

ESA-QCA0071T-C



QCP x3

QDA

QCP(JW)

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REF.: TL/SL/92/JG/FX/

No. Pgs.: 1/ 22

|                 |  |
|-----------------|--|
| AVTO :          | A. MOUTON, C. BROOKS - MMS TOULOUSE<br>L. HAGSTROM - ESA/ESTEC QCP |
| DE/FROM :       | JOSE M GALDO   |
| CC :            | LUIS P GOMEZ, SIXTO ARJONILLA (page 1 only)                        |
| ASUNTO/SUBJECT: | 54HC LOW DOSE RADIATION TEST RESULTS                               |

Please, find attached the results of the irradiation tests performed by STM at low dose rate on the SILEX parts 54HC00, 54HC08, 54HC138, 54HC245 and 54HC4000.

In the case of the VTN and VTP parameters, the results presented in the first rows (SN XX thru CTRL, continuous line in the plot) correspond to the results of the measurements at Harwell. The rest of the figures represent the results of the measurements at STM (pre and post-irradiation, and post-annealing, SN XX' thru CTRL', dashed lines in the plots), which were not carried out in exactly the same conditions. -This values are presented in the STM tables of results as VTN/VTP (static)-.

The x axis of the plots is not to scale and, in order to simplify and accelerate the process of obtaining the plots, the results of irradiation and annealing are put together.

Apart from the failure of IDD1 for the HC00 and the decrease of IDD after the first irradiation step for the HC138, it is specially remarkable the rebound of the parameter VTN for the HC245, making this device to fail after the annealing.

The plots for the rest of the devices will be sent as soon as available (post-annealing results not received from STM yet).

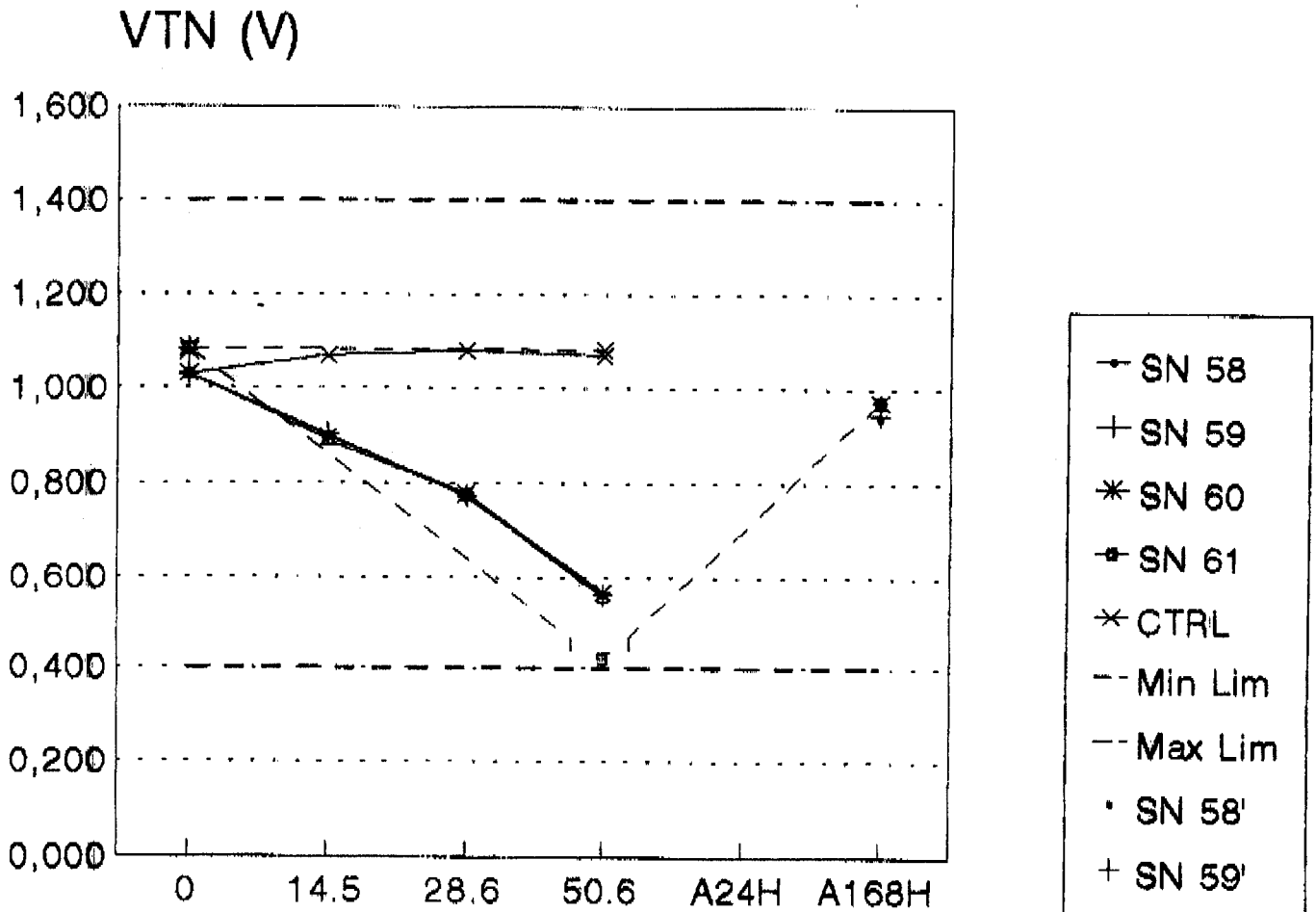
Best regards,

Jose M. Galdo / Parts Engineering

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# 54HC00

## Results of Low Dose Rate Radiation Testing Parameter VTN

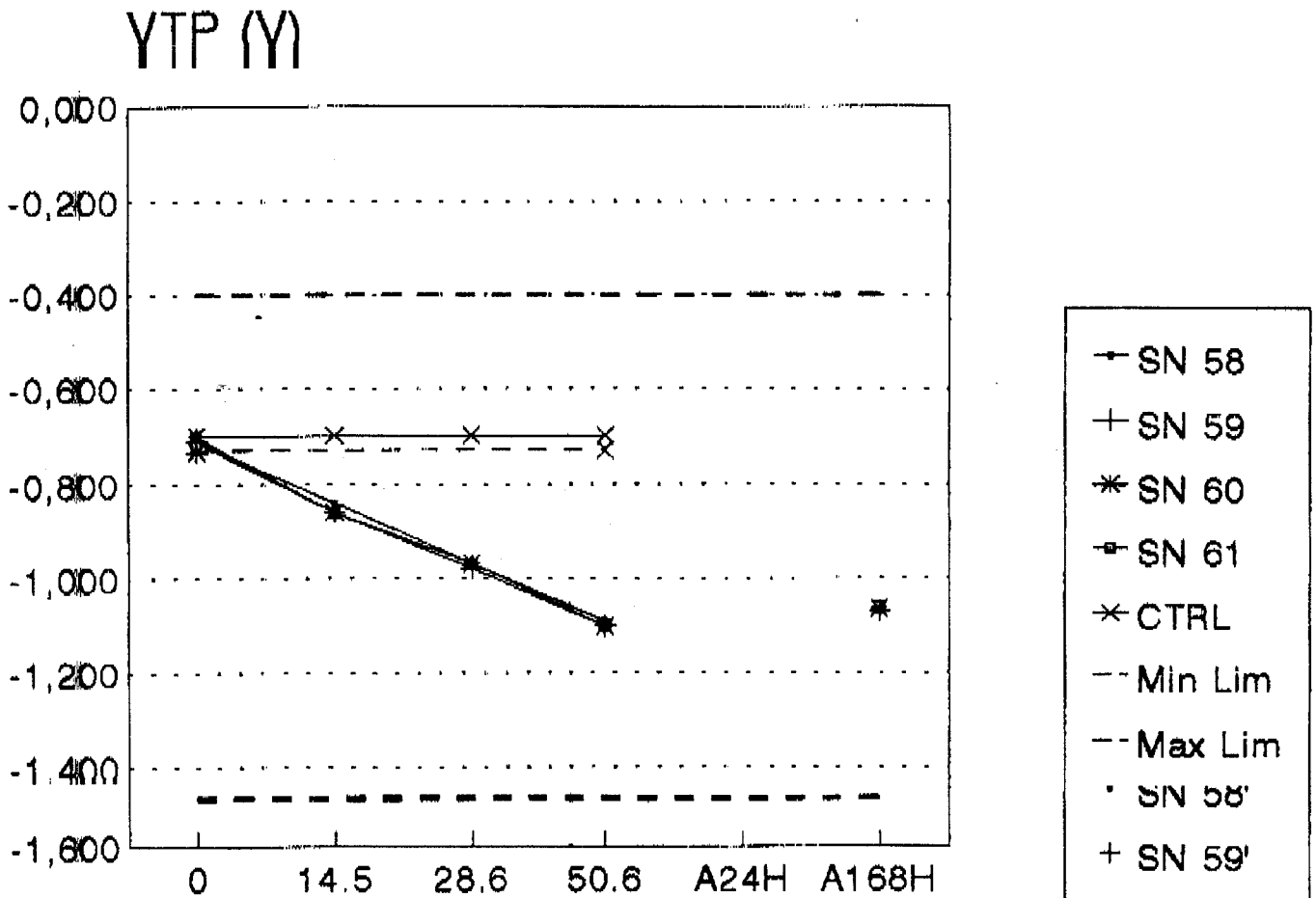


|        |       |       |       |       |  |       |
|--------|-------|-------|-------|-------|--|-------|
| SN 58  | 1,030 | 0,901 | 0,771 | 0,563 |  |       |
| SN 59  | 1,030 | 0,903 | 0,774 | 0,562 |  |       |
| SN 60  | 1,030 | 0,896 | 0,777 | 0,567 |  |       |
| SN 61  | 1,030 | 0,890 | 0,774 | 0,558 |  |       |
| CTRL   | 1,030 | 1,070 | 1,080 | 1,070 |  |       |
| SN 58' | 1,079 |       |       |       |  | 0,939 |
| SN 59' | 1,037 |       |       |       |  | 0,947 |
| SN 60' | 1,078 |       |       |       |  | 0,974 |
| SN 61' | 1,083 |       |       | 0,419 |  | 0,974 |
| CTRL'  | 1,085 |       |       | 1,082 |  |       |

krad (Si)

