PROJECT IN SUPPORT OF CAMBODIAN NATURAL RUBBER CERTIFICATION AND MARKETING

PRCC – Certification Project
AFD funding agreement No. CKH 3000 01 D

Support for accreditation of the Cambodian National Specification Laboratory(NSL)

Jérôme Sainte Beuve

6 to 11 April 2008

CIRAD-PERSYST
UMR IATE

N° - 2186-08

Acknowledgements

I should like to thank the Project Leader, Mr Patrick Pierrat, for allowing me to undertake this mission, and the different stakeholders in the supply chain who agreed to see me and with whom I was able to hold discussions. I particularly thank Kim Chandy – Deputy Quality Manager at the NSL- for the organization of this mission, along with Dr Yin Song, Director of CRRI – for the time they gave up and their very warm hospitality. I do not forget Hun Kim San – Technical Manager at the NSL -, Che Pitou – Quality Manager at the NSL and Im Sopheary – NSL Supervisor- without whom this mission would not have been as fruitful.

List of abbreviations

CRRI	Cambodian Rubber Research Institute
CSR	Cambodian Specified Rubber
IRA	International Rubber Association
JODC	Japan Overseas Development Corporation
MIME	Ministry of Industry
NR	Natural Rubber
NSL	National Specification Laboratory
PRCC	Programme for the Reinforcement of Commercial Capacities
RRIM	Rubber Research Institute of Malaysia
STR	Standard Thai Rubber
TSR	Technically Specified Rubber

People met

- Mr CHHE Pitou, Quality Manager at the NSL
- Miss IM Sopheary, NSL Supervisor
- Mr Morimoto – JODC/Bridgestone
- Mr Chen Seng Heang – Director of the Industrial Laboratory Centre of Cambodia
- Dr Phoeurng Sackona – Director of the Technology Institute of Cambodia (TIC)
- Hun Kim Sam – Technical Manager of the NSL
- Hervé Conan - AFD

Mission Schedule

Saturday 5 April
Departure from Montpellier

Sunday 6 April
Arrival in Phnom Penh, Met by Kim Chandy

Monday 7 April
9 am – Tour of the laboratory and discussion about the latest Round Robin test results
11 am – Meeting at AFD with Hervé Conan
5 pm – Meeting at AFD with Mr Morimoto, H. Conan, Kim Chandy, Kunthea, a representative from JODC

Tuesday 8 April
9 am – meeting at the Ministry of Industry
2.30 pm – Meeting with Mrs Sakona – Director of ITC
3.30 pm – Drafting of a protocol to measure dirt content

Wednesday 9 April
Setting up, monitoring and interpreting volatile matter measurement tests.

Thursday 10 April
Setting up, monitoring and interpreting dirt rate measurement tests.
Consideration of the calibration procedures and parallel tests set up by the NSL.

Friday 11 April
Debriefing with Dr Yin Song and Kim Chandy
Dirt quantification tests
Departure for Montpellier

Saturday 12 April
Arrival in Montpellier

Summary

The main purpose of this mission was centred on recognition of the National Specification Laboratory (NSL) by IRA and improving procedures so that the NSL can rapidly be integrated into the international network of Round Robin Tests, and thereby be acknowledged as the national reference laboratory in Cambodia for natural rubber.

Keywords

- Natural rubber,
- Quality,
- Standardization,
- Accreditation,
- Certification,
- Round Robin tests
- Processing,
- TSR.

Contents

1. Introduction

SOFRECO was assigned by the Ministry of Trade of the Kingdom of Cambodia to carry out a technical assistance mission under a services contract entitled "Consulting services for Cambodian rubber international certificate insurance and commercialization support", funded by *Agence Française de Développement*. This mission was undertaken in connection with that project (PRCC).

The terms of reference for the mission were:

1) Support for international accreditation of the National Specification Laboratory (NSL): analysis and discussion about parallel tests with IRA, comparison of SMR and ISO methods.

2) Training in metrology and calibration of measuring instruments for staff in the laboratory, and in the factory laboratories.

3) Training in laboratory auditing and certification.

4) Contribution to the drafting of a guide of good processing practices.

5) Study on natural rubber certification and registration rules in the countries of the subregion.

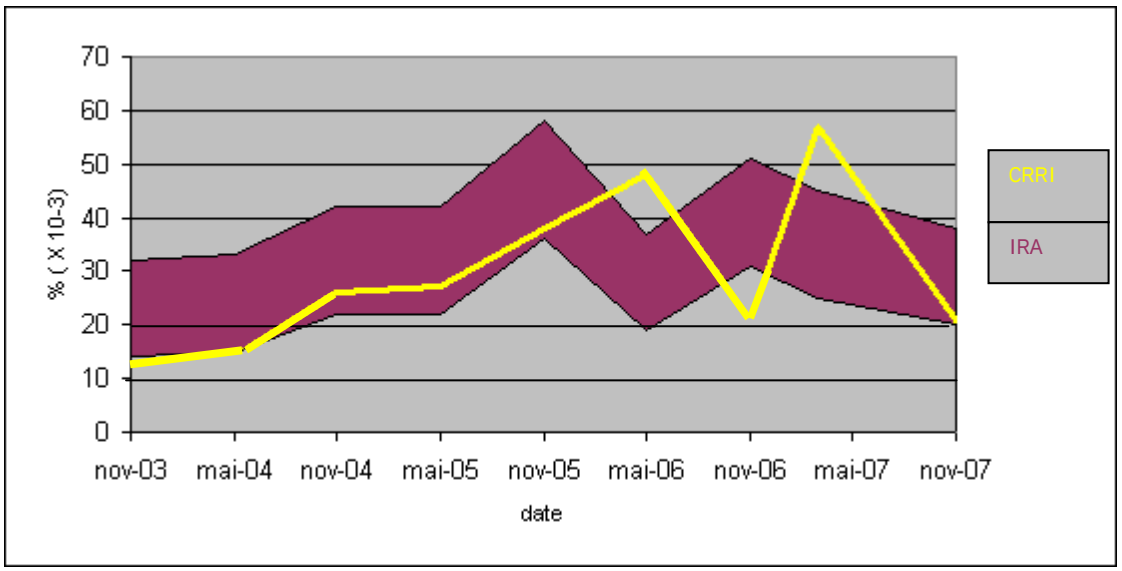
6) Meeting with the expert from JODC to define action by the Japanese expert with a view to continuing support missions launched during the PRCC project.

2. Support for international accreditation of the National Specification Laboratory (NSL): analysis and discussion about the parallel tests with IRA, comparison of SMR and ISO methods

2.1 – Analysis and discussion on the parallel tests with IRA

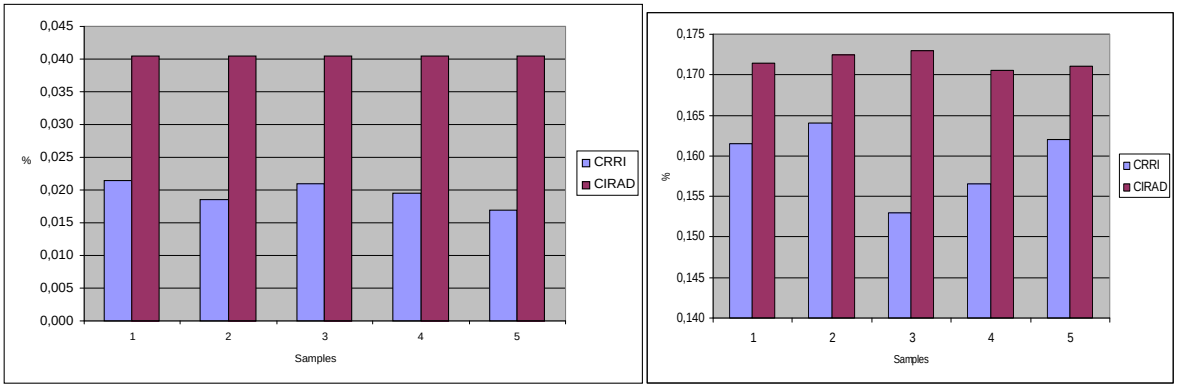
The visit to the laboratory, which has been operational since mid-October 2007, revealed that the new laboratory is bright and spacious; tasks are well organized between the hot and cold rooms. The ISO 17 025 accreditation that is under way has made it possible to structure this laboratory and set in place highly efficient organization.
It was possible to take stock of the results found since November 2003 for the Round Robin Tests. An analysis seems to show, on average, some results that are slightly below the average of the other laboratories: dirt content. As can be seen in graph 1, the underestimation of dirt content is sometimes counterbalanced by overestimations, thereby showing a process that has not been totally mastered.

