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CONTENTS

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Primary Energy Output in January-September 1991

40100004A Beijing CEI Database in English 14 Oct 91

[Text] Beijing (CEI)—Following is a list of China's total output of primary energy in January-September 1991, released by China's State Statistical Bureau.

Item	Unit	1-9/91	1-9/90
Total energy output (in 10,000t of standard coal)		75540.0	75343.0
Raw coal	10,000 T	77281.0	77390.0
State mine	10,000 T	37337.0	36934.0
Local mine	10,000 T	39944.0	40456.0
Dressing coking coal	10,000 T	5036.0	5206.0
crude oil	10,000 T	10432.1	10283.3
Oil processed	10,000 T	8476.0	8350.8
Gasoline	10,000 T	1720.9	1659.7
Kerosene	10,000 T	301.5	306.2
Diesel	10,000 T	2070.0	1985.4
Lubricant	10,000 T	154.6	150.9
Heavy oil	10,000 T	2286.3	2328.8
Natural gas	100 M Cu M	115.74	113.39
Electricity	100 M Kwh	4950.3	4536.6
Hydropower	100 M Kwh	964.1	958.9
Thermal	100 M Kwh	3985.6	3577.7

T = Ton, M cu M = Million Cubic Meter, M Kwh = Million Kilowatt/hour

Joint Venture To Build Nation's Largest Hydropower Station

926B0003D Guangzhou NANFANG RIBAO in Chinese 4 Aug 91 p 1

[Article by Diao Xuanji [0431 3872 3875]: "Joint Venture To Build China's Largest Hydropower Station, State Reaches Agreement in Principle With Guangdong, Guangxi, and Guizhou"]

[Text] On the afternoon of 30 July 1991, the state Ministry of Energy Resources and State Energy Resource Investment Company signed an agreement in principle with government officials from Guangxi Zhuang Autonomous Region, Guizhou Province, and Guangdong Province to develop and build Longtan Hydropower Station on the Hongshui He. This indicates the comprehensive start of preparatory work for construction of Longtan Hydropower Station.

Longtan Hydropower Station will be a key power station on the trunk of the Hongshui He. It will be built based on a normal water impoundment level of 375 meters, and it will have an installed generating capacity of 4,200MW and a guaranteed output of 1,234MW. It is the largest hydropower station in China at present, and it is one of the major strategic projects for construction during the Eighth 5-Year Plan in China. Back in June 1988, the Ministry of Energy Resources, State Energy Resource Investment Company and Guangxi, Guizhou, and Guangdong provinces singed a "Document of Intentions for a Joint Venture To Develop Longtan Hydropower Station on the Hongshui He".

Study of Key Technical Items in Hydraulic Structure Design of Three Gorges

926B0005 Beijing SHUILI FADIAN [WATER POWER] in Chinese No 8, 12 Aug 91 pp 4-6, 18

[Article by Chen Zongliang [7115 1350 2733] of the China Electric Power Enterprise Federation: "A Brief Introduction to Attacks on Key Technical Problems for Hydraulic Structures at the Three Gorges Project and an Outline of Achievements"]

[Text]

I. Brief Introduction to Attacks on Key Problems

Research on key technologies for the hydraulic structures at the Three Gorges project is one of the projects in "Major Scientific and Technical Research for the Chang Jiang Three Gorges Project", the 16th state project to attack key S&T problems during the Seventh 5-Year Plan. Based on the feasibility report approved by the state, the tasks for the plan to attack key problems in this project included five special topics that were also divided into 48 subtopics. The five special topics were: 1) Optimization of the overall configuration of the key facility; 2) Structural analysis and optimization of dam sections with multiple layers of large openings and research on the degree of safety; 3) Underwater structural analysis of steel diversion pipes and plant buildings; 4) Hydraulic analysis of ship locks and research on structural questions; 5) Research on hydraulic questions concerning outlet structures. The units participating in attacks on key S&T problems in this project included: the Chang Jiang Water Conservancy and Hydropower Scientific Research Academy, the Water Conservancy and Hydropower Scientific Research Academy, the Nanjing Water Conservancy Scientific Research Academy, Qinghua University, Hehai University, Wuhan Water Conservancy and Electric Power College, Chinese Academy of Sciences, Dalian Science and Engineering University, Shaanxi Machinery College, Tianjin University, Tianjin Water-Borne Shipping Engineering Scientific Research Institute, Chang Jiang Water Conservancy Commission, and others. The Chang Jiang Water Conservancy and Hydropower Scientific Research Academy, Water Conservancy and Hydropower Scientific Research Academy, and Nanjing Water Conservancy Scientific Research Academy were the units responsible for the special topics. The number of full-time personnel involved in these attacks on key S&T problems each year was about 200. Through the combined efforts from 1986 to 1990 of the units responsible for the special topics and the units responsible for the subtopics and the great deal of scientific research work they did, all of the contractual requirements in the plan were completed. The project and special topic achievements have been examined by the Group of Specialists recruited jointly by the State Science and Technology Commission and the former Ministry of Water Resources and Electric Power and they have been examined and accepted by the Project Examination and Acceptance Group. All of the achievements attained the examination objectives. Overall, the project was at a vanguard level in China and nine of the achievements attained advanced international levels. These achievements can be used for comprehensive analysis of the design for the Three Gorges project and some of the achievements have been included in the feasibility discussion for the Three Gorges project. They provide a scientific basis for the design, and their research methods and achievements can also be used to evaluate other similar projects. Thus, they have rather large extension and application prospects, significant economic benefits, and substantial potential economic and social benefits. They have played a major role in raising overall technical levels and development of the industry.

II. Description of Achievements

The main achievements in the research project on key structural technologies for the Three Gorges project are:

A. Optimizing the overall configuration of the key facility

The Three Gorges project is a huge project that has attracted world attention. The primary structures at the key facility include three parts, the large dam, power station plant buildings, and ship passage structures. In the feasibility research discussion stage for the Three Gorges project, Chinese specialists examined from different perspectives the overall configuration program for the Three Gorges key facility, its technical difficulty, construction reliability, operating conditions, construction schedule, and other aspects and focused on problems like whether or not the open diversion channel should be used as a temporary ship passage channel during the construction period, whether it would be best to divide the construction and diversion into three or two phases, the configuration of the ship passage structures, and so on, and they offered a variety of opinions and proposals. This project dealt with several of these key and major questions and studied optimization of the overall configuration of the flood discharge, power station, ship passage, and other structures. In the area of optimization of the outlet structures and power plant, they compared and studied six different configuration programs and suggested an optimal flood discharge configuration program. The content of the research included flood discharge capacity, river channel flow patterns above and downstream from the dam, effects of flood discharge on power generation and ship passage, trapping and ejection of floating debris, bedrock scouring in the riverbed downstream from the dam, and so on. Three phased diversion programs for the diversion construction schedule and optimal temporary ship passage were compared and studied for optimization of the earth and stone cofferdam configuration in the first phase diversion, and moving forward in time the broadening of bottom protection elevation of the horizontal cofferdam for the first phase during the second phase. For the diversion in the second phase, when the open diversion channel would be used for ship passage, the configuration of the open diversion channel would be optimized. When the open diversion channel is not being used for ship passage, dual-line temporary ship locks with additional silt flushing outlets to replace open channel ship passage were discussed and analyzed. The study felt that this was technically feasible. For the third phase (final phase) diversion, they optimized the configuration of the diversion outlets and temporary spillway notches and optimized the arrangement for simultaneously lowering the gates and sealing the diversion bottom opening in three groups. In the area of optimizing the configuration of the ship passage structures, they compared two types of ship locks, a continuous flight and a dispersed flight with an intermediate channel, as well as the negative effects of non-constant flow in the access channel and the adoption of measures to reduce the effects to a minimum. Achievements were also made in research on the issues of jet flow bedrock scouring, ship passage hydraulics, and jet flow fogging. These achievements fully revealed the technical difficulties and the advantages and shortcomings of the overall configuration of the key facility and provided data for program decision-making.

B. Structural analysis and optimization of the dam sections with multiple layers of large openings and research on the degree of safety

The representative program of the Three Gorges key facility recommended by the feasibility research report was: a total dam length of 1,993 m and maximum dam height of 175 m, including a flood relief dam section a total of 483 m long located in the middle of the riverbed that would be divided into a total of 23 dam sections, each section being 21 m wide, and configured with 23 alternating low-level outlets and 22 surface outlets. The dimensions of the low-level outlets would be 7 X 9 m (width X height) and the base of the outlets would be at a height of 90 m, exactly in the center of the dam. The net width of the surface outlets would be 8 m and they would have a seam-spanning configuration. The height of the top of the dam would be 148 m in the initial phase and 156 m in the later phase. One 5.5 X 20 m (width X height) diversion bottom outlet would be placed at an height of 51 m and it would also have a seam-spanning configuration. It would be refilled with concrete in the later phases. Because the open diversion channel used for construction must be laid out according to ship passage requirements, after the surface outlets of the spillway dam are poured to a height of 109 m, they would have to serve as temporary floodwater passage notches for cut-off of the open channel in the later phases and they would continue to be raised after the flood passes. This operating arrangement creates a situation in which there are multiple layers of outlets and construction seams cutting vertically and horizontally through the dam section, which makes construction more complex and creates effects that cannot be ignored from structural stresses on the large dam and the integrity of the bond between the new and old concrete. At this time, the attacks on key S&T problems selected a typical dam section of the spillway dam with multiple layers of large outlets, considered the effects of surface weakening by the construction seams, and studied and analyzed the static, dynamic, and dam section stability of the dam section outlet structures, the degree of safety of the large dam structure, and other questions. In the area of static analysis, they established an optimized design numerical model and compiled a three-dimensional stress analysis program and did optimization computations and model experiments for the cross-sectional shape. They suggested the effects of local weakening of the body of the dam by the stresses on the dam body, the stress values on the heel of the dam and the toe of the dam, stress values in the area of the low-level outlets, stress values for the arc-gate pedestals, the effects of seams between the new and old concrete on the stress on the body of the dam, temperature stresses on the body of the dam, and other achievements. In the area of dynamic analysis, they comprehensively clarified the dynamic characteristics of the Three Gorges spillway dam and its dynamic reaction states during earthquakes. The initial results derived from using non-linear dynamic computations to analyze the destructive mechanisms of the dam body indicate that the destruction of the dam body generated by a magnitude-9 earthquake would involve pull cracks and there would be no crushing phenomena. Stability analysis of a typical dam section using geodynamic modelling experimental technology and rubber bags filled with sandy conglomerate to simulate lifting pressures to study the stability of the dam body clarified the effects of the rather complex foundation on the dam body. Taking lifting pressure conditions into consideration, the displacement values and degree of safety values were derived for the effects of the design load and overloading.

C. Structural analysis of the steel diversion pipes and underwater plant buildings

The Three Gorges Hydropower Station would have 26 generators installed, each with a unit capacity of 680MW. The behind-the-dam plant buildings would be located on both the left and right banks. The penstock would be 12.3 m in diameter, which is bigger than the steel pipes (D = 12.2 m) at the No. 3 power station at the United States's Grand Coulee Dam, the largest diameter pipes in the world, so they would be super-high pressure pipes. Their PD value would be 14,514 kg/cm, not counting water-hammer conditions. The steel diversion pipe dam section would be 24 m wide, less than double the diameter of the steel pipes. These two factors pose major difficulties for pipe design and configuration, materials, selection, construction and installation, and so on. The underwater structure of the plant buildings would be a large-volume steel-reinforced concrete space structure with a complex shape. Under the water load and the dynamic and static effects of the generators, the structural forces and marginal conditions are extremely complex. Dealing directly with the characteristics of the steel diversion pipes and the underwater structure of the plant buildings at the Three Gorges dam, three steel pipe configuration programs (fully-buried, shallow-buried, and downstream from the dam face) were studied and analyzed in the area of the steel diversion pipes. Achievements in comparing their advantages and disadvantages were suggested and there was a basic clarification of the laws of stress interactions of the steel diversion pipes and dam body and they suggested analysis methods for the temperature field, temperature load, and temperature stresses on the pipes downstream from the dam surface. In the area of the underwater structure of the plant buildings, they carried out comprehensive dynamic analysis and structural reactions and did a great deal of work on analyzing vibration source mechanisms and inspecting resonance, three-dimensional finite element integral structure analysis, three-dimensional photoelastic experiments and model manufacturing loading technology, underwater steel-reinforced concrete reinforcement methods, non-linear analysis of metallic spiral casing encased concrete, and other areas. On this basis, they suggested achievements on principles and methods for three-dimensional dynamic and static analysis of structural integrity and reinforcement of the underwater structure of the plant buildings.

D. Research on ship lock hydraulic and structural questions

The Three Gorges will have dual-line flight of ship locks with a total head of 113 m. They must be capable of handling 10,000-ton grade flotillas and their scale would be unprecedented both in China and foreign countries. To ensure safe operation of the ship locks, a series of key technical problems in the hydraulic and structural areas had to be studied and resolved. In the area of ship lock hydraulics, there were prominent questions, especially those concerning the hydraulics of high-head flights of ship locks. The head of the intermediate lock chambers in the continuous flight of ship locks would be 58.2 m (four stages) or 49.5 m (five stages), higher than existing levels in China and foreign countries. The problems of the high-velocity currents in their filling and emptying valves and unstable flow in the access channel involve complex conditions and difficult attacks on key problems. In the area of the structure of the ship locks, based on the overall configuration of the key facility, the flight of ship locks would be located on the left bank, so the ship lock chambers must be deeply excavated from the rock strata. To reduce the amount of side slope excavation and the cubic meters of concrete in the lock head and lock chambers, there must be research on a structural configuration that uses the excavated rock for the intermediate lock walls. This also concerns a series of hydraulic questions. To select a rational program that conserves construction costs, this project focused on studying the hydraulics of a dual-line flight of ship locks (including five stages and four stages) and structural questions of the lock chambers. Concerning the hydraulics, it was suggested that the discharge capacity of the water conveyance system must be corrected for dimensional effects according to Reynolds numbers and roughness coefficients, the type of abrupt expansion of the corridor after rapid startup and mating of the water conveyance valves, non-constant flow experiment methods, and comprehensive venting measures. In the area of lock chamber structures, research was done on the feasibility of using a lock structure with an anchored thin lining, the stability of the rock blocks within 60 m was discussed, and internal force and temperature stress analysis achievements for the anchored plates were suggested.

E. Research on outlet structure hydraulic questions

The outlet structures for the Three Gorges project are composed of spillway surface outlets (consideration is being given to overflow on the roof of the plant buildings on some dam sections), low-level outlets in the body of the dam, a temporary diversion bottom outlet, and notches. In the area of hydraulics, the characteristics are a large scale, large numbers, high head, high flow velocity, substantial changes in operating head, numerous variations in working conditions, and long operating schedules for the outlet structures. Thus, extensive research, rational design, and safe project operation are very important. This project focused on research concerning the types and hydraulic characteristics of outlet structures (surface outlets, building roof overflow, low-level outlets, and diversion bottom outlet) for the Three Gorges project and suggested achievements for the types and dimensions of the various types of outlet structures, the discharge capacity, marginal pressures, flow patterns, cavitation characteristics, and other areas. This was particularly true for the hydraulic characteristics of the narrow deep bottom outlet, building roof overflow pulsation testing and analysis systems, dynamic response computations, the distributional laws of cavitation positions for dual layers of low-level outlets and diversion outlets in a superposition configuration, and other achievements. These achievements provided rational and effective routes for improving types and flow patterns and for avoiding cavitation erosion and reducing local scouring downstream.

III. Realizations

Under the correct leadership and concern of the State Science and Technology Commission for the project to attack key technical problems regarding the hydraulic structures at the Three Gorges project and through the unity and cooperation and close coordination by three areas, namely the departments directing the project, the Group of Specialists, and the units responsible for the various special topics, all of the tasks involved in work on these attacks on key S&T problems were completed on schedule with assured quality.

Practice in attacking key S&T problems over the past 5 years has shown us that our main experiences and realizations in doing this work well are:

1. In the area of managing attacks on key problems, this project was divided into the three layers of departments directing the project, units responsible for the special topics, and units responsible for subtopics, and they were managed using a signed contract arrangement. Based on the contractual requirements, the units that assumed responsibility for the subtopics had full responsibility to the units responsible for the special topics and the units responsible for the special topics had full responsibility to the departments directing the project. Besides implementing formal contract signing procedures, research programs to attack key S&T problems and overall progress plans were also formulated for each of the special topics. They served as the legal basis for management work and provided for inspections on a fixed schedule, which resulted in considerable improvement in S&T management work levels.

2. In the areas of technical guidance and technical checking work, this project recruited an Group of Specialists and the Group of Specialists conducted its work by assignment from the departments which directed the project. Each year, the directing departments organized a conference of specialists, heard reports, inspected progress in attacks on key problems, and coordinated and revised plans. They also organized the Group of Specialists to go to the units responsible for the special topics and conduct intermediate examinations of their achievements, make technical inspections of the achievements for which they were responsible, and other work. During the course of attacking key problems, the work done by the Group of Specialists was welcomed by all relevant units and it played an important role in raising the level of achievements in attacking key problems and completing tasks on schedule.

3. Formulation of plans for this project and deployment for the five subtopics were done in close integration with key problems concerning hydraulic structures at the Three Gorges project. During the process of formulating plans to attack key problems, the departments directing the project first organized specialists to compile feasibility reports and, after receiving state approval, they also organized specialists from throughout China to study the content of concrete attacks on key problems (including work in the special topics that were to be divided into subtopics). Thus, the project established to attack key problems covered a wide area and was well matched-up, and the content of topic selection was scientific and rational.

4. The line for attacking key technical problems in this project was correct. This is manifested primarily in: prominent foci in attacks on key problems, adoption of methods to integrate a variety of research measures and routes, application of advanced theories and testing equipment, and clarification of basic conditions for attacking key technical problems and the provision of measures and proposals. Besides having applied significance for the key technology for hydraulic structures at the Three Gorges project, they also have reference value for similar types of hydraulic structures.

5. All units responsible for the special topics were extremely concerned with work to select the units to be responsible for the subtopics and they consistently felt that work in this area was a major issue that concerned whether or not tasks to attack key problems could be completed with guaranteed quality on schedule. Moreover, on the basis of instructions from higher authorities, a bid solicitation arrangement was used for certain subtopics to select the units to be responsible for attacks on key S&T problems in a useful exploratory trial.

6. Because the Three Gorges project is still at the design stage, reinforcing attacks on key S&T problems and the relationships between the design and all units attacking key problems are particularly important. During the entire process of attacking key problems, this project was concerned with closely integrating attacks on key problems with the design. Moreover, among the various units attacking key problems, when the essence of the research content of their attacks was approximately the same or identical, they were immediately informed and discussions were held to allow smoother development of the work to attack key problems and eliminate or reduce twists and turns.

7. The measures established to subsidize job positions for state attacks on key S&T problems were deeply welcomed and supported by the personnel involved in attacking the key problems. They were extremely effective in motivating and encouraging the initiative of personnel involved in attacking key problems.

In summary, major accomplishments were made in attacking key S&T problems during the Seventh 5-Year Plan. Given the technical complexity of the Three Gorges project and the fact that the project is still in the design stage, however, there are several other major and key technical problems that have been proposed for inclusion among projects to attack key S&T problems through continued research during the Eighth 5-Year Plan.

Work Officially Begins on Ertan

926B0003C Beijing RENMIN RIBAO OVERSEAS EDITION in Chinese 16 Sep 91 p 1

[Article by reporter Cheng Jian [2052 1696]: "Construction Formally Begins at Ertan Hydropower Station, China's Largest Power Station and the World's Third Highest Dam, 240 Meter High Dam Being Built, Yearly Power Output Will Be 17 Billion kWh"]

[Text] Construction formally begun on 14 September 1991 at Ertan Hydropower Station, China' largest hydropower station. This is an indication that hydropower construction in China has attained a new level.

Ertan Hydropower Development Company, which is responsible for construction of this project, has already issued the order to begin construction to all of the businesses with contractual responsibility. Italy's (Impoglio) Company is the responsible company in a joint venture that includes France's Dumez, China's 8th Hydropower Bureau, France's (Damase), Italy's (Tanno), and other companies. Germany's Holzmann is the responsible company in a joint venture that include China's Gezhoubao Project Bureau, Germany's Hochtief, and other companies. They will be going to the site in succession.

At the Ertan construction site, I saw three new bridges across the Yalong Jiang and nine special construction roads cutting through the mountains. The 46 preparation projects that were built with an investment of 400 million yuan by Sichuan Province have been completed, and they have created excellent conditions for construction of the main project.

According to the progress requirements for the project, diversion of the Yalong Jiang will be carried out at the end of 1993 and the first generator will go into commercial operation in October 1998. The entire project will be completed by June 2000.

Ertan Hydropower Station is located on the Yalong Jiang, the largest tributary of the Jinsha Jiang within Sichuan's borders. The primary structures for the power station will include a large dam 240 meters tall. It will be the first dam in China to exceed a height of 200 meters and will the third highest in the world among similar types of dams. There will also be a huge underground plant building where six 550MW generating capacity water turbine generators will be installed and they will generate 17 billion kWh of electricity annually. The power station's single unit capacity, total capacity, and yearly power output will all hold first place in China.

Construction of this hydropower station at an investment of 10 billion yuan will be done by using a World Bank loan for part of the capital and international competitive bidding will be carried out for the primary civil engineering projects.

Yunnan's Massive Effort To Develop Resources of Lancang Jiang

926B0003B Beijing RENMIN RIBAO OVERSEAS EDITION in Chinese 17 Jul 91 p 3

[Article by reporter Ma Tianze [7456 1131 3419]: "Yunnan Now in Massive Effort To Develop Lancang Jiang Hydropower Resources"]

[Text] Yunnan is now involved in a massive effort to develop the abundant hydropower resources of the Lancang Jiang. It plans to build eight cascade power stations in succession along a section about 800 kilometers long in the middle and lower reaches of the Lancang Jiang with a total installed generating capacity of 13,700MW that will generate 70.8 billion kWh of electricity annually. This will make the Lancang Jiang the largest hydropower and energy resource base area in the southwest China region.

Manwan Power Station, which will have an installed generating capacity of 1,500MW and generate 7.884 billion kWh of electricity annually, is now in the stage of speeding up the pouring of the large dam. Construction of it formally began in May 1985 and the first generator is expected to go into operation and begin generating power at the end of 1992.

The Lancang Jiang, which begins in the Tanggula Shan of Qinghai, flows southward through Yunnan after entering Tibet for 1,240 kilometers. The river has a head of 1,780 meters and a yearly runoff of 68.8 billion cubic meters, making it one of Chinese biggest hydropower "motherlodes". It has abundant and stable water supplies and excellent terrain and geological conditions, which are superior conditions for building cascade power stations.

