People's Republic of China

Ex-Post Evaluation of Japanese ODA Loan Project

"Dalian Environment Model City Project (1) (2)"

External Evaluator: Junko Miura, Global Link Management, Inc.

0. Summary

Environment Model City Projects were implemented in Dalian, Chongqing and Guiyang Cities in order to improve environment by carrying out air pollution control intensively and by building environmental monitoring system, under the "Environment Model City Framework[1]", which was aiming to replicating the good practices of the projects in other cities in China. As Dalian City's energy structure depends on coal, Dalian City was facing serious air pollution along with recent industrialization and increase of vehicles. Thus, it was urgently needed to take actions in air pollution control. Regarding the reduction in the emission of air pollutants such as Sulfur Dioxide[2] (SO_2) and Total Suspended Particular[3] (TSP), expected effects have been observed almost as planned in the four sub-projects, in which actual data were confirmed. Regarding the one sub-project in which actual data could not be confirmed directly with the implementation agency, as far as known from the available information, there was no such evidence that the plants emit pollutants beyond the environmental standards. In addition, effects other than indicators and positive impacts were also observed. Therefore, effectiveness and impact of this project is high. Regarding efficiency of this project, the project cost exceeded the plan, and the project period also significantly exceeded the plan, therefore efficiency of the project is low. Meanwhile, no major problems have been observed in the operation and maintenance system, technical level, and operation and maintenance status of the implementing agency of each sub-project. Financial situations are also stable. Therefore, sustainability of the project effect is high. In light of the above, this project is evaluated to be satisfactory.

1 The framework was proposed at the Japan-China Summit in 1997.

2 SO_2 is one of the major air pollutants. It is generated by burning the fuels including sulfur such as coal or oil. SO_2 is one of the causes of acid rain.

3 TSP is particulate matter which is less than 100 micron in diameter. Smoke dust is one of the smokes. It is solid particulate matter such as soot and burned embers.

1. Project Description

Project Location

Dust remover installed at the tail of kiln

1.1 Background

In China, along with steady economic growth since 1980's, environmental pollution had been worsened due to industrialization and population growth. Particularly, emission of SO_2, TSP and Nitrogen Oxide[4] (NOx) was serious due to the combustion of coals as industrial materials, power generation and heating materials. As a result, density of SO_2 and TSP of the major cities in China was too high to meet the National Environment Ambient Air Quality Standards Grade II[5] (hereinafter refers as the National Standards Grade II).

The target area of this project, the urban areas in Dalian City, also faced serious air pollution problems along with rapid industrialization and the increase of the number of automobiles. Although air pollution in Dalian City was not serious as much as in Guiyang and Chongqing, the dependency rate on coals as energy sources was as high as 69%. SO_2 density in winter exceeded the National Standards Grade II. Under this circumstance, Dalian City was selected as one of the model cities of the "Environment Model City Framework", then this project was implemented.

1.2 Project Outline

The objective of this project is to improve the air quality in Dalian City, by following sub-projects: 1) (then) Dalian Pharmaceutical Factory[6] Environmental Protection Project; 2) Thermal Power Station Project in Yandao Chemical Area; 3) Chunhai Thermal Power Station Extension Project; 4); Dalian Cement Plant Dust Pollution Treatment Project; and 5) (then)

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[4] Nitrogen Oxide is one of the pollutants which are generated by burning of coals or traveling of vehicles. It is one of the causes of photochemical smog.

[5] These national standards were established for the density of air pollutants such as SO_2, TSP and NO_2. The standards were divided into three grades and Grade I is the most strict standards. Grade I standards are applied for natural conservation area. Grade II standards are applied for commercial, residential and agricultural and general industrial areas. Grade III standards are applied for special industrial area.

[6] Dalian Medicine Group Dalian Pharmaceutical Factory has changed to Dalian Merro Pharmaceutical Company in 2000.

Dalian Steel[7] Plant Air Pollution Treatment Project; thereby contributing to the improvement of the environment of Dalian City. The location of the project site is shown in Figure 1.

Figure 1 Location of Project Site

Approved Amount / Disbursed Amount	(I) 5,315million yen/ 2,273million yen (II) 3,202million yen/ 3,116 million yen
Exchange of Notes Date / Loan Agreement Signing Date	(I) March, 2000/March 2000 (II) March, 2001/March 2001
Terms and Conditions	Interest Rate: 0.75%; Repayment Period: 40years (Grace Period: 10 years); Conditions for Procurement: Bilateral Tied
Borrower / Executing Agency	The Government of the People's Republic of China / Dalian Municipal People's Government (DMPG)
Final Disbursement Date	(I) May 2006, (II) July 2010
Main Contractor (Over 1 billion yen)	Dalian International Company (China), Marubeni (Japan).
Main Consultant (Over 100 million yen)	NA
Feasibility Studies, etc.	Feasibility Studies were conducted as follows. 1) Dalian Pharmaceutical Factory Environmental Protection Project: Shanghai Pharmaceutical Design Institute (June 1996) 2) Thermal Power Station Project in Yandao Chemical Area: Shengyang Color Metallurgy Design Institute (May 1998)

[7] Dalian Iron and Steel Group Co. Ltd. was changed to Dongbei Special Steel Company in 2004.

	3) Chunhai Thermal Power Station Extension Project: Heilongjiang Power Design Institute (January 1998) 4) Dalian Cement Plant Dust Pollution Treatment Project: Tianjin Cement Industrial Design Institute (December 1999). For the relocation: Nanjing Cement Design Institute (February 2005). 5) Dalian Steel Plant Air Pollution Treatment Project: Beijing Steel Design Institute (March 2000).
Related Projects	◆ Environmental cooperation with Kita-kyushu Municipal Government (1992-1995). ◆ Development Study "Dalian City Environmental Model Area Development Plan" (1996-2000).

2. Outline of the Evaluation Study

2.1 External Evaluator

Junko Miura, Global Link Management

2.2 Duration of Evaluation Study

Duration of the Study: August 2011 to September 2012

Duration of the Field Study: November 13th to 26th, 2011 and March 5th to 15th, 2012

2.3 Constraints during the Evaluation Study

The following two points were identified as the constraints in terms of effectiveness.

Chuhai Thermal Power Station aimed at reducing air pollutant emission amount by replacing large scale boilers with medium-small scale boilers; however, it was not possible to verify the operating situations of the installed facilities and actual data of the reduced amount of air pollutant emission due to the following reasons: this project was implemented completely by local funds; its implementing agency's management has changed; and the location of the station was also relocated. Consequently, evaluation of this sub-project was done using supplemental information by the Dalian Environment Protection Bureau (hereinafter refers as the DEPB).

Regarding the Dalian Steel Plant Air Pollution Treatment Project, independent SO_2 emission data of the facility covered under this project was not available. Thus, regarding the reduced amount of SO_2 emission by introducing the project facilities, this study compared the target, which was set at the time of the appraisal, with the estimate, which was obtained at the time of the ex-post evaluation.

Based on the above evaluation constraints, judgment of effectiveness was done.

3. Results of the Evaluation (Overall Rating: B[8])

3.1 Relevance (Rating: ③[9])

3.1.1 Relevance with the Development Policy of China

3.1.1.1 Development Policy at the time of appraisal

At the time of appraisal (2000), China's 9th Five-Year Environmental Protection Plan (1996-2000) set the following specific objectives: decrease in the major pollutants emission to the level of 1995; and achieve the emission standards at industrial pollution sources. The Government of China introduced the concept of "SO_2 pollution control area" and "acid rain control area" [10] by the revision of air pollution control regulations in 1995[11], and took intensive actions by designating those areas in 1998. In order to take further actions for improving the environment, the 10th Five-Year Environmental National Protection Plan (2001-2005) targeted reducing the emission of major pollutants by 10% compared with the year of 2000; and decreasing the total SO_2 emission amount in the above two pollution control areas by 20% compared with the year of 2000.

The Dalian's 9th Five-Year Environmental Protection Plan (1996-2000) and the Long-term Plan towards 2010 targeted the achievement of the National Standards Grade II by 2005 regarding the annual average air pollution density. The target values are shown as below.

Table 1 Target annual average of air pollution density in Dalian City

Unit: mg/ m^3

Pollutants	National Standards II	Year 2000	Year 2005	Year 2010
SO_2	0.06	0.05	0.04	0.014
TSP	0.20	0.18	0.15	0.034
NOx	0.05	0.06	0.05	0.07

Source: JICA appraisal documents

In order to achieve the above targets, the following directions were announced: 1) reallocation of industries and restructuring of industry by city planning such as the relocation/reconstruction of primary pollutant sources; 2) strengthening the prevention of

[8] A: Highly satisfactory, B: Satisfactory, C: Partially satisfactory, and D: Unsatisfactory.

