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TRAINING IN WOOD DRYING AND KILN MAINTENANCE

DP/DMI/86/004

THE COMMONWEALTH OF DOMINICA

Technical report: Timber kiln operation and maintenance\*

Prepared for the Commonwealth of Dominica by the  
United Nations Industrial Development Organization,  
acting as executing agency for the United Nations Development Programme

Based on the work of C. R. Levy  
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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

Vienna

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\* This document has not been edited.

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## ABSTRACT

The writer spent three weeks in Dominica. Three days were spent running a workshop on kiln maintenance. The three firms operating kilns were represented along with the Forestry Service and the Small Lumber Producers Association. The workshop was held in a classroom at North Eastern Timbers some 42 miles from Roseau, the capital.

Four sets consisting of an oven, balance, balance weights and transformer were issued to kiln operators and the Forestry Service.

Training was given quite separately from the workshop, in the determination of moisture content by oven drying and calibration of moisture meters.

Visits were made to kiln operators and furniture manufacturers and ad hoc advice given on request.

It is recommended that solar drying in Dominica be upgraded and that consideration be given to preparing correspondence courses in timber technology to service workers in the often remote timber industries in Dominica.

## ACKNOWLEDGEMENTS

The writer is grateful for the assistance and cooperation of many people in Dominica both in Government and industry who contributed greatly to the success of the mission. In spite of the fact that the IDC had a busy programme with staff travelling overseas and eventually a shift to other offices, assistance was freely given by Ms. G. Fingal and Mr. N. Pascal and transport to the many locations around Dominica was provided by Mr. K. Alleyne, Manager of IDC.

He gratefully acknowledges the assistance and encouragement provided by Mr. A. Leevy of the Economic Development Unit and Sister Alicia of NET who kindly provided weekend accommodation and a quiet 'office' for workshop preparation.

Active participation of those attending the workshop was most pleasing and the writer is particularly grateful for the contribution made by kiln operators, Mr. D. Southwell, Mr. A. J. Riviere and Mr. E. Jerome.

Finally, he is grateful to Mr. E. Jerome for making NET facilities available for the workshop and to UNIDO staff in Barbados and Vienna for technical and administrative support.

## 1. INTRODUCTION

The writer was employed for one month on project DP/DMI/86/004/11-02 to provide training in wood drying kiln maintenance and associated areas. This work was a follow-up to a training course in kiln drying carried out by Mr. R. A. Plumptre. The job description is given in Annex I.

After departing Australia on 18 July 1988, he arrived in Barbados on Tuesday, 19 July. On Wednesday, 20 July, he was briefed by Mr. H. Koole at UNDP's Barbados office and received copies of Mr. Plumptre's reports DP/ID/SER.A/1007 of 17 May 1988; 'Study of wood drying in Dominica', of August 1986 (a draft technical report) and the Project Document.

He arrived in Dominica at 10:00 a.m. on 21 July 1988, and had airport authorities contact IDC (Ms. Fingal) to determine where he would be staying so as to complete immigration formalities. He then made his way from Leville Hall to Roseau by taxi.

On Friday, 22 July, he located the IDC offices in Roseau and made contact with Ms. Fingal.

Ms. Fingal made appointments with kiln operators and furniture makers to take up the next week and tentative arrangements were made to run a training course during the week ending 12 August 1988. A full itinerary is given in Appendix II.

## 2. KILN DRYING IN DOMINICA, 1988

### 2.1 Operational kilns

There were only two kilns operating effectively in Dominica in August 1988, CEAF and Westair dehumidifiers at Dominica Timbers Limited (DTL) in

Portsmouth. The CEAF kiln was shut down for major maintenance on 3 August 1988.

DTL are yet unable to obtain a regular supply of logs. Although they are planning a fourth kiln (40,000 board feet (bf)) using recently supplied CEAF equipment, a small (15,000 bf) Westair kiln is out of operation, and they are unable to cut sufficient timber to utilize the two other operating kilns.

DTL is seriously considering importing logs or squares to get better utilization of their sawmill and kiln drying equipment.

All DTL's kiln dried wood is sold as soon as the 'kiln door is opened'.

## 2.2 Non-operational kilns

Neither of the two solar kilns in industry, one at North Eastern Timbers (NET) at Woodford Hill, the other at Home Industries Cooperative (HIC) at Roseau are being used as kilns. The Woodwork Training Center is no longer in operation and the kiln there is apparently not in use.

