

# COMPUTERIZATION OF THE LABORATORY AT THE ILLOVO MILL

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## Abstract

The hardware and software used in the computerization of the Illovo mill laboratory are described. The implications for laboratory managements and possible future developments are also discussed.

## Introduction

Over the past few years the Sugar Industry Central Board (SICB) has been developing an automated cane testing system (AutoLab<sup>2</sup>) to capture data and produce reports with maximum accuracy and speed. This development was initiated at the Maidstone SICB laboratory and later extended to the mill laboratory, where a series of programs were written to cater for their specific needs.

The implementation of the AutoLab system at other mills throughout the industry necessitated the upgrading of hardware which in turn allowed a re-writing of the system's software due to a change in computer language.

The AutoLab system comprises three sections: data capture and storage, analytical control and a report generating facility. The experience gained by the SICB computer division from their AutoLab project was used in the design and development of the mill laboratory software system (MillLab). For the MillLab system it was decided to create a suite of programs that could be used at any mill within the South African sugar industry. To do this a completely flexible package was envisaged that would allow mill staff to configure the analytical and data input, access desired information, perform all necessary computations and then finally produce reports in any desired format.

The decision for the Illovo Mill laboratory to participate in the MillLab project with the SICB was taken towards the end of 1982 its implementation and development began during the 1983/84 season.

## System Hardware

Prior to the decision for the Illovo mill laboratory to participate in a computerized laboratory system, the major portion of the hardware had been installed under the current AutoLab project and had been in operation for approximately one season.

The installed system consisted of a Data General Eclipse S/140 mini computer with an operating capacity of approximately 750 Kbytes. Data is stored on a 25 Mbyte Winchester hard disk and is backed up by magnetic tape at the end of every fourth hour of operation.

An additional three VDU's with keyboards were purchased for the Illovo mill laboratory computerization, so that the data capture/recall and the report writing facilities of the MillLab system could be conveniently accessed.

To make use of the analytical control section of the system a 2,2 kg Sartorius electronic balance was purchased. In addition a pH meter and a digital output circuit board for the existing spectrophotometer were purchased so that both instruments could be interfaced to the computer for the start of the 1984/85 crushing season.

Analytical equipment belonging to the SICB was also utilised and the breakdown of each laboratory's equipment and usage is shown diagrammatically in Figure 1.

## Software

From the outset of this project, the software was designed to provide a sophisticated system that would offer sufficient flexibility, yet would require no knowledge or experience in computer programming to operate it. After the initial setting up of the options by the mill chemist, the systems would be routine and easy to use.

The main sections of the MillLab system comprise the following categories:

### Laboratory Analysis

The software required to execute the laboratory analyses is designed around the official methods as prescribed for the industry.<sup>1</sup> In the present system the mill chemist has the facility to apply any of the analyses shown in the following list to any factory product (e.g. clear juice) he may wish to define.

1	Brix	2	Polarisation
3	Dilution	4	Mass/Volume
5	Solids	6	Ash
7	Moisture	8	Fibre
9	Phosphate	10	Turbidity
11	Colour	12	Starch
13	Conductivity	14	pH
15	Chlorine	16	Sugar Trace Tests
17	Bagasse % Feed	18	Mud Solids
19	Gums	20	P.I. Preparation index
21	Grain Size	22	Reducing Sugars
23	Spec. Surface Area	24	Sucrose
25	Temperature		

When any of these analyses are set up the tolerances that are acceptable for its completion are also prescribed (e.g. maximum and minimum values for sample masses etc).

For analyses that require results to be interpolated from a calibration curve (e.g. starch, phosphate etc) use is made of coefficients to characterize the curve to complete the task. These coefficients can be changed when necessary by means of a linear regression routine.

### Data Access

All information stored within the computer can be accessed retrospectively for two weeks, after which weekly summaries only are available. The data access system allows the viewing of individual sample analyses (where a complete history of the tests performed and intermediate results obtained are recorded) to blocks of data in specific mill areas. In addition SICB information is also available to the mill.

### Report Generator

It is through this section that analyses that have been automatically entered into the computer can be presented in the form of a report for management information. The report writing facility is a simple word processor/editor type package that allows the user to print any available parameter (over 4000 data and calculated items) from the data files to any position on a page with any headings that are necessary.

