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22 June 1984

China Report

SCIENCE AND TECHNOLOGY

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CHINA REPORT

SCIENCE AND TECHNOLOGY

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RADIOLOGY

NATIONAL DEVELOPMENTS

TECHNOLOGICAL REVOLUTION SEMINAR CONTINUES IN ANHUI

HK160845 Beijing GUANGMING RIBAO in Chinese 7 May 84 p 1

[Dispatch from Hefei on 6 May by reporters Xie Jun [6200 6511] and Xue Changci [5641 2490 6101]: "Seminar on New Technological Revolution and System Restructuring Continues in Hefei"]

[Text] Today, at the seminar on the new technological revolution and system restructuring, group discussion was coupled with a general meeting of all those attending. In the morning, all participants were addressed at the general meeting, while in the afternoon, group discussion was held in our separate groups with each group responsible for discussing the problems of science and technology, education, the enterprises, and agriculture, respectively.

The meeting began in the morning. Liang Xian [4731 2099], from the Shekou Industrial Zone, was the first one who ascended the stage. He spoke on the characteristics of that zone and how it was started. His lively speech incited applause and laughter every now and then. Tao Zuji [7118 4371 7535], manager of the Shanghai mechano-electrical products export consultative service company, briefly spoke on his views on the restructuring of our foreign trade system. Professor Li Yining [0632 0110 1337] of the Department of Economics, Beijing University, delivered a brilliant speech entitled "Contemporary Economic Thinking and a Comparison of Economic Patterns." Cui Hemin [1508 7729 3046], lecturer at Beijing's Second Foreign Languages Institute, delivered a speech entitled "The Relationship Between the New Technological Revolution and the New Industrial Revolution."

In the afternoon, those attending the seminar went to the halls where topics they were interested in were discussed. The atmosphere was even more lively at the group discussion. People exchanged their views every now and then and there were occasionally brief interruptions. In addition, outside the halls, small groups of three to five comrades discussed the problems they felt were interesting.

As reformers from all over the country gather in Hefei, various departments concerned in Anhui have organized lectures for them. On the afternoon of 5 May, the Anhui Economics and Management Institute asked Wang Zepu [3769 3419 2528], director of Anshan Iron and Steel Plant's seamless tubing mill, to present a report on the reform of the management of enterprises. This

morning, Deng Xuchu, secretary of the party branch of the Shanghai Jiaotong University, was invited to address the conference on reforming higher education in Anhui. In the afternoon, the University of Science and Technology of China, the Anhui University, and the Anhui Economics and Management Institute invited Professor Li Yining of Beijing University, Cui Hemin, lecturer at Beijing's Second Foreign Languages Institute, and Tao Zuji, manager of the Shanghai mechano-electro products export consultative service company, to give talks.

CSO: 4008/321

BRIEFS

HENAN SCIENCE ADVISORY CENTER--The Henan Provincial Science and Technology Advisory and Service Center was formally established this morning. Vice Governor Hu Tingji presided over the inauguration, at which Liu Zhengwei, secretary of the provincial CPC committee, spoke, emphasizing that it was necessary to fully understand the importance of doing advisory work. He demanded that the center help leaders make policies, vigorously serve medium-sized and small enterprises, and enthusiastically serve specialized households. (Wu Baichuan), vice chairman of the provincial science and technology association, acts as the chairman of the provincial science and technology advisory and service center committee. (Yang Changxi), (Wang Jingfu), (Liu Chuntang), (Sun Chenshan), (Liu Baohua), and (Zhang Jiazhang) act as the vice chairmen. Five veteran experts, (Zhu Peijun), (Ding Shenyu), (Gao Shi), (Zhang Yangang), and (Li Shijun), have been engaged as advisers, and 63 mid-level and senior science and technology workers have been engaged as committee members. [Summary] [HK081507 Zhengzhou Henan Provincial Service in Mandarin 1230 GMT 19 Apr 84 HK]

GUANGDONG SCIENCE, TECHNOLOGY GROUP--To strengthen unified leadership over scientific and technological work, the Guangdong Provincial People's Government recently decided to establish a scientific and technological work leadership group of the provincial government. Vice Governor Li Jianan has been appointed head of the group and Vice Governor Wang Pingshan has been appointed deputy head of the group. The provincial government also decided to set up a scientific and technological advisory committee of the provincial government. The main tasks of the scientific and technological work leadership group are to help the government to formulate a medium-term and long-term plan for scientific and technological development; to study and determine important policies on technology and scientific and technological items; and in accordance with the needs of scientific and technological work, to concentrate on the use of scientific and technological forces and to tackle difficult problems. The provincial people's government will engage professors, experts, and scientific and technological workers as members of the advisory committee. [Summary] [Guangzhou Guangdong Provincial Service in Mandarin 0400 GMT 30 Apr 84 HK]

STRENGTHENING BEIJING SCIENTIFIC WORK--Beijing, 9 May (XINHUA)--A special group headed by Beijing's mayor, Chen Xitong, has been established to promote technical and scientific work in the Chinese capital, according to today's BEIJING DAILY. Aiming at speeding up the modernization drive in the city, the group is to work out long-term programs on science and technology, help formulate policies on major technological problems, and systematize ongoing scientific and technical projects. The paper says that the municipal government has invited more than 1,000 specialists, professors and scholars as professional advisors. They work in 50 groups covering such specialities as forestry, textiles, chemicals, computers and building materials. The computer group has put forward suggestions for developing mini-computer systems and the application of computers in city administration, which have already been adopted by the city authorities. [Text] [OW091413 Beijing XINHUA in English 1302 GMT 9 May 84]

CSO: 4010/89

FLOW INVERSION TEST AND THEORY ANALYSIS FOR HFETR

Chengdu HE DONGLI GONGCHENG [NUCLEAR POWER ENGINEERING] in Chinese Vol 5, No 1, Feb 84 pp 1-6

[Article by Zhang Junxue [1728 0193 1331]: "Flow Inversion Test and Theoretical Analysis for HFETR"]

[Text] Abstract

This paper describes the flow inversion problem, and its experimental study, encountered after pump shutdown in a single downward flow forced cooling high-flux engineering test reactor (HFETR). This work established that flow inversion at 250 kW is safe. Theoretical calculation and thermodynamic computation were made for the flow inversion in a HFETR based on a uniform deceleration quasi-static theory and the results were in good agreement with the experiments.

I. Introduction

The normal mode of cooling in a high-flux engineering test reactor is to pump the coolant in a downward direction through the active zone. This method, shown in Fig. 1, is known as the forced cooling method. Under special circumstances, cooling may also be achieved without running the cooling pump and by relying only on the specific gravity difference and the resulting buoyancy between the heated water in the element can and the high density cold water in the reflecting layer. This type of cooling is called "natural convection." The flow direction of the natural convection is from the bottom to the top and is opposite to the direction of the forced flow. Therefore, when the forced flow is stopped (cooling pump turned off) and the element is still releasing heat, there will be a transition from forced flow to natural convection. This process is called "flow inversion." This condition always occurs after the reactor is shut down and residual heat is being released.

High-flux engineering test reactors have high residual heat release. In particular, the residual heat release rate for the safe shutdown of the cooling pump must be determined when the reactor is shutdown after a long period of running at high power. Excessive heat release could damage the elements and too small a heat release rate is uneconomical. Since there were no

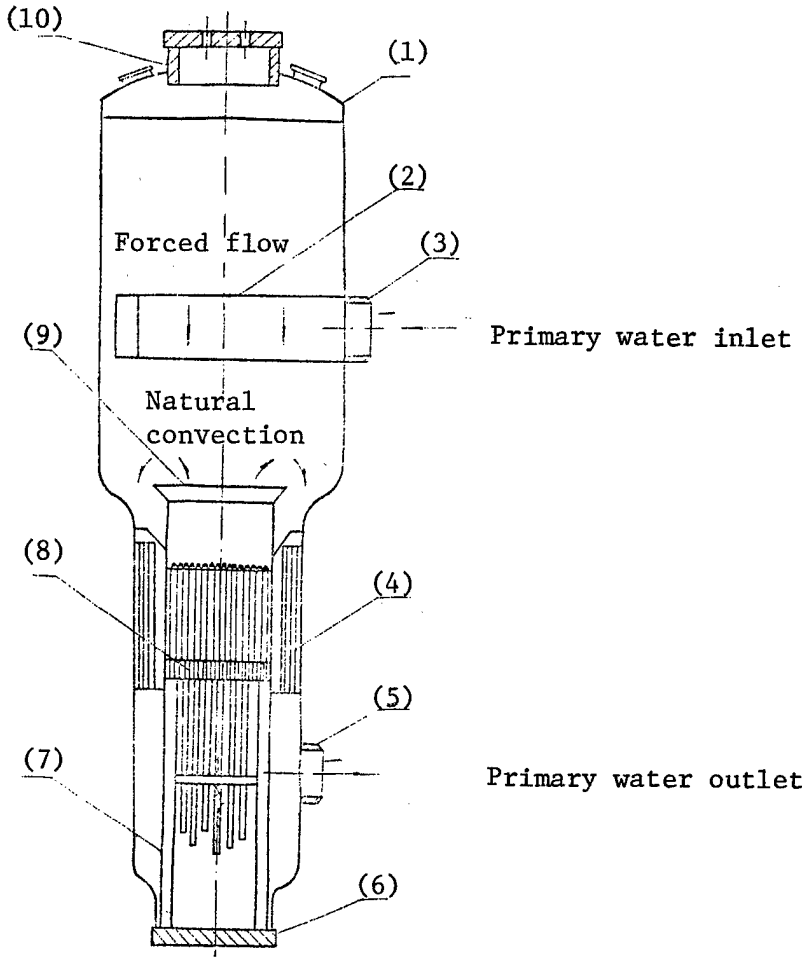

Fig. 1. Direction of coolant flow in pressure vessel

Key:

1. Pressure vessel
2. Coolant distributor
3. Coolant intake
4. Heat shield
5. Coolant outlet
6. Bottom cover
7. Active zone support
8. Grid
9. Shroud
10. Top cover

readily available data in this area, experiments were conducted to determine the heat release rate.