Graph 1: Comparison of dirt contents between CRRI and IRA



During the last test organized as part of the Round Robin Test in March 2008, for which the results had yet to be published when this report was drafted, the six analyses that can be found in annex 1, along with those found by CIRAD as a comparison, were reviewed in detail. A slight difference can be seen, particularly for the quantification of dirt contents and volatile matter, which had already occurred in the last dirt rate measurements. The improvements to be made can be found in § 2.3. Graph 2, below, shows the differences found between CIRAD and CRRI concerning the mean for samples with equivalent dirt contents – samples AA and AD on the one hand, and samples AB and AE on the other hand. This representation makes it possible to display large differences for small dirt content values, but small for large values. In addition, not insubstantial scattering can be seen for high dirt contents that is roughly of the same magnitude as between CIRAD and CRRI.

Graph 2: Dirt content – mean of samples AA and AD for the left-hand graph, and AB and AE for the right-hand graph.



2.2 – Comparison of ISO and SMR methods

Several standards are used to specify natural rubber in the form of compacted crumb (TSR); worth mentioning of the most important used are:

* ISO 2000: International Organization for Standardization, the international standard
* SMR: Standard Malaysian Rubber, a Malaysian standard fixing Malaysian national rules since the 1960s
* ASTM: American Society for Testing and Materials, a standard originating from the USA, very similar to the international standard.

These standards, which differ through their contents, i.e. by the described procedures that have to be applied to assess a given criterion, can lead to significant differences in the values of the criteria measured.

Other national standards have been set in place in the other major producing countries such as Thailand - Standard Thai Rubber (STR).

These different standards – except Standard ISO 2000- provide two types of information:

- procedures for analysing quality criteria
- threshold values for those criteria determining rubber grades.

In reality, Standard ISO 2000 is a specification guide which therefore solely describes analysis procedures. The main difference with the Malaysian standard lies in the sample preparation procedure, which is a little more restrictive in terms of rubber structure for Standard ISO 2000, which has repercussions on the analysis results.

For Round Robin type tests, it is clearly specified at the outset what type of procedures the laboratories have to follow.

The Standards serve as methodological guides for measuring quality criteria but do not provide any ideas on good laboratory practices, such as equipment calibration. That is why laboratories, if they so wish, set in place a quality management system of the ISO 9001, ISO 17 025 type, etc., but that is not compulsory.

2.3 - Discussion on the analyses for which the procedures could be improved.

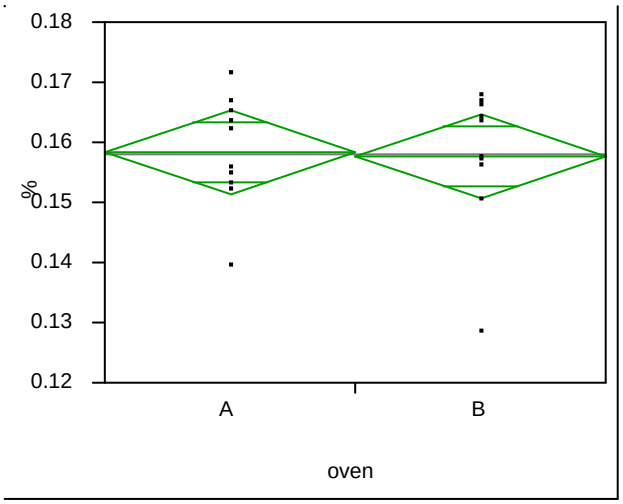
An overview of the results found during the Round Robin tests in previous years revealed some significant differences concerning dirt content measurement, with the NSL systematically finding smaller values, and to a lesser degree for volatile matter quantification. Apparently, this is about to be solved for the latter point. Advantage was therefore taken of this mission to draft several protocols to improve the two analysis procedures.

2.3.1 – Quantification of volatile matter

Two protocols have been drafted to quantify the influence of external factors that might affect the analysis results. Among this set of factors, the type of oven used to dry the samples and the type of cooling, which differs between the NSL and RRIM, have been chosen.

a/ Influence of oven type.
The NSL uses two different ovens to dry samples for volatile matter quantification. A protocol has therefore been set in place, the text of which can be found in annex 2, along with the results table for measuring the impact of the oven type. Graph 3 below shows that the means found for each of the two ovens are not significantly different.

Graph 3: Comparison of means for the two ovens – volatile matter quantification

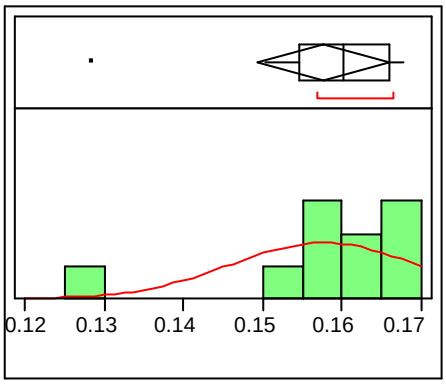


Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Oven	1	0.00000231	2.306e-6	0.0207	0.8871
Error	18	0.00200101	0.000111		
C. Total	19	0.00200332			

However, on two sets of 10 samples taken from the same Latex grade (L) bale, one displayed an abnormally low value showing abnormal scatter (graph 4). This aberrant point may have come either from sample heterogeneity at the outset, the process is not to blame, which seems rather unlikely, or dispersal of thermodynamic constraints inside oven B. The positioning of the samples inside the oven could therefore have an effect. This test therefore needs to be repeated (20 samples if possible to increase the validity of the statistical test) precisely noting the position of the samples in the oven, replicating this test three times.

Graph 4: Distribution of values after drying in oven B (as a % of volatile matter)



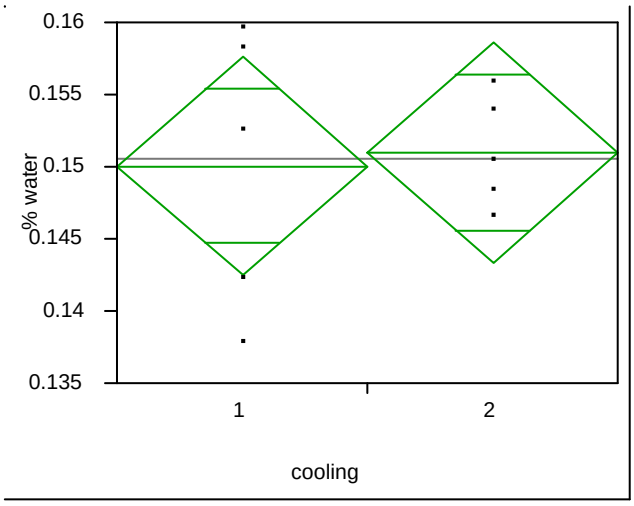
b/ Influence of sample cooling

During the visit by two RRIM technicians to the NSL, they gave a reminder of the procedure used by RRIM to cool samples as they leave the oven, which is different from that usually applied in Cambodia.

RRIM leaves samples to cool in the open air in a laboratory room for half an hour, whereas NSL places them in a desiccator to cool for an hour, so that it does not depend on the outside atmosphere – temperature and relative humidity of the laboratory room – which complies with Standard ISO 248.

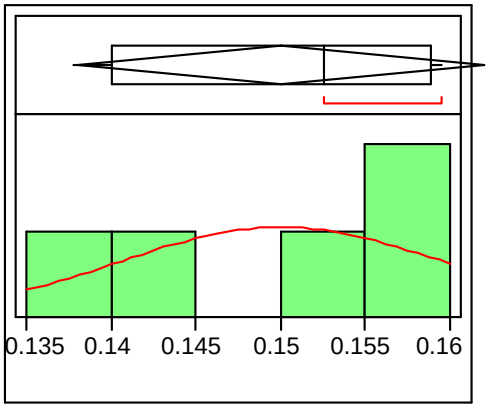
It was therefore decided to test the influence of this type of cooling under the conditions in the air-conditioned NSL laboratory. The protocol and the results can be found in annex 2. It would seem that the procedure used by RRIM, tested under NSL laboratory conditions, improved not the mean, which remained identical, but the scatter of the measurements, as can be seen in graphs 5 and 6. However, this first analysis only involved 10 samples.

