[redacted]

1857

UNCLASSIFIED

CENTRAL RECORD FILE
ACCOUNTABLE CARD BB
FILE No. MC 1441
3-2

JUL 3 1962

File: XMC-1441, 3-2
T-21602
Completed 7/2/62

To: K. L. GILLESPIE - 1332
Attn: W. E. Boyd, 1332-2

Re: Vibration, Vibration and Temperature, and Vibration and Linear Acceleration Tests of Nineteen XMC-1441 Inertial Switches

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## Object of Test

The original object of this test was to determine the component's actuation characteristics during vibration. Following an unexpected condition whereby the units were found to actuate at a lower but not a higher level of vibration, the test was expanded to explore this problem, to test to the original intent and to determine the effect of random vibration on unit function.

## Authorization for Test

This test was requested by Division 1332 in a Work Order Authorization dated May 10, 1962. Mr. W. E. Boyd was the consultant. The material for test was received May 28, 1962.

## Summary

Testing performed under this work order has shown that the MC-1441 Inertial Switch has two critical conditions as regards the actuation during vibration phenomenon. Apparently a critical vibration input of close to 30g exists, above and below which the percentage of actuating units is less.

Actuation percentage is also an apparent function of temperature, with peak percentage of actuation occurring somewhere between 35°F and -15°F.

Random vibration levels of $0.20g^2$/cps cause an increase in actuation time of a nominal 50%, as determined under the conditions of this test.

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## Functional Measurements and Methods

Vibration Machines No. 4 and No. 7 were used to perform the vibration tests.

Thyratron Chatter Testers Nos. 811-19 and 811-37 were used to monitor switch conditions during the vibration tests.

SANDIA SYSTEMATIC DECLASSIFICATION REVIEW
DOWNGRADING OR DECLASSIFICATION STAMP
CLASSIFICATION CHANGED TO: U
Emelda Selph 9/30/98
PERSON CHANGING MARKING & DATE
W C Layne 9/30/98
PERSON VERIFYING MARKING & DATE
AUTHORITY: R.B. Craner
RECORD ID: 98SN4475
DATED: 9/29/98

SANDIA SYSTEMATIC DECLASSIFICATION REVIEW
1st Review Date: 9/28/98
Authority: ☐ ADC ☒ ADD
Name: W Layne
2nd Review Date: 9/29/98
Authority: ADD
Name: R B Craner
Determination (Circle Numbers)
1 Classification Retained
2 Classification Changed to: U
3 Contains No DOE Classified Information
4 Coordinate With:
5 Contains UCAI? NF
6 Comments:
OK for Opened

[redacted]
TCG - NNT - 1

The MB Random Vibration Console with a Peak-Notch Analyzer was used to control V. M. No. 7 during the component functional tests.

The Wyle Servo-Temperature Conditioning Unit and a $CO_2$ temperature shroud were used to supply the temperature environment needed with V. M. No. 4.

A Brown Temperature Recorder, S-56679, was used to monitor component temperature during the tests.

Inertial Devices Test Console No. 2 and Visicorder Oscillograph S-95582 were used to control and monitor the components during the functional tests.

Testing was performed in accordance with SC-4452A(M), except that side acceleration was not monitored.

Procedure and Results

Nineteen EMC-1441 Inertial Switches from Phase II production were subjected to a sinusoidal vibration test to determine if the components would actuate during a vibration environment. Testing was done at room temperature at various vibration inputs.

Twelve of the above units were subjected to another sinusoidal test except that the input was held constant (with a few exceptions) and the temperature varied from room to -65°F.

Six of the above units, modified by removal of the return springs, were given a random vibration test, and tested functionally using the earth's gravitation as the actuating acceleration.

The components tested were, in general, standard Phase II models utilizing the increased travel flapper orifice. This design was found, during earlier temperature vibration testing, to be superior.

Throughout all testing covered in this report the components were mounted on the vibration machines with the resetting mechanism down (gravity aiding actuation). Vibration was uniformly applied parallel to the unit sensitive axis.

The first test of nineteen units was performed on Vibration Machine No. 7. Three test fixtures were used to expedite the test, with each fixture monitored separately for input acceleration. The fixtures were mounted adjacent to one another. During the test one fixture input was controlled, and the monitor on the other two showed that the three inputs did not vary more than 10%.

