel, and the leakage detecting system will be provided for it so that oil spill risks arising from the breakage of fuel tank can be minimized.

In the respect of management, standard procedures for the transportation, handling, transferring and use of fuels will be formulated and team members will be trained to conduct correct operation in order to avoid occurrence of fuel and oil spill accident.

For equipping the fuel spill handling facilities, the refueling areas (including relay points) will be provided with appropriate fuel absorption felt, fuel spillage-preventing container and cleaning device, as well as storage to store fuel-polluted or oil-polluted ice and snow etc, so that fuel and oil spill can be handled in time.

Formulation of oil spill contingency and response plan. COMNAP and SCALOP have drawn up the guidelines of Oil Spill Contingency Plan, covering small-scale area-based fuel and oil spillage (Facility Plan) and large-scale hazardous spillage of fuel that needs joint efforts by several countries in Antarctica (Multi-Operator Plan). In the period of transportation and construction, the Station will draw up fuel and oil spill contingency plan according to the guidelines of COMNAP and SCALOP, as well as the detailed implementation plan for itself. Besides it is necessary to conduct training for the staff involved in refueling and provide simulation training for dealing with oil spill accidents. Fuel and oil handling and fuel and oil spillage response procedures will be reviewed periodically. All oil spill accidents will be reported to the manager of the Station and CAA , and will be put on record in accordance with monitoring requirements.

The Station will formulate safety measures for the spillage accidents of other oils, like machinery lubricant.

5.5 Impacts on snow - ice and the ocean

5.5.1 Impacts on snow and ice and mitigation measures

As the main buildings of the Station will be directly located on the ice surface, the environmental impacts arising from the surrounding snow's moving, clearance and compaction resulting from the construction of the Station will be very limited. As the snow covers a large area of several km^2 around the Station and the snow layer is thick, the quantity of the snow involved in the Station construction and operation, as well as the environmental impacts arising therefrom can be neglected.

Ice core drilling and the storage of the cores will be done in a pit located at sub-snow and ice surface, which means snow and ice digging is needed, it will cause slight impact on the snow and ice environment.

During the construction and operation of the Station, it will be necessary to melt snow for water; hence some snow will be piled up and stored. This will lead to slight impact on the snow and ice environment.

The exhausted gas arising from all the activities is in small amount and it will reach the most part of the snow area, however, due to the changeable wind directions, it will not deposit in any fixed snow surface. The distribution of the emissions on the snow varies frequently with the passing time, and no trace mark of gas composition can be found on the vast ice sheet.

Small amount water of the Station after reverse osmosis standard-reaching treatment will be drained into a pre-placed ice pit of certain depth via an insulation pipe. In the drainage process, the treated water will melt a part of the ice. However, as the drained water will be in very small amount, its impact on snow and ice will not be heavy.

On the way from the Zhongshan Station to Dome A, the driving of the inland vehicle convoy will compact the snow on the road surface, thus changing the natural conditions of the surface snow. However, the action of wind may mitigate such impact. In the low-elevation area, as the wind velocity is higher, the caterpillar traces of vehicles will be covered by snow quickly; while in the high elevation areas, the traces will remain for a period of time, but at last they will also be fully covered by snow.

The issue of reducing impact on snow and ice has been taken into full consideration in the design of the Station. For example., the main buildings of the Station will be directly located on the ice surface, and the accumulation rate of snow is low, the environmental impact arising from the station-surrounding snow's moving, clearance and compaction caused by the construction of the Station is very limited. Moreover, the inland vehicle convoy and the Station will apply clean fuel, i.e., aviation kerosene, and all the vehicles and mechanical equipment will be selected and procured under the condition that they must have excellent performance and be technically advanced. For this reason, the volume of waste gas arising therefrom will be low, and hence, the impact on ice snow will be little. In addition, the inland vehicle convoy will try its best to drive on the relatively smooth ground surface where there are less snow dunes so that the impact on the snow surface can be reduced as much as possible. Besides, the Station will do its best to use recycling water so as to minimize the water to be drained into the ice pits.

5.5.2 Impact on the Ocean and corresponding mitigation measures

In the construction and operation stages of the Station, the personnel and goods and materials will be transported by the Chinese R/V Xuelong which will sail along the regular navigational route.

The operation of the vessel will give rise to solid and liquid waste. The discharge of the waste up to the standard after treatment will still bring about some impacts on the marine environment and its ecosystem.

In line with the past practice of the vessel, most of the solid waste will be packed, compacted and brought back to China for disposal, while the treated sewage and part of the foodstuffs will be discharged into the ocean under the condition that the requirements stipulated in Appendix IV of International Convention for the Prevention of Pollution from Ships (MARPOL) are met. However, greatest effort shall be made not to discharge in the Southern ocean area, especially the areas within 500 nautical miles away from the coastal line.

The vessel shall keep the discharge record for some solid waste, ballast water, sewage and foodstuffs, etc.

The ship hull will be scraped and rubbed by sea ice, thus inevitably leading to the breaking-off of the antifouling paint on the hull. However, on the R/V Xuelong, only the antifouling paint containing no poisonous organic tin compounds is used.

In the stages of construction and operation of Dome A Station, R/V Xuelong will sail along the regular navigation route, therefore, the impact of the sailing at sea will not be specified in this section again. The time necessary for unloading at the existing wharf of the Zhongshan Station would only be 1 or 2 days more than that before the Dome A Station is built, therefore the impact on ocean will be less than the minor and transitory impact. As regards to the environmental issue that may arise, it is already specified in the relevant chapters and sections of environmental impact evaluation, so it will not be specified in this section.

5.6 Sewage

5.6.1 Assessment of Sewage impact

Domestic sewage (grey water and black water) will mainly come from cooking, daily washing and brushing, clothes-washing, bathing, dish-washing and human excrement (See Section 2.5.6 Water supply and drainage system).