An example of the type of complex report that can be generated by this section is shown in Appendix 1.

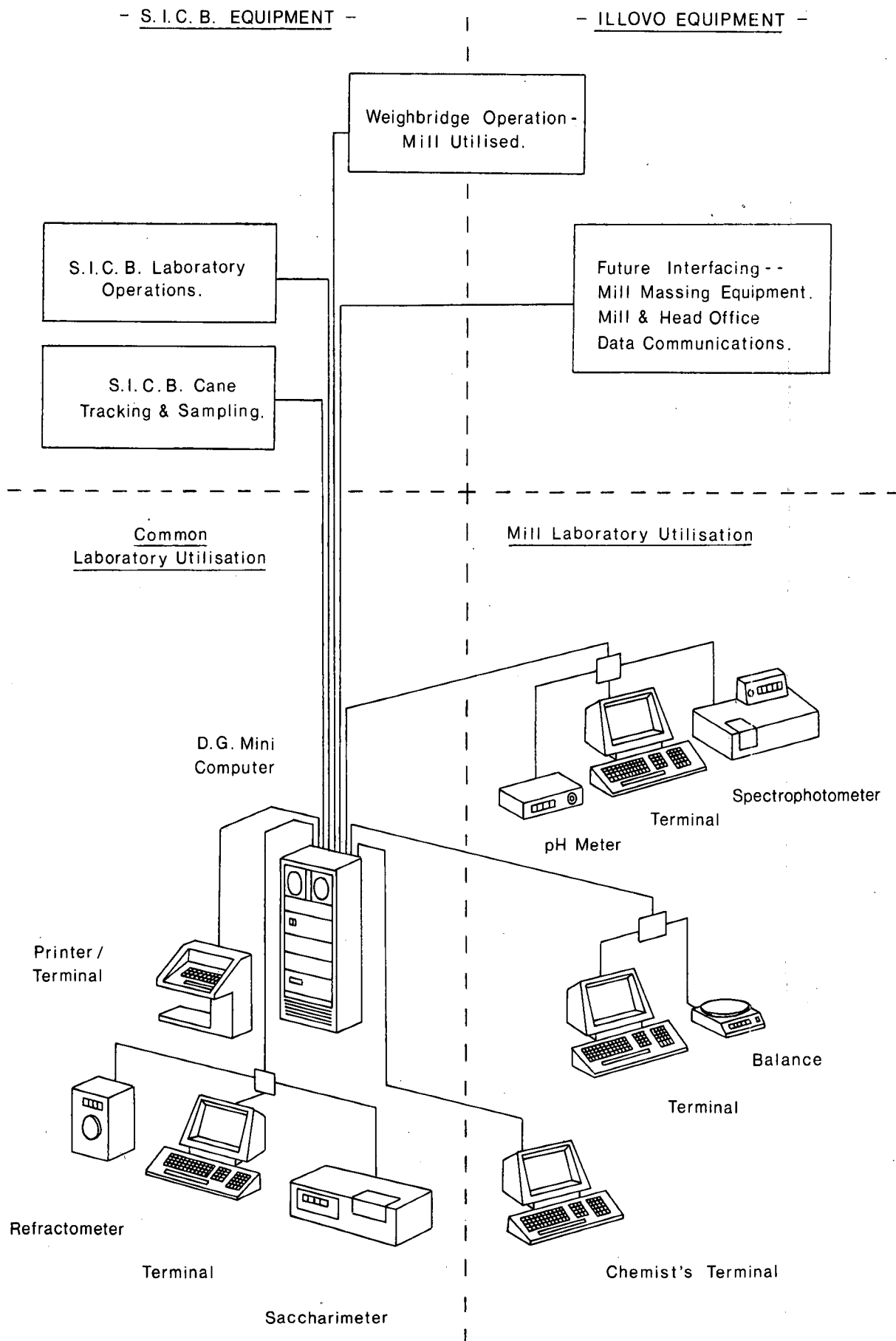


FIGURE 1 The equipment used by the two laboratories.