# 54HC00

## Results of Low Dose Rate Radiation Testing Parameter VTP

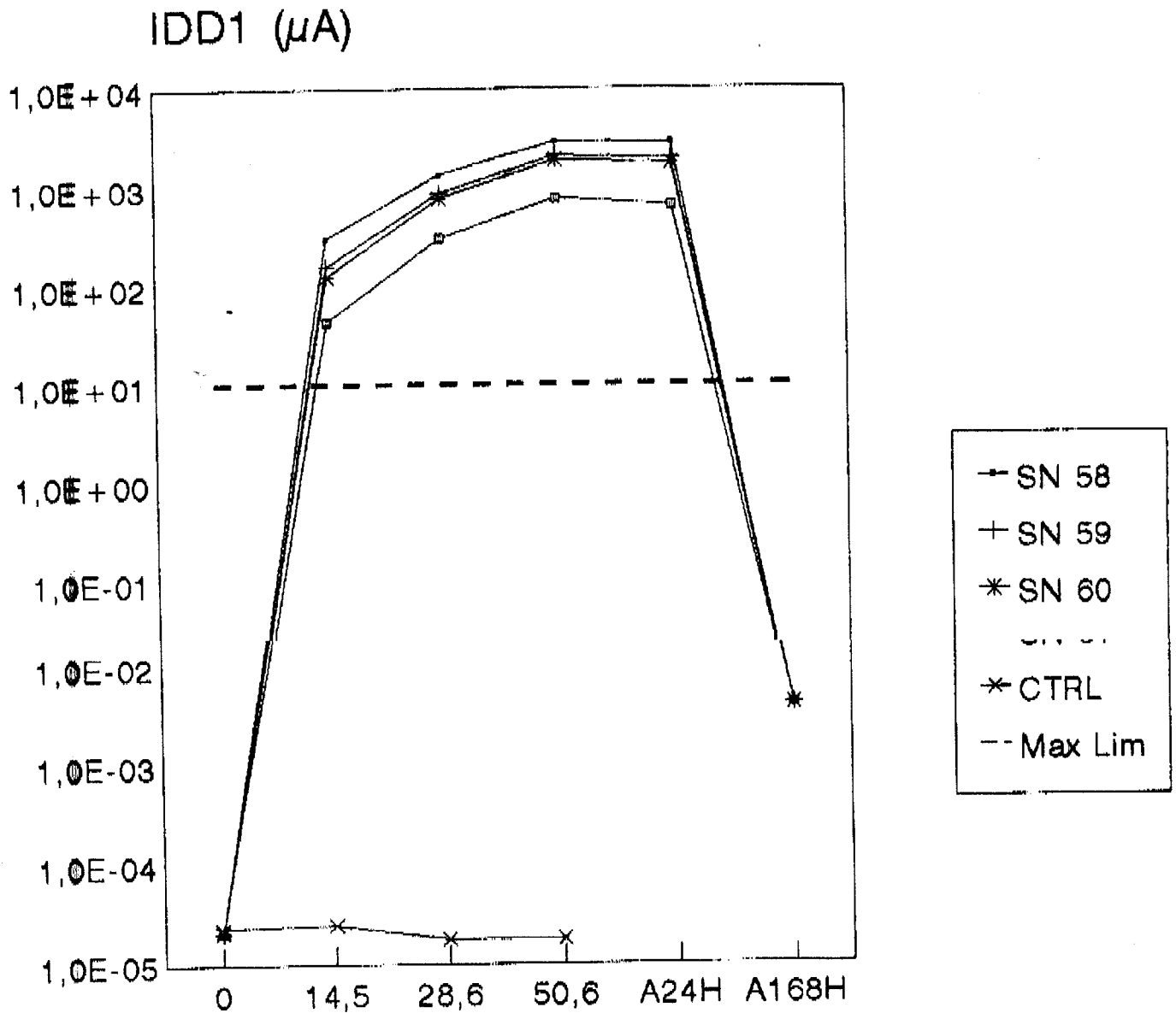


|        |        |        |        |        |  |        |
|--------|--------|--------|--------|--------|--|--------|
| SN 58  | -0,710 | -0,840 | -0,970 | -1,090 |  |        |
| SN 59  | -0,710 | -0,860 | -0,980 | -1,100 |  |        |
| SN 60  | -0,700 | -0,860 | -0,970 | -1,100 |  |        |
| SN 61  | -0,700 | -0,860 | -0,970 | -1,100 |  |        |
| CTRL   | -0,700 | -0,700 | -0,700 | -0,700 |  |        |
| SN 58' | -0,732 |        |        |        |  | -1,067 |
| SN 59' | -0,734 |        |        |        |  | -1,068 |
| SN 60' | -0,733 |        |        |        |  | -1,064 |
| SN 61' | -0,727 |        |        |        |  | -1,061 |
| CTRL'  | -0,730 |        |        | -0,729 |  |        |

krad (Si)

# 54HC00

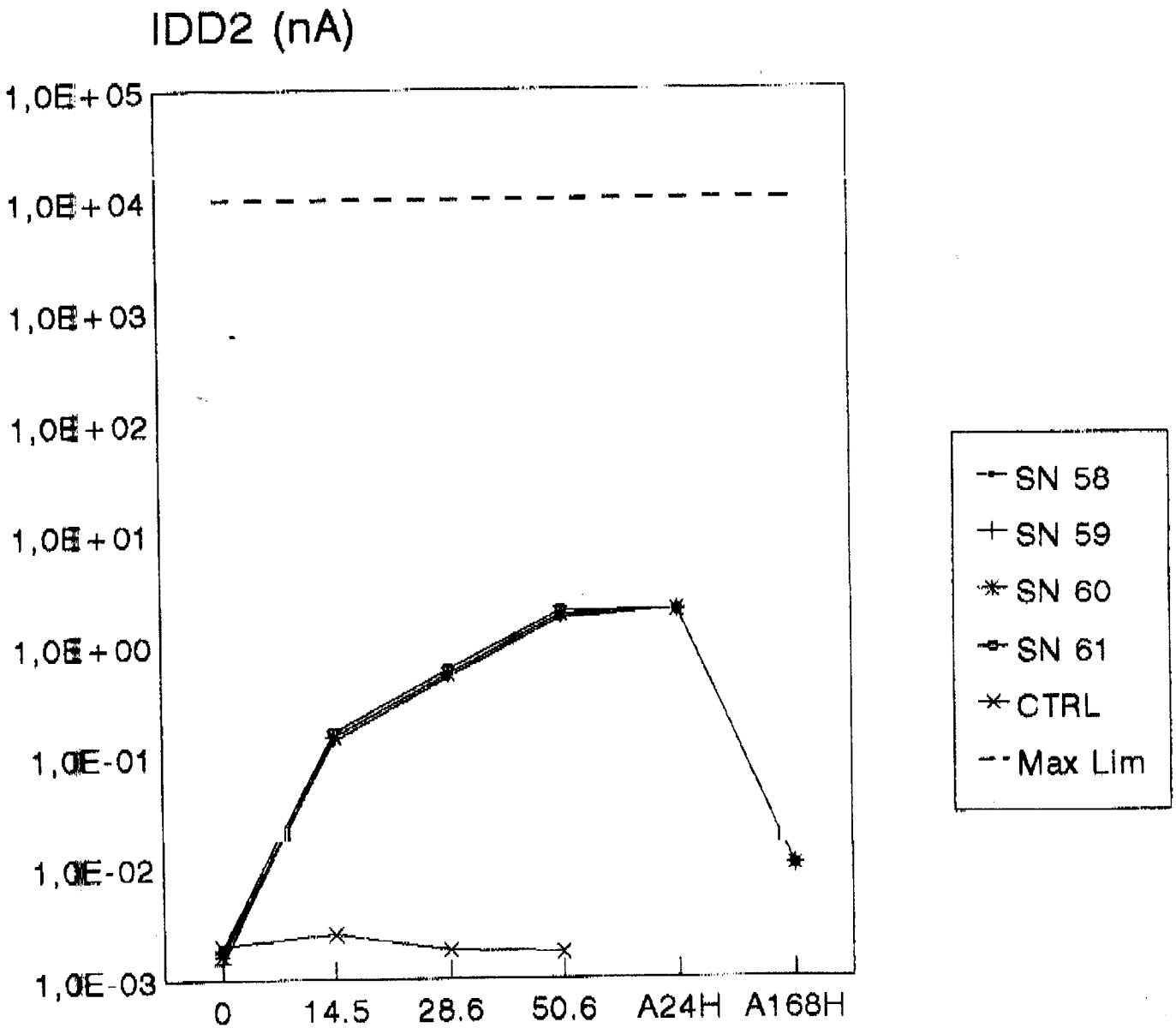
## Results of Low Dose Rate Radiation Testing Parameter IDD1



|       |         |         |         |         |         |         |
|-------|---------|---------|---------|---------|---------|---------|
| SN 58 | 2,1E-05 | 3,0E+02 | 1,3E+03 | 2,9E+03 | 2,8E+03 | 4,0E-03 |
| SN 59 | 2,1E-05 | 1,6E+02 | 8,7E+02 | 2,1E+03 | 1,9E+03 | 4,0E-03 |
| SN 60 | 2,1E-05 | 1,2E+02 | 7,7E+02 | 1,9E+03 | 1,7E+03 | 4,0E-03 |
| SN 61 | 2,1E-05 | 4,4E+01 | 3,0E+02 | 7,6E+02 | 6,4E+02 | 4,0E-03 |

# 54HC00

## Results of Low Dose Rate Radiation Testing Parameter IDD2



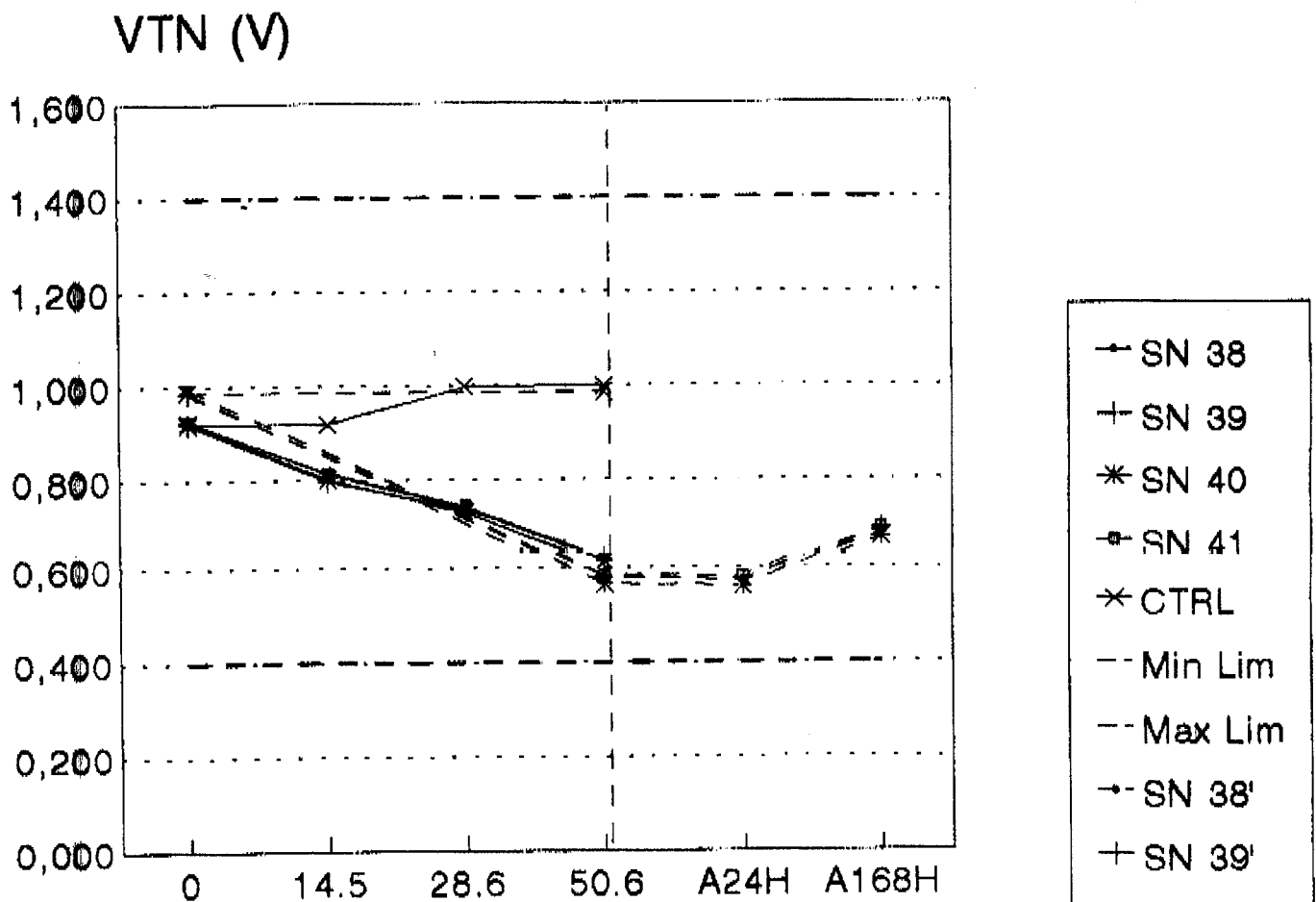
|       |         |         |         |         |         |         |
|-------|---------|---------|---------|---------|---------|---------|
| SN 58 | 1,7E-03 | 1,4E-01 | 5,1E-01 | 1,7E+00 | 2,0E+00 | 1,0E-02 |
| SN 59 | 1,4E-03 | 1,5E-01 | 5,5E-01 | 1,8E+00 | 2,0E+00 | 1,0E-02 |
| SN 60 | 1,6E-03 | 1,5E-01 | 5,5E-01 | 1,8E+00 | 2,0E+00 | 1,0E-02 |
| SN 61 | 1,9E-03 | 1,6E-01 | 6,0E-01 | 2,0E+00 | 2,0E+00 | 1,0E-02 |
| CTRL  | 2,0E-03 | 2,5E-03 | 1,8E-03 | 1,7E-03 |         |         |

krad (Si)