[9] ③: High, ②: Fair, and ①:Low.

[10] SO_2 pollution control area is the area of serious contamination of SO_2. Acid rain control area is the area where acid rain occurs or where there is a possibility that acid rain will occur in the future. Dalian urban areas are designated as SO_2 pollution control area.

[11] The basic framework of air pollution control in China is regulated by Air Pollution Action Law. It was enacted in 1987, and it was revised in 1995 and 2000. The basic principle of controlling air pollutants emission is regulating the density of air pollutants at pollution sources. The State Council established the national environmental air quality standards and established national emission standards accordingly in order to achieve the air quality standards. The local government has a right to establish local standards for the parameters which the state government has not established and to establish local standards which are more strict than the state government.

industrial pollution and exclusion of negative impacts on air quality by the total volume control of pollutant emissions; and 3) strengthening the construction of the metropolitan environmental facilities comprehensively and building metropolitan functions by the expansion of the intensive heat supply system.

3.1.1.2 Development Policy at the time of ex-post evaluation

The 11th Five-Year National Environmental Protection Plan (2006-2010) targeted reducing SO_2 emission by 10%. The current 12th Five-Year National Environment Protection Plan (2011-2015) set the goal of reducing SO_2 emission by 8% as a binding objective[12]. While the national target of reducing SO_2 emission by 10% in the 11th Five-Year Plan was equivalent to 22.94 million tons, the national target of reducing SO_2 emission by 8% in the 12th Five-Year Plan was equivalent to 20.86 million tons. For example, in order to achieve those targets, specific targets were set for each province. In Liaoning Province, the following objectives were set: reducing from 1,200,000 to 1,050,000 (reduction rate by 12%) in the former plan and reducing from 1,170,000 to 1,050,000 (reduction rate by 11%) in the latter plan.

Dalian's 11th Environmental Protection Plan (2006-2010) aimed at the following targets for the total emissions: less than 100,000 tons for SO_2; less than 50,000 tons for Chemical Oxygen Demand[13] (COD); and less than 70,000 tons for TSP. Major specific actions to be taken were raised as follows: 1) strengthening management in priority geographical areas; 2) building an energy-saving society towards the promotion of the development of recycling economy; 3) adjusting energy structure for solving air pollution issues; 4) constructing wastewater treatment plants and improvement of marine environment; 5) strengthening the waste management system; 6) pollution control; 7) strengthening rural and ecological environmental protection; and 8) enhancing the environmental management capacities by improving the environmental monitoring system. Regarding the first one, it was pointed out that the five companies in Gangjingzi District, where air pollution is serious, were to be relocated and that pollution control was to be strengthened. More specifically, it included the relocation of former Dalian Steel and Dalian Cement companies, the introduction of advanced technologies, disposing small scale furnaces, which were not environmentally-friendly, and introducing energy-efficient furnaces, which leads to the solution of smokes.

[12] Binding objectives have legal effects unlike predictive objectives. The 11th Five-Year Plan introduced the concept of biding objectives for the first time.

[13] COD is an indicator which shows the degree of contamination of river water.

3.1.2 Relevance with the Development Needs of China

At the time of appraisal, the central areas in Dalian City faced serious air pollution problems along with rapid industrialization and the increase of the number of automobiles. Although air pollution in Dalian City was not serious as much as in Guiyang and Chongqing, the dependency rate on coals as energy sources was as high as 69%. SO_2 density in winter exceeded the National Standards Grade II. Since Dalian City was designated as SO_2 pollution control areas in 1998, it has been reinforcing its pollution actions until the time of the ex-post evaluation.

3.1.3 Relevance with Japan's ODA Policy

At the time of appraisal, the Implementation Policy for the Overseas Economic Cooperation of the Japan International Cooperation Agency (JICA, then-JBIC) set environmental issues as one of the priority areas for loan projects for China. In addition, the Implementation Policy for China also regarded the environmental issues in China as global issues, thus announced its policy of focusing on lending support to China through air pollution control actions. The Economic Cooperation Policy of the Government of Japan towards China (2001) gave priorities on environment issues, poverty reduction and social development in inland areas, human resource development, legal system, and technical transfer. Among them, assistance cooperation for responding to global issues such as environmental issues was one of the top priorities.

Moreover, this project was implemented based on the "Environmental Model City Framework" which was launched at the China-Japan Summit between then Prime Minister Hashimoto and then Prime Minister Li Peng in 1997. Thus, this project was highly consistent with the Japan's ODA policy. In the selection process of the model cities, serious air pollution situations (Chongqing City and Guiyang City) and the past experiences of cooperation between Japan and China (Dalian City) were taken into account.

This project has been highly relevant with the development plans of China, development needs, as well as Japan's ODA policies, therefore its relevance is high.

3.2 Effectiveness (Rating:③)

3.2.1 Quantitative Effects

3.2.1.1 Operation and Effect Indicators (pollutants emission and reduction amount)

(1) Dalian Pharmaceutical Factory Environmental Protection Project (Phase I)

Table 2 shows the plan and actual of emission amount of pollutants and its reduction rate[14].

[14] Reduction amount/baseline emission amount.

Table 2 Emission amount of pollutants and reduction rate (Plan and actual)

Indicators	Base-line	Plan	Actual					
	2000	2003 (after project completion)	2004 (after project completion)	2005	2006	2007	2008	2011
SO_2 emission amount (ton/year)	170	0 (-170)	0	0	0	0	0	115 (-55)
TSP emission amount (ton/year)	364	0 (-364)	0	0	0	0	0	0
COD emission amount (ton/year)	10,074	25 (-10,049)	31.8 (-10,042)	31.8 (-10,042)	31.8 (-10,042)	31.8 (-10,042)	13.8 (-10,060)	30 (-10,044)
COD reduction rate (%)	-	99.8	99.7	99.7	99.7	99.7	99.9	99.7

Source: Baseline and Planned figures are from JICA appraisal documents. Actual figures are from the questionnaire answer of Dalian Merro Pharmaceutical Company.

Note 1: Figures in ( ) shows the reduced amount.

Note 2: The planned reduced amount of SO_2 and TSP was calculated based on the assumption that the existing boilers were to be replaced by the central heat supply system from Gaoxinyuan District. The planned COD reduced amount was calculated based on the assumption that waste water treatment facility was to be constructed.

Note 3: Data for 2009 and 2010 was not available because the plants were not operated in 2009 and 2010 due to the relocation of the plant.

[SO_2 and TSP]

In October 2003, the factory was relocated from Shahekou District to Gaoxinyuan District as planned, and its self heat supply system was converted to the central heat supply system of Gaoxinyuan District as planned. By this conversion, the SO_2 and TSP emission amount by coal and heavy oil conbustion was zero between 2004 and 2008. The reduction ratio was 100%. Meanwhile, the SO_2 emission amount in 2011 was 115 tons/year (reduction ratio was 32.4%) because the factory had to use its own heat supply system, not the central heat supply system, due to its re-relocation to Yingchengzi area in Gangjingzi District, which was not expected at the time of appraisal.

[COD]

The wastewater treatment facility was completed as planned. As shown in Table 2, COD reduction ratio between 2004 and 2007, and 2011 was 99.7%, the ratio in 2008 was 99.9%.

New Plant
International Production Department

Blister packing machine

Packing Machine

(2) Thermal Power Station Project in Yandao Chemical Area (Phase I)

Table 3 shows the planned and actual emission amount of air pollutants and their reduction rate.

Table 3 Emission amount of pollutants and reduction rate (Plan and actual)

Indicators	Base-line	Plan	Actual				
	2000	2003 (after project completion)	2005 (after project completion)	2006	2007	2008	2009
SO_2 emission amount (ton/year)	4,515	1,081 (-3,434)	1,078 (-3,437)	1,092 (-3,423)	1,089 (-3,426)	1,091 (-3,424)	1,080 (-3,435)
SO_2 reduction rate(%)	-	76.0	76.1	75.8	75.9	75.8	76.1
TSP emission amount (ton/year)	411.	154 (-257)	149 (-262)	151 (-260)	153 (-258)	155 (-256)	152 (-259)
TSP reduction rate (%)	-	62.5	63.7	63.3	62.8	62.3	63.0
NOx emission amount (ton/year)	1,419	928 (-491)	925 (-494)	934 (-485)	927 (-492)	925 (-494)	926 (-493)
NOx reduction rate (%)	-	34.6	34.8	34.2	34.7	34.8	34.7

Source: Baseline and planned figures are from JICA appraisal documents. Actual figures are from the questionnaire answer of Dalian Dye & Chemical Co. Ltd..