II. Experimental Method and Procedure

The primary concern of a reactor experiment is the safety of the reactor. To determine the power for the experiment, we used a uniform deceleration model and made preliminary theoretical estimates[1] and determined that a flow inversion experiment at 250 kW should be safe to do. The experimental procedures are as follows:

1. Operate an incident cooling pump at a flow rate of 650 ton/hr and stabilize the reactor power at 250 kW.

2. Stop the incident cooling pump and record the surface temperature of the element can and the intake and outlet water temperature with a multi-pen recorder.

The measurement results are shown in Fig. 2 and Table 1. The surface temperature of the element is measured with an armored thermocouple.

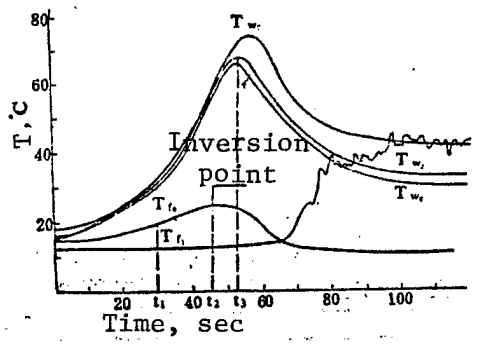

Fig. 2. Temperature of fuel element cladding and intake and outlet temperatures in a flow inversion experiment at a reactor power of 250 kW.

$T_{W4,7,8}$--Fuel element cladding temperature

T_{f1}--Water temperature at top part of the element

T_{fo}--Water temperature at bottom part of the element

III. Theoretical Model for Flow Inversion

1. Determination of times in a uniform deceleration model

Definition : t_o is the time when the pump is stopped and is the starting point of the process. We let $t_o = 0$. The water in the tube undergoing flow inversion enters the upper part of the element at a time t_1, flow inversion begins (zero flow velocity) at a time t_2, and t_3 is the time when the water at the bottom of the element returns to the top.

Water entering the top of the element container at time t_1 reaches the bottom of the container at time t_2 and begins to turn around and flows out of the container at time t_3 and completes the entire process. For the sake of computation, we assume that during the period of t_1 to t_2, the water in the element container is gradually heated and its decreasing density produces buoyancy and the water in the container undergoes uniform deceleration and stops at the bottom of the container. From the equation of motion, we have

Table 1. Temperatures at flow inversion

Parameter	lower water temp	upper water temp	cladding temp	cladding temp	cladding temp
Notation	T_{fo}	T_{f1}	T_{W4}	T_{W7}	T_{W8}
Initial value ^{o}C	15.0	14.1	15.5	17.4	15.2
Maximum value ^{o}C	27.26	50.29	69.95	76.08	68.73
Time to reach the maximum sec	45.0	89.0*	55.0	57.0	54.0
Final value ^{o}C	14.14	43.04	36.45	44.26	34.30

*The temperature rise time is long because the measurement point for the upper water temperature is located 250 mm from the element heating section.

$$a=\frac{dv}{dt}=\bar{\beta}g(\bar{T}-T_u) \tag{1}$$

$$H=\frac{1}{2}at^2 \tag{2}$$

where H is the length of the heated section of the element in meters, $\bar{\beta}$ is the volume coefficient of thermal expansion under the average water temperature in the container in 1/ °C, t is the time in seconds, α is the deceleration in m/sec^2, g is the acceleration due to gravity in m/sec^2, T is the average water temperature, and T_u is the water temperature at the upper opening in °C. Substituting Eq.(1) into Eq.(2), we have

$$t=\left[\frac{2H}{\bar{\beta}g(\bar{T}-T_u)}\right]^{1/2} \tag{3}$$

In the meantime, the water is heated from the temperature T_u to the temperature T_ℓ at the lower end of the container within a time t. Hence,

$$t=\frac{\bar{\gamma}\bar{C}b(T_\ell-T_u)}{2\bar{q}} \tag{4}$$

$$T_\ell-T_u=2(\bar{T}-T_u) \tag{5}$$

From Eqs (3), (4) and (5), we have

$$T_\ell-T_u=2\left[\frac{2H\bar{q}^2}{\bar{\beta}g\bar{\gamma}\bar{C}_p^2b^2}\right]^{1/3} \tag{6}$$

where $\bar{\gamma}$ is the specific gravity of the water at the average temperature in kg/m^3, $\bar{C}_p$ is the specific heat at constant pressure of the water at the average temperature in kcal/kg°C, b is the width of the water gap in meters and $\bar{q}$ is the average heat flow of the element in $kcal/m^2sec$.

(1) Determination of the flow inversion time t_2

After the pump is shut down, the flow speed of the water gradually decays along with the damping of the pump (see Fig. 3).

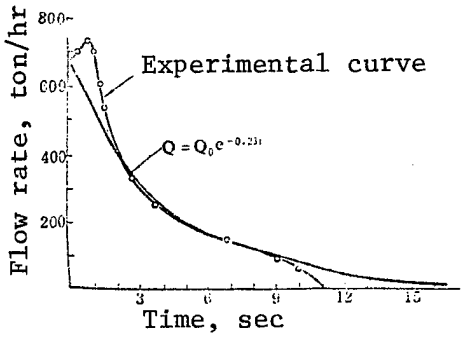

Fig. 3. Flow rate decay of the incident pump

The water in the flow channel stops flowing once the buoyant force is equal to the pressure drop in the active zone. The time interval from the pump shutdown to the stopping of the water flow is the flow inversion time. The pressure drop is given by

$$\Delta p=\xi\frac{H}{d_s}\frac{w^2}{2g}\bar{\gamma} \tag{7}$$

and the buoyant force in the element is given by

$$\Delta p_{buoy}=\bar{\beta}\bar{\gamma}H\left[\frac{2H\bar{q}^2}{\bar{\beta}g\bar{\gamma}^2\bar{C}_p^2b^2}\right]^{\frac{1}{3}} \tag{8}$$

In the above two equations, d_s is the hydraulic equivalent diameter in meters, w is the water flow speed in m/sec, the resistance coefficient for laminar flow is $\xi = 96/R_e$ where R_e is the Reynolds number and is equal to wd_s/ν_f, here ν_f is the kinematic viscosity in m^2/sec.

The average heat flow $\bar{q}$ of HFETR No. 1 is calculated as follows

$$\bar{q}=N\times K_1\times K_2\times 0.97\times 860/n\times F \tag{10}$$

where N is the nominal power of the reactor during the experiment in kW, K_1 is a power calibration factor, taken to be 0.8, K_2 = 1.47 is the inhomogeneity coefficient of the flux, n is the number of elements and is equal to 25.866 in the initial phase of the operation, f is the surface area of each element container and is equal to 1.395 m^2, and the numerical factor 0.97 is the fraction of heat released in the element container as compared to the total heat released by the reactor. At a nominal power of 250 kW, $\bar{q}$ = 1.89 kcal/m^2 sec.

Using the physical parameters at $\bar{T}$ = 20°C, we computed $\Delta p = 308w$ kg/m^2 and Δp_{buoy} = 1.8 kg/m^2. When $\Delta p = \Delta p_{buoy}$, w = 0.005844 m/sec. This is the flow speed under which flow inversion takes place.

From Fig. 3, the decay of the flow rate is $G = G_0e^{-0.23t}$ where G_0 is the normal flow rate at the center of the element container in ton/hr; for HFETR No. 1, G_0 is measured to be 9.6 ton/hr. The decay constant is determined from a fit to the experimental flow rate decay curve. Converting this to a flow rate decay equation, we have

$$w=w_0e^{-0.23t}=\frac{G_0}{f\times 3600}e^{-0.23t}\ (\text{m/sec}) \tag{11}$$

where f is the flow channel area and is equal to 0.00156 m^2. Using Eq.(11), we found t_2 = 25 sec when w = 0.005844 m/sec. The error introduced by the calculation is the inaccuracy in the measurement of the small flow rate. Since the measured value is lower than the actual value, we take t_2 to be 45 seconds.

(2) Determination of t_1

Using the physical parameters at a presumed average water temperature $\overline{T}$ and using the known value of T_u, Eqs (3) and (6) can be iterated to find T_ℓ and t. Using the experimental T_ℓ = 27.3°C and T_u, we found that, from Eq.(3), the water entering the element stops at the bottom of the element 14 seconds before flow inversion. Thus, $t_1 = t_2 - 14$ sec = 31 sec.

(3) Determination of t_3

In the calculation of T_u for the water to return from the lower opening to the upper opening of the element, Eq.(6) may be rewritten as

$$T_u - T_\ell = 2\left[\frac{2H\bar{q}^2}{\bar{\beta} g \bar{\gamma}^2 \bar{C}_p^2 b^2}\right]^{\frac{1}{3}}$$

In this equation, we first choose a value for T_u and find the physical parameters for the temperature $\overline{T} = (T_u - T_\ell)/2$ and iterate until the value of T_u is basically equal to the value chosen. In this calculation, we obtained T_u = 46°C and the experimental value was 43°C. Substituting T_u into Eq.(4), we found that it took 9 seconds for water to return from the lower end to the upper end of the element. Thus, $t_3 = t_2 + 9$ sec = 54 sec.

2. Determination of the average temperature rise of the element

An examination of the entire flow inversion process reveals that the total heat released by the element consists of the heat carried away by the water and the heat used to raise the element temperature. We may therefore reduce the time dependent thermodynamic problem to a steady state problem.

(1) The total amount of heat released by the elements from t_1 to t_3 is given by

$$Q_1 = \bar{q} F (t_3 - t_0) = \bar{q} F t_3 \quad (t_0 = 0) \tag{12}$$

As stated earlier, $\overline{q}$ = 1.89 kcal/m^2sec, F = 1.395 m^2 and t_3 = 54 sec. Substitution into Eq.(12) yields Q_1 = 142 kcal.