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# 54HC08

## Results of Low Dose Rate Radiation Testing Parameter VTN



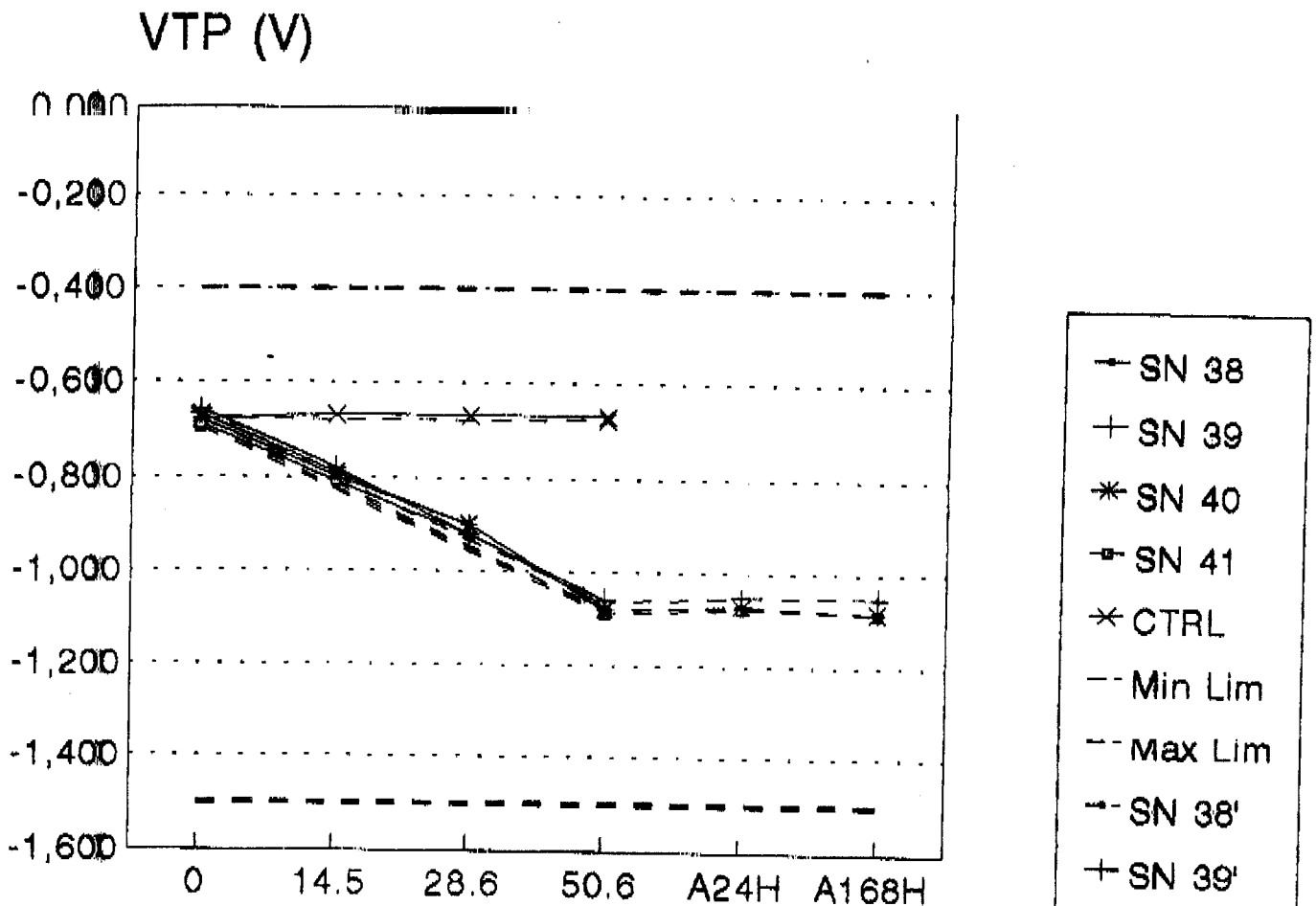
|        |       |       |       |       |       |       |
|--------|-------|-------|-------|-------|-------|-------|
| SN 38  | 0,928 | 0,813 | 0,740 | 0,630 |       |       |
| SN 39  | 0,920 | 0,796 | 0,736 | 0,630 |       |       |
| SN 40  | 0,925 | 0,801 | 0,730 | 0,614 |       |       |
| SN 41  | 0,927 | 0,815 | 0,743 | 0,631 |       |       |
| CTRL   | 0,920 | 0,920 | 0,999 | 1,000 |       |       |
| SN 38' | 0,996 |       |       | 0,580 | 0,573 | 0,682 |
| SN 39' | 0,985 |       |       | 0,581 | 0,572 | 0,692 |
| SN 40' | 0,989 |       |       | 0,565 | 0,560 | 0,674 |
| SN 41' | 0,996 |       |       | 0,584 | 0,581 | 0,694 |
| CTRL'  | 0,989 |       |       | 0,988 |       |       |

krad (Si)

# 54HC08

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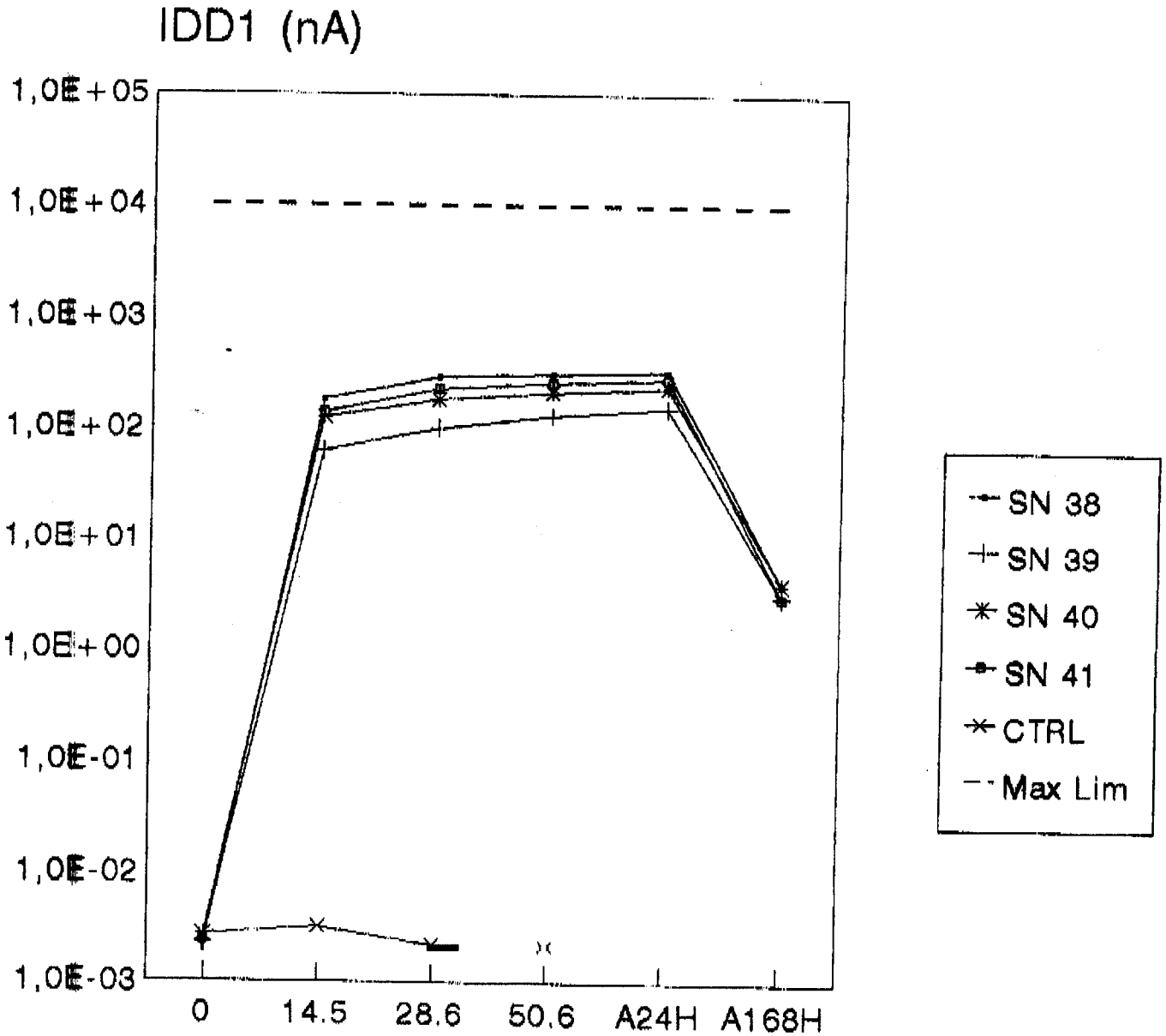
## Results of Low Dose Rate Radiation Testing Parameter VTP



|        |        |        |        |        |        |        |
|--------|--------|--------|--------|--------|--------|--------|
| SN 38  | -0,680 | -0,800 | -0,900 | -1,080 |        |        |
| SN 39  | -0,660 | -0,780 | -0,920 | -1,060 |        |        |
| SN 40  | -0,670 | -0,790 | -0,900 | -1,080 |        |        |
| SN 41  | -0,690 | -0,810 | -0,920 | -1,070 |        |        |
| CTRL   | -0,680 | -0,670 | -0,670 | -0,670 |        |        |
| SN 38' | -0,690 |        |        | -1,083 | -1,071 | -1,085 |
| SN 39' | -0,668 |        |        | -1,065 | -1,053 | -1,052 |
| SN 40' | -0,679 |        |        | -1,081 | -1,073 | -1,084 |
| SN 41' | -0,697 |        |        | -1,089 | -1,078 | -1,087 |
| CTRL'  | -0,681 |        |        | -0,678 |        |        |

# 54HC08

## Results of Low Dose Rate Radiation Testing Parameter IDD1



|       |         |         |         |         |         |         |
|-------|---------|---------|---------|---------|---------|---------|
| SN 38 | 2,3E-03 | 1,8E+02 | 2,9E+02 | 3,1E+02 | 3,4E+02 | 4,0E+00 |
| SN 39 | 2,4E-03 | 6,2E+01 | 1,0E+02 | 1,3E+02 | 1,6E+02 | 3,0E+00 |
| SN 40 | 2,8E-03 | 1,2E+02 | 1,8E+02 | 2,2E+02 | 2,4E+02 | 4,0E+00 |
| SN 41 | 2,5E-03 | 1,4E+02 | 2,3E+02 | 2,6E+02 | 2,8E+02 | 3,0E+00 |
| CTRL  | 2,8E-03 | 3,3E-03 | 2,3E-03 | 2,2E-03 |         |         |

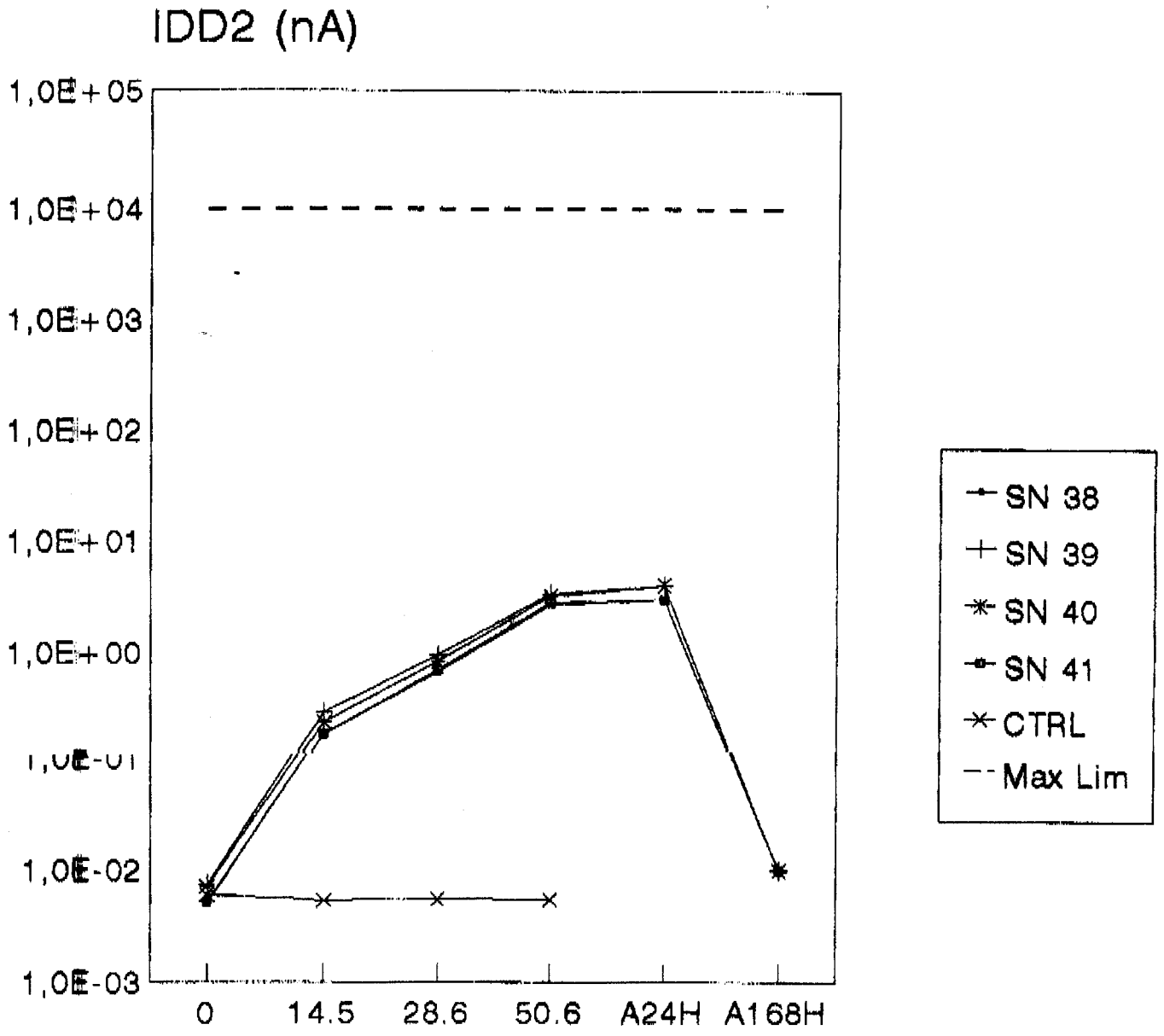
Load (Ω)