Note: Figures in ( ) shows the reduced amount. This reduced amount was calculated based on the assumption that the existing 14 medium and small scale boilers were to be abolished.

As the pre-conditions for the reduction of the emission amount of SO_2, TSP and NOx, the existing fourteen medium and small boilers were disposed of, and the large scale boilers and generation units were installed as planned (for details, see the section of efficiency). The facilities were operated as planned. As Table 3 shows, the reduction rate of SO_2, TSP and NOx were almost as planned.

Meanwhile, in order to reduce air pollutants, during the 11th National Five-Year Plan period (2006-2010), the government adopted a policy called “Shangda yaxiao”, which is a policy promoting closing small scale thermal power stations and integrating them into large and medium scale thermal power stations[15]. For the plan to close small-scale power stations in the total of 50 million kW for the country as a whole, those with 60.06 million kW were closed by 2009[16]. This thermal power plant ceased its heat supply service in 2009 as a part of the policy. Although it is not an effect by this project, closing of small-scale thermal power stations have been contributing to the betterment of air pollution, thus it cannot be

[15] Source: Interview with the Dalian Dye and Chemical Company.

[16] Source: Current status and trend of the green development in China’s 12th Five-Year Plan, China Research Center of the Japan Science and Technology Agency, 2011.

evaluated negatively in terms of effectiveness.

Full view of Yendao Thermal Power Station

Generator

Exterior view of generation facility

(3) Chunhai Thermal Power Station Extension Project (Phase I)

Table 4 shows the baseline and plan of emission amount of air pollutants.

Table 4 Emission amount of air pollutants (Baseline and plan)

Unit: ton/year

Indicators	Baseline	Plan
	2000	2003 (After project completion)
SO_2	5,277	1,141(-4,136)
TSP	1,147	743(-404)
NOx	2,584	1,813(-771)

Source: JICA appraisal documents.

Note: The planned figures in ( ) shows the reduced amount. The reduced amount was calculated based on the assumption that the existing twenty four medium-small scale boilers are disposed of.

According to the interview with the Bureau of Finance of the DMPG, the following facts were found: the implementation agency of this sub-project was merged by other company; the Chunhai Thermal Power Station ceased its operation; and the power station was relocated from Dalian Port to Dayao Bay. In addition, the bureau mentioned that the output of this sub-project was cancelled due to the relocation after the loan agreement was signed. On the other hand, according to the JICA internal document in 2002, it was reported by the DMPG that all the outputs were completed by using local funds by the end of 2002. In any case, the following data was not available: whether large scale boilers installed by this project was re-installed at the relocated place or not; operational status if the large scale boilers were re-installed; and emission amount of air pollutants. Thus, it was not possible to evaluate; however, according to the interview with the DEPB, it was said that almost all the medium and small scale boilers were replaced by large scale boilers and that there are no thermal power stations which emit pollutants beyond the environmental standards.

(4) Dalian Cement Plant Dust Pollution Treatment Project (Phase II)

Table 5 shows the plan and actual of emission amount of air pollutants and its reduction rate.

Table 5 Emission amount and reduction rate of air pollutants (Plan and actual)

Indicators	Base-line	Plan	Plan after revision	Actual			
	2000	2003	2008 (After project completion)	2008 (Note2)	2009 (after project completion)	2010	2011
Cement production amount (0,000 ton/year) (reference only)	55	73	182	77.4	162.0	212.1	181.1
SO_2 emission amount (ton/year) Note1	2,070	1,638 (-432)	269 (-1,801)	89.0 (-1,981)	109.1 (-1,961)	123.0 (-1,947)	127.3 (-1,943)
SO_2 reduction rate (%)	-	20.1	87	95.7	94.7	94.1	93.9
TSP emission amount (ton/year) Note1	8,370	700 (-7,670)	466 (-7,904)	160.6 (-8,209)	259.4 (-8,111)	291.3 (-8,079)	283.5 (-8,086)
TSP reduction rate (%)	-	91.6	94.4	98.1	96.9	96.5	96.6

Source: Baseline and planned figures are from JICA appraisal documents. The plan after revision in 2008 was the one established in 2006. Actual figures are from the questionnaire answer from Dalian Cement Group Company.

Note1: The planned figures in ( ) shows the reduced amount.

Note 2: The new factory started its operation in July 2008, thus the cement production amount and SO_2 and TSP emission amount in 2008 are of the five months (August-December).

As explained later in the section of efficiency, as a part of the environmental policies by the DMPG, the cement plant was relocated from Gangjingzi District in the urban areas of Dalian City to its suburb, Jinzhou New District during the implementation stage. Along with the relocation plan, it was agreed by both Chinese and Japanese parties that the contents of the outputs and the targets for the emission amount of SO_2 and TSP were changed. Based on the revised plan, the outputs were completed almost as planned (For details, see the section of efficiency). As shown in Table 5, the actual reduction rate of both SO_2 and TSP exceeded the revised targets.

Bag Filter

Turbine of the remaining heat supply system

Conveyor for limestone

(5) Dalian Steel Plant Air Pollution Treatment Project (Phase II)

Table 6 shows the planned and actual emission amount of air pollutants. As mentioned in the section of evaluation limitation, the scope of this project included only a part of the plant facilities. Because TSP and SO_2 emission data limited to the facility covered under this project was not available, emission amount for the factory as a whole (ten production lines in total) are shown as below. Steel production amount is also indicated in Table 6 for easy reference. Furthermore, the completion time of the outputs differs, and some outputs were installed at the old plant while others were installed at the new plant. Therefore, the completion time of the outputs linked with its relationship with the emission amount are also indicated in Table 6.

As explained later in the section of efficiency, as the DMPG made a decision to relocate the factory to the suburb in 2005, the old factory was closed in August 2011, then all the functions were transferred to the new factory. The new plant has started to be fully operational since 2011.

Table 6 Emission amount and reduction rate of air pollutants (Plan and actual) and its relation with the outputs

Item		Baseline (2000)	Plan upon the project completion	Actual of old plant								Actual of new plant	
				2003	2004	2005	2006	2007	2008	2009	2010	2010	2011
Steel production amount (0,000 ton/year) (reference only)		35.0	43.0	45.8	53.5	51.3	45.0	50.0	41.0	42.0	42.0	12.4	46.3
Coal consumption amount (0,000 ton/year) (reference only)		12.1	NA	18.4	23.6	28.2	NA	NA	NA	NA	NA	NA	NA
SO2	Discharge amount (ton/year)	160.0	78.0	259.0	306.7	398.9	396.0	275.5	309.0	309.0	309.0	90.0	185.0
	Reduction amount (ton/year)	-	82.0	-99.0	-146.7	-238.9	-236.0	-115.5	-149.0	-149.0	-149.0	70.0	-25.0
	Reduction rate (%)	-	51.3	-61.9	-91.7	-149.3	-147.5	-72.2	-93.1	-93.1	-93.1	43.8	-15.6
TSP	Discharge amount (ton/year)	3,613	243.0	572.7	318.3	306.4	306.4	308.6	378.0	378.0	378.0	80.0	169.0
	Reduction amount (ton/year)	-	3370.0	3,040	3,295	3,307	3,307	3,304	3,235	3,235	3,235	3,533	3,444
	Reduction rate (%)	-	93.3	84.1	91.2	91.5	91.5	91.5	89.5	89.5	89.5	97.8	95.3

(Old Second Plant) Completed installing 1 set of dust remover for 40 ton furnace in 2003. Completed installing 1 set in 2004. Both dust removers had opereted until 2011. Contributed to the reduction of TSP.

(New Plant) Installed Continuous Contricaster in 2009 and operating now. Contributed to the reduction of SO2.

(Old Second Plant) Disposed of three 20 ton furnance in 2004 (Installation of dust removers were cancelled because the furnances were disposed of. Contributed to the reduction of TSP.

(New Plant) Installed one set of 40 ton AOD and dust remover and operating now. Contributed to the reduction of TSP.

(Old First Plant) Three 10 ton furnance + three 15 ton furnance were disposed of as planned (by local funds) .Contributed to the reduction of TSP.

Source: Baseline and planed figures are from JICA appraisal documents. Actual data is from Questionnaire answer from Dongbei Special Steel Company. The SO_2 and TSP emission data are originally from the monitoring report by the DEPB.

Note: The planned reduced amount of SO_2 was calculated based on the assumption that continuous conticaster is installed. TSP planned reduced amount was calculated based on the assumption that the existing furnaces are disposed of and dust removers are installed.