Graph 5 : Comparison of means for the two types of cooling – replicate 1

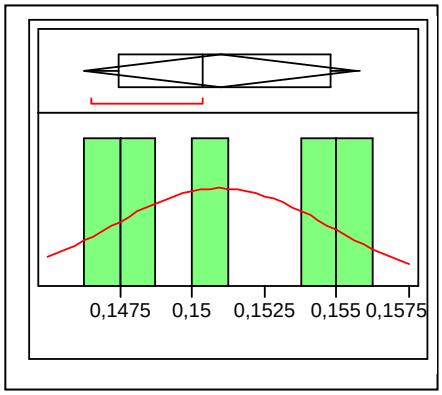


Graph 6: Distribution of volatile matter values with the two types of cooling – replicate 1

With desiccator

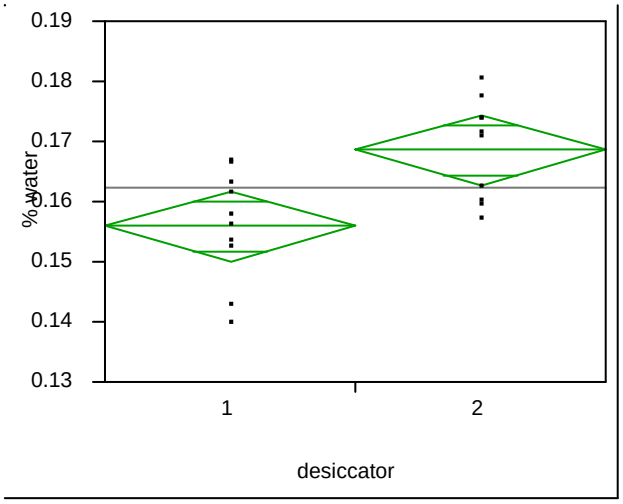


Without desiccator



This is why, the day after, a second replication was carried out with twenty samples from the same rubber bale. The results can be found in annex 2. As can be seen in graph 7, the means obtained with the two types of cooling are statistically different. Logically, the samples cooled in air contained more moisture than those cooled in the desiccator. As previously, the scatter of the volatile matter values was slightly less with open air cooling, as can be seen in graph 8. This second replicate provided new information that had not been appreciated during the first test. A third replication is therefore required with at least twenty samples.

Graph 7: Comparison of means of volatile matters for samples cooled with a desiccator – (1) and without a desiccator (2)

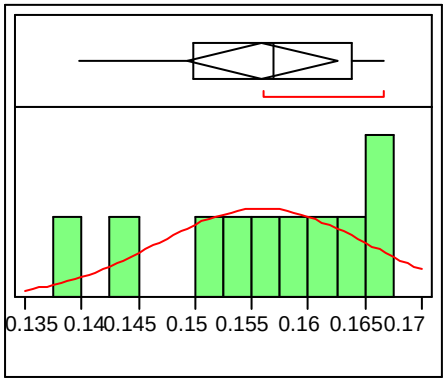


Analysis of variance

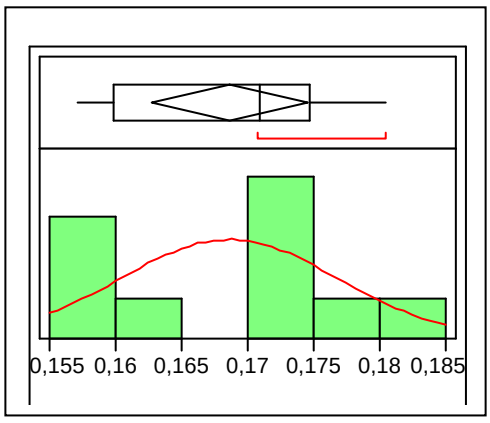
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
desiccator	1	0.00080380	0.000804	10.5239	0.0045
Error	18	0.00137481	0.000076		
C. Total	19	0.00217861			

Graph 8: Scatter of volatile matter values obtained with a desiccator (1) and without a desiccator (2)

With desiccator



Without desiccator



Of course, this preliminary test will have to be confirmed with a larger number of samples – 20 minimum. A second validation will be possible by comparing with the results found by CIRAD.

2.3.2 – Dirt quantification

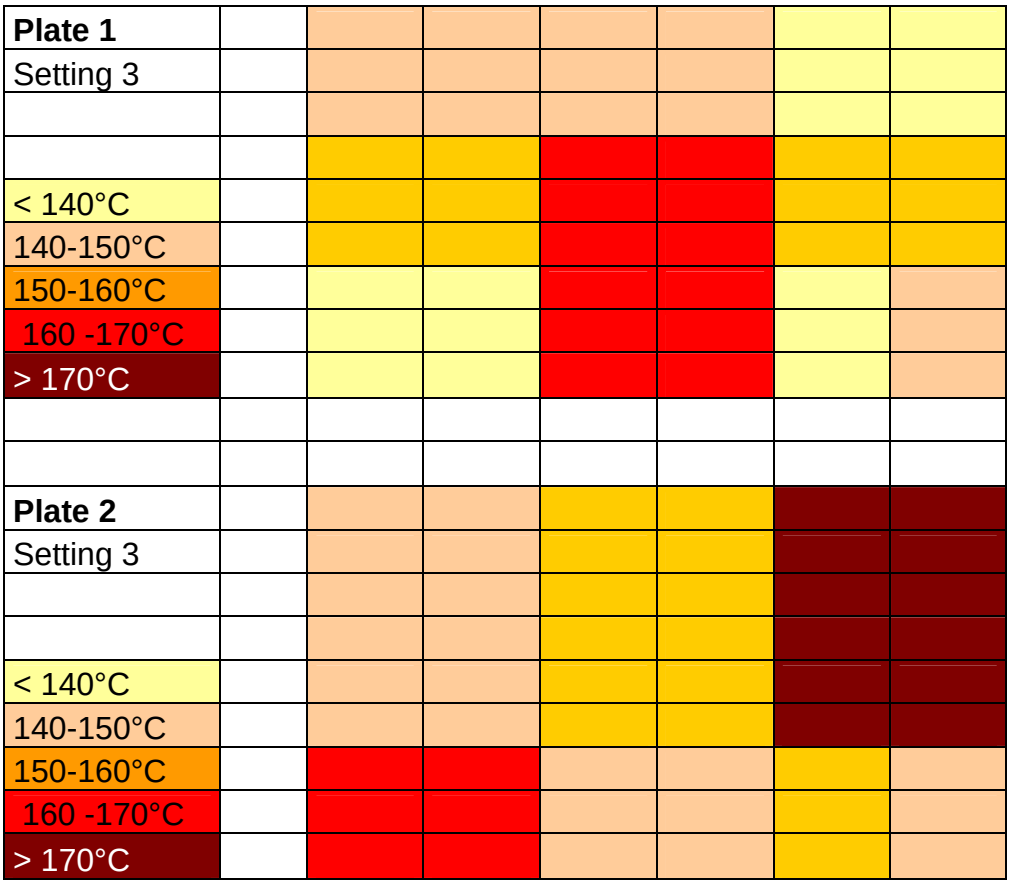
As seen in section 2.1, this procedure needs to be improved rapidly in order to ensure the precision of this measurement at all times and thereby NSL accreditation.
This quantification, the principle of which is described in all national or international Specification Standards for Rubber, requires a degree of adaptation depending on the laboratory environment – chemicals used, equipment, etc. First of all, it should be remembered that the differences between the values found by the NSL and the mean of the values found by all the other laboratories occur only with very clean samples with a very small quantity of dirt of around 0.02% equivalent to 1 or 2 mg or even less. In addition dissolving natural rubber in a solvent is not an easy chemical reaction and has been covered by numerous studies. A (more or less insoluble) gel may form, which will depend on several parameters - type of solvent, time spent in solution, etc. In fact, the Standard states that the solution must pass through a 44 µm screen, which means it must be perfectly limpid. This dissolution depends on the solvent, the temperature of the solution, and the duration. The best compromise therefore needs to be found between those three parameters depending on the constraints of each laboratory, in order to ensure that the 44 µm screen only retains dirt and not small aggregates of poorly dissolved rubber.
In order to improve the current procedure, a protocol has been drafted and assays were carried out for which the results can be found in annex 3.
Two parameters were studied, which seem to play a major role in measurement precision:

- influence of screen soaking; the effect of soaking the screens after filtration was studied to try and quantify the rubber that would remain stuck to the screen.
- influence of solution temperature uniformity; in fact, the Malaysian Standard specifies the use of infrared lamps, one for each Erlenmeyer flask, which guarantees a uniform temperature between the flasks, as all of them are the same distance from the lamps. This practice is not recommended by CIRAD for safety reasons. Indeed, if an Erlenmeyer flask has a defect, the rubber solution is likely to leak, fall onto an electric bulb and cause an explosion. CIRAD recommends using a hotplate. The purpose of this study was to ensure the uniform temperature of solutions placed on the two hotplates used by the NSL.

a/ influence of screen soaking
As can be seen from the results in annex 3, the values found cannot be statistically interpreted in order to quantify the effect of screen soaking. However, the fact that negative values were found, i.e. new and clean screens would appear to have a greater mass than those with dirt, shows that it is compulsory to wash screens at the outset, prior to use. This was confirmed by replicate 2, annex 3, which revealed in two dummy assays a loss of screen mass solely when passed through a neat solution of white spirit.

b/ influence of solution temperature uniformity
The temperature reached by the solutions in each of the Erlenmeyer flask after two and a half hours was measured to gain an idea of temperature uniformity on the same hotplate. The results can be found in annex 4 and reveal substantial scatter, as can be seen in graph 9 below, where differences could reach 30°C on the same hotplate.

