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REACTIVITY BALANCE AND ASSOCIATED
REACTOR PHYSICS DATA - NOVEMBER 1964

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CG-NMP-1, 4-29-94

By DK Hanson, 5-18-94

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REACTIVITY BALANCE AND ASSOCIATED REACTOR PHYSICS DATA - NOVEMBER, 1964

Data in this report are significant to Pile Physics calculations and are submitted by the Area Physicists at the respective reactors. Reactivity in non-uranium charges and in radial and spike enrichment is calculated either by one-group diffusion theory as described in HW-60439¹, or by the simpler flux-squared weighting method. The former method provides a more accurate evaluation for larger enrichment inventories; the latter method is sufficient for radial enrichment of less than about 0.25 per cent excess K.

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IRRADIATION PROCESSING DEPARTMENT

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¹HW-60439, "Operational Reactivity Accounting by One-Group," GR Parkos, 6-18-59

DEFINITIONS

The following definitions apply to the corresponding items in the table. The flux-squared weighting method is used in most cases for evaluating reactivity effects.

A. Reactivity Balances

1. Reactivity absorbed by control rods; determined from calibrations curves.
2. Calculated reactivity absorbed by flexible poison columns. This includes the Poison Column Control Facility, Poison Spline System, and Temporary Poison columns.
3. Calculated reactivity absorbed by the Xenon-135 isotope. This number is calculated with the aid of Xenon tables for the respective reactor.
4. Reactivity absorbed by fringe poison. This includes both "grey" and "black" Li-Al now in use for this purpose.
- 5-6-7. Reactivity absorbed by the materials in each category. (Graphite stringers are included as dummies and blanks, B-metal as plant assistance.)
8. Calculated reactivity loss caused by metal heating; the product of the metal power coefficient in per cent excess k/megawatt and the power level in megawatts.
9. Calculated reactivity contributed by graphite heating; the product of the graphite power coefficient in per cent excess k/megawatt and the power level in megawatts.
10. Calculated excess reactivity a reactor would have if the reactor were at inlet water temperature and Xenon-free, rods were withdrawn, and all absorbers were replaced with uranium; the sum of Items 1 through 8 minus Item 9.
11. Calculated change in cold, clean reactivity since last date reported.

B. Reactor Physics Data - The data does not apply to Items 7 and 8.

1.
$$ECT = \frac{\text{Total Reactor Power in Megawatts}}{\text{Average Maximum Tube Power in Megawatts}}$$

where Average Maximum Tube Power = average of the powers of the ten most productive tubes. ECT can be calculated to within ± 30 tubes at the B, D, DR, F and H Reactors, and within ± 50 tubes at the C, KE, and KW Reactors. The given value is the value figured on the date of report. This is not the monthly average value.

2. Effective to nominal flattening ratio = $\frac{R_e}{R_n}$

$$= \frac{\sum (\text{calculated effective reactivities of central zone inactive columns})}{\sum (\text{calculated nominal reactivities of central zone inactive columns})}$$

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3. Reactivity contributed by enriched uranium (E-metal) used for fringe poison compensation.
4. Reactivity contribution of enriched uranium (E-metal) used for reactivity flattening considerations. The evaluation is for enrichment in the hot-operating pile. The cold pile case would yield a somewhat higher evaluation.
 - a. Reactivity in the radial enrichment ring.
 - b. Reactivity in central "spike" enrichment.
5. Reactivity contribution of enriched uranium (E-metal) to compensate for special loadings. (See footnotes at bottom of page 5.)
6. Per cent helium in pile atmosphere.

7. Flux-squared weighted exposure, $\bar{E} = \frac{\sum E_i f_i^2}{\sum f_i^2}$

where N is the total number of active tubes, E_i is the accumulated exposure (in megawatt days per tube) of the i^{th} column, and f_i is the tube factor of the i^{th} column. This weighted exposure is an index of the reactivity contribution of plutonium in the reactor.

- 8-9. Summations of the tube factors for the total number of active tubes, $\sum f^2$ and $\sum f^3$, are used to evaluate the reactivity effects of flattening and enriched columns, fission product poisons, and exposed uranium discharges.
10. Average tube power of the ten most productive tubes.
11. Average tube temperature of the ten most productive tubes.
12. The effective maximum graphite temperature. This is defined as the maximum temperature occurring on a graphite thermocouple, with appropriate corrections to graphite stringer readings. The corrections take into account the differences in heat transfer from graphite relatively near cooling channels (e.g., filler blocks) and the graphite in uncooled process channels (i.e., front-to-rear stringers). "Nonrepresentative" thermocouple readings are excluded from this report; e.g., thermocouples located within one lattice unit of enriched uranium columns, uncooled process channels, or within clearly defined regions of the graphite possessing nonrepresentative heat transfer characteristics such as the 0.130" coring zone at the K reactors.