At NET, boards are stacked (on spacers) from wall to wall to approximately one half the height of the available kiln space. The fans are not in operation due to electrical failure.

At HIC only about 25 percent of the available height and length was used but, once again, boards were packed from wall to wall across the kiln. Even though the fans were used, there was no opportunity for air to flow through the stack and dry the timber.

In both cases what drying was taking place was at worst accidental, at best coincidental.

It was noted that the solar kilns at HIC and NET were in fact not owned by them but by other agencies, and this may explain why they were not being operated with enthusiasm.

### 2.3 Air drying

All of DTL's and NET's production is air dried to some extent. In the case of DTL, air drying takes place as stacks are built up to go into the kiln. Current average weekly production is about 17,000 bf and kiln capacity is about 50,000 bf. Thus, it takes two weeks to fill the larger (35,000 bf) kiln and one week the smaller (15,000 bf).

In late July/early August, DTL had no logs and the mill was actually shut down but there was still some timber stacked drying under cover.

Drying stacks at DTL are well made with machined spacers set properly in vertical lines. Stacks are square ended both ends and sides are vertical with no protruding sides to interrupt air flow when placed into the kiln. A stacking guide is in regular use.

Drying stacks at NET and HIC need some attention and the problems were discussed at length with the relevant parties.

Air drying would account for 95 percent of drying at NET which produces, apart from sawn lumber, prefabricated housing and quality furniture.



### 3. TRAINING IN MOISTURE CONTENT DETERMINATION

Four ovens and sets of scales had arrived in Dominica and were stored at a factory. They were located by Mr. Michael Pascal of IDC who had taken over coordination of the kiln training programme from Ms. Fingal.

One set was taken to HIC in Roseau and set up to test the oven and calibrate the electrical resistance moisture meter in use there, a PROTIMETER with three scales from 0 to 28 percent moisture content.

A note on the equipment supplied is given in Annex III. The remaining three sets were issued to kiln operators (according to the original plans made by Mr. Plumptre) during the kiln maintenance course.

Staff at HIC were trained in determination of moisture content by the oven dry method and to calibrate their moisture meter. Some six visits were made to HIC for this purpose, lasting from thirty to ninety minutes, to carry out weighing and check the oven temperature. Although at the beginning all measurements were carried out by the consultant, HIC staff were able to confidently take over before the programme was completed.

Gommier (Dacryodes excelsa Vahl.) was chosen for the calibration exercise. Two boards were used with seven and five replicates taken from the first and second board respectively. Full details of the method used and the results obtained are given in Annex IV.

It was decided to repeat this exercise using moisture meters from DTL, HIC and NET during the kiln maintenance course.

#### 4. MAINTENANCE PROBLEMS

As a preliminary to preparing a short course in kiln maintenance it was decided to study existing operations and discuss problems with kiln operators to determine what, if any, particular maintenance problems were and what positive training input could best be made.

##### 4.1 DTL Portsmouth

###### 4.1.1 Westair dehumidifiers

The one Westair kiln (model PD 75) was shut down for routine maintenance some time ago and not put back into service because it was claimed that the costs were at least equal to those of the CEAF kiln which dried twice as much timber. Based on information supplied by 'Howden Air Control', who have now taken over from Westair, mean maximum power consumption for this unit is some 15 kW. Based on published utility rates in Dominica (Annex V), this would cost US\$ 38.30 per day (24 hours). For a 14 day drying schedule this would come to US\$ 3.60/board foot for energy costs (kiln capacity reported to be 15,000 bf).

DTL charge EC\$ 0.45/bf for drying (US\$ 0.16/bf) so the cost of energy is very significant.

###### 4.1.2 CEAF dehumidifiers

The CEAF units are well suited for drying timber, being designed to process a large volume of moist air. Mr. Southwell of DTL reported that when drying some 40,000 bf from about 50% moisture content to 12 percent moisture content, auxiliaries heaters were only used in the first week as the heat pump provided sufficient heating thereafter.

The major maintenance problem was corrosion and CEAF had advised the application of grease to metal parts needing protection. Unfortunately corrosion once started, continues under the grease. All exposed steel bolts and clamps, anodized aluminum, shutters and closure mechanism (used to direct flow of moist air in the dehumidifier) were badly corroded.

DTL carry out a three monthly 'shake down' of this kiln when major cleaning and refurbishing is carried out.

