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Environmental Management in Mega Construction Projects

ECUST PRESS

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Jianming Yang
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Für Meine Familie

Foreword

Quand le Dr. YANG m'a demandé de préfacer son livre « Environmental Management in Mega Construction Projects », j'en fus d'abord flatté puis quelque peu inquiet. Flatté parce qu'il pensait à moi pour cette noble tâche et inquiet parce que le sujet abordé est d'une telle ampleur que je doutais un instant de mes compétences à comprendre.

J'ai pris du temps ... l'auteur me le pardonnera ! Je devais avant tout m'imprégner du chemin parcouru au cours des dix dernières années par Jianming YANG qui fut, au début des années 2001, le meilleur étudiant chinois à l'ENSCMu (Ecole Nationale Supérieure de Chimie de Mulhouse, France), une école d'ingénieurs chimistes parmi les plus réputées de France que j'ai eu l'honneur de diriger pendant le séjour de l'auteur parmi nous. Pour ce faire, je me suis tout d'abord remémoré l'étudiant Jianming. Un être d'exception comme on n'en rencontre que très peu dans une vie. En quelques mois, cet étudiant chinois venu se dépayser en France était devenu une véritable star locale. Intégré dans toutes les associations et sociétés qui avait un nom, tout le monde avait envie d'inviter ce jeune prodige car on savait qu'il apportait, au-delà de sa jovialité, toujours quelque idée innovante.

Jianming YANG a de grandes facultés d'adaptation, une ouverture d'esprit sans égale et une passion dévorante à vouloir repousser les limites de la connaissance aux interfaces entre des domaines très variés. Ne se limitant pas à l'entregent et à l'obtention de diplômes dans un pays bien loin de chez lui (Ingénieur chimiste en 2004 avec une thématique « Economie et Ecologie » qui montre à quel point il affectionne les approches globales puis Doctorat en 2008), Jianming YANG a également été un pontife, jetant des ponts d'amitiés et de liens productifs entre les peuples. Ancien étudiant de l'ECUST (East China University of Sciences and Technology, Shanghai, Chine), il a, avec une très positive opiniâtreté, travaillé sans relâche à mettre en contact son ancienne Université et son Université d'accueil (UHA—Université de Haute-Alsace, Mulhouse, France). J'ose affirmer que si aujourd'hui la Fédération Gay Lussac (FGL, fédérant les plus réputées écoles d'ingénieurs chimistes en France) et ECUST présentent un intéressant programme éducatif permettant de nombreux échanges d'étudiants et d'enseignants entre la

Chine et la France, c'est aussi un peu à l'engagement initial de Jianming YANG que nous le devons. Si on me demandait de personnaliser « les compétences interculturelles » sur lesquelles nous travaillons beaucoup aujourd'hui, en particulier au sein de EUCOR, le Campus européen (120 000 étudiants au centre de l'Europe), je n'hésiterais pas à citer le Dr. Jianming YANG en exemple.

C'est donc convaincu par l'auteur que je me suis adonné à la découverte de son œuvre récente, « Environmental Management in Mega Construction Projects ». J'ai été à la fois rassuré et émerveillé. Rassuré parce qu'il a continué ses explorations aux interfaces de domaines extrêmement variés comme la recherche en sciences environnementales, l'impact économique et écologique de grands projets dans des domaines et dans des zones géographiques très variées, la gestion de ressources humaines incluant la formation, le relationnel, la motivation à entreprendre et à innover. Emerveillé parce que l'étudiant prometteur avait tenu ses promesses et les a transcendées dans son livre. Je n'ai rien regretté du temps investi car cet ouvrage est une approche très fouillée de ce que peut être le management de grands projets dans le Monde moderne.

Je vous souhaite, à vous amis lecteurs de ce bel ouvrage, de prendre autant de plaisir que moi à le découvrir. Pour récompense, vous apprendrez à agir avec enthousiasme pour que le développement durable de notre Monde commun ne soit pas un vain mot. Bonne lecture à vous.

Alsace, France
Décembre, 2016

Prof. Dr. Serge NEUNLIST
Directeur ENSCMu (2004–2011)
1er Vice-Président UHA (2012–2016)
Vice-Président Interculturalité de EUCOR, le Campus Européen

Preface

Environmental protection has become a prevalent idea in China since we stepped in the twenty-first century. People have turned their environmental eyes onto places where they have more daily interactions—where they live and where they work. The concept of "Green" is integrated in many buildings and projects starting from the design. And the final product's operation and utilization exhibits excellence on water conservation, energy efficiency, and low carbon emission. But behind those "Green Stars," are their construction processes as efficient in water usage, energy consumption, and carbon emission as what they have been seen? Or at least, in compliance with all the environmental laws and regulations?