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# 54HC08

## Results of Low Dose Rate Radiation Testing Parameter IDD2

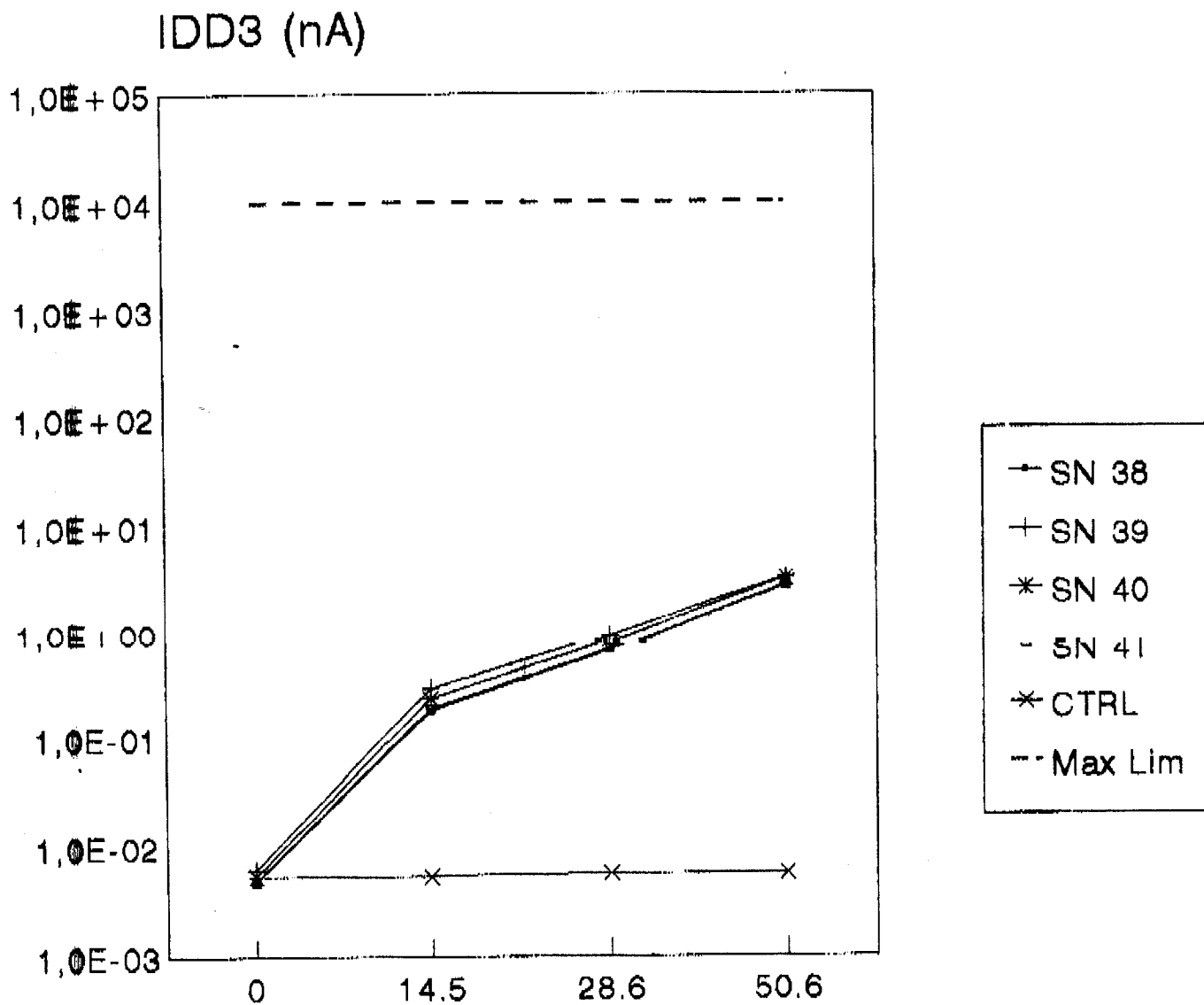


|       |         |         |         |         |         |         |
|-------|---------|---------|---------|---------|---------|---------|
| SN 38 | 5,1E-03 | 1,8E-01 | 6,8E-01 | 2,7E+00 | 3,0E+00 | 1,0E-02 |
| SN 39 | 7,4E-03 | 2,9E-01 | 9,6E-01 | 3,4E+00 | 4,0E+00 | 1,0E-02 |
| SN 40 | 7,1E-03 | 2,3E-01 | 8,3E-01 | 3,2E+00 | 4,0E+00 | 1,0E-02 |
| SN 41 | 5,2E-03 | 1,8E-01 | 6,8E-01 | 2,8E+00 | 3,0E+00 | 1,0E-02 |
| CTRL  | 6,0E-03 | 5,3E-03 | 5,5E-03 | 5,4E-03 |         |         |

# 54HC08

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## Results of Low Dose Rate Radiation Testing Parameter IDD3

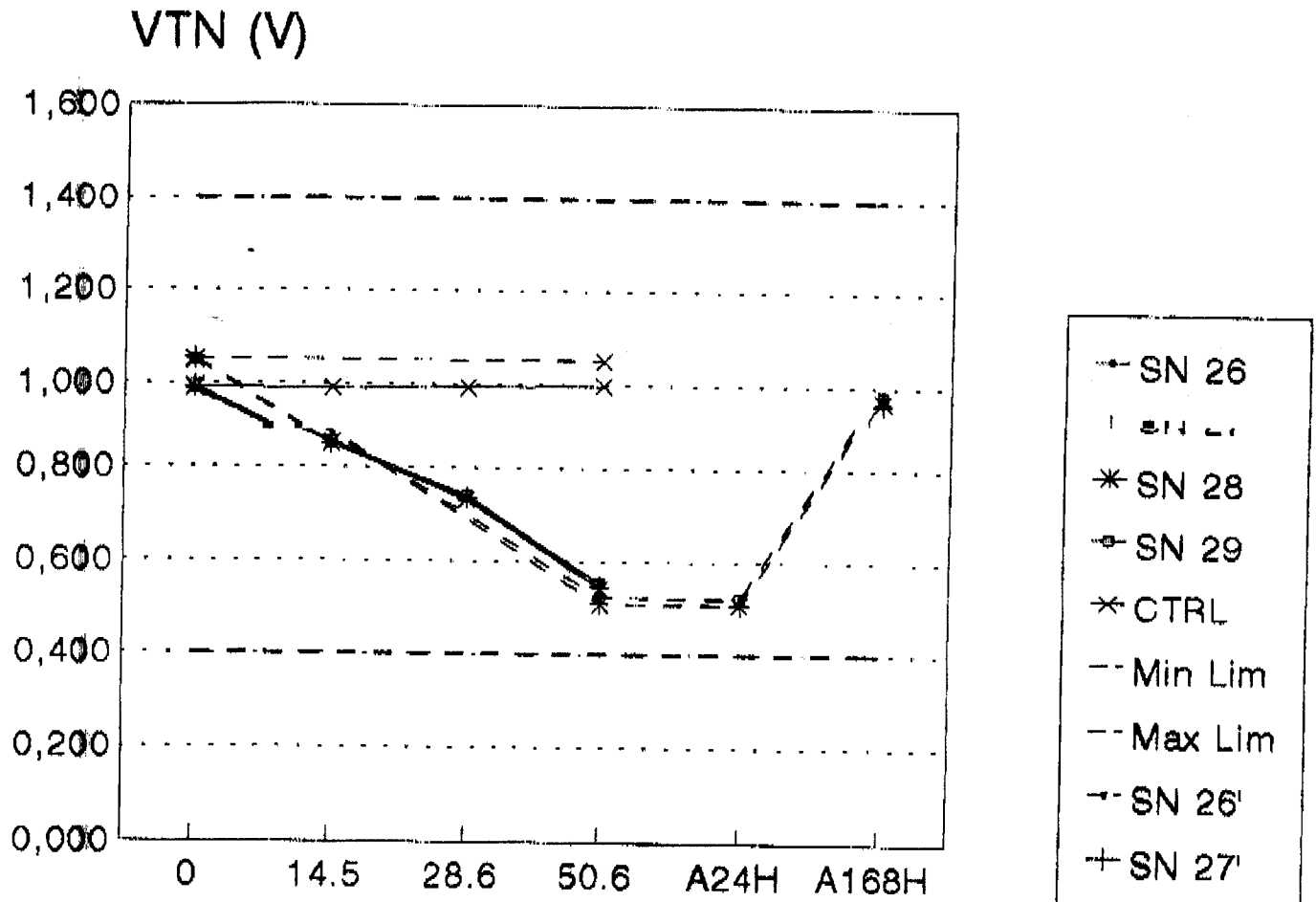


|       |         |         |         |         |
|-------|---------|---------|---------|---------|
| SN 38 | 4,8E-03 | 1,8E-01 | 6,7E-01 | 2,7E+00 |
| SN 39 | 6,2E-03 | 2,9E-01 | 9,5E-01 | 3,3E+00 |
| SN 40 | 5,4E-03 | 2,3E-01 | 8,3E-01 | 3,2E+00 |
| SN 41 | 4,9E-03 | 1,9E-01 | 6,9E-01 | 2,8E+00 |
| CTRL  | 5,3E-03 | 5,3E-03 | 5,6E-03 | 5,6E-03 |

# 54HC138

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## Results of Low Dose Rate Radiation Testing Parameter VTN



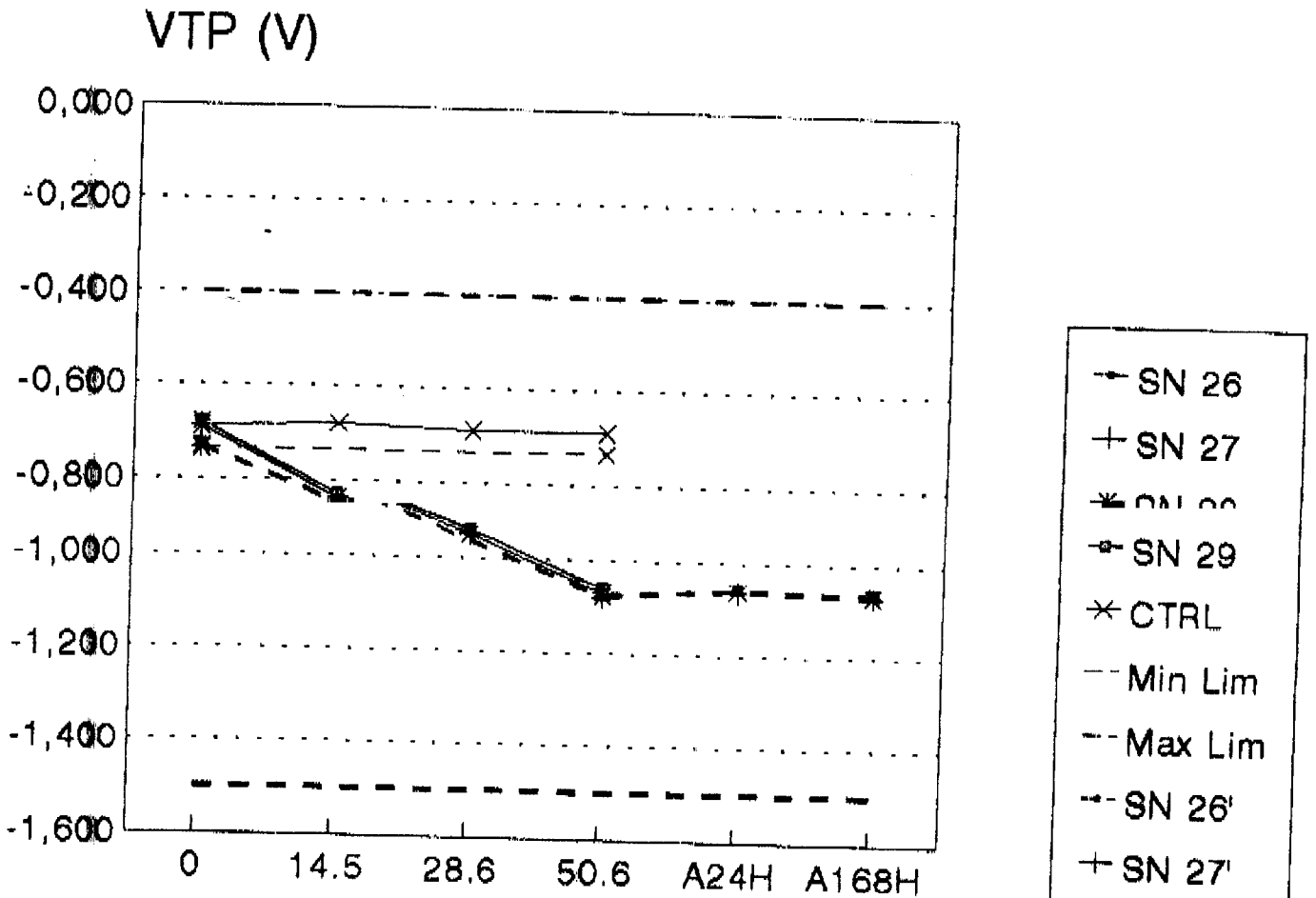
|        |       |       |       |       |       |       |
|--------|-------|-------|-------|-------|-------|-------|
| SN 26  | 0,986 | 0,849 | 0,733 | 0,552 |       |       |
| SN 27  | 0,994 | 0,848 | 0,734 | 0,545 |       |       |
| SN 28  | 0,996 | 0,852 | 0,738 | 0,553 |       |       |
| CTRL   | 0,993 | 0,991 | 0,995 | 0,999 |       |       |
| SN 26' | 1,050 |       |       | 0,523 | 0,518 | 0,978 |
| SN 27' | 1,055 |       |       | 0,508 | 0,506 | 0,963 |
| SN 28' | 1,049 |       |       | 0,508 | 0,507 | 0,968 |
| SN 29' | 1,051 |       |       | 0,522 | 0,522 | 0,982 |
| CTRL'  | 1,052 |       |       | 1,052 |       |       |

