Appendix

1. List of Members of the Field Survey Mission
2. Itinerary of Field Survey
3. Attendants from the Authority
4. Minutes of Discussion
5. Ventilation System Plan
6. Basic Plan for Tunnel Lining
7. Data Provided by the Governor of Ismailia (from S.C.A.)
8. Expansion Plans of Suez Canal (from S.C.A.)
9. Traffic Condition of Suez Canal (from S.C.A.)
10. Traffic Condition of Transportation Crossing Suez Canal (from S.C.A.)
11. Data of Water Supply Pipeline (from S.C.A. and JSE)
12. Data of Suez Canal Banks (from S.C.A.)
13. Tide Tables of Red Sea-Suez (from S.C.A.)

Appendix-1

List of Members of the Field Survey Mission

Appendix -1 Member List of Field Survey Mission

1) Study Team (Phase 1)

- Period : from 23th June to 4th July, 1991

- Member

Mission leader : Mr. Shigeru Nakamura
Director of Grant Aid Division
Economic Cooperation Bureau
Ministry of Foreign Affairs

Members : Dr. Akira Inokuma
Head of Tunnel Division
Public Works Research Institute
Ministry of Construction

: Dr. Katsuhiko Iwai
Chief Tunnel Engineer
Department of Engineering, Nihon Doro Kodan

: Mr. Shin'ichi Mori
Grant Aid Division
Economic Cooperation Bureau
Ministry of Foreign Affairs

: Mr. Shinya Nakai
Director of Second Basic Design Study Division
Grant Aid Study & Design Department
Japan International Cooperation Agency

2) Study Team (Phase 2)

- Period : from 1st August to 9th September, 1991

- Member

Mission leader : Dr. Akira Inokuma
Head of Tunnel Division
Public Works Research Institute
Ministry of Construction

: Mr. Naoharu Taga
Head of Tunnel & Slope Stability
Section
Laboratory of Nihon Doro Kodan

: Mr. Kohichi Miyoshi
Director of Second Basic Design
Study Division
Grant Aid Study & Design Department
Japan International Cooperation Agency

(Hereunder : Consulting Team)

: Mr. Takayoshi Ohtsuka
Chief Consulting Engineer(JSE)

: Mr. Iwao Tsunashima
Deputy Chief Consulting Engineer(JSE)
(Structural engineering for method and procedure of construction)

: Mr. Susumu Nagao
Consulting Engineer(JSE)
(Structural engineering for design of tunnel structure)

: Dr. Akio Maru
Consulting Engineer & Doctor of Science(JSE)
(Analyzing of concrete materials)

: Mr. Masayuki Saitoh
Consulting Engineer(JSE)
(Cost estimation and scheduling of rehabilitation works)

: Mr. Tohru Kawakami
Consulting Engineer(NK)
(Mechanical engineering for ventilation system and instrumental survey)

: Mr. Yuhsuke Doi
Consulting Engineer(NK)
(Civil engineering for related equipment)

: Mr. Masao Chida
Consulting Engineer(NK)
(Geological survey)

: Mr.Shoichi Fujii
Consulting Engineer(NK)
(Electrical equipment)

JSE : Japan Shield Engineering Co.,Ltd.
NK : Nippon Koei Co.,Ltd.

3) Study Team (Draft Final Report Presentation)

- Period : from 21st November to 1st December,1991

- Memeber :

Mission Leader : Dr.Katsuhiko Iwai
Chief Tunnel Engineer
Department of Engineering, Nihon Doro Kodan

Members : Mr. Masashi Kono
Grant Aid Cooperation
Deputy Director, Grant Aid Division
Economic Cooperation Bureau
Ministry of Foreign Affairs

: Mr. Yuki Aratsu
Second Basic Design Study Division
Grant Aid Study & Design Department
Japan Inernational Cooperation Agency

(Hereunder : Consulting Team)

: Mr. Takayoshi Otsuka
Chief Consulting Engineer(JSE)

: Mr. Iwao Tsunashima
Deputy Chief Consulting Engineer (JSE)
(Structural engineering for method and procedure of construction)

: Mr. Susumu Nagao
Consulting Engineer (JSE)
(Structural engineering for design of tunnel structure)

: Mr. Tohru Kawakami
Consulting Engineer (NK)
(Mechanical engineering for ventilation system and related equipment, and instrumental survey)

JSE : Japan Shield Engineering Co.,Ltd.
NK : Nippon Koei Co., Ltd.

Appendix-2

Itinerary of the Field Survey

Appendix - 2 Itinerary of Field Survey

1) 1st Mission

23th(Sun) June, 1991	: Leaving Tokyo
24th(Mon)	: Arriving at Cairo
25th(Tue)	: Having courtesy visit to Embassy of Japan in Cairo and site survey of the Tunnel
26th(Wed)	: Having courtesy visit to the Suez Canal Authority in Ismailia and having discussions with staffs of the Authority
27th(Thr)	: Having discussions with staffs of the Authority and signing the Minutes of Discussion
28th(Fri)	: Having site survey of the tunnel
29th(Sat)	: Leaving Cairo(Leader1) Having discussions with staff of the Authority(Members)
30th(Sun)	: Having discussions with staff of the Authority(Members)
1st(Mon) July	: Having visit to Embassy of Japan in Cairo and reporting
2nd(Tue)	: Leaving Cairo
4th(Thr)	: Arriving Tokyo

2) 2nd Mission

1st(Thr) August, 1991
: Leaving Tokyo

2nd(Fri) : Arriving Cairo

3rd(Sat) : Having courtesy visit to Embassy of Japan, Cairo Branch of JICA and the Suez Canal Authority

5th(Mon) : Leaving Cairo
Arriving Ismailia
Having courtesy visit to S.C.A.

6th(Tue) : Having discussions with staffs of the Authority and explaining the outline of field survey of the Tunnel

7th(Wed) to
31st(Sat) : Having field survey of the Tunnel

1st(Sun) September
: Having discussions with staffs of the Authority and preparing the Minutes of Meeting

2nd(Mon) : Having discussions with staff of the Authority and signing the Minutes of Meeting

3rd(Tue) to
5th(Thr) : Arranging the data and information obtained by the field survey

6th(Fri) : Leaving Ismailia
Arriving Cairo

7th(Sat) : Leaving Cairo

9th(Mon) : Arriving Tokyo

Appendix-3

Attendants from the Authority

Appendix - 3 Attendants from Egypt

1) Suez Canal Authority

Eng. Mohamed Ezzat Adel
Chairman

Dr. Eng. Farouk Abou-Taleb
Director of Management Dept. & Member of Board of Directors

Dr. Eng. Abdel-Hamid Youssef Soliman
Director of Engineering Dept. & Member of Board of Directors

Eng. Hani El-Bon
Director of Works Dept. & Member of Board of Directors

Eng. Naila Marzouk
Deputy director of Engineering Dept.