Current corrections are obtained from a correction factor curve⁽²⁾ generated by the Process Technology Subsection from operating data which were collected from all the IPD reactors.

²HW-80012, Front-To-Rear Stringer Correction, RE Baars, 12-13-63

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FRONT-TO-REAR STRINGER
CORRECTION

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REACTIVITY BALANCE AND

<u>Reactor</u>	<u>100-B</u>		<u>100-C</u>		<u>10</u>
<u>Date</u>	<u>10-21</u>	<u>11-10</u>	<u>10-20</u>	<u>11-22</u>	<u>10-13</u>
<u>A. Reactivity Balance (%Excess k)</u>					
1. Rods	0.88	0.88	0.95	1.05	0.90
2. Supplementary Control	0.40	0.38	0.27	0.45	0.83
3. Xenon	2.64	2.64	2.68	2.70	2.64
4. Fringe Poison	0.17	0.19	0.06	0.05	0.06
5. Special Loadings	1.04 ¹	1.13 ¹	0	0	0.02
6. Plant Assistance	0.11	0.12	0	0	0.02
7. Dummies & Blank Tubes	0.09	0.07	0.08	0.13	0.24
8. Metal Loss	0.51	0.49	0.62	0.66	0.54
9. Graphite Contribution	2.04	2.07	1.85	2.25	2.18
10. Cold Clean Reactivity	3.80	3.83	2.81	2.79	3.07
11. Net Change		+0.03		-0.02	
<u>B. Reactor Physics Data</u>					
1. Effective Central Tubes	1445	1380	1485	1581	1498
2. Effective To Nominal Flattening Ratio	0.52	0.55	0.44	0.45	0.52
3. Enrichment for Fringe Poison Compensation	0.17	0.19	0.06	0.05	0.06
4. Enrichment for Reactivity a) and Flattening	1.36	1.16	1.02	0.99	1.33
b)	0.18	0.18	1.06	0.75	0.80
5. Enrichment for Special Loading Compensation	1.04 ²	1.13 ²	0	0	0
6. Per Cent Helium	55	61	29	31	66
7. Flux-Squared Weighted Exposure	35.6	44.5	31.4	49.4	39.0
8. $I f^2$	2124	2123	2100	2106	2105
9. $I f^3$	2465	2462	2312	2325	2384
10. Avg. Maximum Tube Power	1246	1306	1394	1393	1212
11. Avg. Maximum Tube Outlet Temperature	117.0	118.0	107.3	106.0	116.1
12. Effective Maximum Graphite Temperature	634	642	602	635	621

Footnotes:

¹Depleted uranium charged under PT IP-669-AC and PT IP-694-A at J

²Enrichment to compensate for depleted uranium (1 above).

³Thoria charged under PITA-31 at D and KW Reactors.

⁴Enrichment to compensate for thoria (3 above)