During the maintenance shut down all corroded parts were being wire brushed back to clean metal and silicon sprayed on.

The other problems experienced was cleaning heat exchange surfaces. Westair recommend cleaning 'with downward strokes of a brush' followed by compressed air.

It is not possible to clean off the accumulated volatile wood extractive in this way and the only technique which will not damage the evaporator is to rinse with warm soapy water and this procedure was recommended.

DTL were also experiencing loss of gas from the CEAF dehumidifier and it was noted that the refrigeration engineer would usually have a halogen detector which could be used to find the leak so that repairs could be made. In the meantime, the extra gas is regularly put into the compressor to maintain efficient operation.

#### 4.1.3 Maintenance of kiln buildings

Two major sources of deterioration were, as noted by DTL: Delamination of plywood used to line the kiln and structural damage caused by forklift trucks loading the kilns. The maintenance being carried out in August 1988 involved removal of all damaged plywood lining; replacement or refitting of

fiberglass insulation and repairs to vapour barrier; fitting of a new plywood liner and repainting the inside of the kiln with a bitumastic (black) paint.

This work was completed by 11 August 1988 but cleaning of the dehumidifier continued.

#### 4.1.4 Summary of findings at DTL

The two kilns at DTL are well run and well maintained. A good relationship exists between management and CEAF who are prompt in supplying any replacement parts. With the acquisition of a second 40,000 bf CEAF dehumidifier, the Westair unit in operation will almost certainly be phased out if and when any major breakdown occurs.

#### 4.2 Home Industries Cooperative, Roseau, North Eastern Timbers, Woodford Hill

No particular maintenance problems were experienced at either mill with their solar kilns other than fan motor failure at NET which is being looked after by their electrical staff.

Routine difficulties such as leaking roofs, poorly closing door, faulty baffle closures and so on were dealt with as they occurred.

The major problem at both sites seemed to be failure to establish a daily routine of inspection and routine preventive maintenance.

It is likely that this was because the kilns were being used so inefficiently and maintenance had no priority over other work.

## 5. TIMBER DRYING KILN MAINTENANCE WORKSHOP

9 to 11 August 1988

### 5.1 Introduction

A kiln maintenance workshop was held at the classroom at North Eastern Timbers from 9 to 11 August 1988. These facilities were kindly made available by Mr. E. Jerome, General manager of NET and provided an excellent atmosphere for the workshop with ready access to timber samples and the solar kiln. During the course of the workshop, a log was backsawn without turning to demonstrate sawing degrade caused by normal stresses as opposed to seasoning degrade.

During the lead up to the workshop it became apparent from the range of questions asked and the status of kiln drying that some revisions of basic drying principles was necessary. This was integrated into the monitoring of drying performance and kiln maintenance wherever possible.

The major problem faced during the workshop was the enthusiastic questioning from every participant over a wide range of subjects all related to timber but not necessarily to timber seasoning.

### 5.2 Timber drying kiln maintenance workshop programme

- (a) Principles of timber drying
- (b) Determination of MC by oven drying
- (c) Macro- and microscopic structure of wood
- (d) Swelling and shrinking of wood; data on common Dominican timber species (see annex VI).
- (e) Principles of kiln maintenance (see Annex VII).
- (f) Maintenance of solar kilns - Mr. E. Jerome.

- (g) Maintenance of solar kilns - Mr. A. J. Rivierre
- (h) Maintenance of CEAF dehumidifier kilns and Westair Kilns - Mr. D. Southwell.
- (i) Inspection of solar kiln at NET, Woodford Hill
- (j) Inspection of Westair and CEAF kilns at DTL, Portsmouth.

### 5.3 Certificate of attendance

At the completion of the workshop those who attended were issued with a 'Certificate of Attendance'.

## 6. CONCLUSIONS AND RECOMMENDATIONS

### 6.1 Kiln drying in Dominica

Kiln drying in Dominica centres at one plant, operated by Dominica Timber Limited (DTL) and a too brief analysis would suggest that timber drying was DTL's most successful operation. Solar drying ought for now to be considered a failure in Dominica. The reasons for this may be many and complex but clearly, there are much improved solar kilns now available and the use of these improved solar kilns should be encouraged.

### 6.2 Experimental solar air kilns

Numbers of people spoken to perceived the existing kilns to be almost wholly experimental and as their wish was for a reliable commercial supply of dry timber the tendency was to reject solar kilns and opt for kilns of proven commercial performance.