Dr. Eng. Isis Abdel-Halim Kamel
Deputy director of Works Dept.

Dr. Eng. Mohamed El-Ghamry
Deputy director of Engineering Dept.

Eng. Refaat E. M. Khalil
Manager of A. H. Tunnel, Works Dept.

Eng. Naim Mohamed Ramadan
Chief of Water Section, Works Dept.

Eng. Yehia Abdou Hassan
Chief of Maintenance & Electrical Section of A. H. Tunnel, Works Dept.

Eng. Mohamed Nashat
Manager of Distribution System, Works Dept.

Eng. Said Dawoud
Manager of Ataka, Works Dept.

Eng. Saad Saleh
Executive Engineer of A. H. Tunnel, Works Dept.

Eng. Rafat Abdel-Sid
Executive Engineer of A. H. Tunnel, Works Dept.

2) Ministry of Housing and Reconstruction

Mr. Eng. Hassabalah El-Kafrawy
Minister

3) Local Government of Ismailia

Dr. Ahmed Al Gowely
Local Governer

Appendix-4

Minutes of Discussion

Appendix-4

(1) Date of June 27,1991

(2) Date of September 2,1991

(3) Date of November 27,1991

MINUTES OF DISCUSSIONS
ON
THE BASIC DESIGN STUDY ON THE PROJECT FOR REHABILITATION OF AHMED HAMDI TUNNEL IN THE ARAB REPUBLIC OF EGYPT

In response to the request made by the Government of the Arab Republic of Egypt, the Government of Japan decided to conduct a Basic Design Study on the Project for Rehabilitation of Ahmed Hamdi Tunnel (hereinafter referred to as "the Project") and the Japan International Cooperation Agency (JICA) has sent the Basic Design Study Team headed by Mr. Shigeru Nakamura, Director, Grant Aid Division, Economic Cooperation Bureau, Ministry of Foreign Affairs.

The Team had a series of discussions with the authorities concerned of the Government of the Arab Republic of Egypt and conducted a field observation.

As a result of the study, both parties have agreed to recommend to their respective Governments that the major points of understanding reached between them as attached herewith should be examined towards the realization of the Project.

Cairo, June 27, 1991

Mr. Shigeru Nakamura,
Leader,
Basic Design Study Team
JICA

HANY

Eng. Hany Abdel Halim El-Bon
Director of Works Dept.
Suez Canal Authority

Witnessed by

Mr. Hamed Moustafa,
Undersecretary,
Ministry of International Cooperation

ATTACHMENT

1. Objective

The objective of the Project is to rehabilitate the Ahmed Hamdi Tunnel (hereinafter referred to as "the Tunnel")

2. Project Site

North of Suez city (location map is attached as Annex-1)

3. Responsible Organization, Executing Organization

(1) Responsible organization : Suez Canal Authority

(2) Executing organization : Suez Canal Authority

4. Contents Requested by the SCA

(1) rehabilitation work for the whole length (1650m.) of the Tunnel by the method of the secondary lining after applying the waterproofing sheet including the road deck and ventilation system.

(2) application of one lane open method for daily (and night) traffic during construction period.

5. Contents of the Basic Design Study

(1) Objectives
a. to examine and assess the technical and economic viability of the Project.
b. to make a basic design of the Project.
c. to make a schedule required for implementation (rehabilitation work) of the Project.
d. to estimate the cost of the Project in foreign and local currencies.

(2) Main Scope of the Basic Design Study
a. status of the Project in the National and/or Regional development plan.
b. background of the Project.
c. traffic survey.
d. present condition of the Tunnel (by measurement, core samples, etc.), excluding life line (telephone, electricity and water line).
e. soil condition survey (by boring etc.).
f. construction material survey.
g. operation and maintenance situation
h. activities of executive agency directly related to the Project.
i. present ventilation system.

HANY

(3) Tentative Schedule of the Basic Design Study
Tentative Schedule is attached as Annex-2, anyhow, SCA requested to accelarate the schedule as early as possible and the Japanese side took note about this request.

6. Japan's Grant Aid System

(1) The SCA has acknowledged the system of Japanese Grant Aid

(2) The SCA will take necessary measures described in Annex-3, on condition that the Grant Aid Assistance by the Government of Japan is extended to the Project.

(3) The SCA's share in financing the Project (local currency) will be used in accordance with the relevant laws and regulations of the Arab Republic of Egypt such as tendering, procurement, etc.

7. Arbitration by the International Chamber of Commerce in dispute concerning the Tunnel
The SCA confirmed that;

a. it will not involve the Japanese study team members in the arbitration in any way,

b. it will not use any data, documents or reports prepared by the Japanese basic design study team for the arbitration, and will not present them to the courts neither in Egypt nor in Switzerland,

c. there are no objections to boring and sampling of the Tunnel core and to any other survey activities carried out by the basic design study team for the objectives of the study without causing any serious damage to the Tunnel. The said survey is likely to be ended before the end of August, 1991.

8. Required Assistance from the SCA
The SCA is requested to kindly afford the upcoming basic design study team with every possible assistance for the smooth implementation of the study. The following points are especially requested.

a. to provide the basic design study team with available relevant data, information and local materials necessary for the execution of the study, these data and information are not elgible to be delivered to third party or brought to their notice unless there is a written consent by the SCA.

b. to assign full time counterparts to the basic design study team during their stay in Egypt (4 or 5 engineers and 10 to 15 technicians)

HANY

c. to remove existing wall panels inside the segmented lining for measurement, chipping concrete, etc.

