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# **Science & Technology**

***China: Energy***

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## SCIENCE & TECHNOLOGY

### CHINA: ENERGY

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ERRATUM: In JPRS-CEN-88-003 of 25 April 1988 in article  
DESIGN OF NUCLEAR HEAT, POWER CO-GENERATION PLANT DETAILED,  
on page 42, para. 1, line 4, make "billion" read "million."

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### **Divisions Deepen Over Controversial Three Gorges Project**

40130076 Hong Kong WEN WEI PO in Chinese 4 May 88 pp 1, 2

[Article by Qian Jiaju [0578 1367 7467]: "A Text of Democratic and Scientific Policy-Making"--"Subheads supplied by WEN WEI PO editor"]

[Excerpts] The Three Gorges Project Examination Committee will be responsible for the examination of the Three Gorges Project Feasibility Report submitted by the Ministry of Water Resources and Electric Power [MWREP] and then submit the report to the central authorities and the State Council for approval. Finally, the Three Gorges Project Examination Committee of the State Council will submit the Three Gorges Project Feasibility Report to the NPC for examination. In order to strengthen the leadership over the work of building the Three Gorges Project on the Chang Jiang, the central authorities have appointed Comrade Li Peng, Comrade Bo Yibo, Comrade Wang Renzhong, and Comrade Cheng Zhihua to take charge of and coordinate the work concerning the scientific demonstration of the Three Gorges Project.

Now, work on the scientific demonstration of the feasibility of the Three Gorges Project is underway. However, recently, there have been signs that it is still uncertain whether the scientific demonstration of the feasibility of the Three Gorges Project on the Chang Jiang can be fairly and objectively carried out or not. I not only have reservations about but also doubt the fairness and objectiveness of the scientific demonstration of the feasibility of the Three Gorges Project on the Chang Jiang. Why?

#### **The Internal Instruction Before the Meeting**

The premise of scientific demonstration is democratic decision-making and without this decision-making, scientific democratization would be impossible. If different views cannot be heard or those who hold different views are banned from expressing them, development would become impossible or would look impressive but lack real worth. At the National Scientific Research Work Symposium held on 31 July 1986, Comrade Wan Li said: "The premise for the so-called scientific decision-making is democratization. Without democratization and free expression of views and thoughts, respect for knowledge, qualified personnel, wisdom created by the people, and practical experiences would become impossible and so would the scientific decision-making." Have we realized democratization? As far as the 7th

CPPCC is concerned, before the 7th CPPCC was concluded, the press received an internal instruction demanding a strict censorship on the reports concerning the Three Gorges Project on the Chang Jiang. Why? It was learned that the authorities thought the question of the project was a very complex one and reports concerning the subject might divert the theme of the "Two Conferences." (The fact is that the authorities said that not only the Chinese experts but also the foreign experts believe that the construction of the Three Gorges Project should be carried out. And the authorities urged all those concerned not to listen to the views of those who oppose the construction of the project any more." As a result, although there was strong opposition to the building of the Three Gorges Project both during the panel discussions and the assemblies of the 7th CPPCC and in the speeches addressed to the 7th CPPCC by the deputies, nothing concerning the project was filed, published in the newspapers, broadcast on the radio, or televised. All the news concerning the discussion on the construction of the Three Gorges Project was blocked. (At the very beginning, I did not believe that all the news concerning the discussion on the construction of the Three Gorges Project on the Chang Jiang during the "Two Conferences" was blockaded because I thought that since "Two Conferences" were to hold reelections, democracy would have to be greatly developed during the "Two Conferences." Unfortunately, it is true that all the news concerning the discussion on the construction of the Three Gorges Project was blocked.)

Second, the Hunan Science and Technology Publishing House has published a book entitled "On Macroscopic Decision-Making Concerning the Three Gorges Project." The book has collected the views and essays of many of our country's well-known experts on the Three Gorges Project (such as Li Rui, Lin Hua, Lu Qinkan, and Fang Zongdai). The book has been prefaced by Zhou Peiyuan, the well-known scientist and vice chairman of the CPPCC. Originally, the publication of the book was a quite normal matter. However, when the leaders of the MWREP found out about this book, they put pressure on the Hunan Science and Technology Publishing House through various channels and demanded the publishing house stop publishing the book. The Hunan Science and Technology Publishing House resolutely resisted the pressure and published the book as scheduled. After the book was published, Professor Wang Ganchang (Wang Ganchang is also a division member of the Chinese Academy of Sciences) wrote a commentary on the book in RENMIN RIBAO (OVERSEAS EDITION) on 23 February of this year. After reading Professor Wang Ganchang's commentary on the book, a certain leader of the MWREP criticized the responsible person of RENMIN RIBAO for publishing Professor Wang's commentary. As a result, the scheduled publication of Professor Wang Ganchang's commentary in the domestic edition of RENMIN RIBAO was later canceled.

#### **The Scientific Demonstration Is Incomplete**

Third, several experts have told me that at the scientific demonstration meeting held by the MWREP, they held that the meeting should not only discuss the development plan of the Three Gorges Project on the Chang Jiang but should also discuss the development of the tributaries of the Chang Jiang and other relevant development plans. The meeting should also make a

comparison between the development plan of the Three Gorges Project and other development plans of the same nature to see which plan is more practical, is capable of producing better economic results and quick benefits, requires less investment, and is made on a scientific basis. In other words, those experts held that the meeting should scientifically compare the development plan of the Three Gorges Project with other development plans (to see if it is more practical to develop the tributaries in the upper reaches of the Chang Jiang than to develop the Three Gorges on the Chang Jiang). Nevertheless, the scientific demonstration meeting of the MWREP was not held in this way. The meeting only discussed the question of the construction of the Three Gorges Project to decide whether to maintain the water level of the dam of the Three Gorges Project at 150 meters or at 185 meters. In other words, the meeting held by the MWREP only discussed the question of whether to build a 150-meter dam or build a 185-meter dam for the Three Gorges Project. This is quite ridiculous because the discussion on building either a 150-meter dam or a 185-meter dam for the Three Gorges Project was still centered on the Three Gorges Project only and nothing else. For example, if we discuss whether the office cadres should wear Western-style suits or not, we should first of all make a comparison between the Western-style suits and the Chinese tunics or the suits of other styles to see their respective advantages and disadvantages before making a decision on whether we should wear the Western-style suits or the Chinese tunics or the suits of other styles. We should not discuss whether we should wear double-breasted or single-button-line Western-style suits because both the double-breasted and the single-button-line suits are still Western-style suits and nothing else. The scientific demonstration meeting held by the MWREP was indeed held in such a ridiculous way. The State Council had asked the MWREP to discuss whether or not it is practical to carry out the construction of the Three Gorges Project on the Chang Jiang and whether or not it is practical to carry out the construction project immediately or years later. However, what the meeting held by the MWREP actually discussed was whether to build a 150-meter dam or a 185-meter dam for the Three Gorges Project. The reason given by the MWREP was: We want to "select a dam water level for the Three Gorges Project which is acceptable to all sides so that we can concentrate on more detailed scientific demonstration of the feasibility of the Three Gorges Project" (Please refer to the written speech made by Qian Zhengying at the 7th CPPCC.) Although Qian Zhengying also said: "The initial selection of a dam water level does not mean that the Three Gorges Project will be built. The dam water level initially decided on will not necessarily be the final one. This is because after carrying out the in-depth scientific demonstration, we might revise the original plan." If this was the case, why didn't the meeting held by the MWREP compare the development plan of the Three Gorges Project with other development plans, such as the plan for the development of the tributaries in the upper reaches of the Chang Jiang? Why did the meeting held by the MWREP only discuss the questions of whether to maintain the dam water level of the Three Gorges Project at 150 meters or at 185 meters and nothing else? Qian Zhengying said: "This is only the initial plan which will not necessarily be the final plan. It is quite possible that changes will be made in the initial plan later on." To allow changes in the initial plan does not mean to veto the Three Gorges Project but to determine a dam water level for the

project somewhere between 150 meters and 185 meters. From this, we can see that the construction of the Three Gorges Project has been the fixed policy of the MWREP. And even the holding of the scientific demonstration meeting could not change this fixed policy.

#### **Those Who Hold Different Views Are Discriminated Against**

Fourth, some of my friends were invited to attend the scientific demonstration meeting held by the MWREP on the question of the Three Gorges Project. They told me that some experts and scholars of the MWREP did not agree to the development plan of the Three Gorges Project. They are very dissatisfied with their leaders who, according to these experts and scholars, have always deceived their superiors and deluded their subordinates, practiced fraud, held back unpleasant information, and suppressed democratic atmosphere within the MWREP. These experts and scholars are deeply concerned about the serious consequences of their leaders' malpractices. All those who hold different views on the question of the construction of the Three Gorges Project within the MWREP have either been discriminated against or removed from important positions. The leaders of the MWREP have also tried in every way to put pressure on those who hold different views on the question of the construction of the Three Gorges Project in order to prevent them from expressing their views in public. Several of my comrades were invited to attend the scientific demonstration meeting held by the MWREP last year. At the meeting, they disagreed with the building of the Three Gorges Project. However, when the report of the meeting was published, their names were listed as those who agreed to the building of the Three Gorges Project. The report failed to report the facts. In the report, it seemed that all the participants at the meeting had agreed to the immediate and fast construction of the Three Gorges Project. Later on, only when those comrades protested against such untrue reporting was the report revised. Here, I am not speaking irresponsibly because I have enough evidence to support what I say.

All in all, to build the Three Gorges Project is the fixed policy of the MWREP. This fixed policy has never been changed. And the preparations for the building of the project have never stopped, either. The MWREP has so far held several development meetings on the question of building the Three Gorges Project on the Chang Jiang. The purpose of holding such meetings is twofold: To cope with public opinion and to report something to the higher authorities.

Many people who are ignorant of this fact have turned to thinking that the building of the Three Gorges Project has been suspended because some CPPCC members do not agree to it. This is a sheer misunderstanding. A lot of friends of mine have written to me saying that the building of the Three Gorges Project was suspended because I made a speech at the CPPCC in 1986 and saying that I have done a very good thing for the country. I do not deserve such honor because what they say is not true. In his "Work Report" addressed to the 7th CPPCC on 24 March of this year, Comrade Qian Xueshen said that "many of the views and proposals put forward in the CPPCC have been paid attention to by the party and government leading organs at the central level and by the departments concerned. Some of these views and

proposals have been accepted. For example, the investigation report on the economic rationality and technological feasibility of the key water control project at the Three Gorges has been paid attention to by the leading comrades of the State Council and the report is conducive to the work of scientific demonstration of the feasibility of the project." Some people might ask me why I should say that it is a sheer misunderstanding since Comrade Qian Xueshen has mentioned that. In fact, if we look at the "Work Report" made by Comrade Qian Xueshen in detail, we will find that what the leading comrades of the State Council have paid attention to is the views and proposals which "are conducive to the work of scientific demonstration of the feasibility of the project" and not the views and proposals which call for the suspension or cancellation of the construction of the Three Gorges Project.

### **Zhou Peiyuan Shares My Views**

Many people often overestimate the role played by the CPPCC members. I clearly know my own limitations. In my speech addressed to the CPPCC in 1986, I said: "I realize that what I say cannot bring about any fundamental change because it is extremely difficult and even impossible to stop building a project that has been decided upon and is being built." "However, out of my own sense of responsibility for the country and people, I am willing to try to 'do what is impossible.' This is perhaps also the tradition of our old intellectuals." I have shared the same feelings with Comrade Zhou Peiyuan on the question of the Three Gorges Project. Comrade Zhou Peiyuan said: "The lesson we have learned from our past experiences tells us that we should not be overanxious for quick results. The department concerned should not subjectively think that it is right to build the project simply because it is a huge project of a super-world standard and because by building the project, the department concerned will become famous in the world. Haste makes waste and leads to just the opposite. I want to stress again that if the project is hastily built without going through sufficient scientific demonstration, there will be no end of trouble for the future and it will be too late for those involved to repent by that time." In the 1950's, Comrade Zhou Peiyuan "was once an activist advocating the building of the Three Gorges Project." However, later on, "after reading more materials and having acquired a clearer understanding of the project, especially after the Economic Construction Group of the CPPCC made detailed and practical investigations on the project, I changed my views and began to think that we must be cautious in making any decision in the construction of the project since it would affect the livelihood of the future generations of our nation." (Please refer to the Preface written by Zhou Peiyuan to the book "On Macroscopic Decision-Making Concerning the Three Gorges Project.")

The key to scientifically making decisions on the construction of the Three Gorges Project lies in whether the decision can be made in a democratic way or not, whether the departments concerned are willing to modestly listen to the differing views or not, and whether the departments concerned can encourage the free airing of views and thoughts or not. If the departments concerned continued to suppress differing views, control public opinion, deceive their superiors and delude their subordinates, then it would be

better for the scientific demonstrations on the feasibility of the Three Gorges Project not to be held because the holding of such demonstrations would only waste money and manpower. We are waiting to see what the departments concerned will do!

/9365

**Views on Development of Shanxi Coal Base**

40130066a Beijing ZHONGGUO KEJI LUNTAN [FORUM ON SCIENCE AND TECHNOLOGY IN CHINA] in Chinese No 1, 1988 pp 11-12, 18

[Article by Tan Fangzhong [6223 2455 0112]: "Some Views on Development of the Shanxi Coal Base"]

[Text] In China, the energy shortage has become a primary factor restricting development of our national economy. Coal dominates the structure of energy consumption in China, accounting for more than 70 percent of energy use, and this situation will not change for a long time to come. Electric power production in China is dominated by thermal power, and the growth of township and town industries, rural energy resources, and other things depend on the supply and development of coal. China produced 870 million tons of coal in 1986, second worldwide. Forecasted coal output will reach 1 billion tons in 1990 and must grow to 1.4 billion tons by 2000 to meet the need for development of China's national economy. The lull in China's coal shortage is only temporary. Thus, we must begin now to study strategies and formulate principles and policies for development of China's coal industry.