In addition to the normal analytical functions carried out by the mill laboratory there are also a number of other important laboratory tasks that have to be included. Of these, the following are available to augment the laboratory operation:

#### *Factory Stock Analysis*

This system computes the amount of stock in the factory from a minimum routine information by using previously entered data that characterize vessel shapes and volumes. After entering the figure "cms. out", the computer will calculate the volume and search the analytical files for the corresponding pol and brix % to establish the tons pol and brix. Together with previous stock figures and the data from the cane and mixed juice files, the overall factory performance is then calculated and reported.

#### *Stoppage Analysis*

By setting up a series of codes for plant areas and predefined stoppage types the system allows them to be inter-linked. This enables all stops to be placed in the correct down-time location by simply entering the required codes and the start and duration of the stoppage. This information is made available in the type of report shown in Appendix 2.

#### **Potential Benefits to be gained from MillLab**

The past few years have seen the introduction of automated control and a reduction in the staff in all parts of the factory. The laboratory has also followed the trend to reduce manpower and operating costs, and many mills have adopted the recommendations proposed by Mellet & Dunsmore<sup>3</sup> on the reduced sampling frequency of factory products. With the reduction in the laboratory staff and the number and frequency of the analyses, it is imperative that all remaining analyses are done accurately to ensure the necessary confidence in all results. The tools required to achieve these goals are provided in MillLab.

The potential benefits that emanate from MillLab can be categorized as follows:—

- (1) The mill chemist has a greater control over the laboratory tests that are done during a 24 hour period as the system retains a complete history of the analytical steps (and their corresponding times) carried out on any product (Appendix 3).
- (2) Because analytical equipment is interfaced to the computer and because a series of predetermined steps have been defined that must be followed before results can be entered, all analyses have to be done correctly. No sample record can be erased from the computer file.
- (3) A greater analytical accuracy is achieved as dilution ratios are precisely computed and applied. Consequently, the time to prepare samples for analyses can be reduced. Other analytical aids are also available, from direct grain size computation to mathematical interpretation of graphs and tables, to calculate final results.

- (4) The system can be used to replace the laboratory sheet. Hence, errors that occur during transcription and calculation are eliminated as information required for reports comes directly from the computer. This ensures that all reports are not only produced quickly but are less prone to human error.

Although not quantifiable, the above benefits have become evident during development and implementation of the system at Illovo. In addition the availability of data on demand has led to a better informed management.

#### **Future Developments**

During the 1984/85 season it is proposed to link the mixed juice scale to the computer and to record directly juice masses. Later, this will be extended to incorporate both molasses and sugar scales.

Another field of application is that of data communications. All information required by the mill supervisors and operators can be passed directly to the plant through a series of terminals sited in the factory. This has an additional benefit of not only being able to pass information to the plant as soon as analyses have been completed, but of relieving laboratory staff from the tedious task of updating performance boards.

With the introduction of a modem interlink it could also be possible to transfer reports and other data directly to centralized head office management which would ensure that the information they require is accurate and timeously received.

#### **Conclusion**

The MillLab data capture system is sufficiently flexible and sophisticated to cater for the requirements of mill laboratories in the South African sugar industry. The system allows the mill chemist to ensure that analyses are done accurately and in accordance with the official methods prescribed for the industry.

MillLab offers a relatively inexpensive means (Appendix 4) of upgrading a laboratory from a manual operation to a computer controlled system. A major portion of the cost is carried by the SICB which provides the computing power and the basic package.

#### **Acknowledgements**

The author wishes to thank the software division of the SICB especially Messrs. P. Paine and M. Winship without whose software expertise this project would not have been possible.

#### **REFERENCES**

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2. King S., East, E. P. and Winship M. (1981). AutoLab — A progress report. *Proc S Afr Sug Technol Ass* 55: 67-70.
3. Mellet, P. and Dunsmore, A. (1983). The effect of reduced frequency of sampling and analysis at sugar mill laboratories. *Proc S Afr Sug Technol Ass* 57: 52-55.