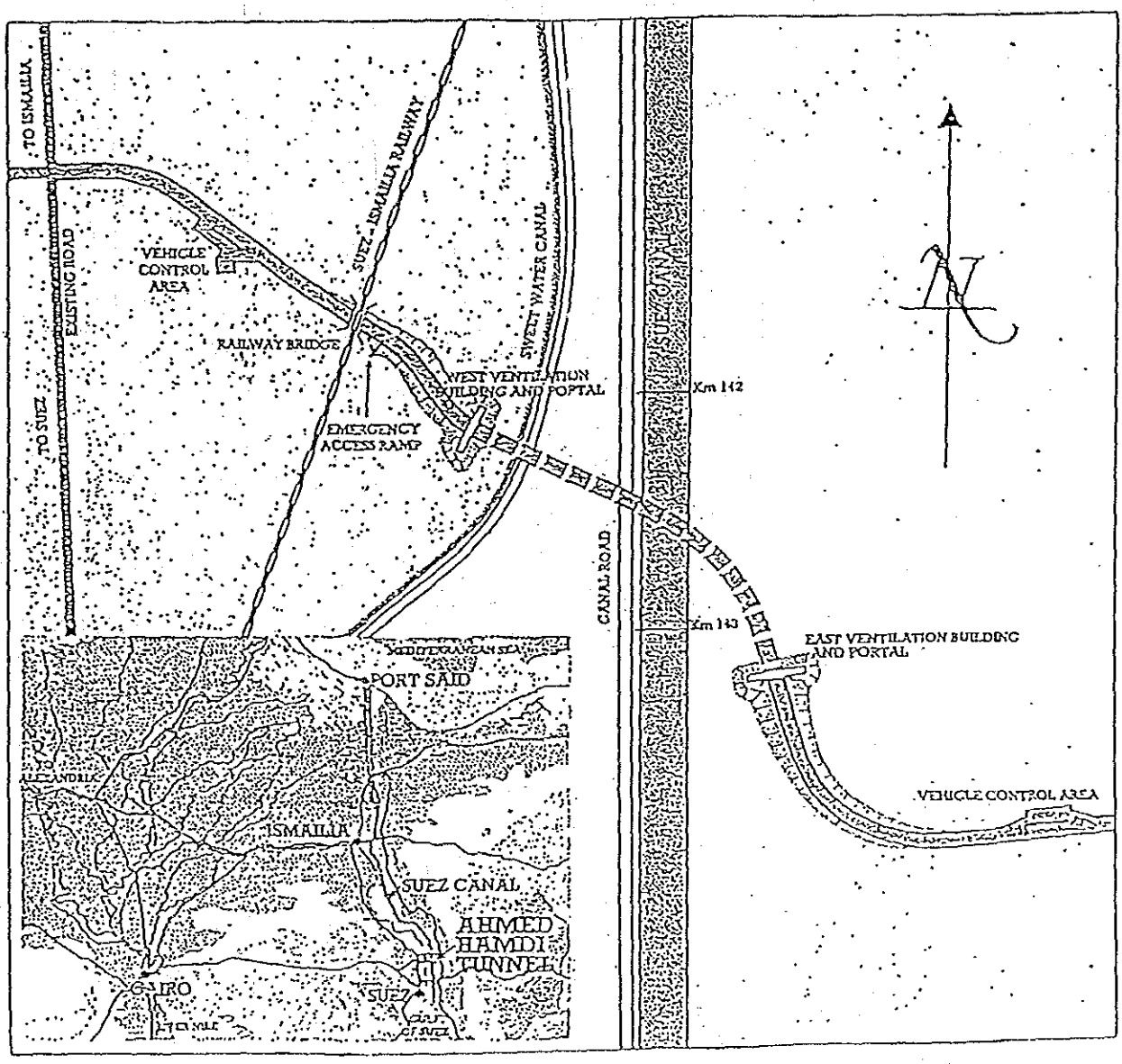
d. to coordinate the concerned ministries and/or agency, if items to be coordinated will arise.

e. to provide the basic design study team with office for the study.

f. to assist custom clearance of the equipment for the study in accordance with the relevant laws and regulations of the Arab Republic of Egypt.

HANI

ANNEX - 1

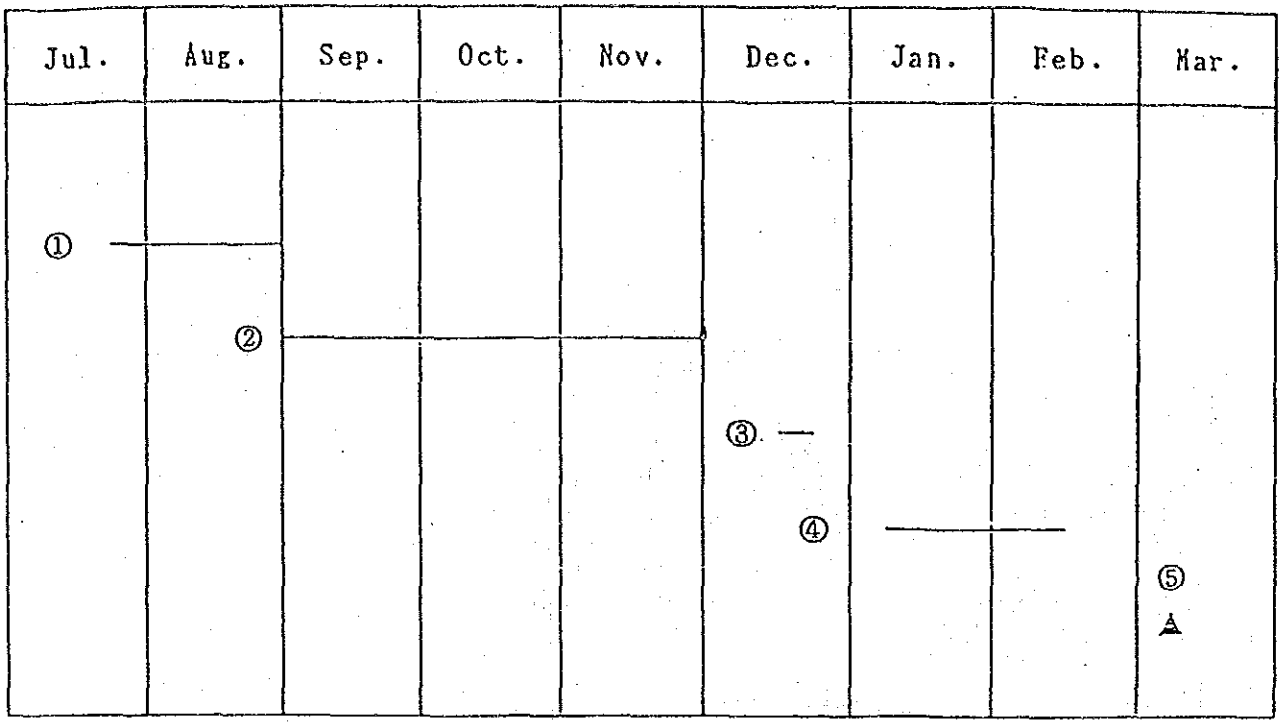


The Location of the Tunnel

HANY

ANNEX-2

Tentative Schedule of the Basic Design Study



①: field survey by technical(consultant) team

②: home office work

③: present and explaination of the draft final report

④: prepare the final report

⑤: submit the final report

HANOI

ANNEX-3

Recommendation for Undertakings by the Government of Egypt in case Japan's Grant is executed:

1. to undertake incidental outdoor works such as gardening, fencing, gates and exterior lighting in and around the site.

2. to construct the access road to the site prior to the commencement of the construction.

3. to provide facilities for distribution of electricity, water supply, telephone, drainage, and other incidental facilities to the Project site.

4. to ensure prompt unloading and customs clearance at ports of disembarkation in the Arab Republic of Egypt and internal transportation therein of the products purchased under the Grant.

5. to secure, with respect to the supply of the products and services under the verified contracts that Japanese nationals shall not be subject to any customs duties, internal taxes and other fiscal levies which may be imposed in the Arab Republic of Egypt.

6. to accord Japanese Nationals whose services may be required in connection with the supply of the products and services under the verified contract such facilities as may be necessary for their entry into Egypt and stay therein for the performance of their work in accordance with the relevant laws and regulations of the Arab Republic of Egypt.

7. to maintain and use properly and effectively the facilities constructed and equipment under the Grant.

8. to bear all the expenses other than those to be borne by the Grant, necessary for the execution of the Project.

HANI

S. T

MINUTES OF DISCUSSIONS
ON
THE BASIC DESIGN STUDY ON THE PROJECT
FOR REHABILITATION OF AHMED HAMDI TUNNEL
IN
THE ARAB REPUBLIC OF EGYPT

A series of discussions on the Project for Rehabilitation of Ahmed Hamdi Tunnel (the Project) have been held between the Suez Canal Authority (S.C.A.) and the Basic Design Study team (the Team) sent by Japan International Cooperation Agency (JICA) and headed by Dr. Akira Inokuma, Head, Tunnel Division, Road Department of Public Works Research Institute, Ministry of Construction. The Team also has conducted a field survey.

As a result of the survey, both parties have agreed to recommend to their respective Governments that the major points of understanding reached between them as attached herewith should be examined towards the realization of the Project.

Ismailia, September 2, 1991

Akira Inokuma

Dr. Akira Inokuma,
Leader,
Basic Design Study Team
JICA

M. E. Adel.

Eng. Mohamed Ezzat Adel,
Chairman of
Suez Canal Authority

ATTACHMENT

1. Design Criteria

(1) The Rehabilitation Works for the whole length (1650m) of the Tunnel shall be made by the method of the secondary lining after applying of the waterproofing sheet including the road deck.

The above mentioned rehabilitation design at the tunnel will allow the implementation of the future widening, deepening and doubling projects of the Suez Canal.

(2) The existing road capacity and limits shall be secured. (The road limit shall be equal to the existing one that is 5.0m in height and 7.5m in width)

(3) Concerning the drainage system, the ground water shall be directed to the drain at the invert and be collected into Nadir sump tank.

(4) The Permanent Water Supply Pipelines shall be installed (two lines) outside of the Tunnel as syphon pipe system crossing of the Canal in order to secure the water supply to the Sinai Peninsula and to facilitate the Rehabilitation Works.

(5) Ventilation System Plan

The transverse system has been recommended by the Team after the comparison between the transverse system and the semi-transverse system for the ventilation in consideration with the safety at the emergency such as "Fire".

On this recommendation, S.C.A. requested further study by the Team on the comparison among the transverse, the semi-transverse and the semi-transverse with the Pilot Shaft from the technical and economical view points to ensure easy maintenance in the future.

The Team has explained that the transverse system is also easy for the maintenance.

The Team has, however, accepted to make this study and to recommend the ventilation method which is considered to be most convenient to secure the safety of the tunnel at the emergency such as "Fire" and easy maintenance.

S.C.A. and the Team should endeavor to decide the ventilation system by the end of September 1991.

Akira Inokuma M. G. Adel.

2. Work Criteria

(1) The traffic restrictions during the Rehabilitation Works to be as follows :
   1) One way traffic.
   2) The speed limit 20km/h, further restriction to be applied to large vehicles.
   3) The traffic to be stopped between 8:00 pm through 6:00 am. At the period of the special work change such as the assembling/dismantling/moving works for Centles and Sliding Forms, the traffic to be stopped the full day(s) as schedule of construction. The period of traffic stoppage should not exceed one month during the Rehabilitation Works. Each stoppage may continue 4 days maximum.

(2) The work to be carried out by 3 shifts. (24 hours per day)

3. Road System and Related Facilities

As a basic policy the road system and the related facilities after being rehabilitated shall recover their former function.

Items shall be replaced or reused as shown in Table 3.1.

The possibility of the reuse of any material will be decided according to the engineers technical points of view.

Akira Inokuma M. G. Adel.

Table 3.1 Road System and Related Facilities

ITEMS	EVALUATION AS TO REPLACE OR REUSE
1. Ventilation Exhaust Duct *1)	
1) Ceiling panels	REPLACE
2) Cowlings to exhaust grille	REUSE
3) Hangers	REUSE
4) Beams(Support frame)	REUSE
5) Coverings from wind leaking	REUSE
6) Diaphragm	REUSE
2. Wall Panels	——— *2)
3. Walkways	
1) Steel frames	REPLACE
2) Deck plates	REUSE
3) Side panels	REUSE
4. Life Lines	
1) 2x500mm NID pipes	REUSE
2) Special telephone cables	———
5. Other Pipes from Nadir Sump	
1) Drainage pipes	REPLACE
2) Drain pipes	REPLACE
3) Exhaust pipes	REPLACE
4) Fire hydrant pipes	REUSE
6. Monitoring	
CO/VI monitoring system CO(8)	REUSE
VI(5)	REUSE
7. Safety Facilities	
1) Tunnel lighting (Except transformer and panel board)	REUSE
2) TV Camera(26)	REUSE
3) Fire points(22)	REUSE
4) Telephone System(14)	REUSE
5) Radio Telephone System	REUSE
8. Electrical Cables	
1) Cable Below Walkway	REPLACE
2) 11kv Power Cable	REUSE

*1) In case of transverse system
*2) Will be decided by the study team after the detail evaluation.