Shanxi is China's largest coal base area at present in terms of preliminary scale, so it occupies an extremely important position. Shanxi's richness in coal is famous worldwide. As early as before World War II, financial concerns in the United States, England, Japan, and other countries attempted to participate in the extraction of Shanxi coal. Japan actually extracted Datong coal and once considered digging a canal to ship out Shanxi coal which would be substituted for a railway transport program. The importance of Shanxi's coal resources is quite apparent.

Shanxi holds almost 250 billion tons of China's proven coal reserves of 870 billion tons, the highest proportion nationwide. There are 85 counties among Shanxi's 119 counties and towns which have rich coal resources, so it can be said that coal is found throughout the province.

There are rich coal resources in Shanxi, the resource conditions are good, and extraction conditions are excellent. Shanxi's coal fields have simple geological structures, the coal seams have gentle inclines, and most of the coal seams of medium thickness occur in groups, so the reserves are quite concentrated. Shanxi coal comes in a full range of varieties, and it has a

relatively low ash content, only 10 to 20 percent, for example, in Datong coal. It is a superior high-grade power coal which is sold throughout China and enjoys an excellent international reputation. Shanxi has gas coal, fat coal, primary coking coal, meager coal, anthracite, lean coal, soft sticky coal, long-flame coal, and other varieties. Yearly anthracite output exceeds 7 million tons, more than 60 percent of the national total. China's largest coal field, the 29,500 km<sup>2</sup> Qinshui Coal Field, is located in Shanxi, as is China's largest coal base area, the Datong Mine, which produces more than 30 million tons of coal annually.

Shanxi ranks first in China in coal output. In 1984, the 62 unified distribution coal mines in Shanxi had a production capacity of 20.78 million tons. There were more than 180 local coal mines which produced 24.74 million tons of coal. There also were 3,189 township and town coal mines which produced more than 72 million tons, ranking first among township and town coal mines in China. Coal output in Shanxi has 210 million tons in 1986, one-fourth the total for China. During the Sixth 5-Year Plan, 4 out of every 10 tons of additional coal output came from Shanxi Province, and Shanxi provided 75 percent of state unified distribution coal. Shanxi shipped out 509 million tons of coal during the Sixth 5-Year Plan, and accounted for 68.1 percent of China's coal exports in 1984.

The economic results in Shanxi's coal industry are good. The cost per ton of coal in all of Shanxi's unified distribution coal mines in 1984 was 18.14 yuan, which was 5.44 yuan less than the national average. Shanxi's coal enterprises rank first in China's coal system in profits and taxes turned over to higher authorities. Actual taxes and profits paid during 1984 by independent accounting unit coal enterprises under ownership by the people in Shanxi totaled 2.323 billion yuan. Full-staff labor productivity in Shanxi's unified distribution coal mines is 1.461 tons/person, which is 0.558 tons/person higher than the national average.

Shanxi has an excellent geographical location. The province is located in central China. Moving eastward through Qinhuangdao and Shijiugang, one can reach east China to the south and northeast China to the north, and on through Shanhaiguan, into Liaoning. To the south lies the Central Plains region. The shipping distances to these coal-short regions are suitable and communications are convenient. In 1984 alone, these regions received shipments of 124.81 million tons of coal. Good construction of the Shanxi coal base area is of extremely great strategic significance. For this reason, attention should be given to these questions:

1. Development of Shanxi's coal industry should continue to give play to the two types of initiative. During the Sixth 5-Year Plan, Shanxi's coal industry moved off the old road of simply receiving funds from central authorities and state-run mine operation to form a new situation of multichannel fund raising and multilevel development. Large, medium, and small mines are moving forward together at an unprecedented pace of development. During the 5-year period, Shanxi increased its net coal output by more than 85 million tons, nearly double the amount during the Fifth 5-Year Plan, and coal output in Shanxi surpassed 200 million tons

for the first time in 1985. Output in township and town coal mines grew by 10 million tons each year, a two-fold increase over the 1980 figure, and they have become a primary force in Shanxi's coal industry. Local coal mines produce two-thirds of Shanxi's coal. According to 1980 statistics, Shanxi's local coal mines have produced a total of 540 million tons of coal over the past 30-plus years, and they have turned over more than 900 million yuan in profits while using only 440 million yuan in state investments. Local coal mines require fewer investments for construction, provide results more quickly, and have lower costs. Moreover, township and town mines do not require state investments, nor must they have indices for recruiting workers. Thus, we should adopt measures to support local coal mines and assure their healthy development. 1) Strengthen leadership, unify planning. Based on resource conditions and needs, state-run unified distribution coal mines should make a rational demarcation of resources with local coal mines so that they do not interfere with each other. Township and town mines should focus on shallow, old extraction regions and leftover and residual coal regions which cannot be reached with conventional shaft mining. 2) The state should provide appropriate financial and material assistance, and provide technical guidance for solution of the problems of local mines, particularly the low recovery rates, unsafe conditions, and other problems in township and town mines. 3) Prospective coal mines at the county level and above should transform and expand in a planned and gradual manner to exploit fully the productive potential of local coal mines. 4) There should be stronger consolidation at township and town coal mines which have low resource recovery rates, cannot guarantee safety, or have no prospects, or they should cease production.

These measures must observe and be matched with unified plans for the Shanxi coal base area to assure that local coal mines in Shanxi become a rational component of the Shanxi coal base area and develop.

2. It would be best if mine construction focused on medium and small-scale mines, for several reasons. One is that medium and small-scale mines have shorter construction schedules. Building a large mine usually takes 7 or 8 years before it begins operating and attains design capacity. In contrast, it usually takes only 4 to 5 years to build a medium-scale mine with a 600,000 to 1.2 million ton capacity. Second, technical equipment in small mines is simple and costs are low. Coal output in the United States was 600 million tons in 1976 and reached 850 million tons in 1982. The main factors behind the 200 million ton increase over the 6-year period was construction of small shaft mines, with their shorter construction schedules and rapid startup.

3. Use the coal industry as a foundation, construct a comprehensive industrial economic base area in Shanxi.

On a world scale, all of the main coal producing nations have focused on coal in primary coal producing regions to build comprehensive industrial base areas. Examples include the Ruhr in the Federal Republic of Germany, Dubas in the Soviet Union, the Appalachian Mountains region in the United States, and so on.

Looking at China's situation, the Fushun, Benxi, Kailuan, and other regions also have developed into comprehensive industrial zones focused on coal. For this reason, Shanxi should combine expanded coal production with major efforts to develop a series of industrial departments for coal processing and utilization, local conversion, and economic diversification. Simple raw coal production, transport, and direct burning certainly cannot be permitted. The thermal efficiency in direct burning of raw coal is only 15 percent, so most of the heat energy is wasted. Comprehensive processing and utilization, on the other hand, can derive many times more economic benefits from coal.

4. Build Shanxi into a large-scale electrical power base area. Out-shipments of Shanxi coal involve shipping ever-increasing amounts, which has caused growing shortages in railway transportation. Shanxi shipped out 509 million tons of coal during the Sixth 5-Year Plan, and coal output in Shanxi must surpass 800 million tons by the year 2000. At present, 40 percent of railway capacity in Shanxi is used to ship coal. It costs more than 20 yuan to ship a ton of coal to Jiangsu and Zhejiang, and coal shipping consumes a great deal of energy resources. We must shift from shipping coal to large-scale power transmission to alleviate the shortage of railway transport and improve the economy of coal utilization.

5. Reinforce transport and construction for out-shipment of Shanxi coal. The key to development of the Shanxi coal base area is transport conditions, mainly railway construction. Since the Third 5-Year Plan, Shanxi coal production has not been coordinated with transport, to the point of "allowing transport to determine production." The coal not shipped out is lashed by nature or water, or is sold locally at a greatly reduced price, causing enormous losses. The first thing to do in railway construction is to electrify the six railways used at present for shipping out Shanxi coal so that they provide benefits as quickly as possible.

We also should reinforce organization of highway coal transport and improve the conditions for highway out-shipment of Shanxi coal. We should improve the Shanxi-Hebei and Shanxi-Henan trunk highways, improve the quality of and widen road surfaces, and so on for continued improvement of highway coal transport conditions.

6. Develop coal liquefaction and pipeline transmission. Due to the low thermal efficiency of direct burning of coal and the emission of waste materials and waste gas which pollute the environment, many nations have formulated environmental laws which prohibit the direct burning of coal. Coal liquefaction is an important direction of development. Coal-water slurries are being used on a large scale in the United States, Canada, and other main coal-producing nations, with very good results. Preparation and combustion of high concentration coal-water mixtures, which are China's substitute for oil fuels, have attained the industrial level and China's first coal-water mixture industrial production line has been built by the Fushun Mine Bureau. Shanxi coal comes in a complete range of varieties, and there are excellent conditions for developing the coal-water mixture industry.

7. Development of the coal industry in Shanxi should be opened up to the outside world. Coal construction involves long schedules and large investments, and technical facilities in China's coal industry are backward, so we need to import foreign investments and advanced technical facilities. Implementation of the policy of opening up the outside world got off to a good start during the Sixth 5-Year Plan, and opening up to the outside world should be done even better during the Seventh 5-Year Plan.

The development of Shanxi's coal resources requires that we consider the development of the coal industry itself, as well as the development of other industrial sectors. Comprehensive development is essential to making greatest use of Shanxi's coal resource advantages and building Shanxi in China's huge resource base area, power base area, and large industrial zone with a full range of sectors so that it becomes the backbone of China's coal industry and makes an even greater contribution to the development of energy resources in China.

12539/9365

### East China Grid Gets Three 500-KV High-Tension Lines

40130067a Beijing JIEFANG RIBAO in Chinese 16 Feb 88 p 3

[Article by reporter Sang Jinqun [2718 2516 3123]: "'Big Arteries' Replace 'Small Arteries'--Two of the Three 500-KV Power Transmission Lines in the East China Grid Have Reached Shanghai, Power Transmission Capacity May Increase About Two-Fold After the Former 220-KV Line Is Replaced"]

[Text] After speeded-up construction, two of the three 500-KV high-tension power transmission lines running from Huainan in Anhui, Xuzhou in Jiangsu, and Gezhouba in Hebei have reached Nanqiao in Fengxian County, Shanghai Municipality. The other line has reached Jiangdu and now is being extended to Shanghai. This indicates that the grid dominated by 220-KV power transmission lines in the East China Grid will be replaced by a grid of 500-KV high-tension power transmission lines at advanced international levels within the near future, which will expand the power transmission capacity of the entire grid.

The East China Grid is China's largest supra-provincial and supra-municipal power grid. Its range of power supply extends for more than 400 km from east to west and more than 600 km from south to north. It has relied primarily for quite some time on connections with 220-KV power transmission lines, and it was unable to adapt to and meet the power use needs of the three provinces and one municipality in east China a decade ago. Beginning in 1983, the state decided to build three 500-KV high-tension power transmission lines here. There are two lines from north to south. The eastern line begins at the Xuzhou Power Plant and passes through Jiangdu, Doushan, and Huangdu to Nanqiao, running for a total length of more than 600 km. The section between Xuzhou and Jiangdu went into service in December 1987 and it is expected that the Jiangdu to Nanqiao section will be completed and go into service during 1988. The total investments exceeded 500 million yuan, including more than \$100 million in loans from the World Bank. The west line runs from the towers at the Luohe Power Plant and passes through Fanchang and Pingyao to Nanqiao. Its total cost also exceeded 500 million yuan. Installation of the 600 km-plus total length was completed in December 1987 and about three-fourths of the lines are in service. Huainan and Xuzhou are major coal base areas in China and several "pit mouth power stations" have been built at Pingxu, Luohe, and Xuzhou. These two power transmission lines will transmit a large amount of

electrical power from here into the East China Grid load centers of Shanghai and the Suzhou and Zhejiang regions.

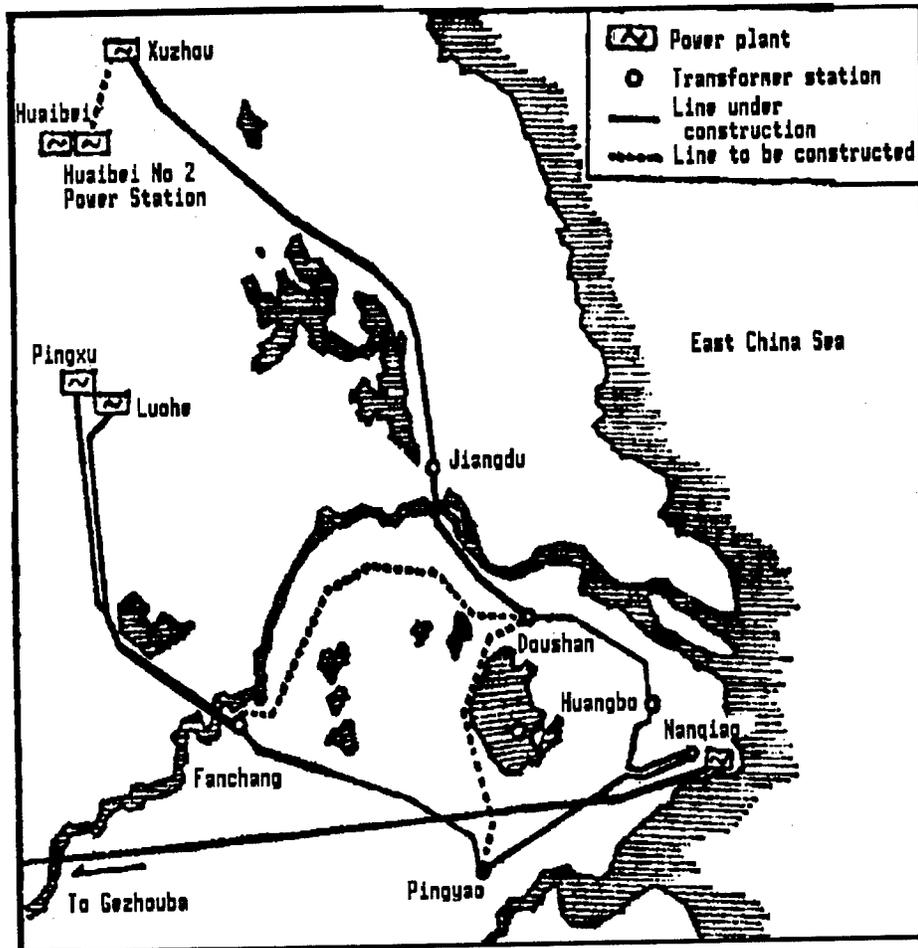


Figure 1. New 550-KV Power Transmission Lines in East China Grid

At the same time, work on the Gezhouba-Shanghai line running from Gezhouba in the west to Shanghai in the east is proceeding smoothly. This is the first long distance high-tension DC power transmission line built in China. Installation of this long line, which runs for a total length of more than 1,000 km through Hubei, Anhui, Zhejiang, Jiangsu, and Shanghai was completed in July 1987. Gezhouba is China's largest runoff hydropower station in terms of construction scale. Each year there have been partial seasonal problems with transmitting power, which has caused "electricity hoarding." When this 900 million yuan-plus project is completed, the terminal power transmission capacity will be 1.2 million kW. Smooth construction of the long-distance high-capacity DC power transmission project will provide a technical reserve for "transmitting power from west to east" in the future.