APPENDIX 1: Report produced by report generator

TECHNICAL SERVICES DIVISION - C.G. SMITH SUGAR LTD.												DATE : 83/09/18					
RAW HOUSE REPORT												MILLOVO MILL					
WEEK												TO-DATE		WEEK		TO-DATE	
WEEK No. 23																	
FROM: 83/09/12																	
TO: 83/09/18																	
PRODUCTS:	POL	MOIST.	PURITY	FIBRE	ASH	ERC	POL	MOIST.	PURITY	FIBRE	ASH	ERC	TONS:				
CANE	12,75	70,24	83,36	14,46	1,84	10,82	13,60	68,94	84,54	14,98	1,49	11,67	CANE	28864	600404		
BAGASSE	1,15	53,34	54,42	44,55	3,82	-	1,33	54,12	60,48	43,69	2,32	-	SUGAR (mte)	6260	70407		
FILTER CAKE	1,34	76,06	-	RET.	86	-	1,38	74,93	-	RET.	82	-	MOL. (85)	2433	25612		
	POL	BRIX	PURITY	RS %	RS/ASH	TPD	POL	BRIX	PURITY	RS %	RS/ASH	TPD	WOOD	0	413		
														0	282		
FINAL MOLASSES	-	-	-	-	-	-	-	-	-	-	-	-					
													RATIOS:				
SUGARS:	POL	MOIST.	TONS	SUGAR QUALITY			POL	MOIST.	TONS	SUGAR QUALITY			EXTRACTION	97,10	96,71		
VHP HULETTES	199,32	0,128	3068	VHP	G.B.	199,40	0,126	63101	VHP	G.B.	199,40	0,126	IB.H.R.	88,81	88,65		
VHP TERMINAL	0,001	0,000	-	STARCH	110	-	199,43	0,119	3371	STARCH	120	-	IO.R.	86,30	85,73		
VHP GOLDEN SYR.	199,34	0,127	170	IFINES	42	-	199,48	0,120	2809	IFINES	36	-	IF.P.1.	101,04	99,36		
GOLDEN BROWN	-	-	-	S.G.S.	0,55	-	-	-	-	S.G.S.	0,59	-	CANE/SUGAR	9,02	8,33		
VHP SYRUP SPEC.	199,37	0,110	6	COLOUR	2333	-	199,53	0,188	59	COLOUR	1573	-	C.R.E.	96,86	96,43		
													CANE/HOUR	189,52	184,96		
TOTAL	199,32	0,128	3244				199,41	0,125	69340				FIBRE/HOUR	27,40	27,78		
													IMB. % FIBRE	433	395		
JUICES:	BRIX	PURITY	PTY DIFF	RSR	RSR D	pH	BRIX	PURITY	PTY DIFF	RSR	RSR D	pH	PREP. INDEX	89	87		
MIXED JUICE	11,13	84,70	-	4,79	-	5,7	12,33	85,70	-	4,94	-	5,6	MOL. CANE (85)	4,31	4,27		
FILTRATE	8,94	83,59	-1,11	3,89	-0,90	8,0	9,05	83,68	-2,02	2,61	-2,33	7,8	IF. CAKE/CANE	1,19	1,16		
CLARIFIER FEED	-	-	-	-	-	-	-	-	-	-	-	-	S.SOLID % MJ	0,11	0,14		
CLEAR JUICE	10,98	84,48	-0,22	4,75	-0,04	7,2	12,16	85,29	-0,41	5,06	0,12	7,1	NON-FOL	1,07	1,08		
SYRUP	163,09	84,53	0,05	4,84	0,05	6,2	165,62	85,26	-0,03	5,39	0,45	6,2	RECIRCULAT.	115	114		
BOILING HOUSE:	BRIX	PURITY	PTY DIFF	EXH.	M3/TBx	in MJ	BRIX	PURITY	PTY DIFF	EXH.	M3/TBx	in MJ	DAC POL FAC.	99,66	99,30		
IA-MASSECUITE	192,14	84,76	0,23	63,21	0,96	192,29	85,45	0,19	64,57	0,96	192,29	85,45	DAC BX FAC.	100,88	100,20		
IA-MOLASSES	166,04	67,17	-17,59	-	-	169,05	67,54	-17,91	-	-	169,05	67,54	MJ-DAC PTY	0,33	0,40		
IB-MASSECUITE	194,55	67,77	0,60	64,26	0,35	194,02	68,02	0,48	65,05	0,34	194,02	68,02	MJ POL/SUC	-	-		
IB-MOLASSES	165,88	42,90	-24,87	-	-	167,98	42,64	-25,38	-	-	167,98	42,64	TIME ACCT.:	-	-		
IC-MASSECUITE	197,00	52,41	9,51	47,47	0,26	195,98	52,01	9,37	48,12	0,24	195,98	52,01	IO.T.E.	90,65	85,64		
IC-MOLASSES	183,76	36,32	-16,09	-	-	183,93	35,99	-16,02	-	-	183,93	35,99	LOST TIME/AVAIL	4,79	7,74		
INTER. PRODS:	BRIX	PURITY	C-NUTSCH	PTY	PTY D	TEMP	BRIX	PURITY	C-NUTSCH	PTY	PTY D	TEMP	MECH. EFF.	98,70	96,05		
IB SUGAR	198,55	91,09	STRIKE	41,50	-10,91	-	198,54	90,70	STRIKE	40,70	-11,31	-	% MECH.	1,19	3,52		
IC SUGAR	196,63	84,22	COOLED	33,19	-8,31	-	196,80	85,02	COOLED	33,95	-6,75	-	% OPERATION	3,37	3,66		
			REHEAT.	33,88	0,69	-			REHEAT.	34,70	0,75	-	% SCHEDULED	3,57	5,16		
			CENTRIF.	36,32	2,44	-			CENTRIF.	35,99	1,29	-	NO. OF STOPS	25	564		
													NO CANE	2,04	76,57		
													RAINFALL (mm)	0,0	319,9		

