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IMPROVEMENT ON LOCOMOTIVE TEST STAND, DALIAN

DP/CPR/85/019

CHINA

Technical report: Upgrading test stand programme plan*

Prepared for the Government of the People's Republic of China
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

Based on the work of Dr W. J. Harris,
Chief Technical Adviser

Backstopping officer: H. Seidel, Engineering Industries Branch

United Nations Industrial Development Organization
Vienna

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INTRODUCTION

The United Nations Development Programme has funded a project for the "Improvement of Locomotive Test Stand" at the Dalian Diesel Locomotive Research Institute. This project will increase the accuracy of and decrease the time for testing locomotives on the test stand. I am serving as Chief Technical Adviser for the project. This report is a progress report after my several weeks in Dalian.

I met the staff of the Dalian DLRI in Pueblo, Colorado, or October 7 and 8 for initial discussions with the staff of the Transportation Test Center of the Association of American Railroads. TTC will serve as the contractor to the project.

I met representatives of DLRI in Beijing on October 15 for an initial review of my schedule in Dalian.

On October 16, I met in Beijing with Dr. Stephens, Senior Industrial Development Field Adviser, United Nations Industrial Development Organization, and members of the DLRI staff. We discussed the project and made arrangements for Dr Stephens to visit Dalian during my stay there.

Attached to this report is a schedule of my activities in China, from my arrival on 15 October to my departure on 6 November (Attachment A).

GENERAL DISCUSSION OF THE DALIAN DIESEL ENGINE RESEARCH INSTITUTE

The Dalian Diesel Engine Research Institute has a staff of 300 engineers, 150 skilled workers, and 100 management support workers. In the past, it received assignments from the Ministry of Railways and carried out tests to support the development and design work of the Locomotive and Rolling Stock Corporation of the Ministry.

It has developed a wide range of test facilities to permit evaluation of radiators, hydraulic and electric transmission systems, intercoolers, and other components. In 1979, it put into service a locomotive test stand of its own design and fabrication.

The test stand is one of three in the world that can perform this function. It has some characteristics that are not matched by the other test stands. For example, it can simulate operations at altitudes up to 3000 to 4000 meters, and it can simulate operations at 105 degrees F. The test stand has been used to evaluate the thermodynamic characteristics and the tractive effort of the Dong Feng 4 locomotive.

Since 1985, the DLRI has been required to earn an increasing amount of its operating costs from contracts. By 1990, it will receive no money for the payment of costs except that earned by contract programmes for the Ministry or for others. Therefore, it has been necessary for the DLRI to develop a variety of skills that can be marketed.

One of the unique facilities at the DLRI is the locomotive test stand. However, in order to contribute effectively to the mission of the DLRI, it was necessary to improve its accuracy of measurement and to reduce the time

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required for testing. UNIDO agreed to fund an upgrade with matching funds provided by China.

DISCUSSION OF THE UPGRADE PROGRAMME

Funding by UNIDO was provided to acquire sensors, transducers, and other components necessary to increase the accuracy of the measurements and to make possible the development of an automatic system for operation of the test stand and for automatic data recording and analysis.

UNIDO agreement required DLRI to work toward procedures that would make it possible for locomotives to be evaluated on the test stand according to the UIC requirements for certification.

UNIDO also provided funding for a technical contractor to assist the Dalian staff of DLRI to achieve the objectives of the upgrade and to train twelve fellows selected from the DLRI staff in advanced operating and measurements techniques.

As Chief Technical Adviser, my responsibility is to assist the DLRI staff and the contractor in pursuing the objectives of the programme and to provide the UNIDO staff with progress reports on the project.

DISCUSSION OF PROGRESS

The DLRI staff has described the required operating characteristics of the components that were ordered to complete the upgrade. These are being furnished to the contractor with a request for assistance in identifying sources of supply. This information, together with a list of equipment and recommendations is attached as attachment B. At this time, the project appears to be on schedule. There will be extensive discussions with the contractor in November and December.

It should be possible to agree on some procurement recommendations shortly after those discussions and on all recommendations by the scheduled date.