Several advanced line installation techniques were used in these three key state projects in the Seventh 5-Year Plan. The Gezhouba-Shanghai line crosses over the "natural moat" of the Chang Jiang near Jiyang in Anqing City, Anhui Province, and the two steel towers on the southern and northern banks are 1,605 m apart. Construction units used direct lifting of the towers for the lines across the river for the first time in China. Several transformer stations and current conversion stations were built along the power transmission line and much advanced foreign equipment has been imported.

According to the East China Power Industry Management Bureau's "500-KV Office" presentation, when the AC/DC transformer station at Nanqiao goes into service, these three power lines will go into full operation and reveal their enormous economic benefits.

At present, the East China Grid also is building a fourth ultrahigh voltage power transmission line from Luohe to Pingxu and on to Fanchang. It also will be extended in 1989 from Fanchang to Nanjing and Doushan. In addition, construction of a line from Pingyao to Doushan also is being considered, and eventually the 500-KV ultrahigh voltage power transmission line will become an even more economically rational dual-return gridwork. According to the presentation, the 220-KV line will be like a "small artery" in the human body and will transmit only at a capacity of 150 to 180 KV. The 500-KV line will be like a "large artery" with a single-return path which can transmit at a capacity of 500 KV, while each circuit in the 500-KV dual-return grid will be able to transmit at a capacity of 1,000 KV.

12539/9365

**Shortage of Materials Hampering Power Equipment Manufacturing Plans**

40130084 Beijing ZHONGGUO JIXIE BAO in Chinese 2 Apr 88 p 1

[Text] It has been learned from the State Machine-Building Commission that in the latter half of 1988 and in 1989, China plans to add some 12 million kW of power generating equipment. But due to the late deliveries of steel products--especially imported steel products--our factories have had major production problems. Those involved believe that this issue, if not quickly resolved, could have a great impact on this plan.

It is understood that this year the country wants to manufacture some 9.38 million kW in power generating equipment and also increase the tasks for 1989. Because of the problem of lead time for the installation of power generating equipment, the East China Grid of the equipment must be done well ahead of time. But there is a current shortage of materials, and personnel of the State Machine-Building Commission's Electrical Equipment Bureau gave this reporter a report from the Harbin Electrical Machinery Plant. Most of the plant's contracts for the 1988 first and second batches of imported steel products had not been signed, having a very negative effect on production. The report read: "The delivery of material is already lagging behind and the completion of our power generation equipment mission for 1988 is seriously threatened. The situation is grave."

/9365

**Briefs**

**LARGEST SF<sub>6</sub> TRANSFORMER**--The first 220-KV high-tension transformer station at the Yangshupu Power Plant in Shanghai, which is the first in China to use Chinese-made SF<sub>6</sub> switching and the largest indoor high-tension transformer station in east China, was completed 13 February 1988 after 18 months of construction and received power successfully. After going into operation, this 220-KV high-tension transformer station will transmit power from the Shidongkou Power Plant and others to Shanghai Municipality and the East Shanghai region, and it will be linked to the Pudong Grid and thereby with the Nanqiao 500-KV large grid system, making it possible to transmit power from the major sources at Gezhouba and in Anhui and Jiangsu to Shanghai. [Text] [40130067 Shanghai JIEFANG RIBAO in Chinese 14 Feb 88 p 1] 12539/9365

**Further Reforms Seen Accelerating Hydropower Construction**

40130054a Beijing SHUILI FADIAN [WATER POWER] in Chinese No 1 12 Jan 88  
pp 3-4

[Article by Lu Youmei [7120 0147 2812], vice minister of Water Resources and Electric Power: "Further Reforms To Accelerate Hydropower Construction"]

[Excerpt] The past year was a record-breaking year in the history of hydropower construction in China: 22 new power generators above 15,000 kW each were installed and put in operation. The total capacity is 1,905,000 kW. For the five hydropower projects in Yantan, Shaxikou, Shitang, Geheyang, and Mantang, the difficult task of river damming has been completed. The total capacity of hydropower is approaching 100 billion kWh. This is the result of the hard work of the employees in the field of hydropower.

Since the Third Plenum of the 11th Congress, the Chinese Communist Party and the Chinese government are very supportive in the development of the abundant water resources in China. Over the past 9 years, 19 medium and large hydropower stations have been approved for construction. The total capacity is 17 million kW. The dam of the Dongjiang hydropower station has begun impounding water. The construction of an arch dam which is higher and larger in volume and flood discharge capacity than the Dongjiang dam has begun at Ertang. In the projects at Gezhouba and Longyangxia, five 125,000 kW and two 320,000 kW turbine generators have been installed and put into operation. These signify that China has reached a new plateau in dam construction and generator installation. In the past 9 years, the workers in hydropower survey, design, research, education construction, operation, and management implemented the reform policy and accelerated the construction of hydropower.

A review of history shows that we have made progress. However, we are still falling behind the leaders in the world. The total usable water resources in the world is 370 million kW. It is an important part of the energy resources in China. Nevertheless, only approximately 7 percent is developed, far behind the level in developed nations. The problems we face are lack of construction capital and outdated management systems. Today there is a serious shortage of electricity in China. How do we solve this

shortage? The answer is to further the reform and to speed up the construction of hydropower.

To develop water resources not only meets energy needs but also satisfies the need to harness rivers for the comprehensive utilization of the resources. Both must be closely coordinated to obtain the optimum economic and social benefits. To this end, flood control, irrigation, shipping, urban water supply, and aquaculture must be developed along with hydropower construction. The principle to follow is that he who benefits must invest his fair share. As nonprofit social benefits, the government should offer special loans as a part of basic construction. To accelerate hydropower construction, it is necessary to reform the capital investment system. Capital should be raised from a variety of stable sources. In areas with an abundance of water resources and capital, an entity should be set up to be in charge of the development effort. The profits from hydropower can be used to feed the further construction of hydropower to maximize the economic and social benefits. The pricing system should also be gradually changed to reflect value and characteristics of hydropower. Electric power should be priced different in peak load and low demand period, as well as in dry and wet season to rationally reflect the economic benefit of hydropower.

The speed of hydropower construction and the level of economic benefit are closely related to the progress in science and technology. The strategy to accelerate hydropower construction requires us to learn science and technology, to respect technical talents, to overcome technical hurdles, to implement technical accomplishments, and to push technology forward. In today's environment of rapid advances in science and technology, we must actively bring in advanced hydropower technology and management experience, perfect technical policies, and systematically modify outdated rules and regulations. In engineering planning and project design, different schemes should seriously be compared with decisions made scientifically. We have to bring a competitive mechanism into early stage work and gradually implement a bidding system for the design work in order to find the best design and team to obtain the best engineering benefit. A design unit must become more business oriented to get more involved with engineering management and engineering practice in order to train some internationally known people who not only know the theory but also the practice and not only engineering and technology but also economy and management. The early stage work must be strengthened. In terms of funding, there should be a steady source of capital to increase the design reserve in order to maintain the strength of hydropower.

In the reform of the basic construction management system, we have gathered some experience in the bidding system. The experience should be seriously summarized. The future effort is to perfect, standardize and legislate it. All units surrounding the management mechanism will accelerate and further the reform effort in order to become more competitive.

It is an urgent matter to accelerate the development of water resources and hydropower. It is also a long-term task. This year, let us focus on reform, speed up our pace, and make a contribution to hydropower in China.

12553/9365

**Briefs**

**Shajiao 'B' Operational--**Southern China's Guangdong Province saw its largest power plant, located in Dongguan City, start operations last week. The Shajiao Power Plant "B" Station, with a generating capacity of 700,000 kW, cost a total investment of 4 billion Hong Kong dollars. The plant was jointly built by the Shenzhen Power Development Company and Hopewell Power (China) Ltd. of Hong Kong. The contractors got the funds from 65 large banks around the world and the construction was completed within 22 months, 11 months ahead of schedule. [Text] [40100026b China Daily (BUSINESS WEEKLY SUPPLEMENT) in English 9 May 88 p 1 HK] /9365

**Bidding Opens on 2400 MW Plant--**Beijing, April 27 (XINHUA)--Bids have been accepted for projects at China's Beilungang thermal power plant, soon to be China's largest. The bids were cast here Monday by eight corporations from Britain, Sweden, France, and the United States for construction on two generators and auxiliary equipment. The project's first bidding was held in 1985, with funds for this phase of the project coming from a World Bank loan of 160 million U.S. dollars. Situated in Ningbo in Zhejiang Province, the station, a key project for China's Seventh 5-Year Plan (1986-1990), will have a total capacity of 2.4 million kilowatts. The first group of generators will help alleviate east China's power shortages. [Text] [40100026b Beijing XINHUA in English 0704 GMT 27 Apr 88] /9365

## **Surveying, Exploiting China's Coal Resources**

40130079 Beijing ZHONGGUO DIZHI [CHINA GEOLOGY] in Chinese No 3, 13 Mar 88  
pp 17-19

[Article by Wang Zhongtang [3769 6988 1016] of the Geology Bureau, Ministry of Coal Industry: "Exploring and Exploiting China's Coal Resources"]

### **[Excerpts] II. China's Total Coal Resources and Coal Types**

New China was established 38 years ago and a large amount of survey and exploration work since then has produced an understanding of the conditions and distribution of China's coal resources. China had proven coal reserves of 845.8 billion tons at the end of 1986. The results of a 1981 coal field forecast indicated that China has total coal resources of 3.2 trillion tons in coal-bearing regions at depths of less than 1,500 m (1,000 m in southern coal fields), making a grand total of about 4 trillion tons, ranking first among the world's major coal-producing nations.

By administrative regions, the provinces (and autonomous regions) with coal resources in excess of 500 billion tons are Xinjiang, Nei Monggol, and Shanxi. Shaanxi, Ningxia, Guizhou, Hebei, Henan, Shandong, and Anhui each have 100 to 500 billion tons.

China's coal resources include all types of coal. By major categories, 83 percent is bituminous coal, 9 percent is anthracite, and 8 percent is lignite. By degree of metamorphism, the coal is 8 percent lignite, 590 percent slightly-metamorphized bituminous coal, 8 percent moderately-metamorphized bituminous coal, 6 percent highly-metamorphized bituminous coal, 10 percent mixed coal (transitional and nonclassified), and 9 percent anthracite. Coking coal varieties account for about 20 percent of total resources.

### **III. Exploring and Exploiting China's Coal**

Coal dominates China's energy resources, accounting for more than 70 percent of the energy mix. Raw coal output in 1986 was 894.04 million tons and 150 million tons of coal was washed, making China one of the world's largest coal producing nations.

The large amount of work done in coal resource exploration and exploitation over the past 38 years has ensured growth in coal output at the rate of 20 million tons a year. The main achievements are:

**1. Discovery of many new coal fields and preliminary clarification of China's total coal resources.**

A national coal field survey was begun in 1956 and on the basis of geological predictions and interpretation of geophysical prospecting results, several new coal fields were discovered after exploratory drilling and confirmation. Discovered on the concealed plain in north China were the Panji, Guqiao, Linhuan, and Sudong mining regions in the Lianghuai [Huainan and Huaibei] coal fields in Anhui, the Yongcheng and Queshan mining regions in Henan, the Jiulishan mining region near Xuzhou in Jiangsu, the Yanzhou, Jining, Feicheng, and Huang He North mining regions in Shandong, the Xingtai mining region in Hebei, the Shenbei and Hongyang Liaoning, and others. These mining regions have many coal seams and good quality coal, and they are located in economically developed eastern China. They transformed the distributional situation of coal resources in China and became a primary target of exploration and exploitation in the coal industry. Most have become China's primary coal industry base areas. In addition, geological surveys and coal prospecting surveys at moderate scales were carried out over a wide area in exposed and unexposed coal fields in central and western China, a preliminary understanding of prospective coal resources was gained, and some key mining regions were explored.

After 1974, the focus was on summarizing experiences and lessons in coal field surveys and prospecting in south China, and carrying out coal prospecting surveys in northeast China and Nei Monggol. The Dongsheng, Baiyinhua, Huolin He, Yimin, Dongbo, and other mining regions were discovered. The Huolin He and Yimin mining regions have enormously thick coal seams and are located near the northeast China industrial region. They now are being built into large-scale open-cut mines.

**2. Two national coal field forecasts completed.**

The first national coal field forecast was organized by the Ministry of Coal Industry in 1959. To move from the known to the unknown, categorical comparison was used to estimate China's coal resources. ZHONGGUO MEITIAN DIZHIXUE [Geology of China's Coal Fields] was published. The second national coal field survey was organized in 1974. Systematic forecast maps were compiled for mining regions, provinces (autonomous regions), and the nation, regional coal field geology was summarized, and ZHONGGUO MEITIAN DIZHIXUE was revised. A basic understanding was gained of coal resource formation and distribution in China which provided a reliable geological foundation for long-term planning in the coal industry.