(2) Heat carried away by water from t_o to t_3

Suppose that the heat carried away by the part of water that flows out of the lower port of the element container is Q_2' and the amount of heat carried away by the part of water that undergoes flow inversion and flows out of the upper port of the container is Q_2''. Then $Q_2 = Q_2' + Q_2''$ and

$$Q_2' = \overline{\Delta T} G_0 \int_0^{t_1} e^{-0.23t}\, dt \tag{13}$$

where

$$\overline{\Delta T} = \frac{T_{u,t_1} - T'_{u,t_0}}{2} = 5℃,$$

The calculated result is $Q_2' = 69.56$ kcal. Since

$$Q_2'' = \frac{T_{\mu,t_3} - T_{\mu,t_1}}{2} \times \bar{\gamma} \times f \times 2H \times C_r = 56 \text{ kcal}$$

we finally have $Q_2 = 125.56$ kcal.

(3) Calculation of the temperature rise of the element

The average specific heat of the element body is

$$\overline{C}_{element} = \frac{M_{core} C_{core} + M_{clad} C_{clad}}{M_{core} + M_{clad}} = 0.188 \text{ kcal/kg°C} \qquad (14)$$

where M and C are respectively the mass and the specific heat of the elements. Thus, the average temperature rise of the element in the flow inversion process is

$$\overline{\Delta T} = \frac{Q_1 - Q_2}{(M_{core} + M_{clad})\,\overline{C}_{element}} = 24.98 \text{ °C} \qquad (15)$$

3. Calculation of the surface temperature of the fourth layer sleeve of the element

The temperature difference between the coolant and the element surface temperature during flow inversion is

$$\Delta\theta = \frac{q(z)}{\lambda}\delta \qquad (16)$$

where

$$q(z) = \overline{q(z)}\frac{\alpha(z)}{\overline{\alpha(z)}} \qquad (17)$$

Here $\alpha(z)$ is the relative distribution of the axial flux of the central element container, z is the axial coordinate with the origin taken at the grid plane, $\overline{\alpha(z)}$ is the average distribution of the axial neutron flux, λ is the thermal conductivity of water in kcal/m hr °C, and δ is the half-width of the water gap in meters.

The temperature rise in the axial direction is

$$\overline{\Delta T}_{element}(z) = \overline{\Delta T} \cdot \frac{\alpha(z)}{\overline{\alpha(z)}} \qquad (18)$$

The axial distribution of the water temperature in the element container from the top to the bottom during flow inversion is given by

$$T_f(z) = (T_{\square}, t_3 - T_{\square}, t_2)\frac{\int_0^z \alpha(z)\,dz}{\int_0^H \alpha(z)\,dz} + T_{\square}, t_2 \qquad (19)$$

The axial distribution of the element surface temperature is

$$T_w(z)=T_f(z)+\Delta\theta(z)+\Delta T(z) \tag{20}$$

The calculated results are listed in Table 2.

Table 2. Central element surface temperature during flow inversion

A	1	2	3	4	5	6	7	8	9	10
axial $\alpha(z)$	0.5856	0.8370	0.9669	1.014	1.0254	0.996	0.8039	0.6039	0.3784	0.4229
$\int_0^z \alpha(z)\,dz$	0.6137	1.343	2.2489	3.2349	4.2546	1.25	6.135	6.839	7.33	7.73
$\int_0^z \alpha(z)dz / \int_0^H \alpha(z)dz$	0.0817	0.1777	0.2904	0.4184	0.5504	0.6792	0.7936	0.8847	0.9483	1.00
$T_f(z)$,℃	26.99	28.00	29.45	30.98	32.55	34.08	35.44	36.53	37.28	37.90
$\Delta\theta(z),\overline{\alpha(z)}=0.773$	9.7	13.87	16.03	16.81	17.0	16.0	13.33	10.01	6.27	7.01
$\Delta T(z)$,℃	18.92	27.05	31.24	32.76	23.12	31.219	25.98	19.15	12.22	13.666
$T_w(z)$,℃	55.59	68.92	76.72	80.55	82.55	82.68	74.74	66.14	55.77	58.57
T_w*4,7,8measured		T_{w8} 67.73	T_{w4} 96.95	T_{w7} 76.08						

A : axial measurement points from bottom to top, Δz = 100 mm.

*Only three axial measurement points for the central element surface temperature.

IV. Conclusion

In the flow inversion experiments, the measured values of T_{W4}, T_{W8} and T_{W7} of the central element container agreed well with the calculated values. Based on the measurement results, a safe and reliable power level was determined for residual cooling pump shutdown.

The author thanks Li Shimo [2621 1102 2875] for assisting with the experimental design, Chen Daolong [7115 6670 7893] for providing the temperature measurement, data and the reactor crew for making the experiments possible.

References

1. P. J. Kpeyger, et al., Nuc. Eng. Design, 12(2), 231(1970).

9698
CSO: 4008/293

DEVELOPING NUCLEAR ENERGY: A MAJOR STRATEGY IN CHINA'S ECONOMIC CONSTRUCTION

Beijing HE KEXUE YU GONGCHENG [CHINESE JOURNAL OF NUCLEAR SCIENCE AND ENGINEERING] in Chinese Vol 4, No 1, Mar 84 pp 1-4, 15

[Article by Jiang Shengjie [5637 5110 7132] of the Ministry of Nuclear Industry received on 8 Nov 83: "Developing Nuclear Energy Is a Major Strategic Measure in Economic Construction in China"]

[Text] Abstract

The circumstances of the development of China's energy resources and the conditions of developing nuclear energy in China were analyzed. It is pointed out that developing nuclear energy is a fundamental strategic measure to solve the energy shortage in China. It is also an effective way to alleviate the energy deficiency in areas where transportation is in short supply. The technical policy for developing nuclear energy was presented.

For several thousand years, there were four major breakthroughs in understanding and utilizing energy resources by mankind, i.e., utilization of fire, discovery of steam engines, availability of electricity and development of nuclear energy. Each major breakthrough had a major promotional effect on the development of the national economy and progress in science and technology. The development of national economy, however, requires more energy. Hence, the consumption of energy in the world is rapidly increasing. In 1950, the total energy consumed in the world was equivalent to 2,600 Mt of standard coal. In 1970, it reached 8,500 Mt of standard coal. It increased dramatically to 9,800 Mt of standard coal in 1979 and it is estimated that it will reach 20,000 Mt of standard coal by the year 2000. By the year 2020, the world's energy consumption will be equivalent to 34,000 Mt of standard coal. The total reserve of petroleum and natural gas, however, is limited. Based on the present consumption rate, production will begin to decline after 1995, [and resources will] be exhausted in several decades. All the nations generally believe that coal is one of the most useful energy resources to replace petroleum in the short term. Therefore, coal production will increase significantly and reach a saturation point by the middle of the next century, still occupying around 25 percent of the energy resources. As for hydropower, 370,000 MW has already been developed in the world, and it will be fully developed by 2020. In view of the status of energy,

it is generally believed that the nuclear energy series represented by thermal neutron reactors, fast neutron breeder reactors and controlled fusion reactors is the most promising new energy source. It may become the major future energy resources for the mankind because thermal neutron reactors are applied in a large scale, fast neutron breeder reactors are already in an industrial demonstration stage and will be commercialized in the near future. These two types of reactors alone can ensure the needs of mankind for several hundred years. Fusion reactors use deuterium in seawater as the fuel. One ton of seawater contains deuterium equivalent to 350 t of standard coal in energy. The deuterium in seawater is inexhaustable. Fusion reactors can support the mankind for billions of years. Once it is successful, the energy resource problem is basically solved.

I. Developing Nuclear Energy - Trend of Energy Development in the World

Since the world's first nuclear power station (5000 kW power) was put on line in 1954 in the USSR, nuclear power has been widely developed. Many national and international energy resources research institutions generally believe that developing nuclear energy on a large scale is a fundamental measure to solve the energy problems in various countries and in the world during the latter part of this century and the early part of the next.

According to statistics in the August 1982 issue of the West German magazine Nuclear Industry and Nuclear Technology, the world has 273 nuclear power stations in operation. The total generating capacity reached 168,000 MW, which is over 8 percent of the capacity of the power stations in the world. There are 290 nuclear power stations under construction. In addition, 110 units are being planned. These nuclear power stations are located in 35 countries and areas in five continents. In addition to a considerable number of nuclear power stations already built in major developed nations such as the US, England, the USSR, France, West Germany, and Japan, developing nations are also urgently building nuclear power stations. Today, Yugoslavia, India, Argentina, Pakistan, Brazil, and South Korea have already constructed nuclear power stations. Over a dozen countries, including Romania, Egypt, and Mexico, are planning to build them. It is estimated that approximately 40 countries in the world will own nuclear power stations by the end of the century. The nuclear power generating capacity in most developed nations will reach 20-30 percent or more of the total power generating capacity.

It is worthwhile noting that not only the nations with little fossil fuel resources, such as Japan and western European countries, must rely on developing nuclear power to solve energy problems but also countries with abundant coal, petroleum, natural gas and water power resources such as the U.S., the USSR, and Canada have huge nuclear power development plans.

Given continuously increasing demand for energy resources, unstable petroleum prices and supplies, depletion of fossil fuel resources, and the as yet underdeveloped large-scale commercialization of other energy resources, developing nuclear power is a technological policy adopted by various countries after studying the situation and prospects of energy resources.

II. Developing Nuclear Energy - A Must for China Given the Status of Its Energy Resources

The supply and demand of energy resources is a contradiction which seriously affects the development of the national economy. Internationally, nuclear power plants have reached a commercial stage. The technology has matured, and is safe, reliable and economically viable. It has become the only new energy resource capable of alleviating the energy shortage on an industrial scale.

