THE LOG SHEET

IS IT TIME FOR A CHANGE?

BY

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The object of this paper is:

(*a*) To explore the existing methods of machinery and system monitoring and data collection within the Marine Engineering Department of a small ship;

(*b*) To assess the suitability of these methods in the light of

(*i*) Established technical advance

(*ii*) The standard of technical competency of Marine Engineering Department personnel; and (*c*) To suggest a departure and base upon it a more realistic method in the interests of increased efficiency.

PART I

The aims of monitoring and data collection are:

(*a*) To provide a continuous record of the operational parameters of machinery and systems from which to:

(*i*) Recognize faulty operation and take action to rectify it;

(*ii*) Recognize developing unserviceability and take action to prevent failure;

(*iii*) Draw conclusions after failure as to the probable cause and thus to be in a position either to modify the operational procedure or to redesign.

(*b*) To provide a usage time scale for planned maintenance purposes and to assist in spreading work evenly between machinery of similar type and function.

(*c*) To provide a continuous logistic record.

(*d*) To provide a record of boiler water state and treatment.

Present routine monitoring and data collection takes the following forms:—

(*a*) Random visual monitoring of gauges and levels within machinery spaces by watchkeepers employed solely in such spaces. The frequency of monitoring is determined by the energy and zeal of the watchkeepers.

(*b*) Programmed monitoring and data collection in machinery spaces once per hour by watchkeepers employed solely in such spaces.

(*c*) Programmed monitoring and data collection once per hour in machinery spaces where watchkeepers are not employed.

(*d*) Programmed monitoring and data collection involving logistics and boiler water treatment, occurring at least daily.

By random monitoring, the watchkeepers ensure that machinery within the watchkeeping station is functioning satisfactorily. As a result of hourly programmed monitoring and data collection the Marine Engineer Officer of the Watch (MEOOW) is presented with a summary of the operational parameters of running machinery and systems and, from this data, can assess the state of the main machinery spaces, gearing and shaftings. Summaries of outside machinery data are also available to responsible ratings and to the MEO.

Data collection involves the logging of the following operational parameters:

Temperatures

Pressures

Levels

Speeds

Usage

Salinity and Alkalinity.

PART II

Present day machinery and systems in established classes are generally very reliable. They may, however, malfunction or fail for three reasons:

(i) Maloperation

(ii) Sudden failure of a component

(iii) Slow failure of a component.

Maloperation has always been a problem and maloperation of modern machinery, with finer clearances, higher speeds, higher bearing loads, more sensitive balance arrangements, smaller size and higher outputs, often leads to quick if not immediate failure. Data collection will not prevent sudden failure by maloperation. If a machine has operational instructions, clearly worded and conspicuously sited adjacent to it, the risk of maloperation is much reduced.

Sudden failure of a component can be prevented by design, by quality control and by the periodicity of planned maintenance schedules. Modern machinery, in general, is of sound design and is reliable. Sudden failure is rare today. Data collection is not likely to prevent it.

Slow failure of a component can nearly always be detected by observation of collected data. In ships of established classes, slow failure is catered for by the periodicity of planned maintenance schedules. Where it is not, then collected data will show a failure trend and allow timely action. Planned maintenance schedules, as a result, will be better tailored to the machinery, or S.2022 action will rectify the design deficiency.

How slow is slow failure? Monitoring and data collection, in the main, occurs each hour. Where random monitoring by sited watchkeepers is not possible, slow failure is that which takes longer than one hour as this is the possible maximum time such machinery is unattended. Where random monitoring is possible, slow failure is that which takes longer than the interval between successive monitoring, an interval which is determined by the enthusiasm of the watchkeeper.

How obvious are the signs of slow failure and how quick is detection? An evaporator will indicate malfunction by 'throwing a cloud'. The detection is quick and precise. A plummer block temperature might indicate a slow failure by trend over as many hours as it takes for the trend to be recognized by the MEOOW. Slow failure of a fresh water pump impeller may show as a loss of discharge pressure, the trend taking weeks or even months to become noticeable. The detection of slow failure is dependent on the blatancy of parameter trends.

Another important factor affecting the time taken to detect a slow failure is the technical competency of the watchkeepers. For example:

(*a*) A rise in cold room temperature could indicate that the refrigeration machinery is not functioning correctly. The system may have been losing refrigerant slowly for hours, causing the compressor parameters to change slowly and room temperatures to change even more slowly. The visiting watchkeeper, the Engine Room 3rd Hand, might well be excused if he did not notice the initial trend in the compressor parameters before the rooms began rising in temperature. The equipment is not understood to this degree by the majority of personnel. The failure trend is not blatant.