**3. Several coal industry base areas were built and they are actively moving toward becoming comprehensive industrial base areas focused on coal.**

Over the past 38 years, based on the need for development of the national economy and society and guided by long-term development plans in the coal industry, old coal mines were rebuilt and expanded and more than 2,000 coal mines and coal washing plants were built. Nearly 100 large and medium scale coal industry base areas were built. Raw coal output in China in 1986 was 894.04 million tons, making it the world's second largest coal-producing nation.

China has gained rich experience in exploring and exploiting coal resources, and we now can prospect, design, and build a large-scale underground mine with an annual production capacity of 4 million tons, a 10 million ton surface mine, and a 4 million ton large-scale coal washing plant. The construction of coal industry base areas has focused an active development of coal, comprehensive utilization of all types of mineral resources, economic diversification, improving precision coal power transmission line capacities and coal conversion technologies, and progressing toward becoming comprehensive industrial base areas for coal, coking, electric power, and the chemical industry!

Guided by the central principle of "reform, invigorate, open up," China's coal industry everywhere is moving toward glory. Raw coal output will reach 1.4 billion tons by the year 2000, with local coal mines accounting for about 50 percent, and technical standards in state-run coal mines will attain or nearly attain those in the world's primary coal-producing nations. The guarantees of coal resources at present are rather high. Due to imbalances in regional distribution, however, there is a shortage of coal resources in the area south of the Chang Jiang, which has a high population density and developed economy. China's coal industry is concentrated in northeast and north China. It has already proven and utilized an enormous amount of coal reserves. Exploration and development is becoming increasingly difficult in deep areas of concealed coal fields and around mining regions, and there is an urgent need for higher technical measures and advanced geological scientific theories to guide the discovery of new resources. There already are serious problems with continued exploration in some provinces (and autonomous regions). The depth of extraction in some large underground mines now averages 600 m, and in the future there will be a continual increase in the geological conditions of extraction in deep areas and in coal extraction work faces focused on comprehensive machine units, all of which will require high precision in geological results. To assure the energy needed to realize China's four modernizations drive, the focus of exploration and exploitation for coal resources in China should shift gradually to the energy resource base area centered on Shanxi. Large-scale coal industry construction now is underway at the coking coal fields and low-ash low-sulfur power coal fields in western Shanxi, western Henan, northern Shaanxi, and southern Nei Monggol, and preparatory work for construction of several coal base areas now in proceeding with urgency.

Northwest and southwest China have extremely rich coal resources. Xinjiang's coal fields, for example, have predicted coal resources in excess of 1 trillion tons, but the only coal resources which have been developed are limited to along railways and near cities. Their proven coal resource reserves amount to only 0.4 percent of China's proven reserves. In the famous "three rivers region" of southwest China which encompasses eastern Tibet, western Sichuan and Yunnan, and southern Qinghai, late Triassic land-sea interface facies coal-bearing rock systems are broadly distributed but very little coal prospecting survey work has been done.

Following the intensification and development of economic system and political system reforms in China, the situation of separation and detachment in management systems in coal field geology departments, organizational redundancy, overstaffing, and irrational deployments of exploration staffs will be transformed thoroughly. We must strive to summarize our own experiences and lessons, continue to study new theories, methods, and technologies in the geological sciences from China and foreign countries, and make a great effort to reinforce exploration and exploitation of coal resources. Based on the principle of comprehensive exploration focused on coal, we must be concerned with the distributional laws of other minerals and rare scattered elements while prospecting in coal fields, explore for natural gas in shallow strata, and reinforce water resources and engineering geology in mining regions. We must do good geological work to develop small local coal mines. We also must continue to strengthen scientific research in coal field geology to provide better geological results to serve coal industry development. We believe that a brighter tomorrow in China's coal industry and coal field geological sciences lies ahead!

12539/9365

### Development of Surface Mining in China Analyzed

40130078 Beijing MEITAN KEXUE JISHU [COAL SCIENCE AND TECHNOLOGY] in Chinese No 3, Mar 88 pp 7-11

[Article by Wei Daifu [5898 0108 4395], Senior engineer, Ministry of Coal Industry Technical Advisory Commission: "Preliminary Analysis of Surface Mining in China"]

[Text] Over the past few decades, the world's strip mines have seen sustained stable growth in output and proportion of total output as a consequence of the rapid development of open-cut extraction technologies and equipment and extraction techniques, the move to large-scale and systematized equipment, and greater reliability. They now exceed shaft mining in output and proportion of total output in Easter Germany, the United States, West Germany, and Australia, and the rate of growth in surface mining has substantially exceeded the rate of growth in shaft mining in the Soviet Union and other countries (Table 1) [not published]. Surface mining is the main thrust of coal industry development in many nations.

The realities of strip mine development in foreign countries over the past few decades have confirmed their advantages compared to shaft mining. Surface mines are larger, can be built more quickly, save on capital construction costs, have lower production costs, higher resource recovery rates, and better safety conditions, can make fuller use of large equipment, and have higher labor productivity. Their disadvantages are that they demand suitable coal resources and the corresponding open-cut extraction equipment, without which large surface mines cannot be opened.

Underground shaft mining has always dominated coal mining in China. Open-cut extraction has developed slowly, and is small in both output and proportion. Output from surface mining in 1949 was about 2.02 million tons, equal to 8.6 percent of total coal output in China. Output from strip mining had risen to only 25.62 million tons by 1985, and the proportion of total coal output in China declined to 2.9 percent.

The reasons for the slow growth of strip mining in China include objective ones like the poor resource conditions of coal suited to stripping and low strip mine equipment manufacturing standards, as well as subjective reasons

like inadequate knowledge, inappropriate planning, management systems, and so on.

## I. Strippable Coal Resources

China has proven strippable coal resources of around 58.1 billion tons, about 62.1 percent of it lignite, with most of the remainder being bituminous coal and very little anthracite. Coal resources available for strip mining are located mainly in Nei Monggol, Shanxi, Yunnan, Xinjiang, and Shaanxi, with a small amount in Liaoning, Heilongjiang, Ningxia, Henan, and other provinces and autonomous regions.

Nei Monggol has the largest strippable coal resources, with proven reserves of 36.2 billion tons, 62.3 percent of the total in China. The resources are found mainly around Jalainor, Yimin, Chenxi, Huolin He, Baiyinhua, Shengli, and Yuanbaoshan in the eastern part, and Jungar and Dongsheng in the western part. All the coal in east Nei Monggol is lignite, and all in the west is bituminous coal.

All the strippable coal in Yunnan Province is lignite, with proven reserves of 9.7 billion tons or 17 percent of the national total. There are 8 billion tons in the Zhaotong coal field, 1 billion tons in the Xiaolongtan coal field, and 120 million tons in the Xianfeng coal field.

In Xinjiang, the Wudong coal field and Hami South coal field are suited to open-pit extraction, all of it bituminous coal, with proven reserves of 3 billion tons.

In Shaanxi Province, the Shenfu coal field is available for surface extraction, and it is high-quality power coal, with proven reserves of about 1 billion tons.

Liaoning, Heilongjiang, Henan, Ningxia, and other provinces and autonomous regions have only limited resources available for strip mining, but resources in these areas are being developed because of the good communications and transportation conditions, and they are the primary producing regions for surface mining in China at the present time.

Overall, most of the coal resources available for strip mining are located in regions which are economically-underdeveloped, have inconvenient communications, severely cold climates, or are in frontier areas. Their extraction ratios are somewhat high. The production-extraction ratio exceeds 5 during normal years in all of China's unified distribution strip mines. Most lignite resources have a rather high ash content and the coal is of rather poor quality. These are the main reasons for the lack of large-scale development in the past and for the slow progress where there has been development. The reserves, extraction ratios, and coal types of extractable strip mines during the 20th century are shown in Table 2.

Table 2. Situation at Developable Strip Mines Prior to 2000

| Mining region and coal field | Reserves<br>(million tons) |             | Extraction<br>ratio | Coal type  |            |
|------------------------------|----------------------------|-------------|---------------------|------------|------------|
|                              | Geological                 | Extractable |                     |            |            |
| Pingshuo                     | Anjialing                  | 470         | 6                   | Gas coal   |            |
|                              | Antaibao No 2              | 676         | 6.5                 | Gas coal   |            |
| Jungar                       | Heidaigou                  | 1,700       | 4.4                 | Power coal |            |
|                              | Harwusu                    | 2,000       | 5.8                 | Power coal |            |
| Huolin He                    | Sharhur                    | 2,580       | 5                   | Lignite    |            |
| Yimin                        |                            | 1,020       | 2.5                 | Lignite    |            |
| Pingzhuang                   | Yuanbaoshan                | 540         | 400                 | 5.5        | Lignite    |
| Urumqi                       | Tiechanggou                |             | 143                 | 5.06       | Power coal |
| Shenfu                       | Huojitu                    | 371         | 352                 | 7.49       | Power coal |
|                              | Ningtiaota                 | 570         | 540                 | 8.22       | Power coal |
|                              | Zhugaigou                  | 28          | 27                  | 5.84       | Power coal |
|                              | Daliuta                    | 108         | 103                 | 5.88       | Power coal |
| Dongsheng                    | Bulian                     | 145         |                     | 5          | Power coal |
| Zhaotong                     | Hehua                      | 1,590       |                     | 1.4        | Lignite    |
| Xianfeng                     | Xianfeng                   | 158         |                     | 3          | Lignite    |

## II. Development of Surface Mine Production and Construction

The rate of growth in surface mining in China during the 1950's basically was the same as the rate of growth in all of China's coal mines, with output from strip mines accounting for 7 to 10 percent of total coal output in China during normal years. Surface mining developed slowly during the 1960's and 1970's, and its proportion of total output in China fell to below 5 percent. It fell again to less than 3 percent during the 1980's (Table 3).

The development of strip mining in China can be divided into three main stages according to actual conditions: The first stage was 1950 to 1957. Before Liberation, there were only a few strip mines in China like Fushun West, Fuxin Xinqiu, and others. Between 1950 and 1955, China built the new Fuxin Haizhou Strip Mine with a design capacity of 3 million tons. Fushun West and Xinqiu Strip Mines were rebuilt, the former expanding in design capacity to 3.6 million tons and the latter to 600,000 tons. The total design capacity of these three strip mines was 7.2 million tons, and the new construction and expansion projects went smoothly. This was particularly true of the Fushun West and Haizhou Strip Mines, which had high output and good economic results, and which trained many strip mine production and management personnel. The second stage was 1958 to 1980. Eight new strip mines were built during this period. They were the Pingzhuang West, Jalainor Lingquan, Yunnan Kebao, Yima North, Hami Sandaoling, Hegang Lingbei, Haibo Bay Gongwusu, and Shihuijing Dafeng Strip Mines. They had a total design capacity of 7.25 million tons. The Lingquan and Yunnan Xiaolongtan Strip Mines were expanded and their design capacity was increased by 3.3 million tons. Most of the strip mines built during this period violated capital construction procedures. With the

Table 3. Historical Statistics for China's Strip Mines

| Year | Total coal output in China | Unified distribution coal mines |                            | Unified distribution strip mines |                            |                  | Proportion of unified distribution coal mines (percent) |
|------|----------------------------|---------------------------------|----------------------------|----------------------------------|----------------------------|------------------|---|
|      | (million tons)             | Output (million tons)           | Productivity (tons/worker) | Output (million tons)            | Productivity (tons/worker) | Extraction ratio |   |
| 1950 | 42.92                      | 30.18                           |                            | 2.41                             |                            |                  | 8.0   |
| 1953 | 69.68                      | 52.18                           |                            | 4.31                             |                            |                  | 8.3   |
| 1957 | 130.73                     | 94.33                           | 0.978                      | 6.36                             | 1.761                      | 7.28             | 6.7   |
| 1962 | 219.55                     | 147.55                          | 0.655                      | 6.83                             | 0.980                      | 7.67             | 4.6   |
| 1965 | 231.80                     | 164.28                          | 0.863                      | 4.22                             | --                         | 16.9             | 2.7   |
| 1970 | 353.99                     | 226.72                          | 0.910                      | 12.20                            | --                         | --               | 5.4   |
| 1975 | 482.24                     | 279.95                          | 0.901                      | 15.71                            | --                         | 5.67             | 5.6   |
| 1980 | 620.13                     | 344.39                          | 0.912                      | 14.03                            | 1.588                      | 7.74             | 4.0   |
| 1985 | 872.28                     | 406.26                          | 0.939                      | 19.44                            | 1.868                      | 5.36             | 4.8   |

Note: Output from surface mining in China in 1980 was 16.99 million tons, and the proportion of surface mining was 2.7 percent. Output from surface mining in China in 1985 was 25.62 million tons, and the proportion of surface mining was 2.9 percent.

exception of the Lingbei Strip Mine, all the other mines simply went into operation and never attained designed capacity for a long time. The Yima North Strip Mine, for example, had a design capacity of 600,000 tons, but took 6.8 years to build and 3.7 years to reach design capacity. The third stage was 1981 to today. Development of surface mining became a focal point of the coal industry. Five large strip mines were constructed at Pingshuo, Huolin He, Yimin, Yuanbaoshan, and Jungar. A policy of opening up was implemented and technical cooperation with foreign countries was actively expanded. Surface mining equipment and technologies were imported, capital was imported, and joint Chinese-foreign investments were used to develop the Pingshuo Antaibao Strip Mine. In addition, strip mine development plans were formulated within China, and preconstruction work like precision surveys, designs, and so on was done. The state also adopted the principle of integrating imports with development, and it developed experimental large-scale primary extraction equipment for 10 million ton and 20 million ton strip mines. Obvious achievements were made in strip mining technologies and construction scale.

1. The scale of new construction and expansion of strip mines is 15 million tons, equivalent to the total scale of construction over the past 31 years. Three new strip mines were built (the 3 million ton Huolin He South Strip Mine, 1 million ton Yimin No 1 Strip Mine, and 7 million ton Pingshuo Antaibao Strip Mine). The total scale of the joint Chinese-American run Antaibao Strip Mine is 15.33 million tons. The Fushun West Strip Mine, Lingquan Strip Mine, and Xiaolongtan Strip Mine were expanded and increased their capacity by 4 million tons. When all of these strip mines go into operation, current strip mine output will increase by about 50 percent.