Smaller projects usually take up smaller places and are completed in a relatively short time. Environmental problems during such projects' construction may not be very severe or can be managed easily. However, key mega projects, are usually massive with a relatively long time to complete. If there is no scientific and systematic management introduced, or just simply copy and paste what is used on smaller projects, safety and environment management will take double or more the efforts than needed but still fail to deliver a satisfactory management result, let alone facing the risk of damaging the environment.

This book has interpreted environmental problems that emerge in key mega construction projects from the perspective of environmental management integrated with construction management. The author(s) have participated in many key mega construction projects. They have put together their experience, international practices together with the real situation in China to help elaborate on management system, team organization, managerial methods and techniques. Therefore, what is in the book and the figures and diagrams can be used as direct reference for other key mega projects. Meanwhile, China's construction companies, including construction supervision companies, environmental supervision companies, construction management companies or even overseas ones, and owner companies can draw complete information about environmental management from this book. Project executives, middle management and/or construction workers can also benefit from it. This book has set up a new standard for environmental management in key mega

construction projects, and with the hope to bring different participants in construction to a more compliant and efficient environmental management system.

The completion of this book has also been greatly supported by the School of Resources and Environment in East University of Science and Technology, Shanghai Academy of Environmental Sciences and ECUST Press. Here we would like to express my sincere gratitude for their support and efforts.

My second child was born the same time when the book was completed. I would like to dedicate this book to my beloved wife and kids.

Shanghai, China Jianming Yang
November 2016

Acknowledgements

For the original version in Chinese, Jianxiang Wang, Jingfeng Xu, and Guangzhao Xu have provided, edited, and compiled a lot of reference materials in this book. Yadong Shang, Baotang Zhang, Ting Qiao, Yi Xiu, Weicheng Cao, Zuxi Hong, Xiaoming Gan have also contributed in writing this book. Simin Wu and Ping Hou are responsible for the consolidation and layout of the book.

For the translated version in English, my former colleague and long-term strategic partner Agnes Zhang has translated most of the book and did the final proofreading. Le Fu, Qianwen Yin, Yining Zhu, Wen Xu, Yuan Tao, Olivia Tang, and Meggie Sheng have also devoted a lot of translation efforts for this book. Ting QIAO finished all the tables and figures translation. Xue Wang, Yingjie Zhong, Grace Han, Tianchen Song, Yanlin Lu, Huijuan Wang, and Ava Cai have also did great in the translation for the work. Ping Hou has taken on the book's compilation and consolidation.

I would like to express my heartfelt gratitude to all the mentioned above and those who have offered their gracious help along the way.

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Part II Construction Process Control

Introduction

Since 1970s, environment pollution has become a significant part to pay attention to while the world is witnessing great economic development. Different countries over the world have also established various laws, regulations, and standards to avoid or curb the pollution and damage caused by economic activities. China's modern economy started in the 80s, took off in the 90s, and got transformed in the first 10 years of the new century. After reform and opening up, various laws and regulations have been set up in China. The awareness and practices to protect the environment is on the rise at the same time, narrowing the gap between the developed countries and us. As we are still in the starting phase, how the government supervises companies and organizations following the law, how the companies and organizations enhance their self-supervision and self-control, and to proactively reduce pollution by means of technology become pressing issues.

A construction project follows an overall design and plan and is supposed to have a complete system with independent production capability or can be utilized. Usually, it is an enterprise (enterprise complex), an institute, or an independent project. It is in one or several construction sites, with an approved proposal and approved overall design and estimate. It is independently budgeted and has an independent organization to follow infrastructure construction procedures closely. It is in compliant with China's overall construction plan; can function as a production facility or to satisfy living needs. Its proposal and feasibility research report are approved. Projects like a factory, a mine, a residence community, a residence building, a school can all be counted as construction projects. Infrastructure project (newly built, enlargement included) and technology transforming projects also count. A construction project can also be substructured as a single project, a unit project (sub unit project), a division project (a sub division project) and a sub project.