TECHNICAL SERVICES DIVISION - C.G. SMITH SUGAR LTD.												DATE : 83/09/18					
RAW HOUSE REPORT												MILLOVO MILL					
WEEK												TO-DATE		WEEK		TO-DATE	
WEEK No. 23																	
FROM: 83/09/12																	
TO: 83/09/18																	
POL LOSSES:	% MJ	% CANE	T. POL	T. BRIX	T. N/P		% MJ	% CANE	T. POL	T. BRIX	T. N/P		CHEMICALS:				
BAGASSE	-	2,83	107	196	89		3,29	2687	4443	1756			LIME (kg/TC)	0,73	0,71		
FILTER CAKE	0,12	0,11	5	5	0		0,12	95	114	19			FLOCC (ppm MJ)	4,11	3,35		
MOLASSES	10,73	10,42	751	2067	1316		9,92	9,60	7835	21770	13935						
MUNDET. LOSS	0,33	0,33	24	-82	-58		1,30	1,26	1027	-98	-929			H3PO4 (ppm MJ)	0,00	2,92	
ACTUAL U/LOSS	0,27	0,26	18,7	-	-		-	-	-	-	-			ENZYME (ppm MJ)	57,50	19,70	
LOSS CONTROL	ENTR.	EFFLU.	PACKING	TOTAL			ENTR.	EFFLU.	PACKING	TOTAL			TANDEM A		TANDEM B		
TONS POL LOST	1,0	4,3	-	5,3			-	-	-	-							
MILLING / DIFFUSION												TANDEM A		TANDEM B			
BRIX, pH & TEMP. PROFILES - WEEK -						BRIX, pH & TEMP. PROFILES - TO-DATE -						WEEK		TO-DATE			
14-	+++++					14-	+++++					TONS CANE / HOUR	28864	600404	-	-	
12-	+++++					12-	+++++					TONS CANE / HOUR	189,52	184,96	-	-	
10-	+++++					10-	+++++					TONS FIBRE / HOUR	27,40	27,78	-	-	
8-	+++++					8-	+++++					ASH % CANE	1,84	1,49	-	-	
6-	+++++					6-	+++++					ASH % BAGASSE	3,82	2,32	-	-	
4-	+++++					4-	+++++					EXTRACTION	97,10	96,71	-	-	
2-	+++++					2-	+++++					IC.R.E.	96,86	96,43	-	-	
0-	+++++					0-	+++++					IMBIBITION % FIBRE	433	395	-	-	
16,0-	+++++					16,0-	+++++					IPOL % BAGASSE	1,15	1,33	-	-	
15,0-	+++++					15,0-	+++++					MOIST. % BAGASSE	53,34	54,12	-	-	
14,0-	+++++					14,0-	+++++					IFREP. INDEX	89	87	-	-	
12,0-	+++++					12,0-	+++++					RES. JUICE PTY.	54,42	60,48	-	-	
10,0-	+++++					10,0-	+++++					IO.T.E.	90,65	85,64	-	-	
8,0-	+++++					8,0-	+++++					LOST TIME % AVAIL.	4,79	7,74	-	-	
6,0-	+++++					6,0-	+++++					MECHANICAL EFF.	98,70	96,05	-	-	
4,0-	+++++					4,0-	+++++					NUMBER OF STOP	25	564	-	-	
2,0-	+++++					2,0-	+++++					IPOL FACTOR	99,66	99,30	-	-	
0,0-	+++++					0,0-	+++++					IDRAUGHT JUICE pH	5,7	5,6	-	-	
	SJ 1 2 3 4 5 6 7 8 9 1 P 1 1						SJ 1 2 3 4 5 6 7 8 9 1 P 1 1										
	DIFF. CELL NUMBERS 0 W 1 2						DIFF. CELL NUMBERS 0 W 1 2										
MAJOR STOPS:	HOURS	MINS.	REMARKS									M.M.					
NO CANE	2	02										P.M.					
MILLS 'L' CARRIER TRIP	1	25										LAB.					
REPAIRS-EXHAUST LINE	1	30															
BOILER 'E' CONVEYOR TRIP	1	15															