After the first generator at Manwan Power Station goes into operation and begins generating electricity, Yunnan will make a joint investment with the state Ministry of Energy Resources to build Dazhaoshan Power Station, which will have an installed generating capacity of 1,260MW and generate 7.5 billion kWh of power annually. Most of its generators will go into operation and begin generating electricity by the end of this century. Xiaowan Power Station is an important key power station. It is the upstream one of the eight cascade power stations and will have an installed generating capacity of 4,200MW and generate 17.8 billion kWh of electricity annually. The start of construction at Xiaowan Power Station is planned for 1996 and it will go into operation and generate electricity in 2007.

Work Begins on Initial Phase of Xiaolangdi Project

926B0003A Beijing RENMIN RIBAO in Chinese 2 Sep 91 p 1

[Article by reporter Li Jie [2621 2638]: "Construction Begins on First Phase of Xiaolangdi Key Water Conservancy Project, Total Investment 10 Billion Yuan, Design Reservoir Capacity 12.65 Billion Cubic Meters, Hydropower Station Total Installed Generating Capacity 1,560MW"]

[Text] Construction formally started on 1 September 1991 on the initial phase of the big Xiaolangdi Key Water Conservancy Project, a key state construction project during the Eighth 5-Year Plan and another of China's magnificent projects in the history of controlling the Huang He.

The dam site for the Xiaolangdi Key Water Conservancy Project is located on the trunk of the Huang He about 40 kilometers north of Luoyang City in Henan Province. This large-scale project is mainly for the purposes of flood prevention, icing prevention, and silt reduction along with water supplies, irrigation, and power generation, and it will have an important position in the overall configuration for comprehensive control and development of the Huang He.

The Xiaolangdi project will be composed of three main parts, a large dam to block the river, floodwater drainage and silt discharge structures, and water diversion and power generation structures. The designed maximum dam height is 154 meters and the total reservoir capacity will be 12.65 billion cubic meters. The long-term effective reservoir capacity is 5.1 billion cubic meters. It will have 15 tunnels for floodwater drainage, silt discharge, and water diversion for power generation. It will also have one normal and one unusual floodwater drainage channel. The hydropower station will have a total installed generating capacity of 1,560MW and generate an average of 5.1 billion kWh of electricity annually.

The main part of the project will take about 8 years to build and will involve a total investment of 10 billion yuan.

Two Water Power Stations Planned

40100005 Beijing CHINA DAILY (Economics and Business) in English 1 Nov 91 p 2

[Article by staff reporter Huang Xiang]

[Text] China's principal State energy investor has joined forces with local financiers to build two hydro-electric power projects in central and northeastern China.

The State Energy Investment Corporation (Seic) has recently signed contracts with provincial leaders of Hubei and Heilongjiang provinces to finalize arrangements concerning funding and management of the projects, China Daily learned yesterday.

Under the agreements, construction costs will be shared between Seic and local investors. The two sides are also committed to share ownership, management and profits upon the completion of the projects.

The agreements also involve "necessary arrangements for the affected population," said a Seic official.

In the case of Lianhua Hydropower Station in Heilongjiang Province, Seic has pledged to supply 70 percent of the total costs while local sources are responsible for the rest.

Sources said the Seic funding will cover the construction of the power station itself and electricity transmission system, the bulk of a hydropower undertaking. The local contribution will be used for resettlement and compensation for people who have to move.

The corporation will not reveal the exact cost until its feasibility study has been approved by the central government. A 550,000-kilowatt-capacity project should cost between 2.5 billion yuan ($471 million) to 3 billion yuan ($566 million).

With four turbine generating units, the Lianhua station will be capable of producing 790 million kilowatt-hours of electricity a year upon its scheduled operation in 1998.

A seic official said that the construction of the project is planned to start in 1992, with the first generating units commissioned in 1996.

Heilongjiang Province is among the nation's most industrialized but energy-starved regions. It has long been dependent on neighbouring areas for electricity supplies.

The Gaobazhou project in Hubei is comparatively small with a kilowatt capacity of 240,000.

With investment equally divided between Seic and the province, the project is designed to supply power for industries within the province.

Abundant in water resources, Hubei has seen the establishment of a number of major hydropower works. Of them, the 2.7-million-kilowatt Gezhouba Power Station on the Yangtze River is the largest in China.

Coal Production To See Record Capacity Boost

40100004B Beijing CHINA DAILY (Economics and Business) in English 29 Oct 91 p 2

[Article by Huang Xiang]

[Text] The Ministry of Energy Resources has pledged to increase the country's annual coal production capacity by more than 50 million tons by the end of 1992.

This target was set because a steady recovery of industrial growth depends on coal, CHINA DAILY was told yesterday.

The ministry ended a working conference on Friday in Beijing to finalize its goal.

Vice-Minister Hu Fuguo said the 50-million-ton quota is a must for the industry. The increase will largely be directed for use in new coal-based power plants.

Industry sources noted that the meeting was held at a time when the nation's industrial growth surged 15 percent, the highest growth this year.

They said the fast economic recovery will soon stretch the energy sector to its limits because coal stockpiles are being drained nationwide.

Previously, the ministry warned that the sluggish coal sales had bottomed out and projected a tight coal supply when the economic pick-up gained its momentum.

According to Hu, the industry is currently constructing 88 coal mining shafts with a total production capacity of 132 million tons of coal.

Of them, the vice-minister revealed, 47 shafts are now required to be put into operation by the end of next year, increasing the designed capacity by 56 million tons.

According to ministry officials, the central government is expected to further increase its funding in the sector. So far this year, government appropriations in the coal industry have reached 1.14 billion yuan ($215 million), the highest in a decade. Hu said the increased funding has ensured smooth construction of coal projects.

The industry is due to complete construction of 26 mining shafts by the end of this year to increase the country's coal production capacity by 28.7 million tons of coal a year. This will be the biggest annual increase in the country's coal production capacity in China's history.

Meanwhile, the conference reported an improved coal production for July-September.

The coal industry registered a 1.1 percent increase over the same period last year, overturning a drop in production in the past two months.

China's Petroleum Exploration Strategy

926B0008A Beijing SHIYOU XUEBAO [JOURNAL OF PETROLEUM] in Chinese Vol 12, No 3, Jul 91 pp 1-5

[Article by Zhang Houfu [1728 0624 4395] of the Petroleum University, Beijing: "Viewing China's Petroleum Exploration Strategy from a World Perspective"; manuscript received 24 Nov 90]

[Excerpts] [passage omitted]

China was the first nation in the world to extract and utilize natural gas. After following a long and tortuous path, China has now become one of the world's biggest oil-producing nations with yearly petroleum output in excess of 100 million tons. We have leapt from being a so-called "oil-poor nation" to an petroleum exporting nation and China's petroleum industry has made brilliant achievements that have attracted world attention and made prominent contributions to the nation's socialist modernization and construction. However, petroleum and natural gas are not "inexhaustible" eternal resources and the water content of the old oil regions of east China is rising rapidly. Comprehensive and detailed consideration of what China's oil and gas resource exploration strategy should be during the Eighth 5-Year Plan, Ninth 5-Year Plan, and into the 21st Century has become an urgent issue. To enable scientific decision making, we should spy out the principles that China should adopt based on the directions and characteristics of world oil and gas exploration. [passage omitted]

China is a vast country covering an area of about 9.6 million square kilometers and has abundant reserves of oil and gas resources. Because it has been continually subjected to the effects of subduction by the Indian Plate and Pacific Ocean Plate, it has obvious tectonic characteristics that have created three types of petroliferous basins in China (Figure 1). East China is mostly extension-type fault-subsidence basins from the Yanshan

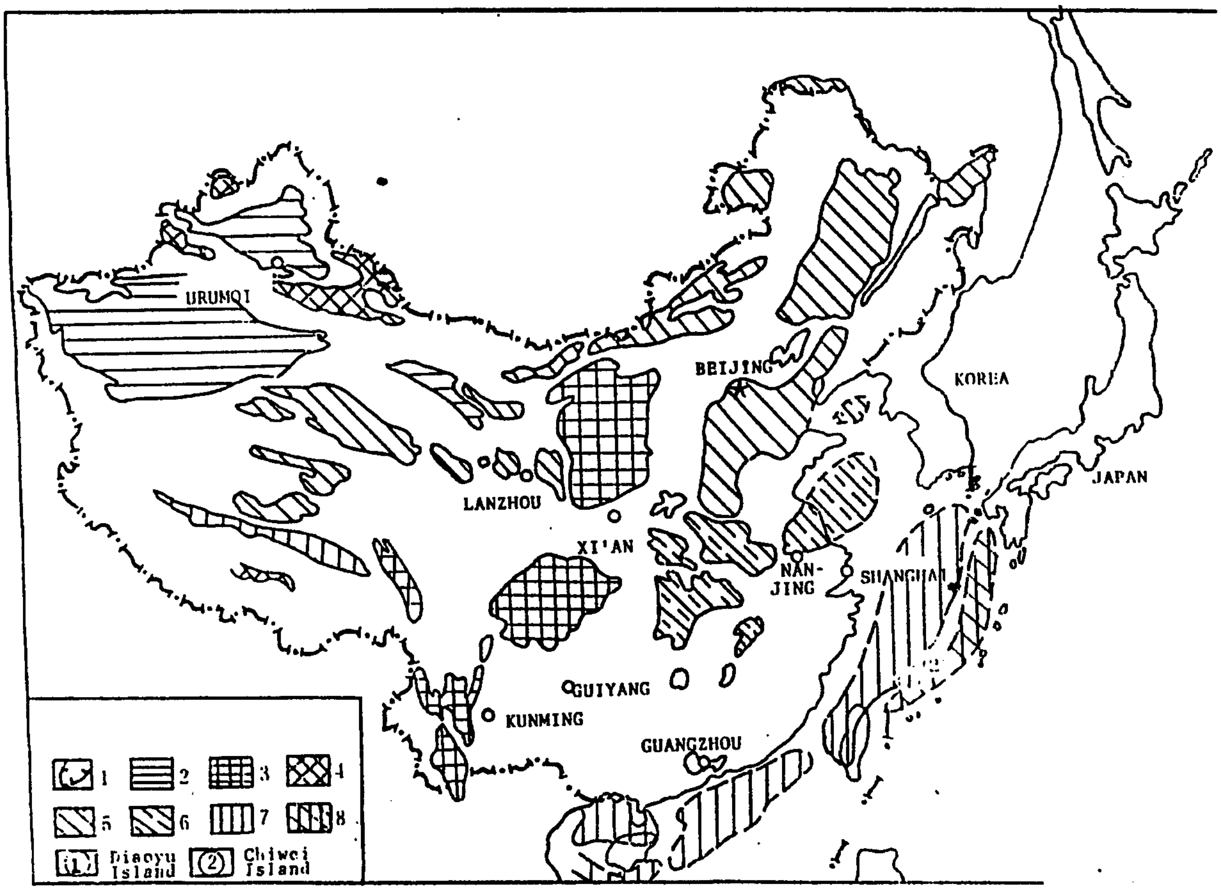

Figure 1. Distribution of China's Major Sedimentary Basins

Key: 1. Sedimentary basin; 2. Late Hercynian period to Himalayan period; 3. Indosinian period to Yanshan period; 4. Indosinian period to Himalayan period; 5. Middle Yanshan period to Himalayan period; 6. Late Yanshan period to Himalayan period; 7. Early Himalayan period to late Himalayan period; 8. Late Himalayan period

period to Xishan period (continental) and Xishan period (marine) that are distributed with a NNE or NE strike. West China is mostly compression-type intermontaine and premontaine basins from the late Hercynian period to the Xishan period that extend in a WNW direction. Central China is mainly transitional subsidence basins from the Indosinian period to Yanshan period. Over the past 30 years, oil and gas exploration and development have been focused on various continental basins of east and central China and they have made enormous contributions to stabilizing China's petroleum output at about 100 million tons a year. Exploration of non-structural oil and gas pools, however, is still rather weak. West China contains large petroliferous basins like the Tarim Basin, Junggar Basin, and others, but the communication and geographical conditions are extremely difficult. The basins along the southeast coast contain abundant oil and gas resources but they pose quite a few technical problems for exploration, development, transportation, and so on. China is extremely rich in coal-formed gas, oil-formed gas, and other natural gas resources, but the degree of exploration is very low. Given the basic petroleum geology situation outlined above, in conjunction with the state's Eighth 5-Year Plan and long-term plans, and in accordance with the trends and characteristics of world oil and gas exploration, the oil and gas exploration strategies that China should adopt in the short term and in the medium and long terms is a very important topic. I will now offer some suggestions for discussion and reference:

1. Searching for large oil and gas deposits should be one of the primary objectives in China's oil and gas exploration. Those with the greatest prospects are the two large basins of Xinjiang, Tarim and Junggar, and the offshore area of southeast China. Besides the Karamay-Urho oil region that has been developed for over 30 years, high-output oil and gas wells have been drilled in northern Tarim, central Tarim, and eastern Junggar and there substantial prospects for finding large oil and gas deposits. In the Liaodong Bay, Southeast Qiong, Zhujiangkou [Pearl River Mouth] and other basins off the southeast coast, the Suizhong 36-1, Ya 13-1, and other large oil and gas deposits and high-output oil and gas wells have been found and high-output oil and gas flows have already been drilled from the East China Sea Basin. These marine sedimentary basins are important regions to search for large oil and gas deposits. However, because of restrictions by communication and geographical conditions and by marine drilling, extraction, and transportation conditions, forming a large-scale production capacity will require creating all sorts of conditions and accelerating the pace of exploration and development. Estimates indicate that they will not be able to make a huge contribution to the state until the Ninth 5-Year Plan and early 21st Century.

2. With the need to ensure yearly output at the 140 to 150 million tons level during the Eighth 5-Year Plan, we must mainly rely on exploiting potential in the old oil and gas regions of east and central China, including major efforts to locate non-structural oil and gas deposits and relatively new exploration areas, such as the region around Changtan at Daqing in the Songliao Basin as well as the Bohai Bay, Subei-Nanhuanghai [Northern Jiangsu-Southern Yellow Sea], Jianghan, and other basins which have considerable potential for finding non-structural oil and gas deposits. In addition, we should also strengthen exploration and research for new regions in the Erlian, Linqing, Jarantai, and other basins.

3. Quickly strengthening natural gas exploration and locating large and medium-sized gas deposits is an important way to use gas to supplement oil. Sichuan, Ordos, Songliao, Bohai Bay, and other petroliferous basins as well as Southeast Qiong, East China Sea, and other marine basins should be included among important targets for natural gas exploration. In addition, we should make a major effort to strengthen research on the formational conditions and distributional characteristics of coal-formed gas deposits in the Carboniferous-Permian system of the North China platform, the upper Permian system and Jurassic system of south China, and other regions where coal-bearing strata systems have developed and accelerate the pace of exploration for coal-formed gas resources. We should also include them in exploration deployments as soon as possible and create favorable conditions in the areas of manpower, materials, and finances.

In summary, when the 21st Century arrives and world oil and gas reserves and output begin to decline, China's prospects for oil and gas exploration and development will be even broader and more prosperous.

Great Strides Made in Exploration of Western Oil and Gas Fields

926B0004B Beijing ZHONGGUO KEXUE BAO [CHINESE SCIENCE NEWS] in Chinese 16 Aug 91 p 1

[Reported by New China News Agency Reporter Wu Guoqing and Chen Xhiqiang]

[Excerpts] Over 200,000 workers are now working in western China to develop and explore oil and natural gas reserves and important progress has been made.

During visits to the Tarim, Junggar, Qaidam, and the Shaanxi-Gansu-Ningxia basins and the Hexi Corridor, this reporter witnessed large-scale exploration and development of oil and natural gas. The Gobi Desert, for so long barren desert land, has now produced very encouraging scenes. Numerous settlements have grown up around the oil fields. Rows and rows of oil rigs tower into the sky. [passage omitted]

Lu Minggang, head of the Exploration Department, China Oil and Natural Gas Company and the man responsible for the exploration of oil in the Western part of China, told this reporter that western China is the cradle of the nation's oil industry and is also the next target area for the nation's oil industry development in the next century. He added that the nation's strategic policy of "stabilizing the east and developing the west" ushers the western part of the nation's oil and natural gas development into a new era.

Western China has rich reserves of oil and natural gas. Evaluation of the oil and natural gas resources done by relevant departments indicates that China's future oil resource is 78.7 billion tons and the natural gas resource is 37,300 billion cubic meters. Forty percent of the oil and 50 percent of the natural gas are located in the northwestern part of the country, an area comprising one-third of the total land area of China.

In Tarim Basin, Qiu Zhongjian, deputy general manager of the China Oil and Natural Gas Company and the man directing the development and exploration of oil in this area, said that after two years of 15,000 oil workers' hard work, high output oil-bearing structures such as Linnam, Yingmaili, Tazhong, Donghetang and Jilake have been discovered. Development there has reached the state of grasping the reserves, grasping the area and grasping the big oil field. Moreover, Linnam oil field has been made into a 600,000-ton oil field. During the Eighth 5-Year Plan, Tarim Basin will have the capacity to produce 5 million tons of oil per year.

Qiu Zhongjian also pointed out that Donghe #1 well in the Donghetang Structure is the nation's first well in a marine sandstone structure to produce a flow of 800 tons a day. This opens up an entirely new area in oil exploration in the west. The Tazhong oil structure spans an area of 8,200 square kilometers, over three times the size of the Daqing oil field.

The Turpan-Hami Basin, located in the Hexi Corridor, has also seen rapid progress in exploration and development. In four new fields—Shanshan, Qiuling, Elihu, and Wenjixiong—and a series of high-potential oil and gas structures, considerable amount of crude oil reserves has been obtained. By the end of the year, production capacity will reach 500,000 tons. During the Eighth 5-Year Plan, capacity is expected to reach 3 million tons. Junggar Basin, the basin developed earliest, has also entered the stage of full-scale exploration. Oil fields like Beisantai, Santai, and Majong were recently discovered to the east of Karamay oil field. This year, activities centered on the interior of the basin and it was discovered that the central bulging belt area has many large oil-bearing structures, proving that this area of the Junggar Basin has large oil reserves.

The breakthroughs made in the exploration and development of natural gas are also very spectacular. In the center of the Shaaxi-Gangsu-Ningxia Basin, a world-class natural gas field was discovered. In the Sichuan Basin, last year's production reached 6.4 billion cubic meters, accounting for 40 percent of China's total output of natural gas. Natural gas structures were also discovered in the eastern, central, southern, and western part of Sichuan Province. [passage omitted]

Recent Petroleum Exploration Efforts in Tarim Summarized

926B0010A Urumqi XINJIANG RIBAO in Chinese 14 Sep 91 p 1

[Article by Reporter Zhang Lixue [1728 4539 1331]]

[Text] After 2 and one-half years of struggle, workers from among the more than 19,000 employees at major oil fields around the country have discovered four high-yield oil fields and a number of oil-bearing structures at Tarim, and petroleum geological reserves have been verified that will become a solid base at Tarim for a production capability of 5 million metric tons of crude for the national Eighth 5-Year Plan.

After years of exploration and verification in the 560,000 square kilometers of the Tarim Basin, petroleum and natural gas deposits have been found that represent, respectively, one-seventh and one-fourth of all national reserves. It is the largest oil and gas basin in the country and it has become the main arena for opening up petroleum resources in the west.

The battle began in April 1989 when the Tarim Petroleum Prospecting and Development Headquarters implemented the "two-new, two-high" policy (new technology, new techniques, high level, and high profits), and comprehensive project management and the new administrative structure of the A/B contract system. Excellent teams and advanced facilities were selected from various major oil fields around the country, domestic advanced technology and imported foreign advanced technology were assembled and employed, and initially, industrial technologies suitable to the special features of Tarim were lined up to expedite the pace of prospecting and development. Throughout a period of over 2 years, the petroleum workers at the two promontory areas of north and central Tarim, five locations rich in oil and gas were discovered: Lunnan, Yingmaili, Tazhong, Donghetang, and Jilake. The four high-yield oil fields that were found are all located in the north Tarim promontory where there are many oil-bearing strata with quite good surface conditions amenable to development and production.

A 500-square-kilometer oil- and gas-bearing site has been discovered in the Lunnan area. The Lunnan and Sangtamu oil fields are situated in two structure belts in an area where dissimilar oil- and gas-bearing strata alternately join to form stretches of rich oil layers. Of which, the Lunnan oil field has already commenced test production and may produce more than 500,000 metric tons of crude oil this year. The five oil wells at Sangtamu oil field have all produced a high output of commercial grade oil and gas and may enter test production next year.

The Donghetang oil field, a high-production oil field of roughly 20 square kilometers is being readied for production. Its deepest oil layer is 120 meters, and single well output is high, of which, Donghe-1 well's daily output of crude oil is 836 cubic meters and natural gas is over 5,800 cubic meters; Donghe-11 well's 180-meter core interval has yielded over 140 meters of oil- bearing core. It is expected that this oil field will be completed and on line in 1993.

In the original 70-square-kilometer oil- and gas-bearing site brought under control at the Jilake oil field, three test wells have high output oil and gas flow, and four others that are now being drilled show presence of oil and gas. The stratigraphic material analysis of this area indicates that it will become a large-scale oil field.

At the same time, Tarim petroleum workers are getting a high-yield flow of commercial grade oil flow from two structures in the Yingmaili district. In addition to the high yield oil and gas flow at Tazhong-1, Ta-3 and Ta-5 now being drilled have good oil and gas indicators. Recently, on both banks of the Tarim River, another group of oil- and gas-bearing geological structures have been found.

Oil field workers are striving to attain a crude oil production capability of 5 million metric tons per year, and to open up even larger territory, in order to drive Tarim petroleum prospecting and development to ever greater growth.

Junggar Claims 'Historic' Breakthrough in Oil Exploration

926B0010C Urumqi XINJIANG RIBAO in Chinese 16 Sep 91 p 1

[Article by Reporter Zhang Zhaowen [1728 6389 2429]]

Junggar Basin, again China's main battlefront for petroleum development in the west, is the bearer of good news: Karamay oil men have drilled nine strategic exploratory wells in the desert areas deep within the Basin, all of which have brought forth high-volume flows of oil and gas, earning for Junggar Basin a prospecting breakthrough of historic proportions.

According to Chinese and foreign experts who have used 11 different methods of calculation, the volume of petroleum resources in Junggar Basin is 8 to 10 billion tons, but because of limited circumstances the Xinjiang Petroleum Administrative Bureau, in the next 30 years or more, will only be able to explore the periphery of the Basin, leaving 80 percent of the area's petroleum deposits beneath the Basin's desert.

