CONTROLLED PLANT OPERATION IN THE SOUTH AFRICAN SUGAR INDUSTRY

by G. C. Sheppard

Three years ago Mr. H. E. Hastings presented a paper to our Association describing planned or preventive maintenance procedures, suitable for the control of engineering work in the sugar industry. These procedures have since been introduced at a refinery and at some six sugar mills where they are achieving a measurable degree of success.

The purpose of presenting this paper today is to describe a second stage in improving control and reducing costs in the Sugar Industry. This relates to a system of scheduled process operations, to labour control and training, and to quality control, all of which have been successfully applied to various processes in other industries. They are now beginning to bear fruit in the Sugar Industry.

We believe from our experience in process operations both in the Sugar Industry and elsewhere, that this approach is an essential counterpart to preventive maintenance and can be profitably applied to sugar processing plants.

To indicate the dimension of this problem let me refer you to a large sugar factory where five to six hundred non-Europeans are employed at a wage cost of about £60,000 per annum. About half of these operators contribute directly to the quality and quantity of the finished product. The remaining half are employed on non-operating manual work.

It is clearly in the best interests of management to take all possible steps to train this labour with a view to improving standards of process control, cleanliness and operator maintenance. The successful application of a scheme such as I propose to describe today will, firstly, provide an effective basis for improving the quality of operation and, secondly, a means of reducing labour costs. The scheme also provides opportunities for the payment of incentive bonuses to reward operators, both European and African, for increased plant efficiency where incentive payment is management policy. The logical result of this reorganization is to increase profits and to improve the remuneration of the employees remaining in service.

Although a tremendous amount of money is invested in sugar milling and refining plant and equipment, the whole industry of sugar manufacture depends for its success upon human factors—the judgment of directors, the administrative ability of managers, the technical skill of engineer and process specialists, and so on.

Those of us closely associated with the industry are acutely aware of two problems in this respect, namely the relatively unspecific instructions given to non-European operators as to what is required from them and a resultant looseness in definition of duties and responsibilities for supervisors.

You will all have had experience of this situation. Operators take jobs over with general verbal instructions from predecessors whose own ideas of the job are vague. When different people in the same or different plants are questioned regarding these duties, the variation in reply is startling.

A single effective method of specifying exactly what is to be done, operation by operation, throughout a plant, with a follow-up procedure to ensure that the correct standards are observed, will obviously offer the industry improved efficiencies and reduced costs. Moreover, the duties of supervisors can then be dimensioned and the best obtained from these key men.

This paper describes such a system. Its name is "Standard Operating Control". It is simple to introduce and easy to run. It consists primarily of crystallising the industry's experience into a set of fundamental rules and instructions.

The control system has been designed to:

(*a*) Obtain maximum utilization of labour and machinery under the variable conditions found in a process plant.

(*b*) Standardize operating procedures and improve process controls.

(*c*) Promote plant cleanliness.

(*d*) Provide indicators for management to take immediate corrective action when standard conditions are not being maintained.

(*e*) Form a sound and permanent basis for operator training.

(*f*) Improve operator effectiveness and engender enthusiasm by clearly defining actions and responsibilities.

(*g*) Determine accurate labour requirements.

(*h*) Form the basis for equitable incentive bonus payments where required.

The sequence of steps in the development of a control system is as follows, and specimens of the so-called "schedules" and "check lists" will be discussed later.

The number and current distribution of direct operators in relation to the process is determined by interrogating the operators themselves and from discussions with their supervisors. A preliminary survey is then made of the plant to record the shortest route each operator should take in order to inspect every process unit under his control without duplication. This route is plotted on a schematic diagram to ensure that the whole section area has been covered. The route is then divided into convenient sub-sections of particular control significance.

A list is then made of the "key points" or "indicators" necessary for effective plant and quality control. The time to carry out each inspection is assessed, but the frequency of inspection and the operator responsibility is not specified at this stage.

OVERSEERS CHECK SHEET.

SECTION: JUICE HEATERS. Date .... 19 ....
N.B.:

INITIAL UNDER THE RELEVANT SHIFT IF OPERATING PROCEDURE IS CORRECT AS LAID DOWN.

		12 - 8		8 - 4		4 - 12		COUNTER - SIGN.	
		✓	SIGN	✓	SIGN	✓	SIGN	✓	SIGN
1. Heater steam pressure: B2	I								
6 - 8 p.s.i. : B3	I								
: B4	I								
: B5	I								
: B6	I								
: B7	I								
2. Juice Temperature 210° - 215° F	I								
3. Shut down heater No.	I				X		X		
4. Shut down heater cleaned and checked effectively	I				X		X		
5. Juice pipe cocks greased	I								
6. Floors clean. (Day Shift)	I		X				X		
7. Heaters clean. (No.2 Shift)	I		X				X		
8. Piping clean. (No.1 Shift)	I				X		X		
9. Structure and walls clean (Day Shift)	I		X				X		
10. Hand-rails and steps clean. (No.1 Shift)	I				X		X		
11. Four effective scrapers provided	W								
12. No steam/spillage leaks	W								
13. Units lagged and painted	I								
14. No Live steam used	I								

SPECIAL CLEANING/PAINTING INSTRUCTIONS.