A mature enterprise or a normally productive factory can follow certain laws and experience to manage Environmental Impact. But for a construction project with lots of uncertainties in design and construction processes, it faces tremendous

challenges and difficulties as the infrastructure and sewerage system are not possibly in place in the early stage. This is especially true for key mega projects. The integration and combination of different design and construction partners, different trades, and the different levels of devotion and professionalism of the managers will add another layer to this complication and challenge. The challenges and difficulties are totally different from that of normal scaled or small scaled projects, even different from a simple add-up of them all.

At the same time, key mega projects often will attract a lot of attention from the government agencies and the public. Generally speaking, a key mega project needs to be approved by municipal administration agency, in some occasion, by provincial administration department. Some special projects, for instance, Three Gorges project has been directly approved by the Party Central Committee and the State Council. A lot of research has taken place focusing on the project itself, however, the government will also have experts and scholars study the impact of such project to the economy and political status nationwide, so that they can offer a comprehensive supervision and necessary support. If the environment management department could work with the government, and at the same time use the support and resources from the government, the environment management will be more efficient.

Given the features and complexity of construction projects, key mega projects will always need professional management procedures. In fact, a construction project management procedure is a work sequence specified through rules and regulations by the nation, from decision-making, design, to construction and completion acceptance. Any construction projects, technology upgrading projects above certain amount of investment and single project within the territory of PRC, no matter it is state-owned or individually invested, shall follow the construction project management procedure. This procedure has been streamlined in recently years, but overall there are five phases, as followed:

1. Project Proposal (Pre-feasibility Research) Phase

In accordance with the long-term development of national economy and society, industrial planning and district planning, a project proposal (or pre-feasibility research report) will be compiled with the result of market research, forecast, and analysis. The project proposal needs to be approved by the government agency in jurisdiction, thus a project can get started. Some projects will be filed. In this proposal phase, Environmental Impact will be briefly stated, and in some district the government needs to have a preview of the environment protection measures or file it on record for reference.

2. Feasibility Research

Feasibility research is conducted in order to avoid and reduce the wrong decisions and to increase positive impacts in all manners. The feasibility research is aimed to evaluate and demonstrate the feasibility in terms of technology, engineering,

economy, environment and resource utilization, based on the national economy plan, district plan, and industry plan and requirements, as well as market demands. Multiple proposals will be compared to produce a feasibility research report (including infeasibility) so that the design will have a solid ground. Feasibility research report will be approved by agency in jurisdiction. In this phase, the environment management is to write an Environmental Impact evaluation report to be approved.

3. Design Phase

When a project is approved to set up, the design company will produce a detailed execution plan according to the feasibility research report and national design codes and government approvals. It has a preliminary design and construction design. In this phase, environment related work is to set up environment protection measures in the preliminary design and to make sure the protection measures and budget will be realized and audited. Meanwhile, if a project is required to hire environmental supervisor, Jian Li, the owner company should entrust environmental supervisor, Jian Li, to verify the design documents are in compliant with the environment protection report.

4. Construction Phase

Construction is the actual execution activity of the construction company following the design documents with construction supervision. Before construction, the owner company needs to apply for the commencement approval. In this phase, the environment-related work is to follow EIA and design document to make sure the environmental protection measures are taken; the protection facilities are built in place. For projects required to hire environmental supervisor, Jian Li, the owner company will entrust Jian Li to start their environmental supervision in the course of construction.

5. Commissioning and Completion Acceptance

With the completion of a construction project, the owner company shall carry out commissioning and test, finish the completion acceptance report and follow other acceptance procedures, so that this project could be turned over to production or operation. Except for the main works of the project, items like environment protection, fire system, statistics, archiving and documentation, labor and sanitation, professional safety and auditing should also follow the acceptance procedures. In this phase, environment-related work is to follow Construction Project Completion Environment Acceptance Management Regulations and Methods to finish the acceptance procedures. Commissioning is normally specified as 3 months or 6 months. If the time window has passed, the owner company should apply for a prolonged time for no more than a year.

