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A LOAD-CELL-BASED WEIGHING SYSTEM FOR WEIGHING 9.1- AND 12.7-TONNE UF₆ CYLINDERS

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For the independent verification of UF₆ cylinder masses by the International Atomic Energy Agency (IAEA) at uranium enrichment facilities, an 18-tonne capacity Load-Cell-Based Weighing System (LCBWS) has been developed. The system was developed at Brookhaven National Laboratory and the Oak Ridge Gaseous Diffusion Plant and calibrated at the U.S. National Bureau of Standards. The principal components of the LCBWS are two load cells, with readout and ancillary equipment, and a lifting fixture that couples the load cells to a cylinder. Initial experience with the system demonstrates that it has the advantages of transportability, ease of application, stability, and an attainable accuracy of 2 kg or better for a full cylinder.

*Research carried out under the auspices of the U.S. Department of Energy, Contract No. DE-AC02-76CH00016 (at BNL) and No. DE-AC0584 OR-21400 (at ORGDP)

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A LOAD-CELL-BASED WEIGHING SYSTEM FOR WEIGHING
9.1- AND 12.7-TONNE UF₆ CYLINDERS

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SUMMARY

In order to apply International Atomic Energy Agency (IAEA) safeguards to low enriched uranium in enrichment and fuel fabrication plants, it is necessary to have independent means of verifying the weights of UF₆ cylinders. In order to satisfy this need, several load-cell-based weighing systems have been developed with the capability of weighing a 30-in. UF₆ cylinder.⁽¹⁻³⁾ These systems have a capacity of 4.5 tonnes and have been demonstrated to have an accuracy of 1 kg at full capacity. Their portability, ease of assembly and use, accuracy, and stability afford advantages for their use in a wide variety of weighing operations.

In order to provide for the verification of the masses of large-capacity UF₆ cylinders by the IAEA at uranium enrichment facilities, a new, 18-tonne-capacity load-cell-based weighing system (LCBWS) has been developed.⁽⁴⁾ The system was developed at Brookhaven National Laboratory and the Oak Ridge Gaseous Diffusion Plant (ORGP) and calibrated at the U.S. National Bureau of Standards (NBS). Its principal components are two 9-tonne-capacity load cells with associated readout and ancillary equipment and a lifting fixture that couples the load cells to a UF₆ cylinder. The lifting fixture was designed for use with the double-hook overhead bridge cranes installed at the Portsmouth Gas Centrifuge Enrichment Plant feed and withdrawal building. The system is illustrated in Figure 1.

In a weighing operation, each of the load cells is suspended from a crane hook, and the lifting fixture and cylinder are suspended in turn by the two load cells. The change in resistance of each load cell, proportional to the force exerted on it, is sensed by a transducer indicator which provides a digital readout closely proportional to the applied force. The load cells and transducer were calibrated together previously

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directly in units of force, and the temperature dependence of the response determined. The stability of the system is verified independently by a standardizer which simulates the response of the load cell. Small corrections for temperature and system drift are applied to the load-cell indicator values to obtain the applied force for each load cell from the NBS calibration, and the sum of the two forces, with appropriate corrections for the local acceleration due to gravity and air buoyancy, provides a mass value to be compared with the mass determined by the facility scales.

In an initial evaluation program at the ORGDP, the performance of the system has been tested in a repetitive series of weighings of 9.1- and 12.7-tonne UF₆ cylinders and of one 9.1-tonne replica mass standard. The results of these measurements are compared with the facility mass values in Table I. An analysis of the results, combined with the known uncertainties in facility mass values, indicates an average bias of 0.1 kg between the two sets of measurements and an overall accuracy of 2 kg or better for the LCBWS, which is quite sufficient for its intended use in verifying declared facility masses of UF₆ cylinders.

The system, although considerably more massive than the earlier 4.5-tonne systems, is readily transportable and straightforward in its application, with the weighing of a cylinder requiring, typically, about 15 minutes. The relative ease of operation, stability, and accuracy of the large LCBWS suggest that it may constitute a useful alternative, in favorable circumstances, to existing facility weighing systems.

References

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We do not prefer a poster session.