In designing the Station, the data of wastewater amount arising from the Stations of various countries were collected, however, the data collected are very limited. According to the records of Mäkitalo (1992) and Markland (1990), the volume of the waste water produced per person per day on the average in the Wasa Station is 60 liters. Wasa Station is located on Nunatak. There are people living there seasonally, and sauna bath, shower bath, low-water-consumption dishwasher and washing machine are available. German Neumayer Station is located on the Ekström Ice Shelf, where the water consumption per person per day is estimated at 117 liters (Enss, 2004). In the American Amundsen-Scott Station, the water consumption per person per day is estimated at 95 liters (Number of personnel living there in summer is 230 -235； NSF, 2004). According to the design of the Station, the production of wastewater will be minimized, and the wastewater treatment system will be provided. In the system, the techniques of ultra-filtration and reverse osmosis will be used for filtration, sterilization and treatment, and the treated water up to the standards will be reused for clothes-washing, bathing and sanitary cleaning, etc. The filtered residues will be collected and transported back to China. When the expedition team is about to withdraw from the place, all the water in the pipelines will be emptied to ensure the soundness of the equipment. This small amount of water after being treated and reaching the standards will, via an insulation pipe, be drained into a pre-placed ice pit at a certain depth. During the drainage, the treated water may cause the melting of part of ice and snow and further affect the snow and ice in the lower layers. Due to the fact that the water to be discharged will be in very small amount, the water quality will reach the required standards and the ice-flowing is extremely slow in the Dome A area, so the scope and extent of the impacts will be relatively limited.

As for the toilet, in the construction stage of the Station, packing type water-free onboard toilet will be used with which all human excrement will be packed up and carried out of Dome A area ; in the operation stage of the Station, a negative pressure flush-free system will be used to reduce the volume of faeces. With this system, the faeces will not be specially treated, but be directly barreled and carried out of Dome A area, thus minimizing the impact on the local environment.

In addition, oil-polluted matters left from washing will also be collected and carried out of Antarctica.

As the environmental baseline value of Dome A area is very low, the indirect effect and cumulative effect of tail water discharge after the standard-reaching treatment of reverse osmosis will be the extension of the contamination area and the scientific value of the contamination area will be affected to some extent. However, because that the volume of water to be discharged will be very small, the most advanced and efficient treatment system of ultra-filtration membrane plus reverse osmosis will be adopted, and the treated water will meet and surpass the quality standard of Category II water body of the Environmental quality for ground water of the People's Republic of China, which will nearly reach the water quality from the drinking water source, the impacts on the local environment will be very limited.

5.6.2. Mitigation measures for sewage impacts

Water-saving device will be provided in the design of the Station in order to reduce the amount of water needed and to minimize the production of wastewater. At the Station, the waste water will be treated through techniques of ultra-filtration and reverse osmosis to filter, sterilize and treat the wastewater. The treated water that reaches the standards will be reused for clothing washing, bathing and sanitary cleaning, etc.

The filtered residues will be collected and transported out of Antarctica. When the expeditioners withdraw, all the water in pipelines shall be emptied to ensure the soundness of the facilities.

As for the human excrement, in the construction stage, the packing type water-free onboard toilets will be used, and all human excrement will be packed up and transported out of Dome A area; and after the Station is built, negative pressure flush-free systems will be used to reduce the volume of the faeces. The faeces will not be specially treated, but directly barreled and transported out of Dome A area so as to minimize the impacts on local environment.

5.7 Solid waste

During the stages of the Station construction and operation, a certain amount of solid waste will be produced, and the solid waste produced during the construction stage will be obviously more than that produced during the stage of operation.

According to the definition of Annex III (Paragraph 8) of the Protocol on Environmental Protection to the Antarctic Treaty and China's relevant management regulations on Antarctic garbage, solid waste is classified into following categories:

- Recoverable garbage (Metal, plastic, paper, wood and glass, etc.)
- Organic waste (Waste arising mainly from food)
- Hazardous waste (Category 4：Battery and waste fluorescent lamp etc.)
- Unclassifiable garbage
- Fuel drum

5.7.1 Solid waste produced in the construction stage

In the construction stage of the Station, a considerable amount of innocuous solid waste will be produced. They will be mainly packing materials and building materials, including metal, plastics, glass and wood, etc.

Capital construction will also produce a relatively small amount of hazardous waste, such as agglomerate, battery, solvent, oily waste and paint, as well as solid domestic waste and food waste. The amount of wastes possibly produced in the construction stage of the Station is estimated (see Table 19).

Table 19 Estimated amount of wastes to be produced in the construction stage of the Station

Content	**Quantity**	**Unit**
Empty fuel drum	100	Drum
Packing materials	2	20 ft. container
Kitchen/food	1	20 ft. container
Hazardous waste	1	Small box
Others	1	20ft. container

5.7.2. Measures for minimizing solid waste during construction

The following measures will be taken to reduce solid waste: Drawing up scientific and detailed construction plan in advance and do not take unnecessary materials to the construction site, striving to prefabricate and assemble container buildings at home and reduce unnecessary packing materials to the minimum extent, do not take prohibited products (See Appendix III of the Protocol on Environmental Protection) to Antarctica and keep the quantity of hazardous articles to the absolutely minimum extent, solid waste will be classified, appropriately stored, labeled and put into a fixed position of the waste container waiting for transportation, making greatest possible effort to reuse these solid wastes, like empty fuel drum, formulate the management plan for construction waste, conduct training on the personnel, so as to make them familiar with and have a good command of the classification, storage and disposal of wastes, appoint a team member as environmental officer to direct and supervise correctly the implementation of waste management procedure, and appoint another team member as a waste manager to implement properly the waste management procedure and make regular supervision for it.

All the solid waste will be brought back to China for final disposal when the expeditioners withdraw from Antarctica. Part of the human excrement will be brought to the Zhongshan Station for disposal.