(*b*) A stage pressure in a multi-stage compressor might drop slowly. If the watchkeeper is familiar with the machine and knows the stage pressure limits, he will quickly detect the parameter trend. If the watchkeeper is not familiar with multi-stage air compressors, and the majority of junior ratings are not, then the machine can be under-performing quite badly before the parameter trend becomes obvious to him.

A third factor affecting the time taken to detect a slow failure is the tendency of watchkeepers to place varying degrees of relative importance on machinery parameters, considering some to be vital and others, at the other end of scale, hardly worth a glance. An experienced watchkeeper will monitor carefully those parameters which will indicate fast failure or result in fast failure, e.g., vacuum, L/O pressure, steam pressure, auxiliary cooling water pressure, superheat temperature. The parameters, which he knows by experience are not those which indicate fast failure, he monitors with much less enthusiasm, yet it is often these parameters which will indicate slow failure.

Failure is either sudden and non-detectable or it is slow and can be detected by monitoring of functional parameters. The timely detection of slow failure depends on:

(*a*) The blatancy of the parameter trend

(*b*) The ability to recognize the trend

(*c*) The relative importance of the parameter in the mind of the watchkeeper.

The MEOOW, the most competent man on watch, monitors data from the main machinery spaces and the shafting. His only feedback on the state of outside machinery, is the opinion of the Engine Room 3rd Hand, a relatively junior and unqualified rating. The outside machinery is thus supervised, in the main, by a junior rating who may have no real knowledge of the function of what he is monitoring. It is difficult for him to recognize a failure trend unless, or until, it affects a parameter he knows to be important, e.g., a cold room temperature. Outside machinery is monitored carefully and knowledgeably only when the MEO or an experienced senior rating visits it.

Outside machinery in the charge of a sited watchkeeper is supervised more closely. However, the supervision is of a routine nature and often slow parameter trends are not recognized until other parameters (which he considers to be the important parameters) begin to show a trend. An example is slow failure of a Diesel generator circulating water pump. It may show as a slow drop in discharge pressure over many watches but only when rough running or high exhaust temperatures are developing might the watchkeeper seek the assistance of the departmental ERA.

To sum up:

(*a*) Modern machinery in established classes is generally not prone to sudden failure by any cause other than maloperation.

(*b*) Sudden failure cannot be prevented by data collection.

(*c*) Detectable failure is defined as that which occurs over a period of time which is longer than the interval between successive parameter monitorings.

(*d*) Slow failure, by any cause other than maloperation, is catered for, in established classes, by the periodicity of planned maintenance schedules.

(*e*) Slow failure can be prevented by recognition of parameter trends.

(*f*) The timely detection of slow failure depends on the blatancy of parameter trend, the technical competence of the monitor and the relative importance of the parameter to the monitor.

Referring back to the first paragraph of Part I, the aims (*a*) (*iii*), (*b*), (*c*) and (*d*) of monitoring and data collection are well met by present methods. These methods do not fulfil aims (*a*) (*i*) and (*a*) (*ii*) with the efficiency and exactitude this age dictates. In requiring the recognition of faulty operation or developing unserviceability, the present methods presuppose that every monitor is a technically competent, experienced, zealous, enthusiastic, unbiased rating who has an enquiring mind, unbounded energy and is slightly intuitive by nature. This is, sadly, not the case. Unserviceability occurs much more frequently than it should in this age of generally well designed machinery of almost