[TSP] Disposing obsolete furnaces and installing dust removers, which were indispensable requirements for reducing TSP emission, were completed as planned by 2004 (For more details, see the section of efficiency). Since the project completion in 2003, TSP reduction rate has been between 80% and 90% of the plan, slightly less than the target value of 93.3%.

One set of 40 ton Argon-Oxygen Decarburization[17] (AOD) furnace with the annual production capacity of 100,000 tons and dust remover was installed at the new plant in 2009[18]. In 2011, when the new plant was fully functional, TSP reduction rate was 95.3%, while the target was 93.3%. As the set of AOD furnace and dust remover installed at the new plant is the only one set in the plant[19], it is possible to say that the implementation of this project has brought the achievement of the above indicator.

[SO_2] One set of continuous conticaster[20] (hereinafter refers as CC), which was the indispensable requirement for reducing SO_2 emission was installed at the new factory at the end of 2009[21]. Figure 2 shows the image of CC.

Independent SO_2 emission data of the facility covered under this project in 2011, when the new factory became fully functional, was not available. Thus, this study compares the target reduction amount of SO_2 emission by introducing the project facilities, which was set at the time of the appraisal, with the estimate, which was obtained at the time of the ex-post evaluation. According to the estimate by Dongbei Special Steel Company, SO_2 emission amount was reduced by 82.5 tons/year by introducing one set of the CC procured under this project. The calculation method of the estimate is as follows: The CC produces a total of 312,500 tons billets/year. Coal gas consumption is 1,000 m^3 per one ton of billet production by the blooming method (see footnote 20). Therefore, it can be considered that a total of 312,500,000 m^3 coal gas consumption was saved by introducing the CC. SO_2 emission amount per one million m^3 of coal gas consumption is 264 kg. Therefore, it is estimated that a total of 82.5

17 AOD is the process of accelerating decarburization reaction by blowing oxygen which is diluted by argon.
18 Source: Interview with Dongbei Special Steel Company.
19 Source: Same as above.
20 CC is the facility to produce certain shape of billets, which are the half-finished products, in the process that melted iron becomes solid. In Japan, until 1960's, steel factories used to pour melted irons into molds, to wait until the irons cool down, to heat the irons again, and to spread the irons by blooming pressing machines in order to produce billets. However, this blooming method was not good in terms of energy-efficiency because it needed to heat the cooled irons repeatedly. Since CC was invented in 1970's, the blooming process was omitted, then it became possible to produce billets from liquid steel directly. As a result, the enhancement of production and saving energy was achieved. Source: Nippon Steel Corporation, "Book about Iron and Steel", 2004.
21 Source: Interview with Dongbei Special Steel Company.

tons/year SO_2 emission amount was saved (312.5 m^3 x 264kg=82,500kg)[22]. Because JICA appraisal documents do not indicate the estimation method of the target SO_2 reduction amount of 82 tons/year, simple comparison cannot be allowed, but, it can be said that the target reduction amount was achieved by introducing the project facility.

At the new factory, there are three more sets of CC which have the same production capacity as the one procured by this project or more, the total production capacity is equivalent to approximately 1,530,000 tons/year. If calculating simply, a total of 404 tons/year SO_2 emission amount (1,530,000 tons/312,500 tons x 82.5 tons) was saved for the factory as a whole by introducing four sets of CC.

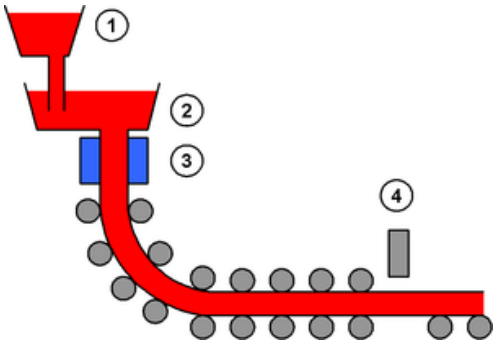


Figure 2 Outline drawing of Continuous Conticaster

1. Ladle: Pour liquid steel into the ladle in the upper part. Remove inclusion contained in liquid steel.
2. Tundish nozzle: Remove inclusion.
3. Molds: Molds are cooled down by water. Liquid steel starts to be solid.
4. Gas cutting machine: Solid steel is cut by gas cutting machine into certain length.

Source: Nippon Steel Corporation, "Tetsu to Tekkou ga wakaru hon" (Book about Iron and Steel), 2004.

Overview of Dongbei Special Steel Plant

AOD furnace and dust remover

Continuous Conticaster

[22] Source: Questionnaire answer from Dongbei Special Steel Company.

3.2.2 Qualitative effects

Apart from the indicators, it was confirmed that the consumption amount of coals, petrol and power was reduced by implementing this project. For example, at the pharmaceutical plant, energy consumption amount for each energy source was as follows in 1997: 2,509 tons/year of coals; 60 million kWh of power; about 15,000 tons/year of heavy oil; 115 tons/year of gasoline; 171 tons/ year of diesel; 30,811 tons in total by Standard Coal Equivalent (SCE). The energy consumption after the project completion was approximately 5,200 tons by SCE in 2005, which means it was reduced to 17% of the energy consumption in 1997[23].

At the cement factory, this project installed generator (7,500KW), and the factory has been generating 50,400,000kWh/year by using the remaining heat of the kiln inlet and outlet. This made it possible that a total of 20,000-30,000 coals are saved annually and that a total of 50,000 CO_2 emission amount is reduced annually[24]. Furthermore, by replacing the facilities along with the relocation of the plant, the required coal consumption for producing one ton of cement was reduced from 240kg to 110kg. Power consumption required for producing one ton of cement was also reduced from 125kWh to 98kWh.

3.3 Impact

3.3.1 Intended impacts

3.3.1.1 Improvement of air quality in Dalian City

According to the National Standards Grade II which has been applied since 1996 to the present, the limit value of average density of pollutants such as SO_2, TSP and NOx, which were set as the effect indicators for this project at the time of appraisal, is regulated. Not only these parameters, but also the limit value of the average density of Particulate Matter less than 10 micron[25] (PM10) and Nitrogen Dioxide (NO_2) is also regulated by the National Standards Grade II. Similar to other cities in China, the DPMG monitors PM10 and NO_2 instead of TSP and NOx. The data obtained during this study was that of SO_2, PM10 and NO_2. Because it was not possible to compare the plan and actual data regarding PM10 and NO_2, this study compares the limit value of the average density regulated by the National Standards Grade II with the actual average density. Table 7 illustrates the baseline, plan, actual and the limit value regulated by the National Standards Grade II regarding SO_2, TSP, PM10, NOx and NO_2.

[23] Source: Loan Situations Report of Dalian Merro Pharmaceutical Company.
[24] Source: Questionnaire answer from Dalian Cement Company.
[25] PM10 is the particulate whose trapping efficiency becomes 50% in the ten micron of aerodynamic diameter. It is the definition is generally used worldwide.

Table 7 Annual average density of air pollution in the central areas of Dalian City (Baseline/Plan)

Unit: mg/ m^3

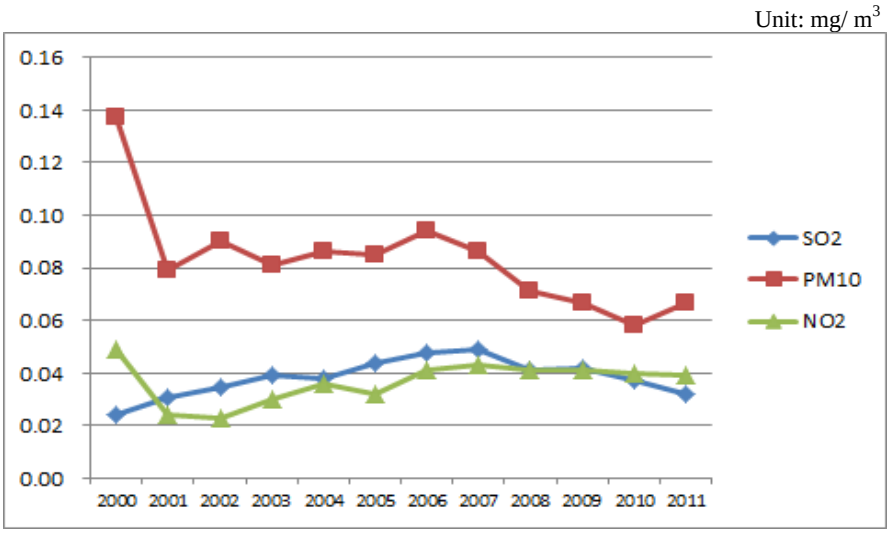
Indicators	Standards Grade II	Central area in Dalian City (Baseline)	Dalian City (Plan)			Dalian City (Actual)	
		1999	2000	2005	2010	2005	2010
SO2	0.060	0.038	0.050	0.040	0.014	0.044	0.037
TSP	0.200	0.146	0.180	0.150	0.034	NA	NA
PM10	0.100	NA	NA	NA	NA	0.085	0.058
NO_X	0.050	0.046	0.060	0.050	0.070	NA	NA
NO2	0.040	NA	NA	NA	NA	0.032	0.040

Source: The baseline and planned figures are from JICA appraisal documents. The actual data is from the data provided by the DEPB (original data: Dalian Municipality State of the Environment).