2. Diversification in extraction technologies. Before 1980, most of the 19 strip mines used single bucket and railway extraction techniques, while a few used single bucket and truck extraction techniques. In recent years they have begun using rotary bucket and conveyor continuous extraction techniques, single bucket, truck, and conveyor semi-continuous extraction techniques

3. Technical equipment standards have been greatly improved. Before 1980, all the drilling equipment used in China's strip mines was percussion drills, the extraction and loading equipment was 4 m<sup>3</sup> and less mechanical shovels, and the transport equipment was drawn by steam locomotives. Only three mines had standard gauge electric locomotives, and a few mines used trucks under 27 t.

The original producing strip mines have replaced their equipment over the past few years. The main drilling equipment in use at new strip mines is buried-hole drills and gear wheel drills. For extraction and loading equipment, they are using imported 24 m<sup>3</sup> capacity mechanical shovels, 15 and 8 m<sup>3</sup> hydraulic shovels, Chinese-made 10 m<sup>3</sup> mechanical shovels, and 400 to 700 m<sup>3</sup>/hour small rotary bucket excavators. For transport equipment, they are using Chinese-made 1.2 m-wide conveyors with a belt speed of 4 ms, and imported 154 ton, 108 ton, and 68 ton dump trucks and earthmovers, front-loaders, bulldozers, and other auxiliary equipment.

4. There have been rather substantial developments in technical equipment manufacturing capabilities. Not only can we develop our own technical equipment for 5 million ton strip mines, including all of the technical equipment for intermittent extraction technologies, continuous extraction technologies, and semi-continuous extraction technologies, but there has been major progress in the development of primary excavation, loading and transport equipment for 10 million ton and 20 million ton strip mines. Trial manufacture has been successful for Chinese-made 10 m<sup>3</sup> mechanical shovels, Chinese-foreign cooperation to develop 14 and 23 m<sup>3</sup> mechanical shovels, and 100 t and 154 t load dump trucks, and they now are being used on a trial basis.

5. Foreign investments and joint investments have been used to run large-scale strip mines. In June 1985, China's Pingshuo No 1 Coal Company, Ltd., signed a contract with the United States Occidental Petroleum Company to organize the China Island Creek Coal Company, Ltd., for joint investments to develop the Antaibao Strip Mine. The associated coal preparation plant has an intake washing capacity of 15.5 million tons, or 11.95 million tons of commodity coal after washing, and it went into formal operation in July 1985.

### III. Primary Technical Economic Benefits of Surface Mining

China's strip mines lag considerably behind the developed nations, but their technical economic results are better than China underground mines.

1. Larger scale. The largest strip mine is the Fushun West Strip Mine, which has a design capacity of 3.6 million tons of commodity coal, equivalent to 5.2 million tons of raw coal. The largest underground shaft mine is the Xishan Guandi Mine, with a design capacity of 3.3 million tons. The former is 57.5 percent larger than the latter in scale, and the Antaibao Strip Mine is second only to the Datong, Kailuan, and Yangquan Bureaus.

2. Higher productivity. Average productivity in unified distribution strip mines from 1981 to 1985 was 1.495 to 1.868 tons/worker, while the average productivity in China's unified distribution underground mines over the same period was 0.873 to 0.939 tons/worker. Productivity was highest at Fushun West Strip Mine, where productivity in 1986 was 3.38 tons/worker of commodity coal, equivalent to 4.9 tons/worker of raw coal, which is 22 percent higher than the 4.05 tons/worker figure at Lu'an Wangzhuang Mine, the underground mine with the highest productivity.

3. Higher resource recovery rates. The resource recovery rate in underground mines is usually around 50 to 60 percent, while the average figure for surface mining is 94 percent.

4. Better safety conditions.

5. Shorter construction schedules. Haizhou Strip Mine, built during the 1950's, had a design capacity of 3 million tons and was built in 3 years. Huolin He Strip Mine, built during the 1980's, has a design capacity of 3 million tons and also took 3 years to build. The Yimin No 1 Strip Mine has a design capacity of 1 million tons and took 1 year to build. The Antaibao Strip Mine took 2 years to build, while the Liantong Mining Region took about 4.5 years. A 3 million ton underground mine, however, takes 8 to 10 years, a 1 million ton mine takes 4 to 6 years, and a 10 million ton mine takes 18 to 20 years. Obviously, construction of strip mines is two to four times faster than shaft mines.

6. Economic benefits. For various reasons, including the fact that the current price of coal is too low, the interest on capital construction loans varies by industry, modernized strip mine extraction equipment is just now being developed in China, imported equipment is too expensive, the development of production, transport, and sales cannot be coordinated, and so on, analysis of the economic results of strip mines is more complex, which is a question that urgently demands study and resolution.

The high price of open-cut extraction equipment in China has made the cost per ton of coal in modern strip mines approximately the same as or higher than the cost per ton in coal in modern underground mines. On the surface, it would appear that strip mines have no advantage in lower costs, but strip mines can be built faster than shaft mines and the interest rate on investments in coal mine capital construction set by the state are far lower than the interest rate on investment loans in the national economy as a whole, so the advantages of strip mines in earlier output and greater output also are not apparent. Without a standard for scientific evaluation

which conforms to economic laws, it would be hard to derive a scientific conclusion in research on the feasibility of strip mine construction.

China now has 14 primary strip mines. In 1986, five of them made total profits of 121.19 million yuan while nine lost a total of 86.36 million yuan. The most profitable were Haizhou Strip Mine, with profits of 74.30 million yuan, and Xiaolongtan Strip Mine, with profits of 36.58 million yuan. Huolin He Strip Mine suffered the most severe losses, at 47.57 million yuan.

Returns are better in bituminous and anthracite strip mines. Total investments in the Haizhou Strip Mine were 136 million yuan, and it paid in more than 634 million yuan in taxes and profits over 34 years up to 1986, which was 3.66 times more than the investment. Total investments at the Fushun West Strip Mine were 188 million yuan, and it had total profits of 490 million yuan through 1986, more than double the investment. This mine now is in the process of technical transformation so it has had slight losses. The Xinqiu Strip Mine extracts residual coal in mine shafts. It had total profits of 72.29 million yuan from 1957 to 1985, which was more than the total investment of 58 million yuan. This mine was in an expanded extraction period in 1985 and the extraction ratio rose to 9.24. Yearly output fell to 900,000 tons, the cost of raw coal rose to 31.6 yuan/ton, and the mine had total losses of 9.2 million yuan. The average cost for raw coal at the Fuxin Bureau's five shaft mines was 42.55 yuan/ton, so the cost at the Xinqiu Strip Mine was only 74.3 percent that in the underground mine. In comparison, the economic results from open-cut extraction of residual coal are better in strip mines. Of the five strip mines which simply went into operation, the Sandaoling, Dafeng, and Yima North Strip Mines basically overcame their problems and earn yearly profits in excess of 3 million yuan. The Lingbei and Gongwusu Strip Mines still operate at a loss, the former because the administrative units retained too many funds and the latter because it has restricted production due to inadequate railway out-shipment capacity, so the main causes for the losses were not problems with the enterprises themselves.

With the exception of the profitable Xiaolongtan Strip Mine, the remainder of the six lignite strip mines operate at a loss. Xiaolongtan Strip Mine produced 3.22 million tons of coal in 1986 and had profits of 36.58 million yuan. Its advantages are: a low production-to-extraction ratio (about 1), few nonproductive personnel, low wages, and Chinese-made main equipment. The cost per ton of coal was only 8.71 yuan in 1986, the lignite was of better quality and had a higher calorific value, and the selling price per ton of coal was 20.58 yuan. This mine developed from a small one to a large one via three expansions, and stable development of production was a primary reason for the good administrative results at the enterprise. Huolin He Strip Mine had the worst losses among the strip mines. It produced 1.51 million tons of coal in 1986 and lost 47.57 million yuan, with an average loss of 31.7 yuan/ton for the coal. The main reasons for the high losses were poor quality coal and a too-low selling price. The cost of coal was 40.17 yuan/ton in 1986 but the selling price was only 15.5 yuan. Truck transport was used in the pits, and the ton/kilometer shipping cost was too high, about five times higher than the cost of

railway transport. Much equipment was imported and component costs and depreciation costs were high. Component costs per ton of coal in 1986 were 8.54 yuan and equipment depreciation costs were 8.49 yuan, and the two accounted for 42.4 percent of the cost per ton of coal. The development of production, transport, and marketing were not coordinated. Plans for this mining region were changed several times, preparations for construction were too spread out, and there were too many nonproductive personnel. This mine's losses actually stemmed from real problems with open-pit lignite extraction in eastern Nei Monggol.

#### IV. Main Issues in Surface Mining and Suggestions

1. Suggestions for good surface mine development planning. Besides the extremely unfavorable resource conditions for open-pit extraction, the reason for the slow development of surface mining in China is that no scientific and stable development plans were formulated in the beginning or implemented, which is an objective factor that has affected development.

The three strip mines including Haizhou Strip Mine built during the First 5-Year Plan were very productive. The eight strip mines including the Pingshuo Strip Mine built from 1958 to 1980 violated capital construction procedures. Most were "three-sided" projects that simply went into production, involved long construction schedules, and had unacceptable economic results. During the Sixth 5-Year Plan, attention was given to strip mine development, and development plans for five large strip mines were formulated in 1982. They promoted work in strip mine prospecting, design, construction, equipment manufacture, foreign cooperation and exchanges, and other areas. The formulation of this plan, however, lacked systematic technical economics analysis and could not be completely and stably realized. Not only does strip mine construction itself require an enormous amount of capital, but it also is closely tied to and interdependent on users, power plant construction, and railway communications and transport. Without a scientific development plan for guidance, strip mine construction cannot proceed smoothly and is likely to create major economic losses. Two generating units with a total capacity of 900,000 kW at the Yuanbaoshan Power Plant which have been in service for 4 years are an example, but the date to start construction of the Yuanbaoshan Strip Mine to supply the coal has never been decided. Construction of Huolin He South Strip Mine, Tongliao Power Plant, and Tongliao-Huolin He Railway were not synchronized, production was not coordinated, and economic results were very poor.

Coal production, supply, and demand involves large-scale systems engineering. Its goal is to satisfy the demand of users (a large city or economic zone) for coal (including coal converted to electricity, coal gas, coking coal, and so on). It includes coal production and construction, transport of coal and its converted products, and other primary links. development plans for coal mine construction (including strip mine construction) should include plans for the entire system of coal production, supply, and demand as well as feasibility research for coal mine construction projects, and they should be decided upon during the system plan optimization process and not carried out independently.

Feasibility research for construction projects in electric power, railways, communications, and other departments in similar systems also should be decided upon during the system plan optimization process and not carried out independently. This requires that state comprehensive design units or state-assigned comprehensive design units take responsibility for organizing design units in the relevant departments for joint system planning. The main content of system plans should include two parts:

1) System optimization. Comprehensive design units first of all should work with the relevant units to analyze energy demand (types, quantity, and quality of energy resources) in certain energy-short statuses and decide upon system construction scale. Next, they should join with relevant units to study various programs for developable energy production base areas (coal mines, hydropower stations, and other energy resource producing areas), energy conversion patterns (thermal power stations, coal gasification plans, and so on), and patterns of energy transport (railway, waterborne, pipeline, power transmission lines, etc.), and to organize all types of energy production, supply, and demand systems. Third, all design units should conduct feasibility research on engineering projects for all links. Last, comprehensive design units should organize the relevant design units to carry out technical economics comparisons and system optimization to select a system with optimum macroeconomic benefits.

2) System construction optimization. The scale of construction which should be attained during each stage of every engineering project link for system optimization should be used to formulate all types of arrangements for design progress, construction procedures, interlinks, and investments for all engineering links during subsequent stages, and there should be optimal selections.

After the system plan is formulated, and after evaluation organized by authoritative organs and passing examination and approval by state planning departments, it can make arrangements with great certainty for design and construction plans for every engineering project link and supervise and inspect the completion of engineering projects according to construction pace demands. The goal in formulation of this sort of plan is to meet user demand. It uses system macroeconomic benefits as the criterion and has a solid scientific foundation. This can avoid having each department formulate their own plans and making coordination by the State Planning Commission difficult, as well as the shortcomings and losses which this causes.

2. The question of integrated coal/power administration. Lignite accounts for 62 percent of China's present 58.1 billion tons of proven reserves available for surface mining, but all of our lignite strip mines are operating at a loss, with the exception of the Xiaolongtan Strip Mine which is profitable because of its superior conditions. Huolin He, Yimin, and Yuanbaoshan Strip Mines in eastern Nei Monggol have precisely-surveyed reserves of 4 billion tons, and the results of construction feasibility research conducted over the past few years and current production realities indicate that expansion at the Huolin He and Yimin Strip Mines or new construction at the Yuanbaoshan Strip Mine still would result in losses

after they went into operation, and they would be even less able to repay capital construction investment loans. Serious problems face lignite strip mine development and management. The main reason for the losses at lignite strip mines is the poor quality of the coal and the too-low price of the coal. A major part of the production costs paid by the coal mines and the economic benefits due them are transferred into the hands of coal-using units, which is a problem that remains to be solved. Not only does this make it hard to develop lignite strip mines, but power plants also have no sources, so it may be hard to solve the power shortage problems of northeast China.

Foreign strip mines produce large amounts of lignite. East Germany produces more than 300 million tons each year, the Soviet Union more than 100 million tons, and West Germany, the United States, Czechoslovakia, and other nations more than 10 million tons. Their main lignite users are power plants, lignite gasification, comprehensive utilization, shaped coal, and so on. In administration systems, most have established integrated coal power bodies for unified management of coal extraction, power generation, and lignite processing.

The East China Coal Company held a Northeast Region Lignite Comprehensive Utilization Technical Economic Symposium in February 1987 especially for the purpose of studying strategies to develop comprehensive lignite utilization in the northeast economic region. It was felt that comprehensive utilization of lignite and integrated coal/power economic bodies are the main developmental trend in world lignite exploitation, and that it was realistic and feasible to use lignite for local power generation and achieve integrated management of coal and power, which would aid the development of enterprises and the entire national economy. Joint administration of coal and power has several advantages.

