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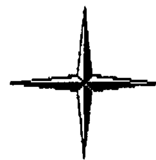

Daimler-Benz Aerospace

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Fax von/from Nr.: **(49) 89 607-23039**

Firma/firm: **DASA-DS**

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Abt./dept.:

Datum/date.: **06.04.95**

cc: **ESA - Jan Minnee**

Our Reference: CLU-CPP-298/95

Subject: EEE Parts Procurement for CLUSTER-SSR

Reference: Radiation Tests on 54AC/ACT Series

For a commercial project the ADCE from Dasa, assembled with several different Class S 54AC/ACT logic devices from NSC, was subjected to a total dose radiation test in order to investigate the hardness level. The total dose test was performed with a dose rate of approximately 2 Krad (Si)/min using a Cobalt 60 gamma ray source. During the experiment it was observed that the total supply current of the board increased dramatically starting already after an exposure of 10 Krads (Si). In contradiction to our expectations the board failed (power consumption) after approximately 50 Krad (Si) but was still functioning.

After subsequent analysis the failure was traced back to the ICC consumption of several NSC 54AC device types only. Several individual device types showed an ICC (static state) consumption above 20 mA.

Procurement History

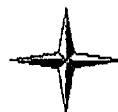
The 54AC/ACT series from NSC was procured considering a total dose hardness of 100 Krads (Si). This assumption was based on available radiation data. According to the requirements all devices were designed to met:

- 54AC devices: ICC = 700 µA max (1.5 mA max for some device types) after exposure to 100 Krads (Si).
- 54ACT devices: ICC = 2.5 mA max after exposure to 100 Krads (Si).
- All devices remained within the specification after annealing (accelerated aging).

In parallel to the CLUSTER parts procurement the 54AC/ACT series was procured for other projects where a radiation lot acceptance test was performed on each lot by NSC. Since the same wafer lot was used for about half of the CLUSTER device types a radiation lot acceptance test report is available from the other projects. All lots passed and were well within the specification.

Total Dose Verification Tests at Dasa (High Dose Rate)

In order to verify above test results stock parts available at DASA were subjected to Co-60 total dose testing with a dose rate of 1.77 Krad (Si)/min. These additional tests were performed on four different 54AC types which were considered as worst case candidates during the board analysis:



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- 54AC04	DC 9310A	M38510/75701SDA
- 54AC08	DC 9344A	M38510/75203SDA
- 54AC14	DC 9310A	M38510/75702SDA
- 54AC574	DC 9305A	M38510/75604SSA

The results are presented in the attachment of this fax; however a final report was also established and is available upon request. Please note that the radiation testing was performed obeying the conditions of MIL-STD-883D, Method 1019.4 and applying the NSC bias conditions.

Although all part types showed a high annealing trend for the ICC parameters, 2 part types, i.e., 54AC04 and 54AC14, still indicated measurement values for ICC far beyond the specification limits, whereas the 54AC08 and 54AC574 recovered well below the specification limits. It can also be stated that non of other tested electrical parameters significantly degraded during the radiation and annealing tests (functional and DC parametric testing according to detail specifications).

Total Dose Verification Tests at Dasa (Low Dose Rate)

In order to gain more information on the radiation behavior of the 54AC/ACT familie DASA performed in addition a low dose experiment, i.e., with a dose rate of 18 rad (Si)/min up to an accumulated total dose level of 100 Krads (Si). Depending-on the availability of stock parts the following device types were subjected to testing:

- 54AC04	DC 9242A	M38510/75701SDA (same wafer lot as DC 9310A)
- 54AC10	DC 9242A	M38510/75002SDA
- 54AC10	DC 9231A	M38510R75002SDA (Life Test units, same wafer lot as DC 9242A)
- 54AC14	DC 9242A	M38510/75702SDA (same wafer lot as DC 9310A)
- 54AC574	DC 9305A	M38510/75604SSA

The results showed no difference to the high dose rate results except for the 54AC574 who showed marginal lower degradation of the ICC parameter. The results are presented in the attachment of this fax; however the accelerated aging test is in progress and the results will be available end of this week (7.-8. Apr.).

Summary

As can be seen out of the DASA radiation tests the results are in strict contradiction to the delivered NSC radiation lot acceptance test results. Since even the low dose tests indicate no significant difference in the radiation behavior, the results are of a major concern for all space projects, So far the radiation results can be summarized as follows:

- The 54AC/ACT series from NSC passes the radiation total dose test up to 100 Krads (Si) prior to burn-in (verified in most cases by lot to lot testing).
- Total dose tests performed after burn-in at Dasa indicate totally different results; i.e. all tested lots failed ICC consumption which was found to be far out of the specification (up to 30 mA instead of 700 µA or for some devices 1.5 mA).
- Such a behavior for MOS technologies was first observed by the Sandia National Laboratories in Dec. 94 and their results will be published during the next "Nuclear and Space Radiation Effects Conference".
- The reason for this phenomenon is unknown; further testing and evaluation is in process at NSC and Dasa.