2.1 China Is One of a Few Major Energy Producing and Consuming Nations in the World

China is the world's largest energy consuming country. However, the average energy consumed per capita is very low. In 1980, the energy consumed per capita was only 610 kg of standard coal, which is only one-quarter of the average world level. Urban residents in China only consume 12 kilowatt-hours per capita per year, which is only a fraction of that in a developed country.

Most of the areas in China are short of electricity. Due to the power shortage, factories in many provinces are forced to stay open for 4 days and shut down for 3, or operate for 5 days and close for 2. In recent years, the power shortage per year was 40-50 billion kilowatt-hours, leading to a reduction of more than 20 percent in industrial productivity.

2.2 Demand for Energy Resources by the Grand Objective of Quadrupling the Economy

The twelvth conference of the Chinese Communist Party called for the quadrupling of agricultural and industrial production by the end of this century. It is a magnificent strategic goal. From the economic growth rate, it must grow by more than 7 percent per year. Until the year 2000, total energy production will only increase a little more than one-fold as compared to that in 1980. However, the growth rate of power generation must coincide with the rate of industrial growth. Electricity must also be quadrupled; 75 percent of the power generated in China will be produced by burning coal. Even if coal consumption is reduced by upgrading old plants technologically, there will be a shortage of 0.4 billion tons of standard coal before year 2000.

2.3 Uneven Distribution of Conventional Energy Resources in China Limits Production Development

Because of the extremely uneven geographic distribution of energy resources, there is a shortage of available transportation--a major constraint limiting the development of energy production. Today, transporting energy resources in China occupies 43-47 percent of the total national transportation capacity. We should accelerate developing and utilizing various energy resources, especially nuclear energy, in order to satisfy the strategic goal of quadrupling the economy.

Therefore, the energy structure should be changed in areas of shortage to provide electricity and heat by nuclear energy. Whether from the technological and

economic viewpoint or from the environmental protection angle, building large nuclear power plants in these areas is an important way to ease the energy shortage.

2.4 Nuclear Energy Heating Opened New Territory in Nuclear Applications

There is a shortage of petroleum resources in China, and the country has adopted a policy to curtail the burning of oil. In this context, the potential savings in "replacing oil with nuclear" are very large. It is new territory in nuclear energy applications.

Presently, most fuel consumed is not for generating electricity. Approximately 70 percent is used for industrial and residential heating. Because of the worsening shortage in petroleum and the desire to export more petroleum to obtain more foreign exchange, we are investigating the use of coal or nuclear energy to provide heat. The transmission of thermal energy, however, is more difficult. It will be necessary to adopt a relatively small-scale plant to generate both heat and electricity by nuclear power. In addition, the thermal efficiency of a nuclear power plant is only around 30 percent, while it may reach 90 percent for a nuclear plant designed for both heat and electricity. Such medium or small-scale nuclear plants can still be economically viable despite the higher construction cost per kilowatt. We are considering plans to supply industrial steam to large petrochemical plants by using nuclear energy. For example, Jinshan Petrochemical Plant in Shanghai requires a great deal of steam (approximately 500 t/h). Originally, this steam was supplied by an oil-burning furnace. Although we had considered using coal to replace oil, due to difficulties in transporting the coal and the possible detrimental effect on the quality of products from ashes and harmful gases released by burning coal, a plan to construct a small 450 MW nuclear heating plant was proposed to replace oil. In order to ensure the reliability of steam generation, two reactors will be built simultaneously, capable of producing 2 x 500 t/h of saturated steam at a pressure of 16 kg/cm^2. This heat supplying power plant plan has already been received and approved.

2.5 China Already Has Basic Conditions To Develop Nuclear Power

After 27 years of hard work, the nuclear energy industry in China has reached considerable proportions. A relatively complete scientific research and industrial system has been established. It is the foundation of military nuclear energy in China, as well as a sound basis for developing nuclear power.

In the aspect of uranium ore, preliminary exploration of reserves to date indicates that, in addition to satisfying military use, they are sufficient to operate pressurized-water reactor power plants representing 15,000 MW in installed capacity for over 30 years. Furthermore, there are still vast areas not yet surveyed. It is estimated that new ores can still be discovered. Technologically, China has the capabilities to exploit and smelt uranium ores, separate isotopes, fabricate fuel elements and process spent fuels. China has constructed and operated over a dozen experimental, production, and small power reactors, with experience in designing, installing, operating, and modifying reactors. A number of technical teams have been developed. The foundation of

building the equipment for a large nuclear power plant is also quite good. The production techniques of special structural materials used in reactors have also been mastered.

III. Nuclear Energy Development Policy in China

Developing nuclear energy is a long-term strategic measure to solve the problem of energy resources in China. It is also an effective way to alleviate the shortage of transportation in energy deficient areas. The conditions to develop nuclear power in China have matured. Premier Zhao announced in the First Conference of the Sixth People's Congress that "China will speed up developing the power industry from the standpoint of thermal power, hydroelectric power, and nuclear power." Recently, the state invited experts from around the nation to fully demonstrate our nuclear power policy. The experts unanimously believed that:

(1) China should choose pressured-water reactors in the class of light water reactors as the basic reactor type in first generation nuclear power plants before the year 2000.

(2) The single reactor power level in a Chinese nuclear power plant should be on the order of a million kilowatts.

(3) China already has the ability to develop nuclear power plants alone--300 MW prototype reactors have already been built. However, in order to speed things up, it should be ready to import foreign technology and equipment for larger nuclear power plants. Through its own scientific research, foreign technology will be digested, absorbed, and mastered. On this basis, we should create and develop our own technology to quickly realize domestic production of nuclear power plant equipment and build our own civilian nuclear industry system.

(4) In industrially developed but transportation-poor areas along the coast in China, a larger effort will be aimed at developing nuclear power. By the end of this century, China may build nuclear power plants up to 10,000 MW.

(5) The fuel for nuclear power plants must originate from inside China. It is necessary to produce more concentrated uranium to ensure the supply of fuels to nuclear power stations. To this end, we must develop the centrifuge method. Prospecting for uranium ores must be accelerated and economically viable reserves must be expanded. Scientific research related to the survey, exploration, and exploitation of uranium mines must be carefully managed.

(6) In order to conserve natural uranium and separation power, preparation should be made ahead of time to process spent fuel elements in civilian power generating reactors (to separate the uranium and plutonium for recycling).

(7) Most of the fossil fuels in China are used for heating. The utilization efficiency is very poor. It is an effective way to solve the power shortage in energy deficient areas by "using nuclear instead of oil" and "using nuclear instead of coal." Therefore, the reactor technology already under control in China should be used to study heat supplying nuclear power stations and regional

low temperature heat supplying nuclear power stations. The treatment and final desposition of radioactive wastes produced by nuclear power plants should be actively investigated.

IV. Exploitation of Nuclear Energy Technology and Outlook of Its Utilization

There should be a long-range plan for developing new reactors. A special fund is budgeted based on the principle of spending less and doing more. Furthermore, international collaboration should be fully utilized to prepare the technological work in order to catch up with further development in nuclear energy.

(1) From the long-range requirement of nuclear neergy development, it is necessary to build fast breeder reactors immediately in order to fully utilize 238U which exists above 99 percent in natural uranium as the energy source. We must intensify our scientific research on fast breeder reactors by the year 2000 in preparation for the construction of commercial reactors in the 21st century.

(2) The high-temperature air-cooled reactor is a new multi-purpose reactor capable of providing heat for high-temperature technologies. Furthermore, it can be used in the gasification and liquefaction of coal. Research should be started right away.

(3) The use of controlled fusion is a long-term direction in energy development. The experimental research on controlled fusion must be strengthened. A policy to link Chinese research with international exchange and cooperation should be accepted. During the "Seventh Five-Year Plan" period, design indicators for the "451" Tokamak already built should be met in order to prepare for the construction of an experimental ignition fusion apparatus.

In early 1980, there were great differences in opinion as to whether nuclear power should be developed. After over 3 years of investigation and demonstration, the viewpoint has become almost unanimous. It is generally believed that nuclear power is an important energy resource second only to coal and hydroelectric power in order to realize the goal of quadrupling the national gross product by the end of this century. Developing nuclear energy is an important strategic measure in the economic construction in China. A long-term plan for developing nuclear power should be drawn up and included in national economic planning. This planning should formulate the scale and rate of construction of nuclear power plants from a national angle, the technical path, the correlation between imported technology and developments made in China, the procedures to produce the equipment in China, and the sources of capital and personnel. The most important thing is to determine the overall objective of nuclear power development. It should be developed immediately in energy deficient areas such as Huadong, Dongbei, and Guangdong to alleviate the shortage and to contribute to the economy and personal income of the people. Furthermore, it acts as the foundation for the further development of nuclear energy in China in this century.

12553
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TARGET TRACKING DISPLAY SYSTEM SUCCESSFULLY DEVELOPED

Beijing GUOJI HANGKONG [INTERNATIONAL AVIATION] in Chinese No 4, Apr 84 pp 46-47

[Article by Zhang Keying [1728 0668 3841] and Zhou Zichuan [0719 5261 0356]]

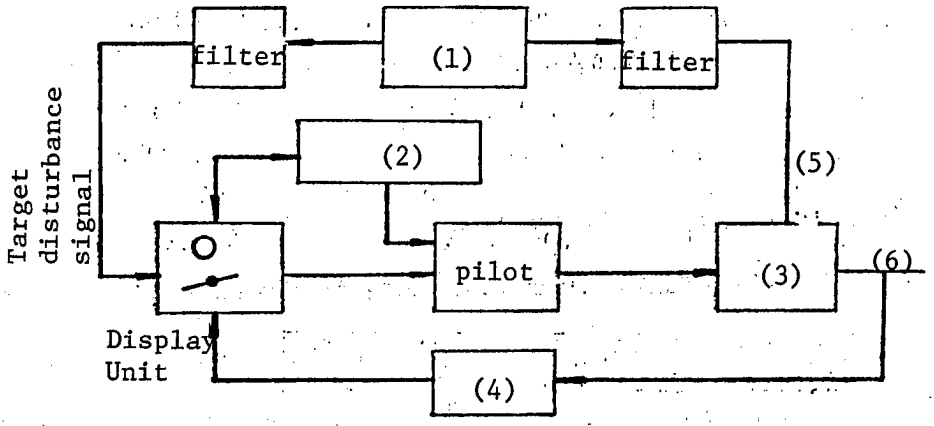
[Text] The flight performance of a manned aircraft depends on the closed-loop charactoristics between man and machine. Even the open-loop specification given in the flight performance manual is established according to the pilot's assessment of man-machine closed-loop characteristics. However, due to limitations in flight equipment, past studies of flight performance did not establish any systematic correlation between the pilot's qualitative assessment and the quantitative measurement of aircraft parameters. Since a pilot's qualitative assessment is based on the accomplishment of a particular flight mission, and the measured data on flight parameters are based on responses of typical control actions, it is difficult to draw general conclusions about flight performance based on the limited correlation between flight test results and measured data.