ITEM/UNIT	DETAILS OF WORK	PROGRESS.

REPORT ON FAULTY ITEMS:

ITEMS FOR JOB REQUESTS:

DANGER: DO NOT CLEAN MOVING MACHINERY.

Fig. 1

During the preliminary survey, the general plant condition is assessed in conjunction with supervision. Attention is paid to:

(*a*) Prevention of splash, leakage, dust and spillage.

(*b*) Accessibility.

(*c*) Facilities for the disposal of dirt.

(*d*) Provision of simple automatic devices to relieve operators of onerous checking duties.

(*e*) Safety.

As the investigation proceeds methods studies are undertaken. Consideration is given to plant and equipment alterations and modifications which can result in improved operation or reduced labour cost. Certain of these modifications can be carried out immediately. In the majority of cases however, a concise report is prepared with the engineer for management indicating the cost and benefit of such changes. The agreed projects are suitably programmed and followed through to completion.

Operation specifications are developed for every portion of the plant requiring operator inspection or control. Each specification is subdivided into "key-points" which are the individual operations that must be performed at pre-determined intervals of time. Limits are defined as they occur.

Operating Schedules consist of four main parts, namely:

1. Routine operating duties.
2. Maintenance to be carried out by the operator.
3. Cleaning responsibilities.
4. Corrective action to be taken where abnormal conditions are encountered.

A specimen schedule for juice heaters is shown in Table 1. Each item in sequence of operation is detailed to leave no doubt as to how the job should be carried out and what corrective action should be taken. Cleaning duties and the responsibility for carrying them out are clearly defined.

Standard times are established for the scheduled elements of work either by actual study or by estimation. The frequency or period between the carrying out of elements of maintenance and cleaning tasks is established by discussion with management and by study of the process. The established times are then multiplied by their frequencies and the volume of work necessary for the effective running of each section is determined.

Appropriate rest allowances are made and the size of the section allocated to an operator is governed so as to load him for about 75 per cent of the working shift. He is thereby given an allowance for contingencies amounting to approximately 25 per cent of his working time.

The total number of scheduled check points in one operator's section can be as high as 200 per shift. To assist the operator to cover all these points effectively, the routine work for each shift is time-tabled hour by hour to form a job operating sequence. Where jobs occur intermittently during the shift, an allowance is made to permit their execution.

