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INDUCED ELECTRICAL TRANSIENTS OBSERVED IN THE TALOS-W ADAPTION KIT

SCDR 135-59

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SANDIA SYSTEMATIC DECLASSIFICATION REVIEW
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AUTHORITY: WC Layne
RECORD ID: 98SW0424
DATED: 10/28/97

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September 1959

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ABSTRACT

An undesirable electrical transient signal has been found to appear in the Mk 5 Mod 0 adaption kit at the time of a TALOS-W missile power changeover. A description of the transient, suggested cause, and cure are discussed.

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Summary

After several tests, it has been determined that the MC-749 explosive switch in the Mk 3 Mod 0 interconnecting box, when installed in the weapon, is exposed to an unacceptably large electrical transient induced into the MC-749 firing circuit at the time of missile power shifts. The largest transient resulted from changeover of the missile from "off" to "external power" and vice versa when the missile was on one of the launchers of the USS Galveston.

History

The TALOS program has had a long history of relay operation or switching transients, causing unwanted signals to occur in various places. It will be recalled that two missile flights (6b type) were destroyed prematurely in flight by a relay transient occurring at the trailing edge of the arm pulse. Later it was found that the Mk 5 adaption kit arm/fire relays could also cause a disturbance to the missile (1) by causing an unwanted response of the missile wings, (2) by introducing a transient into the missile telemetry, and (3) by causing multiple and spurious detonate pulses. In each of the above cases, action has been taken to correct the problem.

It should be noted, however, that in the case of the adaption kit arm/fire relays, it was observed that the simple act of de-energizing these relays resulted in an inductive "kick" from the relay coil which resonated with distributed capacitances of missile and adaption kit wiring to produce an oscillation at a frequency of about 200 kc/sec and an amplitude of about 250 volts lasting for some several milliseconds. This oscillation was apparently then coupled into nearby parallel wiring to cause the observed missile excitation.

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In January 1959 Sandia participated in the Navy HERO program (Hazards of Electromagnetic Radiation to Ordnance) by providing an instrumented warhead section which was exposed to severe electromagnetic radiation aboard the USS Galveston. When installed in the missile and with the missile on one of the ship's launchers, no indications of radio-frequency energy were observed either in the thermocouples used to simulate some of the explosive actuators or in the other actuators which were not simulated (included as a go/no-go check on results) except during the moments of missile power shifting.

To assure that this thermocouple indication was not caused by any external radio-frequency input, the missile power changeover was repeated with all shipboard radio-frequency sources turned off. The thermocouple output was again observed at the time of power changeover and appeared the same as observed earlier.

The recording indicated a peak current of 5 milliamperes. Realizing that the thermocouple could not be depended upon for an adequate indication of the exact nature of this type of transient because of its limited frequency response, it was deemed necessary to run further tests to better define the signal and determine whether or not a problem existed. The load across which this signal was observed was the thermocouple-simulated MC-749 explosive switch. This switch is used for disabling the warhead on the launcher (if desired) by permanently opening the adaption kit circuit associated with arming of the warhead MC-821 high-voltage safing relay. Thus, the effect of this undesired transient could be to cause "dudding" of the weapon at the time of missile power changeover.

Tests

Following the HERO test, Sandia requested that Bendix, Mishawaka, record with a high-caliber oscilloscope the transient on the "Warhead Disable" wire observed during missile power changeover when using a 4-ohm non-inductive resistor as a simulated load. Bendix has reported on their results separately (see Reference 2) but, briefly, the transient appeared to have a frequency of 10 to 15 megacycles modulated at about a 1-megacycle rate, and to have an amplitude of from 0.5 to 1.0 volt peak, lasting 400 to 600 microseconds. It should be noted that this was the missile alone (without lengthy ship's wiring attached), and it was not considered the complete

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answer. Nevertheless, the Bendix test did show the transient to be near the danger point.

During the week of July 27, 1959, the same test was run aboard the USS Galveston, using a Model 545 Tektronix oscilloscope but this time with all pertinent ship's wiring attached.