The environment protection procedures are generally based on the main works, lasting through the whole construction project. In every step of construction, there are different requirements in regards with environment protection. Shown as

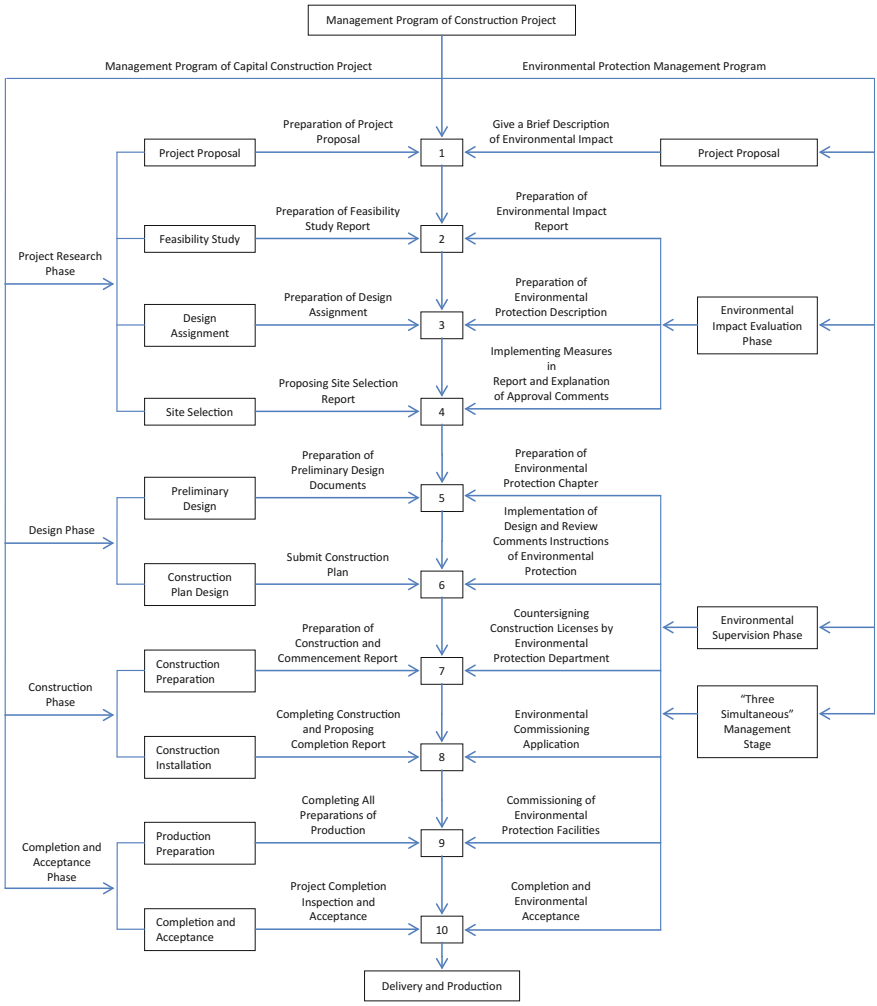

Fig. 1 Mega project management procedure

flowchart (Fig. 1), we could understand how environment protection procedures are closely connected with basic construction procedures.

The editor will use his own work experience to elaborate on environmental protection in construction preparation, process control and completion acceptance, which has always been a hot topic for general society and business world.

Part I
Construction Preparation

A key mega project, same as any small- or medium-sized project, needs to be deliberately planned, designed, and approved before it can officially start.

A mature company has developed its own ways and methods to get properly prepared to start a construction project. Among those preparations, setting up environmental guidelines, building environmental management team and submitting environmental impact assessment report are the most important steps.

Chapter 1
EHS Concept and Interrelation

HSE expands as health, safety, and environment. This management system, also known as EHS (hereinafter referred to as EHS), is introduced by European and American companies. Compared to ISO9000 quality management system and ISO14000 environment management system, EHS has safety included. Safety, environment, and health management are actually closely interrelated in production and construction practices, thus are integrated as EHS management system. Security management sometimes is incorporated in EHS in some European and American companies or construction projects, so that they can be managed as HSSE comprehensively.

In petroleum, chemical engineering, medicine, manufacture, and food industries, EHS has received more and more attention. A practical EHS management system can serve as a framework to provide overall guidance and principles for a company to establish specific goals and management systems regarding environment and occupational health management. Due to a late start, the advantage of EHS has not really manifested itself in China yet; but among multinational corporations, EHS has been placed in a very important position in the management system.

Health means to be both physically and psychologically (mentally) well and intact. Safety is to eliminate any and all unsafe factors and guarantee the smoothness of production activities without any injury to the workers' health, or damage to the company's property, or threaten people's lives. Environment is the sum of all natural forces or effects that are closely related to human beings and will affect people's life and activities; it includes not only the combination of different natural elements, but also the ecological relationship formed by the interactions between human and the nature. Safety, environment, and health management system follows the model of "Plan–Do–Check–Act" (PDCA).