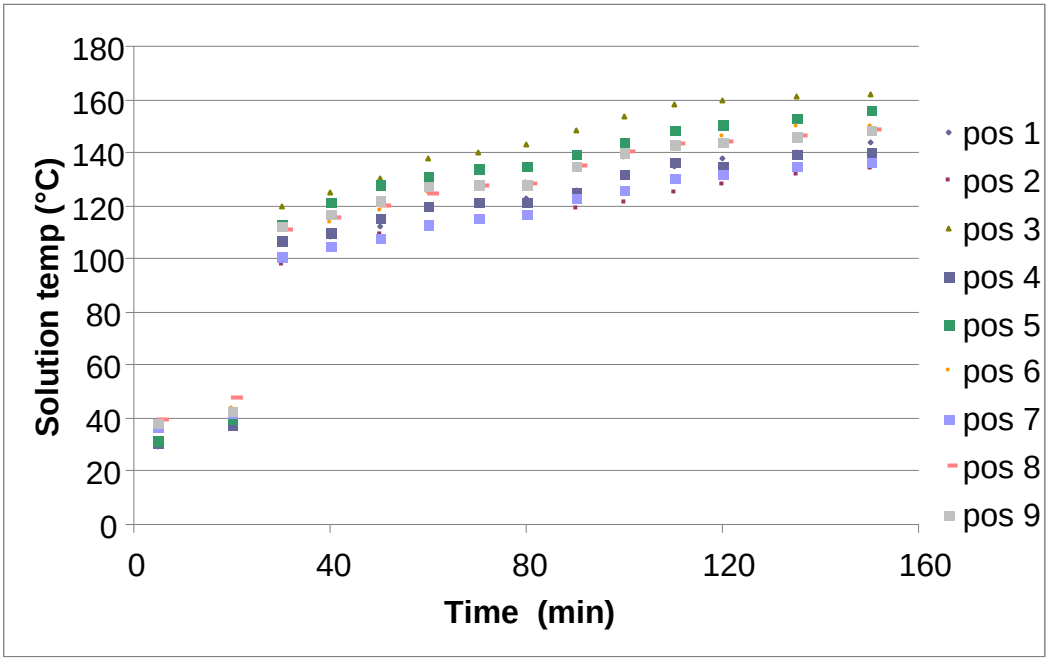
Graph 9: Temperature mapping for the two hotplates; temperature reached after 150 minutes



The solution applied by the NSL, which consists in moving the Erlenmeyers as soon as the rubber solution starts boiling does not appear to be repeatable, and in no way constitutes a scientific approach.

Likewise, the temperature rise kinetics reveal that the recommended temperature is only reached after two hours, as can be seen in graph 10 below.

Graph 10: Temperature kinetics for plate 1 – setting 3



The positions indicated in graph 10 correspond to the diagram in annex 4.

Recommendations

Concerning the procedures

It is necessary to reconsider the main factors likely to cause dirt content to vary.

* take a sample of 20 g not 10 g as suggested by Standard ISO 249, so the quantity of dirt will be larger and weighing will be less subject to variations depending on outside phenomena,
* Check that the peptizer solution used is at the right concentration,
* Control the dissolving temperature: 125-130°C recommended by Standard ISO 249. Avoid using an instrument and conditions likely to result in localized overheating.
* Clean new screens. Indeed, even if the 44 µm screens are new and come from the same supplier as at RRIM in Malaysia, they may be contaminated by products that could be dissolved in contact with the solvent. They must therefore be washed for ½ h at 100°C in a solution of white spirit, followed by ½ h in a solution of Teepol, then rinsed in water before being dried in a desiccator.

* In terms of the solvent, it is recommended, at least for the Round Robin Test, that the turpentine recommended by the Malaysians be purchased. This does not rule out continuing studies on white spirit which is easier to find in Cambodia, and much cheaper. Thus, one parameter will have been dealt with, for the moment.

* As regards the solution temperature and dissolving time, a good compromise needs to be found. It is recommended that hotplates be purchased that deliver a uniform temperature over the entire surface of the plate.

It is essential to create a database containing all the results of analyses carried out at the laboratory. The software created specially to create specification certificates must be able to record numerical data at the same time in an Excel type database, so that annual summaries can be drawn up, but also to enable the statistical studies required for monitoring production and improving procedures.

3. Training in metrology and measuring instrument calibration for staff at the laboratory and in factory laboratories

3.1. Visit to the Ministry of Industry, Mines and Energy

Thanks to an appointment made by Kim Chandy before my arrival, we were able to visit the national metrology laboratory of Cambodia – Industrial Laboratory Centre of Cambodia (ILCC). The purpose of the visit was to gain a clearer understanding of calibration issues for the equipment at CRRI by looking at the skills already existing in Cambodia.

The buildings housing this laboratory are all new and the equipment it was possible to see is very recent and has just been funded by UNIDO, fortunately with a solid support programme, in Sri Lanka, to train the technicians who will be using the equipment.

The laboratory is subdivided into three parts:

- microbiology
- chemistry
- metrology

Thirty-six people currently work in this laboratory. Not all three sections are operational yet, the personnel is being trained and the machines are not yet in working condition.

The section of particular interest to us, metrology, is divided into six sub-sections:

- Pressure
- Thermometer
- Mass
- Volume
- Electricity
- Dimension

Only the first 4 sub-sections appear to be operating. The instruments intended for metrology are installed and some technicians seem to have been trained in their use.

This laboratory, which is nationally recognized in Cambodia, has yet to receive ISO 17 025 accreditation, for which the procedure is under way. However, many of the NSL instruments can be calibrated by this national organization:

- press manometer
- thermometers
- balances – standard weights

A particular request was made for calibration of the thermometer that regulates the PRI oven temperature. A visit by ILCC technicians to the NSL may provide a solution to that problem. However, this laboratory is not yet equipped to measure air flows.

It would seem that few Cambodian organizations use the services and skills of this laboratory, which is a great pity. The NSL could turn to this laboratory to acquire metrology skills and participate in the calibration of certain instruments. However, the NSL would need to perfectly control this procedure and be aware of the consequences for the analyses that will be carried out at the NSL.

Before organizing ILCC reference laboratory support at the NSL on a permanent basis, it needs to be checked that the environment of that laboratory effectively enables metrology assays to be carried out. On the day of the visit, there was no electricity in this section, so all the equipment was at the temperature and relative humidity of the outside.

3.2 Calibration

Today, all the thermometers – thermocouple – have already been checked by ILCC (in 2006), as have the standard weights used to calibrated the NSL laboratory balances. The following now remains to be done:

- recommence the thermometer calibration procedure – certification lasts 1 year
- recommence the standard weights calibration procedure – certification lasts 2 years
- calibration of the two manometers for the press – colour-
- calibration of the micrometer to calibrate the spacing of the mill rollers
- checking of screen aperture dimensions – take a random sample and send it to the ILCC laboratory
- check changes in the colour disks used as a reference to measure colour. Contact the disk manufacturer to find out the reference: wavelength? by transmission or reflection? etc.
- calibration of the PRI oven thermometer by ILCC – each year.

4. Training in laboratory auditing and certification

Training certificates for the three laboratory staff – Kim Chandy, Hun Kim San, In Sopeary – have been supplied to the NSL as requested.

Parallel tests with the factory laboratories – Chup, Krek, Snoul, Memot, Chamcr Andong, began in 2005 at a rate of 4 tests per year. The results of the tests were sent to each laboratory, showing major scatter between laboratories. Written comments and recommendations now need to be drafted by the NSL and sent to each of the laboratories involved, followed by one or more inspections to solve the scatter seen. A critical analysis of the means, standard deviations, value of the Z score and K score is essential. Training courses could even be organized at the NSL on the analyses displaying major scatter, such as dirt, PRI and volatile matter.

5. Drafting of a guide of good rubber processing practices

The situation in Cambodia can be summed up as follows: at the moment, most rubber is processed in latex form to produce type L and type 3 grades. Processing procedures can be improved to add more value to these two products. As a general rule the equipment is there. To prepare for the future, it seems necessary to propose procedures enabling the manufacture of new high added-value grades from latex, such as 3 CV. Some additional equipment is necessary. Lastly, the emergence of the smallholder sector will oblige processors to entirely revise their production line – equipment and procedures - to manufacture and export grade 10. This change in practices requires an effort to adapt from all the stakeholders in this supply chain –

smallholders, middlemen, remillers, transporters, etc. One important point which will require an effort from smallholders lies in the cleanliness rules during collection and storage before transport to the factory.