In early 1990, thousands of oil men opened up the heart of the desert. On 30 October of last year, they began to drill Bencan-2, the first exploratory well deep in the desert. later on, oil derricks were erected on the Cainan, Baijiahai, and Mosouwan structures. Although the weather in the desert is severe and drilling and prospecting conditions are extremely difficult, the well drillers, who came from Karamay, worked day and night. Up to now all exploratory wells drilled have brought forth high oil and gas flows, and other wells still being drilled are showing good indicators for the presence of oil and gas.

Jiangsu Fields Open New Area of Exploration

926B0010B Shanghai JIEFANG RIBAO in Chinese 30 Aug 91 p 5

[Article by reporter Sang Jinquan [2718 2516 3123]]

Recently at a session of the Jiangsu Oil Field Prospecting Technology Symposium reporters learned that progress has been made in oil and gas exploration at Jiangsu oil field. This year in the Jinhu and Gaoyou depressions, a succession of high-grade traps and possible oil-bearing traps have been discovered, and some with promising deposits have basically been brought under control. There has also been progress in limestone deposit prospecting. Proven reserves and reserves now under control are about at the average annual levels of the Sixth 5-Year Plan and Seventh 5-Year Plan. At the same time, in the land portion of the Hongze depression, traps distributed in a belt have been found, and in the lake portion, a large tectonic setting has appeared; at the Yancheng depression, the first well revealed a deep natural gas flow; new findings have also been made by a deep strata seismic probe in the Changzhou area of southern Jiangsu. As a result, Jiangsu oil field has initiated a prospective action plan for geological prospecting with both primary and reserve arenas.

The Jiangsu area comprises an extensive prospecting territory: first, it encompasses an array of 10 deep-layered depressions of mesozoic- and cenozoic-group continental deposits of the north Jiangsu Basin, second is primarily the mesozoic-paleozoic-group marine deposits of the south Jiangsu promontory, and third is the north Xuzhou section's coal-related gas area. The main effort of developing and constructing oil fields is still confined to the Gaoyou and Jinhu depressions in the north Jiangsu basin. Hereafter, the prospecting territory will be greatly enlarged, enclosing a large area where there is a sound natural resources base for sustained and steady development of oil fields.

The geological circumstances of Jiangsu oil field are very complex. As the chief geologist at the prospecting bureau, Ma Li [7456 4539], assesses it, the multi-phase tectonic activity segmentally changed the basin structure causing the oil and gas to change segmentally and develop differently; the oil-bearing structure branched out and fractured, and remains as fault blocks; the level of enriched oil and gas is deep, and it is very much complicated by many factors which affect exploitation. Most of the 20 proven oil fields are small. Objectively, the geological conditions dictate that in the north Jiangsu Basin the search will be mainly for small oil fields, but chief geologist Ma Li believes that whether there is a rather large oil field in the making among the group of small oil fields cannot yet be determined. According to analysis of new oil field prospecting data, Hongze and Gaoyou lake areas both have geological conditions for the formation of quite large scale deposits of oil. Several sections of the Gaoyou depression also display conditions for a ready formed structure of oil deposits. The western slope of the Jinhu depression and the Baoying slope have conditions for quite large limestone oil deposits, and the belt of depressions in the western portion of Gaoyou presents conditions for rather large-scale stratified-rock oil deposits. He pointed out that it is important to dare to take risks, to courageously bring about new prospecting ideas, to develop new prospecting technology, to open up new prospecting areas and find new forms of oil and gas deposits.

Reportedly, the Jiangsu Eighth 5-Year Plan for proving deposits is about equal to the sum of the Sixth 5-Year Plan and the Seventh 5-Year Plan. Oil fields have already made distinct advances in seismology, seismic prospecting; they have also strengthened geological and geophysical research, and have accomplished good trap appraisal work.

In order to reach the Eighth 5-Year Plan target of becoming a million ton oil field, beginning this year, simultaneously with the main attack on the Jinhu and Gaoyou depressions, Jiangsu oil field will extend the scope of prospecting, actively develop the Haian depression, appraise the further exploration of Hongze and Yanchang depressions, struggle for a breakthrough in south Jiangsu, establish an industrial production test base for shallow strata oil wells at Jurong, strive for effective deep-strata development to effect a favorable replacement cycle of natural resources. One place where a storming of the fortress for geological prospecting is taking place is at Baili oil field where, on the one hand, traps are being predicted in new places and new belts, deposits are being brought under control, 10-million class oil fields, or oil fields of 3 or 5 million tons are being found, and on the other hand, the prospecting of old areas and finding of the groups of small enriched high yield oil fields are also being carried out.

Shengli Hits High Crude Flow in Bohai

926B0004A Shanghai WEN HUI BAO in Chinese 17 Aug 91 p 1

[Article by Special Reporter Xu Yanggang and Reporter Wei Dong]

[Excerpt] A high crude oil flow has been discovered in Qingbei #21 oil-well in a very shallow water area of Bohai north of the Yellow River's entrance into the sea by workers on Shengli Platform #4 of the Shengli Oil Field Shallow Water Drilling Company. The discovery is the latest important breakthrough in shallow water drilling in the Shengli oil field. At the end of the first half of the year, four big oil-bearing structures had been discovered and over 100 million tons of oil had been determined to be in existence in oil-bearing structures. Preparatory work for the development of Qingdao oil field, China's largest shallow water oil field discovered so far, is now in high gear.

The movement of oil drilling to shallow water areas of the Shengli oil field is a strategy of recent years. Oil field units have built China's largest and strongest shallow water oil drilling company, with five oil drilling platforms and 34 support vessels. Over 40 oil wells have been drilled. So far, four oil-bearing structures—Qingbei, Kendong, Qingdong and Dawangbei—have been discovered. A high daily output of 128 tons of crude oil flow was obtained from Qingbei #21 oil well, which is situated in the shallow water of Bohai near the Yellow River's entrance into the sea. This verifies the existence of China's largest shallow water oil field, the Qingdao oil field.

This year the nation has designated the area one of the four key battlefields for exploration and development of oil. Shallow water drilling has become the key for increasing production of the potential oil reserve of the Shengli oil field for the present and for the future.

To accelerate the exploration of the shallow water areas, Shengli authorities recently established the Shallow Water Engineering Department under the Shengli Oil Field Management Bureau. So far this year, eight seismic battalions have been activated and sent out in an effort to accelerate geological survey work. All five drilling platforms of the Shallow Water Company were sent out to sea a month earlier than normal in past years. Various difficulties were overcome in drilling and instead of drilling one round of wells in one marine season as was the case in the past, two rounds of wells are now drilled per marine season. The result of one year's work is now equal to that of two years. But this July, all five platforms had finished drilling the first round of oil wells and all five wells made encouraging discoveries. [passage omitted]

Natural Gas Exploration in Central Shaan-Gan-Ning Basin Summarized

926B0008B Xian SHAANXI RIBAO in Chinese 13 Aug 91 p 1

[Article by Jiang Yong [5592 0516], Liu Dongming [0491 2639 2494], and Liu Yi [0491 5030]: "Opening the 'Veil' of a Big Gas Deposit, An Outline of the Current Situation in Natural Gas Exploration in the Central Shaan-Gan-Ning Basin"]

[Text] After the discovery of natural gas in the central part of the Shaan-Gan-Ning [Shaanxi-Gansu-Ningxia] Basin, northern Shaanxi, which made an enormous contribution to the Chinese Revolution, is again attracting the attention of people throughout China. From the winter of 1990 to the spring of 1991, the state transferred over 5,000 people to open the curtain on a major exploration battle in Jingbian County, an area with rich accumulations of gas deposits.

Half a year has passed. What is the overall current situation in exploration and development prospects now, and what is their actual value for extraction and utilization? Armed with these questions, we accompanies state Ministry of Energy Resources minister Huang Yicheng [7806 3015 6134] in late July on a visit the main battlefields in exploration.

I. The "Veil" Has Been Opened on a Big Gas Deposit

Illustrations of the deployment of drilling show that at present, the Changqing Petroleum Exploration Bureau has set up to drill 25 wells within an area covering 3,200 square kilometers in Shaanxi's Jingbian and Hengshan Counties and that gas has been found in every well. Moreover, acidification testing of the output provided 14 gas producing wells with more than 100,000 cubic meters and two "gas tiger" wells with more than 1 million cubic meters. The Changqing Bureau will divide the exploration battlefield into three work regions, the south, north, and central, and they have quite substantial prospects.

Gratifying breakthroughs have been made in exploration covering 1,000 square kilometers in the northern part. In the beginning, this region was considered to be the edge of the gas deposit but three wells were deployed here in 1991 and all have been drilled to completion. With the exception of one well that had rather poor gas quality indications, there were major breakthroughs at the two other wells. After acidification testing of the output of the northernmost well, the Shaan 11 well, its daily output of natural gas was 100,000 cubic meters. This well together with the Shaan 17 well, which is located slightly to the south on the same longitude line, form an area that is connected to the central gas deposit.

Major discoveries were made in exploring an area covering 1,000 square kilometers in the southern part. This region was a blank area for natural gas exploration. The logging situation for the Shaan 12 well exceeded all expectations on 20 May 1991 when daily natural gas outputs of 250,000 cubic meters were obtained, the highest for all the exploratory wells. This extended the favorable zone for high output a big step to the south.

The exploration region covering 1,200 square kilometers in the central part is the core location in the main battle for natural gas exploration. After high-output gas flows were obtained from the Shaan 1 parameter well in June 1989, 15 wells have now been completed and none of them were empty. Moreover, all of the high-output gas wells are evenly distributed throughout this region and in particular the area outside the line of high gas output formed by the Shaan 6 well at the southwestern end and the Shaan 7 well at the southeastern end has attracted attention.

II. The Central Zone Is in Northern Shaanxi

On 22 June 1991, Xinhua Agency announced the news that a world-class large gas deposit had been discovered in the central part of the Shaan-Gan-Ning Basin and a roar was raised throughout China. Everyone was concerned: how big was the region with natural gas accumulations? Where was the central zone?

Responsible comrades in the exploration bureau posed these two questions. At present, exploration work is continuing, so there is no way to make a final determination of the area and scope of the gas deposit. However, we can tell our readers that data that has been checked and ratified indicates that the central part of the gas deposit accumulation is in Jingbian and Hengshan Counties in northern Shaanxi and that the main battlefield for the big army is in Jingbian County.

III. Gas Deposits Cover a Large Area With Very High Industrial Extraction Value

Since the beginning of 1991, there have been constant reports of victory from the exploration battlefield that have affected the Shaanxi, Gansu, and Ningxia region and China as a whole. The State Council immediately formally included natural gas exploration in this region in the Eighth 5-Year Plan and will increase its investments during this period to 1.2 billion yuan in order to accelerate completion of the overall tasks in exploration.

At present, the world-class gas deposit that we now hold in our hands has its own characteristics. First, it covers a large area and has substantial reserves, and it is the biggest of the gas deposits discovered to date on the Chinese continent and marine area. Second, the gas deposits have a stable distribution and there are eruptions from the primary gas strata. The underground gas deposits are linked together to form a sheet from east to west and from south to north and there is good continuity of the gas strata. Third, the reserve strata are controlled by a weathered crust at the top of the Ordovician system and the weathered crust exists over a large area on the central paleouplift. The lithology is carbonate rock and the results after acidification transformation are significant. The logged daily output from the Shaan 6 well was 100,000 cubic meters. After acidification processing, the daily output reached 1.26 million cubic meters. Hydrogen sulfide logging of several gas wells shows that they basically are low sulfur-content gas, which is a full indication of the excellent quality of the natural gas from the future gas field. The difficulty in processing is rather small and it is a world-class large gas deposit that will require small investments, produce major benefits, and produce results quickly and that has a very high industrial extraction and comprehensive utilization value.

Development of New Broadband Ultrasonic Testing Technique for Nuclear Fuel Elements & Composites

926B0001 Beijing HE DONGLI GONGCHENG [NUCLEAR POWER ENGINEERING] in Chinese Vol 12, No 4, Aug 91 pp 60-65, 70

[Article by He Fengqi [0149 7364 1477] of the China Nuclear Power Research and Design Academy, Chengdu: "Research on a Broadband Ultrasonic Non-Destructive Testing Technology For Nuclear Fuel Elements and Composites"; draft manuscript received 28 March 1990, revised manuscript received 13 March 1991]

[Text] Abstract: Based on the nonhomogeneity, thin layers, high quality requirements, and so on of laminar composite structures, this articles discusses the characteristics of ultrasonic testing and describes the principles of broadband phase-amplitude ultrasonic testing of bonding quality and imaging ultrasonic testing technology. Experiments show that this technology and the design of the testing system are rational and that the broadband ultrasonic system is characterized by a small dead zone, high resolution, good reliability, powerful functions, and so on. It has already been used in automatic non-destructive testing of nuclear reactor elements, explosive composite structures, electronic components, and other laminar composite materials.

Key terms: nuclear fuel elements, composite structures, broadband ultrasound, imaging display.

I. Introduction

Research and development on composite material technology and techniques for quality inspection occupy an important status in materials science and engineering. The major advantages of composite structures are that they foster the advantages of all types of materials while overcoming their disadvantages, using their strengths to compensate for their weaknesses to create new properties. To satisfy the technical requirements of reactor engineering, aerospace, the electronics industry, and other sciences and technologies, all advanced nations are competing in R&D on composite materials and structures composed of metals, non-metals, ceramics, and so on. In the nuclear industry, for example, there are nuclear reactor elements composed of cladding materials (Al, Zr, SS, or graphite) and nuclear fuel cores (U, U alloys, UO_2, U_3Si_2, or U_3O_8 dispersoids); chemical containers composed of steel bases with linings made of stainless steel, titanium alloy, aluminum alloy, or other corrosion-resistant materials; heat exchangers for explosive welding of pipes made of unusual materials to pipes and plates, and so on (Figure 1). Because reactor elements are directly related to nuclear safety and because most new composite materials are used in incisive sciences and industrial and military industry products, all finished products must undergo strict quality testing and have accurate geometric parameters, so there is a special need for non-destructive testing. For this reason, R&D on the corresponding new technology and new instruments and equipment for non-destructive testing has become an important topic[1-3].

Products made from composite materials are unlike simple homogeneous materials and they pose many new

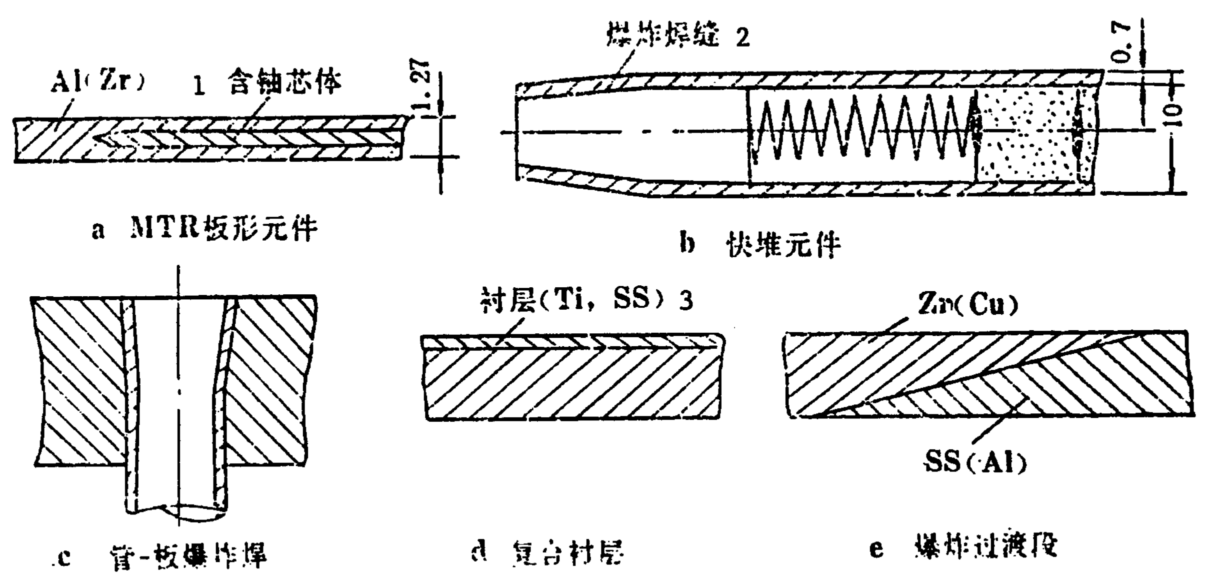

Figure 1. Typical Element and Composite Structure

Key: a. MTR plate-shaped element b. Fast reactor element c. Tube-plate explosive weld d. Composite lining e. Explosive transition segment 1. Uranium core 2. Explosive welding suture 3. Lining demands and new research topics for testing technology. The laminar composite materials used in the nuclear industry alone include cladding layers that may have multilayer structures, so testing instruments must have sufficiently high resolution. Bonding quality tests are often required between layers. Product quality is related not only to the size of defects but also to their shape and distribution, so bonding quality image displays must be provided. Precision non-destructive testing technology is required for the thickness of each layer and the total thickness. Each of the layers is composed of different materials that often have major differences in properties (see Table 1), so special information on processing methods must be considered. Large quantities and high quality standards require automatic scanning, intelligent classification, printed records, and other advanced technology.

Table 1. Sound Properties of Some Composite Structure Layer Materials

Material	Density d, g/cm^3	Longitudinal wave velocity C, X 10^{-4} mm/s	Acoustic resistance Z, X 10^{-5} g/ cm^2 X seconds
Aluminum (Al)	2.70	6.26	1.69
Zirconium (Zr)	6.44	4.65	2.99
Titanium (Ti)	4.58	5.99	2.74
Steel (Fe)	7.70	5.90	4.51
Stainless steel (SS)	8.03	5.56	4.55
Tungsten (W)	19.1	5.46	10.42
Uranium (U)	18.7	3.37	6.30
Water	1.00	1.49	0.149
Air	1.3 X 10^{-3}	0.34	0.00004

Over 10 types of new technologies for non-destructive testing of composite materials have been developed in recent years. Among them, more research has been done on acoustic testing technology. Large numbers of research experiments have confirmed that the broadband ultrasonic longitudinal wave return wave method is the most sensitive and most easily achieved automation and imaging technology for testing laminar composite materials.

II. Broadband Ultrasonic Testing Technology

Given the characteristics of composite materials, using conventional ultrasonic flaw detection instruments and technologies cannot satisfy requirements. This requires the development of new types of ultrasonic non- destructive testing technology and equipment with the following technical requirements:

A. Small dead zone, high-resolution ultrasonic detecting heads and instruments

Laminar composite structures have many thin layers. For example, plate-shaped and tube-shaped fuel elements for reactors (Al- U_3Si_2+Al, Al-Al_xU, Zr-UO_2+Zr, and so on) have a cladding thickness of only 0.25 to 0.5 mm, a total thickness of only 1.37 to 3 mm, and a corrosion-resistant lining of only 0.5 to 1 mm. To test the bonding quality of these components and the thickness of each layer, the dead zone and resolution of ultrasonic detecting heads and instruments must be 0.2 to 0.5 mm.

The dead zone refers to the thickness of the surface layer that cannot be accurately inspected with the ultrasonic pulse return wave method. Resolution refers to the minimum distance in space that can be resolved during ultrasonic testing. The size of the dead zone and the resolution are determined by the detecting heads and by the properties of instrument circuits. The dead zone created by the detecting head's near-field region can be overcome using the delay method, but another factor that affects the dead zone and resolution is the specific width ($T_{excitation}$) of the electrical pulses excited from the wafer. When the effects of inertia and elasticity in the energy converter convert the electrical pulses into sound pulses, they must also be sustained for a time width ($L_{conversion}$). The actual sound pulse width (t_{sound}) is equal to the sum of the two (Figure 2). For this reason, the dead zone, or the minimum distance that can be resolved, (L_{min}) can be expressed as:

$$L_{min} = C \text{ over } 2 (T_{excitation} + L_{conversion}) \quad (1)$$

In the formula, C is the sound velocity of the material being tested.

To reduce a detecting head's dead zone and increase its resolution, the width of the excited electrical pulses can be reduced and a way must be found to reduce the period of the energy converter's free characteristic oscillation. To reduce the width of the excited electrical pulses, the method used most now employs the "clocking" electrical pulses generated by avalanche tubes or high- speed controllable silicon or the steep leading edge and gentle following edge of high amplitude electrical pulses. To reduce the period of free characteristic oscillations of energy converters, besides using wafer materials with rather high damping (such as lithium sulfate, lithium iodate, or lithium niobate), the primary methods are increased absorption damping and appropriate matching of electrical circuits. Figure 2b shows the waveform of broadband ultrasonic pulses. For example, when using

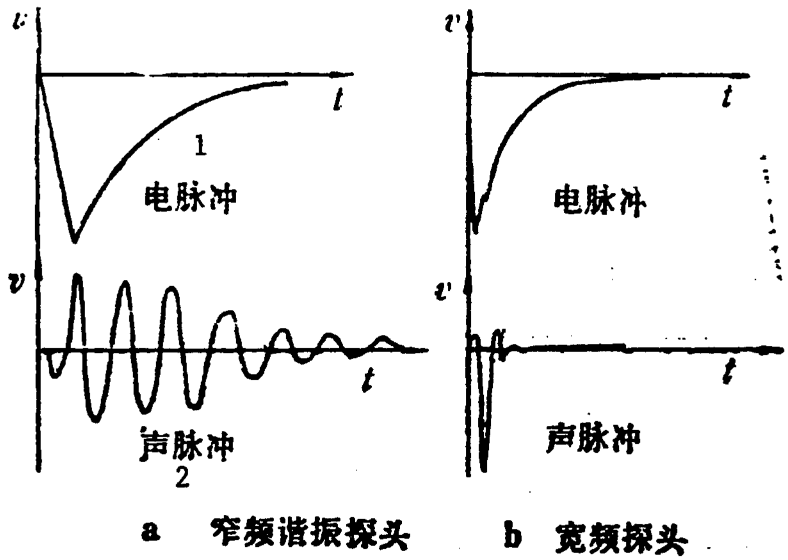

Figure 2. Ultrasonic Detecting Head Electrical Pulses and Sound Pulses

Key: a. Narrowband resonant detecting head b. Wideband detecting head 1. Electrical pulse 2. Sound pulses

the electrical excitation pulses generated by avalanche tubes, the energy converter is composed of approximately 20 MHz lithium iodate wafers and high damping absorption blocks. The ultrasonic pulses obtained in this manner are basically only one-half cycle long and their width is determined primarily by the resonant frequency of the wafers (Figure 2b).

When making the detecting heads, attention also must be given to low-frequency radial vibration interference in the wafers. Wafer materials with thick electromechanical coupling and rather large coefficients, and with rather small radial coupling coefficients must be selected and matching inductances should be used to tune the thickness resonance frequency to inhibit the generation of radial vibrations.