With the closure of the Woodwork Training Center there is no longer any opportunity to introduce new kiln designs to a government training institute for proving under Dominica's conditions.

North Eastern Timber (NET) is very interested in solar drying and other aspects of timber technology, training and development and in spite of their poor performance with the small experimental solar kiln, NET could provide a practical industry based alternative to the Woodwork Training Center.

### 6.3 Solar drying for export

In a recent OAS sponsored (August 1988) meeting in Barbados, plans to develop exports to the United States of America based on (dried) furniture components were discussed and it was recommended that solar kilns be used to dry the timber in Dominica. Lack of control of solar drying and inability to predict accurately when drying will be complete could result in the loss of export markets before they are even partially developed.

### 6.4 Training in Timber technology

During the course of the consultant's work in Dominica it became apparent that what was lacking was not so much specialist knowledge about kilns and kiln maintenance but basic knowledge of timber technology. The opinion was developed that given an understanding of timber technology the timber workers would soon avail themselves of literature on drying, preservation, construction, and so on and learn what was necessary to function competently in those fields. Timber technology cannot be taught effectively in seven days or even seven weeks but requires a structured course of study over perhaps three years. Given the small population of Dominica and the high cost of mounting such a course the best procedure may be to develop a correspondence course making full use of modern communication systems such as video recordings. Such a course would be of great value to all countries with a timber industry not just Dominica.

In the 1950/60s, CSIRO in Australia developed a correspondence course in kiln drying which was used to train kiln operators all over Australia, so there is at least one precedent for correspondence study in the timber industry.

Video tapes will take students into the best universities in the world and from electron microscopic views of microfibrils to the giants of the forest, exposing them to a breadth of experience no one could possibly gain otherwise in a lifetime of study and travel.

Timber industry workers often find themselves in remote locations in a vast forest far from towns and technical colleges. While their need and desire for improved knowledge and qualification may be great, their opportunities for acquiring this knowledge are often effectively nil.

Those who do acquire the knowledge often do so by moving to the cities and travelling overseas. Many never return to the industry to actually use the knowledge so acquired.

Thus correspondence courses may have the added advantage of bringing information to much greater numbers and to those actually involved in the timber industry in remote rural forest areas almost all of whom presently miss out.

#### 6.5 Summary of recommendations

- (a) Dehumidifiers provide a valuable alternative drying system to conventional kilns and their use should be encouraged wherever cheap electric energy is available.
- (b) Solar drying should be further pursued in Dominica with improved designs and owner operation.



- (c) Solar drying should not be recommended for furniture component export projects or other projects needing precise timing of deliveries.
- (d) Training in timber technology should have priority over training in specialists areas.
- (e) Correspondence courses using modern communication technology may provide the best solution to the dearth of knowledge in timber technology especially in the developing tropics where many seeking such knowledge are denied it by their very location in a remotely located timber industry.

## Annex I - Job description



## UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

MAINTENANCE TO THE KILN DRYING OF THE WOOD INDUSTRY**JOB DESCRIPTION**

DP/DMI/86/004/11-02

<b>Post title</b>	Kiln maintenance expert.
<b>Juration</b>	One month
<b>Date required</b>	As soon as possible
<b>Duty station</b>	Roseau, Commonwealth of Dominica
<b>Purpose of project</b>	To improve the quality of the output of the existing wood drying kilns in the Commonwealth of Dominica.
<b>Duties</b>	<p>The expert will be attached to the Wood Work Training Centre of the Forestry and Parks Service of the Government. He will be expected to:</p> <ol style="list-style-type: none"> <li>1. Prepare a guide for a preventive maintenance scheme for the existing kilns;</li> <li>2. Prepare a guide for an inventory control system for the existing kilns;</li> <li>3. Assist in establishing the maintenance scheme and the inventory control system;</li> <li>4. Train staff of the Centre and of three local companies;</li> <li>5. Prepare (part of) a final report.</li> </ol>

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Applications and communications regarding this Job Description should be sent to:

Project Personnel Recruitment Section, Industrial Operations Division  
 UNIDO, VIENNA INTERNATIONAL CENTRE, P.O. Box 300, Vienna, Austria

**Qualifications** A university degree in engineering. Extensive experience in the maintenance of wood drying kiln equipment and inventory control systems. Ability to train.