5.7.3 Solid waste produced in the operation stage

Perennial station's data indicate that the volume of solid waste resulting from per person per year is 2.3m^3. According to calculation based on this figure, the volume of solid waste produced per person in the proposed summering station will be less than 1 m^3. (Table 20)

Table 20 Estimated amount of waste to be produced in the operation stage of the Station

Content	Quantity	Unit
Empty fuel drum	60	Drum
Packing materials	1	20ft. container
Kitchen/Food	1	20 ft. container
Hazardous waste	1	Small box
Others	1	20 ft. container

Waste produced by human during field operation for scientific expedition should be brought back to the Station for appropriate disposal.

5.7.4 Measures to minimize solid waste in the operation stage

The following measures will be taken to reduce solid waste: Try best to reduce unnecessary packing materials to minimize the volume of waste at the site, do not take prohibited products (See Appendix III of the Protocol on Environmental Protection) to Antarctica, the quantity of hazardous articles will be kept to the absolutely minimum extent, solid waste will be classified, appropriately stored, labeled and put into fixed the position of waste container waiting for transportation, make greatest possible effort to reuse these solid wastes, like empty fuel drum, formulate a waste control plan, including stipulations on the collection, storage, utilization and treatment of waste, conduct training on the personnel, so as to make them familiar with and have a good command of the classification, storage and disposal of waste; appoint a team member as an environmental officer to direct and supervise correctly the implementation of waste management procedure, and appoint another team member as the waste manager to implement properly the waste management procedure and make regular supervision for it (BAS, 2004a).

All the solid waste will be brought out of the site and back to China for disposal upon the withdrawal of the expedition team. Part of the human excrement will be brought to the Zhongshan Station for disposal. Try to bring the waste produced by human during field activities back to the Station for appropriate disposal.

5.8 Assessment of noise impacts

5.8.1 Analysis on the source of noise

Noise will come from:

- Unloading activities of vessels and aircrafts
- Land transportation
- The operation of vehicles, generators and the facilities for science activities.

Animals living in the area of the Chinese Zhongshan Station may be disturbed by noise. However, as the area is not the gathering place of animals, the impact is limited.

From the Zhongshan Station to Dome A, no gathering place of animals has been found, indicating that there is little impact on animals.

General activities of the Station, especially the operation of vehicles will produce noise and so does the scientific activities in which the operation of generator or any other mechanical equipment required. As the Station is to be built in the inland area where there is no fauna and flora, so there is no noise impact on them.

5.8.2 Measures to mitigate noise impact

Minimizing the operations of vessels, aircrafts, vehicles and mechanical equipment etc.. If it is necessary to operate aircraft, its flight will be kept within the height and space limit stipulated in the Antarctic Flight Information Manual formulated by COMNAP; Maintenance and service will be provided regularly for vehicles, generator and mechanical equipment etc. so as to keep noise to the lowest level.

5.9 Light pollution

5.9.1 Analysis on the sources of light pollution

When the expeditioners live and work at the Station, light source will be needed for illumination. As the man-made light source will be added to the area where there is only original natural light, certain impact will be brought to the surrounding environment. However, since there is no fauna and flora existing in the Dome A area, the man-made light source can only affect, to some extent, the scientific research projects sensitive to light. At least in 10 years, Dome A Station will work as a summer station. During the operation stage in the Antarctic summer, the Station will be in the period of polar daytime, therefore, light impact arising in this period of time will be very little.

5.9.2. Measures to mitigate light pollution

Try to reduce the use of illuminating light, the scattering light, especially those above horizon as much as possible in the design of external light.

5.10 Fauna and Flora

5.10.1 Analysis of impact on fauna and flora

The loading and unloading at the existing wharf of the Zhongshan Station and the transportation between the wharf and the Zhongshan Station may give rise to impact on animals. However, this impact will be very small and transitory because the area around the Zhongshan Station is not the gathering place of animals, and these activities will take place in December or February when the mating season of animals has come to an end.

During the operation stages of the Station, aircraft flights will be very seldom. If there is any, the flight of aircraft will be kept within the limit of height and space stipulated in Antarctic Flight Information Manual formulated by COMNAP.

In the construction and operation stages of the Station, there will be no impact on local fauna and flora since there is no fauna and flora living in the surrounding areas.

5.10.2 Mitigation measures

Reduce as much as possible the use of vessels, vehicles, mechanical equipment and aircraft etc., provide training for crews, pilots, engineering staff and members of the scientific expedition team, and ensure to minimize the interference towards seals, birds, penguins and oceanic animals near the Zhongshan Station.

5.11 Physical interference, esthetic value

5.11.1 Analysis of environmental impact

Dome A is an area with the lowest temperature on earth, as well as an area of Antarctic ice sheet with the highest elevation. It is wild and desolate. Therefore, there will be little local visual impact to build the Station there, except some minor impact within the limited visual range.

As the main buildings of the Station will be built directly on ice surface, the environmental impacts arising from the moving, clearance and compaction of the floating snow around the station area will be very limited.

During the construction and operation of the Station, it will be necessary to melt snow to make water, and to pile up and store snow may bring about minor impact on snow and ice environment.

The Station will use recycling water to its great extent, only a small amount of standard-meeting treated water will be discharged, therefore the impact on ice and snow is limited.

The use of vehicles and mechanical equipment by the Station will leave traces on snow surface, however, these traces will soon be covered by snow, hence there will be only transitory and minor impacts.

The Station will use clean fossil fuel and renewable energy resource as much as possible, update equipment with high efficiency, so the impact on atmospheric is slight.

The Station will implement its Waste Management Plan, to bring waste out of Antarctica; in addition to implementing the Environmental Management Plan for the Station so as to reduce the negative impact on the local environment.

5.11.2 Mitigation measures

In the design of the Station, the local environmental conditions will be taken into full consideration, and harmonization with the local environment will be made to the greatest possible extent so as to minimize visual impact, and make the station an important supporting base enabling scientists to conduct on-the-spot expedition at the inland ice sheet of 75^0～85^0 S, 70^0～80^0 E.