The components were cycled from 50 cps to 400 cps, except as noted in Table I, at a rate of 4 min/octave. This frequency range has been shown, by earlier testing, to be the most severe in effect on the component. The test temperature was monitored with a thermocouple mounted on one of the test fixtures, as close to the component as possible. During the testing the component reset circuits were monitored for opens, and the actuate circuits were monitored for chatter and for closure.

The components were first subjected to one full cycle at an input acceleration of 45g. During the test only one component, Serial No. BBR-0113-E2, actuated with an input acceleration of 45g.

In an effort to determine the minimum actuate level of the component which actuated at 45g input, the unit and two others were tested with an input acceleration of 30g. All three components actuated at 30g input. The same three components were tested with input accelerations of 20g, 15g and 10g. Of the three components tested one component, Serial No. BBR-0113-E2, actuated at 20g and 15g only.

Because of the performance of the three components at 30g, the remaining components were retested at an input acceleration of 30g. Six of the nineteen components actuated with an input acceleration of 30g.

Of the six components which were tested at an input acceleration of 20g, only two components actuated. Of the six components which were tested at an input acceleration of 15g, only one component actuated. None of the six components actuated with an input acceleration of 10g.

Because of the poor performance of the components at room temperature, it was decided to perform a post-mortem on the components before continuing to low temperature testing. Upon disassembly and inspection it was found that the components were full of small particles which had come from the internal parts of the units. This portion of the test was terminated until the units could be cleaned and the worn or damaged parts repaired.

All data taken in this portion of the test are recorded in Table I.

Twelve of the units, with nickel plated parts, were returned for temperature vibration testing. Test setup, this time on Vibration Machine No. 4, was almost identical to the previous test, with all the temperature conditioning, monitoring and control equipment added. The same test data was recorded.

Four test temperatures, 75°, 35°, -15° and -65° (all °F), and a vibration

input level of 15g were chosen. The components were cycled as before, except as noted in Table II. A few check runs were made at levels other than 15g and these are recorded in Table II.

One unit, BBR-0115-E2, actuated at 35°F and 15g input. Fully open reset circuits were more common. At 76°F one unit showed opens; at 35°F three were open; at -15°F eight were open, and at -65°F five were open. These data indicate that a critical temperature exists somewhere between 35°F and -15°F.

The unit which actuated at 15g was also tested at inputs of 10g, 12g and 14g. Actuation occurred at 14g and open reset circuits were present at all three levels.

Three units were tested at -65°F at levels of 25g and 30g. All three showed open circuits, and one, S/N BBR-0124-E2, actuated at both levels.

All data taken in this portion of the test are recorded in Table II.

Six units were subjected to a combined linear acceleration, random vibration test at room temperature to check the effect of vibration on unit function.

Testing was performed on Vibration Machine No. 7 using a single fixture. Three levels of power spectral density were used, and the bandwidth was 20 cps to 2000 cps. Equalization over the test frequency range was held to ± 3 db.

The components were modified by removal of the return spring. The units were held in the reset position by the fixture magnet until such time as actuation was desired. The earth's gravitation supplied the linear acceleration needed for actuation.

From 1 to 3 runs were made with no vibration, at vibration levels of $0.05g^2$/cps, $0.10g^2$/cps and $0.20g^2$/cps and again with no vibration. Component actuation times were obtained by monitoring with the Visicorder.

Two sets of data were taken. One with the components sealed at an oil temperature of 175°F and one with a temperature of 120°F. All data recorded during this portion of the test are listed in Table III.

In general, the higher the vibration level, the greater the effect on component actuation. The effect was greatest on the lower fill temperature units. Actuation time increased a nominal 50% at $0.20g^2$/cps for the

120°F fill temperature tests. No permanent effect was noted, as the no vibration runs before and after vibration were essentially identical.

Table 0 in this report contains a list of test notes applicable to Tables I and II.

C. G. Sam
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M. L. Shannon
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CGS:7321-1:kv

Enclosures: Tables 0 through III

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TABLE O

THE FOLLOWING NOTES APPLY TO THE TESTS AND TEST DATA LISTED IN TABLES I AND II.