A new document has been drafted (annex 5) which needs to serve as a basis for processors, but also for CRRI auditors.
On this subject, Japanese cooperation, through JODC, is funding a Japanese expert for two years to improve processing techniques, and thereby the quality of exported rubber.

6. Strengthening of human resources

A discussion was held with the Director of the Technology Institute of Cambodia (TIC) – Mrs Phoeurng Sackona - with Kim Chandy, a former TIC student.
The departure from CRRI of Teck Meil, who had been trained to carry out audits of the rubber production factories, weakens NSL skills in this area. It would seem that, since his departure in September 2007, the NSL has not sought to replace him. This shortfall in skilled human resources could start to be resolved if CRRI established closer links with Cambodian institutions that have such skills, such as the Royal University of Agriculture (RUC) and TIC. Despite the fact that Kim Chandy spent several years studying at TIC, there have been no visits or exchanges between the two organizations. It is strongly recommended that Dr Yin Song pays a visit to the Director of TIC to explain to her the natural rubber situation in Cambodia, the stakes for the country, and the skills to be found. Numerous MSc level trainees in the chemistry department apply for practical training courses each year, it would be a pity for CRRI not to benefit. This would make it possible to test individuals over several months before thinking about perfecting their training and recruiting them should the opportunity present itself.

7. Conclusions and prospects

This mission was used to take stock of the certification procedures entered into by the Cambodian National Specification Laboratory. The Round Robin Test organized under the aegis of IRA, in which the NSL is taking part as a guest member, shows that all the results found by the NSL comply with the set of results found by the other laboratories taking part in the Round Robin Test, except for dirt content, which still remains a little low. The volatile matter analysis procedure could also be improved; two protocols are proposed. For the assessment of dirt content, that analysis needs to be improved for the next parallel tests. Intervention is recommended in three areas:

- buy and use new hot plates that guarantee uniform solution temperatures,
- set up monthly parallel tests between CIRAD and the NSL up to November 2008, the date of the next tests organized by IRA,
- introduce, analyse and make recommendations for specific protocols to solve the differences found for dirt quantification – compromise between temperature and dissolving time – and volatile matter quantification (see § 2.3.1). Protocols will be sent by CIRAD, adapted by CRRI according to its constraints, then implemented and, lastly, jointly analysed

Depending on the results of the different tests undertaken up to October 2008, a technical support mission will be made to the NSL at that time. The following timetable summarizes the tasks to be completed between now and the end of the year:

Recommended action

	May	June	July	August	September	October	November
NSL to order and purchase hotplate	Kim Sam	Kim Sam					
and turpentine	Kim Sam	Kim Sam					
1st parallel test for dirt			K S/In So				
2nd parallel test for dirt				K S/In So			
3rd parallel test for dirt					K S/In So		
4th parallel test for dirt						K S/In So	
Volatile matter protocol 1:							
position of samples in oven			Kim Sam				
Volatile matter protocol 2:							
comparison of air and desiccator drying			Kim Sam				
Dirt protocol 1:							
comparison washed/unwashed screen		Kim Sam					
Dirt protocol 2:							
time/temperature optimization with white spirit		Kim Sam					
Dirt protocol 3:							
time/temperature optimization with turpentine		Kim Sam					
Dirt protocol 4:							
mapping of solution temperature		Kim Sam					
Creation of database							Kim Sam
Parallel tests with IRA							Kim Sam
Mission by CIRAD expert (if necessary)						FB	

The parallel tests with the factory laboratories with a view to their accreditation are perfectly organized by the NSL – 12 tests have already been carried out to date – and show a degree of result scatter among the participating laboratories. True dialogue needs to be established between the factory laboratories and the NSL after each test, in order to improve the analysis procedures. Recommendations need to be made, or training sessions organized with the teams of laboratory technicians presenting results too far from those found by the NSL.

In order for the NSL to continue improving its analysis procedures, it is necessary for it to have access to databases that contain all the laboratory analysis results and for it to use efficient statistical tools. The database needs to be fed by the data inputting software for Cambodian rubber certification, and with the results of the numerous tests that are being and will be conducted.

Calibration of the measuring instruments is making good headway and should be ensured on a permanent basis by the national metrology laboratory, but also internally through appropriate training.

The PRCC is set to come to an end in 2008; a follow-on should be envisaged to perpetuate the current achievements and enable all the initial objectives to be fulfilled. Such a follow-on could take the form of a project to enhance skills on a regional scale in terms of Quality. Indeed, in Southeast Asia, it is in the interest of some countries which are newly confronted by the constraints of international trade in natural rubber, such as Laos and Cambodia, to enter into exchanges and benefit from the experience of those who have been involved in it for a long time, such as Vietnam and especially Thailand. Such an exchange of knowledge between countries in the same subregion, which could possibly be supported by contributions from other countries, lays the foundation of a research platform in partnership (PCP), which CIRAD is in the process of creating with Thai partners.

Such a follow-on, focusing on natural rubber quality and its management, could take the form of training seminars organized in each of the four countries on very precise topics such as metrology, statistics for use in quality management, the concept of quality for the different stakeholders in the supply chain, the "batch" notion, laboratory accreditation, etc. It would need to be made sure that the main people involved in the Quality process actively take part in this programme, particularly among smallholders, traders, authorized laboratories and the NSL.

Mission schedule
PRCC project
Mission by J. Sainte beuve
2008

	April 5	April 6	April 7	April 7	April 8	April 8	April 9	April 9	April 10	April 10	April 11	April 11	April 12
	Saturday	Sunday	Monday	Monday	Tuesday	Tuesday	Wednesday	Wednesday	Thursday	Thursday	Friday	Friday	Saturday
			AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM
Departure from Montpellier													
Arrival in Phnom Penh - Welcome by K. Chandy													
Briefing with Dr Yin Song and Kim Chandy													
Meeting with Mr Morimoto and H. Conan - AFD Office													
Accreditation of the NSL: analysis and discussion of the latest parallel test results: analysis of the dirt and volatile													
matter procedure, SMR/ISO comparison													
Training in metrology, calibration of measuring equipment for NSL staff: planning, frequency, cost													
visit to MIME and TI C													
calibration of the roller mill													
Elaboration of a guide on technical conditions for rubber													
production and training session													
Study of certification and registration rules													
in neighbouring countries													
Debriefing with Dr Yin Song, visit to French Embassy													
Departure from Phnom Penh													
Arrival in Montpellier													

Annex 1

Comparison between CIRAD and CRRI
Round Robin Test - March 2008

			CRRI					CIRAD		
Dirt										
SPECIMEN	1	2	3	4	5	1	2	3	4	5
AA	0.023	0.017	0.023	0.013	0.017	0.039	0.040	0.042	0.039	0.040
AD	0.02	0.02	0.019	0.026	0.017	0.042	0.041	0.039	0.042	0.041
AB	0.166	0.162	0.16	0.15	0.159	0.171	0.172	0.174	0.171	0.170
AE	0.157	0.166	0.146	0.163	0.017	0.172	0.173	0.172	0.170	0.172
Po										
SPECIMEN	1	2	3	4	5	1	2	3	4	5
CA	30.5	30.5	30	31	29.5	31.0	31.0	31.0	31.0	31.0
CD	30	31	30	30.5	30	31.0	31.0	31.0	30.5	31.0
CB	34.5	34	34	34.5	35	35.0	35.0	35.0	35.0	35.0
CE	34.5	34.5	34.5	34.5	34.5	34.0	34.5	34.0	35.0	35.0
PRI										
SPECIMEN						1	2	3	4	5
CA		71.7	à	74.6		77.4	74.2	77.4	77.4	77.4
CD		69.4	à	75.4		77.4	77.4	77.4	78.7	77.4
CB		78.6	à	83.6		82.9	82.9	82.9	82.9	82.9
CE		79.7	à	82.6		85.3	85.5	85.3	82.9	82.9

Volatile matter

SPECIMEN	1	2	3			1	2	3
BA	0.38	0.31	0.31			0.30	0.28	0.33
BD	0.33	0.37	0.37			0.32	0.34	0.38
BB	0.67	0.77	0.64			0.60	0.58	0.61
BE	0.64	0.66	0.76			0.63	0.63	0.58

Ash

SPECIMEN	1	2	3			1	2	3
GA	0.22	0.22	0.23			0.26	0.26	0.26
GD	0.23	0.21	0.23			0.27	0.25	0.26
GB	0.33	0.33	0.34			0.38	0.39	0.41
GE	0.39	0.34	0.35			0.37	0.39	0.41

Annex 2
Volatile matter quantification

Protocol
for volatile matter quantification

Influence of drying oven type

Procedure:

Comparison of results obtained at CRRI, Cambodia, with two different ovens and at the CIRAD laboratory in Montpellier.