This article describes a Chinese-built target tracking display system which was developed to study the general relation of man-machine closed-loop performance. It was certified in September 1983. The system has four major components: the display unit, the hit efficiency calculator, the pseudo-random signal generator and the attitude gyroscope (see Figure 1).

Display Unit. The display unit consists of a 7-inch picture tube which can display two graphical symbols. One is a line segment with a bright dot in the center; it represents an image of the aircraft being controlled by the pilot. The length of the line segment can be varied to simulate the wing span of the aircraft. The image of the aircraft is controlled by the three attitude signals: pitch, yaw, and roll; the pitch, yaw, and roll motions of the aircraft are represented by movements in the vertical, horizontal and tilted directions on the screen. The other symbol is circular ring, which represents the distance between the target and the controlled aircraft. The target ring makes vertical and horizontal motions on the display screen which are controlled by the random disturbance signal.

When the geometric center of the controlled aircraft enters the target ring and remains inside the ring for over 0.7 seconds, and then a pulse signal is sent to the display unit, the circular ring on the screen will disperse and become much brighter, indicating that the target has been hit.

Figure 1: Schematic Diagram of the Target Tracking Display System



Key:

1. Pseudo-random signal generator
2. Hit efficiency calculator
3. System + aircraft
4. Attitude gyroscope
5. Simulated atmospheric distrubance
6. Aircraft motion

The display unit is located directly in front of the pilot's line of vision.

Hit Efficiency Calculator. Based on the error between the motion parameters of the two images, the calculator determines if the hit condition has been met; it also calculates the tracking efficiency and displays both the number of hits and the tracking efficiency with single-diget and two-digit numbers respectively.

1) Determining whether the target has been hit.

After the image center of the controlled aircraft has entered the target ring for t seconds (loop stabilization time), and the pilot pushes a fire-control button, the calculator will send a pulse signal to the display unit to indicate a hit. If either of the above two conditions is not satisfied, no pulse signal is sent. The value of t in the calculator can be varied to simulate different loop stabilization time.

2) Calculating the tracking efficiency.

Tracking efficiency is a measure of the pilot's performance in tracking the target. Figure 2 shows a schematic diagram of calculating the tracking efficiency. The formula for calculating tracking efficiency is

where:

$$\eta = \frac{\int_0^T (a^2 - \varepsilon^2)\,dt}{\int_0^T d^2\,dt}$$

式中: $\alpha^2 = A_X^2 + A_Y^2$ $(\alpha = OA)$

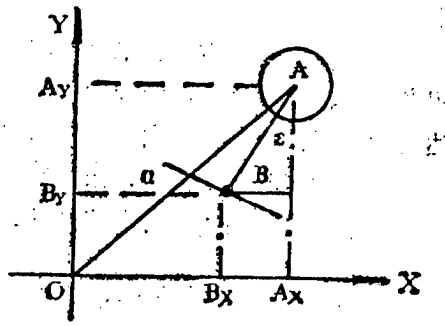
$\varepsilon^2 = \varepsilon_X^2 + \varepsilon_Y^2$ $(\varepsilon = AB)$

$\varepsilon_X = A_X - B_X$

$\varepsilon_Y = A_Y - B_Y$

T is the test cycle which may be 30, 60, 180, or 240 seconds depending on the test condition.

Figure 2: Schematic Diagram of Calculating Tracking Efficiency

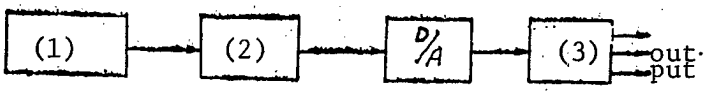


Pseudo-Random Signal Generator

It produces independent random signals in three channels, two of which are sent to the display unit for simulating disturbance motion of the target ring; the other is sent to the aircraft for simulating atmospheric disturbances (see Figure 1). The components and basic principle of the generator are shown in Figure 3.

The pseudo-random sequence generator generates a white noise sequence with uniformly distributed power spectral density over a wide frequency band; the sequence is passed through a digital filter to produce a slowly varying, narrow-band (determined by the transfer function of the digital filter) digital random sequence. It is then passed through a digital-to-analog converter to obtain a step-function continuous waveform; finally, it is passed through a smoothing loop to achieve the smoothed, desired signal.

Figure 3: Components and Principle of a Pseudo-Random Signal Generator



Key:

1. Pseudo-random sequence
2. Digital filter
3. Smoothing digital-to-analog converter

The generation of pseudo-random sequence and the digital filter operation are carried out by a single-board computer. The digital-to-to-analog conversion and the smoothing circuit are located on the same board; the entire computational procedure and the coefficients of various filter combinations are fixed in a read-only storage unit.

Based on the different filter characteristics and different forms of tracking, the pseudo-random signal generator can produce 12 different states, which can be selected according to the tracking mission.

Attitude Gyroscope

Vertical gyroscope: TPW-1A reflects changes in the aircraft pitch angle θ and tilt angle γ.

Bearing gyroscope: TH-5A reflects incremental changes in the bearing angle $\Delta\Psi$.

During tracking tests, the attitude gyroscope converts the attitude changes of the aircraft into voltage signals which are sent to the display unit to control the 3-degree-of-freedom motion of the aircraft image.

The target tracking display system is an important tool for studying man-machine closed-loop flight performance. Its main functions are as follows:

1) It provides the pilot two modes of tracking: chase tracking and compensation tracking. In the so-called chase tracking mode, the target and the aircraft are presented to the pilot as two independently moving images; the pilot's task is to control the aircraft to chase after the target, and try to maintain coincidence between the two. In the compensation tracking mode, the relative motion between the target and the aircraft images is presented to the pilot; the target image remains stationary, whereas the aircraft image moves in a random manner; the controlled motion of the aircraft is basically the difference between the two images. From the point of view of flight mechanics, these are two different tracking missions, and the pilot has different mathematical models in executing these two missions.

2) It can be used to study the characteristics of both three-axis and single-axis tracking. In the case of three-axis tracking, the target moves along a straight line in the x-y plane, and the aircraft performs pitch, yaw and roll motions along the three axes; the result provides an evaluation of the overall tracking performance of the man-machine closed-loop system. In the case of single-axis tracking, both the target and the aircraft perform single-degree-of-freedom motions, from which the tracking performance of the man-machine closed-loop system for a particular axis can be evaluated.

3) The system displays for the pilot the real-time tracking efficiency and the number of hits. These two parameters are auxiliary indicators of the man-machine closed-loop tracking characteristics which not only reflect the quality of the tracking performance, but also provide incentive for the pilot to strive for better combat results.

4) It can provide simulated atmospheric disturbance signals to flight simulators through the use of a servomechanism.

The main advantages of using this system to study the flight performance of man-machine closed-loop system are as follows:

1) It is economically more attractive than the method of using a fixed light ring to track an actual target, and using a photogun to read the relative position between the aircraft and the target. It has good repeatability because it does not involve actual flight of the target aircraft; also, while the motion of the target image is random and hard to perdict, it does follow a definite rule. In addition, this method provides easy coordination and data recording, thus resulting in improved test flight performance.

2) Its performance is better, and it provides more functions than a modified instrument tracking display system.

3) Not only is this system designated as special equipment for variable-stability aircraft, but it can also be used on flight simulators and prototype aircraft for flight performance certification.

In view of its capabilities and advantages, the target tracking display system will undoubtedly play an important role in future development of aviation technology.

3012
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RESEARCH ON MILITARY MEDICINE NEEDS CIVILIAN COOPERATION

Beijing JIEFANGJUN YIXUE ZAZHI [MEDICAL JOURNAL OF CHINESE PEOPLE'S LIBERATION ARMY] in Chinese No 1, 20 Feb 84 pp 74-75

[Article by Cheng Tianmin [4453 1131 3046]: "Lectures on Military Medicine"]

[Text] In the course of starting a new phase in China's socialist modernization, the integration of the military and civilian sectors with a dual purpose has become an important guiding principle of economic construction. In the medical and health professions, military units and local authorities should cooperate closely to strengthen research in military medicine. This can also have an important significance for implementing strategy and developing medicine.

Military medicine is the practice of general medicine in military units, particularly under wartime conditions. Since it is "military" medicine, it inevitably develops in accordance with the development of weapons and warfare. The most advanced science and technology frequently attains its initial applications, breakthroughs and development in the development of weapons systems (in the areas of launching, delivering and inflicting casualties). Taking total war, triphibious warfare and electronic warfare as important characteristics of modern war, new theories of military science and technology and war-making practice have raised many new problems for military medicine. For example, traditional thinking held that military units were at the front, and the civilian sector was at the rear, with a clear line of demarcation between the two; however, in modern warfare the distinction between front and rear is not so sharply drawn. It used to be that with conventional weapons the majority of the casualties were from bullet wounds, shrapnel wounds, bruises, etc.; but in modern warfare not only can there be large numbers of peculiar wounds from atomic, chemical and biological weapons, but there can also occur a great many new wounds, some prominent examples being wounds from high velocity light-weight materials, antitank missile burn syndrome, etc. Military medicine directly parallels changes in weaponry and the conditions of warfare, with continuous research on and the solution of new problems. Since it is military "medicine," it must develop along with developments in all of medicine. Military medicine (except for that part which is purely military) must take medicine in general as its foundation, and developments in military medicine can in turn promote the development of medicine in general. There is no lack of examples of this kind of mutually complementary dialectical relationship. For example,

in the fields of cytology and hematology, research into the making of blood and cells has provided important ways and methods for the treatment of extremely acute radiation injuries. In the field of radiation medicine, research into making blood and creating cells has again promoted development in the treatment of a plastic, common leukemia and such other blood diseases into transplant immunization, etc.