The procedure for the test was as follows:

An aft-support assembly from an innerbody was attached to a missile. The missile was placed on the launcher and the "backscratcher" connector mated. The Warhead Disable line in the strut cable of the aft support assembly was connected to the oscilloscope by means of a long (approximately 6 feet) coaxial cable made for the purpose. The shield or ground wire of the coaxial cable was connected to a missile ground wire in the same strut cable. A 4-ohm (approximately) noninductive resistor was used to simulate the explosive-switch actuator. The missile power changeover was performed and the transient signal recorded by means of a Polaroid camera.

In addition,as a separate test and as an additional go/no-go indication, an actual MC-749 was attached to the same strut wires as above and the missile power changeover accomplished. After changeover, the squib switch was checked for indication of firing.

Test Results

The go/no-go test with the MC-749 explosive switch showed no firing of the switch resulting from changeover.

The oscilloscope pictures obtained, indicate approximately the same voltage amplitude as that observed by Bendix for a missile alone (0.5 to 1.0 volt peak amplitude), but of a lower frequency (estimated to be about 200 kc/sec) and a much longer duration (in one case it was observed to be going strong after 4000 microseconds). It was further noted that in one case the transient stopped after about 400 microseconds and recommenced approximately 3000 microseconds later (see attached photos).

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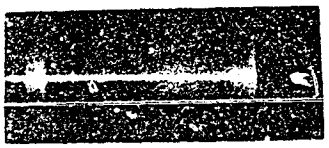
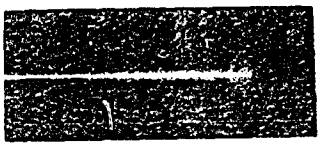


Changeover — Off to External

Changeover — External to Off

Vertical Sweep — 0.5 volts/cm
Horizontal Sweep — 500 μsec/cm



Changeover — External to Off

Changeover — Off to External

Vertical Sweep — 0.5 volts/cm
Horizontal Sweep — 100 μsec/cm

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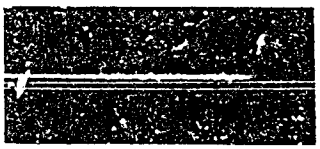
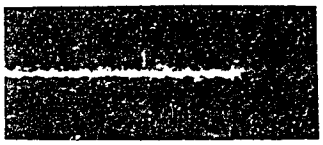


Changeover — External to Off



Changeover — Off to External

Vertical Sweep — 0.5 volts/cm
Horizontal Sweep — 10 μsec/cm

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Conclusions

The transient falls in the "grey" area of the firing characteristics of the MC-749 explosive switch and, hence, may or may not cause firing. The voltages observed could result in currents of 250 milliamperes (2-1/2 times guaranteed no-fire current but approximately 1/2 the "guarantee-fire" level). The duration was variable but lasted for a sufficiently long time in some cases to approach the firing time of the MC-749.

Recommendations

Owing to the nature of the transient and the nature of the effect (complete dud of the weapon) it is recommended that the Bureau of Ordnance take action to remove the transient from the Warhead Disable circuit at missile-power changeover time.

In addition, it is further recommended that the Bureau of Ordnance conduct a thorough search for other transients on other warhead-section input lines which occur at any time other than normal.

It should be noted that all of the tests run to date have been on a Type II missile; the same problems may exist for the Type IV (and later) missiles and should be investigated.

Finally, it is recommended that in the future all circuits associated with the warhead either in the missile or on the ship be adequately shielded to prevent pickup of unwanted signals.

LIST OF REFERENCES

1. Letter, Walters, N. L., Bendix Aviation Corporation (Mishawaka) to Treibel, W. E., Sandia Corporation, Warhead Disable Transient, CDI, Ref. Sym: 837:NLW:sew 13:4231, April 27, 1959.

2. Young W. E., Report of Shipboard HERO and Vibration Tests of the Mk 5 Mod 0 Adaption Kit and XW-30 Warhead Mated to a TALOS 6bW Missile, Sandia Corporation, SCDR-121-59, SRD, (to be published).