Regardless of the shape of the relatively narrow pulses, they develop in a Fourier series and all are composed of several sinusoidal vibrations of different frequencies and different amplitudes. If the frequency band of the electrical circuit is not broad enough, many of the sinusoidal vibrations may be suppressed, which could then distort and broaden the pulses. To eliminate and weaken this type of effect, both the energy converter and amplifier must be of the broadband type. Of course, an overly-broad frequency band may cause more noise signals to be mixed in, so appropriate choices of upper and lower frequency limits and bandwidth must be made. The signals arriving from the detecting head include excited pulses of up to 100 V and return wave signals of only a few mV to several 10 mV. To prevent the amplifier from becoming blocked by the emitted pulses, a limiting circuit should be added between the detecting head and the preamplifier (Figure 3).

To make an ideal small dead zone flaw detector, besides the analysis outlined above, other measures should also

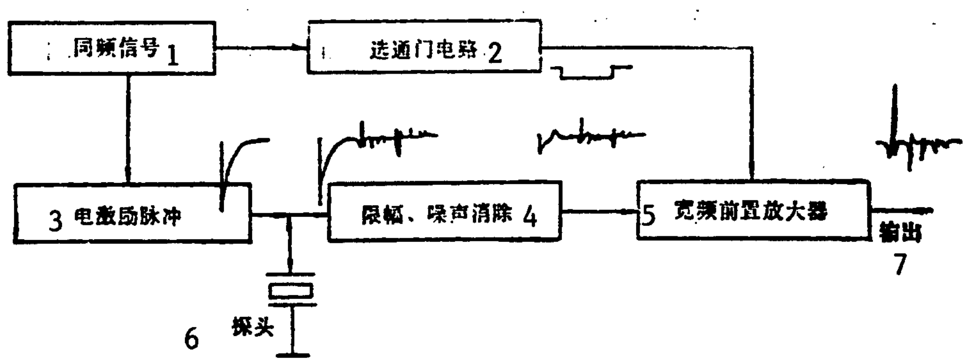

Figure 3. Broadband Ultrasonic Tester Emitting and Receiving Elements

Key: 1. Synchronized signals; 2. Gate circuit; 3. Electrically excited pulse; 4. Amplitude limitation, noise elimination; 5. Broadband preamplifier; 6. Detecting head; 7.Output

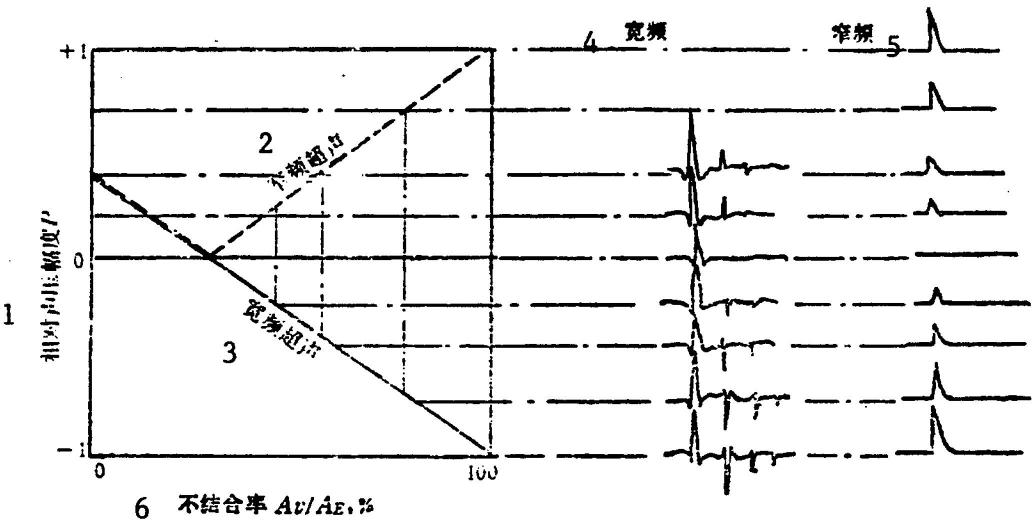

Figure 4. Aluminum-Clad Nuclear Core Element Return Wave Information Principle Analysis

Key: 1. Relative acoustic pressure amplitude P; 2. Narrowband ultrasound; 3. Broadband ultrasound; 4. Broadband; 5. Narrowband; 6. Non-bonding rate Av/Ae, in percent

be adopted to reduce noise interference. For example, focused detecting heads could be employed to spatially restrict interference reception and gate circuits can be used to eliminate much clutter interference from the time domain.

B. Analysis technology concerning return wave information

The characteristic parameters of ultrasonic waves include waveform, frequency, phase, amplitude, and so on. In regular ultrasonic industrial testing, only amplitude information is utilized. In ultrasonic testing of composite materials, however, the phase and amplitude of the return wave pulses are affected by differences in acoustic resistance, type and dimensions of defects, and so on at the boundary between two types of materials, and the frequency spectrum is affected by the thickness of these layers.

References [4-6] describe sound path analysis for the velocity of ultrasonic waves in laminar composite materials and extrapolation formulas for calculating the phase and amplitude of return wave pulses.

Acoustic pressure (p) is an algebraic quantity. Its absolute value represents the height of the return wave pulses and its sign represents the phase relationship of the return waves to the incident waves. When using ultrasonic waves to test composite materials, phase signals sometimes cannot be ignored. For example, in elements with Al cladding and cores with a high uranium content, the acoustic resistance of the cores will be significantly higher than the Al cladding (see Table 1). That is, if there is excellent bonding, there will be obvious return wave signals at the boundary of the cladding and core. The most fundamental distinction between bonded and non-bonded ultrasonic information is phase inversion. It is very difficult for industrial ultrasonic flaw detectors that use resonant wave testing to accurately diagnose bonding or non-bonding. Broadband phase and amplitude ultrasonic technology and instruments, however, can distinguish them with 100 percent accuracy (Figure 4). Similarly, this problem exists for titanium corrosion-resistant lining structures and so on which have widespread applications value. See references [4, 5] for details.

C. Precision thickness measurement and dimensions measurement functions

There are strict requirements on the thickness and external dimensions of cladding layers for nuclear fuel elements and certain other composite materials. During the ultrasonic testing process, they must be measured quickly and accurately and their category and warnings must be printed and output. The precision of thickness measurement by the instrument must be better than plus or minus 0.01 mm.

D. Ultrasonic detecting head automatic scanning and image display functions

To inspect for defects in fuel elements and electronic components, testing systems must have very high sensitivity (0.05 to 1 mm), which requires a precise and rapid C-scanning inspection drive system. Because testing signals must undergo computer processing and provide simulated C-type image displays, the scanning mechanism must be precisely synchronized with the computer and operate strictly according to sequence. The C-type image displays and B-type fault image displays plotted by the computer can enable direct observation of the size of laminar defects and their position.

III. Automatic Ultrasonic Testing System

The ultrasonic testing system is composed of a broadband phase-amplitude flaw detection thickness gauge, high-damping water-immersed focused detecting head and regulator, C-type stepping scanning inspection device, operating drive power source, intelligent interface circuit, microcomputer system, broad-line graphics printer, sample tank, and so on (Figure 5).

A. Ultrasonic testing system

The BS-305 broadband phase-amplitude ultrasonic flaw detection thickness gauge was successfully designed and developed according to fuel element inspection requirements. This instrument uses broadband and phase-amplitude ultrasonic technology for bonding analysis. The sound pulses are only about 50 ns wide, the diameter of the focal point of the water-immersed focused detecting head is 0.5 to 1 mm, and the sampling rate can be as much as 2 to 3 times per second. Inside the instrument there are leading and following dual gates that can be precisely adjusted, automatic boundary tracking, a coupling loss alarm, precision thickness gauge, and other circuits. Besides having a small dead zone, high resolution, return wave phase and amplitude information analysis, thickness measurement and classification, pulse counting and classification, and other functions, this device also has characteristics like ease of connection of output signals to the computer interface, and so on.

B. X-Y scanning inspection drive device

To achieve automatic inspection and defect distribution imaging, the ultrasonic sound beam must scan precisely according to sequence. When each emission is completed and after the samples are collected and the data are processed, the computer transmits a step command to the drive power source and the detecting head advances one step (0.2 to 0.5 mm) along the X axis. When scanning of one line is completed, the computer transmits a return scan command. After the detecting head advances one step along the Y axis, it begins the return scan. Scanning of a two-dimensional surface is achieved in this way. To obtain undistorted images, the scanning device must move in strict accordance with the computer commands, so the scanning device must have a very high precision of stepping distance and position repetition.

C. Computer system

After the signals coming from the ultrasound device are preprocessed by the interface circuit, they are transmitted to the computer for internal operation and diagnosis processing. Then, the results are coded and modulated and displayed on the CRT screen as points of different brightness (light meaning bonded and dark meaning non-bonded). Finally, a proportional image of the sample is obtained. To ensure the precision of the display and the speed of data processing, everything from the emission of the ultrasonic wave to data collection and processing, display and storage, and movement of the scanning device must be carried out under a strict computer-controlled time sequence.

IV. Testing Experiment Results

The successfully researched broadband ultrasonic testing technology and its instrument system have been used successfully in testing of bonding quality in aluminum-clad uranium elements, dispersed-type fuel core plate-shaped elements, explosive composite heat exchangers, various types of metallic transitional segments, corrosion-resistant linings, and so on and in precision measurement of dimensions, planeness, and so on. Figures 6 and 7 show the C-scanning image display and typical ultrasonic return wave waveforms. The experimental and production results show that:

1. There was very good conformity of the ultrasonic wave waveforms and the theoretical waveforms plotted through principle analysis and the dissected metallographic observations were consistent with the ultrasonic

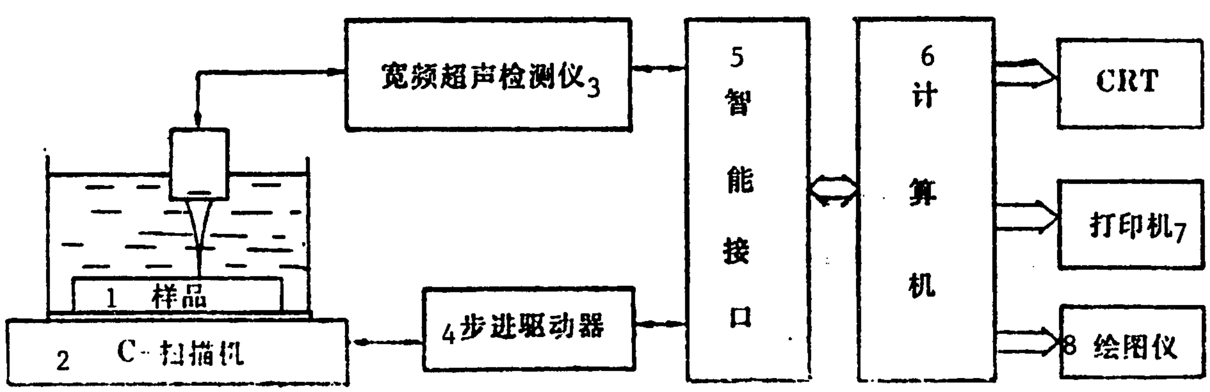

Figure 5. Block Diagram of Computer Information Ultrasonic System

Key: 1. Sample; 2. C-scanner; 3. Broadband ultrasonic tester; 4. Stepping drive; 5. Intelligent interface; 6. Computer; 7. Printer; 8. Plotter tests. The experiments confirmed that the ultrasonic instruments, drive, and display systems that were developed were accurate and reliable.

2. The new broadband ultrasonic technology has high resolution as well as phase, amplitude, and frequency information analysis functions that have excellent adaptability for testing composite materials and unusual structures. In conjunction with the computer system, it can achieve digitization, imaging, intelligent diagnosis and classification, printing and storage, and other functions.

3. Because the water-immersed focused detecting head has microcomputer program control of stepping scanning and utilizes boundary tracking and other technology, it guarantees excellent dynamic testing reliability and has advantages like high scan precision, good repeatability, easily regulated scanning parameters, and so on.

In the research and experiment work, I received substantial support and cooperation from Li Huifeng [2621 1979 0023], Zhai Zhilin [5049 4460 2651], Zhang Chengzuo [1728 2110 0146], Ti Zhongxin [6696 1813 0207], Zhang Zhiyi [1728 1807 3015], Liu Jinjiang [0491 6855 3068], Shi Shulian [2514 3219 5571], and other comrades, and I would like to express my special gratitude here.

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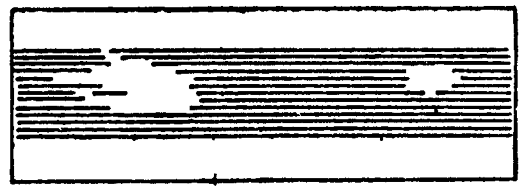

Figure 6. C-Scan Image Display

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[5] He Fengqi, He Kexue Yu Gongcheng [Nuclear Science and Engineering], Vol 6, No 4, 1986 p 360.

[6] He Fengqi, "Computer Imaging Broadband Ultrasonic Testing of Monolithic Capacitors", 12th World Non-Destructive Testing Conference, Amsterdam, Holland, April 1989.

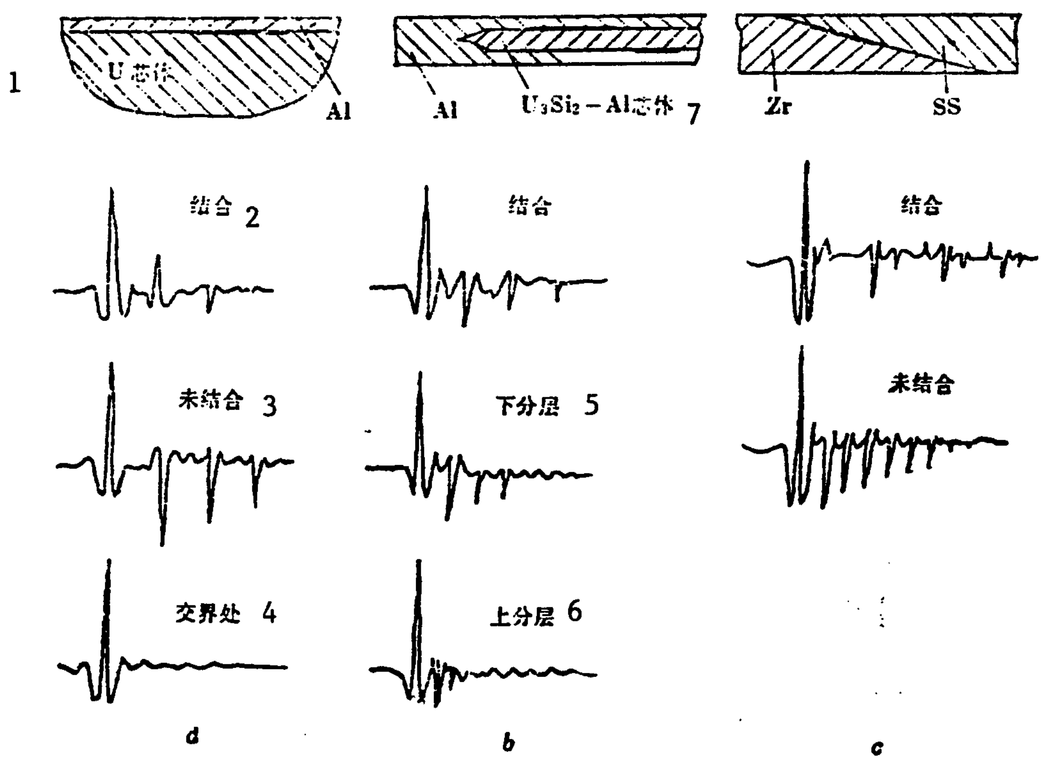


Figure 7. Typical Ultrasonic Return Wave Waveform

Key: a. Low-enrichment uranium element; b. MLC capacitor; c. Zr-SS transitional segment; 1. Uranium core; 2. Bonded; 3. Non-bonded; 4. Boundary region; 5. Lower sub-layer; 6. Upper sub-layer; 7. U_3Si_2-Al core

Update on 5MW Low Temperature Heat Supply Reactor

926B0006A Beijing RENMIN RIBAO in Chinese 7 Sep 91 p 1

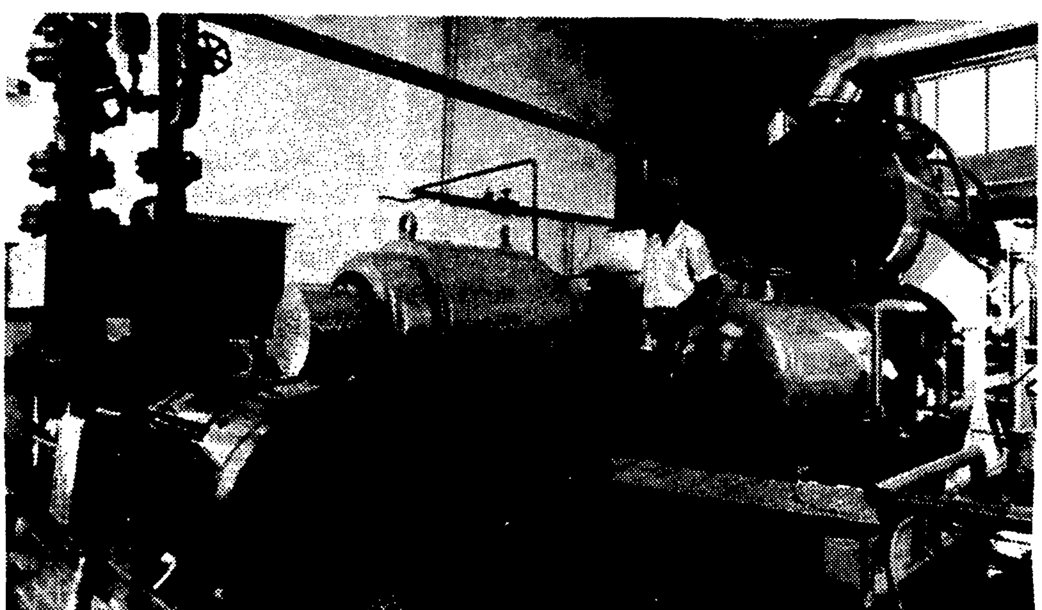
[Article by reporter Wen Hongyan [3306 4767 1750]: "Combined Heat and Power Supply at First Low-Temperature Nuclear Heat-Supply Reactor, China Opens New Route to Peaceful Use of Nuclear Energy"]

[Text] After China's successful development of its first 5MW low- temperature nuclear heat supply reactor during the Seventh 5-Year Plan, a major breakthrough has been made in comprehensive utilization of the low-temperature nuclear heat supply reactor. The 5MW low-temperature nuclear heat supply reactor, jointly undertaken by the Qinghua University Nuclear Energy Technology Design and Research Academy, Wuhan Chang Jiang Motive Power Company, and Qinghua University Thermal Energy Engineering Department, was recently operated successfully for combined heat and power supply and the nuclear power it generated entered the power grid.

Combined heat and power supply by the 5MW low-temperature nuclear heat supply reactor was a part of key state attacks on S&T problems during the Eighth 5- Year Plan. This special topic began the design in January 1990 and completed installation and debugging on 10 August 1991. It took only 20 months to achieve 72 hours of combined heat and power supply power operation. The successful operation for combined heat and power supply of the low-temperature nuclear heat supply reactor has laid a technical foundation for combined heat and power supply by large commercial nuclear heat supply reactors.

Combined heat and power supply by the low-temperature nuclear heat supply reactor uses the heat released by nuclear fission of the reactor fuel to produce low-temperature steam that generates electricity by driving a steam turbine generator and then uses the excess heat from the condensed water from the steam turbine to supply heat. A four-loop configuration used for the heat transfer prevents radioactive matter from entering the steam loops and the heat grid system, which absolutely ensures the safety of users.

At present, extremely few countries are using nuclear power plants for combined heat and power supply and the reason is the safety requirements of the nuclear power plants. They must be built distant from urban residential areas, which makes heat supply uneconomical. The low-temperature nuclear heat supply reactor that China has developed, however, has inherent safety so it can be built near urban residential areas. Moreover, because the output value from generating power is far greater than heat supply, combined heat and power supply can further raise the economic benefits from low-temperature nuclear heat supply reactors by 20 to 30 percent, which gives them even greater advantages compared to coal-fired boilers.



Combined heat and power supply operation of the 5MW low-temperature nuclear heat supply reactor, a state project to attack key S&T problems during the Eighth 5-Year Plan, was recently successful at the Qinghua University Nuclear Energy Technology Design and Research Academy. This photo shows technical personnel inspecting the operating conditions of the low- pressure steam turbine generator. Photo by XINHUA Agency reporter Wang Chengxuan [3769 0701 6693].

Qinghua University's Nuclear Energy Program Highlighted

926B0006B Beijing RENMIN RIBAO OVERSEAS EDITION in Chinese 17 Sep 91 pp 1, 4

[Article by RENMIN RIBAO OVERSEAS EDITION reporter Kong Xiaoning [1313 2556 1337]: "Tracks of the Climber: A Visit to Qinghua University's Nuclear Energy Technology Design and Research Academy"]

[Text] During the last part of August 1991, in the State Seventh 5-Year Plan Attacks on Key S&T Problems Achievements Exhibition Hall, there was usually a large crowd of viewers around the 5MW low-temperature nuclear heat supply reactor mockup. This was the first integrated natural circulation encased heat supply reactor in the world to be placed into operation, and it is the first reactor in human history to apply a new type of hydraulic control rod. Its appearance in the world is an indication that China, which began working in the nuclear field several decades later than foreign countries, has today climbed up to the peak of world S&T in the area of nuclear heat supply technology.

I. The Spirit of "Number 200"

The tracks of the climber thickly dot the foot of Cang Shan in Changping County in the Beijing suburbs. "Number 200", the Qinghua University Nuclear Energy Technology Institute (its named was changed to a Design and Research Academy not long ago), is located here.

In the early 1960's, several young people who had just walked out of the doors of their universities gathered there. At that time, the institute director was 36 years old and the average age of the employees was 23 and ½ years. They dedicated their bodies and worked without food or sleep in making their own vow to "use our own hands to create the springtime of the motherland's atomic energy industry". Eventually, the screened experimental nuclear reactor designed and built by China itself was completed in 1964.

In the 1970's, the research personnel who had already entered middle age made an urgent request to "dedicate themselves to the service of their country by building a reactor" Still, they were subjected to continual interference that turned their aspirations into thin air.

Finally, with the arrival of the springtime of science in the 1980's, people's enthusiasm at "Number 200" to build reactors flared up again. They knew deeply that in China large amounts of coal are consumed to provide heat and that in a medium-sized city, the amount of coal consumed for heating during the winter took over 10,000 coal cars to transport and that it also polluted the environment. If nuclear heat supplies were substituted for coal heat supplies, however, only 2 tons of nuclear fuel would be required each winter, and it would not cause pollution, so this was a fundamental way to solve the problem.