The close relationship between military and general medicine is due to the fact that there are very many common intrinsic relationships between casualties in military units in time of war and injuries in the civilian sector in peacetime. Important manifestations of these are: (1) the basic causes of illness (or injury) are all physical, chemical or biological; (2) fundamental pathological process (changes in function, metabolism and structural patterns) of the organs' reactions and their clinical manifestations are the same; (3) some illnesses or injuries which occur in military units or in wartime can also occur in the civilian sector and peacetime; (4) the fundamental principles and measures of treatment and prevention are the same; (5) research methods (a course of study, via technology, etc.) of each can quote or influence the other. However, when military medicine is compared to general medicine, it has its particular characteristics, notably: (1) In war, large numbers of casualties can happen suddenly and swiftly, as in the 1945 atom bomb raid on Hiroshima, during which in addition to the 106,000 killed on the spot, in less than a quarter of an hour there were 97,000 wounded, or as in the fourth Middle East war of October 1973, where in just 18 days both sides suffered 70,000 casualties. (2) There are many acute wounds and illnesses, many serious wounds, many multiple wounds and many compound injuries. (3) There can occur particular injuries and illnesses which are rarely if ever seen in peacetime. (4) Treatment is carried out under difficult conditions or field conditions. (5) Medical supplies can be depleted in large quantities. (6) The relationship between technology and duty is extremely close, and hygienic work depends even more on many aspects of the military, the government and rear-echelon units for direction, assistance and cooperation. We fully recognize that military medicine has similarities to general medicine, and its own characteristics, and that it can actively and organically put into practice the experience, conditions and methods of general medicine, while keeping in mind and stressing research on solving the problems of military medicine.

Research into military medicine must of course be assumed primarily by military units, but it also requires civilian participation. This is because in addition to the dialectical relationship between military and general medicine, there are also many urgent problems of military medicine which military units alone cannot completely study and resolve. Also, if there should be a sudden outbreak of widespread, large-scale war, one can imagine that the masses of dead and wounded could be so numerous as to far exceed even the number of personnel directly engaged in combat. Moreover, as far as the majority of military casualties is concerned, it will be necessary for military and civilian units jointly to provide treatment and jointly irradicate any future medical disasters resulting from combat (especially guarding against epidemics). Comrade Deng Xiao Ping has pointed out, "War can break out at any time. We absolutely must not waste our time but must intensify our preparations for war...." (In a talk before the Plenary Session of the Central Military Committee, in "Selected Works of Deng Xiao Ping," p 75). Not to make the best use of time

is to waste time. If during peacetime we do not pay close attention to the study of military medicine, and do not disseminate knowledge of military medicine, then we will pay a heavy price in wartime and suffer enormous losses.

How to strengthen the relationship of military and civilian units and their study of military medicine? I propose that a workable approach would be to have joint cooperation in medical education, scientific and technical interchange and organization of scientific research.

I propose that in civilian medical colleges there be increased content which deals with modern battle wounds; this will not necessarily require setting up new curricula, but subjects could be added to or integrated into existing courses. If it is the study of surgery, there should be increased content dealing with field surgery; if it is in basic medical courses, there should be more units and sections dealing with the particular wounds and injuries which can result in wartime. Naturally, there can also be special lectures offered in military medicine.

I propose that in the various scholarly activities of learning, and in learned societies, attention be given to gathering and discussing topics concerned with battle casualties: for example, a pathology society could interchange with battle pathology; a physiology society could interchange with battle physiology (wounds), or particular physiological reactions, etc. There should be a plan for opening up the publications of professional and popular literature on military medicine. In ZHONGHUA YIXUE ZAZHI [National Medical Journal of China] and other scientific journals, publish articles and lectures on subjects concerned with military medicine. Distribute throughout the entire nation the Chinese Army's important medical journal, JIEFANGJUN YIXUE ZAZHI [Medical Journal of Chinese PLA]. In order to increase the interchange between the military and outside, popularize knowledge of military medicine and share the direct burden still more, I propose that special columns be started to systematically introduce this aspect's fundamental knowledge and progressive content.

I propose there be an increase in joint scientific research, organizing concerned civilian units to assume direct responsibility for medical research that is specifically military in nature, moreover integrating peace and war, military and civilian, in a dual capability. Adopt an attitude of study and inquiry. As a first step, I wish to raise the following several study topics for your reference:

1. Integrate the establishment of peacetime urban civil air defense with the study of wartime urban defense problems. Approach the strategy and tactics of position, geography and topography, construction facilities, shelter conditions, population dispersal and evacuation, etc. from the standpoint of the special characteristics of urban areas. Study how different kinds of war (especially atomic war) result in cities suffering varying degrees of destruction, estimated depletion of numbers and the system of war relief; how to establish peacetime and wartime joint rear-echelon hospital bases; how to convert these rapidly from a peacetime to a war footing, etc. These aspects have already received considerable attention in other countries. For example, in the United States it has been estimated that if the Boston area were attacked

by air or ground nuclear weapons, the number of resultant dead and wounded would reach 2 million in either case. In the fourth Middle East war, Israel converted all its peacetime hospitals to a war footing just 4 hours prior to the outbreak of the war. In the first 4 hours of the war, they increased some of the hospitals' authorized bed space by 40-60 percent, or which 60-80 percent were empty beds, thereby speedily accomplishing their preparations for treating battle casualties.

2. Promote the idea that in both peace and war there be equally significant research into methods of treatment, for example, diagnosis of the location of damaged internal organs, microscopic surgery, transplants, etc. Promote research into major injuries or illnesses that can occur in either peacetime or war (for example, burns, frostbite, crushing injuries, etc.) We should also pay attention to research on peacetime injuries and illnesses that are similar to wartime casualties or to reactions to war wounds. An example here is the class of wounds which result from chemical toxicants such as organic phosphorous and cyanide; these are of the same class as the leukopemia which results from radiation, etc. Make sure that peacetime research results can be directly or indirectly transferred and utilized during wartime.

3. Promote equally research on epidemic prevention during peacetime and war. For example: exercise and fitness under specific natural conditions, collective and individual water supplies and nutrition safeguards and surveys of the natural sources of epidemic. We can also integrate earthquake relief with the study of precautionary information on the occurrence and development of epidemics.

4. Promote research in the basic theory of battle wounds, for example, internal complications, frequent visceral function exhaustion, casualty shock, infection, tissue repair, etc. Progress or breakthroughs in these areas would no doubt have equally important leading significance for both peacetime and wartime casualties.

5. There should be research on ways of increasing improvements in the more complex methods of treatment in peacetime, especially simplifying these so that they will be more useful in war.

6. There are some wartime casualties which are rarely if ever seen in peacetime, for example, acute radiation sickness or complications from radiation, etc. For these we can only concentrate on carrying out animal research experiments. But to what extent the animal results can serve for people, and how to make the transition of these results for use in clinical practice, is in itself an important subject for research. A great many civilian medical units can be of important use in this kind of "transition," for example, in the application of anti-radiation medicine in treating casualties and other illnesses.

7. In general, military and civilian cooperation in the mission of researching military medicine is urgently needed over a wide domain. The prospects are smooth and bright for us to make a joint contribution to the development of military medicine.

(Received October 1983)

12625
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LIFE SCIENCES

HOSPITAL REFORM WORK SUMMARIZED

Beijing JIANKANG BAO in Chinese 2 Oct 83 p 3

/Article by the policy research office of the general office of the Ministry of Hygiene: "Hospital Reform Work Must Be Resolutely Continued"/

/Text/ Recently we went to the two provinces of Heilongjiang and Jilin and came to understand the hospital reform situation at the county level and above, and our general impression is that the direction of hospital reform is correct, the work of pilot projects in reform has shown results, and the work of reform must be resolutely continued.

I. Progress in Hospital Reform and Its Major Characteristics

Judging from the several hospitals that we visited, they are all placing the major emphasis on the reform of management systems and management methods; have put into effect all kinds of responsibility systems that integrate responsibility, authority, and advantage; linked up the quality of the work of the various medical specialty offices and of individuals with a definite economic advantage; mobilized the enthusiasm of the broad mass of staff members and workers; done much work; and worked well, so as to serve their patients better. Though the forms of the responsibility systems are many, all have the following three common characteristics:

The first is fixing what tasks are to be performed. They are emphasizing making the improvement of the quality of service the main point of emphasis, and have formulated a set of standards for assessing quality. Harbin Medical College, for example, in order to step up quality management, have brought under their control all the various factors that influence the quality of medical treatment and other work, formulating target quality standards, controlling norms for various measures as well as the basis (system) for various working procedures, and summing up their statistical data, thus standardizing and normalizing their quality control. Jilin City's Fourth Medical College has proposed the requirement of "fixing five things, in order to guarantee five": fixing the number of personnel to be assigned, in order to guarantee the tasks to be performed; fixing the tasks, to guarantee safety and quality service; fixing standards of service, to guarantee patient satisfaction; fixing income and expenses, to guarantee the reasonable use of surplus cash; and fixing hygienic materials and management costs, to guarantee a reasonable degree of economy. They also

formulated standards for entering and leaving the hospital for 107 diseases; standards for deciding when those who have been cured must be sent home; and standards for outpatient care and ward management, the quality of basic nursing, and the quality of basic required technology. These methods have not only guaranteed the quality of medical care work, but also serve very well to heighten the professional and technical level of the medical service personnel.