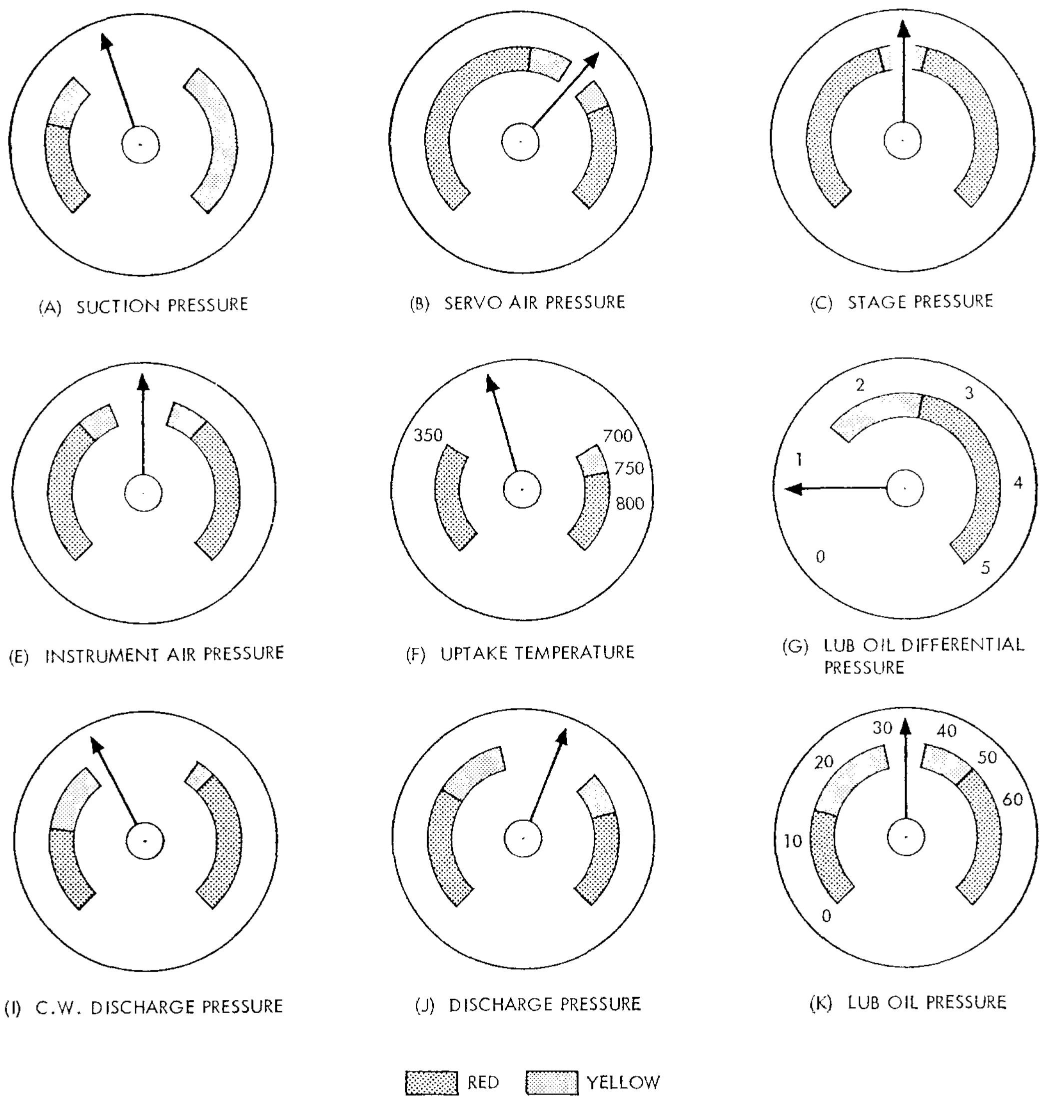

FIG. 1

traditional function. If the present method of supervision could be modified, by tailoring it to the ability of the supervisors, the aims (*a*) (*i*) and (*a*) (*ii*) could be fully met. A significant gain in serviceability would result.

PART III

At present, data collection is a slavish business which is prone to recording error and produces, for a well-operated serviceable machine, data of little value. If one accepts that machinery in this day is generally reliable, then the present system of monitoring and data collection is largely only proving every hour what one has already accepted.

What do temperatures, pressures and levels, etc., really mean? They are parameters of operation of a machine or system and indicate a function, having clearly defined values under steady conditions. Although these parameter values will differ in different conditions, in general there will be an upper limit or a lower limit or both, beyond which the function is incorrect. These limits are well known in ships of established classes.

If all indicating devices were to have these limits appended to their scales together with coloured zones to indicate transient or danger values and a white