NOTE 1: CYCLING RANGE 50CPS TO 400CPS AT A RATE OF 4 MIN/OCTAVE.

NOTE 2: CYCLING RANGE 50CPS TO 200CPS AT A RATE OF 4 MIN/OCTAVE.

NOTE 3: ACTUATE CIRCUIT CHATTER IN LOWER TEST FREQUENCIES.

NOTE 4: CYCLING RANGE 35CPS TO 280CPS AT A RATE OF 4 MIN/OCTAVE.

NOTE 5: CYCLING RANGE 40CPS TO 320CPS AT A RATE OF 4 MIN/OCTAVE.

NOTE 6: CYCLING RANGE 40CPS TO 280CPS TO 35CPS AT A RATE OF 4 MIN/OCTAVE.

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| SERIAL NUMBER | VIBR. ACC. (G) | ACTUATION | RESET OPEN CIRCUITS DURING CYCLING (UP-CPS) | (DOWN-CPS) | TEMP. (°F) | FIXT. NO. | NOTES |
|---|---|---|---|---|---|---|---|
| BBR-0107-E2 | 45 | No | No | No | 76 | I | 1 |
| | 30 | No | No | No | 72 | I | 2, 3 |
| BBR-0108-E2 | 45 | No | No | No | 82 | I | 1 |
| | 30 | No | No | No | 78 | I | 2, 3 |
| BBR-0109-E2 | 45 | No | No | 125-116 | 74 | I | 1 |
| | 30 | YES 107cps | 101-ACT. | — | 60 | I | 2, 3 |
| | 20 | No | 99-101, 103-110 | 106-87 | 75 | I | 2, 3 |
| | 15 | No | 81-90 | No | 82 | I | 2, 3 |
| | 10 | NO | NO | No | 78 | I | 2, 3 |
| | 30 | YES 125cps | 111-ACT. | — | 80 | I | 2, 3 |
| | 45 | No | 137-139 | — | 76 | I | 2 |
| | 30 | YES 128cps | 116-ACT. | — | 82 | I | 2 |
| BBR-0110-E2 | 45 | No | No | No | 75 | I | 1 |
| | 30 | No | No | No | 76 | I | 2, 3 |
| | 30 | No | 112-127 | 112-95 | 72 | I | 2 |
| BBR-0111-E2 | 45 | No | No | No | 75 | I | 1 |
| | 30 | YES 107cps | 99-ACT. | — | 64 | I | 2 |
| | 45 | No | No | — | 70 | I | 2, 3 |
| | 30 | No | No | — | 75 | I | 2 |
| | 20 | No | 97-101 | 98-85 | 76 | I | 2 |
| | 15 | No | 85-108 | 89-70 | 72 | I | 2, 3 |
| | 10 | No | 61-69, 73-101 | 81-69 | 78 | I | 2, 3 |

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| SERIAL NUMBER | VIBR. ACC. (G) | ACTUATION | RESET OPEN CIRCUITS DURING CYCLING (UP-CPS) | (DOWN-CPS) | TEMP. (°F) | FIXT. NO. | NOTES |
|---|---|---|---|---|---|---|---|
| BBR-0112-E2 | 45 | No | No | 165-155 | 82 | II | 1 |
| | 30 | Yes 148cps | 119-Act | — | 60 | II | 2,3 |
| | 20 | No | 106-126, 142-160 | 113-95 | 75 | II | 2,3 |
| | 15 | No | 125-129 | No | 82 | II | 2,3 |
| | 10 | No | No | No | 78 | II | 2,3 |
| | 30 | No | No | No | 80 | II | 2,3 |
| | 45 | No | No | No | 76 | II | 2,3 |
| | 30 | No | No | No | 82 | II | 2 |
| | 35 | No | No | No | 84 | II | 2 |
| BBR-0113-E2 | 45 | Yes 135cps | Yes | — | 74 | II | 1 |
| | 30 | Yes 107cps | 94-Act | — | 60 | III | 2,3 |
| | 45 | Yes-136cps | 127-Act | — | 60 | II | 2,3 |
| | 20 | Yes-98cps | 88-Act | — | 75 | III | 2,3 |
| | 15 | Yes-94cps | 65-68, 74-Act | — | 82 | III | 2,3 |
| | 10 | No | No | 64-59 | 78 | III | 2,3 |
| | 30 | Yes-123cps | 110-Act | — | 80 | III | 2,3 |
| | 45 | Yes-142cps | 123-Act | — | 76 | III | 2,3 |
| | 30 | UNIT WAS NOT RESET | | | | III | 2 |
| BBR-0114-E2 | 45 | No | No | No | 75 | II | 1 |
| | 30 | No | No | No | 72 | II | 2,3 |
| BBR-0115-E2 | 45 | No | No | No | 75 | III | 1 |
| | 30 | No | No | No | 76 | II | 2,3 |

