Figure 8. SCIAM Density Meter savings compared to a nuclear device.

A further survey applicable to the installation at the DuPont Maxville Mine is provided in Table 2. In this survey the annual cost due to inaccuracy in Figure 8 is modified to account for the cost comparison between a 400mm (16") nuclear and SCIAM Density meter on concentrated zirconium slurry. The realizable savings are based on the accuracy of the SCIAM Density Meter given in Table 1.

Table 2. Cost savings using a single 400mm (16") SCIAM Density Meter.

Average cost of mining zirconium slurry (Reference Roskill)	$1.05 per ton
Average mined per day	75000 tons per day
Average mining rate per 350 day year 75000 x 350	26,250,000 tons
Cost per year	$27,562,500
Nuclear density meter typical overall accuracy	2%
Cost of Ambiguity	$551,250 per year
SCIAM Density Meter typical overall accuracy	0.285%
Cost of Ambiguity	$78,553 per year
Savings Realized By SCIAM Density Meter	$472,700 per year
+ Running and Purchase Costs Of Nuclear Device	$411,000 per year
TOTAL SAVINGS	$883,700 per year

MASS FLOW MEASUREMENT IGNORING ENTRAINED GAS

Density meters are often used in pipelines in series with a magnetic flow meter for mass flow measurement. These flow meters operate on the principle of Faraday's Law, where a conductor passing through an electromagnetic field generates a Voltage proportional to the velocity of the conductor. The slurry is the conductor. The physics of Faraday's Law assures that the generated Voltage is unaffected by variation in media density, and as such volumetric flow is measured. When the magnetic flow meter electrical output is multiplied by a linear density meter electrical output, an output is provided proportional to the mass flow of the media. Wet or dry mass flow is a fundamental requirement of the mining industry. Should dry mass mined be the parameter upon which payment for work done is based, the system may be scaled in terms of dry totalized and dry rate of mass flow of the media, with density being expressed in % dry solids. Such parameters may all be computed knowing the carrier liquid and solids density constants of the media. The SCIAM Density Meter is well adapted for such a system, as shown in Figure 9.

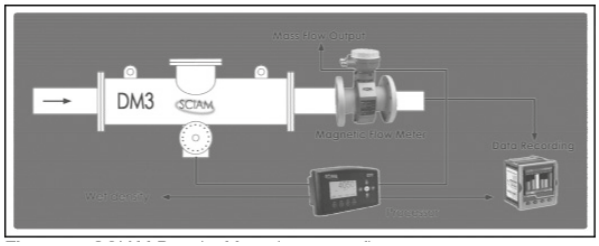

Figure 9. SCIAM Density Meter in a mass flow system.

The choice of the magnetic flow meter is normally recommended on the basis of their having a relatively high magnetizing current, preferably in the Amps regime, with a relatively high exciter frequency, typically > 20 Hz. This ensures a high signal to noise ratio and accuracy < ± 0.5% of reading when used with a typical 'noisy' mining slurry. Any small amount of gas entrainment does not significantly affect signal noise of such recommended magnetic flow meters. However, consideration should be given to the amount of entrained gas in the media flowing through a magnetic flow meter. It is calibrated in the full condition and will give a positive error directly proportional to the % entrained gas, as well as any error due to a noisy signal.

The measurement of concentrated zirconium slurry in a 400mm (16") pipe at the DuPont Maxville Mine is photographed in Figure 10. The mass flow system is scaled in dry mass flow totals and mass rate of flow, with % dry solids measured by the SCIAM Density Meter (reference: DuPont). The magnetic flow meter is installed downstream of the SCIAM Density Meter, which provides the straight length of pipe necessary for the flow meter. Zirconium concentrate has particularly abrasive particles. With a normal velocity around 3 m/s (10 fps), already many millions of tons have successfully passed through the SCIAM Density Meter. Since replacing a nuclear density meter, the benefits are improved mass flow accuracy, reliability and significantly reduced maintenance burden.

Figure 10. Mass flow installation at DuPont's Maxville Mine, Florida.

MASS FLOW MEASUREMENT WITH ENTRAINED GAS COMPENSATION

A unique mass flow application for SCIAM Density Meters is in the mass flow measurement of slurry with entrained gas. The SCIAM Density Meter measures mass directly. Unlike inferential density meters, the signal quality of the SCIAM Density Meter is unaffected by entrained gas, or even if the Flow Tube is partially full. Regardless of these conditions, the reference volume in a SCIAM Density Meter has been defined by calibration and only continuous mass requires measurement to determine density.