The most uniform possible raw material available at the NSL should be used at the outset, namely a piece from a bale of type L rubber.

Quantity of rubber: 350 g
Type of rubber: TSR L
500 g should be sent to CIRAD in Montpellier for parallel analyses.
Homogenization: SMR type: 6 passes at 27 +-2°C, friction 1:1.4, gap spacing 1.65 +-0.16 mm

Weigh 20 pieces weighing 10 g each with a balance accurate to 0.01 mg.
Mill: 2 passes at ambient temperature, gap spacing 0.33 +- 0.05 mm
Heat the two ovens to 100°C +-2 for 30 minutes
Place the samples in the two hot ovens and dry for 4 hours at 100°C +- 2 °C

* Place 10 pieces in oven A
* Place 10 pieces in oven B

On leaving the oven, place each sample in a polyethylene bag and place the bags in two desiccators – one for each oven – for 1 hour at ambient temperature, 22 – 23°C. Remove each sample from the polyethylene bag and weigh each sample with a balance accurate to 0.01 mg.

Results table

CRRI Vol. matter test, 7 April 2008
Specimen of L

Oven	Specimen number	Weight before milling	Weight after drying in the oven and time in the desiccator		
		g	g	g	%
A	1	10.1696	10.153	0.0166	0.16323159
A	2	10.0206	10.0051	0.0155	0.15468136
A	3	10.059	10.0436	0.0154	0.15309673
A	4	10.0589	10.0436	0.0153	0.15210411
A	5	10.1788	10.1623	0.0165	0.16210162
A	6	10.1217	10.105	0.0167	0.16499205
A	7	10.1238	10.1097	0.0141	0.13927577
A	8	10.0835	10.0678	0.0157	0.15569991
A	9	10.1964	10.1794	0.017	0.16672551
A	10	10.2751	10.2575	0.0176	0.17128787
B	11	10.1818	10.1665	0.0153	0.15026813
B	12	10.0538	10.0381	0.0157	0.15615986
B	13	10.1044	10.0879	0.0165	0.1632952
B	14	10.13	10.1132	0.0168	0.16584403
B	15	10.3047	10.2885	0.0162	0.15720982
B	16	10.2778	10.2646	0.0132	0.12843215
B	17	10.0859	10.0691	0.0168	0.16656917
B	18	10.0675	10.0517	0.0158	0.15694065
B	19	10.0597	10.0432	0.0165	0.1640208
B	20	10.0796	10.0627	0.0169	0.16766538

Protocol
for volatile matte quantification

Influence of the type of cooling

Procedure:

Comparison of the results obtained at CRRI, Cambodia, with those obtained at RRIM with cooling in the laboratory.

The same rubber should be used as that to assess the effect of the oven type.

Quantity of rubber: 350 g
Type of rubber: TSR L
Homogenization: SMR type: 6 passes at 27 +-2°C, friction 1:1.4, gap spacing 1.65 +-0.16 mm

Weigh 20 pieces weighing 10 g each with a balance accurate to 0.01 mg.
Mill: 2 passes at ambient temperature, gap spacing 0.33 +- 0.05 mm.
Heat oven A to 100°C +-2 for 30 minutes.
Place the samples in the hot oven and dry for 4 hours at 100°C +- 2°C

On leaving the oven, place each sample in a polyethylene bag then:

* place 10 pieces in a desiccator for 1 hour at ambient temperature, 22–23°C after removing the polyethylene bags

* hang 10 pieces in their bags inside a laboratory room without air-conditioning

Remove each sample from its polyethylene bag and weigh it with a balance accurate to 0.01 mg.

Results

1st replicate

CRRI vol. matter test, 8 April 2008
sample of L identical to that used on 7 April

			weight before milling	weight after drying in oven and time in desiccator		
Oven		Drying	g	g	g	%
A	1	1	10.0858	10.0719	0.0139	0.1378175
A	2	1	10.125	10.1106	0.0144	0.1422222
A	3	1	10.1546	10.1384	0.0162	0.1595336
A	4	1	10.1103	10.0943	0.016	0.1582545
A	5	1	10.0333	10.018	0.0153	0.1524922
A	6	2	10.0117	9.9963	0.0154	0.15382
A	7	2	10.0993	10.0845	0.0148	0.1465448
A	8	2	10.1124	10.0974	0.015	0.1483327
A	9	2	10.1738	10.1585	0.0153	0.1503863
A	10	2	10.0149	9.9993	0.0156	0.1557679
		cooling in desiccator		1		
		cooling in open air for ½ hour		2		

2nd replicate

CRRI vol. matter test, 10 April 2008

	sample of L		Weight before	Dry weight	Qty water	Qty water
Oven		Drying	g	g	g	%
A	1	1	10.0561	10.0397	0.0164	0.1630851
A	2	1	10.0403	10.0236	0.0167	0.1663297
A	3	1	10.1947	10.1788	0.0159	0.1559634
A	4	1	10.1695	10.1539	0.0156	0.1533999
A	5	1	10.0781	10.0622	0.0159	0.1577678
A	6	1	10.0421	10.0268	0.0153	0.1523586
A	7	1	10.1628	10.1486	0.0142	0.1397253
A	8	1	10.1647	10.1502	0.0145	0.1426505
A	9	1	10.098	10.0817	0.0163	0.1614181
A	10	1	10.1465	10.1296	0.0169	0.1665599
A	11	2	10.2498	10.2337	0.0161	0.1570762
A	12	2	10.3503	10.3338	0.0165	0.1594157
A	13	2	10.2508	10.2344	0.0164	0.1599875
A	14	2	10.3053	10.2877	0.0176	0.1707859
A	15	2	10.2542	10.2357	0.0185	0.1804139
A	16	2	10.3455	10.3287	0.0168	0.1623894
A	17	2	10.3122	10.2939	0.0183	0.1774597
A	18	2	10.2557	10.2379	0.0178	0.173562
A	19	2	10.3	10.2821	0.0179	0.1737864
A	20	2	10.2236	10.2061	0.0175	0.1711726
		cooling in desiccator		1		
		cooling in open air for ½ hour		2	= Malaysian procedure	

Annex 3
Dirt quantification

Protocol

Improving the dirt quantification process

Objective: Assess how the dirt rate is affected by the hotplate and by screen cleanness.

Procedure:

- two methods
  - 1/ * soak the screen and its holder for 1 h at 100°C in white spirit
    * no soaking
  - 2/ * heat on a hotplate, 1, with a given heat distribution
    * heat on a hotplate, 2, with another heat distribution

Tests are to be carried out in parallel between the CRRI laboratory and the CIRAD laboratory in Montpellier.
Perform 5 replications with 5 Erlenmeyers

Quantity of rubber: 400 g
Type of rubber: TSR L
500 g should be sent to CIRAD Montpellier for parallel analysis.
Homogenization: SMR type: 6 passes at 27 +-2°C, friction 1:1.4, gap spacing 1.65 +-0.16 mm

Weigh 20 pieces of 20 g each
Milling: 2 passes at ambient temperature, gap spacing 0.33 +- 0.05 mm
Weigh around 10 g for each piece and cut into at least 10 pieces.
Prepare 20 Erlenmeyers containing 250 ml of white spirit accompanied by 1 ml of Kempep at ambient temperature.
Place 10 g (around 12 pieces) in each of the 20 Erlenmeyers and allow to rest for 12 h at ambient temperature.
Number the 20 Erlenmeyers from 1 to 20.
Prepare the screen and weigh it with its holder.
Place the 20 Erlenmeyers on the two hotplates at ambient temperature and stir.
Switch on the hotplates, setting knob to position 3.
After 3 hours, test fluidity with a glass rod.
Take Erlenmeyer No. 5 and filter the solution, rinse with hot white spirit to remove all rubber, rinse the screen with its holder with hot white spirit.
Place the screen with its holder on an aluminium tray lined with a sheet of paper for 2 minutes then place it in an oven at 100°C for 1 hour. Place in a desiccator for 1 hour, then weigh.
Take Erlenmeyer No. 8 and filter the solution, rinse the Erlenmeyer with hot white spirit to remove all rubber, rinse the screen and its holder with white spirit.

Place the screen with its holder in a large beaker with white spirit at ambient temperature.
Once the set of screens and their holders have been used for filtration, heat the white spirit and screens for an hour.
Place the screen and its holder on an aluminium tray lined with a sheet of paper for 2 minutes, then place it in an oven at 100°C for 1 hour. Place in a desiccator for 1 hour, then weigh.
Each test, soaking and no soaking, should be replicated five times.