The people at "Number 200" spent an entire year doing systematic survey research and program comparisons for all types of nuclear heat supply reactors in foreign countries. In the end, they decided that developing an integrated natural circulation encased nuclear heat supply reactor would be their primary direction of attack. At the same time, they got busy conducting experiments with three-loop low-temperature nuclear heat supply in their existing screening experiments and reactor and used practice to study and explore nuclear powered heat supply technology. Relying on their scientific foundation, while fighting to establish their research project, they immediately received the attention and support of relevant leadership departments of the state and this research project was very quickly included in state projects to attack key problems.

During the busiest phase of development work, deputy senior engineer Dong Duo [5516 6995], the person with primary technical responsibility, was unfortunately discovered to be suffering from parotid cancer and did not recover his health after two operations, but he still returned to his work post. His colleagues repeatedly warned him to be concerned with his rest, but he always answered by saying "if I work, it doesn't mean with certainty that I will die sooner, and if I rest, it isn't certain that I will live longer. The party and the state have trained me and if during the years I am alive I can complete China's first low-temperature nuclear heat supply reactor, that is my greatest aspiration."

From the time that the design of the 5MW low-temperature nuclear heat supply reactor began in September until sustained full-power operation of the heat supply reactor was achieved smoothly on 19 December 1989, over 100 research personnel gave up so many of their days off and holidays during 5 years of struggle that it was even hard for them to count them accurately. In the reactor building, which had no windows and was a single color everywhere, this verse often appeared: "what is the month and day now" someone would suddenly ask those around them when there was a break in the work. After much thought, they would shake their heads and finally laugh as a group.

Through difficulties and hardships, they eventually completed it. In the unique device that the people of "Number 200" eventually developed themselves, neutrons were used to fiercely bombard the atomic nucleus of uranium 235 to form violent nuclear fission, which released huge amounts of heat.

II. Collective Assault

The 5MW low-temperature nuclear heat supply reactor can be used as a large commercial experimental reactor. The sparrow may be small, but it has all the vital organs." Its body contains 25 subsystems and the nuclear core alone is composed of over 6,000 parts and components and there are several 10,000 connectors for the control system on the control console. Moreover, there are no other nuclear heat supply reactors like this one that have been placed into operation in China or foreign countries. When one is in a place without a path, they must cut their own path.

The people of "Number 200" have confidence in victory. The reason is that they have advantages formed through long periods of being involved in incisive scientific research: they can pool the wisdom and efforts of everyone and make a collective assault.

They divided up the technically complex systems and projects that required a huge amount of work and the 10-plus research offices in the academy and the cooperating units outside the academy assumed joint responsibility.

When the Reactor Physics Research Office received the research task for "physical startup", they knew that this would be a difficult burden. What they faced was an entirely new project. What could they do? They began by preparing their own experiment program and the research office continually held discussion meetings. At the meetings, one would suggest a program and another would offer an opinion. When one discussion was not successful, they discussed it again until they finally decided upon a rational program. In this way, from the academy director to the research personnel and on down to the workers in the metal working shops, everyone tried in every possible way to use their skills and intelligence to build the reactor. In the collective, people formed relationships of mutual assistance and eventually their intellectual advantages took shape.

During the early period of reactor construction, the Thermal Hydraulics Research Office received the low-temperature reactor thermal hydraulics experiments and other tasks. These involved auxiliary attacks, so they could not produce many theses and there were also few bonuses. If they thought about continued work on horizontal technological development on the basis of previous research, they could produce high-level research articles and could fight for even higher economic incomes. When an acute contradiction occurred between local interests and overall interests, a conviction stirred up a wind in their minds: "a solid track must be laid out for a 100 meter dash, and we are laying the stones for the track". They worked with all their effort to participate in developing items for the low-temperature reactor, an item urgently needed by the state, and completed their tasks satisfactorily.

III. Students Become Competing Opponents

In March 1984, specialists from the Power Plant League of Germany's Siemens Company came to Beijing for a conference to introduce the concept of a new type of hydraulic control rod for nuclear reactors. Control rods are components in the nuclear core that control reactor power and achieve safe reactor shutdown, and they are one of the keys to reactor construction. Research personnel from the Qinghua Nuclear Energy Technology Design and Research Academy only felt that they were somewhat in the dark listening at the meeting. Not long afterward, however, Chinese nuclear power experts gained a clear understanding of the principles and advantages of these new control rods and decided to use them in the 5MW low-temperature nuclear heat supply reactor.

After another one-half year of digesting, they proposed their own concept for a paired-opening hydraulic stepping drive that was different from those in foreign countries. By the summer of 1985, the birth of an entirely new type of paired-opening hydraulic stepping cylinder was announced. Regardless of the type of accident such as a loss of pressure, power outage, ruptured pipe, and so on, this new type of hydraulic control rod drive device could simply rely on its own weight to drop into the reactor core and shut down the nuclear fission, thus ensuring that there would be no chance of a reactor failure.

In January 1990, the German specialists paid another visit. After hearing a description, one of the specialists said emotionally "we commend your accomplishments but at the same time we feel regrets because we were the first to suggest the concept for this type of control rod. We studied it for 10 years but up to today they have been stalled in the laboratory research stage, whereas you have converted them into a reality in a reactor." Dr. (Fulai'e), a world-renowned nuclear power expert also sent a congratulatory telegram that was full of warmth: "your success with the 5MW low-temperature reactor is not only an important milepost in the world's development of nuclear heat supply reactors, but is also an important milepost in solving the pollution problems that exist in China and many other countries."

On 2 September 1991, at the State Seventh 5-Year Plan Attacks on Key S&T Problems Summary Commendation Conference in the Great Hall of the People, the low-temperature nuclear heat supply reactor again received a commendation from the CPC Central Committee and the State Council. Looking back at the course they had just taken, Qinghua Nuclear Energy Technology Design and Research Academy director Wang Dazhong [3769 1129 0022] said: "making use of the favorable conditions of opening up to the outside world and studying advanced experiences in foreign countries have enabled us to stand at the peak of nuclear technology by climbing on the shoulders of foreigners. Even more important is that we have not copied anything from foreigners in our international exchanges. Instead, we have resolutely relied mainly on our own efforts, integrated with China's national conditions, and taken China's own route."

Photo caption: This photo shows Wang Dazhong (left), chief specialist in the State Commission of Specialists in the High Technology and Energy Resources Fields and director of the Qinghua University Nuclear Energy Technology Design and Research Academy, with other specialists carefully inspecting the nuclear reactor turbine flowmeter and hydraulic control rod drive device. Photo by XINHUA Agency reporter Wang Chengxuan [3769 0701 6693].

Measures for Energy Conservation Discussed

Greater Efficiency, Reorganization Urged

926B0016A Beijing ZHONGGUO NENGYUAN [ENERGY OF CHINA] in Chinese No 9, 25 Sep 91 pp 1-3

[Article by Wang Zhuokun [3769 0587 2492] and Shao Yi [6730 3015] of the Ministry of Energy Resources Energy Conservation Department: "Some Trivial Views on Energy Conservation Measures"]

[Text] The energy resource industry is a basic industry and China has consistently made the energy resource industry one of its strategic foci in economic development.

In the area of energy resource utilization, we have always adhered to the principle of "combining development with conservation". Major efforts to conserve electric power, oil, and coal, to extend heat and power cogeneration, to develop surplus heat utilization, to continue implementing the policy of substituting coal for oil, and to strive for higher energy resource utilization rates are the focus and important technical measures for work during the 1990's.

I. Raising Energy Resource Utilization Rates

China has extremely severe shortages of energy resources, but there are also extremely severe phenomena of irrational utilization and waste of energy resources. Calculated according to product variety, China's unit consumption is 30 to 90 percent higher than in the developed nations. Calculated according to output value, our energy consumption is 3 to 4 times higher than the developed nations. Projections indicate that we will experience a shortage of more than 100 million tons of standard coal in energy resource supplies by 1995 and more than 300 million tons by the year 2000. Energy resource development involves large investments and takes long periods, and it requires the corresponding transport capacity guarantees. Thus, substantial increases in a short period of time are difficult. Energy conservation is direct and produces quick results, and it provides rather good economic and social benefits. It is an important way to alleviate China's shortages of energy resources.

A. Reduce the coal consumed to generate electricity

The total capacity of China's thermal power generators at present is 100,000MW and they consume 290 million tons of coal annually. In 1990, average consumption of standard coal in China to supply power was 427 grams/kWh, about 100 grams higher than advanced world levels. Calculated on the basis of yearly power output of 500 billion kWh, we are burning an additional 50 million tons of standard coal each year. By the end of this century, our installed generating capacity and power output will double. Calculated on the basis of current coal consumption, we will burn an additional 140 million tons of raw coal each year. According to Ministry of Energy Resources plans, by the end of this century the amount of coal consumed per kWh of electricity must be reduced by 60 to 70 grams and coal consumption must be reduced by 5 grams during 1990. The primary measures for reducing coal consumption in power plants are:

1. Install high parameter, large capacity generators. Consumption of standard coal to supply electricity in newly-built generators in the future must not exceed 330 grams. It must not exceed 270 to 280 grams in heat-supply generators.

2. Improve low efficiency generators. Our 20,000MW of moderate and low- pressure generators at present consume 600 to 700 grams of coal and some consume as much as a kilogram or so. We should replace these generators with high parameter, large capacity generators. Those with somewhat better equipment situations and which have users of heat can be transformed into heat supply generators. We plan to abandon 5,000MW during the Eighth 5-Year Plan and use the coal saved to build large generators or heat supply generators. Among them, some boilers can be converted into or replaced with circulating fluidized bed boilers and used to increase the thermal efficiency of boilers. At the same time, we can expand their adaptability to coal varieties and meet the need to reduce sulfur dioxide discharges.

3. Improve some of our existing high-pressure generators. At present, we have a total of 60,000MW in 50MW, 100MW, 125MW, and 200MW generators. They also consume rather high amounts of coal and should be upgraded to reduce their coal consumption.

B. Improve existing industrial boilers and industrial kilns and ovens

Energy consumption by industrial boilers and industrial kilns and ovens accounts for about 60 percent of China's total energy output, so they are one of the focal points for social energy conservation. China now has 400,000 industrial boilers that produce 800,000 tons of steam/hour and consume more than 300 million tons of raw coal annually, greater than the amount of coal consumed by power plants. The thermal efficiency of these boilers is generally only about 60 percent and some are even lower. The direction for upgrading them should be to work on heat and power cogeneration and centralized heat supply. The thermal efficiency of condensed steam power plant boilers at present is more than 90 percent, but the overall efficiency of generators is just 38 to 39 percent. Most of the heat is carried away by the cooled water from the steam turbines, so there are major losses at the cool end. Heat and power cogeneration and centralized heat supplies can greatly increase the thermal efficiency of generators and they can be used to replace small boilers that consume large amounts of energy and cause considerable pollution. Their advantages are gradually receiving public recognition and they have become a world trend. The thermal efficiency of small capacity circulating fluidized bed boilers at present can be greater than 80 percent and they can be used to replace low efficiency industrial boilers in places not reached by large heat grids.

China now has 114,000 industrial kilns and ovens that consume 200 million tons of standard coal a year, with some 50 million tons being used solely for the baking of bricks. The thermal efficiency of industrial kilns and ovens is even lower and their thermal energy utilization rates are 20 percent lower than the levels that can be attained at present, which is equivalent to consuming an additional 40 million tons of standard coal each year.

C. Reduce self-utilization rates in coal mines and oil fields

Average self-utilization of coal in China's unified distribution coal mines at present is 396 tons/10,000 tons. Among them, the average is 303 tons/10,000 tons for coal mines inside Shanhaiguan under the jurisdiction of the China Unified Distribution Coal Mine Corporation. Oil fields have a self- utilization rate of 1.99 percent and a loss rate of 1.79 percent. These indices are considerably worse than advanced world levels. In the future, we should make a major effort to develop coal conservation and oil conservation work at coal mines and oil fields. Building coal gangue power plants in mining regions, adopting circulating fluidized bed boilers, and achieving heat and power cogeneration and centralized heat supply can reduce the self-utilization of coal in mining regions and replace some of the good coal used to generate power, so the coal conservation benefits would be substantial. The capacity of coal gangue generators China now has is rather small, the power plants are rather small in scale, and they are developing slowly. By the end of 1990, only 27 coal gangue power plants with a total installed generating capacity of 260MW had gone into operation. Building coal gangue power plants near coal dressing plants in mining regions is a development direction for the future.

D. Do good social electricity conservation

There is waste to varying degrees in all types of electricity use by society. For power-using equipment, the more prominent problems are with power use by blowers, water pumps, and lighting. The operating efficiency of all of China's blowers and water pumps is about 20 percent lower than similar products in the industrially developed countries and they are consuming an additional 30 billion kWh of electricity each year.

Power use for illumination accounts for 8 percent of total power output, equal to 45 billion kWh a year. In general, incandescent lamps (first-generation light sources) and fluorescent lamps (second-generation light sources) are most commonly used for lighting and incandescent lamps in particular emit large amounts of heat radiation and have low optical efficiency. In addition, there is usually no control equipment for lighting and there is considerable waste of electricity. At present, some localities are using third-generation energy-saving lighting sources like high-voltage sodium lamps, rare earth trichromatic fluorescent lamps, metallic fontanelle compound lamps, and so on that greatly reduce electricity consumption. If they can be extended over a large area, the electricity conservation benefits could reach 50 percent.

II. Improve the Energy Resource Structure

China's present energy resource structure is not very rational and this has created waste of energy resources. Improving the energy resource structure is a future objective and direction.

A. Gradually increase electric power as a proportion of energy resource consumption

Electric power as a proportion of energy resource consumption can to a certain extent reflect energy resource utilization rates and technical levels. The proportion of China's primary energy resources used at present to generate electricity is 23 percent, while this figure is 35 to 45 percent in the developed countries. Within coal consumption, the proportion at present that is converted into secondary energy resources including electric power, coal gas, and coke is 35 percent, including 27 percent that is converted to electric power. This is far smaller than the proportion in the developed countries.

Energy consumed as electric power that accounts for a large proportion of the eventual consumption of energy resources indicates a high degree of electrification and high rates of energy resource utilization. It is also conducive to centralized control and improvement of pollution discharges. China's plans call for 29 percent of total coal output to be consumed by power plants in 1995 and 33 percent in 2000. This means that over half of future increases in coal output will be used to generate electricity.

B. Accelerate hydropower construction

China has abundant hydropower, wind power, solar power, geothermal, and other energy resources. Hydropower resources are renewable resources, which means that they can be used repeatedly. Wind power and solar power are inexhaustible energy resources that should be fully utilized.

China is the world's leader in hydropower resources but we have only developed 9 percent of them so far and hydroelectric power accounts for less than 20 percent of China's total electric power output. The state has been very concerned about developing hydropower and the total hydropower installed generating capacity will reach 80,000MW within the next 7 years, double the present amount. This is an extremely significant and important decision for the strategic deployment of energy resources, reducing the pressures on coal production and transportation, environmental protection and comprehensive utilization, and safe and economical operation of power grids.

C. Accelerate the development of nuclear power

Nuclear power accounts for a substantial proportion in many countries and it is necessary to build atomic energy power plants at load centers that lack hydropower resources and mineral fuels. China began late in developing nuclear power and now has two nuclear power plants under construction. Daya Bay Nuclear Power Plant in Shenzhen, Guangdong will have two imported 900MW generators that will begin generating electricity at the end of 1992 and 1993, respectively. Qinshan Power Plant in Zhejiang is now installing a Chinese-made generator that may produce power by the end of 1991. The second phase of the project will involve two 600MW Chinese-made generators.

Over the next 10 years, plans call for the scale of construction starts for nuclear power plants to be 11,000MW and we will strive to gain an understanding of the manufacturing technology for 600MW equipment and achieve a shift to domestic production of nuclear power equipment before the end of this century.

D. Improve the quality of coal combustion in thermal power plants

To reduce environmental pollution and transportation pressures, besides building pit-mouth power plants, there should also be specific requirements for the ash and sulfur content of coal. Coal with a high ash content must be washed before it is shipped out and the coal gangue must be dressed out. The average yearly ash content of the coal now used in China's thermal power plants is 29 percent, which is rather high and should be reduced as quickly as possible.

As for the sulfur content in coal combustion, given environmental protection requirements and China's financial situation, we should adopt a method that gives preference to low sulfur content high heat value coal, and we should give preference to supplying cities and enterprises that discharge large amounts of smoke. The Shenfu-Dongsheng coal field, for example, is one of the world's superior quality huge coal fields and has a heat value of 290,000 kilocalories/kg, an ash content of 6 to 8 percent, and a sulfur content of 0.3 percent, so it should receive preference in development and utilization.

Coal Industry

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[Article by the China Unified Distribution Coal Mine Corporation Energy Conservation Office: "Deal with Concrete Matters Relating to Work and Innovate, Open Up and Advance, Push Energy Conservation Work to a New Level During the Eighth 5-Year Plan"]

[Text]

I. Major Achievements in Energy Conservation Work During the Seventh 5- Year Plan

1. A significant reduction in energy consumption per unit product and per unit product value. During the Seventh 5-Year Plan, average total energy consumption per 10,000 yuan in output value was 13.14 tons of standard coal, a reduction of 3.88 percent from the figure of 13.67 tons of standard coal during the Sixth 5-Year Plan, so about 1.59 million tons of coal was conserved over 5 years.

Self-utilization of coal to produce 10,000 tons of coal averaged 350 tons during the Seventh 5-Year Plan, a reduction of 10 tons from the average during the Sixth 5-Year Plan, so a total of about 1.486 million tons of coal going for self-utilization was conserved over 5 years.

Average actual total electricity consumption per ton of raw coal during the Seventh 5-Year Plan was 37.08 kwh, a reduction of 0.65 kWh from the Seventh [as published] 5-Year Plan, so 966 million kWh of electricity was conserved over 5 years.

Actual total energy consumption to produce 10,000 tons of raw coal during the Seventh 5-Year Plan was 166.22 tons of standard coal, an increase of 9.32 tons from the average during the Sixth 5-Year Plan and an average yearly increase of 1.2 percent, which was slightly lower than the average yearly rate of increase during the Sixth 5-Year Plan.

2. Several energy conservation capital construction projects and energy conservation technical upgrading projects were completed. In a situation of relatively short capital, 231 energy conservation capital construction projects were completed, 457 low-efficiency boilers were replaced or upgraded calculated at 1,324 tons of steam per hour, and more than 23,000 pieces of high energy consuming electromechanical equipment was replaced or upgraded, forming a yearly energy conservation capacity of 2.152 million tons of standard coal.

3. Active extension of a total of 18 energy-saving new technologies, new techniques, new materials, and new equipment items adapted to the characteristics of coal mines. Examples include a changeover of primary fan blowers to warped blades and guide blades, water extraction by water pumps without bottom valves, controlled silicon and hydraulic coupler speed regulators, random control of belt conveyors in mineshafts, upgrading front and rear arches of boilers and associated ventilation equipment, high-efficiency aluminum silicate insulation materials, upgrading magnetic slot mud with Jo-type electrical machinery, and so on.

4. Developing and studying several new energy-saving products at advanced international levels. Over 10 scientific research achievements like a series of high-efficiency heat exchange component products, ZJ series sludge pumps, waterproof coal balls for gasification, 1.6 meter two-section gasification ovens, energy-saving fans, energy-saving explosion-proof lamps for use in mines, high energy-saving honeycomb coal and stoves, and so on have been deeply welcomed by users.

5. Formulation of several energy conservation methods and provisions. We formulated 10 types of methods and provisions including implementation methods for the coal industry to adhere to the "State Council Provisional Regulations for Energy Conservation Management"; provisional methods for grade raising (and setting) in coal industry energy conservation management; energy resource statistical methods for coal enterprises; energy equilibrium implementation methods for coal enterprises; energy equilibrium technical inspection and acceptance methods for coal enterprises; certain provisions for coal energy conservation, coal enterprise energy conservation management grade raising (and setting) methods, and so on. The implementation of these methods and provisions has gradually moved coal mine energy conservation work onto a scientific and standardized track.

6. Reinforced energy conservation technology training work. We organized 23 energy conservation technology training classes of various types at several levels and trained over 1,200 people, raised the management levels and technical levels of energy conservation management personnel, and filled out energy conservation forces. In addition, we completed energy equilibrium measurement work in 250 enterprises, clarified the energy resource structure, distribution, and flow direction of these enterprises, analyzed energy consumption levels in enterprises and the energy consumption situation for their primary energy consuming equipment, and searched out energy conservation locations and energy conservation potential in enterprises. This provided a more scientific foundation for raising energy resource management levels and energy resource utilization rates in enterprises, increasing the economic benefits of enterprises, and formulating energy conservation technical upgrading programs.

7. Several model energy conservation enterprises, energy conservation advanced collectives, and energy conservation advanced individuals have appeared. Five coal enterprises have been named national advanced water conservation units, seven have been named corporation model energy conservation enterprises, and there are 29 advanced energy conservation collectives and 59 advanced energy conservation workers.

II. Preliminary Ideas for Energy Conservation During the Eighth 5-Year Plan and Energy Conservation Objectives Over the Next 10 Years

To ensure the needs of national economic and social development, the basic ideas for the China Unified Distribution Coal Mine Corporation in the Eighth 5-Year Plan and 10-year program are that the corporation's raw coal output should reach 396 million tons in 1995 and 477.3 million tons in 2000. Estimates indicate that energy resource consumption in the China Unified Distribution Coal Mine Corporation will be 16.67 million tons of standard coal in 1995 and 20.33 million tons of standard coal in 2000. Energy resource production departments are major consumers of energy and they have acute energy shortages. For this reason, during the Eighth 5-Year Plan and the next 10 years, the tasks for energy resource development and energy resource conservation are even more arduous than during the Sixth 5-Year Plan and Seventh 5-Year Plan in that they must complete the state's raw coal production plans, do good coal processing, provide users with coal products that meet specifications, create the conditions for social energy conservation, transportation conservation, and improvement of the atmospheric environment, do good energy conservation and consumption reduction work in the coal production and processing processes, and try to consume fewer energy resources while producing more coal products. For these reasons, the Eighth 5-Year Plan Energy Conservation Plan and 10-Year Energy Conservation Goals of Struggle were formulated.

A. Primary energy conservation indices

1. Total energy conservation during the Eighth 5-Year Plan must be 1.67 million tons of standard coal, an average yearly savings of about 334,000 tons of standard coal and a yearly energy conservation rate of 2.2 percent. During the Ninth 5-Year Plan, there should be energy conservation of 1.89 million tons of standard coal, which is a yearly conservation average of 378,000 tons of standard coal.