Topical area: International Safeguards--Authentication Techniques; Equipment

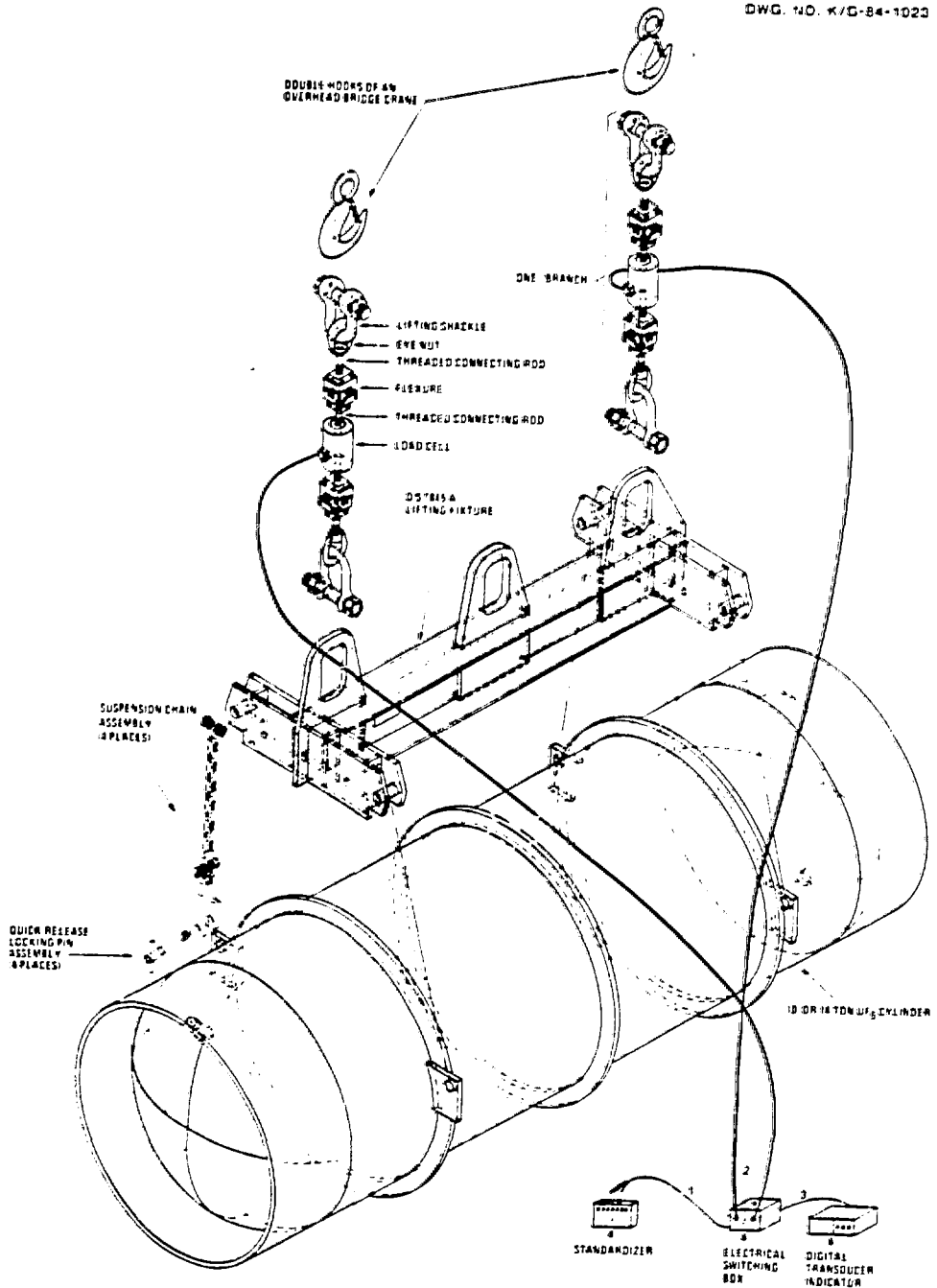


Fig. 1. The 18 Metric-Ton-Capacity Load-Cell-Based Weighing System Prototype.

Table I
Results of Load-Cell-Based Weighing System Test

Cylinder Number	Facility Mass Value M_0 (kg)	Load Cell Measurement M_L (kg)	$M_0 - M_L$ (kg)	$(M_0 - M_L)$ Bias (kg)	$\sigma(\text{Bias})$ (kg)
<u>9.1 Tonne</u>					
Replica Mass Standard	11,748	11,750.9	-2.9	-0.42	1.13
		11,747.9	0.1		
		11,749.3	-1.3		
		11,745.6	2.4		
KM401	11,506.7	11,503.1	3.6		
		11,503.6	3.1		
KM1867	11,532.6	11,529.2	3.4		
		11,529.5	3.1		
KM1663	11,521.3	11,518.7	2.6	2.43	0.70
		11,516.3	5.0		
KM1516	11,446.4	11,443.6	2.8		
		11,442.7	3.7		
KM409	11,539.9	11,540.6	-0.7		
		11,542.2	-2.3		
<u>12.7 Tonne</u>					
UK1122	14,836.6	14,834.2	2.4		
		14,833.5	3.1		
UK1207	14,494.1	14,497.1	-3.0		
		14,495.1	-1.0		
UK1233	14,560.3	14,564.1	-3.8	0.93	0.85
		14,560.0	0.3		
UK1237	14,534.5	14,530.9	3.6		
		14,527.8	6.7		
UK1239	14,507.3	14,507.7	-0.4		
		14,507.8	-0.5		
UK1232	14,843.8	14,842.1	1.7		
		14,841.7	2.1		

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