**Language** English

**Background information** Upon the request of the Prime Minister of the Commonwealth of Dominica, a UNIDO Consultant, Mr. R. A. Plumptre went on a mission to assess the needs for wood drying in Dominica. The project development facility of the United Nations Development Programme (UNDP) financed this mission.

At present some eight kilns are operational in Dominica to dry lumber. Up until 1978, no kilns were in use. This rapid growth in kilning capacity was a response to a realization that for quality joinery and furniture manufacture, wood drying is essential. There has not however, been a corresponding growth in the capability to measure moisture content, temperature and humidity accurately in order to monitor and control the drying process.

Dominica has a total land area of 751 km<sup>2</sup>. Of this, about 50 percent is covered with forests. The 363 km<sup>2</sup> of forest land contain extensive reserves of Gommier, a hardwood species. It is widely used in building construction and furniture and joinery manufacture.

The Government of Dominica is making a great effort to diversify the productive base of the country and to expand the manufacturing sector, including the wood processing sector.

With an increase of output in both quality and quantity of the wood processing sector, it is essential that there exists local capability to measure moisture content, and temperature and humidity accurately in order to monitor and control the drying process of wood lumber.

Since the present wood drying capacity in Dominica seems to be big enough for the present (and foreseeable future) demand, efforts should now be made to ensure the quality of the kilning process. This can be realized through the supply of equipment to measure moisture content and to train staff in using this equipment. Apart from this, a staff must be trained in maintenance of the kilns. At present, there is a shortage in local expertise regarding maintenance, resulting in unnecessary breakdown and repair time. A (preventive) maintenance scheme could put an end to this problem. A list of the type of kilns in operation is in Mr. Plumptre's report, which will be handed over to the expert.

## Annex II - Itinerary of the consultant

<u>Date:</u>	<u>Activity, people met and places:</u>
Monday, 18 July	Departure Australia
Tuesday, 19 July	Arrival Barbados
Wednesday, 20 July	Briefing at UNDP Barbados with Mr. H. Koole (Mr. Ryan had departed on home leave)
Thursday, 21 July	Arrival Dominica
Friday, 22 July	IDC, Roseau, Ms. G. Fingal, Mr. K. Alleyne
Saturday, 23 and Sunday, 24 July	Course participation, study of project reports
Monday, 25 July	North Eastern Timbers (42 miles from Roseau), Mr. E. Jerome, Mr. T. Drepaull, Sister Alicia
Tuesday, 26 July	Home Industries Cooperative, Roseau, Mr. A. J. Riviera, Mr. M. Cuffy, Mr. J. Jackson
Wednesday, 27 July	Mr. A. Leevy, Economic Development Unit and Mr. W. P. Louis, Permanent Secretary, Ministry of Trade, Industry and Tourism. Ogheden Industries, Furniture manufacturers, Cochrane.
Thursday, 28 July	Charles Bros., Furniture manufacturers, Roseau. Ogheden retail furniture outlet, Roseau.
Friday, 29 July	NET Woodford Hill to deliver and set u-p oven and balance, DTKL Portsmouth, Mr. Pemberton
Saturday, 30 July	Waited in vain all day for pickup at Portsmouth to further inspect kiln at DTL
Sunday, 31 July	NET Woodford Hill
Monday, 1 August	Public Holiday
Tuesday, 2 August	DTL Portsmouth, Mr. D. Southwell
Wednesday, 3 August	Roseau, Mr. R. LaRonde, ECNAMP, Cottage Forest Industries Project (Small Lumber Producers Assocaition).
Thursday, 4 August	Mr. E. H. Charles, builder, door manufacturer, etc.
Friday, 5 August	Confirming invitations for workshop/ course preparation IDC
Saturday, 6 August	NET Woodford Hill
Sunday, 7 August	Course preparation
Monday, 8 August	Final preparation for course - Roseau
Tuesday, 9 August to Thursday, 11 August	NET Woodford Hill Workshop on kiln maintenance
Friday, 12 August	Roseau, returned equipment borrowed for workshop, spoke with Mr. Allyene, Mr. Pascal, Ms. Fingal, Mr. Leevy about workshop.
Saturday, 13 August	Departed Dominica for Barbados Barbados (Mr. H. Koole)

