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COLLEGE OF ENGINEERING
DEPARTMENT OF NUCLEAR ENGINEERING

BERKELEY, CALIFORNIA 94720

February 26, 1979

Docket No.: 50-224

Reactor License R-101
Technical Specifications Change #6

Robert W. Reid, Chief
Operating Reactor Branch #4
Division of Operating Reactors
U. S. Nuclear Regulatory Commission
Washington D. C. 20555

Dear Mr. Reid:

We hereby request the following change to our Technical Specifications, Technical Specifications D.6. states:

> "Each fuel element and fuel follower shall be checked for transverse bend and longitudinal elongation after the first 100 pulses of any magnitude and then after the first 500 pulses above 1.5% $\Delta k/k$. If any element distorts to or beyond the maximum limits during the first 500 pulses above 1.5% $\Delta k/k$, inspection of each element shall be made after the next series of 500 pulses above 1.5% $\Delta k/k$. If no element distorts beyond maximum limits after a series of 500 pulses above 1.5% $\Delta k/k$, the number of pulses above 1.5% $\Delta k/k$ between inspections may be increased to 1000. If an element is found to distort beyond maximum limits after a series of 1000 pulses above 1.5% $\Delta k/k$, the next inspection interval shall be reduced to 500 pulses above 1.5% $\Delta k/k$. The maximum interval between inspections of fuel elements shall be no greater than one year. The limit of transverse bend shall be 1/16 inch over the total length of the element. The limit on longitudinal elongation shall be 1/10 inch. The reactor shall not be operated with elements which have been found to exceed these limits. Any element which is exhibiting a clad break as indicated by a measurable release of fission products shall be located and removed from service before continuation of routine operation."

We request Technical Specification D.6. be changed to read:

> "Each fuel element and fuel follower shall be checked for transverse bend and longitudinal elongation after the first 100 pulses of any magnitude and then after the first 500 pulses above 1.5% $\Delta k/k$. If any element distorts to or beyond the maximum limits during the first 500 pulses

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above 1.5% Δk/k, inspection of each element shall be made after the next series of 500 pulses above 1.5% Δk/k. If no element distorts beyond maximum limits after a series of 500 pulses above 1.5% Δk/k, the number of pulses above 1.5% Δk/k between inspections may be increased to 1000. If an element is found to distort beyond maximum limits after a series of 1000 pulses above 1.5% Δk/k, the next inspection interval shall be reduced to 500 pulses above 1.5% Δk/k. The limit of transverse bend shall be 1/16 inch over the total length of the element. The limit on longitudinal elongation shall be 1/10 inch. The reactor shall not be operated with elements which have been found to exceed these limits. Any element which is exhibiting a clad break as indicated by a measurable release of fission products shall be located and removed from service before continuation of routine operation."

Our request for this change is based on the following reasons:

1. The past eleven annual fuel measurement (1966-1977) indicated that the transfer bend and longitudinal elongation of each fuel element were within limits specified in our Technical Specifications.

   Figures 1 to 5 show the results of up to eleven annual measurements made on 17 standard 8.5 wt% stainless steel cladded elements in the B and C ring of the TRIGA III Berkeley Research Reactor core. Each data point (dot) represents a difference measurement - referred to the length measurement made prior to installation of the fuel in the core. The dots, progressing from left to right, represent the difference measurement for each of the up to eleven annual periods (1966-1977). Each fuel element location in the core, and the fuel element ID number are stated at the bottom of each graph. Our best estimate of the sensitivity of the measurement technique is ±0.010 inch. The growth of each element was calculated from its growth curve after a linear-trend analysis (with an arbitrary slope) was performed for all measured differences. Figure 6 shows a typical linear-trend analysis for a fuel-element-growth calculation. Linear-trend analysis of the measurements as function of the average total accumulated energy of approximately 4000 MWh's and average 254 pulses over an average period of 8 years of 17 fuel elements in the B and C ring, shows a growth pattern in the positive direction for 15 out of 17 fuel elements. The B an C ring elements were selected for this analysis because these elements are located in the region of the highest neutron flux. The average growth was found to be 0.008 inches ±0.008 inches, which is approximately similar in magnitude to the sensitivity of the measurement technique itself. The error was calculated by taking 2 rms deviations of the differences between the measured data and

the best straight line. The highest growth is still well below the limit on longitudinal elongation specified in our Technical Specifications of 0.10 inch. The measurement technique to determine bend is a simple go-no-go gauge. In no instance has any fuel element ever failed the go-no-go test. Consequently, we conclude that no element has experienced a transverse bend over the total length of the clad $\geq$1/16 inch.