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| SERIAL NUMBER | VIBR. ACC. (G) | ACTUATION | RESET OPEN CIRCUITS DURING CYCLING (UP-CPS) | (DOWN-CPS) | TEMP. (°F) | FIXT. NO. | NOTES |
|---|---|---|---|---|---|---|---|
| BBR-0118-E2 | 45 | No | No | No | 80 | I | 1, 3 |
| | 30 | No | No | No | 78 | II | 2, 3 |
| BBR-0119-E2 | 45 | No | No | No | 76 | II | 1 |
| | 30 | YES 106CPS | 103-ACT | — | 72 | III | 2, 3 |
| | 45 | No | No | — | 70 | II | 2, 3 |
| | 30 | No | — | — | 75 | II | 2, 3 |
| | 20 | YES 101CPS | 114-128 | 108-ACT | 76 | II | 2, 3 |
| | 15 | No | 89-118 | 96-74 | 72 | II | 2, 3 |
| | 10 | No | No | No | 78 | II | 2, 3 |
| BBR-0120-E2 | 45 | No | No | No | 76 | III | 1 |
| | 30 | No | No | No | 76 | I | 2 |
| | 30 | No | No | No | 63 | I | 2 |
| BBR-0121-E2 | 45 | No | No | No | 75 | II | 1 |
| | 30 | No | No | No | 76 | II | 2, 3 |
| | 30 | No | No | No | 63 | II | 2, 3 |
| BBR-0122-E2 | 45 | No | No | No | 82 | III | 1 |
| | 30 | No | No | 107-100 | 78 | III | 2 |
| BBR-0123-E2 | 45 | No | No | No | 102 | I | 1 |
| | 45 | No | No | No | 80 | II | 1, 3 |
| | 30 | No | No | No | 76 | III | 2, 3 |
| | 30 | No | No | No | 63 | III | 2, 3 |

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| SERIAL NUMBER | VIBR. ACC. (G) | ACTUATION | RESET OPEN CIRCUITS DURING CYCLING (UP-CPS) | (DOWN-CPS) | TEMP. (°F) | FIXT. NO. | NOTES |
|---|---|---|---|---|---|---|---|
| BBR-0124-E2 | 45 | No | No | No | 102 | II | 1 |
| | 45 | No | No | No | 80 | III | 1, 3 |
| | 30 | Yes-120cps | 87-91,97-Act | — | 64 | II | 2, 3 |
| | 30 | Yes-133cps | 125-Act | — | 72 | II | 2, 3 |
| | 45 | Yes-149cps | 144-Act | — | 70 | III | 2, 3 |
| | 30 | Yes-130cps | 113-116 | — | 75 | III | 2, 3 |
| | 20 | No | 107-139 | 119-81 | 76 | III | 2, 3 |
| | 15 | No | 89-119 | 106-76 | 72 | III | 2, 3 |
| | 10 | No | No | No | 78 | III | 2, 3 |
| BBR-0125-E2 | 45 | No | No | No | 76° | II | 1 |
| | 30 | No | 110-113 | 108-96 | 64° | III | 2, 3 |
| BBR-0126-E2 | 45 | No | No | No | 102 | III | 1 |
| | 30 | No | No | No | 76 | III | 2, 3 |
| BBR-0127-E2 | 45 | No | No | No | 74 | II | 1 |
| | 30 | No | No | No | 72 | III | 2, 3 |