Akira Inokuma M. E. Adil

4. Services and Products to be covered by the Egyptian side related with the Road System and the Related Facilities.

(1) Water Supply

1) The Canal dredging for the syphon portion
2) The excavation/earthing for the onland portion
3) Ductile Iron Pipe 500mm NID, 500m length (from S.C.A. stock)

(2) Special telephone cable

The temporary work and the permanent work to be carried out by the Egyptian side according to Japanese indication for the location and the work schedule of the construction.

(3) Ceiling panels

The ceiling panels (material only) in case needed.

5. Others

In regard to the items 1,2 and 3 in the ANNEX-3 of the Minutes of Discussions dated June 27, 1991, the following shall be defined as the matter to be carried out by S.C.A. at this point of time.

1) Temporary yard for work
2) Access road for Work
3) Ware house for material and equipment
4) Water supply for work
5) Electric Power supply for work
6) Installation of Telecommunication service (telephone and telefax) for work

Akira Onokuma M. Y. Abdel.

6. Inter-Relations between Rehabilitation Works of the Tunnel and Expanding(Widening) Work of the Canal.

Judging from the structurally and functionally deteriorated situation of the Tunnel and the safety of traffic in the Tunnel, and the Rehabilitation Works of the Tunnel, the team recommended that the Expanding(Widening) Work of the Canal should be executed after the Rehabilitation Works of the Tunnel is substantially completed.

S.C.A. has explained the importance of the widening the Canal for 20m on the east side and requested the study team to find out the most optimum work schedule for the Rehabilitation Works starting from the nominated Canal expansion portion of the Tunnel (east side).

The study team has accepted this.

Akira Inokuma M. E. Adil

MINUTES OF DISCUSSIONS
BASIC DESIGN STUDY ON THE PROJECT FOR
REHABILITATION OF AHMED HAMDI TUNNEL IN
THE ARAB REPUBLIC OF EGYPT
(CONSULTATION ON DRAFT REPORT)

From June to September, 1991, the Japan International Cooperation Agency (JICA) dispatched study teams on the Project for Rehabilitation of Ahmed Hamdi Tunnel (hereinafter referred to as "the Project")to the Arab Republic of Egypt, and through discussions, field survey, and technical examination of the results in Japan, JICA has prepared the draft report of the study.

In order to explain and consult the Egyptian side on the components of the draft report, JICA sent to Egypt a study team, which is headed by Dr.Katsuhiko Iwai, Chief Tunnel Engineer, Department of Engineering, NIHON DORO KODAN, and is scheduled to stay in the country from November 22 to 29, 1991.

As a result of discussions, both parties confirmed the main items described on the attached sheets.

Ismailia, November 27, 1991

Katsuhiko Iwai

Dr. Katsuhiko Iwai
Leader,
Draft Report Explanation Team,
JICA

M. E. Adel

Eng, Mohamed Ezzat Adel,
Chairman of
Suez Canal Authority

ATTACHMENT

1.Draft Report

1) The Suez Canal Authority (S.C.A.) has agreed and accepted in principle the philosophy of Draft Report proposed by the Team.
2) The Egyptian side showed some remarks during discussions of the Draft Report and the Japanese side promised to take them into consideration in the Final Report.
3) The Team will finalize the Draft Report in accordance with the confirmed items, and JICA will send the Final Report to the Government of Arab Republic of Egypt by the end of March, 1992.

2.Duty of Egyptian side

Regarding item 5 in the Minutes of Discussions dated September 2, 1991, and items 1,2 and 3 in the ANNEX-3 of the Minutes of the Discussions dated June 27,1991, the following is a clarification of the task to be carried out by S.C.A.

1) Electric power supply for the work*

(1) in temporary yard
380V, 500kVA
(2) in tunnel
3.3kV, 400kVA

2) Fresh water supply for the work in the temporary yard*

500m^3/day.

*S.C.A. shall provide the sources of electricity and water, while the Japanese side has to undertake all necessary arrangement, connections and installations to provide the sites with electricity and water.

K. Iwai

M. G. Abdel

3) Installation of telecommunication service facilities

(1) One(1) phone and one(1) telefax for Supervisory Cosultants.
(2) Three(3) phones and one(1) telefax for Contractor

S.C.A. installs the telecommunication service facilities without paying the bills for the use of these services.

4) To prepare the space for demolished/dismantled concrete structures such as road deck, and those dismantled concrete blocks are allowed to be left as demolished condition.
The Japanese side takes all responsibilities to transport the demolished/dismantled concrete to the space identified by S.C.A.

5) To control the safety of traffic in the Tunnel between 6.00am and 8.00pm during the works

6) To provide fire extinguishers and one fire engine to be used in case of fire emergency for the safety of the traffic passenger(s) during the works.

Concerning items 5),6) S.C.A. authorizes the instructions proposed by the Japanese side to insure the safety of traffic in the Tunnel during the Rehabilitation Works.

3.Legal Dispute

The Team expressed the hope once again that the legal dispute related to A.H.Tunnel would be solved as soon as possible so that the Japanese side could start to take necessary steps toward the realization of the Project.
S.C.A. promised to make at most effort and to take necessary measures for the smooth implementation of the Project.

K. Iwai

M. H. Abdel.

Appendix-5

Ventilation System Plan

11th Oct., 1991

TO: Eng. Mohamed Ezzat Adel
Chairman of
Suez Canal Authority

FROM: Dr. Akira Inokuma
Leader of
Basic Design Study Team
JICA

Att.: Dr. Eng. ISIS A. Camel

FAX. NO. 064-220785

SUBJECT: Ventilation System Plan

Based on the Minutes of Discussions agreed on 2nd September 1991, we have the pleasure to submit the study results on the Ventilation System Plan for the AHMED HAMDI TUNNEL.

The following three alternatives were compared as shown in the attached table, and details are described in the ATTACHMENT.