2. At this time, our prediction is that the future utilization of the reactor will be approximately the same as for the past 2 to 3 years. The pulsing and steady state history of the TRIGA III Berkeley Research Reactor is detailed in Table 1.

Steady State Operations and Pulsing History
of the
TRIGA III Berkeley Research Reactor

Calendar Year	MWH's	Pulses
1966	41	54
1967	419	47
1968	702	57
1969	756	97
1970	723	39
1971	738	13
1972	518	15
1973	503	27
1974	523	22
1975	333	26
1976	185	17
1977	170	33

Table 1

3. We feel that each annual inspection and measurement sequence is now more detrimental than beneficial to the overall safety of the system.

4. The proposed change will not alter any part of our technical specification in connection with the pulsing program.

5. Historically the measurements required for TRIGA type fuel elements were promulgated to detect fuel elements which were nearing cladding failure due to either transverse bending and/or longitudinal elongation. Both such dimensional deviations were the result of a "ratcheting" effect from pulse experiments performed elsewhere on early aluminum-clad TRIGA fuel elements. We are not aware of any known cases of fuel element dimensional change due to only steady-state operation over either a short or long term. The stainless-

steel-clad elements, such as those in the Berkeley Research Reactor, are more stable dimensionally than the aluminum-clad elements in pulsing operation, as demonstrated herein and by experience of GSTR Denver, Colorado, and Penn State University.

The requested change was reviewed by the Reactor Hazards Committee of the Berkeley Research Reactor.

A further revision of the wording of these technical specifications to comply with the new format requested by NRC, will be forthcoming in the near future.