krad (Si)

# 54HC138

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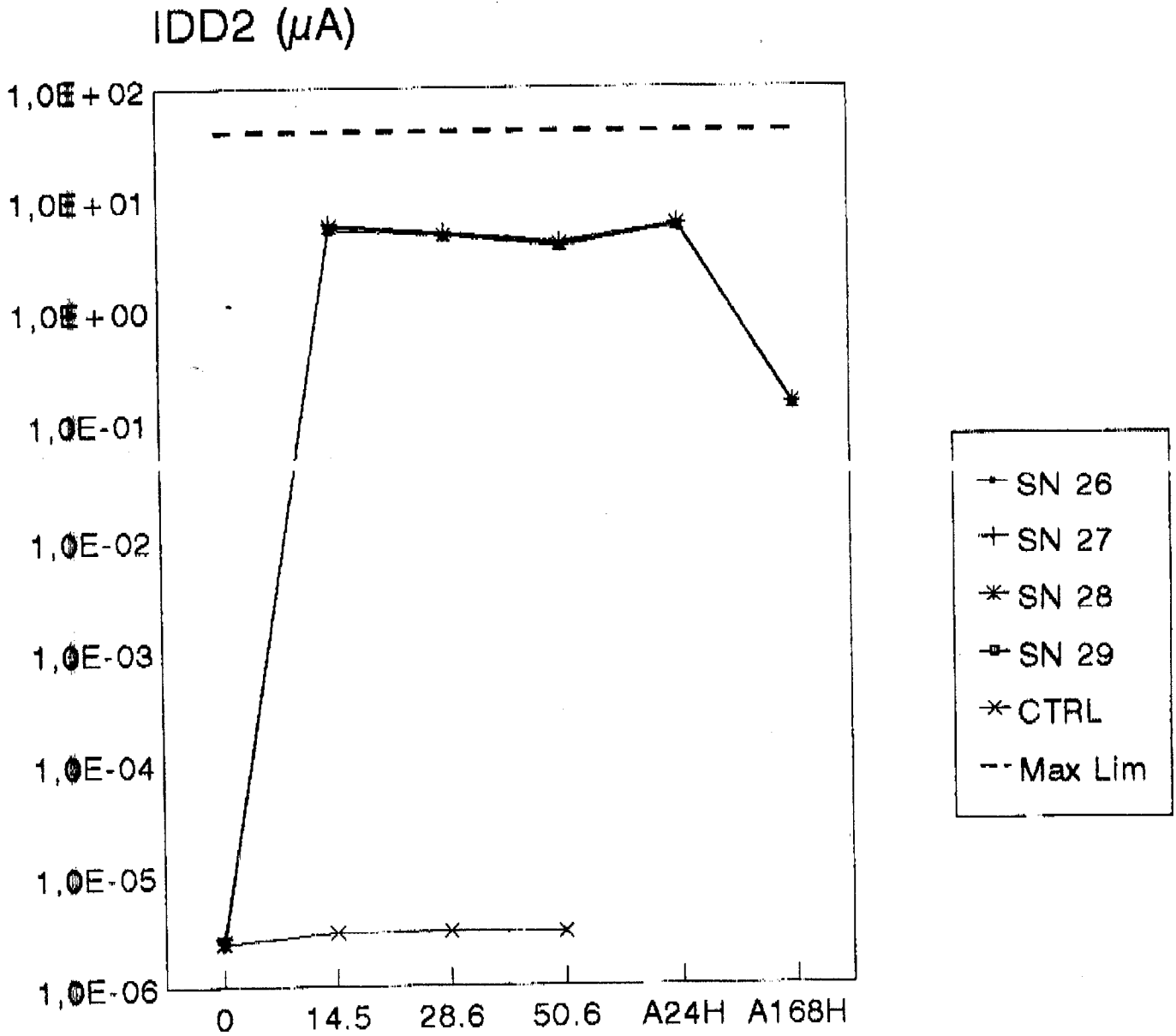
## Results of Low Dose Rate Radiation Testing Parameter VTP



|        |        |        |        |        |        |        |
|--------|--------|--------|--------|--------|--------|--------|
| SN 26  | -0,690 | -0,840 | -0,940 | -1,060 |        |        |
| SN 27  | -0,690 | -0,840 | -0,950 | -1,070 |        |        |
| SN 28  | -0,680 | -0,840 | -0,950 | -1,070 |        |        |
| SN 29  | -0,690 | -0,840 | -0,950 | -1,070 |        |        |
| CTRL   | -0,690 | -0,680 | -0,690 | -0,690 |        |        |
| SN 26' | -0,731 |        |        | -1,074 | -1,059 | -1,066 |
| SN 27' | -0,736 |        |        | -1,080 | -1,065 | -1,073 |
| SN28'  | -0,732 |        |        | -1,078 | -1,062 | -1,068 |
| SN 29' | -0,729 |        |        | -1,074 | -1,058 | -1,062 |
| CTRL'  | -0,737 |        |        | -0,735 |        |        |

# 54HC138

## Results of Low Dose Rate Radiation Testing Parameter IDD2

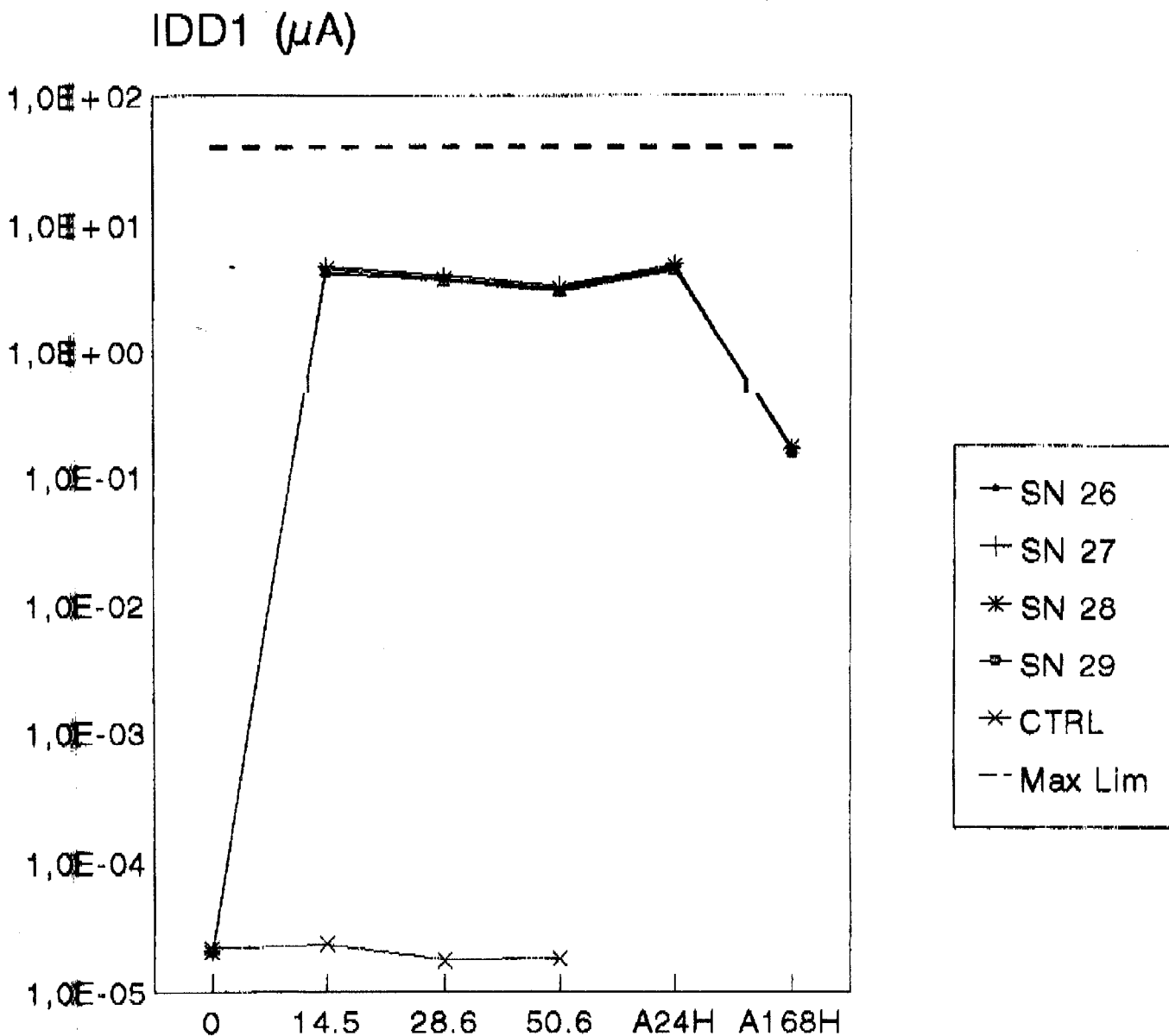


|       |         |         |         |         |         |         |
|-------|---------|---------|---------|---------|---------|---------|
| SN 26 | 2.2E-06 | 5.2E+00 | 4.5E+00 | 3.7E+00 | 5.6E+00 | 1.4E-01 |
| SN 27 | 2.7E-06 | 5.9E+00 | 4.9E+00 | 4.0E+00 | 5.9E+00 | 1.4E-01 |
| SN 28 | 2.5E-06 | 5.6E+00 | 4.7E+00 | 3.8E+00 | 5.7E+00 | 1.4E-01 |
| SN 29 | 2.6E-06 | 5.2E+00 | 4.5E+00 | 3.7E+00 | 5.5E+00 | 1.4E-01 |
| CTRL  | 2.4E-06 | 3.0E-06 | 3.1E-06 | 3.0E-06 |         |         |

krad (Si)