- Transverse system
- Semi-transverse system
- Semi-transverse system with the Pilot Shaft

The Team wishes to once again recommend the "Transverse System" as the most appropriate and convenient system in order to secure the safety of the tunnel at the emergency such as "Fire", and easy maintenance. The summary of the reasons for our recommendation are as follows:

1) Semi-transverse system with the Pilot Shaft (not recommendable)

The technical necessity of a vertical shaft to improve the semi-transverse system could not be identified from the view point not only of ventilation capacity but also of emergency operation, and the newly required cost for an imaged scheme would exceed the cost of the ceiling plates for the transverse system. This system, therefore, is not recommendable.

2) Semi-transverse System (acceptable but not recommendable)

The proposed system is the most economical plan to supply fresh air from lower duct, which is quite acceptable with the air supply capacity of the existing fans. However, in the case of fire it could not be effective to extract smoke from the lower mouths by operation of reversible fans.

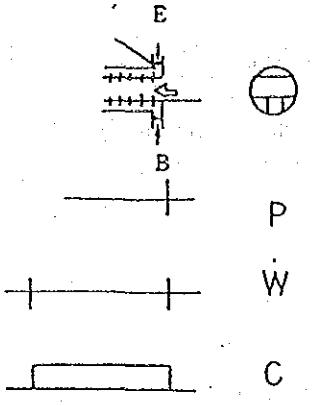
3) Transverse System (recommendable)

The original ventilation facilities not only could be utilized under the conditions that the duct areas are reduced to 70 percent but also this system can be operated as the semi-transverse system except in case of emergency, ~~which~~ the Team would like to propose from a view point of cost saving in the operation. This system is recommendable even in the case of fire with the reasons that continuous extraction of smoke into the exhaust duct could be secured.

Your kind attention and acceptance will be highly appreciated.

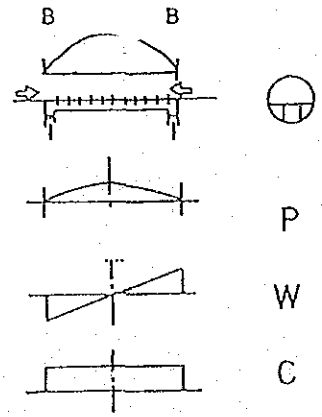
Dr. Akira Inokuma

Selection of Ventilation System



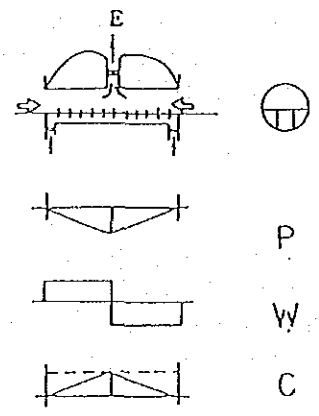
1) Transverse Ventilation System

A required ventilation volume was reviewed by the latest PIARC standards (1987) which showed the high possibility to utilize the existing facilities at maximum.



2) Semi-transverse Ventilation System

This system was proposed in 1990 by the TASK TEAM due to less required rehabilitation cost with omission of ceiling plates for exhaust duct.



3) Vertical Shaft Ventilation System

This system was proposed by S.C.A as the combination with semi-transverse system which may utilize the pilot shaft digged before and backfilled after construction of the tunnel.

where

P : Pressure in Tunnel
W : Wind Velocity in Tunnel
C : Concentration of Gas in Tunnel

COMPARISON OF VENTILATION SYSTEM

1.0 £.E. = ¥40.-

Item	Transverse System		Semi Transverse System		Vertical Shaft System	
A. Ventilation facilities	Supply fans (6), Exhaust fans (6)	○	Supply fans (6), Exhaust abandon	Δ	Vertical Shaft, ventilation building shall be constructed	Δ
B. Reusable existing fans	75 percent	○	37 percent	Δ	50 percent	Δ
C. Service level for users	Stable, comfortable & no against wind flow	○	Hot, dirty & less comfortable due to exhaust by traffic flow	Δ	Hot, dirty & less comfortable due to exhaust by traffic flow	Δ
D. In case of fire (First : fire occured) (Second : after fire extinguished) (Third : return to ordinary conditions)	First : Stop supply fans only and fire fighting	○	First : Stop fans and fire fighting	×	First : Stop fans and fire fighting	×
	Second : Reversed operation of supply fans, full operation of exhaust fans	○	Second : Reversed operation of supply fans	×	Second : Full operation of vertical exhaust fan, reversed operation of supply fans	Δ
	Third : Air supply & exhaust fans ordinary operation	○	Third : Delay to ordinary operation	Δ	Third : Delay to ordinary operation	Δ
E. Consumption of electricity	£.E. 0.6 Million per year	Δ	£.E. 0.4 Million per year less than that of Transverse	○	£.E. 0.5 Million year	Δ
F. Newly required cost	Recovery of ceiling plates £.E. 3.0 Million	Δ	Nothing to invest	○	Vertical shaft & ventilation building with control system £.E. 3.7 Million	Δ
G. Value of abandon property	Good utilization of existing facilities £.E. 1.5 Million	○	Exhaust fans with facilities £.E. 7 Million	×	Exhaust fans with facilities £.E. 5.5 Million	×
H. Operation	Very familiar to S.C.A. staff	○	Untouchable to exhaust fans	Δ	A little complicated	Δ
I. Maintenance (Spare parts)	£.E. 0.03 Million/Year	Δ	£.E. 0.02 Million/Year	○	£.E. 0.025 Million/Year	Δ
Project cost (10 years) (E + F + I)	£.E. 9.3 Million (£.E. 7.2 Million)	Δ	£.E. 4.2 Million	○	£.E. 9.0 Million	Δ
Total Evaluation	Recommendable	○	Acceptable except in the case of emergency	Δ	Not recommendable	×

ATTACHMENT

Ventilation System Plan

1. Introduction

Ahmed Hamdi Tunnel has a full transverse ventilation system. The Basic Design Study team (The Team) reviewed the required ventilation volume based on the latest PIARC standards (1987) and planned the ventilation system for the Rehabilitation works of the Tunnel based on the following main policies:

- The Team considers that the existing facilities for ventilation has a present value of about £.E.15 Million, therefore, the existing facilities should be utilized as much as possible without scrapping them.
- The present traffic volume is 1,500 veh. per day. However, correct traffic forecast in future would be quite difficult due to parameter of development in Sinai area. Therefore, the plan of tunnel facilities shall be based on the maximum possible traffic for the tunnel, which was calculated at 1,500 veh. per hour. (See DATA-1)

2. Ventilation Volume Reviewed by PIARC (1987)

In the review, the maximum emission of gas were given from the standard D of PIARC which includes the countries having no restriction by law to control the emission of gas per veh.