ASSOCIATED REACTOR PHYSICS DATA

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Page 5

O-D	100-KE		100-KW		100-F		100-H		100-DR	
<u>11-29</u>	<u>10-25</u>	<u>11-26</u>	<u>10-27</u>	<u>11-25</u>	<u>10-25</u>	<u>11-17</u>	<u>10-25</u>	<u>11-15</u>	<u>10-15</u>	<u>11-19</u>
<u>0.83</u>	<u>0.65</u>	<u>0.65</u>	<u>0.75</u>	<u>0.94</u>	<u>0.73</u>	<u>0.87</u>	<u>0.74</u>	<u>0.76</u>	<u>0.74</u>	<u>0.81</u>
<u>1.11</u>	<u>0.08</u>	<u>0.21</u>	<u>0.09</u>	<u>0.40</u>	<u>0.33</u>	<u>0.79</u>	<u>0.33</u>	<u>1.30</u>	<u>0.73</u>	<u>0.52</u>
<u>2.64</u>	<u>2.76</u>	<u>2.76</u>	<u>2.52</u>	<u>2.76</u>	<u>2.64</u>	<u>2.66</u>	<u>2.64</u>	<u>2.64</u>	<u>2.62</u>	<u>2.65</u>
<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0.14</u>	<u>0.14</u>	<u>0.34</u>	<u>0.34</u>	<u>0.12</u>	<u>0.18</u>
<u>0.29³</u>	<u>1.12¹</u>	<u>0.99¹</u>	<u>0.15³</u>	<u>0.15³</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>
<u>0</u>	<u>0.13</u>	<u>0.14</u>	<u>0.04</u>	<u>0.04</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0.03</u>	<u>0.03</u>
<u>0.24</u>	<u>0.02</u>	<u>0.02</u>	<u>0.02</u>	<u>0.02</u>	<u>0.08</u>	<u>0.08</u>	<u>0.11</u>	<u>0.11</u>	<u>0.41</u>	<u>0.41</u>
<u>0.51</u>	<u>0.66</u>	<u>0.66</u>	<u>0.61</u>	<u>0.66</u>	<u>0.55</u>	<u>0.57</u>	<u>0.58</u>	<u>0.57</u>	<u>0.46</u>	<u>0.48</u>
<u>2.76</u>	<u>1.81</u>	<u>1.76</u>	<u>1.16</u>	<u>1.87</u>	<u>2.00</u>	<u>2.43</u>	<u>1.57</u>	<u>1.80</u>	<u>2.39</u>	<u>2.66</u>
<u>2.86</u>	<u>3.61</u>	<u>3.67</u>	<u>3.02</u>	<u>3.10</u>	<u>2.47</u>	<u>2.68</u>	<u>3.17</u>	<u>3.92</u>	<u>2.72</u>	<u>2.42</u>
<u>-0.21</u>		<u>+0.01</u>		<u>+0.08</u>		<u>+0.21</u>		<u>+0.75</u>		<u>-0.30</u>
<u>1495</u>	<u>2398</u>	<u>2425</u>	<u>2330</u>	<u>2334</u>	<u>1485</u>	<u>1545</u>	<u>1484</u>	<u>1523</u>	<u>1448</u>	<u>1460</u>
<u>0.52</u>	<u>0.42</u>	<u>0.42</u>	<u>0.40</u>	<u>0.40</u>	<u>0.50</u>	<u>0.50</u>	<u>0.59</u>	<u>0.59</u>	<u>0.56</u>	<u>0.52</u>
<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0.14</u>	<u>0.14</u>	<u>0.34</u>	<u>0.34</u>	<u>0.18</u>	<u>0.18</u>
<u>1.31</u>	<u>1.09</u>	<u>1.00</u>	<u>0.67</u>	<u>0.67</u>	<u>0.78</u>	<u>0.78</u>	<u>1.39</u>	<u>1.39</u>	<u>1.09</u>	<u>1.20</u>
<u>0.64</u>	<u>0.14</u>	<u>0.16</u>	<u>0.50</u>	<u>0.50</u>	<u>0.27</u>	<u>0.27</u>	<u>1.11</u>	<u>1.11</u>	<u>0.19</u>	<u>0.18</u>
<u>0.29⁴</u>	<u>1.12²</u>	<u>0.99²</u>	<u>0.15⁴</u>	<u>0.15⁴</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>
<u>70</u>	<u>62</u>	<u>70</u>	<u>73</u>	<u>81</u>	<u>57</u>	<u>63</u>	<u>60</u>	<u>60</u>	<u>65</u>	<u>69</u>
<u>43.0</u>	<u>45.4</u>	<u>50.4</u>	<u>27.6</u>	<u>72.5</u>	<u>29.3</u>	<u>44.9</u>	<u>29.8</u>	<u>47.3</u>	<u>41.7</u>	<u>48.4</u>
<u>1927</u>	<u>3492</u>	<u>3449</u>	<u>3429</u>	<u>3264</u>	<u>2116</u>	<u>2108</u>	<u>1890</u>	<u>1890</u>	<u>2096</u>	<u>2096</u>
<u>2118</u>	<u>3991</u>	<u>3873</u>	<u>3810</u>	<u>3694</u>	<u>2426</u>	<u>2405</u>	<u>2026</u>	<u>2026</u>	<u>2416</u>	<u>2416</u>
<u>1274</u>	<u>1835</u>	<u>1815</u>	<u>1730</u>	<u>1885</u>	<u>1250</u>	<u>1223</u>	<u>1294</u>	<u>1255</u>	<u>1173</u>	<u>1267</u>
<u>117.2</u>	<u>114.7</u>	<u>109.2</u>	<u>109.6</u>	<u>112.4</u>	<u>119.7</u>	<u>118.5</u>	<u>120.1</u>	<u>114.5</u>	<u>112.5</u>	<u>118.6</u>
<u>628</u>	<u>733</u>	<u>742</u>	<u>698</u>	<u>670</u>	<u>647</u>	<u>644</u>	<u>644</u>	<u>642</u>	<u>644</u>	<u>612</u>

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