The Station will use clean fossil fuel and solar energy as much as possible; adopt highly efficient vehicles and mechanical equipment, so as to minimize the emission to the atmosphere.

The Station will reduce as much as possible the use of vehicles, mechanical equipment and aircraft and gradually mark out the driving lines of vehicles to ensure that the number of tracks can be kept at the lowest level.

The Station will do its best to use cycling water so as to minimize the volume of smelted water and subsequently, the impact on the local environment.

At the end of the operation of the Station, all the equipment will be disassembled, dismounted and transported out of the Station, thus leaving no obvious traces. The dismounting and clearing work of the Station will be done in accordance with the requirements of environmental impact evaluation.

5.12 The introduction of alien species and the transmission of diseases

5.12.1 Analysis of environmental impact

During the capital construction and operation of the Station, the risk to introduce alien species or transmit diseases into Antarctica will be very little. Because firstly, all the team members to go to Antarctica must pass an all-round and strict physical examination, the occurrence of communicable disease will be impossible. Secondly, cooked food and dried food will be taken as much as possible. Thirdly, wastes will be put under effective control. All wastes will be properly preserved and be taken out of Antarctica as much as possible. And fourthly, the temperature in Dome A is very low, any introduced species may be unable to survive outdoor for a long time.

5.12.2 Mitigation measures

Paragraphs 4(5)-(6) of Annex II of the Protocol on Environmental Protection and the stipulations of the Appendix will be strictly observed and the introduction of alien species and the migration of diseases will be prevented to the greatest possible extent.

Meanwhile, following the normal practices of the Chinese Antarctic expedition team, a comprehensive and strict physical examination will be carried out for the team members so as to prevent the occurrence of communicable diseases; foodstuff will be kept under control so as to ensure all the foodstuff, including the food provided at the Station and the food for field encampment, be safely stored and disposed. A cleaning process will be applied to all clothing, scientific instruments, mechanical and field-operational equipment etc. before being transported into Antarctica and particularly, the railed and wheeled vehicles will be rinsed before entering Antarctica. And all the wastes will be well managed and properly disposed of and be brought out of Antarctica to the greatest possible extent.

5.13 Impact matrix

According to the analysis mentioned above, the table of impact matrix which summarized the environmental impacts of the construction and operation activities is completed (Table. 21). The output and resulting environmental impact of each activity is identified. The probability, extent, duration and significance of these impacts are then ranked according to the criteria below, and finally measures that CAA will put in place to mitigate or prevent those impacts from occurring are shown (Table 22, 23).

Table 21 Criteria for ranking impacts

Title	Content	Details
Activity		
Nature	Type of activity	
Output		
	Description of the potential results of activities that may cause impacts	
Impacts		
Extent	Geographical area affected	Area-specific, local, regional ,continental and global
Duration	Duration of impact	Very short (minutes to days), Short (weeks to months), medium (years),long(decades) , permanent and unknown
Intensity	Likelihood of impact occurring	Low, medium , high , certain
Significance	Importance of impact	Very low, low, medium, high, very high
Effects		
Direct	Qualitative description of what is directly, indirectly and cumulatively impacted by the Activities /Output	
Indirect		
Cumulative effect		

Table 22 Impact matrix of construction activities for the Dome A Station

Activity	Output	Predicted impacts	Probability	Extent	Duration	Intensity	Significance	Mitigation or preventive measures
Material loading and unloading at the Zhongshan Station	Atmospheric emission	Very small, but cumulative contribution may lead to deposition of particulates and heavy metal particles	Certain	local to global	Long	Very low	Very low to low	Use clean fuel as much as possible. Minimize the use of vessel, vehicle, mechanical equipment and aircraft. When practicable, vessels to operate on one engine only to reduce emissions.
	Disturbance short time and relatively small to penguins(Knox, 1994), birds (Shirihai, 2002) and seals (Bonner, 1989)	Increase energy expenditure of animals	Low	Area-specific (Coastal sea area of the Zhongshan Station)	Very short	Very low	Very low	Educate the expedition team members to avoid the interference of animals to the greatest possible extent. Minimize the use of vessel, vehicle, mechanical equipment and aircraft.
Bulk fuels transfer and storage	Over 208L. fuel oil spillage Max. spill volume 30,000L.	Snow and ice contamination. Atmosphere pollution due to Volatilization. Possible indirect impact on science.	Medium (leakage in small volume) very low (For over 1000l., leakage in great volume)	Area-specific	Long	Very low (leakage in small volume) medium (For over 1000l., leakage in large volume)	Very low (leakage in small volume) medium (For over 1000l., leakage in large volume)	Provide double-layer fuel oil tank and spill detecting system to minimize the risk of spillage arising from oil tank breakage Formulate oil spill contingency plan, examine periodically the procedure of fuel handling and oil spill response. Train and educate relevant personnel to enable them to operate correctly and canonically and prevent the occurrence oil spillage accident. Provide oil spill handling apparatus, oil absorption felt, oil spill prevention container and cleaner and storage to store oil-polluted snow etc. so as to timely tackle potential oil spill accident. Once oil spill accident takes place, report to the Head of the Station and CAA and undertake monitoring.