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| SERIAL NUMBER | VIBR. ACC. (G) | ACTUATION | RESET OPEN CIRCUITS DURING CYCLING (UP-CPS) | (DOWN-CPS) | TEMP. (°F) | FIXT. NO. | NOTES |
|---|---|---|---|---|---|---|---|
| BBR-0109-E2 | 15 | No | No | No | 76 | I | 1 |
| | 15 | No | No | No | 35 | I | 1 |
| | 15 | No | No | No | -15 | I | 1 |
| | 15 | No | No | No | -65 | I | 4 |
| BBR-0111-E2 | 15 | No | No | No | 76 | II | 1 |
| | 15 | No | No | No | 35 | II | 1 |
| | 15 | No | No | 56-54 | -16 | I | 1 |
| | 15 | No | No | No | -65 | II | 4, LOOSE RESET LEAD |
| BBR-0112-E2 | 15 | No | No | No | 76 | III | 1 |
| | 15 | No | No | No | 35 | III | 1 |
| | 15 | No | 54-56 | No | -15 | III | 1 |
| | 15 | No | No | No | -65 | III | 1 |
| BBR-0113-E2 | 15 | No | No | No | 77 | I | 1 |
| | 15 | No | No | No | 35 | I | 1 |
| | 15 | No | 54-56 | 54-53 | -15 | II | 1 |
| | 15 | No | No | No | -65 | I | 4 |
| BBR-0115-E2 | 15 | No | 112-138 | 88-79 | 77 | II | 1 |
| | 15 | YES 82cps | 56-ACT | — | 35 | II | 1 |
| | 15 | YES 84cps | — | — | 35 | II | 1 |
| | 10 | No | No | 72-70 | 35 | II | 2 |
| | 12 | No | 82-91 | 65-55 | 35 | II | 2 |
| | 14 | YES 91cps | 53-ACT | — | 35 | II | 1 |

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| SERIAL NUMBER | VIBR. ACC. (G) | ACTUATION | RESET OPEN CIRCUITS DURING CYCLING (UP-CPS) | (DOWN-CPS) | TEMP. (°F) | FIXT. NO. | NOTES |
|---|---|---|---|---|---|---|---|
| 0115 CONT. | 15 | NO | 51-58 | 77-50 | -16 | II | 1 |
| | 15 | NO | 51-72 | 67-45 | -65 | II | 4 |
| | | | | | | | |
| BBR-0119-E2 | 15 | NO | NO | NO | 77 | III | 1 |
| | 15 | NO | NO | NO | 35 | III | 1 |
| | 15 | NO | NO | 55-52 | -16 | III | 1, LOOSE RESET LEADS |
| | 15 | NO | NO | NO | -65 | III | 4 |
| | | | | | | | |
| BR-0120-E2 | 15 | NO | NO | NO | 80 | I | 1 |
| | 15 | NO | NO | NO | 35 | I | 1, 3 (90 CPS) |
| | 15 | NO | NO | NO | -16 | I | 1 |
| | 15 | NO | NO | NO | -64 | I | 4 |
| | 30 | NO | NO | 77-47 | -64 | I | 3, 5 |
| | 25 | NO | 71-74 | 61 | -65 | I | 3, 5 |
| | | | | | | | |
| BBR-0121-E2 | 15 | NO | NO | NO | 80 | II | 1 |
| | 15 | NO | 70-73 | 69-60 | 35 | II | 1 |
| | 15 | NO | 57-60 | 59-54 | -16 | II | 1 |
| | 15 | NO | NO | 49-47 | -64 | II | 4 |
| | 30 | NO | 79-83 | 77-49 | -64 | II | 5 |
| | 25 | NO | 40-? | — | -65 | II | 5, OPEN RESET LEAD |
| | | | | | | | |
| BBR-0124-E2 | 15 | NO | NO | NO | 80 | III | 1 |
| | 15 | NO | NO | NO | 35 | III | 1 |
| | 15 | NO | NO | NO | -16 | III | 1 |
| | 15 | NO | 52-55 | 49-47 | -64 | III | 4 |