# 54HC138

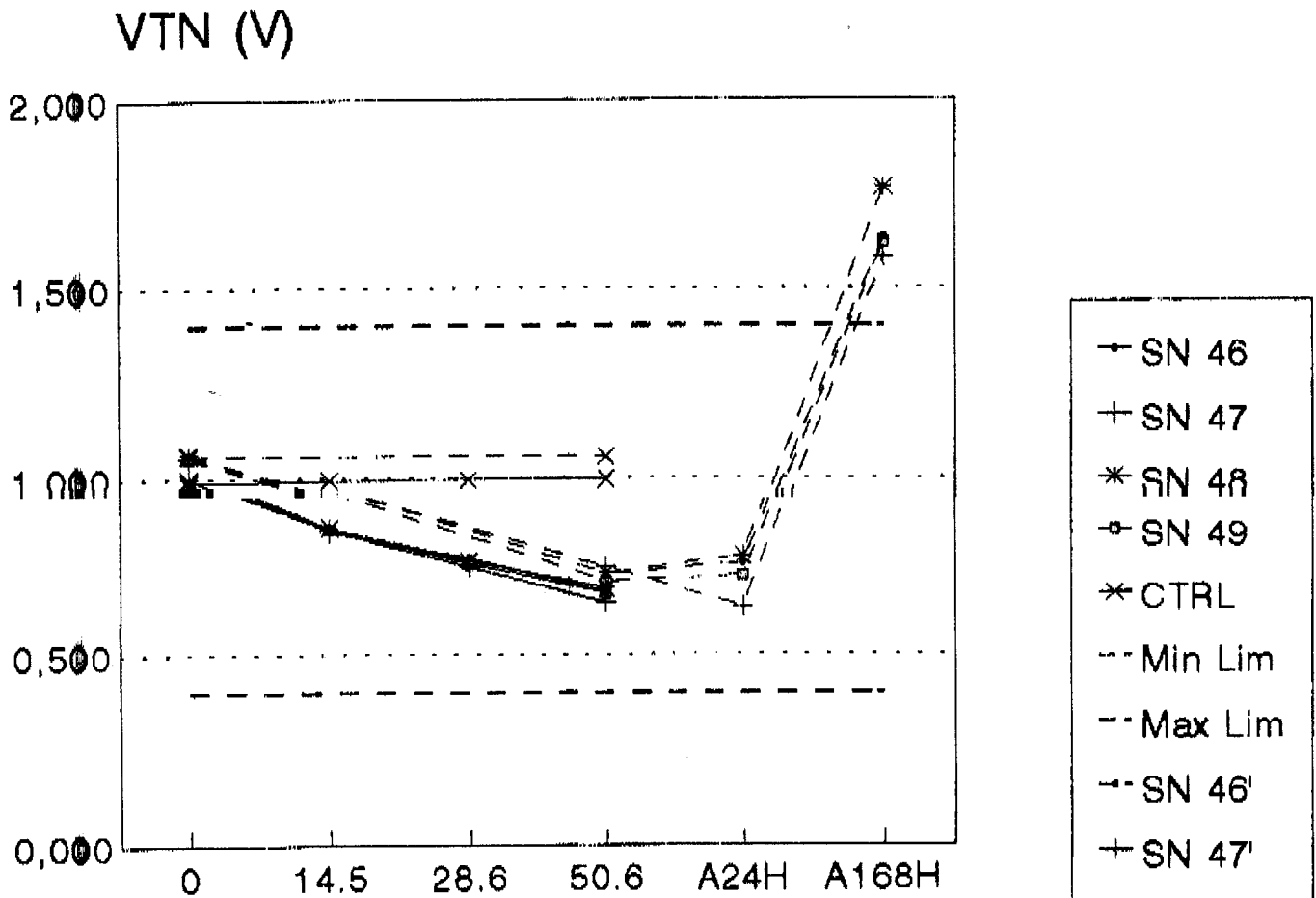
## Results of Low Dose Rate Radiation Testing Parameter IDD1



|       |         |         |         |         |         |         |
|-------|---------|---------|---------|---------|---------|---------|
| SN 26 | 2,0E-05 | 4,2E+00 | 3,7E+00 | 3,1E+00 | 4,5E+00 | 1,5E-01 |
| SN 27 | 2,1E-05 | 4,6E+00 | 3,9E+00 | 3,2E+00 | 4,8E+00 | 1,6E-01 |
| SN 28 | 2,0E-05 | 4,4E+00 | 3,7E+00 | 3,1E+00 | 4,7E+00 | 1,7E-01 |
| SN 29 | 2,1E-05 | 4,1E+00 | 3,6E+00 | 2,9E+00 | 4,4E+00 | 1,5E-01 |
| CTRL  | 2,2E-05 | 2,4E-05 | 1,8E-05 | 1,8E-05 |         |         |

# 54HC245

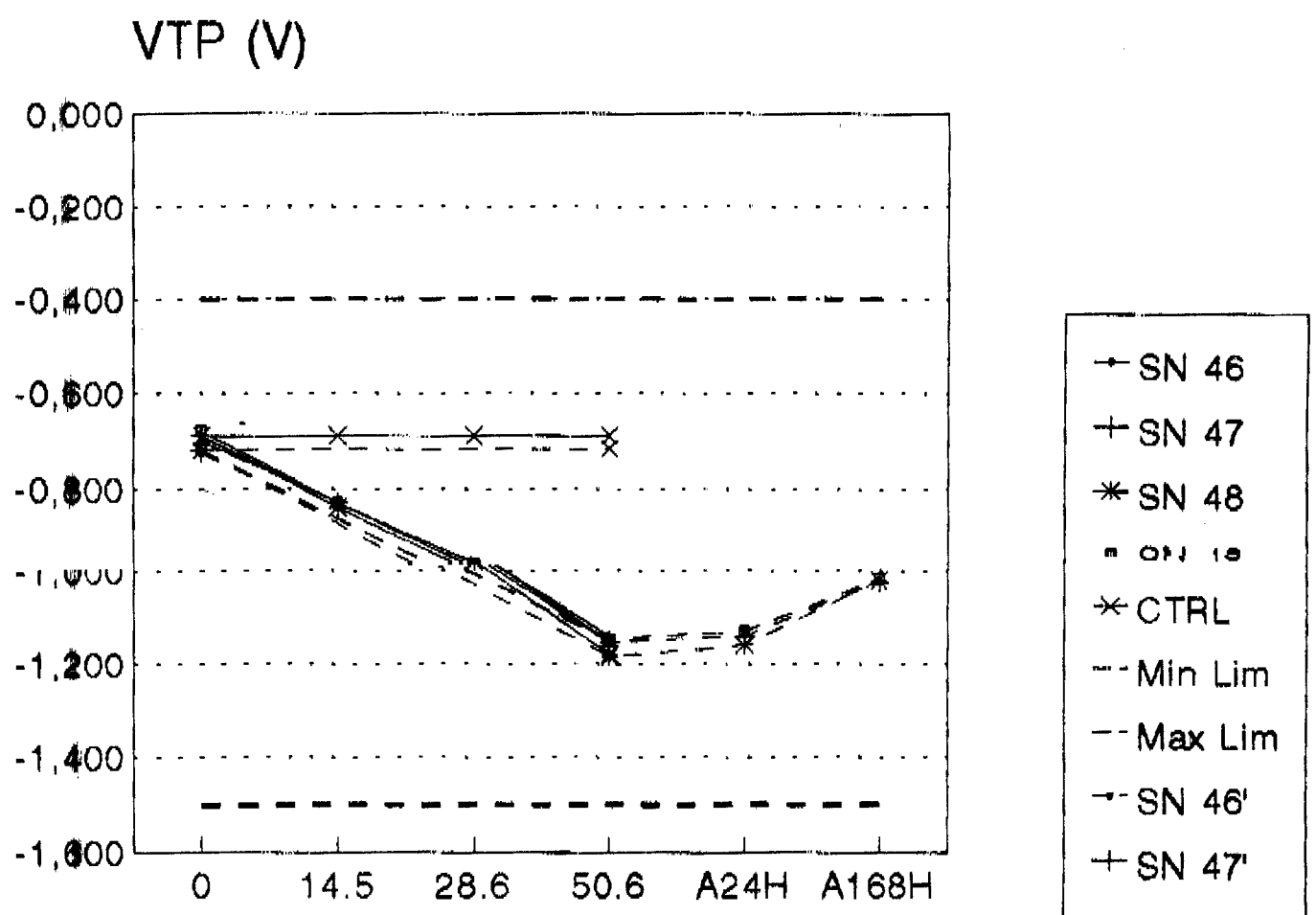
## Results of Low Dose Rate Radiation Testing Parameter VIN



|        |       |       |       |       |       |       |
|--------|-------|-------|-------|-------|-------|-------|
| SN 46  | 0,981 | 0,834 | 0,755 | 0,666 |       |       |
| SN 47  | 0,977 | 0,829 | 0,734 | 0,637 |       |       |
| SN 48  | 0,997 | 0,837 | 0,748 | 0,674 |       |       |
| SN 49  | 0,984 | 0,834 | 0,741 | 0,661 |       |       |
| CTRL   | 0,988 | 0,993 | 0,994 | 0,995 |       |       |
| SN 46' | 1,061 |       |       | 0,715 | 0,744 | 1,632 |
| SN 47' | 1,053 |       |       | 0,733 | 0,626 | 1,582 |
| SN 48' | 1,064 |       |       | 0,715 | 0,762 | 1,765 |
| SN 49' | 1,054 |       |       | 0,695 | 0,709 | 1,619 |
|        |       |       |       | 1,056 |       |       |

# 54HC245

## Results of Low Dose Rate Radiation Testing Paramotor VTP



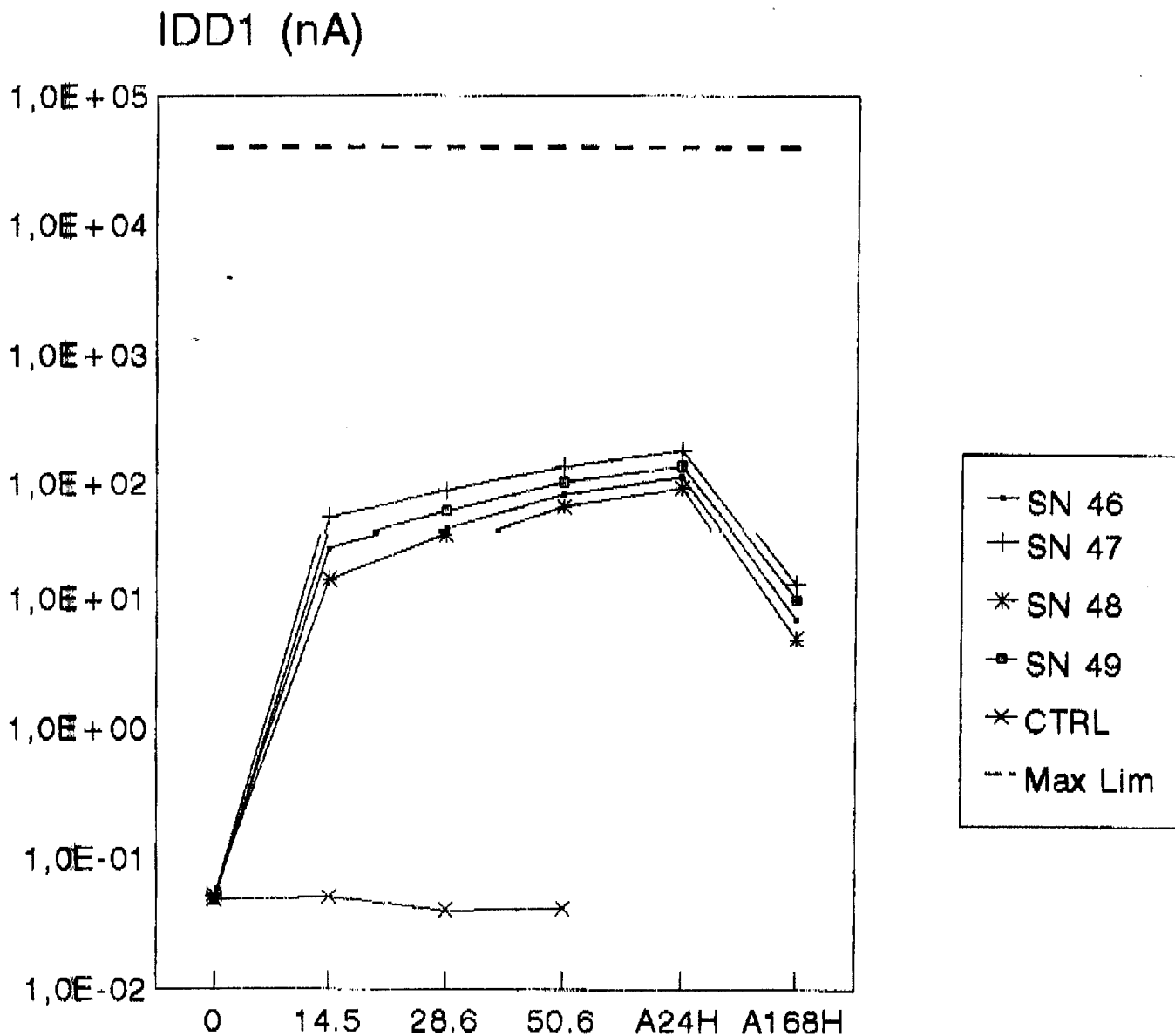
|        |        |        |        |        |        |        |
|--------|--------|--------|--------|--------|--------|--------|
| SN 46  | -0,700 | -0,830 | -0,960 | -1,140 |        |        |
| SN 47  | -0,690 | -0,830 | -0,970 | -1,153 |        |        |
| SN 48  | -0,690 | -0,840 | -0,980 | -1,180 |        |        |
| SN 49  | -0,680 | -0,830 | -0,960 | -1,150 |        |        |
| CTRL   | -0,690 | -0,690 | -0,690 | -0,690 |        |        |
| SN 46' | -0,725 |        |        | -1,146 | -1,130 | -1,024 |
| SN 47' | -0,720 |        |        | -1,153 | -1,140 | -1,026 |
| SN 48' | -0,720 |        |        | -1,185 | -1,160 | -1,022 |
| SN 49' | -0,718 |        |        | -1,151 | -1,130 | -1,017 |
| CTRL'  | -0,719 |        |        | -0,718 |        |        |