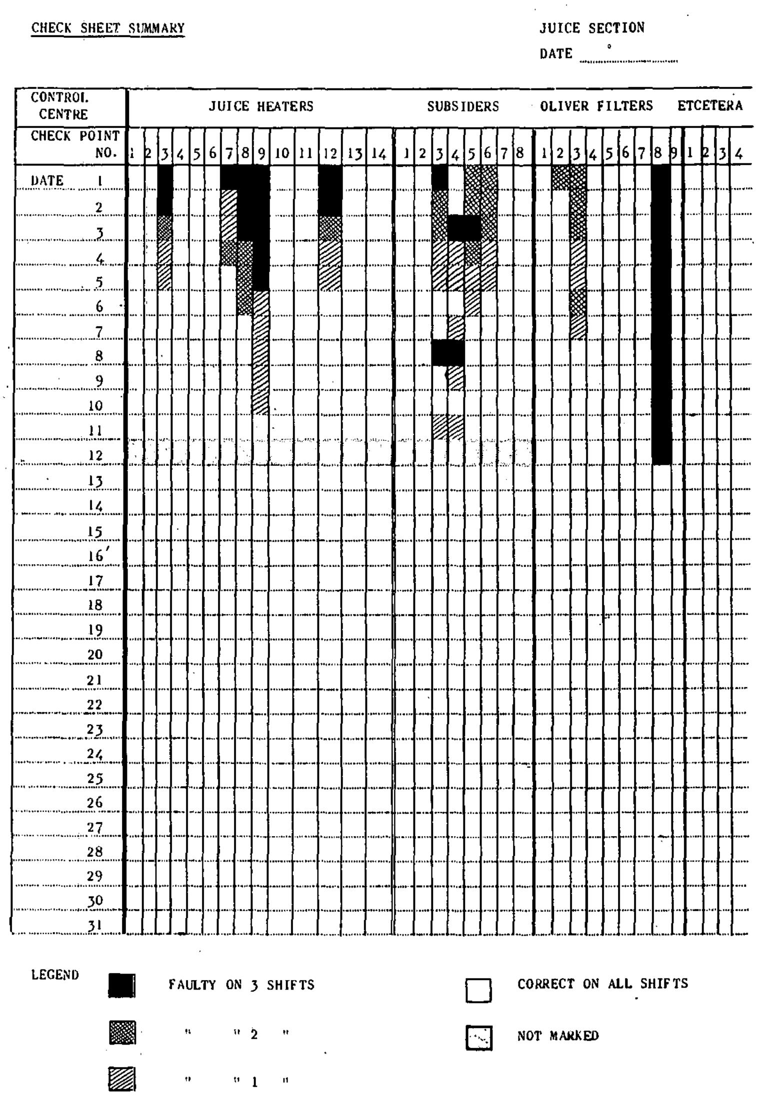

Fig. 2

The next step is to train the operators to carry out their duties as specified in the schedules. Suitable instructors are appointed, preferably from the existing staff of sirdars and boss-boys. Their duties are to instruct operators, section by section, to indoctrinate novices and to return to sections to put the operators right if their work deteriorates. Copies of the operating schedules are displayed in each section on permanent glass-covered notice boards.

A check sheet is compiled in the form of a questionnaire for each control centre by listing the scheduled items. A specimen check-sheet is shown in Fig. 1. Each point must be sufficiently clear to permit an answer "Yes" or "No". Some points, which may be of particular operating importance, are "blocked" to attract attention. Under incentive conditions these points carry prescribed penalties if they are not in order.

During every shift the shiftsman, records his assessment of each check point by making a tick (√) if satisfactory or a cross (×) if unsatisfactory and certifying by his signature. Space is provided for acknowledgement by his senior official. The shiftsman also records any faulty conditions, such as leaking pipes, broken windows, etc. with their location. A Works Order is passed to the engineering department requesting the necessary repairs.

A letter code "I" and "W" is included at the side of the check sheet opposite each check point to indicate the foreward action required if the shiftsman has marked it with a cross. "I" indicates that the instructor should correct the operator, "W" indicates that the engineering department should be notified for examination.

Routine over-checking is the responsibility of a senior official to ensure consistant assessment by shiftsmen.

Each check sheet is mounted in a locked frame placed within the most important position in the section to which it refers. The sheet can only be marked by a personal visit to every part of the plant at least once per shift. This ensures that the shiftsman visits each section regularly.

Check sheets are changed daily and the data is summarised on a "Summary Chart" (Fig. 2) which indicates pictorially the condition existing at each check point in every operator's section. The chart shows a daily picture over a period of one month.

Each check point is represented by a block on the chart for each day of the month. Shades of black are used for ease of interpretation. "Black" if faults are repeated on all three shifts of the day, "Cross hatch" indicates faults for two shifts, and "Single hatch" faults reported for one shift. Where check points have not been inspected by the shiftsman, the space is "Stipple hatched".

Special attention is focussed on check points shown faulty for any length of time. This is done by the formation of vertical black bars on the chart. Management regularly selects faulty points for correction by the shiftsmen or artisans. These points are signified by red pins on the chart. They are entered by the planning officer on a report to the officials concerned for the necessary action. Instructions for special cleaning and painting are given in a similar manner, and times are set for carrying out abnormal work.

The success of standard operating control derives largely from the elimination of non standard practices. It is advisable to effect this improvement one section at a time until the whole plant has been covered.

The process manager pre-plans daily the units to be run the following day. Check points referring to units not run are crossed off the check sheet. For purposes of calculating performance percentages the remaining number of check points are termed the "credits possible" and the number of check points ticked by the shiftsman are the "credits earned".

The trend of operating efficiencies is determined weekly by calculating the effective labour performance for each section, department and the whole plant. This calculation is made by expressing the sum of the standard times for credits earned as a percentage of the operators' available time. The effective hours worked and the performance percentages are graphed to give a continuous indication of trends.

The records maintained provide a sound basis for the payment of incentive bonuses, to European and non-European staff. Premiums are payable on a scale commensurate with the percentage performance achieved by each operator and for items such as fuel conservation, recovery, purity or output from a particular section. Penalties may be debited to individuals in the form of pre-determined penalty rates for salient check points. Individual penalties can be applied at the discretion of the process manager or engineer on recommendation of the shiftsmen or other officials.

The establishment of operating controls automatically sets the process labour complement. At the same time a positive move is made to ensure that tasks are carried out effectively, and that management is provided with up-to-date information on the weak points in the organization. With this additional measure of quality control, management can confidently reduce labour with full assurance that the running of the plant will not deteriorate.

TABLE I. (Procedure No. J.S. 8.)