EHS management system mainly highlights the scientific management thoughts on prevention first, leadership commitment, full participation, and continuous improvement. Since 1990s, EHS has solved the managerial problems of safety, health, and environment. It has turned management from hindsight to foresight and

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reduced incidents significantly. EHS itself has become a part of the company culture as well.

Leadership commitment is the core of EHS. Commitment is the fundamental requirement and driver of EHS; top-down commitment and the nurture of EHS culture in an organization at the cornerstone of its success.

EHS requires risk analysis in order to predict possible harm and outcome of a certain activity, so that effective measures can be taken in time to prevent or reduce possible personal injury, property loss, and environment pollution. It emphasizes on prevention and continuous improvement and is a highly self-restraint, self-improved, and self-motivated mechanism. It therefore is regarded as a modern management model and is one of contemporary enterprise systems.

The key of a system is people and procedure. It means to integrate EHS guideline, legal requirement, and business strategy into the company's requirements so as to achieve continuous EHS improvement in compliance with the company's EHS guideline. In addition, the management system should set up procedures to identify and solve the root factors of nonconformance.

In China and abroad, EHS has played a very important role in some foreign invested or joint venture construction projects. EHS runs through the whole project, from project approval, risk analysis, safety evaluation, environment evaluation, occupational disease prevention and treatment to expert panel review, professional institution certification, governmental agencies' (Development and Reform Commission) approval.

Normally, in a large foreign invested construction project, EHS is independent from construction department and directly reports to top project management, similar to Quality Assurance/Control. This vertical management makes EHS serve the project without being constraint by it; it helps EHS to be managed fairly and independently, with thorough implementation throughout the project. The flexibility and adaptability of EHS management model also allows it to be adjusted according to the different sizes and complexity requirement of different projects.

HSE as different components of EHS, has the same goal to reduce harm, incidents, pollutants, wastes, operation costs, and other potential unfavorable factors, and to enhance credibility, increase revenue, and improve reputation. As of organization structure, safety, health, and environment are usually set as separate departments, under a general organization of EHS department. This is especially true for mega construction projects because of the fact that EHS is actually interwoven. For instance, in the relationship of environment and health, environment is significant to the survival and health of human beings; suitable living environment can increase human being's lifespan. On the contrary, if harmful materials produced by human production and living activities are not treated appropriately, the environment will be damaged; human's health may be hurt in the short term, even the well-being of future generations might be threatened in the long run. Epidemiological research proves that 70–90% of human diseases are related to the environment. If we want to live long and prosper, we must maintain a harmonious relationship with the external environment. The human beings can only enjoy fresh air, clean water, and good food by controlling pollution and improve the

environment. Dust, waste water, exhausts, solid wastes, noise, light pollution and use and disposal of toxic and hazardous chemicals are inevitable in mega building construction environment. These are all closely connected to health. Several recent reports about occupational diseases and injury are all related to terrible working environment. Both environment managers and health and hygiene managers shall make joint efforts to identify, evaluate, eliminate, monitor, and supervise harmful elements to the environment. In practice, environment department shall be watchful and prevent potential danger in advance. Health department shall share the necessary data and facts they have found with environment department to urge for actions.

Safety and environment are even more inseparable. Orderly and clean working environment can unconsciously improve the workers psychological well-being and develop a safety culture. Quality and efficiency can thus be assured. A chaotic placement of construction wastes, excavated soil, and building materials on a construction site will result in not only environmental problems, but also safety issues as there is no safe passage. Either a safety or an environment manager could step in and remove such risks. Even though safety and environment are separate functions in EHS organization, it is required that they should collaborate closely with each other in actual practices in the field. However, in reality, the construction company may put safety as priority, but overlook the importance of environment management; safety personnel may be asked to work on both safety and environment, resulted in little real effective environment management. They may lack the knowledge of latest laws and regulations on environmental protection, underestimate environmental risks in production or construction, or take insufficient or inappropriate measures. Incompliance happens frequently. Therefore, professional environment managers shall be staffed in EHS, especially in mega construction projects, reflecting the trend of specialization.

In recent years, with further improvement of China's economy and opening-up, a lot more foreign investment has brought into the market leading EHS management experience, safety has already been a competing priority in many foreign invested joint ventured or state-owned projects as Chinese government keeps emphasizing it. Since recent years, the deteriorated hazel air has drawn lots of attention to environmental protection, making environment management the top of agenda, and laws and regulations all the more stringent. Hence, some large and mega projects have went beyond just safety and environment evaluation. Their process control is now focused on both safety and environment, rather than only on safety. Environment Jian Li has also been introduced into the system to control the overall process.

