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## Revised Calibration for High Pressure Electrical Resistance Cell\*

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IN 1960 a high pressure electrical resistance cell was developed in this laboratory,<sup>1</sup> utilizing the supported taper principle previously applied to an optical apparatus.<sup>2</sup> The calibration of the electrical cell was tenuous as it was based on some poorly located phase transitions at low and moderate pressure plus a gross extrapolation of Bridgman's electrical resistance data for platinum.<sup>3</sup> Since that time a number of transitions have been located more accurately and x-ray diffraction techniques utilizing the tapered piston cell<sup>4</sup> have become available. A new calibration is presented here, based largely on x-ray diffraction work. The piston diameter and internal geometry of the x-ray cell can be made identical to the electrical cell (22 mm diam, 2 mm flat, 18° taper), but the x-ray cell contains a layer of lithium hydride and boron with platinum collimation in addition to pyrophyllite, while the electrical cell contains only pyrophyllite. Nevertheless, this calibration represents a considerable advance over the previous one. Many of the calibration data were taken with Al or Ag powder using the shock data of Rice *et al.*<sup>5</sup> interpolated to room temperature.<sup>6</sup> The 111, 200, 220, and 311 lines were utilized. Above 250-300 kilobars the dishing of the pistons made it impossible to obtain the 220 and 311 lines clearly. Above 400 kilobars only a few

points were obtained for the 111 line. Data were also obtained for NaCl to over 200 kilobars. Applying Decker's calculated  $p$ - $v$  values for NaCl,<sup>7</sup> we checked the Al and Ag data closely. MgO<sup>8</sup> also gave consistent results to 300

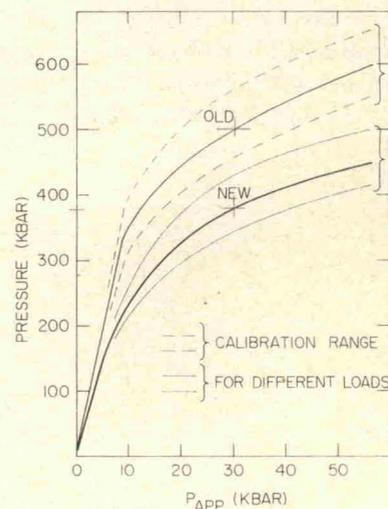


FIG. 1. Old and new calibrations for high pressure electrical resistance cell. Typical values.

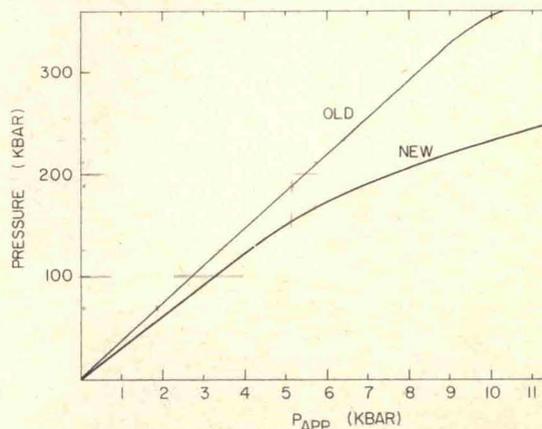


FIG. 2. Calibration for low pressure region. Typical values.

TABLE I. Electrical cell calibration. Pressure vs applied pressure. (Related to pressure necessary for 100 kilobars.)

| Pressure     | $P_{APP}/P_{100}$ kilobars |
|--------------|----------------------------|
| 100 kilobars | 1.00                       |
| 130          | 1.32                       |
| 150          | 1.60                       |
| 200          | 2.50                       |
| 250          | 3.80                       |
| 300          | 5.60                       |
| 350          | 8.20                       |
| 400          | 12.00                      |
| 450          | 16.70                      |
| 500          | 24.00                      |

TABLE II. Approximate location of transitions.

|                        | Old     | New     |
|------------------------|---------|---------|
| Bi                     | 88      | 73-75   |
| Fe                     | 133     | 110-115 |
| Ba                     | 144     | 118-122 |
| Eu                     | 150-160 | 122-130 |
| Pb                     | 160     | 128-132 |
| Rb                     | 190     | 142-153 |
| Cs <sup>a</sup> (max)  | 170-180 | 133-142 |
| Ca <sup>a</sup> (max)  | 350-375 | 235-255 |
| Rb <sup>a</sup> (max)  | 420-435 | 290-320 |
| CdS <sup>a</sup> (max) | 460     | 320-340 |
| ZnS <sup>a</sup> (max) | 550     | 410-420 |

<sup>a</sup> Maximum in resistance-pressure curve.

kilobars. The calibration is established as follows: The pressure is a linear function of applied force to 100 kilobars (and substantially linear to 130 kilobars). For higher pressures the change of pressure (from 100 kilobars) vs fractional change in applied pressure is shown in Table I. This was obtained by taking the fractional change in pressure with the fractional change in applied force from the x-ray data to 400 kilobars and extrapolating primarily by assuming the relative pressure is a linear function of the logarithm of the relative applied force at pressures above 400 kilobars. (This condition holds quite well in the range 300-400 kilobars.) Typical curves for the old

and new calibration appear in Fig. 1, and the low pressure region is expanded in Fig. 2. The absolute values vary from bar to bar of pyrophyllite, and with the machining and loading technique of the operator. Ranges are indicated in Fig. 1. From a single 15 cm bar of pyrophyllite sufficient pellets can be made for half a dozen low pressure calibrations and high pressure runs.

In Table II appear the old and new pressures obtained from typical calibration curves for a number of transitions. These are not presented as standards. It is of interest to note that the transitions in the low pressure region generally agree reasonably well with recent values obtained in other laboratories.

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