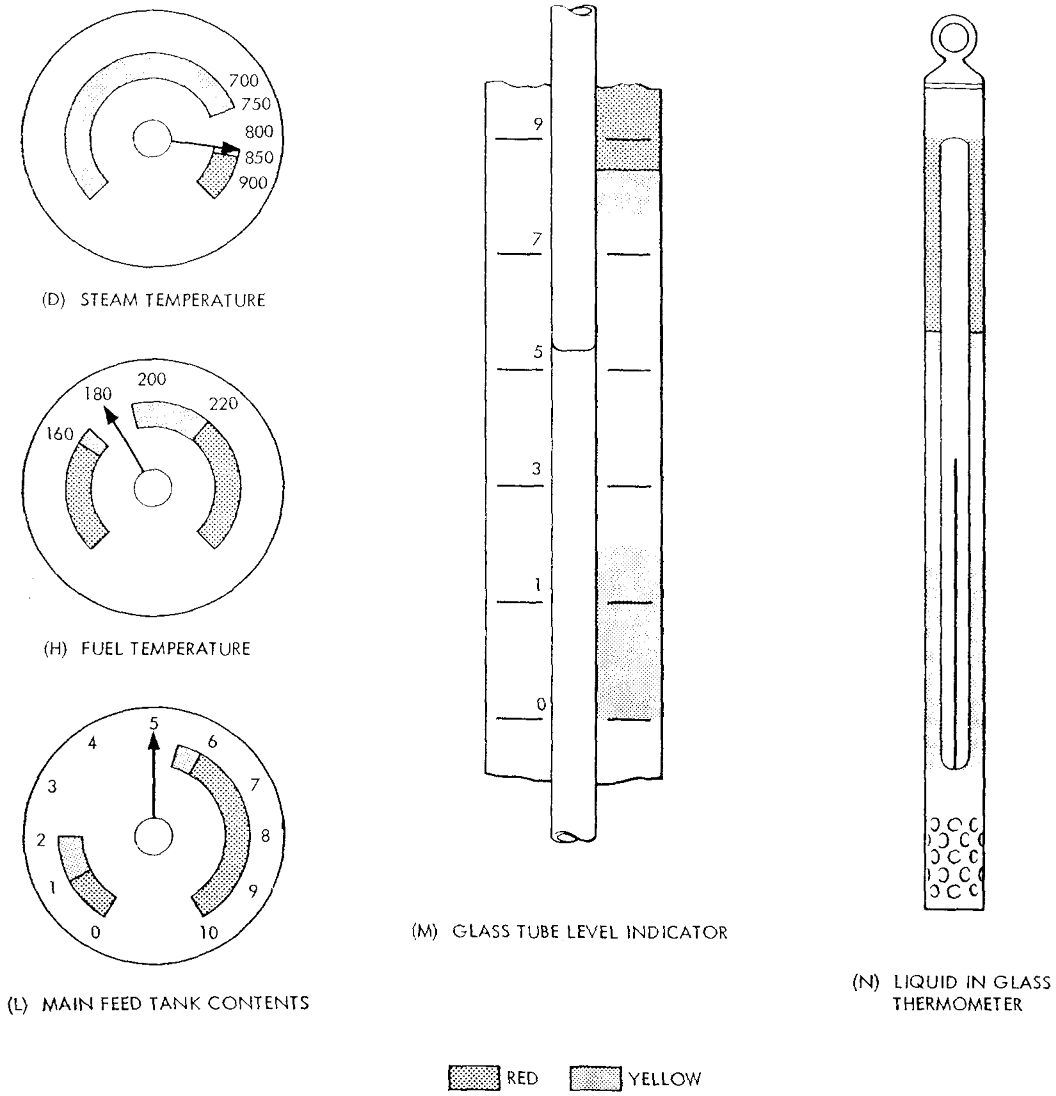

FIG. 2

zone to indicate normal operating values, one could scan a machine's gauges quickly and confirm serviceability. Any gauge will indicate positively maloperation or lessening serviceability. The machine or system gauge would thus be a focal point for concern and prompt action. Watchkeepers now will be concentrating on discovering what is not correct rather than on collecting a thicket of routine and, in the main, useless information. The ability to discover a fault is now not dependent in any way on the technical competence of the monitor. There can be no preconceived parameter bias in a monitor's mind.

The monitor can easily recognize a trend before damage occurs because the indicator moves out of the operating zone and he is thus presented with a fact which requires no intuitive decision.

No readings need to be logged. Having confirmed serviceability a watchkeeper can move to the next machine. He will complete his rounds in a fraction of the present time. His level of experience has no detrimental effect on the quality of his monitoring. He can do rounds more frequently and thus closer supervision of running machinery is also ensured. Should he find an indicator out of the operating zone he can inform the MEOOW and continue with his rounds. If he is the MEOOW and cannot rectify the fault quickly he can inform the rating responsible for the equipment. Defects can be quickly discovered and action can be prompt.

There is no indicator fitted which does not lend itself to 'zoning' and an example of zoning of typical indicators is shown in FIG. 1. Glass tube and liquid thermometers can be zoned on the protection jackets using heat resistant paints. All glass faced gauges can be zoned by using transparent coloured tape, suitably shaped and fixed to the glass (3 M Inc have products excellently suited to this purpose). Level indicating glass tubes can be zoned by painting coloured strips on the attached scales as shown in FIG. 2.