OPERATING SCHEDULE FOR JUICE HEATERS

Plant Inventory numbers B3 to B7

IMPORTANT STEPS	KEY POINTS
	A. Operating
Steam Pressure	1. Check that steam pressure on each heater is 6-8 p.s.i.
Juice temperature	2. Check that temperature recorded on the juice pipe line to the flash tank is between 215° and 220°F.
Clean Heater:	3. On the 12-8 shift shut down the next heater to be cleaned.
	4. Start up reserve heater if not already in operation.
	5. Move board inscribed "to be cleaned" to the next heater due for cleaning.
	6. Drain juice from heater.
	7. Remove end covers.
	8. Dry out scale by steam heating.
	9. Clean out tubes with the 4 scrapers provided.
	10. Steam test heater for leaks.
	11. Replace end covers securely.
Recorder charts.	12. Replace charts.
	13. Ink pens.
	B. Corrective Action
Incorrect Juice temperature.	1. Regulate and equalise exhaust steam pressure on all operating heaters and adjust steam valves by turning anti-clockwise to raise pressure and temperature and turning clockwise to lower them.
Low temperature.	2. Start up additional heater if available.
	3. Augment exhaust steam with live steam and advise overseer who will check flow of exhaust steam to heaters.
Use of live steam.	4. Report to Overseer.
Leaking heater.	5. If heater is leaking report to Overseer, then take heater off range, drain off juice, open end covers in order to locate leak.
Overseer's report.	6. If fault is serious report to Engineer, Process Manager or Factory Manager.
Sugar in condensed water (Routine Laboratory Test).	7. Run water to waste and test heaters individually for leaks.
	C. Cleaning
Heaters and piping.	1. Brush down heaters and piping with a soft broom.
Floors, steps and handrails.	2. Hose down and brush with bass broom.
Supporting structure and walls.	3. Brush down with soft broom or bass broom as required.
	D. Maintenance
Lubrication: 2D.	1. Grease cocks on juice pipes (4 per heater) at the beginning of shift.

The President said that his first impression of such a scheme operating in a sugar factory was that it was a very useful way of controlling the labour providing the factory was running according to plan. He wanted to know what would happen if something quite unforeseen happened. For example one could imagine the mill stopping and the boilers running out of fuel. If all departments had been cut down to a minimum where would the labour come from to carry fuel?

Mr. Sheppard said that in the first place the management would have to decide what to do, but when a tight labour complement had been established allowance should be made for such a contingency. A labour pool would be established so that some extra labour could be brought out in the case of an emergency. This pool would normally amount to about 5 per cent of the total labour complement. It would do some intermittent work and would be available for use in an emergency. Generally speaking there was always a certain proportion of labour in and around a plant which could be taken away from routine work for a limited period of time if necessary.

Mr. Thumann said that if one was going to economise and have a labour pool this labour could not be spared for emergencies. The labour pool would necessarily be small and would be quite inadequate to cope with an emergency such as the boilers running out of fuel. When such labour was brought in, in the case of an emergency, the supervision was very difficult and it was impossible to get 100 per cent efficiency from this casual labour force. He said that he had had practical experience of these conditions and the question arose; would it not be better to stop the mill for a few hours to work up to pressure in the boilers or to carry a few extra labourers?

Mr. Sheppard said that the first aim of the process control system was to improve the standard of operational work. Emphasis was placed firstly on quality of operation and secondly on labour reduction. When control of process had been improved it would be possible to reduce labour in most plants. To avoid putting management in a difficult position when an emergency arose some compromise should be arrived at, so that a reasonable amount of excess labour would be carried to meet such an emergency. He said that the condition was arising in this country when labour would not always be so plentiful and it was important to increase the utilisation of the available labour force.

Mr. Frost supported Mr. Sheppard in his contention that operators should be properly trained. He considered that safety should head the list of items a, b, c, d and e on page 60. Very often when an accident occurred it was found that the labourer had never had any proper instructions given to him, but had picked up his knowledge from the person who did the job before him.

Mr. Sheppard agreed that attention to safety was most important. A substantial amount of original work was necessary to satisfactorily introduce the control scheme. Expenditure on additional technical and clerical assistance should be regarded as a capital investment in the initial stage. Once the standard of operational control had been raised to the required level of perfection any additional staff would be released. The necessary checking procedures would then be taken over by the European staff which would be reinforced by non-European inspectors or supervisors where necessary. The introduction of such a scheme would have to be piece-meal so that the planning staff would not be over-loaded. A feature of the completed scheme would be to reduce the number of unskilled labourers in the plant, and to reinforce supervision by promoting educated and more enlightened non-Europeans to supervisory duties. He said that a result of the scheme would be to reward labourers for increasing their productivity by improving conditions of service and increasing the number of better paid jobs.

The President pointed out that the large number of plant operators would have to receive a certain amount of verbal instruction because they could neither read nor write. Nevertheless he thought this scheme could be an important contribution to the efficiency in the sugar industry in the future.