2.1 Ordinary Conditions

The required ventilation volumes were examined based on the following inputs:

- Design traffic volume	1,500	veh./H
- Design speed	60	km/H
- Component of diesel car	36	percent

1) Ventilation for CO Gas

PIARC gives 150 PPM as an allowable concentration of CO, this results is 121 m^3/s of ventilation. (See DATA-2)

2) Ventilation for VI Level

PIARC requests 410 m^3/s (See DATA-3)

2.2 In Case of the Most Serious Traffic Jam

The following assumptions give the required volume of 409 m^3/s (See DATA-4) for the traffic jam:

- Design traffic volume	2,000	veh./H
- Design speed	10	km/H
- Component of diesel car	0	percent
The maximum allowable concentration of CO gas	250	PPM

Based on the above calculations, it can be said that the maximum ventilation of 410 m^3/s is required for the Tunnel.

3. Ventilation Capacity after Rehabilitation

3.1 Air Volumes by Operation Levels

Existing fans have the following capacities (m^3/s) as a total of west and east side systems:

Operation Level		Supply	Exhaust
7	(Auto)	616	648
6	(Manual)	504	528
5		338	354
4		244	254
3		118	126
2		62	66
1		0	0

The required air volume (410 m^3/s) can be supplied by the level of 6 operation (504 m^3/s).

3.2 Effect of Reduced Duct Area

The Team calculated the duct areas as follows:

Duct	Existing	After Rehabilitation
Supply	10.8 m^2	7.8 m^2 (73%)
Exhaust	10.5 m^2	8.0 m^2 (76%)

The maximum required supply volume of 410 m^3/s is less than 70 percent of the maximum existing supply volume of 616 m^3/s, which indicates that safety operation of fans could be arranged not to increase the wind pressure to the fans.

4. Selection of Ventilation System

4.1 Semi-transverse with Pilot Shaft

Technical points

- The wind flow velocity in the tunnel were observed to be about 3 m/s at the west side, and about 1.5 m/s at east side, this difference is assumed to be caused by the tunnel alignment, and therefore local concentration of gas may occur at the east side near the tunnel centre. However the local concentration of gas at the lowest point can be resolved by throttle adjustment to supply fresh air.

- The pilot shaft was dug before and backfilled after the tunnel construction. The location of the shaft is located at 200 m west side from the lowest point of the tunnel which may not be considered to be the most suitable, however, there are no other more suitable places available at the east side due to widening of the Canal.

- Generally, foul gas is to be exhausted by normal traffic movement through the tunnel section, and the acceptable longitudinal flow velocity should be maintained at less than about 10 m/s; the calculated longitudinal flow velocity of the tunnel shows about 5 m/s (410 $m^3/s \times \frac{1}{2} \div 45\ m^2 = 4.5$ m/s), which means that there is no necessity to improve the semi-transverse system by adding a pilot shaft for exhausting of foul gas. Besides, the actual movement of foul air in the 2-way, 2-lane tunnel can not be analyzed with a theory which makes it difficult to plan a vertical shaft.

- In the case of fire, a vertical shaft does not provide any special merit to extract hot air, however, smoke can be exhausted through the shaft, after the fire is extinguished.

The necessity of a pilot shaft for ventilation was not identified.

Economical points

The cost of the semi-transverse scheme, with a pilot shaft was estimated to be about £.E.3.7 Million, as follows:

	£.E
- Pilot shaft excavation (1,100 m3) 6.0 m diameter, 33 m depth redrilled including concrete	130,000
- Shaft inner surfacing (700 m2)	260,000
- Partial guide duct (200 m)	380,000
- Exhaust building (30 m2 x 20 m)	1,500,000
- Transfer of fans (30 days)	150,000
- *Control system*	
* Source in coming panel/distribution panel	250,000
* Transformer	130,000
* Power control panel/Monitor panel	380,000
* Feeder panel	100,000
* Electrical cable (11 KV)	250,000
* Setting up cost	220,000
Total	3,750,000

The newly required cost estimated showed a higher cost than the cost of ceiling plates for the transverse system. Also, this system can not provide a more convenient service level to the users than that provided by the transverse system. Besides, the amount of £.E.5.5 Million in abandoned facilities is a big loss of property.

4.2 Semi-transverse System

Technical points

- From the view point of ventilation in the tunnel, this system is quite acceptable because the existing fans have enough air supply capacity.
- In case of emergency such as fire, reversed operation of fans is not effective. Generally, most of the semi-transverse system supplies fresh air from upper

duct (not from lower duct) and exhausts smoke more effectively by reversible fans. Unfortunately, the proposed semi-transverse system is to supply air from the lower duct, which is the main reason that we could not recommend it.

Economical points

- This system is the most economical system in operation, maintenance and investment, however, it must be pointed out that the sunk cost by scrapping the exhaust fans and building is the highest amount of £.E.7.0 Million. (See DATA-5)

4.3 Transverse System

Technical points

- Air flow from the lower to the upper duct is the best ventilation system in a tunnel due to no wind pressure to traffic.
- Required air supply volume reviewed by the Team can be supplied by the existing fans through the reduced ducts.
- Generally, structural inspection inside the exhaust duct is not required, and the main target of the tunnel rehabilitation is to provide a maintenance free tunnel. Therefore, the reduced duct (70% of the original one) will not cause any trouble in maintenance.
- Local concentration of gas can be resolved by the arrangement of air supply and exhaust mouth.
- In the case of emergency such as fire, this would be the most appropriate system in order to continuously extract smoke into the exhaust air duct which could also provide more safety space in the tunnel.

Economical points

The cost of the ceiling plates was estimated at about £.E.3.0 Million as follows:

	£.E
- Concrete with reinforcing bar (1,000 m^3)	625,000
- Form works at field factory (20,000 m^2)	165,000
- Hangers, beams etc. (500 ton)	1,875,000
- Site transport/erection (3,000 ton)	142,000
- Other materials	125,000
Total	2,932,000

The project cost was estimated at about £.E.9.3 Million including spare parts for maintenance and electricity charge for 10 years.