- 1) It would guarantee unified planning and synchronized construction of coal mines and power plants, coordinate production, and would not affect energy supplies in coal and power planning and construction.
- 2) Power plants would have stable sources of coal meeting quality requirements.
- 3) Power plant profits could supplement coal mine losses. Integrated coal/power companies could internally readjust and change existing unequal hardships and benefits among coal mines and power plants, which would promote joint development of coal and power and solve the problems of lignite strip mines in eastern Nei Mongol.
- 4) It would motivate the initiative to develop lignite strip mines and guarantee energy supplies for northeast China.

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## Coal Mine Automation Technology in China Reviewed

40130060 Beijing MEITAN KEXUE JISHU [COAL SCIENCE AND TECHNOLOGY] in Chinese No 1, Jan 88 pp 44-47

[Article by Tang Yun [0781 0336] of the Changzhou Automation Institute, Academy of Coal Science: "Views on Development of Coal Mine Automation Technology in China"]

### [Excerpts] I. Outline

Coal mine automation technology is an important part of a progress in science and technology. Automation is a synthetic science and technology which uses machines to carry out information processing, measurement, decision making, and control. Coal mine automation includes a rather wide range of technologies and its tasks are extremely difficult. In its standards for modernized coal mines, the Ministry of Coal Industry proposed the achievement of mechanized excavation, standardized quality, modernized mine transport, modernized surface storage, loading, and shipping facilities, standardized electrical equipment management, modernized dispatching communications and command, implementation of scientific management, and using advanced technical facilities and modernized management to achieve good safety, small staffs, high efficiency, and good results so that all technical economics indices attain or approximate advanced foreign coal mining levels of the 1980's. None of these can be detached from automation. Thus, coal mine automation is a necessary and important indicator of modernized coal mine construction.

### II. The Current Situation in Coal Mine Automation in China

Research on coal mine automation technology in China began in the 1960's but did not develop well for various reasons. By the late 1970s and early 1980's, as the degree of mechanization in coal mine production continued to grow, research on coal mine automation technology was expanded and several gratifying achievements were made. Examples include centralized control facilities for scraper conveyors, CK-2 excavation area communications, signalling, and centralized control facilities, mine shaft telephone and inclined shaft worker car signal facilities, automatic mine telephone control communications systems, KJ-1 mine shaft environment monitoring and production monitoring and control systems which are at international 1980 levels, and other scientific research achievements. All of these are being

used in production and have provided obvious economic and social benefits. Overall, however, the level of coal mine automation in China remains backward relative to the world's main coal producing nations. The main discrepancies are: microcomputer development and utilization are only in the initial stages; mine communications equipment is outdated, there are only single types of products, communications quality is poor, and there are no complete communications networks for entire mines; manual operations are involved in most transport and lifting links, which uses a large number of personnel and causes frequent accidents, and the level of automation is low; there are too few varieties of working condition and environmental parameter sensors and some are not reliable; research forces for the structures and special components used in automation facilities are weak, and no standardized and systematized products have taken shape; no research has been done on automatic control systems and hydraulic support assembly control for excavation equipment. There is an urgent need to strengthen our forces and to take action to develop research in all of these areas to meet the need for modernized mine construction.

### III. Some Views on the Development of Coal Mine Automation in China

Given China's national situation, healthy development of coal mine automation technologies in China requires that we do the following things:

#### 1. Increasing product varieties, improving quality

The reliability of a new product, new facility, or new system is evaluated through performance and useful life indices. Many factors determine reliability, but the main ones are research and design, component selection, processing and manufacture, user operation and maintenance, and others. Statistical data from the relevant fields indicate that research and design factors account for 40 percent, component factors for 30 percent, processing and manufacturing factors for 15 percent, and user factors for 15 percent. It is apparent from this that equipment itself accounts for 85 percent of reliability factors. How can we improve the reliability of new products? First, we must have good research and design, and we must seriously discuss and examine principles, tenets, structures, circuits, component selection, technical conditions, standardization, range of flexibility, and other things. Second, we must assure the quality of processing. Conscientious inspections must be made of the techniques, working models, materials, component sorting and aging, equipment measurement and inspection, and other areas according to the demands of construction blueprints. Third, the new products must be used correctly. There must be conscientious technical training for operating and maintenance personnel, and we should issue operating permits to those who pass examination and meet the requirements. Strict adherence to these demands would assure major improvements in new product quality and reliability. There are many examples of successful experiences and lessons from failures in practice in scientific research work. Examples include the development process involved in CK-2 work-face communications, signal, and control facilities, and in KJ-1 environmental and production situation monitoring systems. Extremely close attention was paid to quality, with excellent results.

## **2. Focusing on whole unit design, developing integrated configurations**

During program design of scientific research projects, we should integrate with real conditions in Chinese coal mines and focus on two things:

### **1) Dealing correctly with the relationship between the single and the whole**

For coal mine automation technology, we should deal correctly with the relationship between main systems and subsystems and between systems and components. In the past, many single item projects were undertaken in scientific research work and many single item achievements were made. However, it was quite common for one single item to be incapable of linking up and matching up with one or more other single items. As a result, they could not function, provided no overall benefits, and were hard to extend. An example is a microcomputer-controlled production monitoring and control system (main system). There were no unified technical standards or standard connections for the subsystems in each production link, or could the subsystems be connected with the main system. Primary data from the subsystems could not be transmitted to the central station at the surface, and management personnel at the surface could not gain a quick understanding of equipment operating conditions in each underground production link. Another example is an advanced coal digger which could not be connected with chain conveyors and did not fit hydraulic supports. Although the coal digger was advanced, it could not function properly. Many such examples show that the development of a scientific research project first of all requires an overall design. The organic and matching relationships between systems and between equipment or facilities in an overall design should be handled correctly, every project item should be developed according to the requirements of the overall program design, and only then should it be assembled and connected to achieve the goal of an integrated configuration and comprehensive benefits. The design concept for the overall KJ-1 system program developed by the Changzhou Automation Institute was quite rational, and attention was given to the interconnective relationships between the main system and the subsystems of each production link. Each subsystem has unified technical standards and standard connections, and they can operate independently or connected to the main system. Moreover, the primary data passes along a main transmission channel to the central station at the surface, with excellent results.

### **2) Developing multilevel automation technology facilities based on China's existing coal mine systems and different mine types**

At present, China's coal mines include unified distribution state-run coal mines, local state-run coal mines, and collectively run or individually run coal mines. There are differences between mines, differences in technical and management levels, and differences in facilities and economic power, so each coal mine has different needs. To deal with this intricate situation, we should study the question of how to adapt multilevel coal mine automation technology facilities to different needs.

First, the guiding ideology should focus closely on the four areas of safety, efficiency, energy conservation, and improving management levels for effective development of coal mine automation. This guiding ideology and consideration of the concrete situation in mines should be used to develop multilevel coal mine automation technology facilities.

For large and medium-sized mines, we should select 77 mines with good coal seam preservation conditions, high degrees of mechanization, and rather high management levels which can achieve planned modernization with fewer investments and high output as well as certain large and medium-sized key coal mines from among the 600 unified distribution coal mines to develop several high-level computer-controlled environmental and safety monitoring systems, mine production monitoring and control systems (including fixed equipment, transport systems, lifting systems, electrical power load regulation systems, and so on), complete mine communications and dispatch systems, and surface computer network management systems, and these coal mine automation systems and facilities should attain advanced foreign levels of the 1980's.

To meet the needs of medium and small mines, we should develop several economical environmental safety monitoring systems and economical monitoring systems in each production link and small-scale mine communications and dispatching systems to improve safe production, full-staff efficiency, and scientific management levels.

### **3. Research units should shift toward an administrative pattern focused on economic benefits**

As reforms in S&T systems intensify, administrative expenditures in technical development scientific research units will decline gradually. These scientific research units should shift from their past state of focusing solely on scientific research toward a scientific research administration pattern to achieve economic independence as quickly as possible. There also must be a corresponding change in our concept of scientific research achievements. In the past, scientific research units felt that they had completed their tasks when a scientific research project made a confirmed achievement, that extension of the achievement was someone else's business, and that there was no connection to economic benefits. This outdated concept should be replaced. A confirmed achievement in a scientific research project is gratifying, but it must be converted into new products used in production to form forces of production which provide definite economic and social benefits. While developing forces of production, scientific research units should obtain suitable economic incomes for their own existence and development.

For this reason, technical development research should focus on economic results with careful calculation of all aspects of the developmental work.

These projects should look at the needs of coal mine production and the future benefits which new products can have for coal mines. Examples include increases in output or throughput, improvements in labor

productivity, decreases in energy and raw materials consumption, improvements in product quality, reductions in operating personnel, improvements in labor conditions, improvements in production safety, improvements in management and administration levels, and other economic and social benefits. This also means that projects should be concerned with marketing these new scientific research products.

When a project begins, it should press for speed, fight for time, and strive to reduce research costs. Scientific research achievements are commodities, and a suitable plant should be found as quickly as possible for technology transfers and agreements on deducting a percentage from new product sales and profits to enable scientific research units to obtain greater economic incomes.

To meet the needs of the reformed situation, the Changzhou Automation Institute established a technical consulting center with crack troops and made it responsible for advertising and marketing new products of scientific research as well as providing a full line of services ranging from supplying complete sets of equipment, installation and debugging, and technical training for personnel, to startup, inspection, and acceptance. This method received a warm welcome at the work sites, with obvious benefits. During the first half of 1987 alone, the institute signed complete unit contracts worth more than 6 million yuan with Datong Meigukou Mine, Kailuan Fangezhuang Mine, Yanzhou Nantun Mine, and Pingdingshan West Mine.

Practice has proven that the Changzhou Automation Institute's focus on economic results to shift from simple scientific research to an administrative form has been successful, and it has great vitality.

#### **4. Accelerating scientific research work**

The Ministry of Coal Industry's call for modernized mine construction requires that the pace of research work on coal mine automation and mine communications be speeded up and schedules be shortened. How can this be done?

1) Strengthen political ideology work, establish an excellent professional morality. Some comrades must strive to overcome their fear of hardship, seeking leisure, sticking to old ways, viewing scientific research plans as soft indicators, and an irresponsible attitude of not caring if they are completed or not. The great majority of scientific research personnel must have strong senses of responsibility and urgency. They should complete scientific research plans on time or ahead of schedule, continually provide the state with scientific research achievements, and make the needed contributions to coal industry modernization.

2) Implement a topical responsibility system, serve as an economic lever. Whether they are vertically-directed topics or horizontally-entrusted development topics, responsibility contracts should be signed between institutes (offices) and topical groups. There should be rewards for completing the tasks and punishments for not completing them.

3) Advanced Chinese and foreign automation technologies should be transplanted and there should be assimilation, transformation, and innovation integrated with the characteristics and needs of China's coal mines. This would produce twice the results with half the effort, and it would significantly shorten research schedules. The noise-resistant telephones used on naval vessels produced by the Changzhou Nautical Instrument Plant are an example. Our communications group combined with the characteristics of China's coal mines and cooperated with this plant to convert them into special purpose noise-resistant telephones for use in coal mines and coal preparation plants in just a few months. This solved production and dispatch communications problems in a high-noise environment which had gone unsolved for many years. The KJ-1 environmental and working conditions monitoring system is another example. Because it absorbed advanced technical experience from MINOS in England, SCADA in the United States, and other systems, a period of only about 3 years was required for successful development of a mine shaft environment and working conditions monitoring system at advanced levels of similar international products in the 1980's.

4) Draw support from external forces to develop coal mine automation technology. As everyone knows, scientific research forces in China's coal system are backward compared with petroleum, electric power, machinery, electronics, space flight, and other industrial sectors in China. Moreover, the technical situation in China's coal industry, our main energy resource, is extremely backward, so there is a very acute contradiction between coal industry modernization and the relative weakness of coal science research forces. In this situation, besides giving full play to the role of S&T forces in the coal system itself, we also should push for support from external departments, which is an important measure that should receive attention. Mine shaft communications modernization problems in coal mines which urgently require solution are an example. The Changzhou Automation Institute cooperated with the No 738 Plant and No 834 Plant in the Ministry of Electronics Industry for joint development of an automatic telephone dispatch communications system for use in mines. The institute also cooperated with the No 574 Plant in the Ministry of Aviation to develop a computer telephone communications system. All of these examples show that relying primarily on our own strengths while actively seeking external support is a definitely feasible and good method for developing coal mine automation technology.

5) Select good trial manufacture plants. One important link in work to develop new products is to select good trial manufacturing plants. After technical designs are examined and approved, the appropriateness of the trial manufacturing plant chosen is very closely related to the scientific research schedule and new product quality. Based on many years of practice and experience, the selection of trial manufacturing plants should focus on the following principles: first, the plant should be enthusiastic, and it should have the technical forces and equipment conditions for trial manufacture of the new product; second, it should be able to guarantee the quality and progress of the new product; third, it must be willing to pay a certain amount of technical transfer fees; fourth, after the new product is

examined and approved, the plant must be able to use its existing technical conditions for production in large numbers; fifth, it is best if the plant site is near the scientific research unit responsible for design tasks to facilitate contacts and quick solutions to technical problems, since this could shorten trial manufacture schedules; sixth, technical personnel should participate in structural design to assure rational and feasible product processing technologies; seventh, trial manufacture contracts should be signed and observed by both parties.

6) Select good industrial testing sites. Besides routine testing, submission for safety inspection, and surface assembly and debugging, test prototypes also should undergo 3 months or even longer of industrial testing. This is the most realistic and comprehensive test of prototype performance, quality, use conditions, and whether or not its relationship with other matching equipment is appropriate. Thus, the appropriateness of the site selected for industrial testing is extremely closely related to evaluation of the quality of research and research schedules. These are the main points to consider when selecting a site for industrial testing: 1) The mine should be enthusiastic and capable of providing the conditions needed to test the prototype; 2) It should have fixed testing operations and maintenance personnel with specific technical skills; 3) It should have specific maintenance equipment and testing measures; 4) The success of the industrial prototype test should make production safer and improve economic results at the mine, and they should be willing to pay to keep the prototype; 5) Testing programs and agreements should be formulated, and both parties should observe them.