Table 22 (Continued) Impact matrix of construction activities for the Dome A Station

Activity	**Output**	**Predicted impacts**	**Probability**	**Extent**	**Duration**	**Intensity**	**Significance**	**Mitigation or preventive measures**
The use of vehicle and power generator	Atmospheric emissions	Minor but cumulative contribution to local and global atmospheric polluting including greenhouse gas emissions and the deposition of part of the particulates. Possible direct impact of pollution on science.	Certain	Local to global	Long	Low	Low	Minimize the use of vehicle and generator. Adopt vehicle and generator with high combustion efficiency, advanced technique, excellent performance and low emission Adopt clean fossil fuel with high combustion efficiency. Use as much as possible renewable energy for power supply and heating. If possible, install air-cleaning device on vehicles and generators and provide periodical maintenance and service se as much as possible.
	Small volume fuel oil spillage during refueling and operation	Contamination of snow and ice. Possible indirect impact on science.	Medium	Area-specific	Long	Very low	Very low	Provide double-layer oil tank and spillage detecting system to minimize the risk of oil spill arising from oil tank breakage Formulate oil spill contingency plan, examine periodically the procedure of fuel handling and oil spill response. Train and educate relevant personnel to enable them to operate correctly and canonically and prevent the occurrence oil spillage accident. Provide oil spill handling apparatus, oil absorption felt, oil spill prevention container and cleaner and storage to store oil-polluted snow etc. so as to timely tackle potential oil spill accident. Once oil spill takes place, report to the Head of the Station and CAA and undertake monitoring.

Table 22 (Continued) Impact matrix of construction activities for the Dome A Station

Activity	Output	Predicted impacts	Probability	Extent	Duration	Intensity	Significance	Mitigation or preventive measures
General construction activity	Increased quantity of solid and liquid waste (including sewage and grey water).	Contamination of ice and snow. Possible indirect impact on science.	Certain	Local	Medium Impact time period of discharged water is long	Very low	Very low	Formulate waste control plan Train relevant personnel to ensure their work will be done according to job requirements. Solid wastes, especially hazardous waste, to be taken to Dome A will be minimized, try best to reuse articles already taken there; all solid wastes will be stored in different categories and packed up before being taken out of Antarctica. All human excrement will be packed and cased, and brought out of Antarctica. Reuse treated waste water to the greatest extent to reduce water consumption and discharge
	Increased in activities at construction site	Loss part of the value of wildness. Possible indirect impact on science.	Certain	Local	Medium	Very low	Very low	In the design of the Station，environmental protection issue is fully considered，and relevant measures taken, e.g., to make max. use of renewable energy, recycling water and equipment with advanced technology and high environmental efficiency, so as to reduce the environmental impact. When the operation of the Station terminates，the station will be completely cleared away from Antarctica and no obvious trace will be left there.

Table 23 Impact matrix of the Dome A operation activities

Activity	Output	Predicted impact	Probability	Extent	Duration	Intensity	Significance	Mitigation or preventive measures
Material Loading and unloading at the Zhongshan Station	Gas emission	Very small but cumulative contribution may lead to air pollution and deposit of particles and heavy metal particles	Certain	Local to global	Long	Very low to low	Very low to low	Use clean fuel as much as possible. Minimize the use of vessel, vehicle, mechanical equipment and aircraft. When practicable, vessels to operate on one engine only to reduce emissions.
	Disturbance short time and relatively small to penguins, birds and seals	Increase energy expenditure of animals	Low	Area-specific (Coastal sea area of the Zhongshan Station)	Very short	Very low (Not the gathering place of animals)	Very low (Not the gathering place of animals)	Educate the expedition team members to avoid the interference of animals to the greatest possible extent. Minimize the use of vessel, vehicle, mechanical equipment and aircraft.
Bulk fuels transfer and storage	For over 208L. fuel oil spillage, max. volume of 30,000 l leakage	Snow and ice contamination. Atmosphere pollution due to Volatilization. Possible indirect impact on science .	Medium (spillage in small volume) Very low(For over 1000L., spillage in great volume)	Area-Specific	Long	Very low(spillage in small volume) Medium(Over 1000l., spillage in great volume)	Very low(spillage in small volume) Medium(Over 1000l., spillage in great volume)	Provide double-layer oil tank and spillage detecting system to minimize the risks of oil spill arising from oil tank breakage. Formulate oil spill contingency plan, examine periodically the procedure of fuel handling and oil spill response. Train and educate relevant personnel to enable them to operate correctly and canonically and prevent the occurrence of oil spillage accident. Provide oil spill handling apparatus, oil absorption felt, oil spill prevention container and cleaner and storage to store oil-polluted snow etc. so as to timely tackle potential oil spill accident. Once oil spill accident takes place, report to the Head of the Station and SOA/CAA and undertake monitoring.

Table 23 (Continued) Impact matrix of the Dome A operation activities

Activity	Output	Predicted impact	Probability	Extent	Duration	Intensity	Significance	Mitigation or preventive measures
The use of vehicles and power generators	Atmospheric emission	Minor but cumulative contribution to local and global atmospheric polluting including greenhouse gas emissions and the deposition of part of the particulates. Possible direct impact of pollution on science.	Certain	Local to global	Long	Low	Low	Minimize the use of vehicle and generator. Adopt vehicle and generator with high combustion efficiency, advanced technique, excellent performance and low emission. Use clean fossil fuel with high combustion efficiency Use as much as possible renewable energy for power supply and heating. If possible, install air-cleaning device on vehicles and generators and provide periodical maintenance and service.
	Small volume fuel oil spillage during refueling and operation	Contamination of snow and ice. Possible indirect impact on science.	Medium	Area-specific	Long	Very low	Very low	Provide double-layer oil tank and spillage detecting system to minimize the risk of oil spill arising from oil tank breakage. Oil tanks and oil pipes be checked periodically. Formulate oil spill contingency plan, examine periodically the procedure of fuel handling and oil spill response. Train and educate relevant personnel to enable them to operate correctly and canonically and prevent the occurrence of oil spillage accident. Provide oil spill handling equipment，oil absorption felt and oil spill preventing and cleaning equipment，as well as oil-polluted ice packet, etc. so as to deal with the oil spill accident timely. Once oil spill accident takes place, report to the Head of the Station and SOA/CAA of China and undertake monitoring.