The other part of the technical upgrade relates to the need for computer programmes to establish automatic operations and data collection and analysis. The staff of DLRI has developed a concept of the necessary system architecture. This concept will be sent to the contractor before the first visit of the contractor. One of the staff members of the contractor was responsible for developing the system architecture for the test stand at the TTC. Discussion during his visit to Dalian and subsequent communications will make possible an early start on the writing of the necessary programmes based on the operating characteristics of the sensors and transducers that will be ordered. In this manner, the software will be available when the test components are delivered. The computer hardware for the upgrade is already at DLRI as a part of the matching contribution from China.

The fellowship programme is the third part of the upgrade project. Twelve fellows have been selected by DLRI. They took a six-month intensive course in English and passed an examination given and graded by the English Language Testing Institute and Certification Division of the University of Michigan.

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I have reviewed technical reports on the test stand prepared by several of the fellows. The reports can be understood, although they are not yet in perfect English.

I have had interviews with the fellows. They can engage in some technical discussions of their work. They are continuing in their work toward greater fluency and will be in a position to participate in the fellowship programme on schedule. That schedule is attached as attachment C.

GENERAL OBSERVATIONS

Approval of the "Improvement of the Locomotive Test Stand" by UNIDO was a very useful step in the development of the industrial capability of China. There are many railroad problems that can be addressed by experimental work on the upgraded test stand. The upgrade programme is essential to the effective pursuit of that work.

The leadership of the DLRI is dedicated to the successful completion of this programme. The technical staff has already shown its merit by the design and construction of the test stand, which, as has already been stated, is one of only three in the world and has several unique capabilities.

On completion of the upgrade programme, the test stand will make it possible for the DLRI to undertake much more work in China and for a variety of overseas sponsors.

There are significant opportunities for further upgrading of the test stand after this project is completed. One of these, the incorporation of dynamic actuators is discussed in Attachment D.

CONCLUSIONS

1. Work in progress on the UNIDO project for "Improvement of the Locomotive Test Stand" in Dalian is being pursued at a pace that indicates a high probability of completion of the project on schedule.

2. The experience of the staff of the DLRI in designing and building the test stand and that of the contractor (TTC) in upgrading the test stand should assure timely resolution of technical problems that can be expected to arise in the course of a project of this size and complexity.

3. Continuing review by the Chief Technical Adviser, the Senior Industrial Development Field Adviser of UNIDO from Beijing and the senior technical staff from UNIDO in Vienna should make possible the timely resolution of any administrative and procedural problems that may arise.

Attachment A

SCHEDULE OF ACTIVITIES OF CHIEF TECHNICAL ADVISOR

Dr. W. J. Harris

October 7, 1987	Meet in Pueblo, Colorado, with DLRI and TTC
October 8	Meet in Pueblo, Colorado, with DLRI and TTC
October 14	Depart for China
October 15	Arrive in China Meet with DLRI staff to plan
October 16	Meet with UNIDO in Beijing; Railway Ministry
October 17	Meet with China Academey of Railway Sciences
October 18	Visit with China Academy of Railway Sciences
October 19	China Academy of Railway Sciences
October 20 to November 2	DLRI
November 2 and 3	Review with UNIDO and DLRI
November 4	DLRI and Fly to Beijing
November 5	Meet with UNIDO; Railway Ministry; CARS
November 6	Depart for USA

Note: No delay time was taken in transit to or from duty station in China

P.S. As a result of the discussions in Dalian, it became clear that a signficant amount of material was avilable for the TTC staff that would make the visit of experts more effective. An extensive letter with many attachments was sent on October 29, 1987, to TTC. The attachments included descriptions of the locomotive test stand, the components to be ordered, the nature of the proposed computer system architecture, and related matters. The TTC staff was requested to bring much information to Dalian, including brochures and price lists for the components to be ordered. A copy of the letter was delivered to Dr. Kenneth Stephens, SIDFA, Beijing.

A DESCRIPTION OF THE PERFORMANCE REQUIREMENTS OF EACH OF THE COMPONENTS THAT ARE REQUIRED FOR THE UPGRADE OF LOCOMOTIVE TEST STAND