##### **5. Grasping development trends, clarifying goals of struggle**

At present, the degree of mechanization in coal extraction in China's coal mines is 49.74 percent, including 25.65 percent in comprehensive extraction, while the extent of mechanization in tunneling is 48 percent. Only 65 mines among the 600 unified distribution coal mine have installed safety monitoring systems with various functions, and only a few have improved their communications. Development levels are very uneven, however, and mine production monitoring systems remain in the industrial testing stage. Given this situation, the development of coal mine automation technology in China should be carried out in stages and in a focused manner. The goals of struggle during the Seventh 5-Year Plan should be: take aim at the 77 modernized mines planned for construction and key coal mines with the proper conditions to achieve safety and production monitoring, communications and dispatching modernization, and automation of transport and lifting to transform the technical and safety situation and raise full-staff efficiency and management level in these mines, and to establish models and provide experience for modernized mine construction in the future.

Besides focusing on the above goals, striving for perfection, and improving and extending previous scientific research achievements to adapt to the need for modernized mine construction, scientific research in the area of coal mine automation technology also should take the initiative to develop research on computer software, economical safety and production monitoring

systems, various types of sensors which are in short supply at present, standard structures, special-purpose components and devices, actuators, fiber optic applications in coal mines, program-controlled switchboard communications systems, and infrared, laser, and ultrasound technologies to sustain reserve strengths in scientific research work in the area of coal mine automation.

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## Shanxi Streamlines Coal Transport

40130082 Taiyuan SHANXI YIBAO in Chinese 15 Apr 88 p 1

[Report by Li Zhongcheng [2621 1813 6134]: "Provincial Government Issues Circular on Strengthening Management of Coal Transport and Sales To Ensure Fulfillment of State Plans"]

[Excerpt] To safeguard the state economic policy for the building of an energy base in Shanxi, to strictly carry out the State Council's regulations on the management of important means of production, to strengthen the management of coal transport and sales in the province, and to ensure the fulfillment of the state plans for the transport of coal by rail to other places, the provincial people's government recently issued a circular on strengthening the management of coal transport and sales.

The circular pointed out: In line with the State Council's regulation that "important capital goods for industrial and agricultural production should only be operated within the stipulated scope of operations by the approved departments and enterprises rather than by other enterprises and individuals" and the relevant regulations of the provincial government on the transport of coal by rail to other places, the provincial people's government reaffirmed that, with the exception of the coal transport and sales companies at all levels and the coal import and export units, other units and individuals are not permitted to deal in local coal (not including coke, humic acid, formed coal) transported by rail out of the province. The provincial people's government has instructed the provincial Economic Commission, the provincial Planning Commission, the provincial Administration for Industry and Commerce, the Rice Bureau, the provincial Coal Department, and the Coal Transport and Sales Corporation to form a provincial group for reorganizing enterprises dealing in coal, which is responsible for sorting out and reorganizing in the first half of this year all units transporting coal by rail out of the province and for issuing new business licenses. After the reorganization, all units and individuals without business licenses will not be allowed to deal in coal transported by rail out of the province. In the future, all units applying for permission to deal in coal transported by rail out of the province should first obtain the approval of the provincial Economic Commission and then the provincial Administration for Industry and Commerce may accept their registration and issue business licenses.

It is necessary to simultaneously reorganize the production and operational scale of the coal mines run by the army or jointly run by the army and the people in the province. During the period of reorganization, approvals will not be granted to new mines run by the army or jointly run by the army and the people. If the mines run by the army or jointly run by the army and the people want to transport coal by rail out of the province, whether this has been listed in the plan or not, they should go through the transport formality at the local coal transport and sales department. They are not allowed to book railway wagons themselves.

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### Briefs

**More Reserves Found at Shengli--**Jinan, May 4 (XINHUA)--Chinese geologists have discovered a new oil reserve at Linyin, in Shandong Province's Shengli oil field, with a deposit estimated at more than 700 million bbls. According to Qian Kai, deputy director of the geology institute at the oil field, this is one of 12 major discoveries made there in just the first 3 months of this year. The Shengli oil field is the second largest in China, after Daqing in northeast China. It produced 31.6 million tons of crude oil last year. The other discoveries have revealed that there are good prospects of new oil reserve in a triangular area at the Yellow River's outlet to the sea in Shandong Province. New commercial oil flows have been verified in some newly exploited areas, and rich gas reserves have been found in other locations. Qian Kai said that the 12 major geological discoveries will promote consistent development of the Shengli oil field. [Text] [40100927b Beijing XINHUA in English 1132 GMT 4 May 88] /9365

**New Field in Hebei--**Shijiazhuang, May 12 (XINHUA)--A new oil field is being developed south of Tangshan City, which was the epicenter of a devastating earthquake that rocked northeast China 10 years ago. The Jidong (east Hebei Province) oil field expects to produce 1.26 million bbl of oil this year with output rising to 7 million barrels by 1990. Reserves, which have yet to be verified, have been put at 700 million bbl. Samples have shown the oil is light and low in sulphur and viscosity, local officials told XINHUA. The oil field is located in the Bohai Bay Open Region where economic and technical conditions and transport facilities are good. It is Hebei Province's major grain producing area, too. The province has two other oil fields, Dagang, China's second largest, and Huabei, as well as three petrochemical works capable of refining 14 million barrels a year. [Text] [40100027a Beijing XINHUA in English 1336 GMT 12 May 88] /9365

**Oil, Gas Well In Beibu Wan--**On the eve of May Day, the Western South China Sea Petroleum Corporation struck another high-yield oil and gas deposit in Beibu Wan. The well produces 489 m<sup>3</sup> of natural gas a day. The well, identified as well Wei 11-4, Bei-1, is 94 km southwest of Beihai City in Guangxi Province. Drilling on the well officially began on 9 March 1988 and was completed on 16 April. There are 12 oil and gas layers with a total thickness of 64.3 m. A spokesman revealed that the well was drilled

on a structure just north of the existing Wei 11-4 oil field and that the oil is light and at fairly shallow depths. Also, as it is situated between the existing Wei 11-4 and Wei 11-1 oil fields, future development will be quite convenient. [Text] [40130085 Guangzhou NANFANG RIBAO in Chinese 10 May 88 p 1] /9365

**Studies Favorable for Development of Small-Scale HTGR**

40130073 Chengdu HE DONGLI GONGCHENG [NUCLEAR POWER ENGINEERING] in Chinese Vol 9 No 1, Feb 88 pp 19-23

[Article by Xu Jiming [1776 0644 2494]: "Summary of Preliminary Feasibility Study of the Use of HTGR's in China"]

[Text] **Abstract:** The place and role of HTGR's in China's nuclear development are summarized, a preliminary survey and analysis of the internal Chinese market for HTGR's is made, and a preliminary adaptation design and economic estimates for the HTR-100 small-scale HTGR power station are presented. Construction of HTGR power plants in China is technically feasible, and in some geographic areas the cost of power produced with them will be similar to that of coal fired power plants of the same size.

**I. Place and Role of HTGR's in China's Nuclear Development**

**A. Current Status of Development**

The high-temperature gas-cooled reactor (HTGR) is an advanced reactor type with extensive application potential. In some countries it has a research and development history of 25 years, and although for historical and economic reasons the rate of development has been somewhat slower than expected, experimental HTGR's and demonstration power plants in the 300 kW class in Germany, the United States, and the United Kingdom have already proved the technical feasibility of this reactor type. HTGR's are currently advancing toward commercial status in West Germany and the United States. Series-producible and modular designs (HTR-100, HTR-300, HTR-500, and HTR-Module (200 MW thermal) already exist in West Germany, and the cost of producing power with the 500-MW HTR-500 is already competitive with that of pressurized-water reactors in the million-kW class. The MHTGR-350 commercial modular design (140 MW electric) has already made its appearance in the United States. Vigorous research and design efforts are underway in other countries such as the Soviet Union and Japan, and preparations to build multiple-use experimental HTGR's are in progress with a view to possible use for coal gasification, steel making and hydrogen production by thermochemical splitting of water.

## B. Distinctive Characteristics of HTGR's and Applications in China

HTGR's differ from light-water reactors in the following respects:

1. They use "all-ceramic" clad-particle fuel elements, a heat resistant graphite core structure, and helium coolant. The power density is one-fifteenth that of light-water reactors, with a higher negative temperature coefficient, so that they have very high inherent safety, with no danger of core meltdown.

2. They can supply process heat at 950°C or higher and can be used with high-efficiency conventional generator units, giving a power generation efficiency of up to 40 percent. HTGR's can be used for extraction of high-viscosity oil, oil shale extraction, coal gasification and liquefaction, and production of hydrogen from water. They can supply heat at higher temperatures than other reactor types.

3. The fuel conversion ratio is high, the fuel cycle is flexible, and deep burnup is achieved. HTGR's can use not only low-enrichment uranium dioxide and uranium carbide fuel, but also high-enrichment uranium-thorium fuel, thus making thorough use of thorium resources. Fuel burnup can be as high as 100 GW-day/ton. In a 100-MW (electric) nuclear power plant, for example, an HTGR requires replacement of only 55 percent as much natural uranium equivalent each year as a pressurized-water reactor.

4. The core and fuel elements are easy to design and manufacture, particularly in the particle-bed core and particle fuel element designs.

5. Relatively few engineering safety systems are required, so that the reactors are easy to operate and manage.

6. With spherical fuel elements and a particle-bed core, the reactor can be refueled without being shut down, so that the availability is 5 to 10 percent higher than in current light-water reactors.

To summarize, because of the excellent inherent safety of HTGR's, the rather high fuel utilization rate, and the extensive prospects for use of their high-temperature process heat, they will have applications in world nuclear development that cannot be taken on by other reactor types.

In order to make up for the lack of conventional energy resources and rectify the excessive dependence on coal in the current energy structure, China must make vigorous, systematic efforts to develop nuclear power and nuclear heat supply. In accordance with China's nuclear power development guidelines and in view of the characteristics of HTGR's and their current technical maturity, the author believes that under China's economic conditions it will be possible in the near term (before the year 2000) to build a small demonstration HTGR heat and power plant using low-enrichment uranium dioxide fuel and that in the long term (from the year 2000 on) these reactors will be able to supplement pressurized-water power plants and fast breeder reactors in combined heat and electric power supply (including the provision of steam and electric power for thermal extraction

to high-viscosity oils and for the petrochemical industry) there will then be a gradual shift to the use of their process heat for coal gasification and hydrogen production, and the thorium-uranium fuel cycle will be implemented, thus making thorough use of thorium resources.

## **II. Market Analysis**

The range of applications of HTGR's includes the power generation market and most of the heat supply market, but because in technical terms they are still in the development stage and especially given China's current economic and technical constraints, the mid-term market for HTGR's should be considered in terms of the following principles: 1) construction and utilization to be begun in the 1990's; 2) use in economic development zones and border development zones with serious shortages of electric power and fossil fuel resources; 3) only medium and small-size (especially the latter) power plants and heating plants to be built, with consideration of economic development needs and the capacity of the power grid and heat supply network; and 4) use by departments and geographic areas suited for future conversion to the use of the process heat of HTGR's.

Based on the above principles, a preliminary survey indicates that the market for use of HTGR's for generation of electric power, combined heat and power supply, and coal gasification is roughly as follows.

### **A. The Electric Power Market**

Some of China's current economic development zones are implementing the special economic zone policy but lack fossil fuel resources and have extreme energy shortages; all of them have independent medium and small-size local power grids, and all hope to make up their deficiencies with nuclear power. A preliminary on-the-spot survey of plant sites indicates that the use of small HTGR's for electric power production would be suitable in many areas.

### **B. The Combined Heat and Power Supply Market**

Major users of combined heat and power supply in China are integrated petrochemical enterprises and oil fields producing high-viscosity oil. The use of HTGR's for combined heat and power supply has the following advantages.

1. Process steam can be supplied at high, medium, or low pressures and temperatures.
2. There would be a great saving on crude oil: a petrochemical plant could save about half of its oil consumption, and a 30-percent saving of crude oil could be realized in the thermal extraction of high-viscosity oil.
3. The heat energy utilization rate is high, up to 85 percent.
4. The plants can be built near cities and industrial areas, and they have higher availability rates and better load regulation characteristics than power stations using pressurized-water reactors.

### **C. The Coal Gasification and Liquefaction Market**

Coal gasification and liquefaction can greatly increase utilization of the caloric content of coal (especially low-caloric-value coal) and raise the efficiency of comprehensive utilization of coal. Use of the high-temperature process heat of HTGR's for coal gasification has at least two major advantages over the conventional method: 1) it would save 25-50 percent on coal while increasing the coal utilization rate; 2) it would decrease pollution resulting from discharges of harmful gases into the environment during coking of coal. For example, the use of process heat from HTGR's for gasification would decrease sulfur dioxide emissions by a factor of 5 compared with the conventional method. China has abundant resources of coal suitable for gasification; reserves of brown coal alone exceed 100 billion tons.

### **III. Summary of Preliminary Feasibility Study of the First HTGR Power Plant**

#### **A. Selection of Unit Reactor Capacity and Core Type**

Selection of unit reactor capacity for nuclear power plants is governed by local power grid conditions and power station economics. In economic terms, reactors with higher unit capacity require a smaller specific investment but involve a greater investment burden and greater risk. In addition, unit reactor capacity should not in general exceed 10 to 15 percent of power grid capacity.

There are currently two types of HTGR reactor designs: the particle-bed core, which uses spherical fuel elements, and the rod type core, in which rod fuel elements are inserted into channels in hexagonal graphite prisms. Each has its advantages and disadvantages. In view of West Germany's successful experience with a particle-bed HTGR and the fact that China's international cooperation partner (BBC/HRB) Brown Boveri and Company High-Temperature Reactor Builders is the designer and supplier of the West German experimental AVR power plant (15 MW) and the 300-MW demonstration power plant, its HTR-100 reactor should be the HTGR reactor chosen as a reference for feasibility studies.

#### **B. Design Features and Main Design Characteristics**

The design under consideration is based on the AVR reactor technology, which has been in operation for 20 years, and on design, construction and trial operating experience with the HTGR reactor. Its main design features are as follows.