2. During the Eighth 5-Year Plan, self-utilization of coal to produce 10,000 tons of raw coal must be reduced from 305 tons in 1990 to 295 tons in 1995. This would mean conserving 1.52 million tons of self-utilization coal over 5 years, an annual average coal conservation of 304,000 tons. This should be reduced to 285 tons during the Ninth 5-Year Plan, which would conserve 2.1 million tons of coal, an average yearly coal savings of 420,000 tons.

3. Conserve 1.25 billion kWh of electric power during the Eighth 5-Year Plan, an average yearly power savings of 250 million kWh. Conserve 1.45 billion kWh of electric power during the Ninth 5-Year Plan, an average yearly savings of 290 million kWh.

4. Total energy consumption per 10,000 in value of output should be reduced from 12.9 tons of standard coal in 1990 to 11.4 tons of standard coal in 1995, an average yearly energy savings of 2.5 percent, and to 10.5 tons of standard coal in 2000.

5. Using the 1990 figure of 178.74 tons of standard coal as the total amount of energy consumed to produce 10,000 tons of standard coal, the average annual rate of growth by 1995 should not exceed 1.5 percent and the rate of growth must not exceed 1 percent by 2000.

The proposal of these goals of struggle was made in consideration of the requirements of the overall objectives for national economic and social development and in consideration of actual conditions in coal enterprises, and they can be achieved with some effort. Because our energy conservation work began rather late, our technical foundation is weak and we lag considerably behind advanced levels in China and foreign countries in the areas of energy resource management and energy resource utilization. Statistics show that the energy resource utilization rate for unified distribution coal mines is just 22 percent, whereas the average energy resource utilization rate for China as a whole is 32 percent and advanced nations usually have energy resource utilization rates of 50 to 60 percent. For comparable industries, energy resource consumption in unified distribution coal mines per 10,000 yuan in value of output is 6.45 tons of standard coal but the average level for China is 4.72 tons of standard coal. The main reasons for the low energy resource utilization rates and the high energy consumption per value of output and unit product in coal enterprises are:

Backward energy resource utilization patterns. The coal savings from a shift from steam heating to hot water heating could exceed 30 percent. At present, hot water heating in coal mines accounts for less than 20 percent. The China Unified Distribution Coal Mine Corporation uses about 4 million tons of coal annually for heating. If most of them were to shift to water heating, they could conserve more than 400,000 tons of coal a year.

Centralized heat supply and connected heat supplies could bring coal savings of about 30 percent. Heat supplies in mining regions at present are still scattered small clusters of stoves and less than one-fourth of the area has central heating.

Coal mines have much high energy consuming equipment of many types that is outdated. Surveys indicate that over one-third of the large-scale fixed equipment at unified distribution coal mines is a mixture of outdated equipment that is technically backward and of low efficiency. Some of the equipment in old mining regions that was placed into operation during the 1930's is still in use today. The operational efficiency of this mixture of outdated equipment is 10 to 20 percent lower than new equipment. Upgrading or replacing it could conserve more than 500 million kWh of electricity each year. Most mine gas, coal gangue, coal slurry, and other low heat value fuels are still not being fully utilized, so it is apparent that there is great potential for energy conservation in coal enterprises and that there are still a substantial number of energy conservation tasks.

B. The focus of energy conservation work during the Eighth 5-Year Plan

Energy conservation work during the Eighth 5-Year Plan should use the "Provisional Regulations for Energy Resource Conservation Management" as its yardstick and the "10-Year Plan for National Economic and Social Development and Eighth 5-Year Plan Program" as a foundation for implementing the "(Trial) Provisions for Coal Mine Energy Resource Conservation" (abbreviated as the "Provisions"), adhere to the principle of "a combined focus on development and conservation", handle more matters, be concerned with actual results, and do good work in the following areas.

1. Use adherence to the "Provisions" as the core, strengthen basic energy conservation management work, increase understanding of energy conservation.

Conscientiously adhere to the "Provisions", make a comprehensive examination of implementation conditions during the previous year in the first quarter of each year, write summary reports, and send them to the corporation's Energy Conservation Office. The corporation's Energy Conservation Office will organize a sample survey and report on conditions to promote comprehensive implementation of the "Provisions".

Reinforce leadership, perfect the administrative system. All units should foster the functional role of energy conservation organs, and energy conservation organs should have duties, responsibilities, and rights. Systems of regulations should be complete and the management system should be perfected. Those with enthusiasm for energy conservation work, who understand specialized knowledge, and who are capable of doing the work should be put to work in energy conservation organs. New construction, expansion, and technical upgrading projects should undergo inspection and joint examination by energy conservation organs. Projects should do the "three things together" in energy conservation measures and avoid starting new projects by blinding selecting low efficiency and high energy consuming equipment that will require replacement or upgrading after it is completed, creating even greater waste.

Reinforce basic work in energy conservation management. We should focus mainly on work in these areas during the Eighth 5-Year Plan.

a. Perfect the deployment of energy resource measurement instruments, fill in holes in enterprises that have already obtained measurement certifications during the Eighth 5-Year Plan, further perfect and improve them, and raise their measurement grades one step. For enterprises that have not obtained measurement certifications, make an effort to enter them into a grade and firmly transform the situation of imperfect measurement of energy resource consumption. By 1995, most enterprises should obtain measurement certifications of grade 3 and higher and we should strive for about a 60 percent gauge installation rate for explosion-proof gauges used in mineshafts. New construction, expansion, and technical upgrading projects should be provided with energy resource management instruments and they should be designed, built, and placed into operation simultaneously with the projects.

b. Do good work on energy resource statistics. Conscientiously implement the "Coal Enterprise Energy Resource Statistical Methods", further perfect original recording, statistical accounts, and statistical reports for energy resource consumption, and fully foster the informational and data roles of energy resource statistics. Undertake competitive comparison and assessment activities for energy resource statistics, reinforce training for energy resource statistical personnel, and raise professional levels.

c. Broadly extend an energy consumption quota management system. Energy consumption quotas (especially work procedure energy consumption quotas) are the foundation of management work and an important part of making energy conservation management work more scientific. We must focus on compiling work procedure energy consumption quotas, perfect a quota management system, and make a major effort to undertake energy consumption quota assessment. Coal mines should include the nine energy consumption items in the "Provisions" in the scope of assessments and raise energy consumption quota management levels. By 1995, energy consumption quota management should be achieved for over 80 percent of electromechanical equipment larger than 100 kW, boilers larger than 2 steam tons, and other primary energy consuming equipment.

d. Continue to undertake enterprise energy equilibrium measurement work. All enterprises with total yearly energy consumption in excess of 5,000 tons of standard coal should complete enterprise energy equilibrium measurement work to provide data for raising enterprise energy resource management levels and formulating energy conservation measures.

Broadly undertake propaganda and education concerning energy conservation. Make full use of all types of propaganda tools, do propaganda concerning the principles, policies, and importance of energy conservation, exchange energy conservation experiences, disseminate advanced achievements, impart knowledge concerning energy conservation, and further improve the understanding of energy conservation by all employees.

2. Continue working on raising (setting) grades in enterprise energy conservation, focus on building model energy conservation enterprises.

With raising grades of enterprises as the objective, promote the raising of grades for energy conservation; with the raising of grades for energy conservation as the foundation, ensure the raising of grades for enterprises. The raising (setting) of grades for energy conservation in enterprises must lead the raising of grades for enterprises. Based on provisions in the newly promulgated "Coal Enterprise Energy Resource Conservation Management Grade Raising (Setting) Methods", conscientiously do good work and ensure quality. Plans call for the total number of national-level energy conservation enterprises in the corporation system to reach 500 by 1995, equal to about 35 percent of the total number of enterprises.

Make efforts to undertake work to build energy conservation and model enterprises. Energy conservation or model enterprises should be the primary leaders in concern for energy conservation work, have complete energy conservation organs and a complete system of regulations, achieve unified and attributed management of energy resources, make energy conservation management regular, systematic, standardized, and scientific, actively promote technical upgrading for energy conservation, adopt advanced technology and equipment, achieve energy conservation in energy-consuming equipment and production techniques, become energy conservation-type enterprises with high efficiency, low energy consumption, and advanced technology, develop all items of work in a comprehensive manner, and surpass state grade 1 energy conservation enterprises. During the Eighth 5-Year Plan, we plan to establish five energy conservation and model mining bureaus, 10 energy conservation and model mines, and five energy conservation and model plants, equal to about 1.5 percent of the total number of enterprises.

3. Rely on technical progress, extend the "four new things" in energy conservation, accelerate technical upgrading of high energy consuming energy.

During the Eighth 5-Year Plan, we will focus on conserving electricity and coal. We must complete several scientific research projects including the development of a series of explosion-proof electricity meter products for use in mines, economically rational energy conservation upgrading of old blowers, research on coal slurry molding techniques, development of waterproof, desulfurized, converted, and other new types of molded coal balls, study high efficiency, low cost, and broadly available industrial molded coal bonding agents, study economically rational gasification technologies suitable to the characteristics of coal mine production and scattered residences, and so on. Extend energy-saving transformers, high efficiency water pumps, high efficiency blowers, electrical machinery speed regulation, magnetic slot mud, no-load automatic shutoff devices, controlled silicon stepless speed regulation, energy-saving furnace arches, insulated furnace walls, high efficiency pipe insulating materials, and other energy conservation technology and materials.

Coal consumed in coal enterprise boilers accounts for about 56 percent of total coal use, and electricity consumption by the "four main articles" accounts for more than 64 percent of the electricity used for raw coal production. This shows that the consumption of coal by boilers and the consumption of electricity by the "four main articles" hold a decisive status. During the Eighth 5-Year Plan, we should replace and upgrade all the low efficiency high consumption "four main articles" now in operation that fail to meet equipment requirements. Upgrade 50 percent of the low efficiency high consumption electrical machinery now in operation. Change the phenomenon of "a big horse pulling a small cart" and strive for a 3 percent increase on the basis of the 45 to 48 percent electricity utilization rate during the Seventh 5-Year Plan, and achieve an electricity conservation capacity of 600 million kWh. All low efficiency boilers and pipeline network insulation that fail to meet state pronouncements should be brought up to standard and we should strive for a 2 percent increase on the basis of the national average thermal efficiency during the Seventh 5-Year Plan and form a coal conservation capacity of 180,000 tons during the Eighth 5-Year Plan.

4. Strive for a good focus on energy conservation project construction.

Based on actual conditions in all areas, establish several projects with good energy conservation benefits. All locations with suitable conditions should actively develop heat and power cogeneration and locations that are unable to develop heat and power cogeneration should actively implement centralized heat supplies. Increase the centralized heat supply capacity by 20 percent during the Eighth 5-Year Plan. With the exception of steam heat supplies to satisfy special requirements, implement hot water heat supplies in all other cases. Projections indicate that this could form a coal conservation capacity of 400,000 tons.

All places with abundant gas resources should fully utilize gas and supply gas for production and household use. In locations without gas resources, mining regions with suitable conditions should develop coal gasification and adapt to local conditions in adopting 1.6 meter diameter dual-section furnaces and water coal gas generating furnaces. For coking, gasification, and so on, the gasification rate should reach 40 percent by 1995 to achieve a coal conservation capacity of 250,000 tons. Actively developed molded coal and achieve a shift to molded coal to conserve energy resources and reduce environmental pollution. Make a major effort to advocate utilization of coal gangue, coal slurry, and low heat value fuels, develop coal gangue and coal slurry fluidized bed boilers and power generation, and conserve good coal.

5. Be concerned with conserving oil and water.

Consumption of oil accounts for a substantial portion of total energy consumption in enterprises. High oil-consuming vehicles and other oil-burning machines and tools should be discarded in accordance with state stipulations. Actively extend vehicle oil conservation technology and use metallic cleaning agents. Coal dressing plants should use flotation oil substitute products, reinforced vehicle management, and other methods to conserve finished oil products. On the basis of unit consumption during the Seventh 5-Year Plan, we should strive to make significant reductions and conserve 24,000 tons of oil over 5 years.

Conservation in water use, treatment of polluted water, and development of new water sources should occupy a rather important status. Actively extend mineshaft water purification technology and closed-loop circulation of washing water used in coal dressing plants. On the basis of water quality and utilization by categories, increase the re-utilization rate of water. Try for a 5 to 10 percent increase on the basis of water re-utilization rates during the Seventh 5-Year Plan.

6. Reinforce energy conservation staff construction.

Our energy conservation staff took initial shape during the Seventh 5-Year Plan but it is very poorly adapted to the multitude of tasks involved in energy conservation. We have insufficient energy conservation personnel and units are incapable of handling matters, and we should actively supplement and readjust them. All units should be concerned with energy conservation personnel training and education. The corporation should fully foster the role of energy conservation technical service centers (stations) and strengthen basic knowledge about energy resource management, energy-consuming equipment management, technical upgrading for energy conservation, and other areas, provide specialized technical training, and raise management levels and technical levels of energy conservation management personnel and energy- consuming equipment operating personnel. During the Eighth 5-Year Plan, we should organize the relevant personnel to compile energy conservation training materials for the characteristics of coal. All leaders involved in the administration of energy conservation should be trained in rotation to enrich their knowledge about energy conservation and their grasp of energy resource policies. Training should be provided for energy conservation management personnel based on the characteristics of their specializations to improve the professional quality and policy levels of energy conservation personnel.

Based on the spirit of the "Provisional Stipulations for Energy Resource Conservation Monitoring and Management" promulgated by the State Planning Commission, we should establish energy conservation monitoring centers for the coal industry as well as a certain number of energy conservation monitoring stations based on work requirements to form an energy conservation monitoring staff. The leadership of the Ministry of Energy Resources and the China Unified Distribution Coal Mine Corporation should assume responsibility for monitoring the energy resource utilization situation in coal enterprises, formulate energy conservation monitoring technology regulations and standards for the industry, compile monitoring programs and plans, training monitoring personnel, collect data and information on coal enterprise energy resource utilization monitoring, and undertake energy conservation monitoring work.

7. Raise capital through multiple channels, increase investments in energy conservation.

Preliminary estimates indicate that it will take an investment of several billion yuan to carry out energy conservation technical upgrading for low efficiency, high energy consumption, and outdated and mixed equipment. It is unrealistic to expect the state and the corporation to provide all of this alarming sum. We must think of ways to gain support from all areas and raise capital through multiple channels. At the same time, all units must study the spirit of running enterprises through hard work and thrift, exploiting internal potential in enterprises, and using limited capital on the cutting edge.

Based on stipulations in the "Provisional Regulations for Energy Resource Conservation Management", we definitely must use 20 percent of our depreciation funds for energy conservation technical upgrading.

The 0.10 yuan per ton of coal energy conservation technical upgrading fund the corporation controls should be used in a focused manner without egalitarianism. We must create the conditions for moving from small to large amounts in gradually establishing energy conservation funds and provide stable capital sources for energy conservation technical upgrading.

The energy conservation tasks of coal enterprises are both arduous and glorious. We are fully confident that we can deal with concrete matters relating to work, innovate, open up, and advance, and think of every possible way to complete all tasks, and push energy conservation work up to a new level during the Eighth 5-Year Plan.

Nuclear Industry

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[Article by Huang Jianping [7806 0494 1627] of the Nuclear Industry Corporation: "Continually Open Up and Advance, Strive To Create a New Situation in Nuclear Industry Energy Conservation Work"]

[Text] 1991 is quality, product variety, and results year. It is extremely important that we focus on energy conservation and consumption reduction work in the Nuclear Industry Corporation, summarize work during the Seventh 5-Year Plan, make deployments for the Eighth 5-Year Plan, and open up a new situation in energy conservation work.

I. A Review of Energy Conservation and Consumption Reduction Work in the Nuclear Industry During the Seventh 5-Year Plan

A. A continual reduction in total energy consumption and unit consumption per unit of product

In 1990, energy consumption per unit of output value fell to 6.11 tons of standard coal per 10,000 yuan, a reduction of 24.38 percent from 1985 and an average annual energy conservation rate of 5.44 percent, which exceeded the plan requirements for an annual average 3 percent reduction in total energy consumption per 10,000 yuan in value of output as required by the state.

There were reductions to varying degrees in unit consumption for the primary products of the nuclear industry during the Seventh 5-Year Plan. Unit consumption for A products declined from 115 kg of standard coal per ton treated to 101 kg of standard coal per ton treated, a 12.2 percent reduction. Unit consumption for B products declined from 25 tons of standard coal per ton to 18 tons of standard coal per ton, a 28 percent reduction. Electricity consumption per unit of C products fell by 9 percent. Reducing unit consumption for products is a prominent achievement of the Nuclear Industry Corporation and an indication that production levels for nuclear industry products have been raised to a new level. It is also the focus of energy conservation and consumption reduction work in the nuclear industry for the future.

B. Management of energy conservation and consumption reduction has gradually been strengthened, consolidated, and improved

During the Seventh 5-Year Plan, the nuclear industry system conscientiously adhered to the relevant laws, decrees, regulations, and standards in the "Provisional Regulations for Energy Resource Conservation Management", which strengthened energy resource management. In conjunction with actual conditions in the Nuclear Industry Corporation, 16 methods regarding energy resource statistics and product energy consumption computation and assessment, enterprise energy conservation grade raising and energy conservation management methods, electricity conservation methods, energy resource monitoring methods, energy conservation and materials conservation award implementation methods, enterprise energy equilibrium measurement, power and water equilibrium computation, and other regulations and standards were formulated. In 1990, an energy auditing microcomputer data processing system was also established for the entire industry, and it reinforced management.

1. Basic work in energy conservation management should first of all clarify resources, undertake enterprise energy equilibrium, and use this to carry along other work. From 1984 to 1986 we undertook our first enterprise energy equilibrium work. Enterprises and business units that consumed more than 5,000 tons of standard coal each year completed this task and carried out inspection and certification work. At the same time, they summarized, analyzed, and wrote the first part of "Nuclear Industry Enterprise Energy Equilibrium Technology Data Collection" and a strict measurement was made of large numbers of nuclear industry enterprises that were completed and placed into operation over the past 30 years. Valuable first-hand data were conscientiously computed, which provided a scientific basis for reinforcing energy conservation management, undertaking energy conservation technical upgrading, and compiling energy conservation plans and programs. Statistics show that enterprise and business units wrote more than 1,500 technical reports and suggested over 4,000 energy conservation technical measures, and they have now implemented about two-thirds of the technical upgrading projects, which have an energy conservation capacity of 350,000 tons of standard coal.

To further intensify energy conservation work, the Nuclear Industry Corporation began its second round of energy equilibrium work by items in 1990. From 1990 to 1991, we first of all carried out electricity and water equilibrium work and decided to make inspections and certifications within 1 year. From 1992 to 1994 we will carry out heat, oil, and enterprise energy equilibrium work.

2. We perfected energy resource measurement methods, which is important basic work for scientific management of energy resources. Enterprises in the nuclear industry have conscientiously adhered to the "Measurement Law", "Energy Resource Measurement Outfitting and Management Principles", "Enterprise Measurement Grade Setting and Grade Raising", and other laws and regulations. Statistics show that by the end of 1990, the outfitting rate for grade 3 energy resource measurement devices in key energy consuming enterprises in the nuclear industry reached 99.5 percent for electricity meters, 75 percent for water meters, 85 percent for steam and compressed air, and 100 percent for finished oil and natural gas products, and most enterprises plotted energy resource measurement device outfitting network charts. Meters for fee collection were installed for household electricity and water use by employees. The contractual fee system was abolished and most enterprises became state grade 2 measurement specification units. Seven enterprises were raised to state grade 1 measurement specification units.

The enterprise and business units under the jurisdiction of the Nuclear Industry Corporation established complete energy resource statistics systems and energy resource statisticians according to the state's "Statistics Law", and they established energy resource statistics networks and original recording and statistical accounts systems that can fill in energy resource consumption statistical report tables on schedule. They implemented energy resource applied microcomputer processing programs, increased the amount of detail in report tables, and increased work efficiency 20 to 30-fold. The application of energy resource applied microcomputer processing programs can accurately measure all types of energy resource flow directions and consumption amounts in enterprises, energy resource utilization conversion coefficients, energy consumption for product comparison, energy consumption for enterprise product comparison, energy consumption for secondary energy resource conversion units, enterprise product energy conservation, and other statistical and computed data which provide a scientific foundation for extensive development of energy conservation work and for decisions on energy conservation technical upgrading.

3. Reinforced product energy consumption quota assessment is the key to good energy conservation work. To strengthen energy consumption assessment for primary products of enterprises, the Nuclear Industry Corporation has used survey research and analysis and for measurement and assessment. From 1987 to 1988 energy consumption quota grade standards were issued in three groups for 36 primary products of the nuclear industry and they are serving as an important foundation for enterprise energy conservation contractual responsibility, energy conservation grade raising, and energy conservation awards. In August 1990, the Nuclear Industry Corporation again revised 11 state grade 1 standard unit product energy consumption quotas. All enterprise and business units have formulated product and equipment energy consumption quotas for their own units, which has basically eliminated the situation in which there were no quotas for energy consumption. They have achieved measurement of utilization, indices for allocation, quotas for consumption, foundations for assessment, and awards for conservation, which has laid an excellent foundation for enterprise energy conservation and consumption reduction work.

C. Extension and application of new energy conservation technology and resolute undertaking of energy conservation technical upgrading for primary technology has produced significant achievements in energy conservation and consumption reduction

Production in the nuclear industry depends mainly on the consumption of electric power, so undertaking technical upgrading focused on electricity conservation for primary technologies is a focus of energy conservation work. Significant achievements have already been made, for example:

1. Optimized operational patterns and turning of rotor disks and other technical upgrading for reactors saved 20 million kWh of power a year.

2. Technical upgrading of the primary equipment used in uranium isotope separation has increased production capacity by 25 to 30 percent and reduced energy consumption for products by 20 to 25 percent, which in conjunction with optimized operational patterns is saving 45 million kWh of electricity a year.

3. A shift from conventional hydrometallurgy to stack immersion produces an electricity conservation rate of 71.62 percent, a steel conservation rate of 60.56 percent, and a water conservation rate of 62.8 percent. Computing on the basis of processing 100,000 tons of ore a year, stack immersion can conserve about 3,189 tons of standard coal compared to hydrometallurgy. This received a ministry-level first place S&T progress award in 1989 and a state first place S&T progress award in 1990.

4. Replacing "less cracking and more grinding" with "more cracking and less grinding" technology for ore slurry in hydrometallurgy plants reduces unit electricity consumption for ore grinding technology from 14.5 kWh/ton to 11.36 kWh/ton, an electricity conservation rate of 22 percent and yearly electricity conservation of 2 million kWh and steel ball conservation of 30 tons.