Very truly yours,

T. H. Pigford
Reactor Administrator

THP:irs

Attachments

cc: Chairman Reactor Hazards Committee
Environmental Health & Safety Officer

FUEL ELEMENT ANNUAL MEASUREMENTS

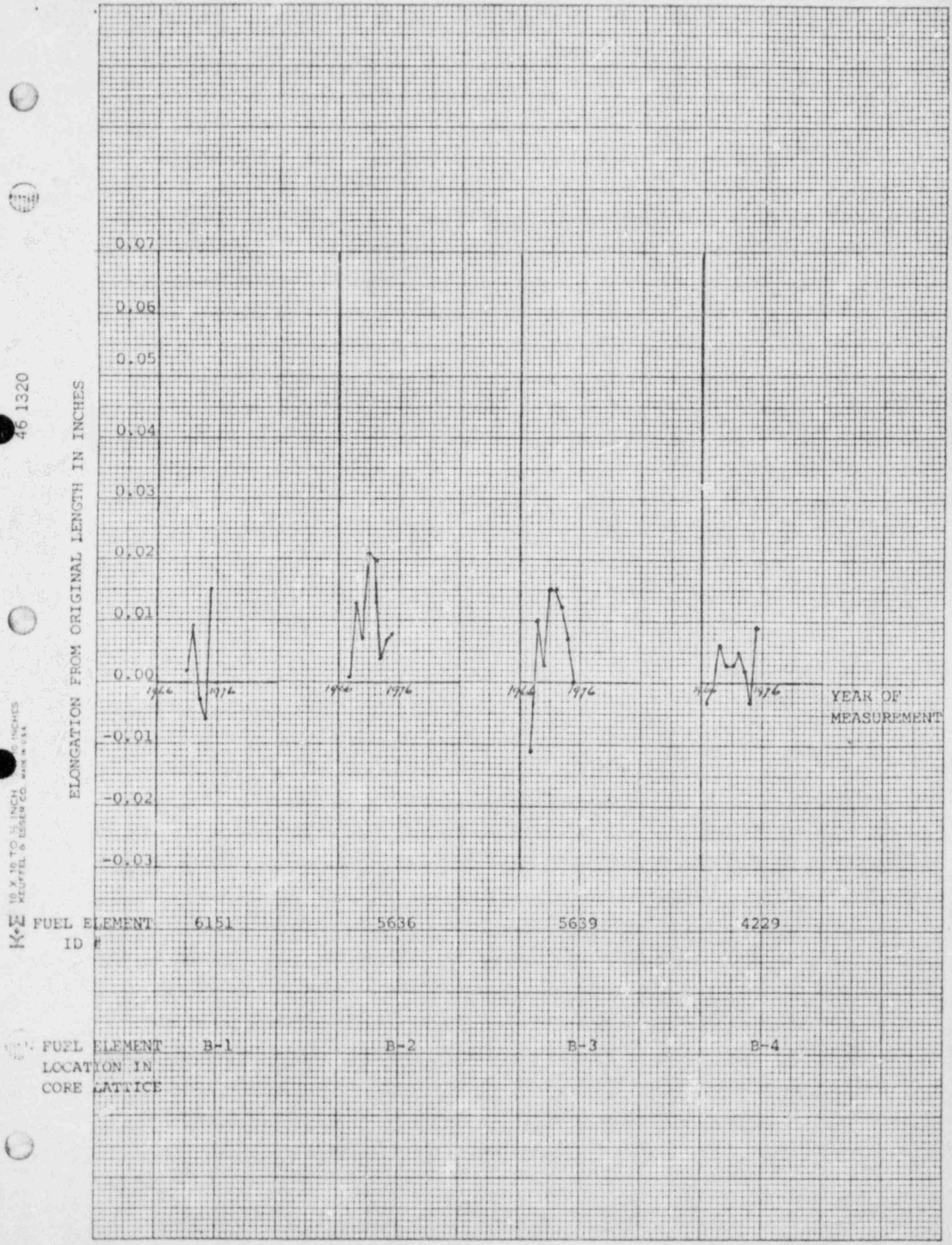


Fig. 1

FUEL ELEMENT ANNUAL MEASUREMENTS