Analysis of results
Replicate 1

CRRI dirt test, 10 April 2008
sample of L

plate	position	soaking	weight after	weight before	mass rubber	difference	
			g	g	g	g	%
1	1	1	20.5781	20.5784	10.1695	-3.0E-04	-2.9E-05
1	2	2	22.3122	22.3049	10.2232	7.3E-03	7.1E-04
1	3	2	20.6981	20.6971	10.0628	1.0E-03	9.9E-05
1	4	2	22.0613	22.0615	10.1582	-2.0E-04	-2.0E-05
1	5	2	22.2728	22.2732	10.1983	-4.0E-04	-3.9E-05
1	6	1	22.6724	22.6729	10.1027	-5.0E-04	-4.9E-05
1	7	1	23.4923	23.4925	10.1987	-2.0E-04	-2.0E-05
1	8	1	22.2516	22.2518	10.1624	-2.0E-04	-2.0E-05
1	9	2	20.5054	20.5058	10.1527	-4.0E-04	-3.9E-05
1	10	1	21.5691	21.5685	10.1857	6.0E-04	5.9E-05
2	11	2	22.1109	22.1108	10.1948	1.0E-04	9.8E-06
2	12	2	23.5208	23.5204	10.1774	4.0E-04	3.9E-05
2	13	2	22.2717	22.2722	10.1658	-5.0E-04	-4.9E-05
2	14	1	21.9008	21.9009	10.3609	-1.0E-04	-9.7E-06
2	15	1	23.501	23.5009	10.1169	1.0E-04	9.9E-06
2	16	1	23.2891	23.2893	10.1418	-2.0E-04	-2.0E-05
2	17	1	23.2906	23.2911	10.1991	-5.0E-04	-4.9E-05
2	18	2	19.9184	19.9187	10.2157	-3.0E-04	-2.9E-05
2	19	2	21.5824	21.5823	10.0827	1.0E-04	9.9E-06
2	20	1	21.4458	21.4462	10.0856	-4.0E-04	-4.0E-05
		soaking of filters		1			
		no soaking of filters		2			

Replicate 2

CRRI dirt test, 11 April 2008
sample of L

plate	position	soaking	weight after	weight before	mass rubber		
			g	g		g	%
2	2	2	22.1112	22.1105	10.3855	0.0007	0.00007
2	3	2	22.2737	22.2727	10.2317	0.0010	0.00010
2	4	2	23.5011	23.5006	10.4228	0.0005	0.00005
2	5	2	21.2918	21.2915	10.3599	0.0003	0.00003
2	6	2	22.1194	22.1191	10.3153	0.0003	0.00003
Control without rubber							
1	5		22.2516	22.2518		-0.0002	
2	5		21.5823	21.5825		-0.0002	

Annex 4

Temperature mapping of the two hotplates

Plate 1

Position

10	**9**	**8**
7	**6**	**5**
4	**3**	**2 1**

Plate 1	Erlen. No.									
Time (min)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
5	30	30	31	31	32	37	36	37	39	38
20	39	39	39	38	40	44	43	42	47	43
30	101	97,9	120	107	113	122	101	101	111	112
40	109	104	125	110	121	130	114	105	115	117
50	112	109	130	115	128	133	118	108	120	122
60	120	113	138	120	131	141	125	113	124	127
70	121	115	140	121	134	143	128	115	127	128
80	123	115	143	121	135	146	129	117	128	128
90	126	119	148	125	139	152	134	123	135	135
100	131	121	154	132	144	158	138	126	140	140
110	135	125	158	136	148	160	142	130	143	143
120	138	128	160	135	151	164	146	132	144	144
135	140	132	161	139	153	166	150	135	146	146
150	**144**	**134**	**162**	**140**	**156**	**166**	**150**	**136**	**148**	**148**

Plate 2

Position

10	**9**	**8**
7	**6**	**5**
4	**3**	**2 1**

Plate 2	Erlen. No.									
Time (min)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
10	36	35	35	37	42	40	39	45	59	47
25	38	37	37	40	41	40	43	53	62	47
35	128	130	125	148	131	132	134	131	137	124
45	133	136	130	152	135	137	136	138	141	128
55	135	142	135	159	165	144	139	162	146	138
65	141	147	137	163	169	149	143	167	151	138
75	143	150	138	165	170	151	144	169	152	140
85	145	150	140	166	170	153	145	170	153	142
95	145	152	140	166	171	154	147	170	154	143
105	146	153	141	167	171	154	148	171	155	144
115	146	153	141	167	172	154	148	171	156	145
125	146	153	141	168	171	155	148	170	156	145
140	147	154	142	168	172	154	148	171	156	145
155	**147**	**154**	**142**	**168**	**172**	**156**	**148**	**171**	**156**	**145**

Annex 5
Guide of Good Processing Practices

1. CHECKS SPECIFIC TO RUBBERS FROM FIELD LATEX

1.1. CHECKING IN THE FIELD

1.1.1 Tapping quality

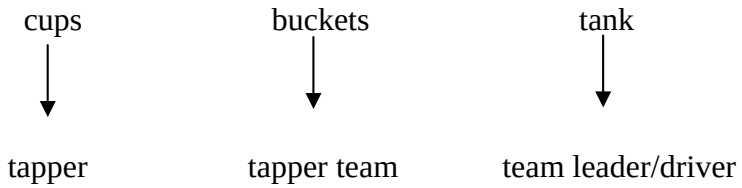
- any change in tapping system must be reported to the person in charge of quality and/or production
- check for contaminants (plant matter, minerals, termite tunnels, polluted cups, others), increase tapper awareness.

Even if tapping checks are the responsibility of the Exploitation/Plantation service and not of the Production/Processing service, it is important to mention this checking point, as poor tapping quality can lead to contaminants in latex that require subsequent treatment to remove them.

N.B.: a factory can convert good latex into a poor product, but cannot turn a bad latex into a good product.

1.1.2 Collection containers

- check that collection recipients are in "healthy" condition:



To avoid any contaminants entering the latex, respecting the cleanness and good condition of the equipment must be a basic rule. Everyone involved (tappers, team leaders, drivers) must be made aware of the importance of this procedure for his own equipment.

1.1.3 Filtration efficiency

Filter condition (cleanness, clogged holes)

- tapper bucket filter → weighing bucket
- weighing bucket filter → tank

Filtration in the field should remove a large share of contaminants. It is necessary to be aware of the importance of eliminating these contaminants at the plantation, to avoid having to do it during processing, which is more difficult and more expensive.

1.1.4 Quality of any added chemicals

- ammonia or other products (titration)
- tapper equipment (equipment for storing and handling chemicals).

Whilst the quality of chemicals is the responsibility of the factory laboratory, it is up to the tapper to check the condition of the equipment and report any defect.
At this level, it is important to define the responsibility for checking in the field:

- responsibility of the Laboratory
- responsibility of the Exploitation Service

1.2. CHECKING ON ARRIVAL AT THE FACTORY

In order to ensure the traceability of each batch of rubber, it is important for the factory to have perfect knowledge of the **origin of the latex received** (Latex identification: provenance, clone, tapping date and system, weighing). The important points to be checked are the cleanness of the equipment and homogenization efficiency. It is necessary to clearly define the responsibility for checks carried out by the factory laboratory, by the "delivery" service, and by the production staff.

- "healthy" condition of taps, ducts, pipes, reception chutes,
- filters (size, mesh, screen cleanness),
- "healthy" condition of reception and/or homogenization tanks,
- homogenization quality,
- correct operation of stirring system (rotation speed, paddle/tank dimensions, stirring time)
- sampling after homogenization for the factory laboratory (equipment, quantity).

1.3. COAGULATION CHECKS

As coagulation is considered to be a chemical treatment, the factory laboratory must have equipment enabling it to carry out the following checks:

- quantity and quality of chemicals added in the field
- determination of DRC before and after dilution (if working at constant DRC)
- pH measurement and acidification curve $\longrightarrow$ traceability document
- quality of chemicals:
  - * dilution water
  - * acids (formic, acetic)
  - * additives for CV, colour, etc.

The person in charge of production must check the following parameters:

- the cleanness of the coagulation tanks and piping
- respect of coagulation tank filling levels (possible checking of pH)
- appearance and checking of coagulum and serum (pH, DRC)
- the coagulation and maturation time prior to processing

Comments:

A key point is the quality of the acid/latex mixture, which will lead, or not, to a homogeneous coagulum, which is a quality required for obtaining a uniform product.