5. Upgrading of outdated electromechanical equipment also produces very good energy conservation benefits and we plan to basically complete upgrading during the Eighth 5-Year Plan.

D. Energy conservation product development achievements

1. The JoF-1 electricity-saving electromagnetic valves developed by the Atomic Energy Scientific Research Academy have an electricity savings of more than 80 percent compared with regular electromagnetic valves. This achievement received an Eureka Gold Award at the 35th Brussels World Invention Exhibition.

2. The smoke prevention and energy conservation additive "ferrocene" (chemical name dicyclopentadienyl iron) developed by Plant 504 provides significant benefits when used in railroad locomotives and other diesel engines for energy conservation, reducing smoke, and reducing environmental pollution.

3. The no shaft seal vertical centrifugal sand pumps developed by the No 4 Research and Design Academy have an equipment efficiency of more than 79 percent and electricity savings of 50 percent. The oil isolation slurry sources that use a new type of ball valve and automatic oil-water boundary control device increase the lifespan of the ball valves by 20 times and reduce oil consumption more than 80 percent. The performance of the pumps exceeds the level of the formerly imported "Mars pumps".

E. Significant achievements in energy conservation grade raising work

A total of 23 enterprises under direct jurisdiction of the Nuclear Industry Corporation entered the ranks of state energy conservation grade 2 enterprises during the Seventh 5-Year Plan. The amount of energy consumed in these enterprises accounts for 65 percent of the total for the corporation, which means that two thirds of our energy consumption levels have now reached relatively advanced national levels. Positive results have been achieved in improving enterprise management quality and reducing product costs. Projections indicate that two enterprises will be promoted to state energy conservation grade 1 enterprises in 1991 and another 3 or 4 enterprises will be promoted to the ranks of state grade 2 enterprises.

Overall, under the leadership of the Nuclear Industry Corporation and enterprise management departments, the nuclear industry developed positive and effective energy conservation work during the Seventh 5-Year Plan and made definite achievements.

II. Energy Conservation and Consumption Reduction Tasks for the Eighth 5- Year Plan

The Eighth 5-Year Plan is the key period for achieving China's second strategic objective for socialist modernization and construction, and it is a key period for enterprises in the nuclear industry to move out of the valley of difficulties in converting from military to civilian production. For this reason, doing good work on energy conservation and consumption reduction and reducing product costs is of major real significance for completing energy conservation plans for the Eighth 5-Year Plan.

Based on the requirements in state energy conservation and consumption reduction tasks and in conjunction with conditions in the Nuclear Industry Corporation, we first assessed energy conservation levels for the previous 10 years and then, in accordance with the requirement by the State Planning Commission that the industry achieve a one-half reduction in total energy consumption per 10,000 yuan in value of output by the year 2000 using 1980 as the baseline year, meaning a reduction from 9.3 tons to 4.65 tons, we determined that the energy conservation rate during the Eighth 5-Year Plan should be 3 percent, which would produce an annual energy savings of 52,000 tons of standard coal. Of this amount, electric power would account for 66 percent and coal for 28 percent. There should be an average yearly reduction of 1 to 5 percent in consumption per unit of primary products. The industry's water re-utilization rate should reach 60 percent. Total energy consumption per 10,000 yuan in value of output should be reduced from 6.11 tons in 1990 to 5.24 tons of standard coal.

Above, we have outlined our planned goals of struggle for the Eighth 5-Year Plan. To achieve this plan, we first of all must analyze successful experiences from the Seventh 5-Year Plan and compare them with advanced levels in foreign countries, point out where we lag behind, and try to catch up and surpass them. At the same time, we must pay attention to the difficulty of our goals of struggle for the Eighth 5-Year Plan, do basic work in all areas in a solid manner, perfect laws and regulations, systems, and standards, make energy conservation management advance along a regularized, scientific, and standardized path, make major efforts to promote S&T progress, slant our limited capital toward energy conservation technical upgrading, enable energy conservation technical upgrading to open its petals and make achievements in enterprises, and contribute to the effort to open up a new situation in energy conservation in the nuclear industry.

Metallurgy Industry

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[Article by Li Guitian [2621 2710 3944] of the Ministry of Metallurgical Industry Energy Resource Office: "Energy Conservation Work in the Metallurgical Industry System During the Eighth 5-Year Plan"]

[Text]

I. A Review of Energy Conservation Work During the Seventh 5-Year Plan

During the Seventh 5-Year Plan, the metallurgical industry made very substantial achievements in energy conservation work and overcame a whole series of problems for China's iron and steel industry during the Seventh 5- Year Plan including energy resource shortages, declining quality of energy resources, insufficient motive power, capital shortages, and so on, and it created specific conditions to guarantee sustained and stable development of the iron and steel industry.

China produced a total of 66.04 million tons of steel in 1990, including 62.73 million tons from the Ministry of Metallurgical Industry system, and the system consumed energy resources equivalent to 97.86 million tons of standard coal. Steel output increased 44 percent during the Seventh 5-Year Plan and total energy consumption increased 27 percent, so we managed to conserve energy and still increase output. Total energy consumption in the industry in 1990 per ton of steel was 1.62 tons of standard coal, a reduction of 126 kg of standard coal from the Sixth 5-Year Plan and a 7.2 percent decrease over 5 years. The average yearly energy conservation rate was 1.4 percent and we conserved a total of 7 million tons of standard coal during the Seventh 5-Year Plan.

In 1990, total energy consumption in key iron and steel enterprises was 1.20 tons of standard coal per ton of steel, so comparable energy consumption per ton of steel broke through the 1 ton barrier during the Seventh 5-Year Plan and reached 0.997 tons of standard coal in 1990, reducing our lag behind advanced levels in foreign countries.

During the Seventh 5-Year Plan, for energy consumption in work procedures for primary products, with the exception of an overall balance maintained in coking work procedures in key enterprises because of the effects of coal varieties and coking coal quality, all work procedures declined to varying degrees ranging from 1 to 28 percent. This included a 28 percent reduction in energy consumption for the converting work procedure in key enterprises, a 21 percent reduction in energy consumption for open-hearth work procedures, and a 16 percent reduction in energy consumption for sintering work procedures in key local enterprises. Baoshan Iron and Steel Complex set a record in China for converter negative energy steel making and the No 2 Smelting Plant at the Capital Iron and Steel Works, the Steelmaking Plant at the Wuhan Iron and Steel Works, and others pushed forward toward this goal. The No 2 Blooming Plant at the Anshan Iron and Steel Complex used microenergy rolling to become China's first special grade blooming energy conservation work procedure.

Major achievements were made in conserving heavy oil, electricity, and other superior quality energy resources. Electricity consumption for steel smelting in electric furnaces dropped from 626 kWh/ton in 1985 to 595 kWh/ton in 1990 at key enterprises, a reduction of 31 kWh/ton, and it was reduced by 35 kWh/ton in key local enterprises. Open-hearth furnace heavy oil consumption dropped from 67 kg/ton of steel in 1985 to 56 kg/ton of steel in 1990, a reduction of 11 kg. The industry as a whole conserved a total of 2.3 billion kWh of electric power and 150,000 tons of heavy oil during the Seventh 5-Year Plan.

Major advances also were made in application of major energy conservation technology during the Seventh 5-Year Plan. The application of dry coke extinguishing technology at the Baoshan Iron and Steel Complex produced very good results and they generated a total of about 400 million kWh over 5 years. Blast furnace furnace-top pressure differential power generation technology was also adopted during the Seventh 5-Year Plan at Jiuquan Iron and Steel Works, Wuhan Iron and Steel Works, Baoshan Iron and Steel Complex, Meishan, and other enterprises. China now has six blast furnace furnace-top pressure differential power generation devices in operation with an installed generating capacity of 38.5MW and yearly electric power output of 230 million kWh. Four of them are Chinese-made equipment. The Jiuquan Iron and Steel Mill 45kW blast furnace furnace-top pressure differential power generation device designed via contractual responsibility by the Ministry of Metallurgical Industry's Automation Research Academy and the Wuhan Iron and Steel Design and Research Academy has now almost attained international levels of the 1980's. The application of continuous casting technology has developed very quickly. The proportion of continuous casting doubled during the Seventh 5-Year Plan and has now reached 22.4 percent. Output of continuous casting billets increased by 9.75 million tons and nearly 1 million tons of standard coal was saved due to increased total energy conservation from continuous casting, equal to 14 percent of total energy conservation in the industry. Definite advances were made in developing and applying new energy conservation technology. The steel ingot microenergy rolling technology developed by the Anshan Iron and Steel Complex has attained international levels. The Xixing Integrated Iron and Steel Company in Wuxi [Jiangsu Province] has adopted a short flow process electric furnace—continuous casting—hot transport—rolling energy conservation technology in its medium-sized and small enterprises. Tianjin No 2 Steel Filament and Cable Plant, Dacheng Metals Plant, and others have successfully applied high efficiency open-flame steel filament heat treatment furnaces. Wuhan Iron and Steel Mill and other enterprises have applied multiseam and other new types of sintering igniters that have substantially reduced coal gas consumption. The rolled steel heating furnace developed for Nanjing Iron and Steel Mill by the Maanshan Iron and Steel Design and Research Academy uses only blast furnace coal gas and was a substantial breakthrough in rolled steel heating energy conservation technology. Several new types of heat exchangers developed and applied during the Seventh 5-Year Plan like replaceable insertion-type heat exchangers, high efficiency jet-flow heat exchangers, and so on have caught up with international currents and made major contributions to energy conservation in China's metallurgical flame industrial ovens and kilns. Definite advances have been made in extending and applying 10 types of electricity-saving technologies including passive local compensation, magnetic slot mud, AC electrical machinery speed regulation, electric furnace oxygen burning guns, and so on. Significant progress was made in surplus heat and energy utilization in the metallurgical industry during the Seventh 5-Year Plan. The number of enterprises recovering converter furnace coal gas increased from seven during the Sixth 5-Year Plan to 14. This is especially true of the big 100 ton-plus conversion furnaces at the Capital Iron and Steel Mill, Benxi Iron and Steel Mill, Anshan Iron and Steel Mill, Baoshan Iron and Steel Complex, and other enterprises that have entered the coal gas recovery ranks. Several independent iron smelting mills have invested in building several small power plants, which has reduced coal gas diffusion losses, improved the environment, solved the power supply problems of these mills, and increased enterprise economic benefits.

II. An Estimate of the Energy Conservation Situation in the Eighth 5-Year Plan

The situation for energy conservation work in the metallurgical industry during the Eighth 5-Year Plan is: coexisting difficulties and advantages, coexisting problems and potential.

The main difficulties are:

1. Increased difficulty of energy conservation. There was an obvious reduction in the energy conservation rate from the Sixth 5-Year Plan to the Seventh 5-Year Plan, with a roughly 1 to 2 percent reduction each year. In the future we must rely on more intensive management and technical progress to achieve energy conservation.

2. For the past few years enterprise retained profit levels have fallen, there is substantial pressure from returned goods and significant reductions in capacity to raise their own capital to move ahead with energy conservation measures, and state investments in energy conservation will also be reduced.

3. Growth of increased energy factors: increased product variety, quality improvement, and environmental protection improvements are all increased energy factors. On the basis of digesting these energy increasing factors, further reductions in consumption of energy resources will certainly be more difficult.

4. The quality of energy resources still awaits improvement. The ash content of coke at key enterprises has now increased to 14.25 percent and is still growing. The viscosity and water content of heavy oil is already significantly less than the Sixth 5-Year Plan and early Seventh 5-Year Plan.

A beneficial condition and advantage is that a substantial portion of the capital construction projects and technical upgrading projects built via investments made during the Seventh 5-Year Plan will attain their output and indices during the Eighth 5-Year Plan and play a role. Examples include the installation of four advanced large blast furnaces, 72 continuous casting machines with a continuous casting capacity of 18.41 million tons, and others, all of which will attain output during the Eighth 5-Year Plan. The levels of conversion furnace coal gas recovery devices completed during the Seventh 5- Year Plan have still not been fostered. Moreover, as reforms are intensified, the economic environment is improved and rectified, and industrial policies are implemented, there will be an improvement in external conditions.

It also should be noted that there is substantial potential for energy conservation. Compared to advanced international levels, we still lag far behind and there are substantial differentials among enterprises within China. Lagging behind is the same as potential and there are things that should be done in this area.

III. Energy Conservation Objectives and Routes for the Eighth 5-Year Plan

1. Objectives: the primary goals of energy conservation work in the metallurgical industry during the Eighth 5-Year Plan should be: the entire industry should achieve sustained energy conservation, key enterprises should create levels, the lag behind energy consumption levels in foreign countries should be reduced, and the differentials among enterprises within China should be reduced. In 1995, total energy conservation per ton of steel in the industry as a whole should reach 1.55 tons of standard coal. It should reach 1.15 tons of standard coal in key iron and steel enterprises and 1.34 tons of standard coal in key local iron and steel enterprises. Comparable energy consumption per ton of steel should reach 0.98 tons of standard coal in key iron and steel enterprises and 1.005 tons of standard coal in key local iron and steel enterprises. The industry as a whole should achieve total energy conservation of 5 to 5.5 million tons of standard coal during the Eighth 5-Year Plan. The annual energy conservation rate in all metallurgical enterprises should exceed 2 percent. For those that have not become state-level energy conservation enterprises, their annual energy conservation rates should exceed 2.5 percent. There should be a universal reduction in work procedure energy consumption and work procedure energy consumption in several key enterprises should approach or attain present levels in Europe and the United States by 1995.

2. Primary routes and measures for achieving energy conservation goals:

Rely on S&T progress and adopt technical measures in an effort to achieve total energy conservation of 3 million tons of standard coal. Increase output of continuous casting billets by 11.50 million tons over 5 years and achieve total energy conservation of 1 million tons of standard coal over 5 years. Utilize surplus heat and energy for energy savings of about 400,000 tons of standard coal, including construction of two new dry coke extinguishing devices to conserve 35,000 tons of standard coal and crude oil, and construction of four to eight new blast furnace furnace-top pressure differential preparatory work generation devices and increasing total power output from existing devices for energy conservation of 105,000 tons of standard coal. Recover and utilize scattered blast furnace coal gas for energy conservation of 260,000 tons of standard coal. Substitute jet coal for coke in blast furnaces for total energy conservation of 350,000 tons of standard coal and recover coal gas in conversion furnaces for energy conservation of 200,000 tons of standard coal, including extending and adopting coal gas recovery technology for conversion furnaces larger than 15 tons and increasing the recovery rate per ton of steel for conversion furnaces that currently recover coal gas. Raise waste steel processing levels and do good cleaning of electric furnaces for energy conservation of 200,000 tons of standard coal. Do technical upgrading for rolled steel heating furnaces to raise the heated air temperature, extend furnace reinforcement pipe lifespans, and extend and utilize non-fixed shape refractories, and other measures for energy savings of 250,000 tons of standard coal. Extend and apply new electricity conservation technology like upgrading iron alloy ovens and kilns and electric furnace coal-oxygen guns. Renew and upgrade power-using equipment and extend passive local compensation, hydraulic couplers, new light sources, magnetic slot mud, and so on for energy savings of 350,000 tons of standard coal. Improve ingot and billet hot loading and hot transport for energy savings of 100,000 tons of standard coal. Adopt energy conservation technical measures for open-hearth furnaces, even-heating furnaces, fireproof kilns, boilers, and other oil-burning kilns and furnaces and try to conserve 70,000 tons of oil, which is equivalent to 100,000 tons of standard coal, and use other technical measures for energy savings of 150,000 tons of standard coal.

Rely on readjustment of product mixes and the industrial structure to reinforce enterprise energy conservation management work and achieve energy savings of 2.5 million tons of standard coal. The Ministry of Metallurgical Industry system should strive during the Eighth 5-Year Plan for an additional reduction of 15 to 20 kg in the iron-steel ratio and achieve energy savings of 1.2 million tons of standard coal. Strive to improve quality, develop new product varieties focused on readjusting the output structure among steel- tolerance, steel-iron alloys, and steel-carbon, achieve structural energy conservation, make a major effort to strengthen energy conservation arrangement work, raise operating and management levels, improve the administrative quality of all personnel, strive for even greater energy conservation management benefits, and try to rely on management to achieve total energy savings of 800,000 tons over 5 years and to achieve energy savings of 150,000 tons of standard coal in rolled steel heating furnaces.

3. Have a prominent focus on conserving coke, conserving oil, conserving electricity, conserving iron and steel materials, improving the continuous casting ratio, and other work.

Conserving coke: this is an important link in energy conservation in the iron and steel industry. There have been sustained increases in the average furnace coke input ratio in key iron and steel enterprises over the past 2 years, rising by 12 kg from 1989 to 1989 and by another 6 kg from 1989 to 1990. There are both external reasons and internal reasons for the rising coke ratio and we should focus over the next 2 years on restoring the average furnace coke input ratio to 1988 levels in key enterprises.

Conserving oil: the industry as a whole consumes over 4.4 million tons of heavy oil annually, over one-half of it used for rolled steel heating furnaces, with open-hearth furnaces coming second. There has been a very small reduction in unit consumption of heavy oil over the past 2 years and there is still great potential for conserving oil. This is particularly true for 1991, when there has been a trend for growing shortages of heavy oil, so we cannot delay in doing a great deal of work focused on conserving oil.

Conserving electricity: we must make efforts at every level to reduce electricity consumption in electric furnace steel smelting. We should extend and utilize surplus heat and excess pressure power generation in conjunction with technical reforms and equipment technical upgrading to reduce the amount of electricity consumed by iron alloys, carbon, and other high electricity- consuming products, accelerate the discarding of energy-consuming electromechanical products, and make a major effort to extend and utilize new energy-saving technologies and products. The Ministry of Metallurgical Industry has already established ten electricity conservation technology extension groups and we should continue to focus on electricity conservation work.

Conserving consumption of iron and steel materials: this is an important link in energy conservation in the iron and steel industry. Further reductions in construction of iron and steel materials, especially a focus on conserving pig iron used in steel smelting, is extremely important.

Further increase the continuous casting ratio: concrete goals and measures have already been determined for the iron and steel industry during the Eighth 5-Year Plan to ensure the achievement of this objective, which is extremely important for energy conservation work.

Non-Ferrous Metals Industry

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[Article by Fu Shiye [0265 0013 2814] of the China Non-Ferrous Metals Industry Corporation's Changsha Company: "A Trial Discussion of Routes for Energy Conservation in the Non-Ferrous Metals Industry"]

[Text] The non-ferrous metals industry is a high energy consuming industry. The energy resources it consumes account for about 2 percent of total energy consumption in China. Thus, the situation in energy conservation work in the non-ferrous metals industry has a substantial relationship to solution of China's energy resource shortages.

This article begins with an analysis of energy conservation achievements in the non-ferrous metals industry during the Seventh 5-Year Plan, searches for energy conservation potential, and attempts to find realistic routes for further intensification of energy conservation work in the non-ferrous metals industry during the Eighth 5-Year Plan.

I.

During the Seventh 5-Year Plan, the non-ferrous metals industry made significant achievements in energy conservation work. The rate of growth in both non-ferrous metals output and taxes and profits (referring to statistical data for enterprises under the jurisdiction of the China Non-Ferrous Metals Industry Corporation; when "non-ferrous enterprises" is used subsequently in this article, it refers to enterprises under the jurisdiction of this corporation) both exceed the growth in energy consumption. Output of 10 types of common non-ferrous metal products grew at an average annual rate of 6.7 percent from 1985 to 1990 and taxes and profits grew at an average annual rate of 16.76 percent, whereas the average annual rate of growth in energy consumption was just 5 percent. The elasticity coefficients of energy resource consumption for output and profits and taxes were, respectively, 0.746 and 0.298. Energy consumption per ton of non-ferrous metal declined by 7.18 percent, electricity consumption per ton of non-ferrous metal declined by 13.96 percent, and taxes and profits earned per ton of standard coal increased by 70.24 percent. Calculated according to total energy consumption for products, we conserved total energy resources of more than 1 million tons of standard coal from 1986 to 1990, a direct conservation value of about 100 million yuan. At the same time, this also provided indirect economic benefits and environmental benefits for enterprises and society.

II.

The main reasons that the non-ferrous metals industry was able to make these achievements during the Seventh 5-Year Plan can be outlined in four points.

1. The party and state have been concerned with energy conservation work and formulated correct energy conservation principles. The state's principle of combining energy resource development with conservation was suited to China's national conditions and clarified the direction for energy conservation practice. To adhere to this principle, the State Council issued its "Provisional Regulations for Energy Resource Conservation Management" in 1986 that provided legal provisions for energy conservation work. The State Council also established an energy conservation affairs conference system that immediately studied and assessed principles, policies, laws and regulations, plans, and reform measures regarding energy conservation, deployed and coordinated energy conservation tasks, and effectively promoted the healthy development of energy conservation work throughout China.

2. An energy conservation work network system that included the industry, local areas, and enterprises took shape and provided organizational guarantees for the undertaking of energy conservation work. All ministries and commissions of the State Council and local governments at all levels established special energy resource management organs that interlinked with the three-level (or four-level) energy resource management networks in all enterprises to form an energy conservation management network system that was interlocked vertically and horizontally from top to bottom. This enabled solid implementation of the party and state's energy conservation principles and policies and of energy conservation tasks and produced real results.

When it was established, the China Non-Ferrous Metals Industry Corporation had specialized energy resource management organs that formulated and promulgated the "Detailed Implementation Principles for the Provisional Regulations for Energy Conservation Management in the Non-Ferrous Metals Industry". It formulated and promulgated over 170 items including non-ferrous product energy conservation examination standards and management standards, heat equilibrium measurement grade standards for all types of ovens and kilns and energy-consuming equipment, and so on. It perfected energy resource statistical report tables and equilibrium tables for the non-ferrous industry and unified statistical requirements and computation methods. It also completed the compilation of energy resource statistics computer programs for smelting and processing enterprises and achieved floppy disk transmission of energy resource equilibrium tables. It undertook energy conservation grade raising activities throughout the industry, and so on. Through these professional activities and daily work, effective industry management and macro guidance of energy conservation was achieved for China's non-ferrous metals industry.

3. Enterprise energy conservation management levels have been continually raised. Enterprise energy conservation management is the foundation of overall energy resource management. All enterprises have established a three-level (or four-level) energy conservation network headed by enterprise leaders with primary responsibility for energy conservation work, with energy conservation management organs as work organs, and with full-time and part-time energy conservation personnel as the backbone force. The members of the energy conservation network monitor and assess energy resources for all energy consumption locations including enterprise production, household use, and so on to suggest opinions on rationalization, implement all energy conservation measures in enterprises, guarantee the implementation of the state's energy conservation principles and policies in their enterprises, and ensure the completion of all energy

conservation tasks. Measurement of enterprise energy resource equilibrium is a difficult basic project. By the end of 1990, the non-ferrous metals corporation system had mobilized over 10,000 people and the corresponding finances and materials for this line of work. They completed 200 energy resource, electricity, and water equilibrium measurements and technical reports that were about 10 million Chinese characters long. Energy equilibrium measurements were completed by 78 percent of the enterprises and 63 percent of the enterprises completed electricity equilibrium measurement and received the corresponding certifications.