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Affected Projects

- CLUSTER-SSR from DASA-DS

Proposed Investigations

In order to determine further proceeding the following points need to be investigated:

1. Total dose data chip level for CLUSTER-SSR.

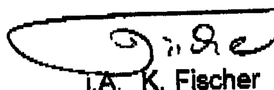
2. With respect to the new radiation total dose data the increase of the ICC consumption can then be calculated and compared with the power supply output.
   For instance, with respect to the radiation data so far available an average increase of the ICC by 1 to 1.5 mA per device is assumed at 25 Krad (Si) under worst case conditions (static conditions: all inputs high or all inputs low). This leads to a total ICC consumption of the CLUSTER-SSR and can be compared with the maximum output of the power supply.

   Since the radiation board test of the Dasa ADCE indicated a ICC increase below 50 mA at 25 Krad (Si) (under dynamic conditions) it seems that under dynamic conditions the increase of the ICC per device is in the range of 0.5 mA. The additional thermal impact needs also to be investigated.

We will advice more details upon availability.

Best regards

Daimler-Benz Aerospace AG
Space Satellite Systems



i.A. E. Riffel i.A. K. Fischer

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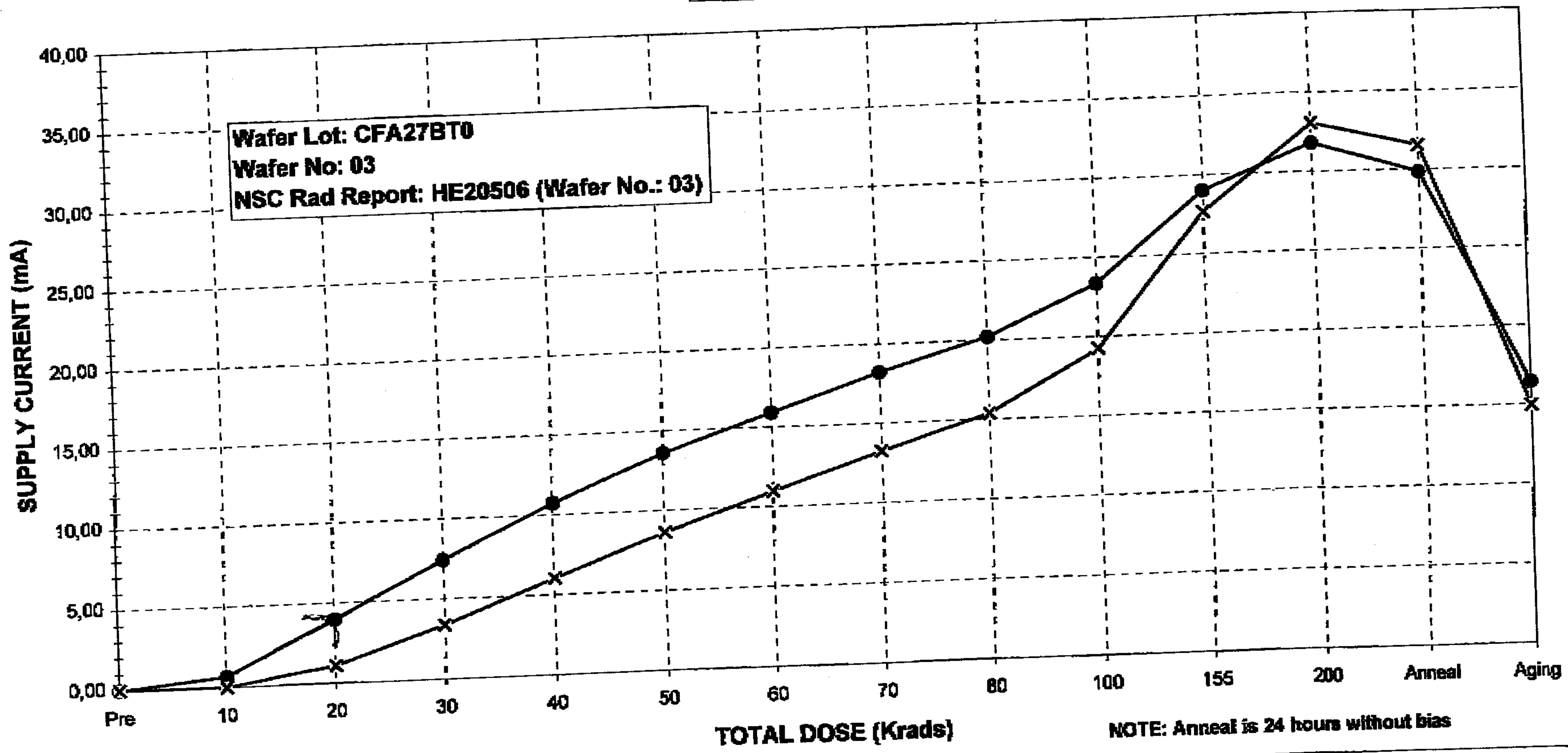
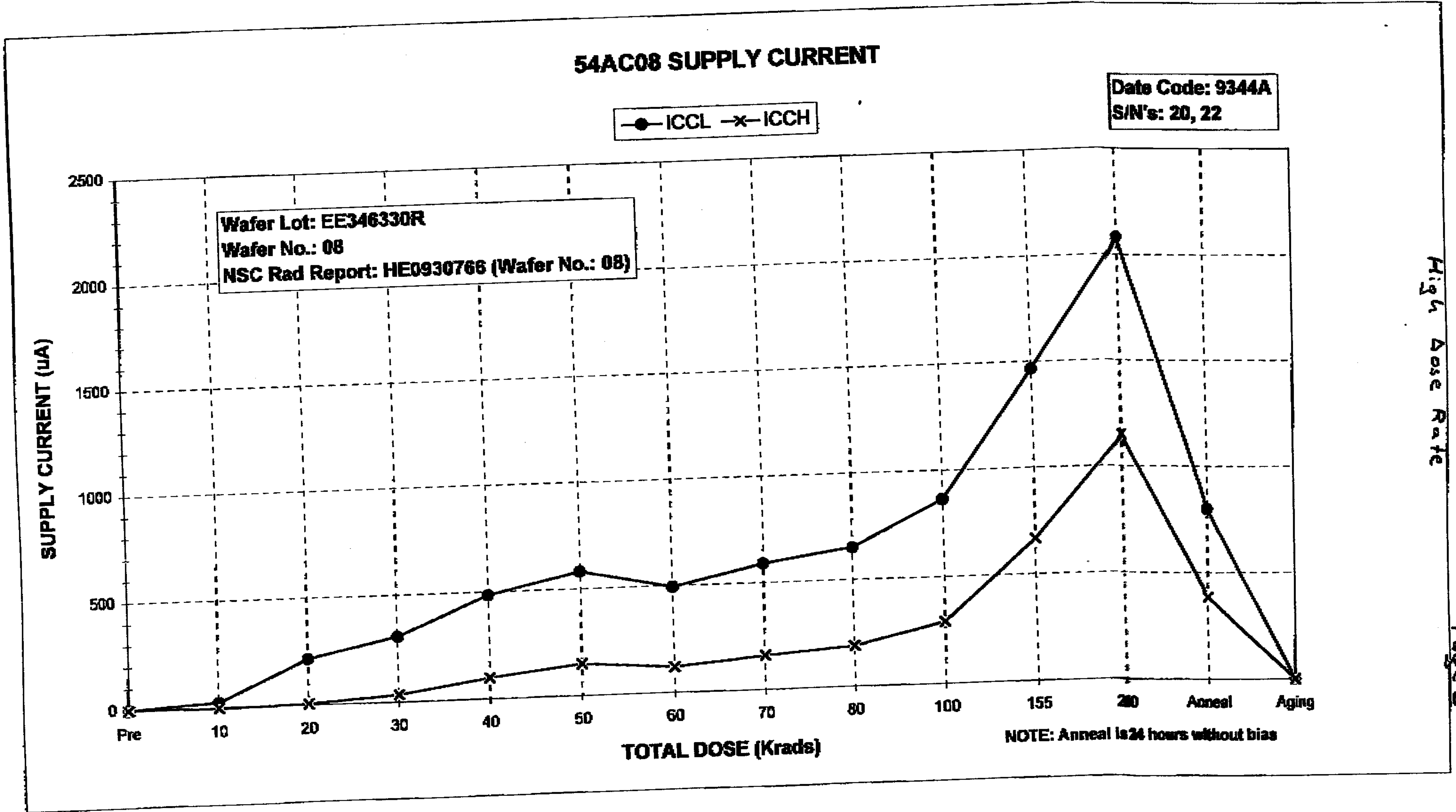
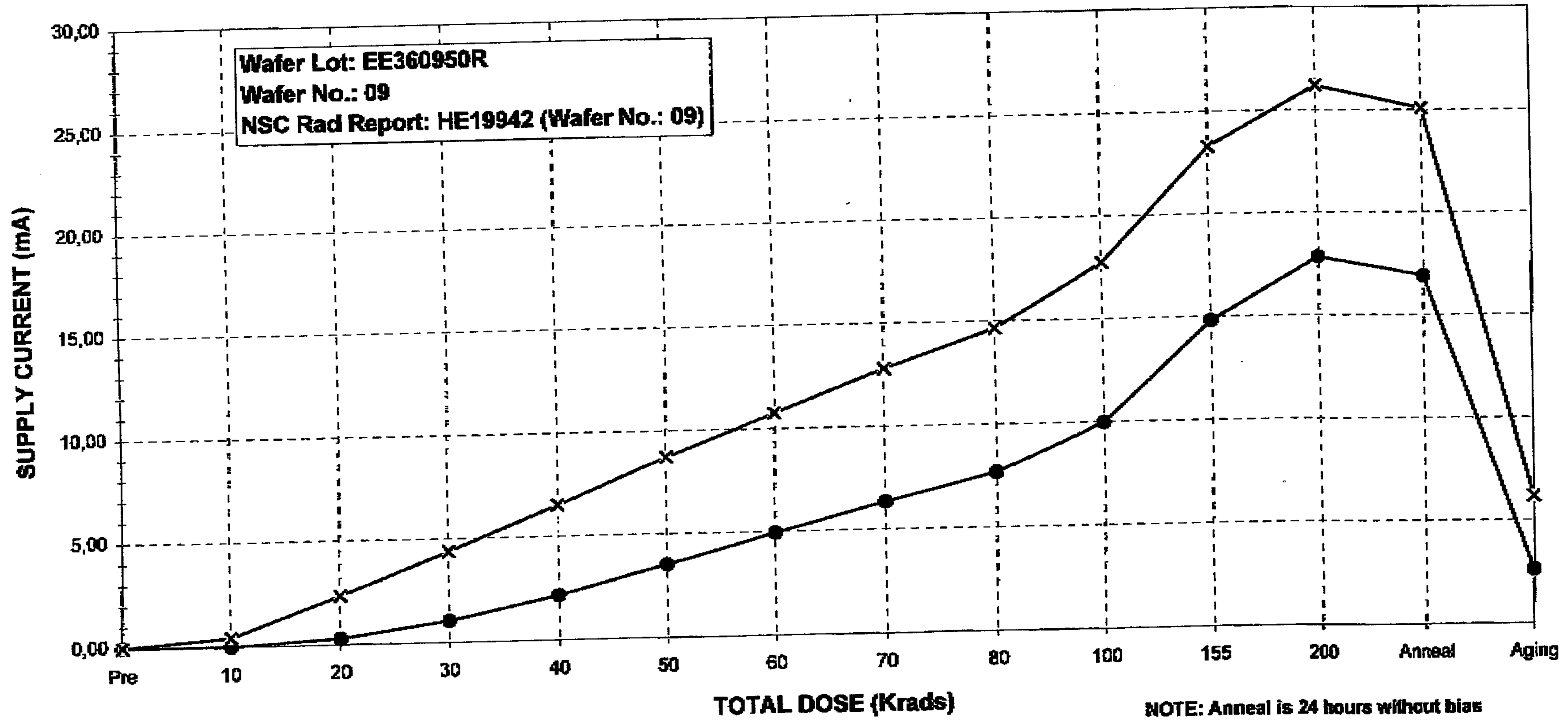