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# 54HC245

## Results of Low Dose Rate Radiation Testing Parameter IDD1



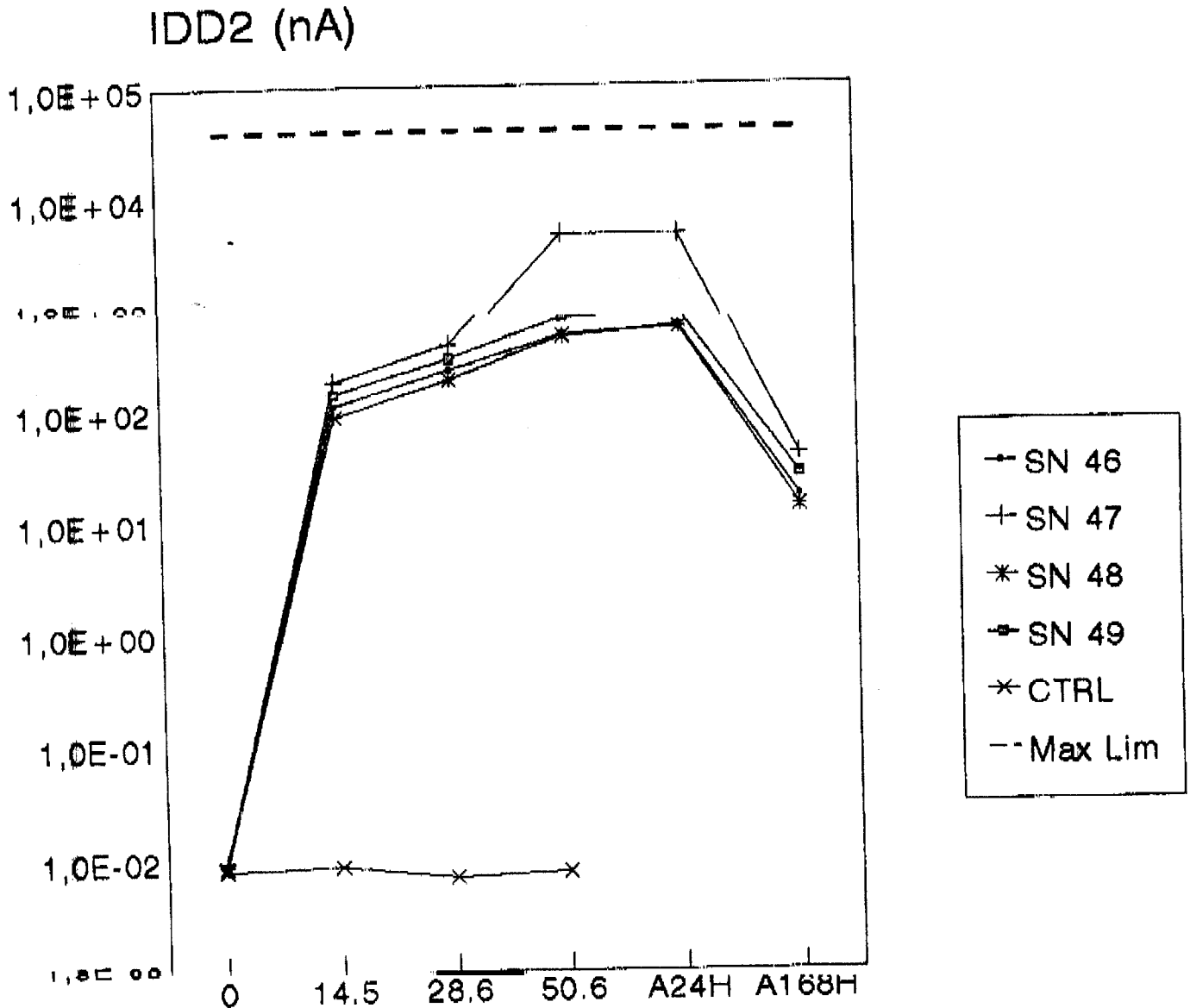
|       |         |         |         |         |         |         |
|-------|---------|---------|---------|---------|---------|---------|
| SN 46 | 5,1E-02 | 2,4E+01 | 4,4E+01 | 8,1E+01 | 1,1E+02 | 7,0E+00 |
| SN 47 | 5,3E-02 | 5,4E+01 | 8,7E+01 | 1,3E+02 | 1,2E+02 | 1,2E+01 |
| SN 48 | 5,3E-02 | 1,4E+01 | 3,1E+01 | 6,5E+01 | 9,1E+01 | 5,0E+00 |
| SN 49 | 4,8E-02 | 3,4E+01 | 6,0E+01 | 1,0E+02 | 1,4E+02 | 1,0E+01 |
| CTRL  | 4,9E-02 | 5,0E-02 | 4,0E-02 | 4,1E-02 |         |         |

krad (Si)

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# 54HC245

## Results of Low Dose Rate Radiation Testing Parameter IDD2



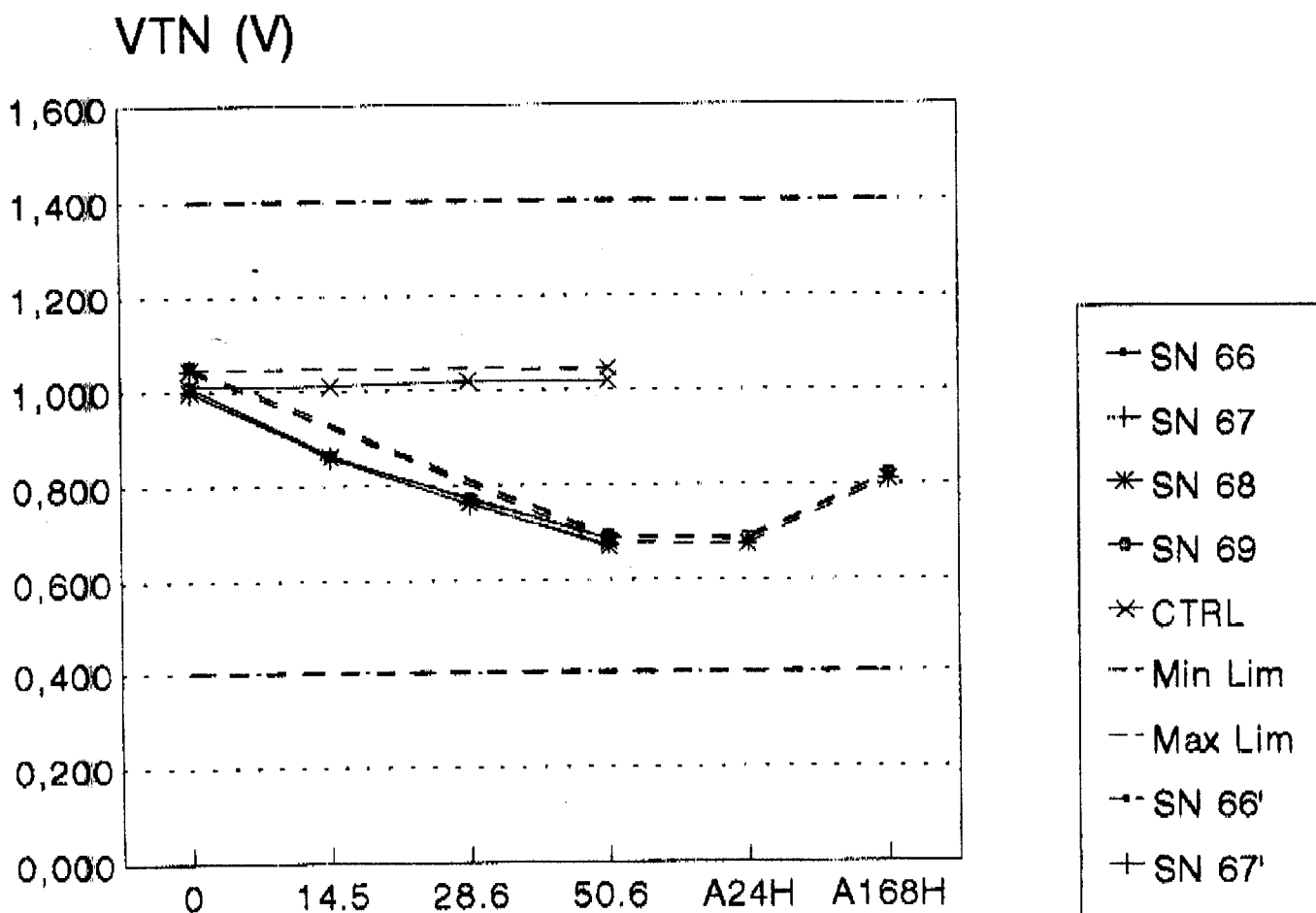
|       |         |         |         |         |         |         |
|-------|---------|---------|---------|---------|---------|---------|
| SN 46 | 8,7E-03 | 1,1E+02 | 2,2E+02 | 4,5E+02 | 5,4E+02 | 1,6E+01 |
| SN 47 | 9,7E-03 | 1,8E+02 | 3,7E+02 | 4,7E+03 | 4,7E+03 | 3,8E+01 |
| SN 48 | 8,8E-03 | 8,6E+01 | 1,8E+02 | 4,4E+02 | 5,1E+02 | 1,3E+01 |
| SN 49 | 8,8E-03 | 1,4E+02 | 2,8E+02 | 6,5E+02 | 7,2E+02 | 2,5E+01 |
| CTRL  | 8,2E-03 | 8,7E-03 | 6,9E-03 | 7,6E-03 |         |         |

krad (Si)

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# 54HC4050

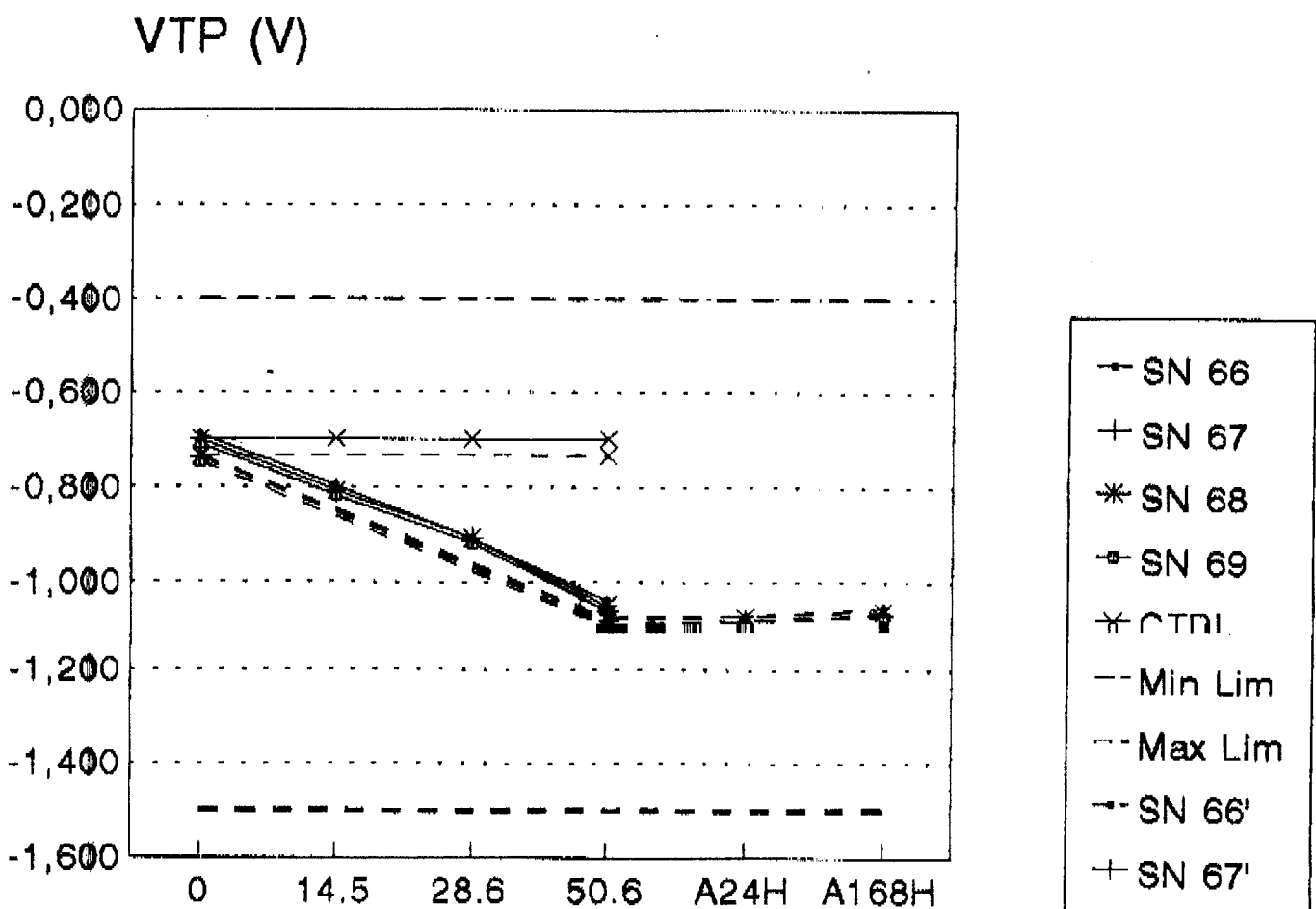
## Results of Low Dose Rate Radiation Testing Parameter VTN