Note: The planned figures were the one established in the Ninth Dalian Environmental Conservation Five Year Plan (1996-2000) and the long-term plan for 2010.

As shown in Table 7, the targets for 2000 adopted in the Ninth Dalian Environmental Protection Five Year Plan (1996-2000) were achieved in 1999. Regarding the targets for 2005 and 2010, the plan aimed at maintaining the 1999 levels of air pollution density by taking environmental actions including this project, considering that it was expected that air pollution would be worsened along with industrialization. The target of SO_2 was not achieved in 2005 and 2010. The possible reason is that air pollution became more serious than expected due to industrialization and the increase of the number of automobiles in spite of the environmental actions. On the contrary, comparing the actual data of SO_2 with the limit value of the National Standards Grade II, it fulfilled the standards both in 2005 and 2010. The actual data of PM10 and NO_2 fulfills the standards in 2005 and 2010.

Figure 3 illustrates the trend of annual average density of air pollution in Dalian City between 2001 and 2011. In spite of rapid industrialization, no sudden aggravation was found for any parameter. The possible reasons why the density has been kept at the previous level include the followings: environmental cooperation project in cooperation with Kita-kyushu City and the Development Study “Dalian City Environmental Model Area Construction Plan” (see the “Related Projects”) were implemented in 1990’s; even after 2000, various environmental counter-measures such as this project and private sector’s investment in cleaner production technology were implemented.



Source: Dalian Municipality State of the Environment and the original data provided by Dalian Environmental Protection Bureau

Figure 3 Annul average density of air pollution in Dalian City (actual)

Regarding the degree of contribution of this project to the improvement of air quality, "Survey regarding the contribution evaluation of environmental loan projects for China- Assistance for improvement of environment in China (air and water) (2005)" conducted by Kyoto University Graduate School entrusted by JICA (former JBIC), was estimated that the the reduction amount by this project (approximately 4,100 tons) accounted for 1.5% of the total SO_2 emission amount (approximately 271,000 tons) in Dalian City in 2003. This study analyzed that the degree of contribution was limited because SO_2 emission amount had been drastically reduced by other interventions prior to the implementation of this project.

3.3.1.2 Perception of air quality improvement by the residents in Dalian City

A beneficiary survey was conducted for 30 persons in Shahekou District and 70 people in Ganjingzi District (100 samples: 73 male samples and 27 female samples). According to this survey, 73% respondents answered that the air quality was improved significantly; 22% answered "improved slightly"; 2% answered "no change"; 2% answered "aggravated"; and 1% answered "don't know"(See Figure 4). Geographically speaking, among 30 residents who live near

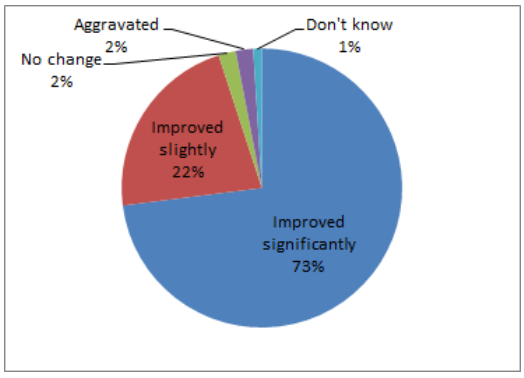


Figure 4: Perception of citizens about the improvement of air quality (N=100)

the old plant of former Dalian Pharmaceutical Company in Shahekou District, 19 respondents (consisting 63% of 30 residents) answered that the air quality was improved around 2000 when the old plant was relocated. Among 40 residents who live near the old plant of former Dalian Steel Company in Gangjingzi District, 38 respondents (consisting 95%) answered that the air quality was improved between 2003 and 2004, and that it made possible for the people to open windows and to dry clothing outside. As explained in the section of effectiveness, the possible reason for this change includes the followings: two sets of dust removers were installed at the old plant between 2003 and 2004; and consequently TSP was reduced from about 3,600 tons/year in 2000 to about 572 tons/year in 2003, then to about 318 tons/year in 2004.

The following reasons for air quality improvement were identified by the beneficiary respondents (multiple answers allowed): relocation of factories to the suburbs (100%); government's regulations on factories for pollutant emissions (97%); control of pollutant emissions by advanced technology (95%); control on the gas emission from automobiles (85%); decrease in the utilization of coals at factories (74%); and decrease in the utilization of coals at households (51%). The above result shows that the citizens understand the environmental policy of Dalian City such as the relocation of factories, the pollutant emission control by regulations or advanced technology.

3.3.1.3 Enhancement of the living environment by improving air quality

The followings were raised as the effects of air quality improvement (multiple answers allowed): dirt on clothing by dust has decreased (93%); it became possible to dry clothing outside (93%); sore eyes and coughing has decreased (93%); and use masks and sunglasses for protecting from dust less than before (91%). Apart from this choice selection, the survey requested the respondents to answer freely. They pointed out the following effects: black smoke from chimneys was decreased; dust on the office desks was reduced; dust on the automobiles was reduced; dust on the clothing dried outside was reduced; and blue sky can be seen than before.

3.3.2 Other impacts

3.3.2.1 Impacts on the natural environment

As far as known from the acceptance and observation report by the State Environmental Observation Center, monitoring reports by Dalian Environmental Observation Center, questionnaire answers from the implementing agencies and the evaluator's field visit, no particular negative impact on the natural environment has been observed. The implementation status and results regarding the environmental counter-measures during the

construction period and the environmental monitoring were described as below.

Then-Dalian Pharmaceutical Factory Environmental Protection Project:

As the counter-measures for noise during the construction period, the following actions were undertaken: the prohibition of construction during night time; the use of anti-noise construction machines; reinforcement of supervision; and regular inspection[26]. Upon the project completion in 2003, the company received the acceptance permission for the project. It was certified as one of the "Environmental Protection Advanced Company" in Dalian City in 2004[27]. DEPB monitors the quality of wastewater and gas emission every year, and the plant also regularly monitors them by itself. The wastewater has been processed in the plant compound, thereby meeting the Grade I of the Liaoning Province Coastal Areas Wastewater Direct Discharge Maritime Standards (DB21-59-89)[28].

The current COD's emission standards are more strict than the standards at the time of appraisal. While the emission standards at the time of appraisal were less than 100mg/l, it is 50mg/l at the time of ex-post evaluation[29]. According to the monitoring report by Dalian Environmental Observation Center, the COD emission density was 31.8mg/l in 2007, 13.8mg/l in 2008, and 30mg/l in 2011, thus it can be said that there is no problem.

Thermal Power Station Project in Yandao Chemical Area:

According to the implementing agency, the environmental monitoring result shows that the emission meets the standards[30].

Dalian Cement Plant Dust Pollution Treatment Project:

During the construction period, the following environmental counter-measures were undertaken: placement of environmental protection management staff; anti-noise actions; the prohibition of construction at night; and watering for preventing sand scattering[31]. No particular problem was pointed out in the acceptance/monitoring report by the State Environmental Observation Center in 2009. Upon the project completion, environmental monitoring has been carried out regularly, but the data could not be obtained.

Then-Dalian Steel Plant Air Pollution Treatment Project:

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26 Source: Questionnaire answer from Dalian Merro Pharmaceutical Company.
27 Source: Loan Situations Report of Dalian Merro Pharmaceutical Company.
28 Source: Project Completion Report (PCR), Loan Situations Report of Dalian Merro Pharmaceutical Company.
29 Source: JICA appraisal document, Questionnaire answer from Dalian Merro Pharmaceutical Company.
30 Source: Questionnaire answer from Dalian Dye & Chemical Co. Ltd..
31 Source: Questionnaire answer from Dalian Cement Group Company.