## Annex III - A note on ovens and balance

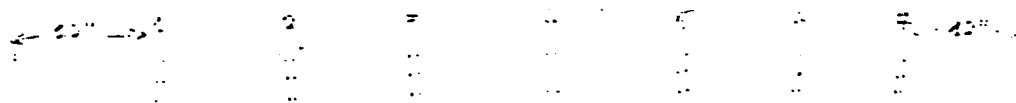
- (a) The following organizations were supplied with an oven and balance for moisture content determination:
- Dominica Timbers Limited (Mr. Pemberton)
  - Forestry Service (Mr. Gregoire)
  - North Eastern Timbers (Mr. T. Drepaul)
  - Home Industries Cooperative (Mr. A. J. Riviera)
- (b) The equipment supplied is listed hereunder:
- Electric drying oven (Grieve) 120 Vac
  - Franzus 220-110 V transformer
  - Franzus adaptor set
  - Ohaus Laboratory Trip Balance
  - Weight set, 12 pieces 500 g to 1 g
- (c) It was most unfortunate that the Grieve 120V electric oven and Franzus Transformer were selected. Grieve supply the same oven at 220V.

Furthermore, the oven bears a notice warning that it should not be left operating unattended. In a normal work situation of 8 hours on and 16 off, this means that oven drying of wood overnight is not advised.

## Annex IV - Calibration of moisture meters

The objective of the exercise was to demonstrate the need for an value of replication of samples and the concept of concept of constant weight to reach the desired end result - a correction factor for a moisture meter.

A 6" x 1" board some 5' long was marked off into seven samples about 2" wide (see fig. 1).



Sample 1

Moisture meter readings were made using the "A Scale" with the electrodes running along the grain and one inch from the two edges and in the centre of the 6" face so that three readings were made for each sample. The electrodes were pushed in about 3/8" to 1/2". The three readings were averaged to give a moisture meter reading for each sample.

Seven samples were then cut on a band saw so as to include the zones where moisture meter readings were made. Each sample was immediately weighed to the nearest 0.1 g and then placed in the oven at 100 to 105o C and dried overnight (for 16 hours).

Next morning each sample was removed from the oven and immediately weighed without cooling and then replaced in the oven. Weighings were continued at convenient intervals exceeding two hours until the change in weight with successive weighings was 0.2 grams or less. (The actual value selected depends upon the size of the sample and the overall rate of loss of weight.)

All weights and MC's were recorded in table 1. The oven dry moisture content was determined according to the formula:

$$\% \text{ moisture content (MC)} = \frac{100 (\text{wet weight minus "constant oven dry weight"})}{\text{"constant oven dry weight"}}$$

From the measurements made, it may be concluded that for this sample of Commier the meter correction is -2.4 when the moisture content is 10%.

Further measurements gave a corrections factor of about -4.5 when the moisture content was 20 to 28 percent (by resistance meter).

The following points were emphasized:

- (a) The resistance moisture meter measures only the electrical resistance which is related to the moisture content. To obtain the moisture content, tests must be made of each timber species over a range of moisture contents and appropriate corrections made to the moisture meter reading.
- (b) The moisture content of a single sample represents only that sample and in order to obtain a good estimate of the moisture content of a stack of wood, a representative sample must be obtained from each part of the stack. Five samples is a good number to aim for. Fewer samples and the result may well be biased, more samples and by the time results are determined the state of the stack may have changed.
- (c) Moisture meter readings cannot be made accurately on hot wood. If measurements of hot wood must be made, appropriate temperature correction figures must be applied. The corrections are of the order of 0.2% moisture content per degree centigrade.

Table 1: Calibration of moisture meter, timber Commier (Dacryodes), date 27.7.1988

SAMPLE #	1.1 1.2 1.3	2.1 2.2 2.3	3.1 3.2 3.3	4.1 4.2 4.3	5.1 5.2 5.3	6.1 6.2 6.3	7.1 7.2 7.3
MC by meter A	12.0 12.0 11.5	11.5 12.0 12.0	12.0 11.7 11.8	11.8 11.8 12.0	11.8 11.8 12.0	11.6 11.5 12.1	11.7 12.2 12.2
Average MC	11.83	11.83	11.83	11.86	11.86	11.75	12.03
MC by oven drying Wet weight (1)	130.2	125.4	138.6	129.7	118.7	109.4	108.6
Oven dry weight	<u>119.6</u> <u>119.0</u> <u>119.1</u>	<u>115.1</u> <u>114.8</u> <u>114.6</u>	<u>127.2</u> <u>128.6</u> <u>126.6</u>	<u>129.7</u> <u>119.0</u> <u>118.4</u>	<u>109.5</u> <u>108.9</u> <u>108.5</u>	<u>109.4</u> <u>110.4</u> <u>110.0</u>	<u>99.8</u> <u>99.5</u> <u>99.5</u>
Constant oven dry W(2)	119.0	119.6	126.6	118.4	108.5	110.0	99.5
Moisture (1-2)÷(3)	11.2	10.8	11.8	11.1	10.2	9.4	11.1
% MC = (3/2 x 100)	9.41	9.42	9.31	9.54	9.44	9.44	11.16
Meter correction	2.42	2.41	2.52	2.32	2.42	2.31	0.87
Mean correction		2.4					