Chapter 2
Environmental Guidelines and Objectives

Owner companies of major projects, whether they have obtained ISO14000 environmental certification (or passed equivalent environmental audit), they will, as normal practices, set up their own environmental guideline and objectives. Environmental guideline is the ultimate goal to achieve for a business, such as "to build a low-carbon green company" and environmental objectives are relatively more detailed and specific, such as "the company will reduce carbon dioxide emissions by twenty percent through technology innovation in the year of xxxx."

A long-term and strategic environmental guideline should be established first. The guideline shall be approved and supported by the Board or the executives, which will set the right tone for environmental protection throughout the company. Then the functional departments can cascade the guideline from top down to make it into tactical actions and specific steps, without being interrupted by internal and external factors. Otherwise, such strategy may become an empty concept simply due to the lack of budget, time or manpower. A more practical approach is to put the guideline and objectives down in formal writing (it will be included in first-class commercial file using ISO or similar certification system). The document shall be kept transparent to the stakeholders, all employees, and public media; or it will be audited by the certification system, which can ensure its implementation—this is also regarded as public or legal supervision.

Environmental guideline and objectives will never remain static; they change in different localities and times.

When a company's business direction has shifted significantly, such as corporate merging and reorganization, or a project's investment and design have had great changes, like adding investment based on design changes, the original environmental guideline, and objectives may not be applicable anymore because of the changes in ownership or spaces. The state-of-the-art technology will develop as time goes by. For example, the fossil fuels are being exhausted on the planet while catalytic oxidation technology has taken a great leap, an environmental guideline then can be made more specific, and the goal can aim higher. For instance, the environmental guideline can be upgraded from a "low-carbon green company" to a

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"low-carbon low-sulfur environment friendly company," environmental objectives can also be updated from to reduce "carbon dioxide emissions by twenty percent" to "carbon and sulfur emissions by half."

It is very important that environmental guidelines and goals are achievable, or can be realized through the joint efforts. Otherwise, they are just empty sayings.

Basically, feasibility means the goal can be realized through common technology with controllable budget. If a business or project states now that they will "have zero carbon dioxide emissions," or "to turn all sewage water into potable water," they must be deceiving themselves or just put on a show. 100% usage of solar panels can be "zero emissions" theoretically, but the current energy conversion rate still cannot be zero. In theory, "physicochemical + biochemical + UF" combined could get any industrial waste water purified to be drinkable, but the cost would be enormous. Thus, it is beyond any company's capability or will to do so. While we could have a beautiful and far-sighted vision regarding environmental protection, the goal should always be realizable and practical.

Following are some examples from the Fortune 500 companies to help us understand how to set up a company's environmental guidelines and objectives. Although the construction of a project is not exactly the same as a company's operation, the commitment and practices on environmental protection are still universal.

2.1 DuPont

Let us first take a look at DuPont—a world leading chemical company. Of course, environment and safety are the most closely related for a chemical company like that.

The core direction of DuPont is Sustainable Growth—the creation of shareholder and societal value while we reduce our environmental footprint along the value chains in which we operate. Through this Commitment to safety, health, and environmental excellence, we affirm to all our stakeholders, including our employees, customers, shareholders, and the public, that we will conduct our business with respect and care for the environment. We will implement those strategies that build successful businesses and achieve the greatest benefit for all our stakeholders without compromising the ability of future generations to meet their needs. We will continuously improve our practices in light of advances in technology and new understandings in safety, health, and environmental science. We will make consistent, measurable progress in implementing this Commitment throughout our worldwide operations and support Responsible Care® as a key program to achieve this Commitment.

Highest Standards of Performance, Business Excellence We will adhere to the highest standards for the safe operation of facilities and the protection of our environment, our employees, our customers, and the people of the communities in which we do business. We will manage security as we do safety. We will strengthen

our businesses by making safety, health, and environmental issues an integral part of all business activities and by continuously striving to align our businesses with public expectations.

Goal of Zero Injuries, Illnesses, and Incidents We believe that all injuries and occupational illnesses, as well as safety and environmental incidents, are preventable, and our goal for all of them is zero. We will promote off-the job safety for our employees. We will assess the environmental impact of each facility we propose to construct or acquire and will design, build, operate, and maintain all our facilities and transportation equipment so they are safe, secure, and acceptable to local communities and protect the environment. We will be prepared for emergencies and will provide leadership to assist our local communities to improve their emergency preparedness.