1. A particle-bed core, continuous fueling and refueling, and fuel recycling.
2. Unitized design with vertical core and steam generators, and use of a steel pressure vessel.
3. Control rods and shutdown absorber pellet system placed inside the reflector.

4. Low power density, ceramic core (80 percent graphite), slow temperature rise and large negative temperature coefficient, so that the power plant has very high inherent safety and can be built near industrial and residential areas.

5. Two steam generator-circular blower circuits using helium coolant for normal operation and decay heat removal. If the excess heat removal system fails completely, the decay heat is transferred to the external cooling system in the cement barrier wall by natural convection and radiation.

6. A flexible fuel cycle that can be adapted to the fuel supply and to spent fuel processing requirements. The design uses low-enrichment  $UO_2$  fuel with a burnup of 95 GW-days/ton.

7. High power generation efficiency (30 percent) and correspondingly low waste heat discharge.

8. In a hypothetical accident in which both the excess heat removal system and external cooling system malfunction and there is a helium coolant pressure loss, the maximum fuel temperature does not exceed  $1,700^{\circ}C$ , which is too low to cause breakdown of the fuel particles, so that radioactive emissions would be very slight.

9. In addition to generating power, the reactor can supply high-temperature, high-pressure steam or  $750^{\circ}C$  process heat.

The main design characteristics of the reactor are shown in Table 1. The power plant's steam supply system consists of the reactor and two parallel helium coolant circuits (one steam generator is divided into two independent tube bundles and two helium circulators), and its main equipment is incorporated into the steel pressure vessel, which is why it is called a "unified design."

### C. Radiation Safety and Economic Evaluation

Calculations indicate that in normal operation, the plant's radioactive emissions will be far below the international standard, and environmental effects in the neighborhood of the plant will be less than  $0.01$  mSv/a. In the worst-case hypothetical accident described above, the amount of iodine-131 discharged will be below the normal control figure and the accumulated thyroid dose within 1 km of the plant will be  $1.06 \cdot 10^{-6}$  Gy [grays], only 1/150 of the prescribed figure.

The general contracting for China's first demonstration HTGR power plant will be done domestically but will use favorable international conditions and some international cooperation and equipment importation will be used to complete design and construction. With the main equipment for the primary circuit of the "island" (reactor, steam generator, circulating blower, and the like), some of the control instruments and the first lot of fuel (accounting for about 47 percent of total equipment investment) imported from West Germany, it is estimated that the total construction

investment on the first HTGR power plant (base cost about 158 million marks and 215 million yuan, equivalent to a total of 507 million yuan with 1986 as the base year) foreign exchange will account for about 26 percent of the total investment for West German manufacture of the plant. The plant will take about 4 years to build; allowing for a year of preliminary work and for exchange-rate fluctuations and interest, the final cost will be 210 million marks and 284 million yuan, equivalent to a total of 662 million yuan. (At the 1968 year-end exchange rate of 1.85 yuan per mark.)

With an annual utilization time of 6,500 hours, the generating cost will be 9.82 fen [0.1 yuan] per kWh, close to the generating cost of 8.3 fen per kWh for the Macun coal-fired power plant in a certain city, and below the generating cost of 12 fen per kWh for a gas-fired power plant that is currently being designed.

If the plant sells the power at 15 fen/kWh, it will earn a profit, with an investment recovery period of 14.2 years. Although its direct economic effect will be rather low, the plant will produce great indirect economic and social benefits springing from the development of China's first demonstration HTGR power plant, an advanced energy source. Construction of the plant will be economically feasible and will save coal and transport, and in the future the high-temperature nuclear process heat will be usable for comprehensive utilization of brown coal and oil shale, which will decrease environmental pollution.

#### IV. Conclusions

The HTGR is an advanced reactor type with excellent inherent safety which has extensive prospects for application in China. It is technically feasible to build a small HTGR power plant or heat and power plant before the year 2000 by making use of appropriate international cooperation agreements and importing nuclear steam supply systems. The reactor is safe and is economically acceptable for certain geographic areas.

The preliminary feasibility study described here was made before the end of 1986. Comrade Xiong Dezong [3574 1795 3827] helped with the market survey, Comrades Bao Jifen [0545 7162 5358] and Zhang Xinbao [1728 2450 1405] made the site surveys, Comrades Li Jiazhang [2621 3946 3864] and Tang Qingsheng [3282 1987 0524] did the reactor core and circuit design, Comrade Kang Chunying [0073 2504 5391] helped with the economic analysis, and Comrade Liu Qirong [0491 4928 5554] helped with the environment radiation safety analysis. The author takes this occasion to thank them.

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**Prospects Said Good for Utilization of Geothermal Energy**

40130066b Beijing ZHONGGUO KEJI LUNTAN [FORUM ON SCIENCE AND TECHNOLOGY IN CHINA] in Chinese No 1, 1988 pp 37-38

[Article by Shi Dinghuan [4258 1353 3883]: "Good Prospects for Geothermal Energy Development and Utilization in China"]

[Text] Energy resources are the primary material foundation for social development. China's success in its four modernizations drive will be determined to a substantial degree by the supply and effective utilization of energy resources.

During the Sixth 5-Year Plan, China relied on scientific and technical progress and made notable achievements in energy production and conservation. However, as the national economy has developed, energy shortages have been quite apparent. According to statistics, China produced a total of 855 million tons of standard coal in primary energy resources (raw coal, crude oil, natural gas, and hydropower) by the end of 1985, but energy resource shortages continue to restrict the development of China's national economy. According to expert forecasts, there will continue to be a major gap between supply and demand for energy to the year 2000, and the energy structure which is dominated by coal will not be transformed in the short term, which will place enormous pressures on the environment and transportation. At present, 75 percent of household energy use in rural areas of China still depends on biomass energy. Not only are utilization rates low, but there has been degradation of the ecological environment which is very ill-adapted to development of the rural economy. For this reason, active development and utilization of new energy resources and readjustments in energy structures is an important route for solving the energy needs of frontier regions and the vast rural areas. Today, based on the principles of adapting to local conditions, supplementation with multiple energy resources, comprehensive utilization, and concern for results, local areas are making great efforts to develop and utilize geothermal energy, and obvious results have been achieved which have attracted the attention of relevant departments.

China has extremely rich geothermal energy resources and as science and technology have developed, this energy now is being used on a wide scale for heating, power generation, aquatic breeding, vegetable cultivation, and

processing of agricultural and sideline products, all of which play an important role in the development of China's national economy.

## **1. China's geothermal power plants have been established in world-famous Tibet**

Besides the large abundance of metallic and nonmetallic ore deposits in the region's strata, the particular geological structures caused by the long-term activity of the Himalayan Mountains also gave the region valuable high-temperature geothermal energy resources. In 1975, to promote development of the Tibetan economy and solve the energy shortage, the state verified a large geothermal field in the Yangbajing region 90 km northwest of Lhasa and included it among key state scientific research and development projects. The relevant departments worked with the government of the Tibetan Autonomous Region to establish the Yangbajing Geothermal Development and Utilization Coordination Group to make arrangements for geothermal exploration and construction of trial power plants, and to mobilize forces in all areas for concentrated attacks on key technical questions. In October 1977, the first 1,000 kW experimental geothermal power generator went into service, and two 3,000 kW generators went into service in 1983. Since passing technical examination and acceptance in July 1985, this power plant has generated more than 100 million kWh, and the cost of power generation is much less than conventional thermal power generation. Afterwards, two 3,000 kW generators were added at the power plant and it now has an installed generating capacity of 13,000 kW, equal to about 30 percent of the installed generating capacity in the Lhasa region. It generated 49 million kWh of power in 1987, equal to 45 percent of the Lhasa grid. Yearly utilization time exceeds 7,000 hours, which has resolved problems with insufficient hydropower during the winter dry season. Since its completion, this power plant has generated 170 million kWh of electricity. It has made geothermal utilization an important part of Tibet's energy resource structure and obtained obvious economic and social results for construction and development of the Tibet region. Its establishment has pushed China into the advanced ranks of international geothermal power generation at the 10,000 kW level.

The completion and startup of the Yangbajing Geothermal Power Plant fully embodied CPC nationality policies and greatly assisted economic construction in Tibet. It has been predicted that during the Seventh 5-Year Plan, Tibet's geothermal power generation [capacity] will reach 25,000 kW, and its enormous geothermal resources will make a major contribution to invigorating development there.

## **2. Preliminary achievements in geothermal utilization in northern China**

The North China Plain is a region with rich moderate and low-temperature geothermal resources, and 102 warm springs have been discovered there. By the end of 1986, geological prospecting departments had drilled 833 geothermal wells in the northern part of the North China Plain. The artesian flow rate of hot water from these wells and springs each year is equivalent to more than 730,000 tons of standard coal. During the Sixth 5-Year Plan, the state included direct utilization of geothermal energy in

North China among key S&T topics. In 1985, with approval by the State Science and Technology Commission, a "North China Geothermal Planning Research Office" composed of more than 10 units from the Ministry of Geology and Mineral Resources, the Ministry of Petroleum Industry, the Chinese Academy of Sciences, and other organs was established, and they set up the "Tianjin Geothermal Research and Training Center" to assume responsibility for scientific research, information, technical services, personnel training, and other tasks related to geothermal energy to complete several attacks on key technical problems. Examples include "geothermal heating and comprehensive utilization," "agricultural uses for geothermal energy," "current geothermal technologies and engineering equipment, and comprehensive utilization systems planning," and others. These scientific research achievements greatly promoted improvements in the technical levels of geothermal utilization and increased economic benefits.

For the past few years, due to the cooperation and coordination by the State Science and Technology Commission and the relevant ministries and commissions, and because of the joint efforts of all areas, more than 20 production base areas which utilize geothermal energy primarily for vegetable cultivation, aquatic breeding, and brood incubation have taken shape in a preliminary fashion in North China. They have solved to a certain extent the shortages of vegetables and nonstaple foods during the off season in the Beijing and Tianjin areas. Cangzhou Prefecture in Hebei Province also has successfully utilized geothermal energy to solve the wintering problems of parent fish, parent prawns, and river crabs. They have used four geothermal wells to build 367 large parent fish and parent prawn wintering sheds, and they have used geothermal energy to develop edible fungi breeding which will place 1 million jin of edible fungi on international markets each year in the future. Xiongxian, Gaoyang, Gu'an, and Hejian counties in Hebei also are using six geothermal wells to build 220 geothermal vegetable greenhouses and more than 120 large sheds which can save 11 million tons of coal each year. Hejian County has developed 1,200 mu in geothermal cropping area which can produce 10,000 jin/mu of cucumbers and 8,000 jin/mu of tomatoes during the early spring. It provided society with more than 2 million jin of fresh vegetables and 50,000 jin of edible fungi during the winter and spring of 1986. Tianjin's Lizigu State Farm is using geothermal energy for incubating and raising chickens, and it has constructed 9,314 m<sup>2</sup> of chicken coops which turned a profit within 3 years, earning 1.44 million yuan in 1986. The North China Petroleum Management Bureau's hydropower plant is using geothermal energy to heat an area of 52,000 m<sup>2</sup> and greenhouses covering 4,000 m<sup>2</sup>. Compared to boiler heat supplies, geothermal utilization provides benefits of about 400,000 yuan per year. The tanning, food products, and other processing industries also are beginning to use geothermal energy. It also has been the focus in development of the "Gold Coast" south of Beidaihe. The exploitation of geothermal energy in North China is very important for achieving supplementation by multiple energy sources and promoting invigoration of the local economy. As geothermal energy develops, it will bring increasing numbers of people onto the path of prosperity.

### 3. Broad prospects for geothermal energy development and utilization

Geothermal energy is a strategic energy resource which has "real short-term benefits and long-term prospects." Over the past decade, enormous progress has been made in geothermal energy resource development and utilization in the world. Although geothermal energy development and utilization in China began relatively late and at a low point, gratifying achievements have been made through efforts over the past 10 years. Now, China extracts about 100 million m<sup>3</sup> of moderate and low-temperature geothermal water each year which is used widely in industrial and agricultural production, in the people's lives, and other areas, with excellent results.

Geothermal energy development and utilization also is an effective way to support poor and backward regions. Western Yunnan Province, for example, has rich mineral and biological resources, but an energy shortage has become one of the factors which restricts resource exploitation. About 90 percent of Yunnan is mountainous, a region of high mountains and steep terrain. It is quite difficult for power grid trunk lines to reach distant mountainous regions, which has left abundant natural resources unused and greatly restricted coordinated development of the entire Yunnan economy. It would seem that a search for geothermal resources is a realistic and feasible step to take. Pengchong is one of Yunnan's forestry base areas, but 85 percent of the primary energy structure in Pengchong comes from the forests and a large amount of forest resources are used directly as fuel, which is an enormous waste. This reduces the forest cover quickly and causes continual degradation of the ecological environment, and the results would not be very ideal. To change this situation, research on resource exploitation and economic development strategies for southwest China have been included among major S&T topics. Indications are that Pengchong is the only high-temperature geothermal region related to volcanic activity in the western part of the Chinese continent, and the region as a whole contains 22 high-temperature geothermal fields with temperatures in excess of 150°C. Comprehensive exploitation of this high-temperature geothermal energy resource not only could "substitute electricity for wood" but also could benefit forest rehabilitation and rational utilization which would be very important for invigoration of the economy of western Yunnan.

At present, there is excessive consumption of China's conventional energy resources because of large-scale development, with negative effects on the ecological environment. For this reason, active development of new energy resources and gradual achievement of "supplementation by multiple energy resources" are urgent tasks for energy development. The development of new energy resources in China should give preference to dealing with regions experiencing energy shortages, distant mountainous regions, and household energy use in rural areas. The development of decentralized, small-scale, and economical new energy resources like solar energy, biomass, wind energy, geothermal energy, and so on is very important. The development and utilization of geothermal energy has seen appreciable results and it

definitely serves as a model which promotes the development of other new energy resources. Looking toward the future, continued development of all types of new energy resources will make an enormous contribution to the four modernizations drive in China.

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