Annex V - Industrial rates of utilities/services  
 Dominica Industrial Development Corporation  
 (all rates in US\$)

## 1. WATER

\$ 1.22 per 1,000 imperial gallon for the first 50,000 imperial gallons.  
 \$ 1.62 for each additional 1,000 imperial gallons.

## 2. ELECTRICITY

Service charge of US\$ 1.48 per month per KVA of installed capacity.

For consumption between 6:00 a.m. and 10:00 p.m. \$ 0.11 per unit (kWh)  
 For consumption between 10:00 p.m. and 6:00 a.m. \$ 0.9 per unit (kWh)

N.B.: Three months notice is required to get off peak hours rate.

Transformers for industrial use can be provided by the Dominica Electricity Services on request from investor. The cost range from US\$ 2,900 to \$ 4,500.

The function is to break down the current from 11,000 volts to 400 volts 3 phase in 4 wires and 230 volts, single phase.

For all rates there is a variable fuel surcharge computed on the basis of fuel utilized, times price of fuel, divided by total number of units consumed. A 10% Government tax is also charged on total consumption.

## 3. TELEPHONE

Installation	\$ 55.40
Monthly rental	20.30
For each additional parallel extension	2.60
Charges per unit call	0.10

## 4. TELEX

Machine installation	\$ 18.50
Monthly rental on machine	79.30

Rental on private wire is dependent on the distance from Cable & Wireless office to installation point. For instale, mile one is \$ 20.70; each additional mile \$ 14.80.  
 Use of telex service US\$ 3.30 per minute to the U.S.A.



## 5. TELEFAX/BUREAUFAX

Handling charge for page 1	\$ 3.70
Transmitting each additional page	0.74
Transmission charge for first 3 minutes	8.00
For each additional minute	2.07

Industrial Development Corporation  
P.O.Box 293, Roseau  
Commonwealth of Dominica

Tel.: (809) 445-2045; 2760  
Tlx: 8642 DOM IDC

## Annex VI - Shrinkage of some common Dominican Timber Species

SPECIE	SHRINKAGE				RATIO T/R	SPECIFIC GRAVITY GRAVITY ODW/ GREEN V
	RADIAL	TANGENTIAL	VOLUMETRIC			
DACRYODES EXCELSA (Gommier)	4.1	6.4	10.5		1.6	0.52
MANILKARA BIDENTATA (Balatte)	6.3	9.4	16.9		1.5	0.77-0.91
LICANIA TERNATENSIS (Bois diable)	8.2	9.6	16.8		1.2	0.90 2
BURSERA SIMARUBA	2.3	3.6	8.6		1.6	0.30-0.38
STERCULLA CARIBAEA (Mahot cachon)	5.2	9.2	13.6		1.6	0.46

1/ Sources: "Tropical timbers of the World". USDA Agriculture Handbook number 607

"Present and Potential Commercial Timbers of the Caribbean", USDA Agriculture, handbook number 207.

2/ Estimate only.

## Annex VII - Timber drying kiln maintenance workshop

Guide to kiln maintenance

The objective of kiln drying is the drying of wood as rapidly as possible keeping degrade at an acceptable level.

The objective of kiln maintenance is to ensure that this may be done without unscheduled interruption or breakdown

The following guidelines apply to all types of kilns irrespective of size or energy source.

They should be followed on a daily basis or, at start up and then routinely where possible.

Instruction on major maintenance is not included as this will be covered by requirements determined here but not met and/or covered by manufacturers' instructions.