The second is strict assessment of quality. A set of strict assessment methods has been formulated. Generally these all involve assessment at two levels, namely, an assessment by the hospital of the medical specialty offices, and assessment of individuals by the medical specialty offices. Harbin Medical College Hospital is assessing their medical specialty offices according to four major norms: for the quantity of work done, the quality of work, the quality of management, and according to an economic index. They have also added supplementary standards, such as those for attendance, hygiene, and service attitude. Those who score well have their allotment increased, and those who do not, have their allotment reduced. The assessment of individuals by the medical specialty offices differs according to the type of work, the nature of the work, and the conditions under which it is performed. For those whose work cannot be measured quantitatively, work procedures are formulated. Six assessment groups have been set up in the hospital, and each of the various medical specialty offices has set up an examination group with a part-time statistician, who maintains a policy of "record daily; discuss and appraise the results weekly; pool the data monthly; and decide on awards through discussion quarterly."

The third is the putting into effect of a system of rewards and punishments. The pilot hosptials' allotment of reward money is based on a system of 200 points (100 points for the medical specialty offices and 100 points for individuals), with points being calculated or deducted according to the medical specialty offices' and the individuals' completion of tasks, and the reward money distributed according to the number of points earned. This method increases the differences in the number of points earned, overcoming egalitarianism in the allotment of reward money, and implementing comparatively well the principle of more reward for more labor.

II. The Results of the Reform

Judging from the hosptials we visited, the reform in all cases has obtained clear results, principally in the following three areas:

A. Outpatient care and the number of patients in hospital have universally increased, alleviating the problem of the difficulty of being examined and staying in hospital. The responsibility systems have mobilized the enthusiasm of the hospital service personnel and all of the staff and workers. Their sense of responsibility has been strengthened; their concept of work discipline has been reinforced; and everyone actively thinks up new methods to tap potential, expand outpatient care, admit more patients into hospital, increase the rate of use of equipment and facilities, launch new areas of professional activity, and strive to do more for the patients. The hospitals' volume of outpatient care generally increased by more than 20 percent, and some patients urgently in need of hospital treatment and cure were admitted to hospital in time and

treated. The hospitals' technical medical specialty offices have taken the initiative to eliminate quotas, and in a timely way have fulfilled the patients' need for diagnosis. A good many hospitals also, as conditions dictate, are adopting administrative and economic measures to encourage and support the launching of housecall and family sickbed work, enabling some old and weak paitnets and those suffering from chronic diseases to be treated at home, to the great convenience of the masses.

B. Hospital administration has been strengthened, and the quality both of medical treatment and of service has been improved. With the responsibility systems, there is a clear division of work; responsibilities are concrete; there are standards for the quality of service and work done; there are systems for examination and assessment; and there are appropriate rewards and punishments. The restraining power of system, the motivating power of material rewards, along with the sense of honor that comes from striving to be advanced, cause everyone to make a great effort to learn as much as possible about their profession, improve their service attitude, and do good work. At many hospitals there appeared the heartening results of an increase in the rate of correctness of diagnosis, an improvement in the writing of medical records and an increase in the rate of timely and antiseptic healing of operative wounds, a strengthening of emergency diagnostic and treatment measures and an improvement in the rate of success of emergency treatment, a stepping up of basic nursuing work, a decrease in the number of patients who require constant looking after, a decrease in incidents of malpractice, and an increase in letters of praise from the masses. Heilongjiang Provincial Hospital, in order to improve its outpatient service, increased the number of waiting-room benches, increased the number of registration, cost determination, cashier's, and pharmacy windows, enabling the problem of "good in three areas and deficient in one" to be fundamentally solved. At the same time, specialized outpatient services were reinforced, and the system of housecall treatment by directors of medical specialty offices and physicians-in-charge was strengthened, effectively improving the quality of outpatient treatment.

C. Reasonable income was increased, so that hospital conditions are gradually improving. Through the hospitals' putting responsibility systems into effect, the various areas of professional work have been further developed, and the hospitals' income has correspondingly increased. At the same time, through economic management, economic business accounting has been strengthened, preventing waste and lost income, and increasing economic benefits. Many hospitals, using their increased income, have increased their medical treatment facilities, and improved conditions for serving the patients, and at the same time the material wellbeing of the staff and workers has been considerably improved.

The increase in the hospitals' income is largely dependent on improving work efficiency and the quality of service, and not on giving the masses any additional unreasonable burden. Taking Harbin Medical College Hospital as an example, to compare 1982, after the responsibility systems were put into effect, with 1981, outpatient service was increased by 50,000 persons teated; 2,113 more patients were admitted into hospital; income from professional services increased 23 percent; and a portion of the medical treatment equipment was fully utilized, increasing income by 30,000 yuan, an increase of 28.6 percent. For outpatient

services an average of 2.61 yuan was collected, an increase of only .25 yuan over the 2.36 yuan charged in 1981. From January through May of 1983, Harbin City's Fifth Municipal Hospital collected an average of 2.67 yuan per person for outpatient services, an increase of only .2 yuan over the 2.49 yuan collected in 1982, and the average cost per person for drugs was 1.72 yuan, an increase of only .07 yuan over the 1.65 yuan charged in 1982. The average cost of a day in hospital was 6.83 yuan, a decrease of .59 yuan from the 7.42 yuan charged in 1982, and the cost for drugs per day in hospital was 3.78 yuan, an increase of only .04 yuan over the 3.74 yuan charged in 1982. The reasons for these slight increases in average charges are mainly an increase in the price of drugs, along with the use of new medical treatment equipment and facilities.

III. Some Questions That Need of Clarification

A. The point of emphasis in reform should be placed on the strengthening of management. The road of hospital reform should be broad, but the emphasis should be placed on strengthening management. This is due to the fact that the management level in hospitals at present is very low; and if their backward aspect is to be changed, it will be necessary to begin with strengthening management. Only by establishing a scientific system of management will there by any improvement in the quality of hospitals or an advancement of medical science and technology. We should in the course of reform and in the course of our practice embark upon a new path of running hospitals that is appropriate to the situation of our country.

At present, the reform of the various pilot hospitals is making progress on the basis of economic management and post and responsibility systems, and some new scientific management features have been added, enabling management work to be further perfected. Tasks to be performed, quality of service, and required economic goals are generally being coordinated; technological management, administrative management, economic management, and post/responsibility systems are being combined; and management is being carried out in accordance with the procedures applying to the various systems, standards, assessments, and rewards and punishments. For this reason, we consider that one can use the name of "management responsibility systems" to summarize the responsibility systems being implemented in the present hospital reform. This designation can all the more serve to reflect the special characteristics and point of emphasis of the hospital reform, and is having a guiding effect on the reform's success.

B. It is necessary to maintain a correct guiding ideology. The aims of hospital reform are to strengthen the hospitals' leadership, improve the hospitals' management, mobilize the enthusiasm of all quarters, improve the quality of medical treatment, and improve service attitude. At the same time, through a reasonable increase of income and management of expenditures, the hospitals' income is being increased. The reform is for the purpose of establishing good, socialist hospitals, and serving the people and the masses better, and definitely not for the purpose of making more money and getting more rewards. At present there are a small number of hospitals in the course of whose reform have appeared the bad tendencies of "in everything, considering money" and "indiscriminately writing a big prescription," and these should be resolutely opposed.

Should a strengthening of economic management and an interest in economic benefits be important features of hospital reform? The answer should be a positive one. This is because in the activities of hospitals, recompense for the various kinds of labor is all manifested in money, and price regulations, in each and every area, have an effect. Economics is the basis on which we do a good job of running hospitals. We need to strengthen the economic management of hospitals, strictly implement economic accounting in accordance with the policies of the state, and organize a reasonable increase of income along with a careful management of expenses. The view that hospitals are welfare enterprises and that one should not have business accounting or stress economic advantage is incorrect and harmful. However, we certainly cannot engage in the practice of "in everything, consider money." We should, through reform, mobilize the enthusiasm of the staff and workers, improve our work efficiency and the quality of our service, avoid waste, and be economical in our expenditures, and by these means increase our economic income--this is what we advocate. The hospitals should also resolutely implement a combined system of commendations and material rewards. The hospitals' reward money should have the effect of rewarding the diligent and punishing the lazy, encouraging the advanced, and goading on the backward; we cannot engage in egalitarianism. Under general circumstances, the collecting of reward money should be resolutely controlled within the scope of state regulations, or should be subject to approval.

C. The forms of responsibility systems within hospitals can be of many kinds. Medical specialty offices within hospitals are many, and their circumstances complex. The tasks to be performed, and the styles of service, of the various medical specialty offices are different, and so the situations of their economic income are also different. For this reason, in putting management responsibility systems into effect within a hospital, these should not be all of one type, but many types should be adopted, based on the special characteristics of the various specialty offices. The experience of some pilot hospitals demonstrates that this way of doing things is comparatively beneficial.

In outpatient and inpatient clinical specialty offices, the method of "five determines and one reward" can generally be adopted, i.e., fixing the tasks to be performed, the quality of service to be attained, the degree of management to be implemented, and the amount of income to be generated and, on the basis of how well the tasks were performed, putting into effect a system of rewards and punishments. The various quotas can be broken down and implemented with respect to people, but the economic quotas will also not be transmitted directly to individuals at lower levels, in order to avoid increasing the unnecessary burden of the masses.

In medical technology specialty offices, the method of contracts can generally be put into effect experimentally, and a system of deductions put into effect for those who exceed the quota, but the proportion of the deductions must be reasonable, and the total amount obtained must be appropriately controlled.

Due to the fact that the rear-service departments are responsible for so many different kinds of work and there are such big differences between them, generally, based on the different kinds of work they are engaged in, for some of them a system can be put into effect in which they are responsible for expenses

and the amount of work to be done, and are allowed to retain and use the surplus; for others, a system of independent business accounting can be put into effect, with responsibility for gains and losses; and for others a system of contracts or a piece-rate wage can be put into effect.