Goal of Zero Waste and Emissions We will drive toward zero waste generation at the source. Materials will be reused and recycled to minimize the need for treatment or disposal and to conserve resources. Where waste is generated, it will be handled and disposed of safely and responsibly. We will drive toward zero emissions, giving priority to those that may present the greatest potential risk to health or the environment. Where past practices have created conditions that require correction, we will responsibly correct them.

Conservation of Natural Resources, Energy, and Biodiversity We will excel in the efficient use of fossil fuels and feedstocks, land, water, minerals, and other natural resources and transition toward the greater use of renewable energy and feedstocks. We will seek to conserve and protect natural resource biodiversity and will manage our land to enhance habitats for wildlife. We will also work with our customers and suppliers to reduce impacts and improve efficiencies along the value chain.

Continuously Improving Processes, Practices, and Products We will extract, make, use, handle, package, transport, and dispose of our materials safely and in an environmentally responsible manner. We will continuously analyze and improve our practices, processes and products to reduce their risk and impact throughout the product life cycle. We will develop new products and processes that have increasing margins of safety for both human health and the environment. We will seek opportunities to make our new and existing facilities inherently safer. We will work with our suppliers, carriers, distributors, and customers to achieve similar product stewardship, and we will provide information and assistance to support their efforts to do so.

Open and Public Discussion, Influence on Public Policy We will promote open discussion with our stakeholders about the materials we make, use and transport and the impacts of our activities on their safety, health, and environments. We will build alliances with governments, policy makers, businesses, and advocacy groups to develop sound policies, laws, regulations, and practices that improve safety, health, and the environment.

Management and Employee Commitment, Accountability the Board of Directors, including the Chief Executive Officer, will be informed about pertinent safety, health and environmental issues and will ensure that policies are in place and actions taken to achieve this Commitment. Compliance with this Commitment and

applicable laws is the responsibility of every employee and contractor acting on our behalf and a condition of their employment or contract. Management in each business is responsible to educate, train, and motivate employees to understand and comply with this Commitment and applicable laws. We will deploy our resources, including research, development, and capital, to meet this Commitment and will do so in a manner that strengthens our businesses. We will measure and regularly report to the public our global progress in meeting this Commitment.

2.2 Sony Corporation

Not only manufacturing companies need detailed environmental goals and plans. Sony, an electronics and entertainment company has also lined out very specific and detailed environmental guidelines and objectives of its own.

Environmental initiatives are one of Sony's most important topics in this age in which a company's consideration of the environment is one of the selection standards for customers when purchasing products.

Sony has continued to promote environmental activities based on our "Road to Zero" environmental plan that aims for a zero environmental footprint. In order to accelerate our environmental activities, we have now established our "Green Management 2020" environmental targets (achievement year: FY2020). As we move toward these targets, the entire Group, including the field of entertainment in addition to electronics, will make the best use of its individual strengths in performing these activities.

The Sony Group has now entered the next stage of its environmental activities. Sony is committed not only to offering products, services, and content that deliver exciting user experiences by inspiring and fulfilling the curiosity of our customers around the world, but also, through our "Road to Zero" environmental plan, to working toward our goal of a zero environmental footprint throughout our business activities.

Sony established the Road to Zero environmental plan in FY2010 in quest of a zero environmental footprint.

FY2050 has been set as the year for achieving a zero environmental footprint, and we have been moving actively towards this goal since FY2010 by setting intermediate targets along the way. Green Management 2020 has been established as the intermediate target set for the FY2020, and we have now entered the next stage of Sony Group's environmental activities.

Be Moved with Sony products while using Minimal Energy

Sony will reduce the annual energy consumption of its products by an average of 30% by FY2020.

We will reexamine our products for further energy-saving potential while developing innovative energy-saving technologies in order to drastically reduce the energy consumption in all major products.

Efficient Production with a Smaller Environmental Footprint

All Sony sites have always sought and implemented energy-saving measures. In addition to further deploy conventional energy-saving activities in all production plants, we have initiated new improvements in our production lines to cut down on our environmental footprint, even when production increases are required.

Tapping the power of entertainment to raise awareness and inspire action

Through Sony's Entertainment products and content, whether in movie theaters, over the airwaves, on a production set, or through new media, we are hoping to reach out to over 500 million people worldwide by FY2020 to raise awareness and inspire action on the issues of environmental sustainability.