N°	EQUIPMENT	MEASUREMENT RANGE	ACCURACY	USE	NOTE
1	Pressure sensor (Diffusion silicon, piezoresistance or else)	1. 0-100 MM H_2O 2. 0-100 MM Hg 3. 0- 3 bar/cm^2 4. 0- 6 bar/cm^2 5. 0-10 bar/cm^2 6. 0-100 bar/cm^2 7. 0-200 bar/cm^2 8. 0-300 bar/cm^2	± 0.2 %	Inlet vacuity Air pressure of turbo charger Water pressure and oil pressure Oil pressure of hydro-static pump and tractive gage oil cylinder	Measuring inlet exhaust pressure of diesel engine
2	Thermocouple	0-100°C	± 0.1 %	Temperature difference of oil and water system	Range of temperature difference: 0-5°C
3	Non-contact torque-meter	0-1000 N-M 0-2000 N-M	± 0.2 %	Power of auxiliary drive system	This kind of torquemeter should be installed easily without removing axle of auxiliary drive system.
4	Flow transducer	Ø 80 MM Ø 100 MM	± 0.2 %	Flow of oil system and water system	Diameter of connected pipe: Ø 80 mm, Ø 100 mm
5	Barometer				With electric output
6	Humidometer				With electric output
7	Shunt or mutual inductor	0- 6000 A 0-10000 A 0-1000 A 0-1500 A 0-2000 A 0- 300 A 0- 500 A 0-750 A	± 0.1 %	Rectified D.C. current of main generator Tractive motor current Armature current of exciter Exciting current of dynamometer Armature current of dynam.	

N°	EQUIPMENT	MEASUREMENT RANGE	ACCURACY	USE	NOTE
8	Current transformer	input 0-75 MV output 0- 5 V	± 0.1 %	After above-mentioned current signals are fetched, they are input to transformer. The outputs of transformer are connected with computer.	The current transformer are used to insulate high voltage circuit from computer. The transformer should have good insulation function to protect puncture.
9	Voltage transformer	input: 0-1500 V 0-1000 V 0- 750 V 0- 150 V 0- 30 V output: 0- 5 V	± 1 %	translate various high voltage to 0-5V	Just same as above-mentioned

LIST OF EQUIPMENT TO BE PURCHASED WITH UNDP FUNDS

Country : The People's Republic of China
Project no. : DP/CPR/85/019
Project title : Improvement on Locomotive Test Stand

No	Equipment	Specifications	Qty	Estimated prices US$	
1	Measure equipment of the relative positions of the rollers	Measurement error less than 0.5 mm	1	60,000	
2	Meter for tractive effort measurement	0-3 ton, accuracy less than 0.2%, 3-40 ton, accuracy 0.5%	1	10,000	
3	Torque-meter	2500 Kg.m, accuracy less than 1%	1	10,000	
4	Torque-meter	200 Kg.m accuracy less than 0.5%	2	10,000	
5	Fuel consumption meter	1400L/h. accuracy less than 0.3%	1	20,000	ordered
6	High accuracy temperature transducer	100 degree centigrade error less the 0.1 degree centigrade	20	15,000	ordered
7	High accuracy pressure transducer	50 mm mercury column error less than 1%	20	25,000	ordered
8	Zero-flux current transformer	10 KV, accuracy above 0.1%	1	10,000	
9	Accurate voltage insulator	1.5 V, accuracy above 0.1%	1	5,000	
10	Computer measurement and control system		1	275,000	
	TOTAL			440,000	

Item No	Name	Description	Manufacturer	Quantity	Unit Price	Amount	Note
I	Digital Fuel Flow Meter	Model DF-3I5	ONO SOKKI CO.LTD	I	JY 633,600	JY 633,600	ordered
2	Flow Detector	Model FP-225 (I-I440 l/h)	JAPAN	I	JYI,I08,800	JYI,I08,800	ordered
3	"440" Thermistor Probes and Assemblies	Om-970-44034	OMEGA ENGINEERING INC U.S.A	50	$ I9	$ 950	
4	Programmable Datalogger	40 Channal Model Om 440-TC-220V	"	I	$ 2,690	$ 2,690	
5	Pressure Transmitter	DPF-I00-3-LVVAB-AAA	YOKOGAWA HOKUSHIN ELECTRIC JAPAN	20		$ I5,000	ordered
6	3059 MICF- Amplifier	3059-EI	AVL Graz/Austria	6	$I,200	$ 7,200	ordered
7	Carrier Amplifier	3075-A02	"	I	$ 2,000	$2,000	ordered
8	Pressure Transducer	I2QP505CLK	"	I0	$500	$ 5,000	ordered
9	Needle Lift Transducer	423 I0 Core	"	5	$ 78	$ 390	ordered
I0	Valve Lift Transducer	Max. Lift ≥ 30mm	"	4	$ 75	$ 300	ordered
II	Control Solenoid Valve	I2ZP7005	"	4	$ 50	$ 200	ordered
I2	Connect Cable	ZI0IA	"	I5	$ I00	$ I,500	ordered
I3	Zero Magnetic Flux Current Transformer	I0KA, Accuracy 0.I%		I	$ I0,000	$ I0,000	
I4	Voltage Mutual Inductor	I.5KV, Accuracy 0.I%		I		$ 5,000	
I5	For PDPII/23 Computer	AVL Digital Analyser	AVL Graz/Austria	I		$ 5,000	ordered
	Power supply	656					