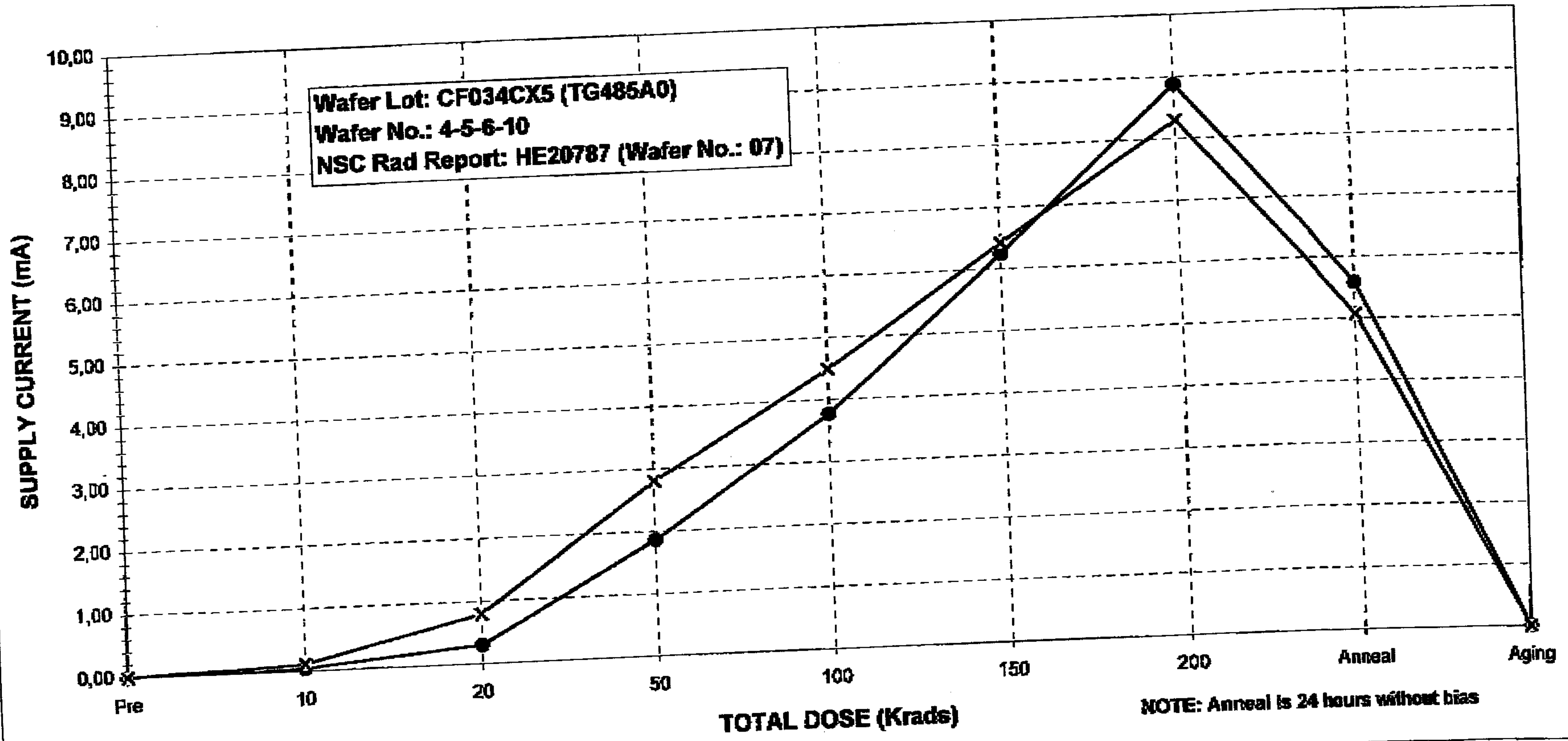
High Dose Rate

15.03.1995

54AC04.XLS


54AC08 SUPPLY CURRENT
ICCL
ICCH
Date Code: 9344A
S/N's: 20, 22
Wafer Lot: EE346330R
Wafer No.: 08
NSC Rad Report: HE0930766 (Wafer No.: 08)
SUPPLY CURRENT (uA)
2500
2000
1500
1000
500
0
Pre
10
20
30
40
50
60
70
80
100
155
200
Anneal
Aging
TOTAL DOSE (Krads)
NOTE: Anneal is 24 hours without bias
High Dose Rate
Page 5


54AC14 SUPPLY CURRENT
ICCL ICCH
Date Code: 9310A
S/N's: 106, 112, 117
Wafer Lot: EE360950R
Wafer No.: 09
NSC Rad Report: HE19942 (Wafer No.: 09)
SUPPLY CURRENT (mA)
30,00
25,00
20,00
15,00
10,00
5,00
0,00
Pre
10
20
30
40
50
60
70
80
100
155
200
Anneal
Aging
TOTAL DOSE (Krads)
NOTE: Anneal is 24 hours without bias
High Dose Rate
Page 6