For the hospital leadership and medical specialty administrative offices a post/responsibility system can generally be put into effect and, based on duties and division of labor, and the standards of work quality, assessments carried out.

D. We must strengthen ideology and political work. Hospital reform is a revolution of tearing down the old and establishing the new, and in order to guarantee the successful progress of this revolution it is necessary to strenghen ideology and political work. Only if there is vigorous ideology and political work can we guarantee that our hospital reform from beginning to end will maintain a correct direction; only then will we be able to solve the problems of ideology and understanding that continually appear in the course of good reform; and only then can we establish the psychology of serving the people with one's whole heart and mind, and socialist medical virtue and medical practices. It is the major guarantee for doing a good job of reform and doing a good job of running our hospitals.

From the point of view of the situation in the entire country, hospital reform work above the county level is at present still limited to experimental units, and has not been carried out in the great majority of hospitals. Due to the limitations of the state's presently-operating personnel, wage, and financial systems it is still not possible for us to carry out a fundamental reform of hospital management systems, particularly the problem of their right of autonomy, but management responsibility systems are something that we can set our hand to putting into effect on an experimental basis in all hospitals, and the various localities can gradually expand the scope of the pilot projects. The pilot hospitals, on the basis of their own conditions, can put them into effect experimentally on a comprehensive basis, and can also put them into effect experimentally in a portion of their medical specialty offices; all types and methods can be experimented with, the experience gained from the experiments summarized, and the methods gradually perfected.

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LIFE SCIENCES

COMPUTERS APPLIED TO PREDICT, PREVENT HEREDITARY DISEASES

Beijing JIANKANG BAO in Chinese 29 Jan 84 p 1

/Article by Xu Huaijin /1776 2037 6855/: "Shanghai's Application of Computers to Study Hereditary Laws of Hereditary Diseases Involving Many Genes Achieves Heartening Results"/

/Text/ Wu Baoxin /0702 1032 9515/ and Zhang Huasong /1728 5478 1345/, teachers of the electronics teaching and research group of the departments of electrical engineering and computer science of the Shanghai College of Communications, together with Dr Hu Danning /7579 6130 1380/ of the diseases involving many genes study group of the Shanghai Genetics Society, have completed scientific research of major significance--the application of computers to the study of laws operating in the transmission of hereditary diseases involving many genes--which was the subject of deliberation last December by Shanghai's Municipal Bureau of Higher Education.

Hereditary diseases involving many genes are some frequently seen human diseases determined by a combination of the environment and heredity, such as coronary heart disease, high blood pressure, glaucoma, psoriasis, schizophrenia, etc., those affected amounting to about 15 percent of our country's population, having a great influence on people's health and on the quality of our country's population. The results of this research solved the problem of devising computer algorithms and programs to compute the transmittability of hereditary diseases involving many genes, so that it was possible to launch the work of consulting the computer to determine the contractability rate of hereditary diseases involving many genes in problematical geneologies. At the same time, they also used computers to formulate charts showing the transmittability of the three diseases glaucoma, coronary heart disease, and psoriasis, in order to extend the benefits of the transmittability/predictability work in multigene hereditary diseases to medical care units that are still not yet equipped with computer facilities, enabling this kind of disease to be prevented.

The methods and procedures provided by the results of this scientific research, transmittability charts for three diseases formulated on the basis of our actual domestic situation, are convenient to use, easy to disseminate, and are applicable clinically. Research into the laws governing the transmission of hereditary diseases involving many genes will have an important effect on launching the prevention and cure of hereditary disease in China, implementing our population policy of producing fewer and better quality people, and improving the quality of the population.

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BRIEFS

NEW ARTIFICIAL BLOOD VESSEL--The Suzhou Silk Textile Sample Factory, with the close coordination of the Shanghai Thoracic Hospital, has developed a machine-woven, polyester fiber, maoxian /3029 4848/-shaped artificial blood vessel. Put to clinical use, the results have been excellent, and it recently won the third-class national prize for invention. Three years ago, a doctor excised a section of 15-year-old Shih Wei's shrunken, narrowed aorta, and implanted a 5.5 cm long, diameter 2 cm, maoxian-shaped artificial blood vessel. A month later the patient, recuperated, left the hospital. This was our country's first clinical application of a maoxian-shaped artificial blood vessel. Up to the present, Shanghai Thoracic Hospital and Beijing's Fu Wai Hospital have successfully implanted this type of artificial blood vessel in the bodies of several tens of cardiovascular patients. The machine-woven, polyester, maoxian-shaped artificial blood vessel is the second generation of polyester artifical blood vessel developed by our country; it employs a distinctive structure in its walls; has good elasticity; is easy to suture; and does not have to be solidified in advance, thus avoiding leaks and the formation of blood clots. Following implantation, within a short time the cells of the corium begin to grow into it, forming a new inner lining for the blood vessel, and healing excellently. This new type of artificial blood vessel is an innovative product of our country. /Text/ /Beijing RENMIN RIBAO in Chinese 22 Feb 84 p 3/ 9634

UNUSUAL BLOOD TYPE DISCOVERED--According to a report in JIANKANG BAO, Beijing researchers on red blood cell groups in cooperation with Japanese experts have discovered the first example in our country of the K^0 antigen. In accordance with the 5-year cooperative research plan of the Red Cross organizations of China and Japan, from 18 November to 6 December last year the Beijing Red Cross Center's blood bank, and the Japanese Red Cross blood transfusion technical delegation engaged in joint research on red cell groups. While examining the phenotypes of 11 red cell blood group systems on healthy blood donors, the researchers discovered our country's first example of the K^0 red cell antigen, adding new material to establish a standard blood group system in our country. The K^0 antigen is one of the rare blood groups among red cells. At present only 50 examples of this blood phenotype have been discovered throughout the world. The discovery of the K^0 antigen in China further confirms the diversity of our country's red cell blood groups and the wide range of distribution of unusual blood groups. /Text/ /Beijing RENMIN RIBAO in Chinese 9 Feb 84 p 3/ 9634

GLOBAL MEDICAL TELESYMPOSIUM--Beijing, 16 May (XINHUA)--Ninety Chinese ear, nose and throat specialists and neurosurgeons from 14 cities joined the first international medical telesymposium last night in Beijing's telecommunications building. The symposium was organized by the American Telephone and Telegraph Company through global communication satellites. Together with experts from 42 countries and regions, the Chinese specialists listened on television and telephone to Professor Madjid Samii making a report in Hanover in Federal Germany on treatment of acoustic neurinomas, a difficult operation on ear tumors. Professor Feng Chuanyi of Beijing's capital hospital discussed the subject with Professor Samii on behalf of all the Chinese participants. [Text] [OW161107 Beijing XINHUA in English 0902 GMT 16 May 84]

RURAL HEALTH SERVICES LOAN--United Nations, 18 May (XINHUA)--The International Development Association (IDA) will lend China 80 million special drawing rights (equivalent to 85 million U.S. dollars) for a project to expand rural health services and train high-level health professionals. The project will cost a total of 322.8 million dollars, with the remaining 237.8 million dollars to be contributed by the Chinese Government. In announcing the decision in a news release issued here today, the IDA said, "China has had significant success in improving the health of its people," attributing the success largely to China's emphasis on preventive over curative services and its devotion of substantial financial resources to health care. "China also pioneered the development of community-financed auxiliary health workers," the IDA bulletin added. Specifically, the project will finance the expansion and upgrading of facilities in 46 counties in the provinces of Heilongjiang and Sichuan and in the Ningxia Hui Autonomous Region. Additionally, the project will finance technical assistance for public health, preventive medicine, policy analysis and research as well as measures designed to improve the quality of teaching and research at 13 medical colleges. The credit is for 50 years, including 10 years of grace, with annual charges of 0.75 percent on the disbursed amount and 0.5 percent on the undisbursed balance. [Text] [OW190916 Beijing XINHUA in English 0843 GMT 19 May 84]

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TITLE: "Ten Years Medical Follow-up of Four Persons Accidentally Exposed to ^{60}Co γ-Rays"

SOURCE: Beijing ZHONGHUA FANGSHE YIXUE YU FANGHU ZAZHI [CHINESE JOURNAL OF RADIOLOGICAL MEDICINE AND PROTECTION] in Chinese No 2, Apr 84 pp 20-24, 69-70

TEXT OF ENGLISH ABSTRACT: Four cases of acute radiation injury resulting from accidental exposure to a ^{60}Co source in February, 1972, were subject to early medical examination and followed-up for 10 years. Their whole body exposure doses were estimated to be 55~147 rads. The results showed that in the individuals who had received a single dose below 147 rads, the temporary clinical picture and the injuries to hemopoietic function and the male reproductive system were all recoverable, but the chromosome aberrations yield returned to normal slowly. Ten years after the accident, each of the four subjects was in good health, and no cataract or malignant diseases were observed. No obvious abnormalities were found in their children.

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TITLE: "Diagnosis of 20 Cases of Chronic Radiation Syndrome"

SOURCE: Beijing ZHONGHUA FANGSHE YIXUE YU FANGHU ZAZHI [CHINESE JOURNAL OF RADIOLOGICAL MEDICINE AND PROTECTION] in Chinese No 2, Apr 84 pp 25-27, 70

TEXT OF ENGLISH ABSTRACT: Twenty cases of chronic radiation syndrome were diagnosed in our department during 1957-1980. All except one were radiologists, and eight of them had worked in radiological departments for over 20 years. Due to the use of out-dated X-ray machines as well as exposure to radium sources without adequate protection, all these cases were apparently overexposed to radiation.

They presented the following signs and symptoms of chronic radiation syndrome: excitability, palpitation, fatigue, general weakness, loss of weight, over-sweating accompanied by a tendency toward lowered matabolism, peripheral blood cell changes, and chromosome aberrations.

The diagnosis of this syndrome was based on definitive professional and overexposure history, clinical pictures and abnormal laboratory findings.

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