**APPENDIX 2: Typical stoppage report**

STOPPAGE WEEK NO: 33		SUGAR INDUSTRY CENTRAL BOARD - WEEKLY STOPPAGE REPORT						PAGE : 1 REPORT DATE : 84/03/21 TIME : 12.52.35				
PLANT		TYPE OF STOPPAGE		TANDEM 1				TANDEM 2				
				WEEK		TODATE		WEEK		TODATE		
				TYPE	HRS	%	HRS	%	HRS	%	HRS	%
MAIN CARRIER		BOULDERS		22	1.20	33.47	1.20	33.47				
		SUBTOTALS :			1.20	33.47	1.20	33.47	0.00	0.00	0.00	0.00
No.1 CANE KNIVES		CHOKE		14	0.30	12.55	0.30	12.55				
		TRAMP IRON		22	0.08	3.35	0.08	3.35				
		SUBTOTALS :			0.38	15.90	0.38	15.90	0.00	0.00	0.00	0.00
SHREDDER		CHOKE		14	0.05	2.09	0.05	2.09				
		BEATER BAR		21	1.00	25.10	1.00	25.10				
		SUBTOTALS :			1.05	27.20	1.05	27.20	0.00	0.00	0.00	0.00
'1' CARRIER - MILLING		REPLACE CHAINS		13	0.08	3.35	0.08	3.35				
		SUBTOTALS :			0.08	3.35	0.08	3.35	0.00	0.00	0.00	0.00
DIFFUSER		REPAIRING CHAIN		13	0.35	14.64	0.35	14.64				
		SUBTOTALS :			0.35	14.64	0.35	14.64	0.00	0.00	0.00	0.00
No.1 BOILER		LOW STEAM - SLOW FEED		17	0.13	5.44	0.13	5.44				
		SUBTOTALS :			0.13	5.44	0.13	5.44	0.00	0.00	0.00	0.00
		TOTAL STOPS :			3.59	100.00	3.59	100.00	0.00	100.00	0.00	100.00

STOPPAGE WEEK NO: 33      SUGAR INDUSTRY CENTRAL BOARD - WEEKLY STOPPAGE REPORT      PAGE : 2  
MILL NAME: C G SMITH ILLOVO      REPORT DATE : 84/03/21  
TIME : 12.52.35