Attachment C

Request for Proposal P87/37

UNIDO Project DP/CPR/85/019 - Improvement on Locomotive Test Stand, Dalian.

FELLOWSHIP TRAINING PROGRAM.

1.0 Introduction.

One of the requirements of the Locomotive Test Stand improvement project is the provision of an approved fellowship training program for eighteen (18) engineers for a total duration of seventy-four (74) man-months. The Request for Proposal (page 7, Appendix 1, "Substantive Terms of Reference for Subcontract") requires the contractor to provide that training program at the contractor's site. This addendum contains the program scope and schedule following consultation with the Project Director and UNIDO.

2.0 Training Program Objectives.

The main objective of the training program is to introduce the eighteen engineers to new technologies that can be incorporated in the upgrade of the locomotive test stand at the Dalian Diesel Locomotive Research Institute. The secondary objective is to assist them in developing the operating and maintenance procedures so that the system can be maintained in good working order after the upgrade is complete.

The subject matter of the program is listed as items 1 through 10 in Attachment A1. These ten items match exactly the ten fields of study required in the section, "Training Provisions", in Appendix 1 to the Request for Proposal.

3.0 Method of Approach.

To satisfy the objectives stated above, the test stand engineers must be fully familiar with the equipment. This can best be accomplished by assigning them the responsibility for the design of the upgrades. The fellowship training program is set up to accomplish both the conceptual and detailed design phases. This

work will be carried out at the TTC under the supervision and guidance of the contract team members.

4.0 Schedule.

The schedule for the fellowship training program is presented in Attachment A1. It is proposed that the program will commence after completion of the facility assessment report, and will last for a period of ten (10) months.

The fellows are to be divided into two main groups according to the specialist designations required to undertake the two upgrade design phases. A group leader will be appointed by the National Project Director for each group.

Two major milestones have been set for the program. The first requires that the conceptual design be completed by the end of the third month. The second requires that the detailed design be completed by the ninth month so that a design review can be held in Dalian during the tenth month.

5.0 Responsibilities.

5.1 AAR.

The AAR shall be responsible for providing the following:

1. Suitably equipped office accommodations.
2. Access to drafting equipment for the production of design layouts.
3. Access to non-proprietary and non-classified reference materials and manuals.
4. Access to the Roll Dynamics Unit (RDU), including manuals and system drawings.
5. Copies of computer software which has been developed as a result of, or directly applied to, the fellowship program tasks, unless prohibited by existing or third party license agreements.
6. Supervision of the design effort by contract team members.

7. Checking of the designs for accuracy, integrity, and completeness.

8. Assistance in securing suitable living accommodations.

9. Transportation between the living accommodations and the TTC.

The cost of items 8 and 9 will be covered by the fellowship stipends.

5.2 National Program Director.

The National Program Director shall designate a leader for each of the fellowship groups. The Group Leader will coordinate with the AAR's Assistant Team Leader to ensure that the objectives of the fellowship program are being met.