Table 23 (continued) Impact matrix of Dome A operation activity

Activity	**Output**	**Predicted impact**	**Probability**	**Extent**	**Duration**	**Intensity**	**Significance**	**Mitigation or preventive measures**
The operation of the Station	Hazardous waste and harmless waste produced	Contamination of snow and ice. Possible indirect impact on science.	Certain	Local	Medium	Very low	Very low	Formulate waste control plan. Train relevant personnel to ensure their work is done according to job specification. Solid wastes, especially hazardous waste, to be taken to Dome A will be minimized, try best to reuse articles already taken there; all solid wastes will be stored in different classifications and packed up before being taken out of Antarctica. All human excrement will be packed and cased, and brought out of Antarctica.
	Sewage/grey water	Contamination of snow and ice. Possible indirect impact on science.	Certain	Area -specific	Long	Low	Low	All human excrement will be packed and cased, and brought out of Antarctica. Reuse treated water to the greatest extent to reduce water consumption and discharge.
	Light pollution	Due to the impact of light on the sensitive camera for aurora and glow imaging, science activities to some extent may be affected.	Medium	Local	Long	Very low	Very low	Light pollution will be minimized in the design of exterior illumination. Use low pressure sodium lamp.
	The interference of work-station activities on electromagnetic and meteorological observation	Possibly to affect part of the scientific activities	Medium	Area-specific	Long	Low	Low	During the site mapping-out and area division，the electromagnetic observation apparatus and the survey of meteorology marginal layer have been taken into consideration. Adopt electrical apparatus with excellent performance and meeting relevant standards.
Scientific activities	E.g., activities of ice core drilling	Impact on snow and ice	Certain	Local	Long	Very low	Very low	Adopt advanced technology. Formulate monitoring plan. Launch environmental protection and operational training for personnel.
	Part of the scientific facilities that are not revertible	Cause pollution to snow	Medium	Specific area	Long	Very low	Very low	Dismantle to the greatest extent Launch environmental protection and operational training for personnel

6. INDIRECT IMPACT AND CUMULATIVE IMPACT

In order to minimize environmental impacts, the measures to prevent and mitigate environmental impacts have been taken into full consideration in the design stage of the Station, and the EMP has been formulated. The design of the Station ensures high efficiency in energy utilization. According to the design, renewable energy sources will be utilized to the maximum extent; high efficiency, low discharge and low noise equipment will be adopted as much as possible; container buildings will be prefabricated in China to reduce the field construction workload; water will be treated and reused; and the production of wastes will be minimized. These measures will prevent or mitigate the estimated environmental impacts, and play an active roll in environmental protection. The station adheres to the principles of environmental protection and energy-saving etc. in its design, and has established the waste control system, and will ensure low ecological footprint, low energy consumption and minimum waste output. Therefore, no obvious indirect environmental impacts will arise.

Cumulative impacts may arise from the emission to the atmosphere, oil spill, discharge of the treated waste water up to standards in the construction and operation stages of the Station. However, due to the adoption of measures of environmental protection and energy saving, direct impacts will be reduced to a rather low level, there will not be obvious cumulative long-term impacts, and the maximum possibility might probably be the reduction of part of the scientific value of located area.

7. ENVIRONMENT MONITORING PLAN

The building of the Station in Dome A will inevitably bring about some changes in the Station area and its surrounding areas. The potential environmental impacts and the corresponding mitigation measures have been specified in Section 5. In order to exactly understand the actual impacts derived from the construction and operation of the Station and the effectiveness of mitigation measures that shall be taken thereby, and to meet the requirement of sustainable development, CAA has formulated a perfect EMP for Dome A Station.

From 1996 to the early 2008, CAA has organized 5 expeditions on ice sheet along the direction of the Zhongshan Station-Dome A, made comprehensive and multidisciplinary observations and samplings and acquired some environmental baseline data. In January of 2005, the Chinese expedition team successfully reached the top of Dome A for the first time. In particular, during the Dome A inland expedition in the austral summer of 2004/2005 and 2007/2008, the CHINARE has accomplished multidisciplinary observations, samplings and baseline survey, collected environmental baseline data, and established the contrast value for future environmental monitoring.

7.1 Design of Environmental Monitoring Plan

The design of the environmental monitoring plan is based on the survey and analysis of potential environmental impacts, so as to discover as early as possible the disadvantageous impacts and actions may be taken to reduce or eliminate such impacts, thus improving the understanding on interactions between the human and the Antarctic environment.

According to the monitoring requirement, the relevant operation information of the Station, including fuel consumption data, fuel spill, personnel number of the Station, waste products and their disposal route etc. (Table 24) will be recorded. This information will be used to verify the CEE and determine whether these impacts conform to those estimated. With the development of the scope and intensity of acquired information, the validity of the proposed mitigation measures will be reviewed and evaluated.

Table 24 Environmental Monitoring Plan

Monitoring contents	**Monitoring frequency**
Days and quantity occupied by the Station	Year
Voyage	Year
Hours of vehicle operation	Year
Production of wastes	Year
Disposal of wastes	Year
Fuel consumption	Year
Oil spill	As per requirement
Meteorological conditions	Year
Snow deposition/ Erosion features	Year
Snow/Ice sample from ice field	Every 2 - 3 years
Atmospheric sample	Every 2 - 3 years
Living organisms taken to Dome A by human	Every 2 - 3 years

7.2 Monitoring of the atmospheric environment

(1) Monitoring objective: Evaluation and analysis on surrounding environmental impacts caused by the construction and scientific activities of the Dome A Station.

(2) Monitoring scope: Monitoring scope covers the full area influenced by the source of air pollution, monitoring sites will be allocated around the pollution source, samples taken outside the influenced area will be used as background reference; snow samples will be taken from relevant points to measure their contents of heavy metals which will be the basis for the environmental baseline study so as to provide reference data for determination of the environmental standards.

(3) Monitoring items: Operation hours of the vehicles, fuel consumption per year, meteorological conditions, NO_2, SO_2, Pm and smoking dust.