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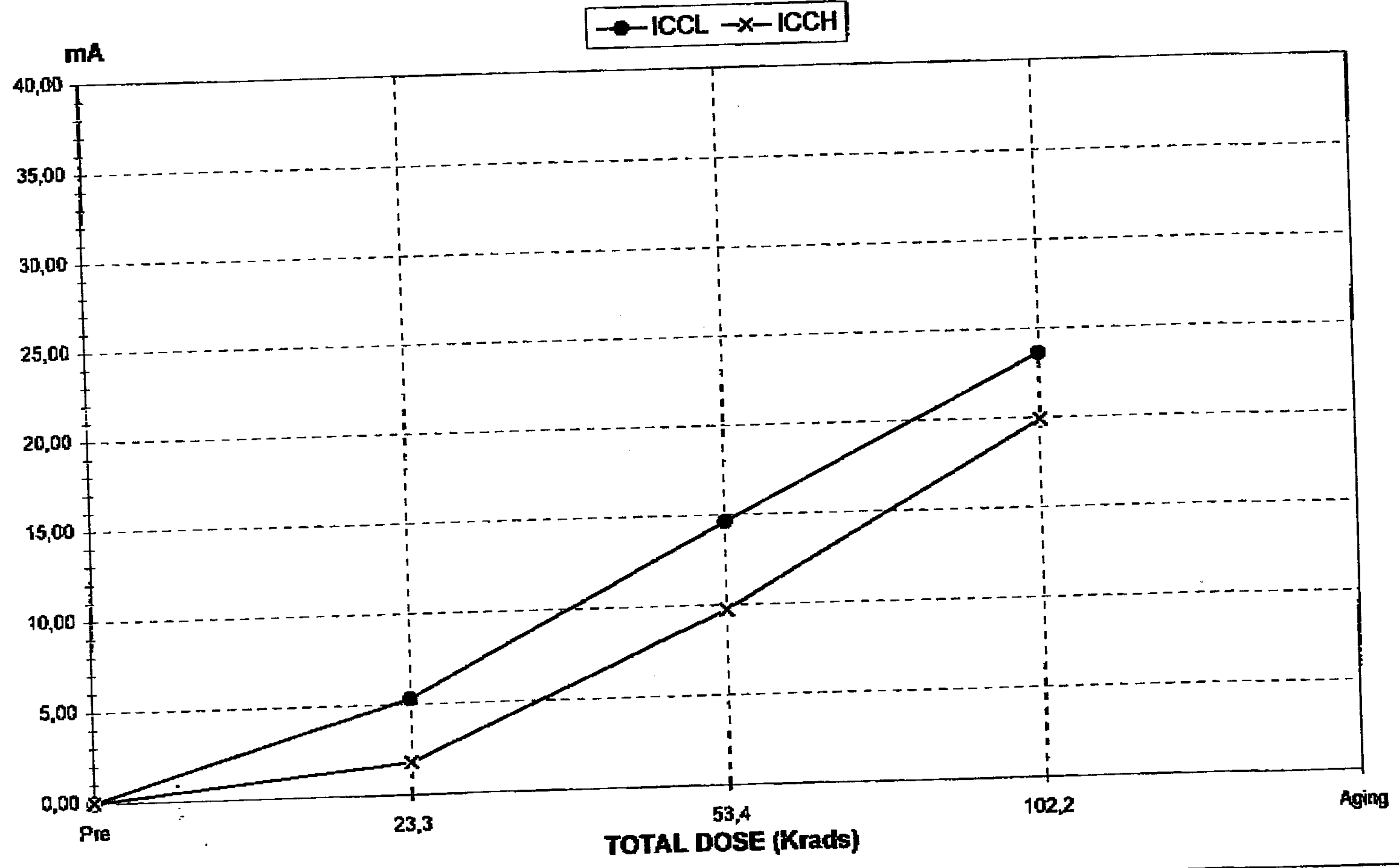