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| SERIAL NUMBER | VIBR. ACC. (G) | ACTUATION | RESET OPEN CIRCUITS DURING CYCLING (UP-CPS) | (DOWN-CPS) | TEMP. (°F) | FIXT. NO. | NOTES |
|---|---|---|---|---|---|---|---|
| 0124 CONT. | 30 | YES 70 CPS | 75-79 | 77-ACT. | -64 | III | 5 |
| | 25 | YES 63 CPS | 69-78 | 68-ACT. | -65 | III | 5 |
| | | | | | | | |
| BBR-0125-E2 | 15 | NO | NO | NO | 82 | I | 1 |
| | 15 | NO | NO | NO | 35 | I | 1 |
| | 15 | NO | NO | NO | -15 | I | 6 |
| | 15 | NO | NO | NO | -65 | I | 4 |
| | | | | | | | |
| BBR-0126-E2 | 15 | NO | NO | NO | 82 | II | 1 |
| | 15 | NO | 68-72 | 70-62 | 35 | II | 1 |
| | 15 | NO | 46-? | — | -15 | II | 6, LOOSE RESET LEAD |
| | 15 | NO | 49-53 | 51-48 | -65 | II | 4 |
| | | | | | | | |
| BBR-0127-E2 | 15 | NO | NO | NO | 82 | II | 1 |
| | 15 | NO | NO | NO | 35 | II | 1 |
| | 15 | NO | NO | 55-53 | -15 | II | 6 |
| | 15 | NO | 49-51 | NO | -65 | II | 4 |

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TABLE III

T-21602

| SERIAL NUMBER | FILL TEMP. (°F) | VIBRATION TEST LEVEL ($g^2$/CPS) FIRST 0 | 0.05 | 0.10 | 0.20 | FINAL 0 | | FILL TEMP. (°F) | VIBRATION TEST LEVEL ($g^2$/CPS) FIRST 0 | 0.05 | 0.10 | 0.20 | FINAL 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BBR-0109-E2 | 175 | 3.81 | 4.50 | 4.82 | 5.03 | 4.14 | | 120 | 3.75 | 4.82 | 5.30 | 5.39 | 3.74 |
| | | 3.73 | 4.43 | | | 3.75 | | | 3.73 | 4.88 | 5.13 | 5.38 | 3.77 |
| BBR-0111-E2 | 175 | 3.87 | 4.40 | 4.75 | 5.16 | 3.62 | | 120 | 3.70 | 5.00 | 5.40 | 5.68 | 3.64 |
| | | 3.60 | | | | 3.61 | | | 3.84 | 4.69 | 5.50 | 5.68 | 3.6[redacted] |
| BBR-0113-E2 | 175 | 2.95 | 4.38 | 4.26 | 4.78 | 2.88 | | 120 | 3.00 | 3.93 | 4.53 | 4.85 | 3.15 |
| | | 3.11 | | | | 2.89 | | | 2.98 | 3.96 | 4.45 | 4.99 | 3.03 |
| BBR-0120-E2 | 175 | 3.67 | 4.86 | 5.38 | 5.88 | 3.61 | | 120 | 3.49 | 5.10 | 5.50 | 5.92 | 3.52 |
| | | 3.64 | | | | 3.61 | | | 3.52 | 4.85 | 4.91 | 5.76 | 3.53 |
| BBR-0125-E2 | 175 | 3.71 | 4.83 | 4.83 | 4.99 | 3.79 | | 120 | 3.60 | 4.51 | 4.91 | 5.23 | 3.57 |
| | | 3.83 | 4.42 | 4.80 | 5.36 | 3.76 | | | 3.57 | 4.26 | 4.97 | 5.41 | 3.60 |
| | | 3.82 | | 4.83 | 5.37 | | | | | | | | |
| BBR-0126-E2 | 175 | 3.86 | 4.47 | 4.71 | 5.13 | 3.83 | | 120 | 3.73 | 4.75 | 4.60 | 5.17 | 3.67 |
| | | 3.81 | 4.44 | 4.76 | 5.14 | 3.82 | | | 3.65 | | | | 3.67 |
| | | 3.85 | 4.44 | 4.69 | 4.76 | | | | | | | | |
| GRAND AVERAGES | | 3.66 | 4.52 | 4.78 | 5.16 | 3.61 | | | 3.55 | 4.61 | 5.02 | 5.41 | 3.55 |
| % CHANGE FR. FIRST | | | +23.5 | +30.6 | +41.0 | -1.4 | | | | +29.9 | +41.4 | +52.4 | 0 |

ALL TIMES LISTED ARE IN SECONDS.

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