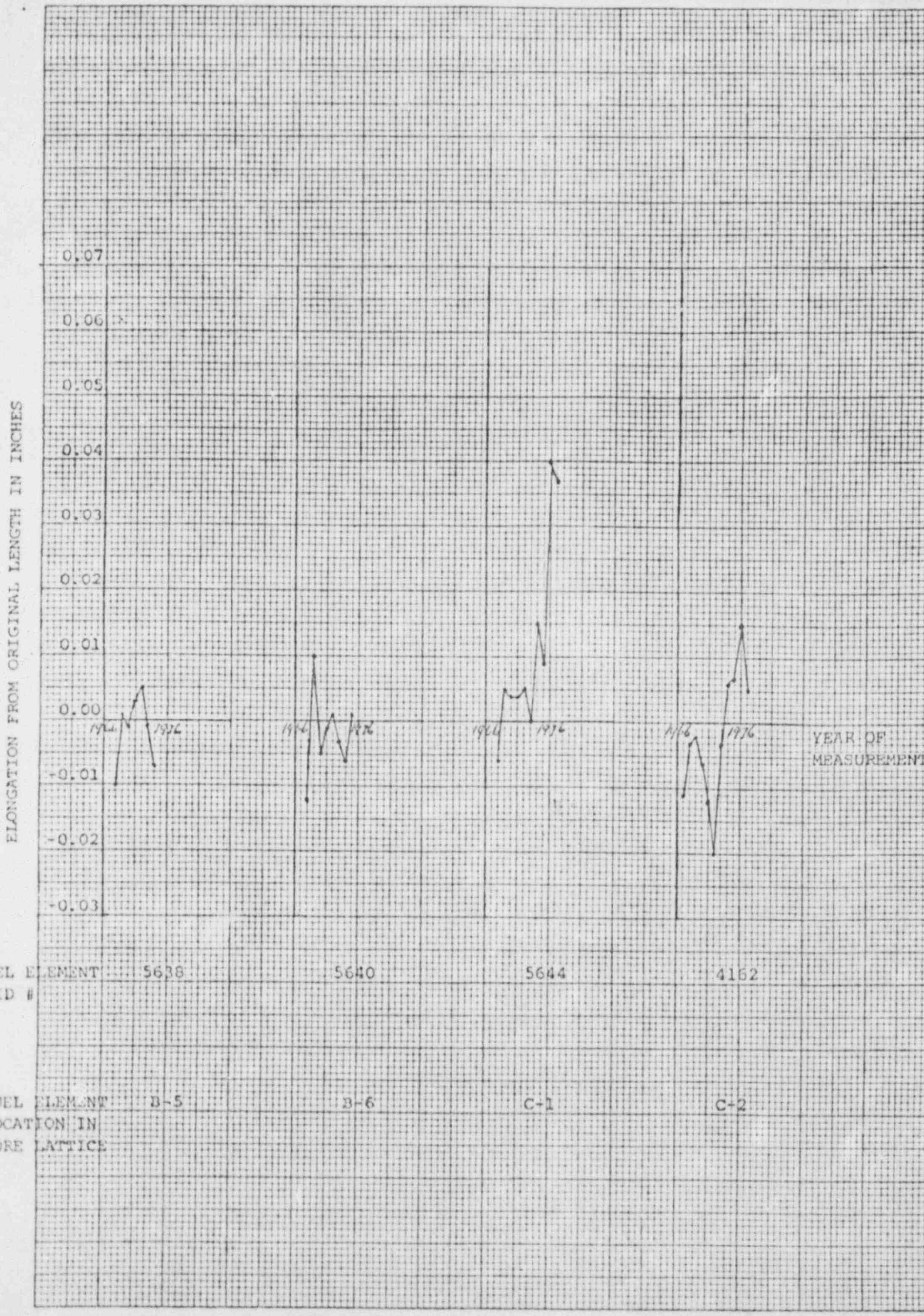


Fig. 2

FUEL ELEMENT ANNUAL MEASUREMENTS

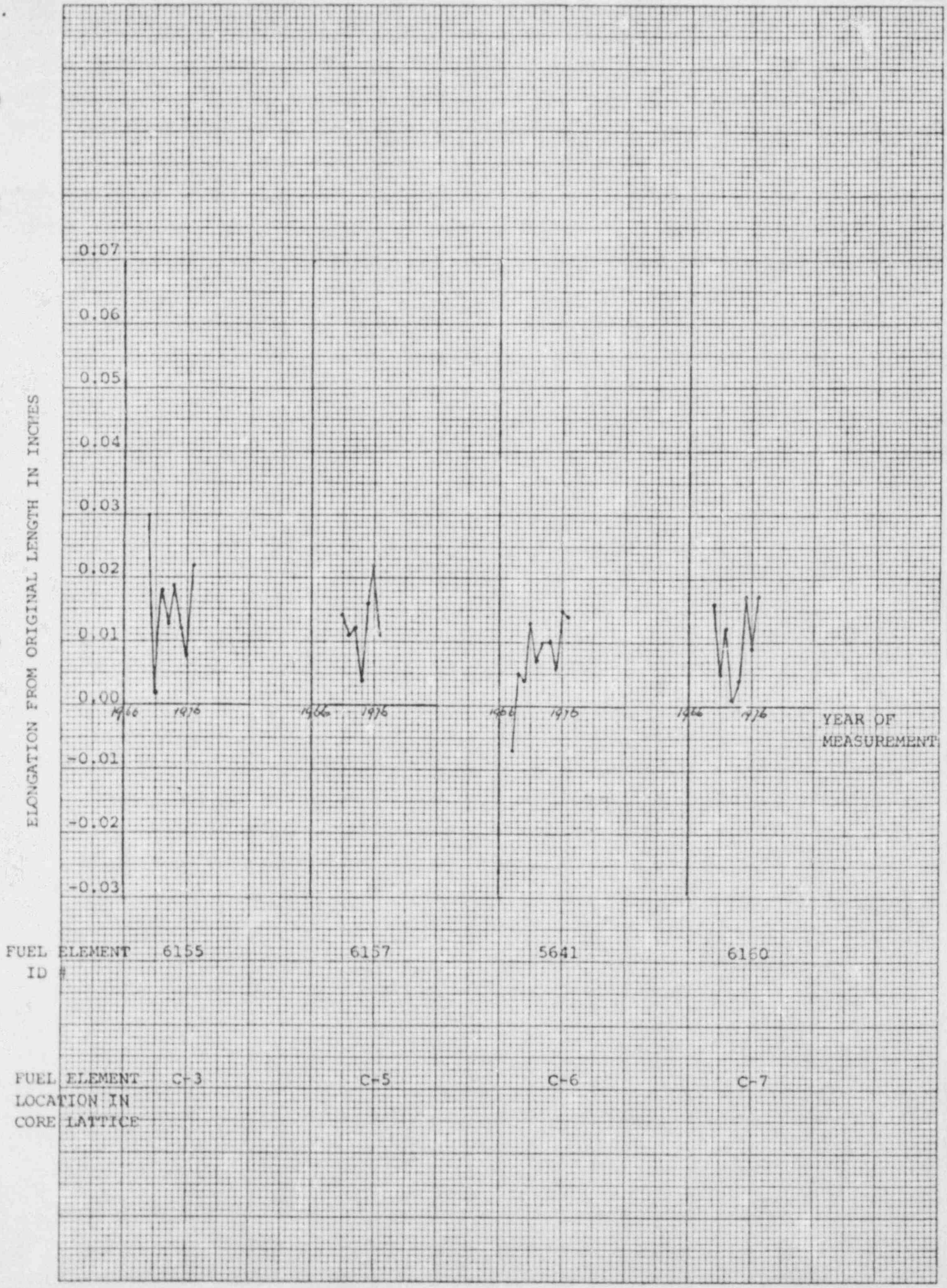