N.B : *After maturing, the coagulum is ready for processing. Care should be taken to ensure it is processed in chronological order of coagulation.*

2. CHECKS SPECIFIC TO CUP LUMP AND COAGULUM RUBBERS

These checks concern the collection, reception and pre-processing phases for cup lumps. It is essential to respect three points: equipment cleanness, elimination of contaminants and homogenization of the raw materials. The addition of chemicals to the cup must be carefully checked.

2.1 COLLECTION CHECKING

Cup lump and/or coagulum collection by the Exploitation Service must be checked by the various people involved (tappers, team leaders, drivers), which should make it possible to deliver "good quality" raw materials to the factory.

- "health" status of containers:
  * cleanness of cups
  * cleanness of tanks; collection recipients
  * storage area in the field (racks)
  * collection truck – condition of skip which might be used for other things.

- storage conditions in the field:
  * isolated from the ground and protected from sunlight and sources of contamination.

- elimination of visible contaminants at each stage from cup to reception:
  * leaves, petioles, wood, soil, sand, oxidized or polluted rubber.

- disaggregation of cup lumps and/or coagula

- tree scrap: collect separately, remove bark and deliver separately to the factory.

- cup lump and/or coagulum storage time in the plantation should be as short as possible.

2.2 CHECKING ON ARRIVAL

Good management of raw material reception is paramount for achieving consistency in rubber quality. Indeed, given the large number of producers and methods specific to each, the quality and volume of raw materials can vary substantially. It is therefore necessary to carry out "MACRO-MIXING" prior to processing to lessen that variability. This operation means indentifying and classing the different raw materials at specific storage sites and sending to the factory a clearly determined composition of raw materials, always in constant proportions, by mixing from the different batches in stock.

- quality evaluation:
  * weighing
  * visual examination after unloading and disaggregation,
  * nature and quantity of contaminants
    . wood, leaves, other plant matter
    . sand, stones
    . metals, PVC
    . polypropylene – polyethylene
    . draw up a check-list of possible contaminants
  * classification of cup lumps and/or coagula by degree of cleanness (sort to get rid of any rejects).

- cup lump and/or coagulum storage conditions at the factory: floor condition, protection from sunlight (concreted and sheltered area), avoid all contact with rain (leaching), puddles and mud.

- maturation time at the factory (minimum duration, maximum duration)

- fill the storage tanks correctly

- clean empty storage tanks before re-using them

- clean the storage areas

- take care to maintain a sufficient stock of raw materials to ensure regular supplies to the factory.
-

The raw material should be selected on as broad a basis as possible.

2.3 CLEANING/WASHING AND MIXING ⟶ FIRST STAGE OF PROCESSING

This concerns operations specific to cup lump rubber before the creping phase or final crumbing. The purpose of these operations is to wash the raw materials, whilst ensuring good mixing.

The following should be checked:

- quality of the water going into the washing/mixing tanks

- cleanness of the washing water in the mixing tanks

- cleaning of the washing/soaking/decantation/homogenization tanks

- cleanness of pre-cleaning and size-reduction equipment (slabcutter, prebreaker, bucket elevators, conveyors)

- maintenance documents (TRACEABILITY)
  * oil level - greasing ⟶ regular lubrication
  * all cutting elements must be regularly checked and sharpened
  * condition of counter-blades/knives/hammers/die plates
  * frequency of checks (in relation to tonnage)

- check that the pieces of rubber move freely in the tanks, mixing well with each other

- regular supplies to the machines

- homogenization and mixing.

3. PROCESSING OF LATEX, CUP LUMP AND/OR COAGULUM RUBBER

This section covers processing operations from the crepers up to drying; creping and crumbing help in cleaning and mixing the raw materials more finely ("MICRO-MIXING"). In practice, the production lines for latex rubber and for cup lump and/or coagulum rubber are separated, but the same type of machinery is involved (creper, crumber, shredder, dryer), with each line having it own settings defined by the processing procedures.

The operating instructions for each machine should be described in a procedures/instruction manual drafted for the factory in question.

NB: *as part of the MAINTENANCE programme each machine must have its preventive maintenance logbook. This is a particular document specific to the factory which defines the share of the verification procedure carried out by the production staff and the maintenance service.*

3.1 CREPERS

It is difficult to quantify the quality of crepe and creping. It can partly be done through the experience of the processor using appreciation criteria (visual or tactile) at the end of creping. However, the surest way seems to be to check machine operation for the following points:

- roller spacing

- groove condition
- rotation speed of the two rollers ⟶ friction ratio
- water supply
- nature and quantity of contaminants retained in the grooves
- cleanness of the machine (traces of oil)
- thickness, uniformity of crepe colour and texture.

To do that, verification periods should be defined (responsibility of the Maintenance or Production services).

Note: *For each batch, check and record the number of passes per machine in the event of manual processing.*

- check the quality of the water used
- ensure regular supplies to the crepers.

3.2 CRUMBING TOOLS

Creping and crumbing quality affects drying efficiency, so regular examination of the size, uniformity and cleanness of the crumb is essential.

The following should be checked:

- preventive upkeep (regular adjustments)
- feed water quality
- cleanness of feed tanks (before/after) and means of transport (belts, conveyors)
- water cleanness
- shredder: setting of the counterblade/condition of grooves
- hammermill: condition of die-plate and hammers
- rotary cutter: position of counterblades and condition of the die-plate (size of holes)
- extruder (condition of die-plate)
- frequency of water changes in the tanks
- evaluation of contaminants (weighing, identification)
- check circulation of the crumb in the tanks and prevent blocking/clogging or stagnation.

3.3 DRYING

Drying is an important operation in processing because poor drying can cancel out all the efforts made at the plantation and during upstream operations to maintain a satisfactory quality level. However, some drying problems (white spots, virgins) are due to crumb heterogeneity on entering the dryer and are nothing to do with the quality or operation of the dryer.

Any chemical treatments

Off-latex rubbers are treated in the homogenization tanks. All chemical treatment of rubber made from cup lumps and/or coagula is carried out between crumbing and drying, either by sprinkling/spraying, or by immersion/soaking of the crumb. In this case the following should be checked:

- draining time
- spraying or soaking time
- the quality of the chemicals (checking of solution concentration).

Operations prior to entering the dryer baskets

- check the loading equipment is clean (Vortex pump, ducts, vibrating screen, hoppers, baskets, trolleys)
- basket filling: check that basking filling height is respected and is uniform in all the compartments
- avoid any excessive agglomeration of crumb in the baskets (good aeration).
- check draining time before entering the dryer (maximum and minimum).

In the dryer:

- dryer instruments:
  * temperature sensor
  * hygrometric sensors (if there are any)
  * regulators/thermostats
  * timers (cycle durations).

All sensors of physical parameters must undergo regular calibration checks to avoid operating drift.

- thermo-mechanical functioning:
  * condition of burners (regular maintenance)
  * fans (verification of air speed)
  * check fuel quality.

- general condition of the dryer:
  * wall insulation
  * entry/exit of infiltrated air
  * condition of seals/flaps.

3.4 LEAVING THE DRYER / WEIGHING / PRESSING

This phase provides the end-product in the form of bales of rubber with clearly determined shapes and weights. The following should be checked:

- temperature of biscuit leaving the dryer (with portable probe) before pressing: check that dry crumb is cooled to below 50°C
- check for white spots and virgins (number, size) before and after pressing, by cutting the bale in two
- remove white spots. If there are many, the bales must undergo a special examination by the processing manager, who must check all the upstream operations
- check that the rubber leaving the dryer is not tacky
- weigh some "biscuits"
- check correct press loading
- check the shape of the pressed bale
- check balances and presses (regular calibration)
- check pressing pressure and duration
- check bale weight (from time to time)
- cut a certain number of bales (as prescribed) and inspect the inside
- detection of metal particles (periodic checking of detector operation)
- all bales must pass through the detector
- take samples to check production and specifications (see section IV), check they are taken from the prescribed bales and in compliance with the standard
- each bale must be wrapped in a polyethylene bag in accordance with specifications
- check that each bale is identified (marking).

3.5 PACKAGING / PALLETIZATION

This is the end-product packaging phase prior to shipment; bales are usually grouped on pallets of 36, placed in slatted crates (wood, metal or plastic).

Sometimes, bales are packed in shrinkable polyethylene. In that case, the condition of the wrapper needs to be checked.

- check there are no signs indicating the presence of insects
- for each pallet, check the condition of the base (nails) and of the wood, and the nature of the chemical treatments that need to comply with local legislation and that in the destination countries
- check how the pallets are stacked

- check that the internal bale temperature before packaging is not too high (risk of individual wrapper softening, and risk of bales sticking together in the crate)
- check pallet "shape" and stability
- identification of each pallet
- check the conditions of rubber storage on pallets (sheltered, well balanced position).