7.3 Monitoring of ice and snow samples

(1) Monitoring objective: Evaluation and analysis on surrounding environmental impacts caused by the construction and scientific activities of the Dome A Station.

(2) Monitoring scope: Surrounding area of the Station.

(3) Monitoring items: Heavy metals, total oil hydrocarbon compound, multi-cyclic-aromatic hydrocarbon, etc.

7.4 Monitoring of oil spill

(1) Monitoring objective: Evaluation and analysis on surrounding environmental impacts

caused by the construction and scientific activities of the Dome A Station.

(2) Monitoring scope: Surrounding area of the oil tanks of the Station.

(3) Monitoring items: Non-methane total hydrocarbon and oils.

7.5 Monitoring of the discharge of standards-meeting treated water

(1) Monitoring objective: Evaluation and analysis on surrounding environmental impacts caused by the construction and scientific activities of the Dome A Station.

(2) Monitoring range: End of the discharging pipe.

(3) Monitoring items: COD and bacterium, etc.

8. GAPS IN KNOWLEDGE AND UNCERTAINTIES

From several expeditions conducted between the Zhongshan Station to Dome A between 1996 and 2008, we have acquired some knowledge on the physical environment of the proposed station area. However, we have not simultaneously proceeded with the study and monitoring on the potential hazards probably caused by the construction and operation of the Station. According to experience, the change of environmental conditions like whether etc. may bring about some uncertain factors.

Besides, technically and operationally, there are also some uncertain factors, such as the change of future activities of the Station, the application of more advanced techniques and the change in the content of scientific activities etc. The designed life of the Station will be at least 25 years, it is impossible for the CEE to integrate the changes arising in the process of operation and installation derived from the technical progress that will be obtained in such a long time, therefore, it is necessary to make additional assessment on these changes. Meanwhile, as the design of the Station is still under continuous improvement, part of the details have not yet been entirely determined, there are still some uncertainties on the aspects of technology and operation.

Knowledge limitations and uncertainties have been fully considered in the Draft CEE for the Chinese Inland Dome A Station in Antarctica, including the unpredictability of environmental conditions such as whether, the changes in future activities of Dome A, the application of upgraded energy technology, the change of scientific activities, and small adjustment to the construction mode etc. These may lead to the delay of the construction and the slight changes in the conditions of scientific and logistic support in the future. (Table 25)

Table 25 Uncertainties in CEE

Potential arising areas	**Uncertainties**	**Intensity of impact**
Fuel consumption	The proportion of generation by traditional generator to solar power generation will be greatly related to the installation and operation conditions of solar generator; and the boiler heating has much to do with the installation and operation of solar heating systems.	Medium (exhausted air pollution)
Time schedule	Seasons needed for the construction of Dome A Station (Estimated at 2 seasons, max. 3, min.1)	Medium(Fuel consumption)
Manpower	Number of project participants may be slightly different to that considered in the draft CEE.	Low (Fuel consumption, waste water discharge)
Design of the Station	The actual size, layout and building's shaping of the Station may be more or less different with current design drawings	Nil.
Site selection for the Station	The position of the Station may be slightly different to that marked in the draft CEE.	Low (Fuel transportation)
Sanitary facilities for construction camp	How to dispose human excrement produced in construction camp of the Station has not been determined, the current prevailing solution is to use packing type water-free onboard toilets.	Low (Waste heat)
Total volume of freight	There can be small difference between the total freight volume and filler size required by the construction of Dome A Station and the estimated figures.	Low (Fuel consumption for inland transportation)

During 2007/2008 austral summer season, the inland expedition team of the 24th CHINARE will continue to work on the survey for the site selection of the Station. Maybe we will get some different results from those we got before. However, this kind of possibility and the possibility to reselect the site will be rather low.

9. ENVIRONMENTAL MANAGEMENT PLAN

In the systematic design of the Station, environmental protection, safety, energy saving and economy are the basis of the assessment and the basis to guide the decision-making. On this account, personnel responsible for environmental impact assessment started to be involved in the design stage of the project scheme, and put forward a number of useful suggestions on how to reduce environmental impacts.

Before the construction starts, CAA will arrange to formulate the Environmental Management Plan, the purpose of which is in line with the stipulations specified in the Protocol and relevant Chinese regulations on environmental protection, to elaborate the managerial links and managerial plan，to define terms of reference for relevant persons, to fulfill mitigation measures and to ensure the minimization of environmental impact.

The Management Plan will cover the management on the refueling and fuels transportation, waste management, equipment management, the management of field operation and the tackling of emergencies etc. The management plan will guarantee the safety and orderly progress of various activities, and consequently prevent the occurrence of environmental accidents and minimize environmental impacts.

In the meantime, CAA will launch education and training on environmental protection, job specifications, contingency tackling and equipment operation etc., for the personnel. In addition, environmental officers will be appointed to supervise the implementation of contract and managerial plan.

In the Station, environment monitoring, investigation and analyse of environmental impacts will also be conducted so as to find out disadvantageous impacts as early as possible and to eliminate or mitigate them in time.

In case any environmental accident or any other accident occurs, CAA will report to the SOA of China and inform every Contracting Party.Upon completion of the capital construction, CAA will together with PRIC draw up a report summarizing conditions of environment, health, safety, accident and monitoring etc.

10. CONCLUSION

CAA has organized and completed the Draft CEE on the proposed construction and operation of the Chinese Dome A Station. The Draft CEE was developed in accordance with Annex I of the Protocol on Environmental Protection to the Antarctic Treaty (1998). The Guidelines for Environmental Impact Assessment in Antarctica (Resolution 4, XXVIII ATCM, 2005) was also consulted.