Over the past several years, the application of electronic computers in energy resource management, the broad undertaking of energy conservation QC groups among employees, and the further perfection of all types of systems and assessment methods and reward and punishment systems have made energy conservation management work in enterprises increasingly more scientific, standardized, and systematic. Effective management has reduced energy consumption each year for the primary products of the non-ferrous metals system. According to statistics from Hunan Province in 1990, the energy consumption stabilization and reduction rate for non-ferrous enterprise products reached 89 percent, which was 19 percent higher than the average level for the province's entire industry and communication system.

4. Technical progress has become an important measure for energy conservation. During the Seventh 5-Year Plan, enterprises under the jurisdiction of the non-ferrous corporation completed 866 energy conservation technical upgrading projects at a total investment of more than 700 million yuan and formed an energy conservation capacity of 680,000 tons of standard coal/year.

Upgrading of production technology and equipment, microcomputer control of production processes, and other technical measures have created the conditions for energy conservation. For example, some enterprises have imported aluminum smelting pipeline chemical leaching devices, roasting kiln energy conservation technology, and direct reduction rectification generators for power supplies from foreign countries that have reduced leaching work procedure energy consumption for aluminum oxide production by one-half compared to existing boil-off devices. Zhuzhou Refinery studied advanced technology from foreign countries and the air cooling tower it used to replace a vacuum evaporation cooler to cool zinc electrolytic liquid has major technical and energy conservation significance. It received a "Totally Superior Existing Enterprise Upgrade Project Award" from the State Planning Commission. This plant also joined with Southcentral China Engineering University for R&D on applications of computer technology in the energy conservation field and achieved significant energy conservation and social benefits, and it is now being extended inside and outside the industry. Many processing enterprises have imported new types of ovens and kilns from foreign countries or relied on their own efforts to develop and upgrade ovens and kilns that have played an important role in energy conservation and consumption reduction. Over the past several years, mining enterprises have developed and extended high efficiency energy-saving blowers, implemented centralized monitoring and control of mineshaft blowers and pumps, applied new technologies to upgrade hoisting, pumping, and cracking equipment, developed automatic pressure filters, and extended large flotation machines that have effectively promoted reductions in electricity consumption for excavation and ore dressing.

Some enterprises are beginning to extend several new technologies for electricity conservation, oil conservation, water conservation, materials conservation, surplus heat recovery and utilization, insulating materials, and so on. Although the extension of these new energy conservation technologies has just begun, they have produced significant results and played a demonstration role, revealing excellent prospects.

III.

To achieve further intensification and improvement on the basis of the energy conservation achievements made during the Seventh 5-Year Plan, we must analyze existing potential for energy conservation to search for routes for future conservation of energy resources.

According to statistics and estimates, taking into consideration technical levels of the 1980's, the potential conservation of energy now used in production in non-ferrous enterprises is about 3 to 3.5 million tons of standard coal, and it can be divided into these five main areas:

1. Technology and equipment for primary products. Because these products are the primary consumers of energy and because existing technology and equipment are backward, they contain 35 to 40 percent of the conservable energy resources among total potential energy savings. For lead technology, which accounts for nearly 30 percent of the gross output of non-ferrous metals, and for leaching, silicon removal, baking, roasting, evaporation, and other primary technology and equipment used in the aluminum oxide production process, all of it is backward (with the exception of certain imported equipment) and energy consumption is about 50 percent higher than in foreign countries, sometimes even more than double. If we adopt new advanced technology for upgrading, unit consumption for aluminum oxide could be reduced about 20 percent. In electrolytic aluminum production, electricity consumption in top insertion troughs and large pre-roasting troughs is far greater than in foreign countries and other types of troughs also lag behind. Technical upgrading and stronger management could reduce consumption by about 1 percent. Average energy consumption for crude copper is 70 percent higher for copper air furnaces and about 50 percent higher for blast furnaces compared to foreign countries, and there is also potential for electric furnaces and flash furnaces. If copper air furnace and

blast furnace technology could be converted to oxygen-rich pool smelting and energy consumption for copper from flash furnaces and electrical furnaces could be further reduced, it would be possible to achieve an average reduction of 15 percent in unit consumption for crude copper. Replacement of outdated extraction equipment, flotation devices, filter presses, ore crackers, and so on at mines would provide an energy conservation potential that could be used to excavate 150,000 tons of standard coal.

2. Extension and utilization of energy-saving technology. Because large amounts of mature advanced energy conservation technology has not been universally extended, we are far from fully exploiting the energy conservation potential of this technology. An example is speed regulation electricity conservation technology, which has an electricity conservation rate of more than 40 percent. Speed regulation devices could be installed on the more than 40,000 AC electric machines in enterprises under direct jurisdiction of the China Non-Ferrous Metals Industry Corporation. This would conserve an estimated 1.2 billion kWh of electricity. Average oil savings from mixing water with heavy oil are 8 percent, but less than 15 percent of the heavy oil consumed each year in enterprises under the jurisdiction of the corporation employs oil and water mixing technology. The energy savings potential would be even greater if we added diesel and water mixing technology. Practice has proven that other technologies, such as replacing water ring vacuum pumps with hydraulic injection pumps, microcomputer control of furnace and kiln combustion, power supply systems and mineshaft ventilation systems, new types of illumination lamps, insulating materials, and so on are effective new energy conservation technologies, equipment, and materials. If they were extended throughout the corporation system, the potential energy savngs could exceed 100,000 tons of standard coal.

3. Surplus heat and energy recovery and utilization. It should be acknowledged that all enterprises did a great deal of work and made significant achievements in the areas of using their surplus heat and energy resources during the Seventh 5-Year Plan. Statistics indicate that the comprehensive utilization rate reached 34 percent, but in actuality 66 percent of the surplus heat and energy resources are not being utilized. For example, efforts in the areas of technology and management could recover one-third of it, which could conserve energy resources equivalent to about 400,000 tons of standard coal.

4. Upgrading old, outdated, high consumption, and low efficiency general purpose electromechanical equipment. Enterprises under the direct jurisdiction of the China Non-Ferrous Metals Industry Corporation have 8,869 blowers and industrial pumps with an installed generating capacity of 427MW that should have been but have not yet been upgraded. The operating efficiency of these outdated blowers and pumps is 15 to 20 percent below state stipulations and they consume an additional 369 to 492 million kWh of electricity each year. There are 81,480 electric motors (installed generating capacity 1,365MW) and 139 boilers that have not been upgraded. If they were completely upgraded, computing the increased efficiency of the electric motors at 2 percent and the average increase in thermal efficiency for the boilers at 10 percent, then 100,000 tons of standard coal could be conserved. Moreover, the fact that the insulating materials and structures of heat supply pipes and heat-using equipment do not conform to state stipulations means that there are heat losses of more than 10 percent. Adoption of new types of insulating materials could reduce heat losses by one-half, which could conserve 140,000 tons of standard coal.

5. Management. There are very substantial differences in energy conservation management levels among enterprises and energy conservation work has developed very unevenly. The scope of energy consumption quota assessment in several advanced energy conservation enterprises exceeds 95 percent and their contractual responsibility systems are constantly being perfected. They have achieved "rational quotas, implementation of divisions, conscientious assessment, and overall realistic rewards and punishments", and their administrative measures are moving toward computerization. In many lagging enterprises, however, energy conservation personnel assigned to a few big energy consumers are incapable of meeting work requirements. There are phenomena of "eating from the big common pot" in administration of energy conservation awards and the enthusiasm of employees for energy conservation has not been motivated. Capital inputs for energy conservation technical progress in some enterprises are less than one-half the amount stipulated by the state. Some enterprises have not integrated energy conservation management with all items of production and administrative management and have not fostered the effects of "systematic energy conservation" and "comprehensive energy conservation". There are also some enterprises that have not completed energy and electricity equilibrium measurement work, so they have no idea of the direction of energy resource flows and number of loss locations in their enterprises and are unclear about the direction of energy conservation, and they have not formulated realistic and effective energy conservation programs and measures. If all big energy consumers could attain the management levels of state grade 2 energy conservation enterprises during the Eighth 5-Year Plan, and if another 10 enterprises could attain state grade 1 energy conservation levels (there were already 10 grade 1 energy conservation enterprises by June 1991), and if all the other enterprises could attain province-level energy conservation enterprise standards, management of energy conservation would rise to new levels.

In summary, regarding the current situation in the nonferrous metals industry, the following five areas are the primary routes for achieving short- term energy conservation: adopt advanced excavation, ore dressing, smelting, and processing technologies and equipment from the mid and late 1980's for primary products; actively extend and apply new energy conservation technology and materials that have been proved by practice to be effective; make full use of enterprise surplus heat and energy resources; accelerate replacement and upgrading of all types of old and outdated high energy consuming general purpose electromechanical equipment that is now in operation; Raise energy conservation management levels in the entire industry and in all of its large and medium-sized enterprises.

On Formulating Energy Conservation Laws

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[Article by Chen Heping [7115 0735 1627] of the State Planning Commission Resource Conservation and Comprehensive Utilization Department: "A Trial Discussion of Some Issues in Formulating an "Energy Conservation Law"]

[Text] The State Council has included the "People's Republic of China Energy Resource Conservation Law" (abbreviated below as the "Energy Conservation Law") in its legislative agenda for 1991. Relevant departments of the state are now organizing for formulation of the "Energy Conservation Law". I will now offer some of my own preliminary views concerning certain issues in formulation of this law.

I. The Importance of Formulating an "Energy Conservation Law"

Since our nation was founded, and especially over the past decade, China's energy resource production has developed very quickly. Total output of primary energy resources was 1.04 billion tons of standard coal in 1990, third place in the world. However, our energy resources are still unable to meet the requirements for development of our national economy and there have consistently been rather severe shortages of energy resources. China has had a sustained electric power shortage for 20 years, the problem of inadequate reserve strengths in coal production is very acute, we have serious shortages of petroleum reserves, and new increases in petroleum output each year fall far short of the required growth. Projections indicate that to attain a per capita GNP of nearly $1,000 by the end of this century, we will have to consume at least 1.7 billion tons of standard coal each year. According to plans, however, output will only be able to reach 1.4 billion tons of standard coal. When we reach a per capita GNP of $4,000 in the year 2000, taking into consideration the energy conservation benefits from S&T progress and changes in the industrial structure, projected energy resource demand will be about 4 billion tons of standard coal. This will require China to maintain an elasticity coefficient for energy resources within the 0.6 to 0.7 range for a rather long period of time, which will take considerable effort toward energy conservation at all levels. Moreover, the elasticity coefficient of energy resources in foreign countries during this period will be between 1.0 and 1.2. The 4 billion tons of standard coal is one-third of total energy resource consumption in the world, so this is an alarming figure. Moreover, resource, production, transportation, and other factors will be hard to overcome and it will be hard for our environmental capacity to accept.

China's energy conservation work began in the 1980's and we have made major achievements over the past decade that have supported the realization of our first strategic objective for the national economy. However, China's situation of low energy resource utilization rates, high unit consumption for products, and poor economic results will not be basically changed. China's energy consumption per $10,000 yuan of GNP is one of the highest in the world and is 3.9 times the world average. China's unit energy resource consumption for primary energy consuming products is 30 to 90 percent higher than levels in the industrially developed nations in the early 1980's. There are also major differentials within the same industry in China and unit consumption in many enterprises has not yet attained the best historical levels. Estimates indicate that China has an energy conservation potential of more than 300 million tons of standard coal, which is equivalent to about one-third of China's present annual energy resource consumption.

China has a relative shortage of energy resources in per capita terms and our energy resource structure which is dominated by coal is facing serious challenges. Per capita energy consumption levels are very low and energy consumption per unit of value of output is very high, so there is enormous potential for energy conservation. Facing this situation in which shortages and waste coexist, people often take a laissez-faire attitude and become accustomed to it, and there has been no change in the concept of focusing on development while neglecting conservation, focusing on speed while neglecting benefits, and focusing on output while neglecting energy conservation. In this type of situation, simply relying on administrative measures and economic measures is no longer sufficient to ensure conscientious implementation of all of the state's energy conservation principles and policies. The use of energy conservation legislation to regulate all types of behavior during the process of energy resource utilization in society as a whole, to readjust the relationships of authority and duty of the state's energy conservation administrative departments and other relevant departments and units, to organically integrate administrative measures, economic measures, and legal measures, to make a gradual transition to leadership, organization, and management of energy conservation mainly through legal measures, to use the force of the state to guarantee achievement of the various rights and duties in energy conservation legal relationships, and to derive the optimum economic benefits and energy conservation benefits are legal guarantees for the smooth completion of energy conservation work as well as a real requirement for national economic development.

II. The Necessity of Formulating an "Energy Conservation Law"

Energy conservation work is concerns society as a whole and touches upon all industries and every citizen. It is also subject to restrictions by resource conditions, economic strengths, technical levels, management quality, personnel quality, and many other objective conditions. This is especially true because reform of China's economic system has not been completed. The prices for energy resources are too low. Energy resources account for only 9 percent of enterprise costs and in a situation where enterprises lack a motive force for energy conservation, adopting powerful measures through energy conservation legislation to clarify the energy conservation responsibilities and duties of enterprises and citizens is obviously even more important.

The "Provisional Regulations for Energy Resource Conservation Management" issued by the State Council have been in effect for more than 5 years now. These "regulations" systematically standardized the content of energy conservation management work in China and played a major role in promoting the normalization, systemization, and standardization of energy conservation work in China. However, these "regulations" are actually administrative measures of the State Council and there is often no concern for supervising and punishing violators. Examples include the weakening of energy conservation management organs arising from reform of state organs, the failure to conduct discussions on energy conservation for new construction, rebuilding, and expansion projects, the loss of control over local oil refining, local coking, condensed steam small-scale thermal power, diesel power generation, and other things that consume large amounts of energy, the transfer of discarded boilers, trucks, and other electromechanical products to rural and mountainous areas, and other problems that have never been effectively and fundamentally resolved.

In China, energy conservation work and environmental protection work began at almost the same time. However, because environmental protection work has the "Environmental Protection Law" and a whole series of other associated laws and regulations, and because an independent administrative and legislative system has been established for it, the social status of environmental protection work and achievements in this work both exceed energy conservation work.

Energy conservation is the most practical and most effective way to prevent and control environmental pollution. China is one of the few countries in the world whose energy resources are dominated by coal. On the average, coal accounts for 28 percent of the world's primary energy resources, but this figure is more than 75 percent in China. Given the poor quality of our coal and various technical and administrative factors, China's average coal utilization is only about 30 percent and we have severe pollution caused by burning large amounts of coal. Discharges from burning coal accounted for 70 percent and 90 percent, respectively, of the total amount of soot and sulfur dioxide discharged in China in 1990. Relatively serious acid rain has appeared in the southwest and south China regions. Over 50 percent of the nitrous oxides discharged into the atmosphere and 85 percent of the carbon dioxide discharged from the burning of mineral fuels also comes from the burning of coal. The "greenhouse effect" of global warming caused by the carbon dioxide discharged from burning large amounts of coal has become a point of contention in international relations. The United Nations has decided to hold an Environment and Development Conference in 1992 to pass the "Treaty to Protect the Atmosphere and Prevent Climatic Changes" that will propose the goal of restricting discharges of carbon dioxide for all countries of the world. As the world's biggest coal consuming country (23 percent of total world coal consumption), China will face an extremely serious challenge. The 14th World Legal Conference held in Beijing in 1990 also included environmental protection and energy conservation legislation as one of the focal points of world legislation. Thus, the formulation of an "Energy Conservation Law" would be an effective measure for China's economic development and alleviation of our energy resource shortages, and it would express our duty to jointly protect the environment for all of mankind.

III. The Feasibility of Formulating an "Energy Conservation Law"

The world's two energy resource crises announced the end of the age of cheap petroleum and along with coal, electric power, oil, and nuclear, energy conservation became the "5th energy resource". All nations of the world, especially the industrially developed countries, are paying greater attention to energy conservation and the governments of all countries have adopted a variety of legislative measures to promote energy conservation work in their own country. It is not just the developed countries like the United States, Japan, West Germany, Italy, England, and others that have promulgated successive "Energy Conservation Laws". Even developing nations and regions like Singapore, the Philippines, Thailand, South Korea, Taiwan, and others have also formulated "Energy Conservation Laws". The "Energy Conservation Laws" promulgated by these countries and regions have played an active role in their passage through the energy crises, rational utilization and conservation of energy resources, and sustained and spurring economic growth. Over the past several years, France, England, and the United States have all experienced positive economic growth in conjunction with negative growth in energy resource consumption. In the "Energy Conservation Laws" of these countries, some provisions have standards to control energy-using equipment, reinforce residential insulation, and reduce room heating. Some provisions changed industrial structures and product mixes, reducing the production of products that consume large amounts of energy. Some provisions reduced street and advertisement illumination, and changed the times for movies, plays, and television.

Some required increased utilization of surplus heat and improved methods of fuel transportation and storage. Some countries also adopted financial subsidies and tax preferences for energy resource conservation, fines for those who waste energy resources, and so on. The national situation in each country is different and the laws have class properties, but from the perspective of actual standards, and from the perspective of legislative experience and skill, we could at least borrow from these countries' "Energy Conservation Laws".

China has been involved in energy conservation work for over 10 years now and the CPC Central Committee and State Council have consistently been extremely concerned about and supported this line of work and have given many important instructions. The State Council and all departments and all regions have formulated rather systematic energy conservation laws, regulations, standards, and systems and the relationships among all levels and all areas have basically been straightened out. The State Council, for example, issued five successive energy conservation directives from 1980 to 1982 and promulgated the "Provisional Regulations for Energy Resource Conservation Management" in 1986. The State Council or relevant departments have also transmitted or published several articles on electricity conservation, coal conservation, oil conservation, rational heat use, energy conservation monitoring, and so on. The practice in these documents has been assessed as correct and the conditions of mature legalized and standardized principles and policies are already in place. This is especially true for the foundation of the rather comprehensive and systematic implementation of the energy conservation "Regulations" and the possibilities of further revision, supplementation, and improvement as well as adopting parts of the "Energy Conservation Laws" of foreign countries. The conditions are in place for raising the "Regulations" to become an "Energy Conservation Law" and the time is mature.

In addition, affirmation of the status of an "Energy Conservation Law" in research by China's energy resource legal system and the State Council's establishment of an "Energy Conservation Law" project have both laid an excellent foundation for formulating an "Energy Conservation Law".

IV. The Urgency of Formulating an "Energy Conservation Law"

Formulation of laws is extremely complex and difficult work and many problems will inevitably be encountered in formulating the "Energy Conservation Law". Examples include the establishment of management organs and supervisory organs, channels for raising capital, the division of labor and cooperation among localities and departments, the rational allocation of legal rights and the matching systems, the scope of readjustment for the "Energy Conservation Law", the relationship between the "Energy Conservation Law" and other related laws, and so on, all of which will require repeated surveys, research, discussion, and working out. After the legal clauses are drafted, there must be repeated solicitations of opinions, coordination, revision, submission for approval, and so on. Thus, there should be overall planning, a concern for time, and an effort to do this work well.

We are now carrying out reform of the economic system and the legislative process should be integrated with practice in reform, using legislation to promote and guarantee the smooth implementation of reform. During the legislative process, we must draw on experience and lessons from other economic legislation, be good at mobilizing and organizing forces in all areas of society, widely solicit views from all areas, do extensive survey research, actively discuss and deliberate, and patiently proclaim and explain to accelerate the pace of legislative work.

Moreover, China's "Energy Conservation Law" will be the leading law for our energy conservation legal system. It would be best for the State Council to issue detailed implementation principles or regulations at the same time that the law appears. Only in this way can the law be implemented. Thus, consideration is now being given to the formulation of matching detailed implementation principles or regulations for the "Energy Conservation Law".

V. Some Concrete Views and Opinions

1. Definition of energy conservation: the adoption of technically feasible, economically rational, and environmental and socially acceptable measures to reduce loss and waste in all links from energy resource production to consumption and more effectively utilize energy resources.

2. Objective of formulating the "Energy Conservation Law": to more effectively utilize our limited energy resources, control the environmental impact of energy resource utilization, establish an energy conservation legal system on the foundation of the "Energy Conservation Law", and guarantee and promote development of our national economy.

3. Guiding ideology in formulation of the "Energy Conservation Law": in adherence and implementation, all industries must place energy conservation in a prominent status, and energy conservation is a long-term strategic principle in China. Use the establishment of a series of energy conservation systems to reinforce understandings of energy conservation in all of society, especially in enterprises, and establish stable, effective, and long-term energy conservation organs. Based on the objective of optimum efficiency in the utilization of energy resources by all of society, coordinate and handle all social relationships in an effort to establish an energy conservation-type national economic structure.

4. Basic principles for formulating the "Energy Conservation Law": embody the principle of integrating the planned economy with market regulation, adapt to the requirements of reform and development. Try in every

possible way to affirm and clarify the legal clauses and make them flexible. When a clause is mature, it should be written down without stressing the entire system. Try for passage, however, and it is better to have something than nothing.

5. Scope of readjustment for the "Energy Conservation Law": readjust all social and economic relationships of energy conservation administrative departments with energy-using units and individuals throughout the entire process of energy resource utilization, development, processing, conversion, transportation, storage, distribution, supply, and so on.

6. Legal status of the "Energy Conservation Law": in the energy resource legal system, energy resource laws are basic laws; industry laws for the coal, petroleum, atomic energy, and electric power industries as well as the "Energy Conservation Law" are backbone laws.

7. Establish an energy conservation monitoring and management system. Copy the methods used by the Ministry of Construction when it established state construction monitoring methods, appoint several elderly experts with specialized knowledge and rich experience as state energy conservation monitors and managers with key responsibility for energy conservation assessment and acceptance for new construction, rebuilding, and expansion projects examined and approved by the state.

8. Establish a national "Energy Conservation Day". Establish a national "Energy Conservation Day" in the "Energy Conservation Law". Conduct wide- ranging propaganda, inspection, exchange, commendation, and other activities on "Energy Conservation Day" to increase all people's understanding of energy conservation.

9. Use "trial implementation" first for the "Energy Conservation Law". China has just begun to establish energy conservation mechanisms and an energy conservation-type national economic structure and the energy resource and conservation legal system is still in the process of being established. To protect the strictness and stability of the law and in consideration of the urgency of energy conservation legislation, we can begin with "trial implementation" for a few years, revise and perfect it on the basis of practice, and then formally promulgate it.

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