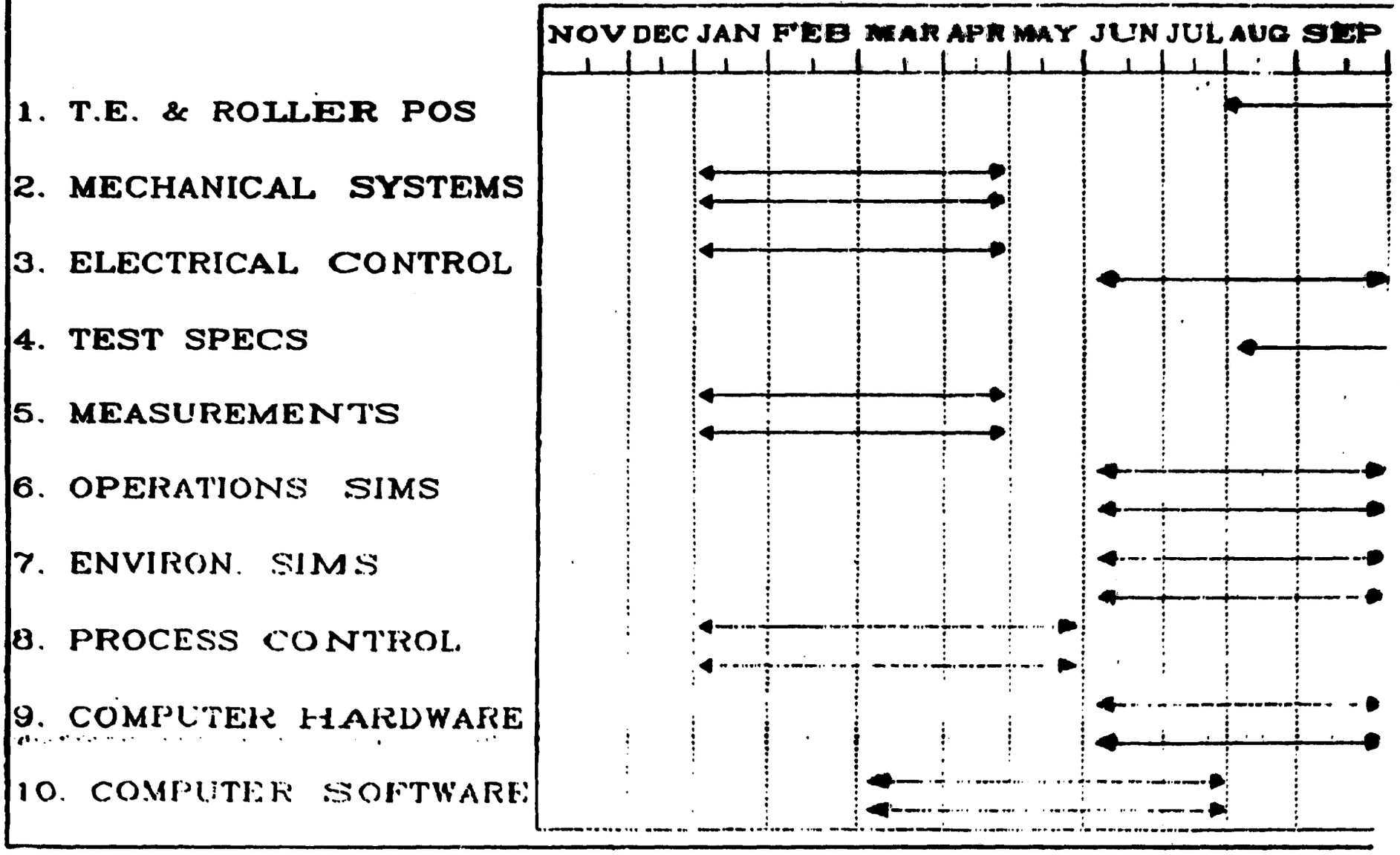
6.0 Safety.

The fellows will be required to comply with all applicable safety and security regulations while working in the TTC laboratories, test sites, and offices.

7.0 Fellowship Fees.

The standard fee for UNIDO fellowship programs is US$1,175/man-month. This represents a total cost of US$86,950.

FELLOWSHIP TRAINING PROGRAM SCHEDULE



A SECOND GENERATION UPGRADE FOR THE DALIAN DLRI TEST STAND

1 November 1987

INTRODUCTION

There is a need for a dynamic test facility in China. Locomotives and freight cars should be tested under controlled dynamic conditions to simulate and measure the dynamic response of a vehicle to track irregularities. It is important to measure the dynamic response of locomotives and freight cars to normal and extreme track conditions in order to be certain that they will be stable under operating conditions in revenue service. If they are not stable, they will introduce excessive forces into the track and cause track damage or contribute to derailments.

China needs only one such facility at the present time. The Dalian DLRI test stand can be upgraded to become such a facility. However, if it is decided to install a dynamic test stand at some other location, there would be no need to add a dynamic capability to the Dalian test stand in the immediate future.