A red zone indicates danger or possible failure. A yellow zone indicates faulty operation or developing unserviceability or a transient condition (on flashing-up perhaps) which must initiate action and the machine will come under prompt scrutiny by a responsible rating. A clear or white zone indicates satisfactory operation.

To ensure that watchkeepers in fact do visit machinery at prescribed times, a simple nightwatchman's key and stamp system can be implemented at low cost. Keys can be placed wherever necessary and thus a visual record of a watchkeepers path is available to the MEOOW and the MEO if necessary. This addition will ensure that all rounds are carried out as ordered.

Co-ordination would be necessary to ensure that all machines of similar type and make were 'zoned' similarly. A team of two would be required to implement this scheme and the team would move from ship to ship within the class. A CERA plus one could convert all gauges in a frigate in two weeks and this time could be reduced as the team becomes more familiar with fitted equipments. The amount of research required to nominate the parameter limits of a machine is not prohibitive when one considers the large numbers of similar machines fitted in the Fleet.

A record of the parameter limits can be given to each ship and when gauges are replaced or 'zoning' damaged ships staff can restore the zoning. A junior shipwright, attached to the team, could install all 'nightwatchman' check point boxes at the same time as 'zoning' is carried out. The most convenient time to effect 'zoning' and implement the system is during any long self-maintenance period when the ship is operational.

This departure from current practice will have the following benefits:

(*a*) Rounds of running machinery and systems can be carried out more frequently thus ensuring closer supervision.

(*b*) Developing unserviceability and maloperation are clearly indicated and can be brought to the notice of a responsible rating positively and quickly.

(*c*) A combination of (*a*) and (*b*) should result in significantly increased serviceability and a reduction in maintenance costs.

(*d*) The advantages of present day costly automatic monitoring devices can be gained, at little expense, using this departure.

(*e*) For a small capital outlay, the MEO could be assured that rounds are being carried out as he ordered and with a continuous high standard of efficiency.

(*f*) Two log sheets only need be kept—that used by the MEOOW to record machinery state, special orders, etc., and that used to record feed water logistics. A reduction in stationery costs would result.

(*g*) The suggested departure, when established, could well lend itself to continuing a high standard of efficiency in the Marine Engineering Department despite complement changes or the massive expansion to be expected in the event of hostilities.

A criticism in the form of questions, is attached as the Appendix and the answers to these questions serve to illuminate the above suggested departure from current practice.

Q. If progressive data is not kept, how can conclusions be reached after failure, as to the probable cause?

A. Fast failure is rare and in most cases will be the result of maloperation or lack of good quality control. It is unlikely that parameters would have been recorded in the first case or a parameter trend apparent in the second.

In almost all cases of slow failure a parameter trend precedes the failure. The suggested departure should prevent the failure. In any case a trend will have been recognized and it is the trend usually, rather than an actual value, which will be of real use when deciding the cause.

Q. The trend of a parameter value is more noticeable than the movements of a needle on a gauge. Why change anything?

A. The trend of the actual parameter value is more noticeable if: (*a*) the monitor attaches importance to that parameter; (*b*) he is technically competent to recognize the significance of the trend; and (*c*) if the indicator is 'unzoned'. (*a*) and (*b*) contain too many 'ifs'. With proper zoning the developing fault or unserviceability is brought to responsible notice positively. The degree of competence of the monitor does not affect the standard of supervision and supervision is more frequent. Developing unserviceability will still occur, but slow failure should be very much reduced if not eliminated. This departure is merely an extension of the Planned Maintenance System.

Q. The present system works and has worked for many years. Why change it?

A. The 'it's always worked before' attitude will only stand up as an argument against change, if it 'works' now. Present machinery in established classes works reliably and predictably in the main and yet, at present, developing unserviceability tends further towards failure before detection and action than it should. Failure of a component may well mean damage to related components or machines and it would be generally true that the further the failure trend progresses, the longer the repair time and the higher the repair cost. This is emphasized by successive generations of machinery.

The further machinery progresses in design the further too should the standard of the supervision progress if we are to get the best value from machinery. 'It's always worked before'—it has worked but to the same standard of reliability as previous machinery designs. The present method of supervision is as unacceptable today as those machinery designs are. We aim at machinery reliability but, by employing unreliable methods of machinery supervision, we tend not to fully reap the benefits of the design effort.