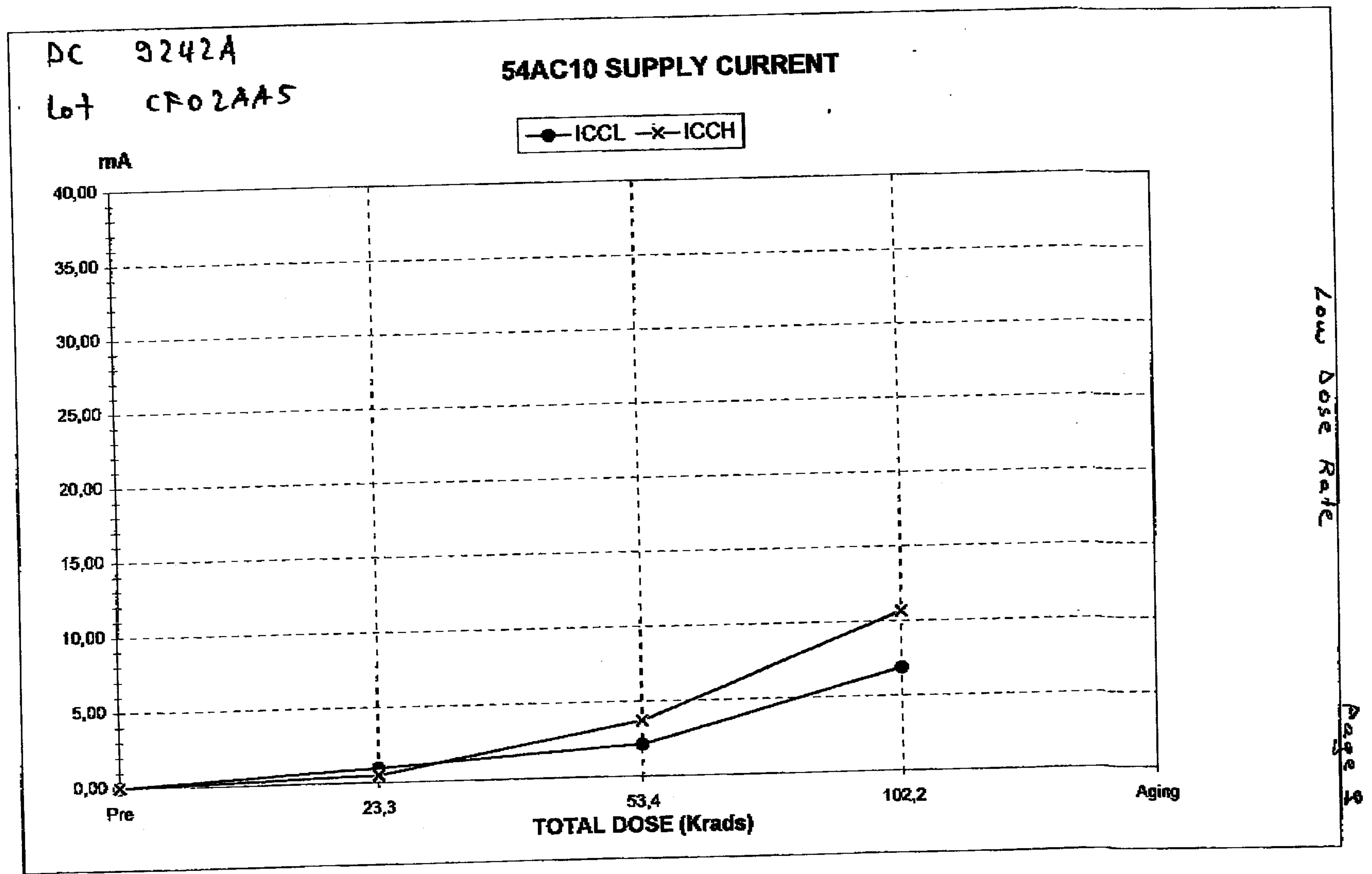
54AC574.XLS