The Team, however, considers that the S.C.A. can operate the ventilation system as the semi-transverse system except in emergency cases which would result in a lower project cost of about £.E.7.2 Million, due to cost saving of electricity charge and spare parts cost for exhaust system.

An operation manual of the system can be prepared in future from the view point of the optimization.

As a conclusion, the Team recommends the adoption of the Transverse Ventilation System which could guarantee the safety of the tunnel even at a time of emergency such as "fire" and easy maintenance.

DATA-1

CALCULATION TABLE OF DESIGN TRAFFICE			
	Item	Unit	PIARC
(1)	Basic traffic volume for 2-way, 2-lane yard	PCU/H	2500
(2)	Proportion of diesel cars (Truck, Bus etc.)	%	36
(3)	Conversion factor of large cars to passenger car (Er)		2.8
(4)	Possible traffic capacity	Vehicle/H	$2{,}500 \times \frac{100}{(100-36)+2.8\times36} = 1{,}500$
(5)	Design speed (Vt)	km/H	60
(6)	Number of car (Dpc)	Vehicle/km	1,500/60 = 25
(7)	Truck and Bus	Vehicle/km	25 x 0.36 = 9
(8)	Design Traffic (Possible capacity)	Vehicle/H	25 x 60 = 1500

DATA-2

CALCULATION TABLE OF VENTILATION FOR CO GAS IN ORDINARY			
	Item	Unit	PIARC
(1)	Allowable gas concentration CO ppm	PPM	150
(2)	CO gas emission per hour (Standard D)	m^3/H/Vehicle	1.5
(3)	CO gas emission per km	m^3/km/Vehicle	$\frac{1.5}{60} = 0.025$
(4)	Basic emission per traffic • km	m/s (Vehicle/H)/km	$\frac{0.025}{3600 \times 150 \times 10^{-6}} = 0.0463$
(5)	Speed factor		1.00
(6)	Gradient factor		1.03
(7)	Elevation factor		1.0
(8)	Tunnel length	km	1.7
(9)	Required ventilation	m^3/s	0.0463 x 1.03 x 1500 x 1.7 = 121

DATA-3

CALCULATION TABLE OF VENTILATION FOR SMOKE DILUTION			
	Item	Unit	PIARC
(1)	Allowable concentration k 1/m	1/m	0.0075 Fluorescent Luminance 8 cd/m^2 Design speed 60 km/H Non visibility through soot $\tau = 18\%$
(2)	Emission of soot qr. (Standard D)	$m^2/H/ton$	25
(3)	Mean vehicle weight	ton	20
(4)	Emission Average	m^2/km	$\frac{25 \times 20 \times 0.36}{60} = 3.0$
(5)	Unit basic ventilation	$m^3/s(vehicle/H)/km$	$\frac{3.0}{3600 \times 0.0075} = 0.1111$
(6)	Gradient speed factor (±3.8%) f/v		$\frac{(2.55 + 0.35)}{2} = 1.45$
(7)	Altitude factor		1.0
(8)	Required ventilation	m^3/s	$0.1111 \times 1.45 \times 1.0 \times 1500 \times 1.7 = 410$

DATA-4

CALCULATION TABLE OF VENTILATION FOR TRAFFIC JAM (PIARC)		
(1)	Design Speed	10 km/H
(2)	Design Traffic	2000 Vehicle/H
(3)	Diesel car	0%
(4)	Allowable CO gas concentration	250 PPM
(5)	CO gas emission per hour (Standard D)	1.5 $m^3/km/vehicle$
(6)	CO gas emission per km	0.15 $m^3/km/vehicle$ (5)/(1)
(7)	Basic emission per traffic•km	$0.15/3600 \times 250 \times 10^{-6} = 0.1667$ $m^3/s \cdot vehicle/H \cdot km$
(8)	Speed Gradient Elevation factor	$0.7 \times 1.03 \times 1.0 = 0.721$
(9)	Tunnel length	1.7 km
		$Q = 0.1667 \times 0.721 \times 2{,}000 \times 1.7 = 409\ m^3/s$

A. Operation/Maintenance Cost

1) Electricity Charge

S.C.A. paid £.E.41,400 for electricity charge for the month of July 1991 of which 10 percent is charge for tunnel lighting with the rate of £.E.0.185/KWH.

Power for Ventilation is to be included in other remaining 90 percent with the rate of £.E.0.147/KWH.

Based on the above, Annual Electricity Charge for Transverse System and semi-transverse system are:

£.E.50,000/M x 12 M/Y = £.E. 0.6 Million/Y (for Transverse)
£.E.50,000/M x 65% x 12 M/Y = £.E. 0.4 Million/Y (for semi-transverse)

2) Maintenance Cost

It is assumed that the maintenance cost will be mainly consisted of cost for Spare parts,

Transverse System: £.E.25,000/Y x 10 Y = £.E.0.3 Million/Y
Semi-Transverse System : 70% of the above, £.E.0.2 Million/Y

B. Value of Existing Ventilation System

Exhaust fans were installed in 1982 with a cost of £.E.24,640 x 8 = £.E.200,000

However, Basic Design Team re-evaluated present value as follows:

- Exhaust House £.E.750,000 x 2 =	£.E.1.5 Million
- Exhaust Fans £.E.750,000 x 8 =	£.E.6.0 Million
- Control System £.E.1,500,000 x 2 =	£.E.3.0 Million
- Duct for Exhaust £.E.250,000 x 2 =	£.E.0.5 Million
Total	£.E.11.0 Million

Considering the lapse of 10 years after construction, the existing facilities is evaluated at 65 percent of £.E.11.0 Million : 65% x 11.0 = £.E.7.0 Million valued

As a total value including the Air Supply fans it is estimated at about £.E.15.0 Million

duct (not from lower duct) and exhausts smoke more effectively by reversible fans. Unfortunately, the proposed semi-transverse system is to supply air from the lower duct, which is the main reason that we could not recommend it.

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(7)	Basic emission per traffic•km	0.15/3600 x 250 x 10^{-6} = 0.1667 m^3/s•vehicle/H•km
(8)	Speed Gradient Elevation factor	0.7 x 1.03 x 1.0 = 0.721
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