The Draft CEE describes the following contents：

- The construction, operation and maintenance of the Chinese Dome A Station
- The operation during the construction stage
- The transportation process for cargos and personnel to Dome A Station
- Analysis of potential environmental impacts
- Prevention and mitigation measures to minimize environmental impacts
- Gaps and uncertainties

The Dome A Region is selected as the site for the new station because it is an ideal site for the study on global climatic and environmental changes. Dome A is one of the most suitable site for drilling and obtaining deep ice cores with an age exceeding one million years, a favorable site for monitoring and detecting global background atmospheric baseline environments, a suitable site for astronomical observations and monitoring ozone holes. In addition, Dome A is one of the sites with the greatest challenges in geological survey in Antarctica. The Gamburtsev，the highest mountains under the icecap in East Antarctica is the direct geo-morphological cause for the formation of Dome A. As it is at an elevation of about 4100 meters and has the greatest potential for obtaining geological samples directly under the ice sheet in the broad inland Antarctica，it is a site with the greatest attraction for geological studies. With unique geographic and natural conditions, Dome A can be a good experimental site for science advancement in some special areas such as low temperature engineering materials, telecommunication technologies and human medical sciences under extremities.

The Chinese Dome A Station will adopt an open-up policy for its Station operation and scientific programs, with an intention to provide a platform for the scientists both from home and abroad as well as an important supporting base for scientists from various countries to pursue field surveys on the inland ice sheet in the region of 75^0~85^0S, 70^0-80^0 E.

The construction of Dome A Station is planned to be initiated in the austral summer of 2008/09 and completed in two austral summers of 2008/09 and 2009/10. At least for ten years after its completion, Dome A Station will serve just as a summer station.

The total construction area of Dome A Station depends on the number of the expeditioners, the need of scientific programs and the inland transportation capacity of vehicles. According to the present design, the total building area is 623m^2 (among which, 204m^2 will be the container-type structure and 419 m^2 will be both prefabricated and assembly structures), 1000m^2 is for the simple storage area and operational yard and 200 m^2 for the solar energy PV generation facilities. The short-term objective is to satisfy15-20 persons for summering, and the long-term objective is to satisfy the optimum use by 25 persons as a year-round station. However, its daily facilities (including kitchen, sanitary facilities and office etc.） as well as contingency- or shelter- required places are designed to accommodate more people.

At the initial design-stage of the Station, full consideration has been given to the environmental impact possibly caused by the construction and operation of the Station as well as the measures for prevention and mitigation of such environmental impacts.

The basic principles of the systematic design of the Station are based on environmental protection, safety, energy saving and economy. For instance, in terms of the selection of construction materials, the environmentally-friendly, and durable materials are preferred; in terms of the use of energy resources, the clean fossil-fuel—aviation kerosene is solely used; in terms of the use of vehicles and equipment, higher energy efficiency, lower emission and lower noise are required; in terms of the mode of construction, the pre-fabricated container building combined with the assembly building made in China is adopted to reduce the workload in situ; in terms of waste management, all wastes shall be strictly classified, properly stored and effectively disposed of and reused as much as possible; in terms of removal of the station, it will be easily decommissioned, disassembled and removed, and no obvious remnants of the occupation will be left. Therefore, during the periods of construction, operation and dismantlement of station, efforts will be made to minimize the environmental impacts as well as the impacts to the natural landscape.

An Environment Management Plan, an Emergency Response Plan and an Environmental Monitoring Plan will be formulated, and training will be provided to the personnel involved. CAA is responsible for ensuring that the environmental management objectives should be met. The measures undertaken above will prevent or mitigate the environmental impacts, and play an important role in the protection of the Antarctic environment.

The construction and operation of the Chinese Dome A Station and the related science programs there will make outstanding contributions to the observation and studies on the global climate change, Antarctic geological survey, astronomical observation as well as environment monitoring etc. and provide a platform for international cooperation in Antarctic studies, which is of great scientific significance and so is quite essential.

The construction and the operation of the Dome A Station has taken full consideration of environmental protection and energy saving, it will use as much clean energy as possible and the updated environmental technologies, so as to minimize its impacts on the environment due to the construction and operation of the Station.

The design of the station is scientific, rational and technically feasible. The construction and operation of the station may only have minor and transitory impacts on the Antarctic environment. Meanwhile, the preventive and mitigating measures will further minimize the impacts on the environment. Therefore, China considers that the initiation of the project is fully justifiable.

11. ABBREVIATIONS

ASMA = Antarctic Specially Managed Area

ASPA = Antarctic Specially Protected Area

ATCM = Antarctic Treaty Consultative Meeting

BOD5 = Biological Oxygen Demand in 5 days

CAA = Chinese Arctic and Antarctic Administration

CCAMLR = Convention on the Conservation of Antarctic Marine Living Resources

CCAS = Convention for the Conservation of Antarctic Seals

CEE = Comprehensive Environmental Evaluation

CHINARE = Chinese National Antarctic Research Expeditions

CO = Carbon Monoxide

CO_2 = Carbon Dioxide

COD = Chemical Oxygen Demand

COMNAP = Council of Managers of National Antarctic Programmes

DEM = Digital Elevation Model

EIA = Environmental Impact Assessment

EMP = Environmental Management Plan

FMEA = Fault Mode Effect Analysis

HC = Hydrocarbon

IPICS = International Partnerships in Ice Core Sciences

IPY = International Polar Year

MARPOL = International Convention for the Prevention on Marine Pollution from Ships

MBR = Institute of Marine Biomedicine

NOx = nitrogen Oxides

PM = Particulate Matter

SAR = Search and Rescue

SCALOP = Standing Committee on Antarctic Logistics and Operations

SOA = State Oceanic Administration of China

SOx = Sulfur Oxides

SS = Sodium Sulfacetamide

TCV = Traveling Convection Vortex

TMT = Thermomechanical Treatment

ULF = Ultra Low Frequency

VOC = Volatile Organic Compounds

WMP = Waste Management Plan

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13. APPENDICIES

13.1 List of figures

13.2 List of tables