According to the monitoring report by the Dalian Environmental Observation Center in 2005, regarding the project facilities under this project, the TSP emission density of No. 10 dust remover in the old plant was 10.0mg/ m^3 (98.5% of treatment efficiency) and that of No. 11 dust remover in the old plant was 13.5mg/ m^3 (98.2% of treatment efficiency). According to the Grade II of the previous industrial furnace and kiln air pollution emission standards (GB9078-1996), the TSP emission density was to be less than 150mg/ m^3 (less than 100mg/ m^3 in the current standards). The TSP emission density of No.4 dust remover in the new plant (former No.11 dust remover at the old plant) was 11.1 mg/ m^3 [32]. In the above respective cases, the actual data was far below the national standards, thus no problem was found.

Regarding Chunhai Thermal Power Station, data related to the counter-measures during the construction and the environmental monitoring could not be obtained.

3.3.2.2 Land acquisition and Resettlement

The planned and actual data regarding resettlement and land acquisition for each sub-project is shown in Table 8. According to the questionnaire and interview with each implementing agency, land acquisition was conducted smoothly. Resettlement did not occur in the three sub-projects out of five sub-projects. Regarding Yandao Thermal Power Station, according to the implementing agency, there was no problem with the contents of compensation for resettlement. However, it was not possible to directly confirm with the employees who had lived in the staff dormitory and had received compensations. For the Chunhai Thermal Power Station Project, direct verification with the resettled households was not possible, either.

Table 8 Resettlement and land acquisition (plan and actual)

Sub-project	Land acquisition		Resettlement	
	Plan	Actual	Plan	Actual
Then-Dalian Pharmaceutical Factory Environmental Protection Project	Had already obtained about 7.6 ha for resettlement site.	As planned for the old plant in Qixianling. Obtained 15.5ha for the new factory in Yingchengzi.	None.	None for both old and new plants.
Thermal Power Station Project in Yandao Chemical Area	Had already obtained about 2.7ha for Construction site.	As planned.	None.	65 persons. Paid compensations to the employees who had lived in the dormitory because the dormitory was demolished.

[32] Source: Questionnaire answer from Dongbei Special Steel Company.

Sub-project	Land acquisition		Resettlement	
	Plan	Actual	Plan	Actual
Chunhai Thermal Power Station Extension Project	Had already obtained about 3.2 ha for construction site.	As planned.	243 households (by September 1999) and two factories (by December 1999).	Same as left.
Dalian Cement Plant Dust Pollution Treatment Project	None.	Acquired 37.2 ha for the new factory.	None.	None. Landfill of the sea.
Then-Dalian Steel Plant Air Pollution Treatment Project	None	Acquired 300 ha for the new factory.	None.	None. Landfill of the sea.

Source: Questionnaire answer from each implementing agency

In light of the above, regarding the reduction in air pollutants emission amount, expected effects have been observed almost as planned in the four sub-projects, in which actual data were confirmed. As the central government announced a new environmental policy, the thermal power station in Yandao ceased its operation. But, closing the small-scale thermal power station has been contributing to the alleviation of air pollution in the end, thus it cannot be evaluated negatively in terms of effectiveness. Regarding the one sub-project in which actual data could not be confirmed directly with the implementing agency, as far as known from the available information from the DEPB, there was no such evidence that the plants emit pollutants beyond the environmental standards. In addition, effects other than indicators and positive impacts were also observed. Therefore, effectiveness and impact of this project is high.

3.4 Efficiency (Rating:①)

3.4.1 Project Outputs

The planned and actual outputs and reasons of change are summarized in Table 9. Among the five sub-projects, the outputs were almost as planned in the four sub-project, although there were some changes in one sub-project (Dalian Cement Plant Dust Pollution Treatment Project). In this sub-project, the change and addition of the outputs occurred due to the relocation of the factory, which was not expected at the time of appraisal. However, as the relocation of the plant was a part of the DMPG's environmental protection policy and as the addition and change of the outputs was consistent with the project purpose, it can be judged that the change was reasonable. After the revision of the plan, the outputs were carried out as revised.

Table 9 Output (Plan and Actual)

Sub-projects	Plan	Actual
Then-Dalian Pharmaceutical Factory Environmental Protection Project	Installation of the production line along with the relocation (liquid filling and sealing machine, capsule filling machine, blister packaging machine, pharmaceutical facility, air pressure and cooling facility, etc. and the construction of wastewater treatment facility (580 tons/day).	As planned. The wastewater treatment facility was constructed by the local fund. Almost all the equipment was re-installed at the plant in Yingchengzi area. A wastewater treatment was also newly constructed there.
Thermal Power Station Project in Yandao Chemical Area	Construction of the boilers (75 tons/h x 3), generation units (12,000kw x 2), coal delivery system, electrical system and thermal control system.	As planned except that the performance of the generation units was changed to 15,000kw.
Chunhai Thermal Power Station Project	Construction of the boilers (130 tons/h x 2) and generation units (25,000kw x 1).	As planned, but all the outputs were completed by the local fund. In order to accelerate the completion time, the DMPG made a decision to carry it out including the loan portion by its local fund.
Dalian Cement Plant Dust Pollution Treatment Project	Bag filter, dust collector for kiln, remaining heat generating system (generator and boiler), coal mill, cement mill, air compressor, central control system, etc.	As planned except the addition of the limestone conveyor system (3.75km) and the change from the air compressor to induced fun. Cement mill, coal mill and central control system were carried out by the local fund (as revised in 2006).
Then- Dalian Steel Plant Air Pollution Treatment Project	Dust removers for one set of 40 ton Electric Furnace (EAF) and one set of 40 ton Ladle Furnace (LF), 40 ton AOD furnace (with the production capacity of 100,000 tons) and the dust removal, Continuous Conticaster (with the total production capacity of 300,000 tons). The above items were to be covered by the loan. Installation of dust removers for three sets of 20 ton furnace. Abolishment of three sets of 20 ton furnace and three sets of 15 ton furnace. The above items were to be covered by the local fund.	As planned. At the time of relocation, dust removers for 40 ton EAF/LF were demolished. AOD furnace and dust remover and CC were installed at the new plant. As the three sets of 20 ton furnace had limited capacities and were inefficient in energy, those were demolished, thus the dust removers for these furnaces (by the local fund) were cancelled. In order to supplement this loss, one set of 25 ton AOD, one set of 40 ton furnace and dust removers were installed at the new plant.

Source: Plans are from JICA appraisal documents and revised plant. Actuals are from PCR and questionnaire answers.

3.4.2 Project Inputs

3.4.2.1 Project Cost

The total project cost estimated at appraisal was 14,684 million yen (of which the Japanese ODA loan amount was 8,517 million yen and the rest was to be locally funded).

The actual total project cost was 21,623 million yen (of which the Japanese ODA loan amount was 5,389 million yen and the rest was locally funded), which was 147% of the planned amount. In the case that the Chunhai sub-project, which foreign currency was zero and the amount of the local fund is unknown, is excluded from the total planned cost, the total project cost was 232% of a total of 9,310 million yen. The actual project costs of the

pharmaceutical sub-project and the thermal power plant sub-project in Yandao were 124% and 121% of the plan respectively. That of the cement sub-project was 658% of the original plan and 140% of the revised plan. That of the steel sub-project was 109% of the plan.

For the pharmaceutical project, the reason for the increase was that there was a rise in prices between the time of estimate, which was calculated at the Feasibility Study (F/S) in 1996, and the time of the project implementation in 2003.

For the thermal power plant project in Yandao, the increase was caused for the following reasons: geographical conditions were found to be more complex during the outline design; it required digging the building's base deeper than estimated at the time of the F/S; and then the civil work cost was increased.

For the cement plant project, the reasons for the increase include the followings, which were caused by the unexpected relocation of the factory: ground leveling and constructing the new plant; purchasing the mining rights of the limestone mountain; constructing a limestone warehouse; adding bag filters; and installing solar energy facilities.

For the steel plant project, the cost was increased as follows: some procedures were required due to the restructuring in January 2003 and the change of regulating authority in September 2004; the procurement procedure for the facilities covered by the yen loan was suspended for about two years; there was a sharp price rise during the intermittence.

Meanwhile, as the thermal power plant project in Yandao ceased its operation, the facility covered under this project is not operating, either. Comparing with the project cost of a total 3,741 million yen, the facility had operated only for five years, thus it is difficult to say that the funds were effectively utilized. At present, the implementing agency and the DMPG have consultations on how to use the existing facilities.

3.4.2.2 Project Period

The actual project period of the pharmaceutical sub-project, the thermal power plant sub-project in Yandao, Chunhai sub-project, the cement sub-project and the steel sub-project was 488%, 233%, 63%, 390% (105% of the revised plan) and 424% of the plan respectively. The planned and actual project period and the reasons for delay are described in Table 10.