31.03.1995



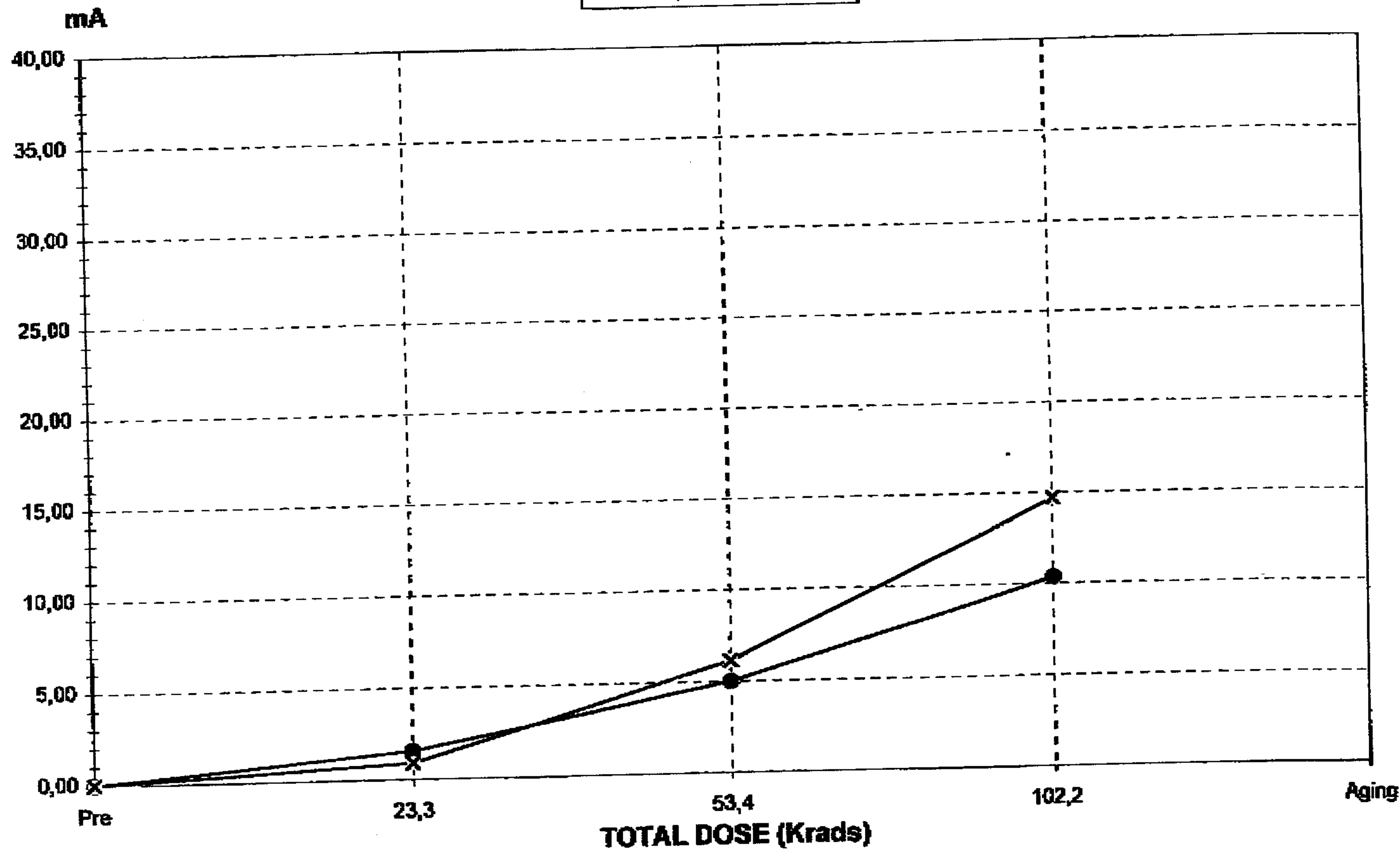
31.03.1995

AC10_2.XLS

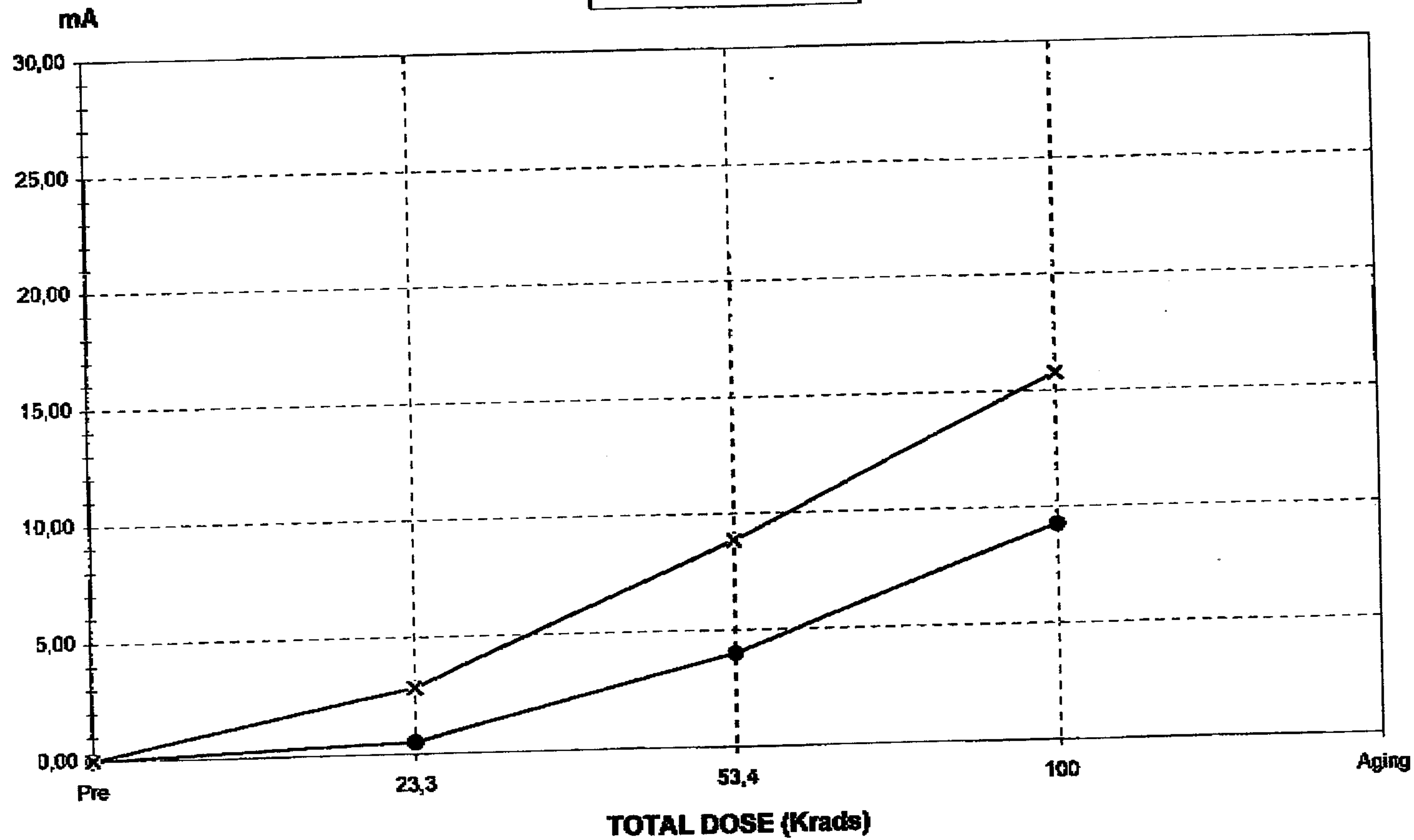
DC 9231A
Lot CF02CAA5

54AC10 SUPPLY CURRENT

Life Test Samples



Low Dose Rate


DC 9242A
Lot EE 360950R
54AC14 SUPPLY CURRENT
ICCL
ICCH
mA
30,00
25,00
20,00
15,00
10,00
5,00
0,00
Pre
23,3
53,4
100
Aging
TOTAL DOSE (Krads)
Low Dose Rate
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