Fig. 3

FUEL ELEMENT ANNUAL MEASUREMENTS

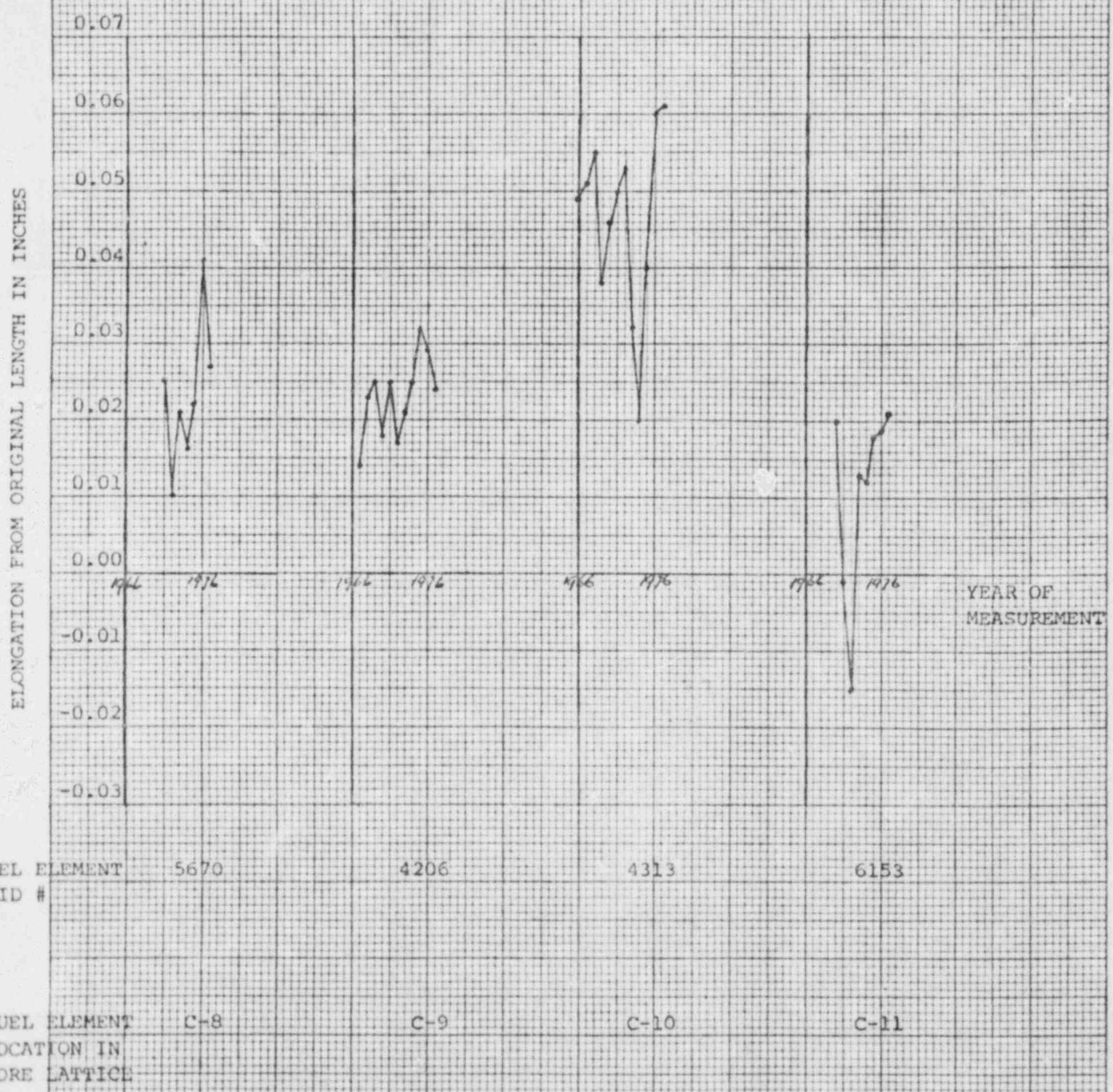
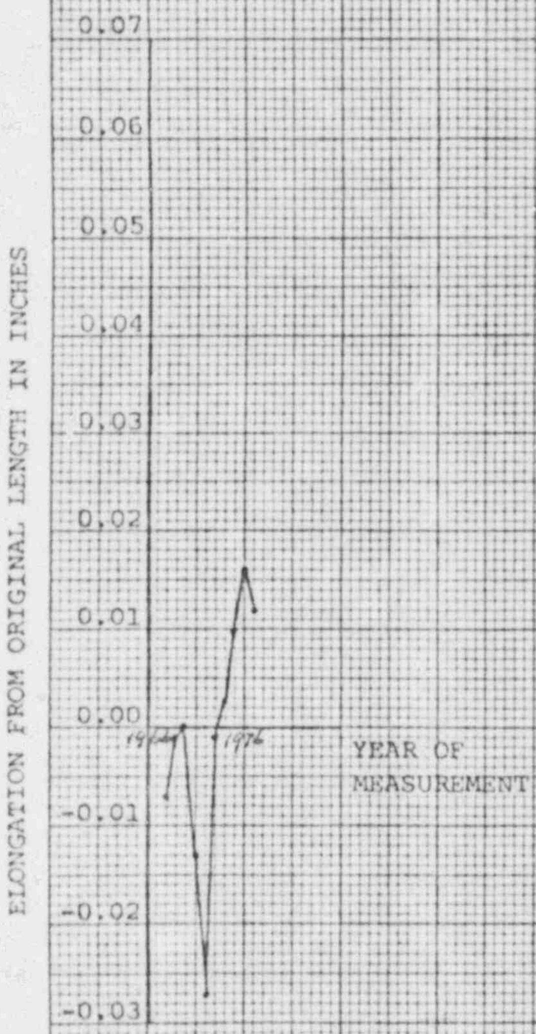