SUMMARY OF WEEK AND TO-DATE STOPPAGES

	TANDEM 1		TANDEM 2	
	WK	T/D	WK	T/D
10 CANE OFF-LOADING	0.00	0.00		
11 CANE PREPARATION	0.00	0.00		
12 MILL/DIFF. & DRIVES	0.00	0.00		
13 CARRIERS / CONVEYORS	0.43	0.43		
14 CHOKE/TRIP/SLIP	0.35	0.35		
15 FLOODING	0.00	0.00		
16 PUMPS	0.00	0.00		
17 LOW STEAM	0.13	0.13		
18 PROCESS	0.00	0.00		
19 ELECTRICAL	0.00	0.00		
20 VARIOUS MECHANICAL	0.00	0.00		
21 VARIOUS OPERATIONAL	1.00	1.00		
22 FOREIGN OBJECTS	1.28	1.28		
91 LINKING UP WITH CANE	0.00	0.00		
92 STEAM PROBLEMS	0.00	0.00		
93 BAGASSE PROBLEMS	0.00	0.00		
94 BACKEND PROBLEMS	0.00	0.00		
95 MILLING PROBLEMS	0.00	0.00		
96 DIFFUSER PROBLEMS	0.00	0.00		
=====				
1 NO CANE	0.00	0.00		
2 SCHEDULED	0.00	0.00		
3 OPERATIONAL	3.16	3.16		
4 MECHANICAL	0.43	0.43		
8 OTHERS	0.00	0.00		
9 SLOW	0.00	0.00		
=====				
TOTAL (ALL STOPS)	3.59	3.59	0.00	0.00
HOURS CRUSHING	44.01	4498.01	0.00	0.00
TOTAL HOURS	48.00	4502.00	0.00	0.00
=====				

SUMMARY OF PERCENTAGES & OVERALL EFFICIENCY

	TANDEM 1		TANDEM 2		TOTAL	
	WK	T/D	WK	T/D	WK	T/D
1 NO CANE	0.00	0.00	0.00	0.00	0.00	0.00
2 SCHEDULED	0.00	0.00	0.00	0.00	0.00	0.00
3 OPERATIONAL	6.80	0.07	0.00	0.00	6.80	0.07
4 MECHANICAL	1.49	0.01	0.00	0.00	1.49	0.01
8 OTHERS	0.00	0.00	0.00	0.00	0.00	0.00
9 SLOW	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL (ALL STOPS)	8.29	0.08	0.00	0.00	8.29	0.08
=====						
OVERALL EFFICIENCY	91.70	99.91	0.00	0.00	91.70	99.91
TONS CANE PER HOUR	117.06	183.45	0.00	0.00	117.06	183.45
TONS FIBRE PER HOUR	20.51	27.74	0.00	0.00	20.51	27.74

APPENDIX 3: Information available on a typical analysis

SAMPLE NUMBER : 2566                      PRODUCT CODE : 4001  
 WEEK NUMBER : 33                      DAY NUMBER : 2                      HOUR : 9  
 DATE/TIME : 831122091201                      NON-TEST CODE : 0

REFRAC      20,11 BRIX              60,40 TIME      10.10.42  
 SACC              67,12 POL              48,50 VOL DIL      1,00 TIME      10.10.31  
 BOWL                      B/MASS      170,09 PD/MASS      100,01 W/MASS      200,35 TIME      09.12.00  
 OD/UNFIL      0,000 COL/CON      0,00 CEL/LEN              0 COLOUR              0 TIME      00.00.00  
 OD/STRCH      0,000 OD/BLAN      0,000 ALIQUOT              0 DIL/FAC              0 STARCH              0  
 TIME      00.00.00  
 SMP/MASS      25,08 DILUT              3,00 TIME      09.16.30 R.S.R.              3,02 TIME      15.20.21

APPENDIX 4

Equipment costs to computerize the Illovo Mill Laboratory

1	Data General VDU and Keyboard	3 off	R 8 400
2	Additional 64 KBytes of memory to accommodate VDU and keyboard	2 off	R 2 500
3	Cabling and additions to computer		R 1 590
4	Sartorius 2 200 gm balance	1 off	R 1 800
5	Orion pH meter with digital output facility	1 off	R 848
6	BCD Output Board for a Unicam Spectrophotometer	1 off	R 239
7	Interface controller for the pH and spectrophotometer	1 off	R 300
			<u>R15 677</u>