Table 10 Project Period (Plan and Actual)

Sub-project	Plan	Actual
Then-Dalian Pharmaceutical Factory Environmental Protection Project	March 2000- November 2000 (9 months)	March 2000- October 2003 (44 months, 488% of the plan) The reasons for delay are the following four: 1) it took longer than planned until the loan agreement became effective (for four months after the Loan Agreement (L/A signing); 2) it took longer than planned until China Export-Import Bank and the Finance Bureau of the DMPG signed the loan sublease agreement and until the Finance Bureau and Dalian Pharmaceutical Group signed the sublease agreement (it took 12 months after the L/A effectiveness); 3) it took longer than planned for selecting a bidding company for the procurement of equipment by the loan portion, for bidding procedures and for contract agreement (it took 12 months after the signing of the sublease agreements); 4) the construction was suspended for six months due to the prevalence of SARS in 2003. The construction of the plant and the installation of the equipment covered by the local fund were completed without delay.
Thermal Power Station Project in Yandao Chemical Area	March 2000- February 2002 (24 months)	March 2000- October 2004 (56 months, 233% of the plan) Same as above, it took longer for L/A effectiveness and the signing of the sublease agreement (about 16 months), and the construction was suspended for six months due to SARS in 2003.
Chunhai Thermal Power Station Project	March 2000- June 2001 (16 months)	March 2000- December 2000 (10 months, 63% of the plan) As the DMPG made a decision to carry out the project by its local fund only, the project completion was earlier than planned.
Dalian Cement Plant Dust Pollution Treatment Project	March 2001- December 2002 (22 months)	March 2001- April 2008 (86 months, 390% of the plan, 105% of the revised plan) It was delayed because it took longer for the procedures, civil work and the change of the plan related to the plant's relocation to Jinzhou New District (at 46 km away from the central city). The reasons for relocations are as follows: 1) the population around the old factory in Gangjingzi District was increased than the estimate at the time of appraisal; 2) the Dalian Airport, next to the old plant, was expanded; 3) as mentioned in the section of relevance, the DMPG made a decision to relocate the plant to the suburb as a part of environmental protection policy in consistent with the Dalian 11th Environmental Protection Five Year Plan.
Then-Dalian Steel Plant Air Pollution Treatment Project	March 2001- March 2003 (25 months)	March 2001- December 2009 (106 months, 424% of the plan) The reasons of delay includes the followings: 1) the procurement procedures were delayed due to the restructuring of the implementing agency and the change of regulating authority[33] (33 months); 2) similar to the cement factory, it took time for the relocation procedures and relocation civil work of the factory to the suburb (24 months) and for re-installation civil work (12 months) along with the DMPG's decision.

Source: JICA appraisal documents for the plan. PCR, questionnaire answer from each implementing agency and JICA internal documents for the actual.

[33] Restructuring from Dalian Iron & Steel Group Co. Ltd to Dongbei Special Steel Group required procedures for asset transfer from the DPMG to Liaoning Provincial Government. It also became necessary to review the sublease agreement of this project. In January 2005, the procurement procedures resumed again. However, due to the rise in prices during the suspension period, contract procedures were difficult in some contract packages. The signing of the contract was extended to September 2005, thus the project was suspended for 33 months.

As Table 10 shows, the common reasons of delay for the Phase I projects included the followings: it took longer than expected until the loan agreement became effective and the relevant parties signed the loan sublease agreement; and the construction was suspended due to the prevalence of SARS. The common reasons of delay for the Phase II project included the followings: the DPMG made a decision to relocate the factories to the suburb as a part of the actions for air pollution alleviation; consequently it required time for the plants to arrange relocations, to relocate, to change some outputs and to re-install some facilities, which were installed at the old plant, at the new plant.

3.4.3 Results of Calculations of Internal Rate of Return (reference only)

At the time of appraisal, neither Financial Internal Rate of Return (FIRR) nor Economic Internal Rate of Return (EIRR) was calculated. The assumptions such as expenses, benefits and projects life are also unknown. Therefore, those were not recalculated at the ex-post evaluation.

In light of the above, the project cost exceeded the plan, and the project period significantly exceeded the plan; therefore efficiency of the project is fair. However, the reason of delay in the project period included the followings: delay in the signing of the loan sublease agreement; intermittence of the construction due to the prohibition of civil work labors' movement along with the prevalence of SARS; and the relocation of the factories during the implementation period in accordance with the government's decision. It can be pointed out that these were beyond the control by the implementing agencies of each sub-project.

3.5 Sustainability (Rating: ③)

3.5.1 Structural Aspects of Operation and Maintenance (O&M)

The O&M system of the implementing agencies of the three sub-projects in operation are stable. The O&M system of each organization is summarized in Table 11.

Table 11 O&M system

Sub-project	Implementing agency	O&M system
Then-Dalian Pharmaceutical Factory Environmental Protection Project	(Then) Dalian Medicine Group Dalian Pharmaceutical Factory (Current) Dalian Merro Pharmaceutical Factory	In January 2000, Dalian Medicine Group Dalian Pharmaceutical Factory became Dalian Merro Pharmaceutical Factory. The number of staff is as follows: 48 managers, 88 technicians, 365 operators, 142 assistants and other staff, 643 persons in total. In 2005, this company received the certificate from Therapeutic Goods Administration (TGA) of the Government of Australia. In March 2010, a new plant was completed in Yingchengzi Industrial Park. In May in the same year, it received an authentication of Good Manufacturing Practice (GMP) by the National Food and Drugs Supervision and Management Department for the first time in China, then started its operation (Source: PCR, the report from Dalian Merro Pharmaceutical Company).
Dalian Cement Plant Dust Pollution Treatment Project	Dalian Cement Group Company	Since 1970's, various actions for environmental protections has been undertaken. Among 410 employees, there are 72 O&M staff. (Source: interview with Dalian Cement Factory).
Then-Dalian Steel Plant Air Pollution Treatment Project	(Then) Dalian Iron and Steel Group Company (Current) Dongbei Special Steel Company	In January 2003, as a result of merger between Dalian Iron and Steel Group Co. Ltd. and Wushun Special Steel Co.Ltd., Liaoning Special Steel Group was established. After merging with Beiman Special Steel Group in September 2004, Dongbei Special Steel Company was established. As a result, the company became the national special steel manufacturer which is the biggest in China and the fifth biggest in the world. The number of staff is about 21,000 persons. As O&M is implemented totally by the company, there is no out-sourcing (Source: JICA internal documents and interview with Dongbei Special Steel).

3.5.2 Technical Aspects of Operation and Maintenance

In each implementing agency, required number of staff with sufficient technical capacities has been allocated. Technical training has been conducted properly. Necessary manuals are also ready for use. Details are described as below.

Table 12 O&M technical capacity

Sub-project	O&M technical capacity
Dalian Pharmaceutical Factory Environmental Protection Project	As the equipment purchased by international competitive bidding were the imported materials with advanced level, the operational capacity of the staff was not sufficient. Therefore, in-country training was conducted seven times (a total of 27 persons) and overseas training was conducted three times (a total of 10 persons). In addition, in order to carry out regular training comprehensively and systematically, the company prepares an annual training plan for each department and for the factory every year. Functional training, quality control training, management training have been carried out and exams are also taken place strictly. At the factory as a whole, training is conducted 40 times a year and a total of 2,000 employees participates the training. The company is keen to hire the technicians with under-graduate diplomas. Among 643 employees, 169 have under-graduate diplomas, four have master degree and two have doctor degree. Along with mechanization, manuals for facility operation and O&M were developed. These counter-measures solved the technical issues which the company faced at the time of project completion. (Source: PCR)
Dalian Cement Plant Dust Pollution Treatment Project	Five staff of the safety and environmental protection section is responsible for the environmental protection. One staff is the graduate from the Environmental Protection Study in Shandong University. Some staff received O&M guidance at the time of hand-over of equipment such as dust remover. Technicians receive a guidance regarding safety and environmental protection at the in-house training every year. (Source: interview with Dalian Cement Factory)
Dalian Steel Plant Air Pollution Treatment Project	Training is conducted regarding operation by position, facility management and regulations. O&M manuals have been utilized not only for regular operation and troubles, but also utilized for training (Source: Interview with Dongbei Special Steel Company).

3.5.3 Financial Aspects of Operation and Maintenance

According to the financial statements and interviews with the implementing agencies, no major problem was observed for their financial situations respectively. Details for each implementing agency are described as below.

