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RELIABILITY ON THE AIR FORCE EASTERN TEST RANGE

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ABSTRACT
The maintainability and operational reliability requirements to operate a one-point-five billion dollar missile testing range with a myriad of highly technical systems, is obviously of great concern to sustain and improve launch programs.

INTRODUCTION
Everyone seems to be emphatically against the "sin of unreliability". Yet, you will scarcely find two people with the same opinion on what constitutes reliability and how it can be achieved.

This paper elaborates on how we do "our thing" on the Air Force Eastern Test Range.

THEORY OF OPERATION
To begin the consideration of reliability, it is obvious that the AFETR cannot base reliability ratings of our equipment on the manufacturer's specifications. We want to trust him, and we do, but we have got to know for sure. We must have empirical data based on careful observation of prolonged performance. There is no other way.

When the manufacturer says he has built a part to last at least 1,000 hours, we thank him, activate the part and begin counting the hours. We count the hours every such part operates. The data-collection process never ends so long as we use any particular item. We keep a careful record of how long each one operates and of any other pertinent data about its operation.

From this body of data, the reliability engineers have ready access to information about the average number of hours such parts have functioned, about the shortest time any one of them functioned, about the optimum conditions for their operation, and about the conditions which put the greatest stress on the part.

They can determine with reasonable accuracy the times when preventive maintenance should be performed, when repairs will probably be needed, and when replacement will be necessary.

The engineer must make those decisions because only he can assess the importance of this part in the entire operation. Our data-gathering system provides him with the most reliable information possible on which to base his decisions.

This method of gathering data and evaluating it to draw conclusions upon which to base future actions is the heart of our reliability system. It is an example of the technique of inductive reasoning one learns about in a basic course in logic, and it is the basis on which your special field, the science of reliability, rests.

The ETR is a one-point-five billion dollar range, with a myriad of highly technical systems. It stretches southeasterly from Cape Kennedy to the Indian Ocean, a distance of 10,000 miles. It has a work force of about 13,546 people (including Air Force, other DoD agencies, Civil Service, and contractor personnel). Any successful launch will usually involve thousands of these employees and hundreds of thousands of the parts on which we need to have reliable data. Finding a more complex operation for which reliability data must be constantly available would be difficult, if not impossible.

A host of units, agencies, services and contractors must stay in constant contact with one another, exchanging critical information, equipment, and support. The Range must provide tracking data and other essential information to the ETR using agencies. By count, there are 61 customers for our National Range services.

The Range also provides the facilities and support services necessary for assembly, checkout, launch and in-flight operations of ballistic missiles, launch vehicles, and spacecraft.

It supports training test operations of tactical groups and operational weapons systems, and satellite operations of the allied nations on a
cooperative basis.

And because we are a service agency with many customers having various demands, we must be constantly prepared to meet emergency national defense commitments.

The operation of the Eastern Test Range is a complicated job, and in not one of these numerous responsibilities can we afford less than maximum reliability. The data on all of our equipment must be complete, accurate, and up-to-date.

There was a time when our only concern was with shooting a ballistic missile down range; and we scheduled it to go when everything was ready to go. Whether the missile went at three one afternoon, at two the next day, or sometime the next week really didn't matter greatly. But when manned and orbital missions are planned, launch times become critical, and accurate reliability figures become essential to success.

The AFETR's reliability and maintainability program has necessarily been tailored to match the changing responsibilities of the Range. Our engineers have developed math models which reflect the reliability data gathered about the operation of all of the individual elements in each system. These models indicate how long a system should operate flawlessly and how long repair of particular breakdowns would require.

These math models are the end-product of the reliability system; however, the fundamental element in the system is the replacement or repair card on which operating personnel record all the pertinent performance data about a particular part. From this Repair Report Card and its thousands of fellow cards grow the mountains of data necessary to construct the math models which predict the reliability of entire systems.

The AFETR began using this report card when our R&M program first started. Our engineers studied many similar forms and cards used by various contractors and companies before deciding on a format -- even that format lasted less than two years. As our requirements changed, so did the report card. In January, 1969, we revised the card, putting it into its present form.

Our operating personnel fill out one of these cards for every repair or replacement they make. They also fill one out for every modification they perform, every unsatisfactory part they receive, and any unusual operation or adjustment they perform or observe. When the completed form reaches the originator's supervisor, he reviews it, then forwards it to the R&M Division for its use.

R&M prepares punch cards from the report cards and adds them to the other data being assembled for use in constructing the math models. Basically, these math models consist of block diagrams showing all major units in a system and their relationship to each other. Its function is to provide a reliability configuration for each item of essential equipment in the system and for the system as a whole. A model not only predicts the reliability of its system, it also identifies the critical elements in the system and so provides a basis for deciding on the monitoring requirements for each item of critical equipment.

One more contribution which this reliability system makes to our operation is providing data about probable downtime in the event of an equipment malfunction. If a malfunction occurs during a countdown, for example, the launch director can immediately consult computer readouts for the probability of repair before T minus zero. With that information from his reliability data pool, he can determine how long a hold to insert or whether he must scrub the mission for failure to support.

It will come as no surprise to you to learn that we try to find engineers with broad scientific background and experience. Assuming we get competent, conscientious personnel to operate the system at all levels, the problem then is to keep them motivated to perform at all times at the peak of their capacity. To try to provide this motivation, we concern ourselves with keeping them constantly aware of the role they and their report cards play in our overall mission.

For one thing, we stress the necessity to each man of the importance of filling out the report card honestly and objectively. If he inadvertently sticks a screwdriver into an electrical connection and blows out the power supply, we want him to understand the need for an accurate, honest report of this unfortunate event. He must understand that we are not trying to find how well he does his job, but how the system can be kept functioning and how it can be made more nearly accident-proof.

An example of how such cooperation leads to an improvement occurred recently after a group of report cards showed that several operators had shorted screw-mounted resistors. Investigating engineers learned that the cover of this unit was fitted so tightly the operator had to use a screwdriver to pry it loose. When he did so, he often shorted out the entire bank. As a result of the accurate reporting of this problem, the unit now has a cover which can be easily removed by hand.

The single step which we believe most helpful in convincing our personnel to report accurately is to keep them informed of the conclusions our Reliability Division reaches as a result of receiving the report cards. This must be a two-way street. Whenever R&M assembles enough cards to reach a tentative decision about improvement of an operation, the improvement is sketched on a flip chart. The supervisor who originally
installed the system takes the flip chart to the men who submitted the cards and explains what the tentative corrective plan is and solicits their comments on the proposal. The men thus realize that their role is important to the overall reliability mission. When our personnel understand this, we have no motivation problem.

CONCLUSIONS

Reliability is never treated lightly at any level. The stronger the program management is at the command level, the stronger the entire program grows at every level down through the channels to that technician who once removed a cover with a screwdriver amid a shower of sparks, but now removes it easily by hand, knowing that this change in his operating conditions is a result of a good system which his efforts are regularly making better.

Since the beginning of the R&M program on the ETR our reliability batting average has improved significantly.

And the proof of that is the launch record. There have been no range caused "scrubs" of major missile or space launches for the last three years on this "man-rated" range. As to the sin of unreliability, we are emphatically against it!