

# Sometimes less is better

How sinking U-boats almost altered the maintenance industry.

## RELIABILITY CENTERED MAINTENANCE (RCM) HAS ITS ROOTS IN AVIATION;

however, they go back further than is commonly thought. RCM was originally called *on-condition* maintenance, a term coined by an industry task group created in 1960 by commercial airlines to investigate the capabilities of preventive maintenance.

This task force made two surprising discoveries: (1.) Scheduled overhaul has little effect on the overall reliability of a complex item unless the item has a dominant failure mode. (2.) There are many items for which there is not an effective form of scheduled maintenance. This gave rise to the creation of a Maintenance Steering Group-1st Task Force (MSG-1) which developed a handbook in 1968 with the minimum scheduled maintenance/inspection recommendations for the Boeing 747-100 aircraft and its engines.

In 1970 the 2nd Task Force (MSG-2) updated the handbook and included both DC-10 and L-1011 aircraft and their engines. In 1974, the U.S. Department of Defense commissioned United Airlines to prepare a report on the processes used by the civil aviation industry to prepare maintenance programs for aircraft. Two United Airlines engineers, Stan Nowlan and Howard Heap, independently discovered that preventive maintenance actually increased the rate of failure in some cases.

Their findings were published in the so-called Nowlan and Heap Report, a landmark report published in 1978 by the Department of Defense actually titled Reliability-Centered Maintenance. At the time they did not know they were rediscovering a concept British embryologist Conrad Hal Waddington had already discovered in 1943, since his wartime work had remained classified for 30 years.

Waddington had been involved in operational research with the Royal Air Force before becoming the scientific advisor to the Commander in Chief of Coastal Command in 1944. His team's principle assignment was to advise how the RAF



Photo courtesy of Wikipedia.

The B-24 Liberator squadrons initially suffered low force readiness due to maintenance.

could more effectively combat German submarines. Among their suggestions were changing the color scheme of the bombers from black to white, resulting in the planes not being spotted until they were 20% closer, yielding a 30% increase in successful sinkings, and changing the detonation depth of the depth charges from 100 feet to 25 feet. Though strongly resisted, this change brought about a sevenfold increase in the number of U-boats destroyed.

Waddington then turned his attention to the *force readiness* of the B-24 Liberator squadrons who only had 20 of their 40 planes flight ready, with many of the unavailable waiting for or undergoing maintenance. After his team gathered data about both scheduled and unscheduled maintenance, they plotted the number of unscheduled repairs as a function of flight time. What they discovered was a sharp increase in the number of unscheduled repairs after each scheduled 50-hour preventive maintenance (PM) event, which declined until the next 50-hour maintenance.

He said that scheduled maintenance “tends to increase breakdowns, and this can only be because it is doing positive harm by

disturbing a relatively satisfactory state of affairs. Secondly, there is no sign that the rate of breakdown is beginning to increase again after the 40-50 flying hours when the aircraft is coming due for its next [PM].”

Waddington's team recommended extending the maintenance intervals, eliminating PM tasks that were not proven to be beneficial, improving scheduling of maintenance personnel and creating better maintenance guidance and documentation. After implementing these suggestions, the effective size of the fleets increased by more than 60%.

Nearly 35 years later, Nowlan and Heap echoed these sentiments in a much more publicly available report, sparking a revolution within the maintenance industry. But it is interesting to think where we might be had Waddington's Operational Research Against the U-Boat been declassified sooner.



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