- |                    |   |
|--------------------|---|
| Stack preparation: | <ul style="list-style-type: none"> <li>- check condition of sticker guides and repair as necessary.</li> <li>- check availability and condition of stickers; discard any damaged or undersized stickers.</li> <li>- check guides used to square off stack sides.</li> </ul> |
| Trolleys and rails | <ul style="list-style-type: none"> <li>- check condition of rails and trolleys, grease trolley wheel bearings; arrange for necessary repairs.</li> </ul>  |
| Lubrication:       | <ul style="list-style-type: none"> <li>- lubricate the following: door hinges; baffle hinges and operating mechanisms; vent hinges and operating mechanisms; fan bearings and electric motor bearings.</li> </ul>   |
| Pulley belts:      | <ul style="list-style-type: none"> <li>- Check pulley belt tensions; adjust where necessary and apply pulley belt dressing.</li> </ul>  |
| Structural:        | <ul style="list-style-type: none"> <li>- Check that doors close snugly and open freely; adjust and repair as needed.</li> </ul>   |

## Control devices:

- Check for holes in walls and roof and structural damage; repaired as needed.
- service control devices according to suppliers' instructions.
- drain water traps in compressed lines and blow down.
- check thermometers and replace when necessary.
- refill clean water supply to wet-bulb thermometers and clean wick.
- replace charts in recorders, check ink supply and pens. Check stock of kiln record sheets and resupply before they run out.

## Baffles:

- Check condition of baffles and repair or replace when necessary.

## Steam supply:

- When operating a steam heated kiln, follow supplier's instructions precisely. If none are available, determine suppliers name and write for instructions.
- Ensure that government regulations on pressure vessels and boilers are followed and that equipment has necessary certification. If in doubt, check with local authorities.

## Drywood storage:

- Check that adequate and appropriate storage is available for dry timber once it leaves the kiln. Timber dried to a low moisture content for use in air conditioned space or for export to a drier climate must be packed, usually in plastic, to prevent moisture uptake. Timber mouldings may be individually "cling-wrapped" or vacuum packed.
- In scheduling the unloading of a kiln of dry wood it is essential that proper storage is available or the timber may require redrying.

**Manufacturers recommendations:-**

Each kiln purchased should come with a set of maintenance instructions dealing with the care of the equipment supplied. These should be photocopied and the original filed in a safe place. the copy should be carefully labled and left with the kiln operator for routine reference; when damaged or lost, further copies should be made from the 'office master copy'.

## Annex VIII - Commercial timbers of Dominica

<u>Local name</u>	<u>Scientific name</u>	<u>Uses</u>
White cedar (poirier)	<i>Tabebuia pallida</i> (Lindl) Miers.	furniture and construction
Red cedar	<i>Cedrela odorata</i> L.	furniture and boatbuilding
Laurier poivre	<i>Hieronyma caribaea</i> Urb. syn.	furniture and construction
Laurier bordemere	<i>Laurier</i> spp.	furniture and construction
Septans	<i>Meliosma herbretii</i>	furniture and construction
Breadfruit	<i>Artocarpus incisa</i> L.f.	furniture and construction
Mahogany	<i>Swietenia</i> spp. mahogany	furniture (principally)
Saman	<i>Pithecellobium saman</i> (Jacq) Benth.	furniture (principally)
Maurisif	<i>Byrsonima martinicensis</i> Kr. Et. Urb.	furniture and construction
Galba	<i>Galophyllum Antillanum</i>	Furniture and construction
Bois blanc	<i>Simaruba amara</i> Aublet.	construction
Caconnier rouge	<i>Ormosia monosperma</i> (Sw.) Urb. syn.	construction and shingles
Bois riviere	<i>Chimarrhis cymosa</i> Jacq.	construction
Balata	<i>Oxythece pallida</i>	construction
Laurier caca	<i>Neceranda antillanum</i>	furniture and construction
Courbaril	<i>Hymenaea courbaril</i> L.	furniture (principally)
Zoranger	<i>Swartzia caribaea</i>	construction
Apricot	<i>Mammea americana</i>	furniture
Bois bande	<i>Richeria grandis</i> Vahl.	construction
Laurier sazelle	<i>Laurier</i> s.p.	furniture and construction
Gommier	<i>Dacryodes excelsa</i> Vahl.	furniture, plywood and construction
Blue mahoe	<i>Hibiscus elatus</i> Sw.	
Teak	<i>Tectona grandis</i> L.f.	furniture and construction
Mahot cochon	<i>Sterculia caribaea</i> R.Br.	furniture and construction