Business Partners Becoming Environmental Partners

To achieve the reduction of the environmental footprint throughout the entire life cycles of our products, we will further encourage our component suppliers, major external manufacturing contractors, and other business partners to help us to reduce our environmental footprint, and collaborate with them to meet our FY2020 targets.

Accelerating the Use of Renewable Energy

In addition to ensuring the thorough implementation of energy-saving measures in Sony sites, we are also accelerating the use of renewable energy. Our aim is to increase the amount of renewable energy that we use in order to contribute to CO_2 reductions equivalent to 300,000 tons by FY2020 through the use of certificates and credits.

2.3 China Metallurgical Group Corporation

Metallurgical Corporate of China (MCC) is a large state-owned corporate group in China. It is also one of the world leading companies in promoting environmental protection awareness and actions. MCC's main business is in conventional high energy consumption industries, meanwhile, they are a top-level construction general contractor nationally even globally. Their definition and guidelines of environmental protection are detailed here for us to study.

2.3.1 Environmental Responsibility

Ecological environment is related to human survival and development. China Metallurgical is committed to promoting coordinated development of social economy and ecological environment. The industry will promote the development and application of environmental technology as a business strategy development for hair

Show direction, leveraging technological advantage to promote energy-saving new technologies, new products, and develop environmentally friendly.

New markets, promote low-carbon economic development, environmental protection industry has developed a unique technology advantages, as corporate social.

Highlight the characteristics of responsibility, resource-saving and environment-friendly society, and make a positive contribution.

China Metallurgical Environmental Policy

Supervision according to law, energy conservation, environmental protection.

Adhere to the scientific concept of development, for the benefit of society and future.

In 2009, the company has million yuan output value (revenue) overall energy consumption 0.1622 tons of standard coal, declines by 12.94%.

2.3.2 Improve the Management System

China Metallurgical actively carry out environmental management system according to environmental policy, subordinate enterprise have passed the ISO14001 environmental management system certification.

Perfect the organizational system.

China Metallurgical and its subsidiaries are all establish emission reduction work leading groups which lead by the main leaders of the enterprises as the first responsible persons.

And they set up establishment of a permanent mechanism of energy conservation management, they make the energy conservation objectives allocate separate tasks, each task will implement into persons and position.

In 2009, China Metallurgical has established statistical monitoring system of the energy saving covers every subsidiaries, all subsidiaries fill in strict accordance with the energy-saving statistical monitoring form regularly and they will report to the headquarter.

Improve the examination system

In 2009, China Metallurgical have formulated the “energy-saving target responsibility assessment and evaluation scorecard,” which covers the Energy saving, energy conservation work organization and leadership, the energy-saving target decomposition and implementation, energy-saving technology and the implementation of energy-saving technological transformation, such as the implementation of energy-saving laws and regulations, and effectively promote energy conservation jobs.

2.3.3 Promote Energy Conservation

China Metallurgical will increase energy conservation capital investment, and R&D capabilities. They will continue to strengthen ecological protection and environmental protection, and actively explore the market in the field of energy saving, capture new opportunities.

2.3.4 Strengthen Research and Development

China Metallurgical Industry will increase the level of environmental protection technology as an important part of enterprise development strategies.

They will actively explore new energy-saving metallurgy, municipal environment and comprehensive utilization of resources, promoting the using of independent research, and development of environmental technology. Until 2009, the company has mastered over sixty great advanced technologies in the area of flue gas pollution control, sewage treatment, they have developed almost a hundred of major equipment and components, the overall technology.

Their technique level is at leading position in the domestic, in which the industrial flue gas desulfurization, pulverized coal injection, reheating furnace, more than thermal power technology and dry dust and other areas are closed to or reached the international advanced level.

2.3.5 Promoting Achievements Transfer

The company will attach great importance to research achievements into applications, such as the use of ground source heat civil design pumps, solar energy, and other green building technology. Independent design and construction of buildings CISDI has won the 2009.

China's top ten green building energy conservation estate. They have independent intellectual property rights to the Biological Aerated Filter and other leading domestic patents and proprietary technology in domestic sewage, industrial waste water treatment, they have successfully entered the construction and operation of municipal sewage treatment plants, sewage treatment facilities hosting operations, environmental engineering process design, and general contracting.

2.3.6 The Development of Circular Economy

Development of circular economy is to promote economic and social development and the natural environment. It is the important way to facilitate sustainable resource.