|        |       |       |       |       |       |       |
|--------|-------|-------|-------|-------|-------|-------|
| SN 66  | 1,000 | 0,862 | 0,772 | 0,684 |       |       |
| SN 67  | 1,000 | 0,859 | 0,761 | 0,673 |       |       |
| SN 68  | 1,000 | 0,859 | 0,761 | 0,669 |       |       |
| SN 69  | 1,010 | 0,863 | 0,771 | 0,685 |       |       |
| CTRL   | 1,010 | 1,010 | 1,020 | 1,020 |       |       |
| SN 66' | 1,044 |       |       | 0,689 | 0,682 | 0,817 |
| SN 67' | 1,046 |       |       | 0,677 | 0,674 | 0,810 |
| SN 68' | 1,045 |       |       | 0,678 | 0,673 | 0,809 |
| SN 69' | 1,052 |       |       | 0,692 | 0,688 | 0,821 |
| CTRL'  | 1,047 |       |       | 1,046 |       |       |

# 54HC4050

## Results of Low Dose Rate Radiation Testing Parameter VTP

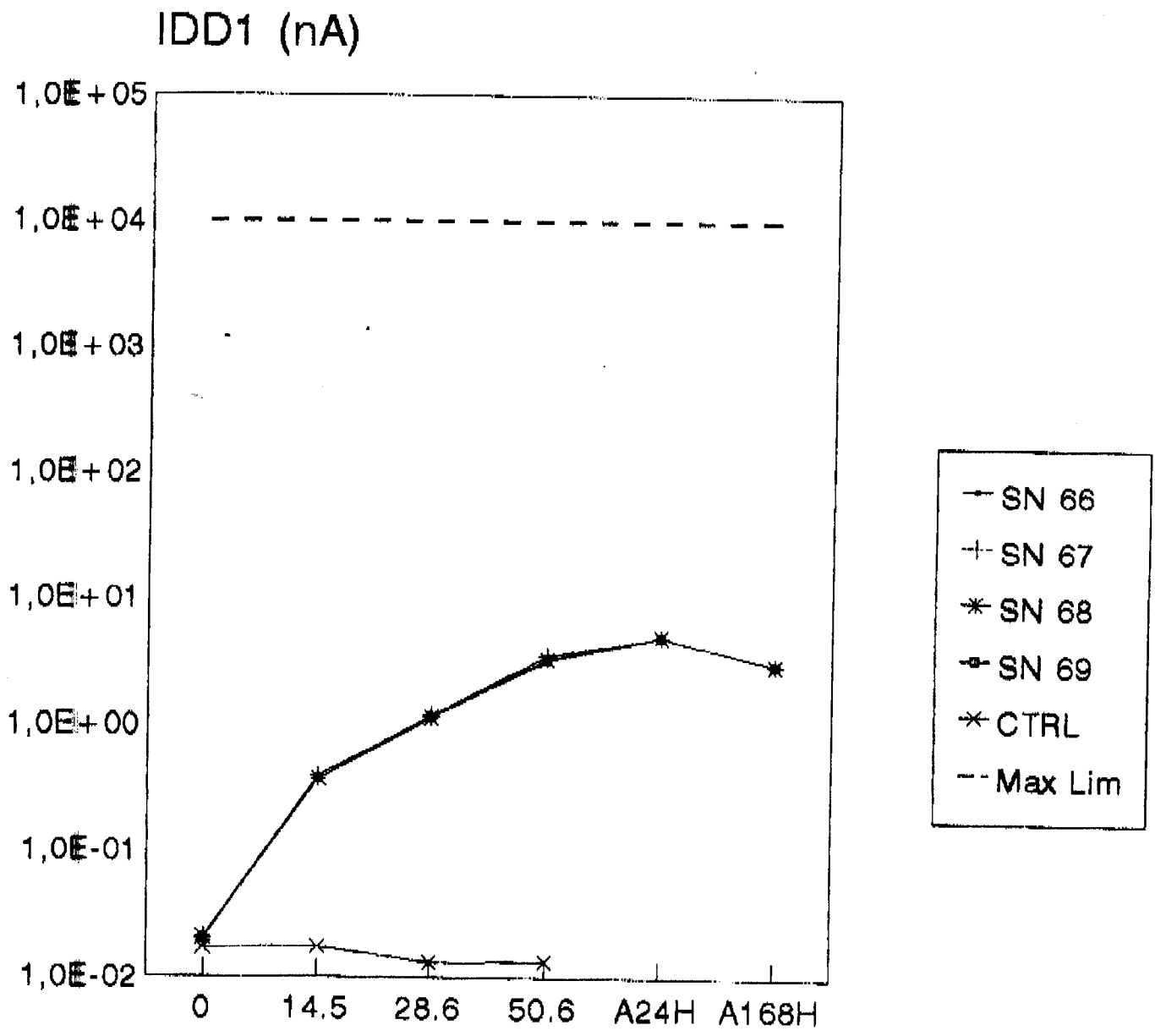


|         |        |        |        |        |        |        |
|---------|--------|--------|--------|--------|--------|--------|
| SN 66   | -0,690 | -0,800 | -0,910 | -1,040 |        |        |
| SN 67   | -0,700 | -0,810 | -0,910 | -1,060 |        |        |
| SN 68   | -0,700 | -0,810 | -0,910 | -1,050 |        |        |
| SN 69   | -0,710 | -0,820 | -0,920 | -1,060 |        |        |
| CTRL    | -0,700 | -0,700 | -0,700 | -0,700 |        |        |
| Min Lim | -0,704 |        |        | -1,075 | -1,072 | -1,054 |
| SN 66'  | -0,739 |        |        | -1,089 | -1,080 | -1,068 |
| SN 68'  | -0,739 |        |        | -1,081 | -1,072 | -1,062 |
| SN 69'  | -0,749 |        |        | -1,093 | -1,083 | -1,073 |
| CTRL'   | -0,735 |        |        | -0,734 |        |        |

- SN 66
- + SN 67
- \* SN 68
- SN 69
- × CTRL
- - Min Lim
- - Max Lim
- - SN 66'
- + SN 67'
- \* SN 68'
- SN 69'
- × CTRL'

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## Results of Low Dose Rate Radiation Testing Parameter IDD1

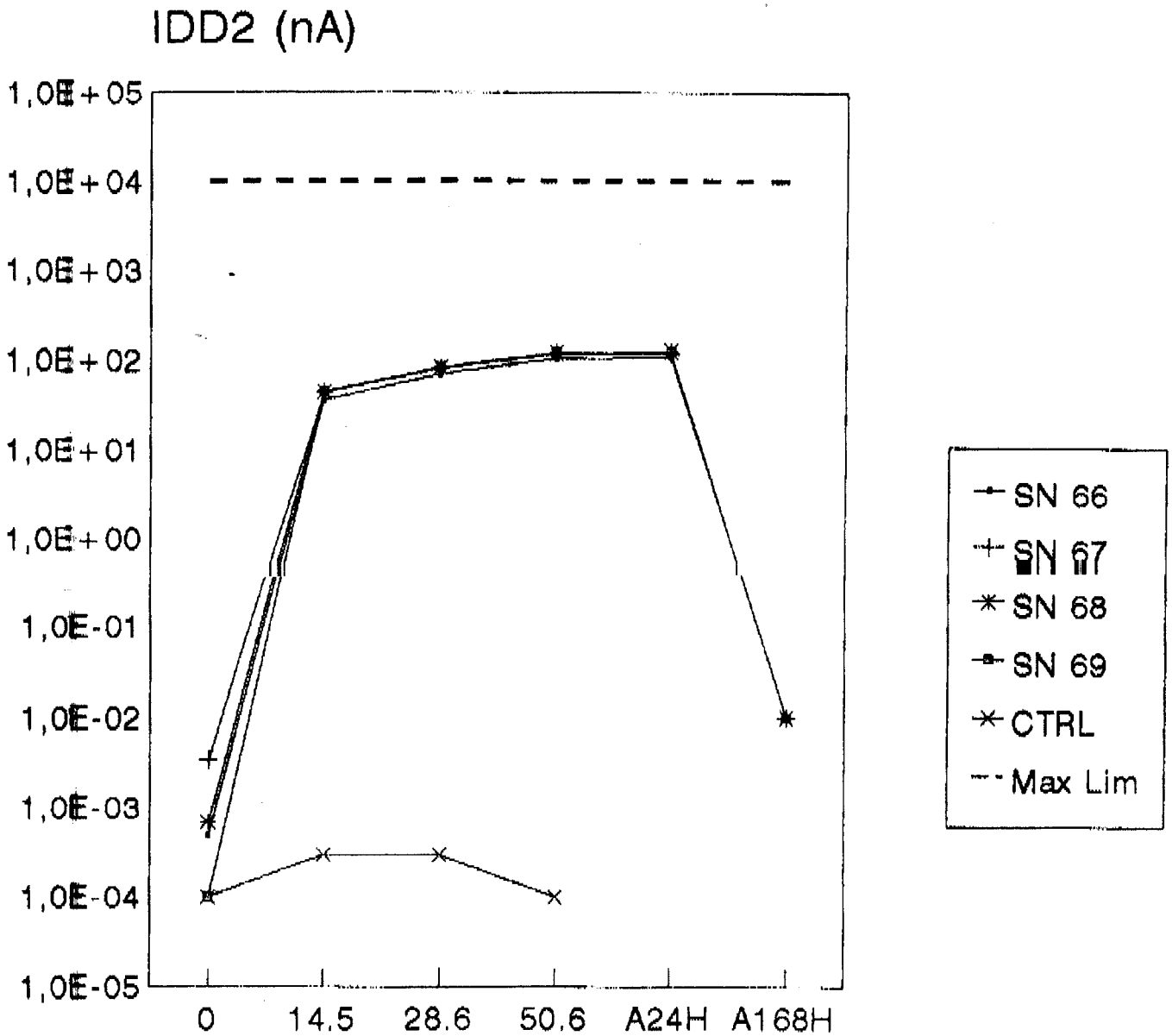


|       |         |         |         |         |         |         |
|-------|---------|---------|---------|---------|---------|---------|
| SN 66 | 2,0E-02 | 3,8E-01 | 1,1E+00 | 3,3E+00 | 5,0E+00 | 3,0E+00 |
| SN 67 | 2,1E-02 | 3,9E-01 | 1,2E+00 | 3,5E+00 | 5,0E+00 | 3,0E+00 |
| SN 68 | 2,1E-02 | 3,8E-01 | 1,1E+00 | 3,3E+00 | 5,0E+00 | 3,0E+00 |
| SN 69 | 2,0E-02 | 3,8E-01 | 1,2E+00 | 3,3E+00 | 5,0E+00 | 3,0E+00 |
| CTRL  | 1,7E-02 | 1,7E-02 | 1,3E-02 | 1,3E-02 |         |         |

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## Results of Low Dose Rate Radiation Testing Parameter IDD2



|       |         |         |         |         |         |         |
|-------|---------|---------|---------|---------|---------|---------|
| SN 66 | 5,0E-04 | 3,7E+01 | 7,2E+01 | 1,1E+02 | 1,1E+02 | 1,0E-02 |
| SN 67 | 3,5E-03 | 4,5E+01 | 8,2E+01 | 1,2E+02 | 1,2E+02 | 1,0E-02 |
| SN 68 | 7,0E-04 | 4,5E+01 | 8,5E+01 | 1,0E+02 | 1,0E+02 | 1,0E-02 |
| SN 69 | 1,0E-04 | 4,6E+01 | 8,6E+01 | 1,2E+02 | 1,3E+02 | 1,0E-02 |
| CTRL  | 1,0E-04 | 3,0E-04 | 3,0E-04 | 1,0E-04 |         |         |

krad (Si)