Fig. 4



FUEL ELEMENT ID # 5612

FUEL ELEMENT LOCATION IN CORE LATTICE C-12

Fig. 5

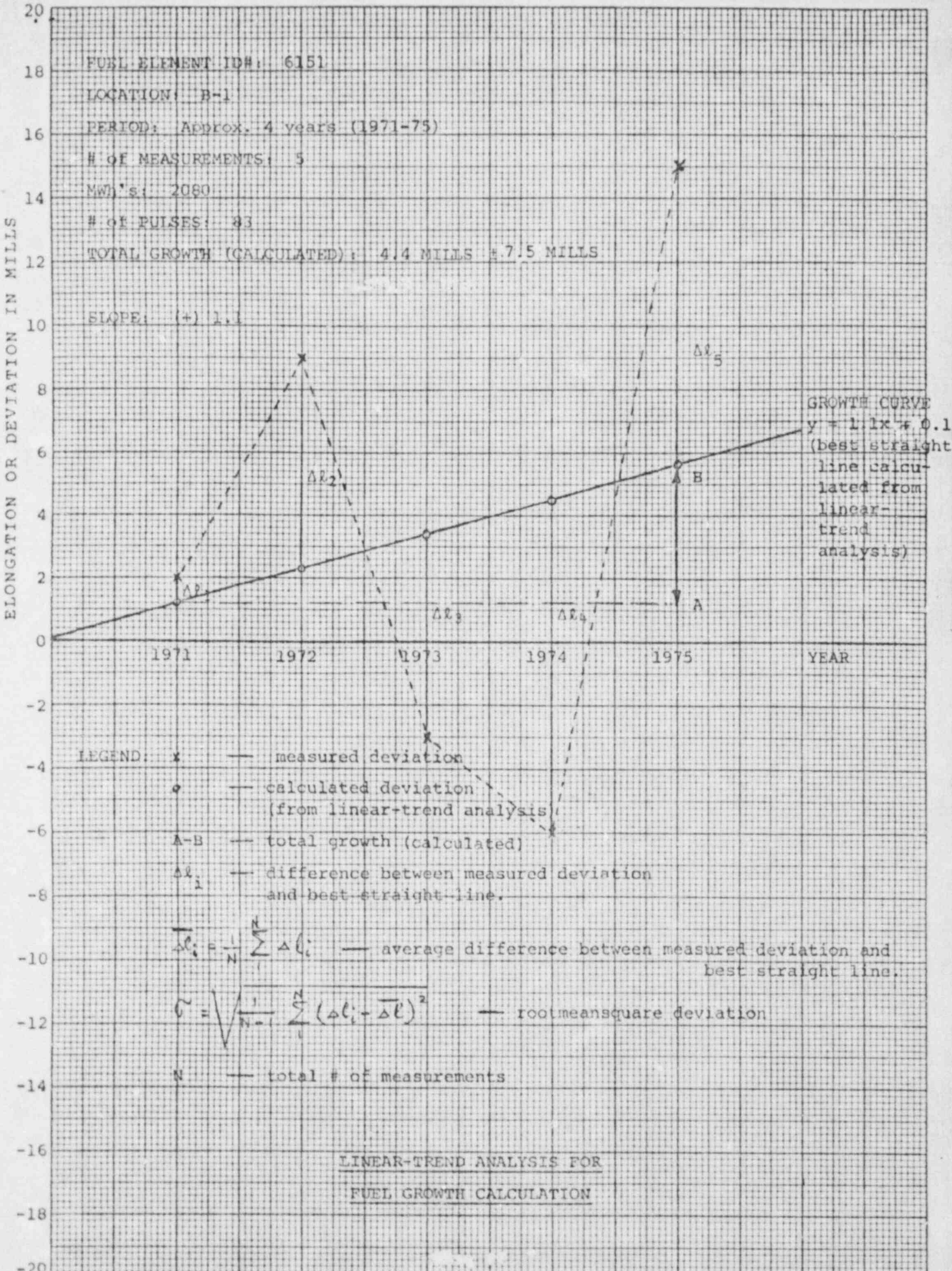

FUEL ELEMENT ID#: 6151
LOCATION: B-1
PERIOD: Approx. 4 years (1971-75)
# of MEASUREMENTS: 5
MWh's: 2080
# of PULSES: 83
TOTAL GROWTH (CALCULATED): 4.4 MILLS ± 7.5 MILLS
SLOPE: (+) 1.1
ELONGATION OR DEVIATION IN MILLS
20
18
16
14
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
1971
1972
1973
1974
1975
YEAR
GROWTH CURVE
y = 1.1x + 0.1
(best straight line calculated from linear-trend analysis)
B
A
LEGEND: x — measured deviation
o — calculated deviation (from linear-trend analysis)
A-B — total growth (calculated)
Δl_i — difference between measured deviation and best-straight-line.
$\overline{\Delta l_i} = \frac{1}{N}\sum_{1}^{N} \Delta l_i$ — average difference between measured deviation and best straight line.
$\sigma = \sqrt{\frac{1}{N-1}\sum_{1}^{N}(\Delta l_i - \overline{\Delta l})^2}$ — rootmeansquare deviation
N — total # of measurements
LINEAR-TREND ANALYSIS FOR
FUEL GROWTH CALCULATION

Fig. 6