ADVANTAGES OF ADDING A DYNAMIC TEST CAPABILITY TO THE DALIAN DLRI TEST STAND

There are a number of advantages of the Dalian DLRI test stand as the site of the dynamic test facility.

1. The upgrade of the Dalian test stand to include a dynamic test capability would cost far less than construction of a totally new facility. The basic test stand is already in place. The computers to operate the facility are already in use and available. The staff has experience in design and construction and would not need expensive foreign contractors to perform these tasks. I only needs funding to acquire the hydraulic actuators, the pumps, and the control system. With modest help from an experienced contractor, the staff could be expected to complete a second generation upgrade that would incorporate a dynamic test capability.

2. The Dalian DLRI has close relationships with the Locomotive and Car Manufacturing Corporation of the Railway Ministry, individual locomotive and freight car builders in China, the China Academy of Railway Sciences, and several universities. Therefore, it could work out cooperative arrangements for research and testing programmes that required the use of the dynamic test capabilities of the upgraded test stand.

3. The addition of a dynamic test capability to the locomotive test stand in Dalian would make it possible to do the full range of required testing on locomotives and freight cars in one place and at one time. These tests could establish whether of a new design was acceptable for extensive rail testing and for use in revenue service in the railway system.

CONCLUSIONS

1. If a decision has not yet been made as to the location of a vehicle dynamic test facility, the Dalian DLRI should be given serious consideration as the preferred location.

.../...

2. The upgrading of the Dalian locomotive test stand to incorporate a dynamic testing capability could be done with a minimum investment because the basic facility is in place, the existing computer facilities can be used, and the staff is capable of the necessary design and construction work.

3. The addition of a dynamic test capability to the DLRI test stand will facilitate comprehensive evaluation of a wide range of essential characteristics of locomotives and freight cars at one time and in one place.

ATTACHMENT E

ADDENDUM TO REPORT OF CTA ON DALIAN DLRI LOCOMOTIVE TEST STAND

W. J. Harris
3 November 1987

This addendum to the report to UNIDO on the progress of work on the locomotive test stand in Dalian lists the work that the CTA has agreed to undertake in the United States and Beijing on behalf of the Diesel Locomotive Research Institute.

ADMINISTRATIVE MATTERS

1. Deliver to Dr Stephens, in Beijing, a letter of endorsement of TTC as the contractor;
2. Return to Dr Stephens, in Beijing, various administrative documents.

TECHNICAL MATTERS ON THE LOCOMOTIVE TEST STAND UPGRADE

1. Emphasize the urgency of procurement of equipment in discussions with TTC;
2. Discuss the extent of need of spare parts and redundancy to achieve a high degree of reliability of the upgrade programme;
3. Send information to DLRI on AAR studies of high accuracy flow meters as possible alternatives to the DLRI fuel measuring system;
4. Arrange for TTC to discuss cable shielding requirements with DLRI;
5. Send attachment 6 to Watts and discuss issues in systems architecture;
6. Discuss with TTC the extent to which it is feasible to simulate the computer system by using programmed inputs instead of real data inputs from test stand during automatic operation, data recording, and data analysis development.

MATTERS RELATING TO INTERNATIONAL STANDARDIZATION

1. Get information from Bouley, UIC, on UIC locomotive testing standards.
2. Get information on possible Japanese locomotive test stand.
3. Encourage TTC to get additional information on international testing standards for locomotives for DLRI.

MATTERS RELATING TO FELLOWSHIP PROGRAMME

1. Encourage TTC to arrange for evening classes at TTC for fellows to increase their fluency in conversational English.

MATTERS RELATING TO LECTURE ON HEAVY HAUL RAILROAD OPERATIONS

Answer questions raised during lecture on heavy haul lecture that require additional information.

.../...

MATTERS HAVING TO DO WITH COOPERATIVE UNIVERSITY PROGRAMMES

Discuss with Texas Transportation Institute the possibility of a cooperative programme with a local university such as Dong Bei University to study the traffic congestion problem of Dalian.

MATTERS HAVING TO DO WITH SECOND GENERATION UPGRADE

Discuss the reasons for and against equipping the locomotive test stand with hydraulic actuators to permit simulation of dynamic loads encountered during operations. Arrange for TTC to bring an analysis of the installation of dynamic actuators to DLRI for discussion in Dalian.