[(Then) Dalian Pharmaceutical Factory Environmental Protection Project (Current Dalian Merro Pharmaceutical Factory)]

As shown below, the company has kept surplus for three consecutive years. The stock price was about 6.8 RMB as of march 2012[34]. Before the project completion, there was deficit since the costs for coals and heavy oil boosted production costs[35]. Meanwhile, as mentioned in the section of effectiveness, the energy consumption was reduced to approximately 17% of the 1997 level in the SCE upon the project completion. As the production costs were reduced, it created surplus.

Since the factory did not operate in 2009 and 2010 due to the relocation of the plant, gross revenue was decreased tentatively; however, as the new plant has been operational since 2011, the gross revenue is expected to increase.

[34] Source: Interview with the Dalian Merro Pharmaceutical Company.
[35] Source: Loan situations report of the Dalian Merro Pharmaceutical Company.

Table 13 Financial status of Dalian Merro Pharmaceutical Factory

Unit: million RMB

Item	2008	2009	2010
Gross revenue	123.36	108.69	70.56
Costs of sales	67.52	53.49	19.9
Selling, general and administrative expenses	26.88	32.12	31.22
Operating profit/loss	29.39	18.27	2.51
Total asset	415.56	396.93	648.16
Current asset	97.5	89.36	79.51
Non-current asset	325.08	67.31	281.92
Current liabilities	414.06	395.73	643.89
Liabilities	415.56	396.93	648.16

Source: Questionnaire answer from Dalian Merro Pharmaceutical Company.

[Dalian Cement Plant Dust Pollution Treatment Project]

The shareholding company of the Dalian Cement Group Company was changed to China Great-wall Asset Management Company, but the company has been operating continuously as a state-owned company[36]. Since the plant could not operate in the first six months in 2008 due to its relocation, the cement production amount remained as low as at 42% of the plan in the same year, and operating profit also dropped as shown in the table below. However, as the plant has fully operated since 2009, both gross revenue and operating profit were increased, which created surplus.

Table 14 Financial status of Dalian Cement Group Company

Unit: million RMB

Item	2008	2009	2010
Gross revenue	364	551	653
Costs of sales	292	457	582
Selling, general and administrative expenses	52	74	92
Operating profit/loss	1	15	16
Total asset	1,250	1,404	1,572
Current asset	548	278	324
Non-current asset	679	1,106	948
Current liabilities	828	710	744
Shareholder's equity	401	448	477
Liabilities	849	955	1,094

Source: Questionnaire answer from Dalian Cement Group Company.

[36] Source: JICA internal documents.

[(Then) Dalian Steel Plant Air Pollution Treatment Project (Dongbei Special Steel Company)]

As Dalian Iron and Steel Group Co. Ltd. was merged with Dongbei Special Steel Company, it became the national special steel manufacturer which is the biggest in China and the fifth biggest in the world. As a result, its management foundation was reinforced. The capital of Dongbei Special Steel Company is approximately 3,644.17 million RMB (47,300 million JPY)[37]. Regarding the proportion to the capital, Dalian Iron and Steel Group Co. Ltd. has 36%; Liaoning Provincial Government has 28%; Wushun Special Steel has 22%; and Heilongjiang Provincial Government has 14%[38]. As shown below, the financial status had been stable in the past three years.

Table 15 Financial status of Dongbei Special Steel Company

Unit: million RMB

Item	2008	2009	2010
Gross revenue	13,307.20	10,553.50	12,496.22
Costs of sales	11,923.50	9,717.80	10,986.60
Selling, general and administrative expenses	675.6	679.6	727.1
Operating profit/loss	126.73	317.8	124.59
Total asset	22,533.27	25,880.60	35,909.67
Current asset	8,527.24	8,429.30	12,743.95
Non-current asset	10,717.56	13,921.40	19,861.35
Current liabilities	11,238.67	13,042.20	20,976.91
Shareholder's equity	6,371.33	5,634.80	4,543.32
Liabilities	16,161.94	20,245.80	31,366.35

Source: Questionnaire answer from Dongbei Special Steel Company.

3.5.4 Current Status of Operation and Maintenance

As far as known from the O&M status of each facility and equipment, O&M plan, and operation records, no problem was observed. It was confirmed that the equipment, which were re-installed at the new plants of the steel company and of the pharmaceutical company, has operated without problems. According to the interview with each implementing agency, it was ensured that the spare-parts, which were imported from Germany, USA and Japan, were also easily available.

In light of the above, no major problems have been observed in the operation and maintenance system, therefore sustainability of the project effect is high.

[37] Source: Interview with the Dongbei Special Steel Company.
[38] Source: same as above.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

Environment Model City Projects were implemented in Dalian, Chongqing and Guiyang Cities in order to improve environment by carrying out air pollution control intensively and by building environmental monitoring system, under the "Environment Model City Framework", which was aiming to replicating the good practices of the projects in other cities in China. As Dalian City's energy structure depends on coal, it was facing serious air pollution along with recent industrialization and increase of vehicles. Thus, Dalian City was urgently needed to take actions in air pollution control. Regarding the reduction in the emission of air pollutants such as SO_2 and TSP, expected effects have been observed almost as planned in the four sub-projects, in which actual data were confirmed. Regarding the one sub-project in which actual data could not be confirmed directly with the implementation agency, as far as known from the available information, there was no such evidence that the plants emit pollutants beyond the environmental standards. In addition, effects other than indicators and positive impacts were also observed. Therefore, effectiveness and impact of this project is high. Regarding efficiency of this project, the project cost exceeded the plan, and the project period also significantly exceeded the plan, therefore efficiency of the project is low. Meanwhile, no major problems have been observed in the operation and maintenance system, technical level, and operation and maintenance status of the implementing agency of each sub-project. Financial situations are also stable. Therefore, sustainability of the project effect is high. In light of the above, this project is evaluated to be satisfactory.

4.2 Recommendations

4.2.1 Recommendation to the Executing Agency

None.

4.2.2 Recommendation to JICA

None.

4.3 Lessons Learned

In this project, one of the sub-projects was completed only by the local fund, and more than ten years has already passed since the completion of the sub-project. Thus, as it was not possible to verify the operating situations of the installed facilities and actual data of the reduced amount of air pollutant emission, the effectiveness of the sub-project could not be evaluated. In the similar project consisting of more than one sub-projects, the actual data of each sub-project is important in evaluating the project overall appropriately. Therefore, it is recommended for the concerned parties to collect actual data even for the portion, which was implemented completely by the local fund, upon the agreement with the executing agencies.

Comparison of the Original and Actual Scope of the Project

Item	Original	Actual
1. Output 1) Dalian Pharmaceutical Factory Environmental Protection Project	Installation of the production line along with the relocation and the construction of wastewater treatment facility.	As planned.
2) Thermal Power Station Project in Yandao Chemical Area	Construction of the boilers, generation units, coal delivery system, electrical system and thermal control system.	As planned except that the performance of the generation's unit was changed to 15,000kw.
3) Chunhai Thermal Power Station Project	Construction of the boilers and generation units.	As planned.
4) Dalian Cement Plant Dust Pollution Treatment Project	Bag filter, dust collector for kiln, remaining heat generating system, coal mill, cement mill, air compressor, central control system, etc.	As planned except the addition of the limestone conveyor system (3.75km) and the change from the air compressor to induced fun.
5) Dalian Steel Plant Air Pollution Treatment Project	Dust removal for one set of 40 ton Electric Furnace (EAF) and one set of 40 ton Ladle Furnace (LF), 40 ton AOD furnace and the dust removal, and Continuous Conticaster. The above items were to be covered by the loan. Installation of dust removers for three set of 20 ton EAF. Abolishment of three sets of 20 ton furnace and three sets of 15 ton furnace. The above items were to be covered by the local fund.	As planned.
2. Project Period	(I) March 2000~February 2002 (24 months) (II) March 2001~March 2003 (25 months)	(I) March 2000~October 2004 (56 months) (II) March 2001~December 2009 (106 months)
3. Project Cost	(I)	(I)
Foreign currency	5,315million yen	2,273 million yen
Local currency	4,860million yen (324.02 million RMB)	3,584million yen (257.15million RMB)
Total	10,175million yen	5,857million yen
Japanese ODA loan	5,315million yen	2,273 million yen
Exchange rate	1yuan = 15Japanese Yen (As of October 1999)	1yuan = 13.94yen (Average between March 2000 and May 2006)
	(II)	(II)
Foreign currency	3,202million yen	3,116 million yen
Local currency	1,307million yen (100.53million RMB)	12,652million yen (887.88million RMB)
Total	4,509million yen	15,766 million yen
Japanese ODA loan	3,202million yen	3,116 million yen
Exchange rate	1yuan = 13Japanese Yen (the time of exchange: unknown)	1yuan = 14.25yen (Average between March 2001 and July 2010)